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The Love and Life of Fiddler Crabs

BY

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(*With six plates*)

Back in 1953 I met the first fiddlers of my life on a muddy stretch of beach some 15 miles from Bombay. These swift-footed and keen-sighted crabs (genus *Uca*) inhabit the mud banks and sand shores, sometimes by the thousand—as seen from a distance. But as soon as I tried to approach their living quarters the flat seemed completely deserted. Walking across a fiddlers' mud flat is like wading through some miraculous lake with the waves receding before one's feet: in front, the waves of hundreds of fiddlers vanish with the crabs dashing underground into their burrows, only to emerge again in the wake of the person causing the general alarm. Thus, in spite of patience and tele-lenses I did not get any satisfactory shots of live fiddlers that year (R. Altevogt 1955 a, b) and was comforted only by the thought that even in the 'professional' literature there were hardly any.

But in 1955 I was back in India. This time it was only fiddlers, and my wife was with me to assist in observation and perseverance. We were settled to spend a full Indian summer on nothing but crabs on the beach. Much was to be done as there were quite a number of blank spots on the behaviour chart of tropical crabs in general and of fiddlers in particular. There were open questions with regard to the feeding technique of these mud-eaters; the 'meaning' and function of the waving movements of the crabs' big claws was still an argument among some zoologists; and nobody had so far seen any copulation in the Indian species, the total number of fiddler copulations seen in

the field amounting to a meagre five witnessed some years ago in the Americas by Miss J. Crane (1941-1944).

There we sat on the sunbaked beach and waited for the turn of the tide and for the fiddlers to come out of their holes in which, guided by some miraculous rhythm, they know how to spend the high water period. And no sooner had the water left the mud flat than the first fiddler peeped out of his, or rather her, hole, for she was a female. Somewhat dazed by the glaring brightness after the dark six hours underground, she made an easy victim for a forced portrait on my wife's thumb. Watching her running along in the field she seemed a terrifyingly small object for the camera's eye though she was of quite an average fiddler's size. The largest Indian species (*Uca marionis*) is at best about 32 mm. broad at the 'shoulders' (i.e. front of carapace) and, because of their extreme shyness, photographing fiddlers in the field is about as difficult as camera-stalking the domestic fly in the laboratory (though the latter activity definitely affords less perspiration). Gradually the flat became covered with fiddlers, all feeding eagerly. The females with their small claws of equal size used them alternately in picking up 'handfuls' of mud while the males could only eat with one hand, one of their claws being grossly enlarged to serve less 'primitive' functions than eating. Weeks later we had found out about the mechanism used in separating the edible contents from the inedible material of the soil. Highly specialized mouth parts with hundreds of 'spoons' on tiny hairs strain out the particulate matter from the mud in a process comparable to the flotation procedure of the gold washer with bowl and sieve. The coarse particles of the soil are rejected from the mouthparts and deposited in the form of pellets besides the advancing crab. Typical patterns are thus formed on the ground which have also been found in fossil deposits and were mistaken for extinct starfishes and crinoids.

With the feeding activity ceasing, the fiddlers entered the second phase of their daily routine, that of waving, fighting and copulating. 'Waving' denotes a typical movement which gave the fiddlers their popular name and which has been referred to as 'beckoning'. The type of waving differs with the species. In the Indian *Uca marionis* it is a relatively simple affair: the animal rises on tiptoes, and at the same time the major cheliped moves upwards and outwards. According to motion picture analysis this takes from $\frac{3}{4}$ up to several seconds. Then follows a very precise-looking and constant downward and inward movement of the claw during which the body is lowered again to its normal position touching the ground. After at least $\frac{3}{4}$ of a second the next waving movement is commenced, and

Fig. 1. Typical habitat of fiddler crabs.
Sympatric population of *Uca annulipes* and *Uca triangularis*. (After R. Altevogt 1957b)

Fig. 2. Fiddlers migrating to new habitats (see text)

Photos : R. Altevogt

Fig. 3. Female (left) and male *Uca marionis* feeding mud. Scale 1 cm.

Fig. 4. Traces of mud-feeding fiddlers : rejected mud balls in linear patterns radiating from crab's hole. Scale 10 cm.

Photos : R. Altevogt

so the crab goes on and on, often for hours. In another smaller Indian species, *Uca annulipes*, waving is quite different and shows a wide outward flexion of the cheliped to an extremely lateral position and then a rapid inward and downward movement. Travellers in the tropics have time and again been fascinated by the attractive spectacle offered by a densely crowded population of waving fiddlers, and there has been much arguing about the meaning and function of this remarkable feature.

We thought of all this while sharp shells gradually made their way through the mud to our naked feet, and the field glasses before our eyes became wet with perspiration. Six hours of low tide on a steamingly hot muddy or sandy beach is quite a long time when you have to sit absolutely motionless on some barnacle-fringed stone with your feet in an oozy mud of some 105 degrees F. and yet, what an exciting experience was provided by each ebb tide session out on the beach through all the months. The slightest motion on the part of the observer sends the fiddlers scuttling down their holes. Thus, it was exasperating, when Leica and movie tele-lenses had been carefully focussed on a spot where we confidently expected a fiddler's copulation or some ardent fight between two rival males to take place or a nuptial couple to indulge in love affairs, to find this happening in an adjacent spot just out of the camera's range and focus!

Finally, however, we learned how to 'handle' the fiddlers, and were able to make a full movie (R. Altevogt 1957 a) on their life and love. Almost every scene had to be taken with reasonable teles, and the quick movements of the tiny animals rapidly changing their distance from the cameras made sharpness of definition and focal depth quite a problem.

I would not say that in the long run the fiddlers of Bombay, Madras, and Rameshwaram fed right from our hands, but feed them with sweets we did, offering paper rolls soaked with sugar solution. Remarkably enough the little gourmets very readily found out the genuine sugar 'candies' from the array of paper rolls presented them soaked with solutions ranging from bitter quinine and salts to artifical sweetners like saccharine and dulcine. The fiddlers' ability to distinguish genuine sugars from artificial sweet substances in choice tests is shared, for instance, by the honey-bee (but not by the domestic chicken). If offered food which was different from the usual mud diet, our fiddlers would always prefer the former. This fact suggests that it may be out of selectional and ecological competition and necessity that fiddlers were forced to take to their

difficult and time-consuming technique of mud-feeding a long time ago in the course of evolution.

The love affairs of fiddlers are highly intricate. In order to shadow the individuals and to trace their ways through the crowds of fellow fiddlers we painted several dozens of them with bright colours using my wife's nail polish as the base to make the colours last through the high and low tides for several days. We thus found out that individual crabs left their living place, supposed to be their 'territory', all of a sudden and without any apparent reason, moving away as far as 66 m. from their first hole within the period of four hours. There were many others travelling 30-40 m. within the same period. Sometimes groups of 20-25 fiddlers, male and female, would gather, form a 'goose line', and leave their native quarter to migrate to a new habitat which did not differ a bit with regard to its ecological data—pH, moisture, temperature, salinity, and so forth. Such a striking behaviour sometimes reminded us of the routine migrations of 'army crabs' on the shores of south-east Asia and Australia. Apparently, however, one must group such spontaneous mass migrations under the heading of 'sport' as there is no apparent reason for the animals to indulge in this kind of 'wanderlust'. Sporting in fiddlers is also seen when a couple, or two or three Ucas run closely together and seem to really enjoy it. As such sprinting couples are sometimes males only, sometimes females only, and sometimes mixed, the activity seems to have no sexual significance, and one cannot but call it 'sport'. There is another kind of sport in some American fiddler species: sometimes funnels or igloo-like superstructures are erected over the entrance of the holes (fig. 7, showing such structures in the closely related Indian *Dotilla blanfordi*, another crab of the fiddler family), and repeatedly fiddlers have been seen to deliberately tear down the neighbour's igloo. Others seal the entrance of the neighbour's hole by plugging it with mud balls. Thus, quite a number of almost human 'nasty' traits of behaviour can be seen on a fiddlers' beach.

Almost human, too, are the females' reactions to the males' often frantic waving efforts. In *Uca marionis*, the largest Indian species, this is not nearly so pronounced as in the smaller *Uca annulipes* or *Uca triangularis*. In the former, the males, becoming pale white with excitement, chase the females often over a considerable distance always waving their claw until they finally get hold of the female and mount her for copulation. Surprisingly enough, this had not been observed so far by former authors reporting on *Uca marionis*, and this lack of information was apparently one of the reasons for the assumption that waving in fiddlers was a means of demarcating

Fig. 5. Male *Uca annulipes* feeding sugar-soaked paper rolls in choice test. Scale 10 cm.

Fig. 6. Male fiddler crab (*Uca marionis*). Note big waving and small feeding claw. Stalked eyes can be folded down sideways. Scale 1 cm.

Photos : R. Altevogt

Fig. 7. "Igloos" of the Indian crab *Dotilla blanfordi*, a relative of *Uca*. Each igloo contains one crab. Scale 10 cm.

Fig. 8. Top display of male *Uca annulipes*. Note wide lateral flexion of big claw which has totally bleached. Scale 1 cm. (After R. Altevogt 1957b)

Photos : R. Altevogt

permanent living and feeding 'territories'. It became quite clear to us, however, that waving is definitely a means of courting and attracting the opposite sex. This was especially obvious in *Uca annulipes*. The males of this small species would wave their cherry-red to white claw frantically as soon as a female, inconspicuously brown and almost hidden by her superb camouflage, approached the love-hungry creatures. Sexual excitement tends to bleach claws, legs, and carapace in this species also, and at the height of the display a male sports a dazzlingly white claw which he waves at top speed once every quarter second (in the larger *Uca marionis* the maximum frequency of waving is about one per second). If a nuptial female responds to the male's ardent love efforts she approaches him, and he—after a final beckoning movement with a deep bow on his knees—goes down into his hole, and she follows him into that subterranean chambre d'amour where copulation is accomplished. In several hundreds of female responses we have only twice seen that a male did not stick to the codes of the tribe forbidding the rape of the female and the copulation above ground by force. We could photograph one of these extremely rare occurrences of copulation above ground in *Uca annulipes,* in spite of the very bad light in the early morning.

From all our experiences it became clear that waving, courting, and copulating were intimately connected with each other. Sometimes the males' drives and activities were so vigorous that, for a moment, even males were mistaken for females and intense display wavings were aimed at them until they showed their big claw identifying them as males themselves.

The fights turned out to be well-regulated, too. When two opponents met each other, their big claws were opened in threat, and then inserted so that a push and pull game resulted, until finally one gave way and moved off. Never have we been able to observe a deadly hit in these often gruesome-looking fights. Often the urge for a fight was so strong that a peacefully feeding male was approached from distances of 1-2 meters and challenged to a fight which was usually accepted. This active spoiling for a fight suggests that fighting in fiddlers is also a means of stimulation, as it is in a number of other animal species, e.g. birds.

A real thriller was our discovery that lovesick fiddlers will fight their own image in a mirror. This is so surprising because in the realm of invertebrates a clear reaction to the own mirror image has so far been found only in the octopus. But the octopus has eyes functionally and anatomically resembling the human type whereas fiddlers, being typical arthropods, possess compound eyes of the

insect type which seemed not too well suited for the perception of patterns. Mirrors placed in the field of nuptial fiddlers evoked ardent fights against the fictitious opponent who seemed somewhat 'irregular' as he would not (and obviously could not) insert his claw for the typical push-pull fight. Sometimes two males were engaged in this type of shadow-boxing in front of one mirror. Often these fights came to an end when the puncher finally got hold of the mirror's edge, apparently 'thinking' that after all the opponent had inserted his claw for the push-pull. In such cases usually the mirror was uprooted from its place in the mud, and neatly turned 'on its back'. One could well understand the little fighter congratulating himself upon his victory!

Thus it seemed that, with fighting for fun and stimulation and with plenty of opportunities for courting, the fiddlers were having a nice time while out on the beach. There were some enemies, however, trying to catch fiddlers and other semi-terrestrial and aquatic crabs. Most cunning of the enemies from the animal world—for, as we shall see, man is also a persecutor of fiddlers—is the Indian House Crow, *Corvus splendens*, so common on the beach and yet so difficult to photograph because of its clever alertness. Next come the Paddybird, *Ardeola grayii*, a small heron with a dull brown and white plumage, and the Whimbrel, *Numenius phaeopus*. The last is a specialist in catching fiddlers. With his long curved beak this bird probes into the fiddlers' holes and pulls the inhabitants out by their big claw. Even when the crab autotomizes this limb the bird is not bluffed or distracted by the manœuvre. He calmly drops the claw from his bill and seizes the escaping victim. Several smaller mammals of the cat relationship (e.g. civet cats, mongooses) and the jackal are also known not to despise shore crabs. Finally, man himself often goes out 'crabbing', even as a non-zoologist. In Europe, where southernmost Spain is the only known habitat of fiddlers—*Uca tangeri* lives there, a species which vanished from Tangiers long ago—man is a grave enemy of these crabs. Up to modern times the big claw of *Uca tangeri* was an important accessory in the typical costume of the local Señoritas—the ladies wore them as a sort of necklace on their blouses. But the Señores in southern Spain, where we went on a crabbing tour in 1956 and 1957, seem to be not any friendlier to the fiddlers, as they eat the claws cooked and soaked in wine. Significantly enough we were not able to find any really full-grown fiddlers on the sandy mud shores of the Guadalquivir River. Only small to medium-sized males were met with, whereas the size of the females was definitely larger. This does not go with general zoology, since in crabs the males are usually larger than the females. And the Spanish

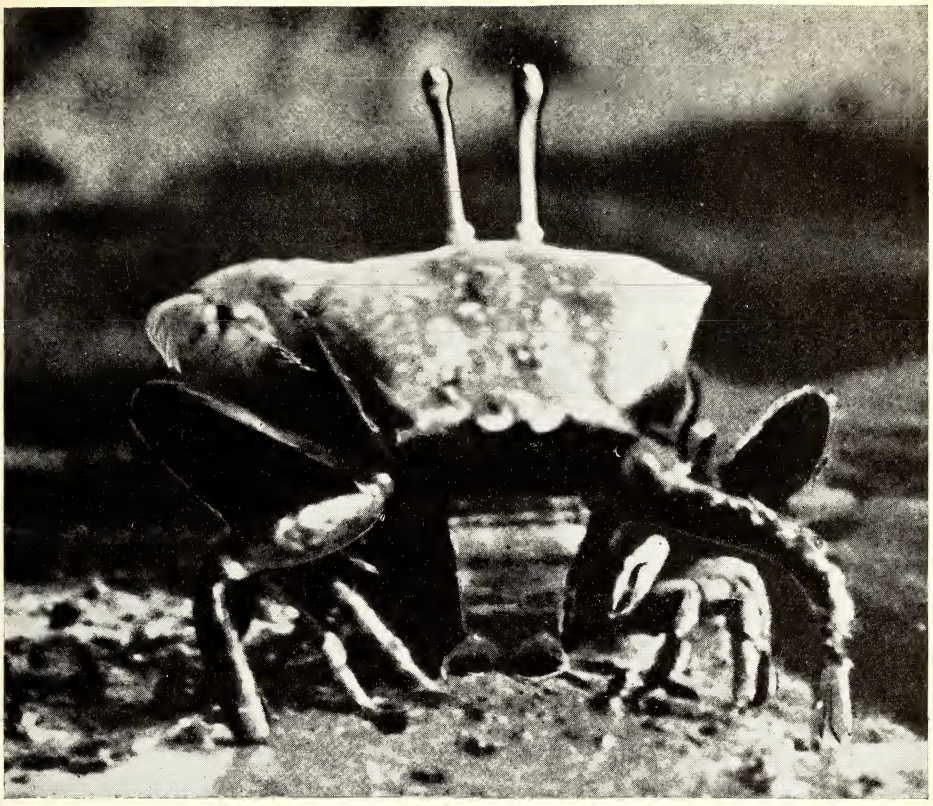

Fig. 9. Copulation in *Uca marionis*. Male abdomen unfolded, female's left claw and legs visible between male's legs. (After R. Altevogt 1957b)

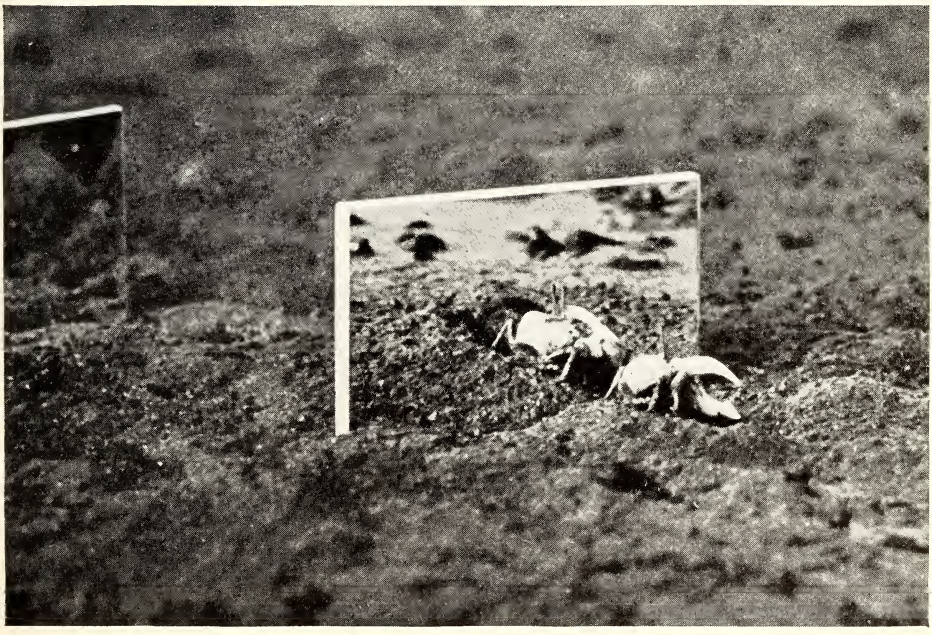

Fig. 10. Male *Uca marionis* starting the mirror fight (see text). Note bleached carapace and claw

Photos : R. Altevogt

Fig. 11. Two fiddler males (*Uca marionis*) ready to insert big claws for the fight

Fig. 12. An unsolved problem in fiddler biology: "Posing", a sort of trance in which the animal's reactions are markedly blocked. Scale 1 cm. (After R. Altevogt 1957b)

Photos : R. Altevogt

gourmets soon gave us the explanation of this fact; large males are caught and, after amputating their big claw, they are let loose again in the field. After some weeks a new claw begins to develop which, however, will never reach its original size. Hence, there is a real 'harvesting' of fiddlers' claws in Spain which provides a typical indigenous item ('bocas') on the menu card. Talking of the only European fiddler *Uca tangeri* we might mention that the type of waving and copulating has only recently been cleared up (R. Altevogt, in the press).

With the low tide advancing, the fiddlers' fighting and courting activities gradually turned over into the last of the typical inter-tidal phases, that of hole digging. Sometimes a fight would ensue for a hole already existing, but equally often the crabs built a new hole by carrying mud balls with their small claw and legs and depositing them about half a yard or so from the hole's entrance. After the hole had become sufficiently deep and wide—the deepest holes opened by us went down as far as 90 cm.—the fiddlers receded into it and closed the entrance with a plug of mud. About 10 minutes before the tide reached the bank all fiddlers had vanished from the scene awaiting the water in their underground shelters and ready to emerge again after these dark six hours.

Whether any environmental factor gives a clue to the fiddlers, guiding them in their wonderfully synchronized inter-tidal activities, or whether some internal rhythm tells them about the tide's come and go, is only one of the many open problems in the field of fiddlers.

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Some Edible Wild Plants from the Hilly Region of the Poona District, Bombay State

BY

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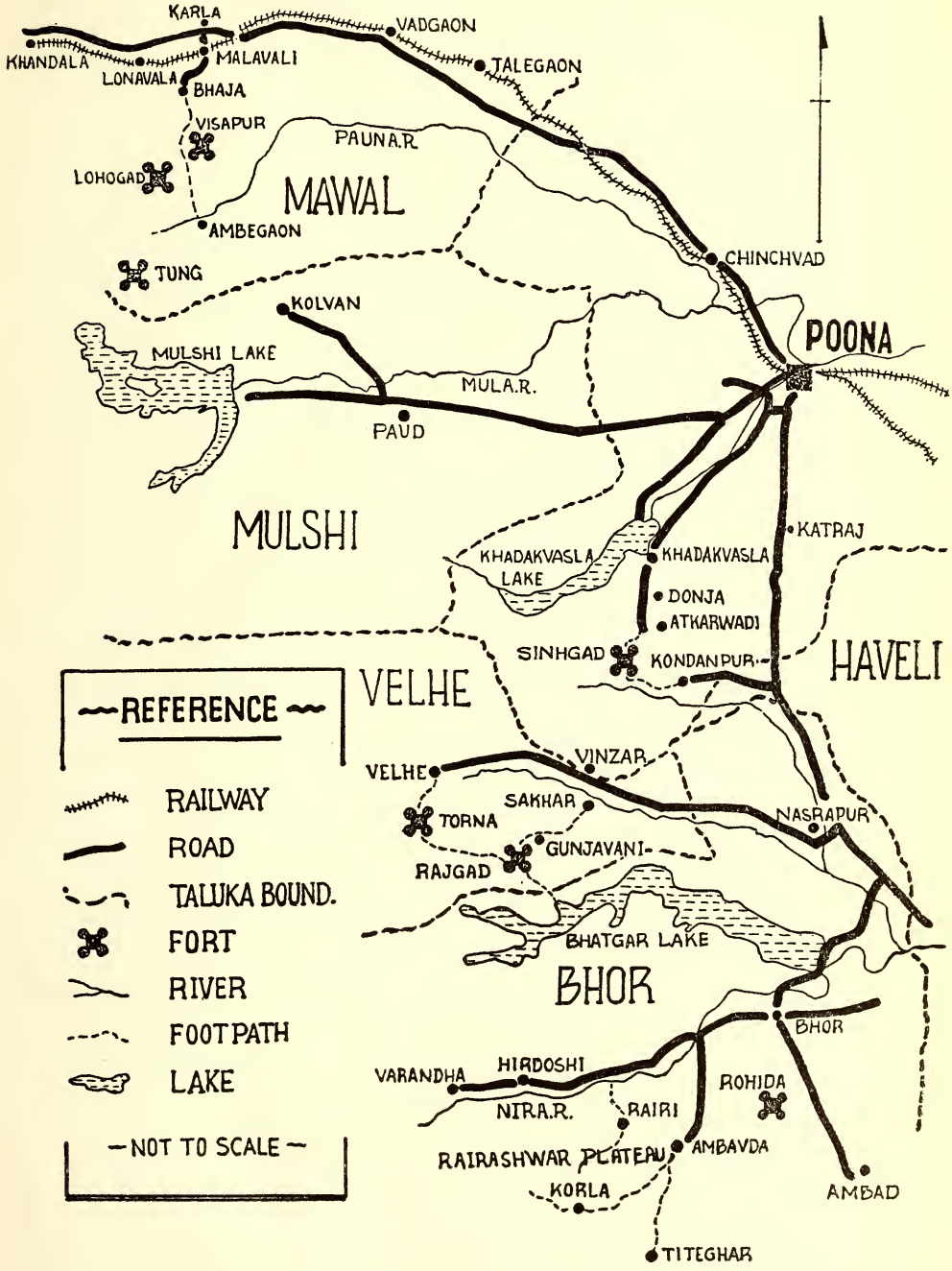
(*With a sketch map*)

The area dealt with in this work covers the hilly region of the Poona District along the Western Ghats. It is loosely known in Maharashtra as the Mawal Hills. The area consists of the Mawal, Mulshi, and Bhor Talukas, Velhe Mahal, and the south-western part of the Haveli Taluka (see map).

This region has always been known for its food scarcity. Its local food produce is hardly sufficient to make up about two-thirds of the local requirements. Thus, for about four months in each year some of its unfortunate inhabitants have to migrate to the neighbouring cities, and the remainder are obliged to subsist on a starvation diet. During the harvest, and also afterwards, these people use many plants occurring naturally in neighbouring jungles as supplementary food which alone enables them to carry on with their half-starved existence.

The young leaves of some plants are used as food (e.g. *Chlorophytum tuberosum* Baker, *Cassia tora* L., *Smithia conferta* Sm., etc.). In some cases it is the flowers which are used as food (e.g. *Clerodendrum serratum* Moon, *Dioscorea pentaphylla* L., etc.). The fruit, whole or part, is also sometimes used as food (e.g. *Salmalia malabarica* Schott, *Ficus glomerata* Roxb., *Meyna laxiflora* Robyns, etc.). In some cases underground tubers or rhizomes are useful as food (e.g. *Ceropegia lawii* Hook., *Ceropegia hirsuta* Wight & Arn., *Vigna capensis* Walp., etc.). In the summer even the gum from some trees is utilised as food. During the monsoon, several types of puffballs and toadstools spring up, some of which serve as a valuable supplement to the diet.

Some of these wild plants can be used as food without much preparation, while in some cases they have to be washed, fried, and mixed with standard food.


KARLA
VADGAON
KHANDALA
MALAVALI
TALEGAON
LONAVALA
BHAJA
VISAPUR
PAUNA R.
LOHOGAD
MAWAL
AMBEGAON
CHINCHVAD
TUNG
KOLVAN
POONA
MULSHI LAKE
MULA R.
PAUD
MULSHI
KATRAJ
KHADAKVASLA LAKE
KHADAKVASLA
DONJA
ATKARWADI
SINHGAD
KONDANPUR
HAVELI
VELHE
VINZAR
VELHE
SAKHAR
TORNA
NASRAPUR
GUNJAVANI
RAJGAD
BHATGAR LAKE
BHOR
BHOR
VARANDHA
HIRDOSHI
ROHIDA
NIRA R.
RAIRI
RAIRASHWAR PLATEAU
AMBAVDA
KORLA
AMBAD
TITEGHAR
REFERENCE
RAILWAY
ROAD
TALUKA BOUND.
FORT
RIVER
FOOT PATH
LAKE
NOT TO SCALE

It is possible that large scale use as food of some of these plants may lead to harmful effects. For example, it is believed that tubers of *Ceropegia* when eaten frequently cause temporary blindness. Hence it would be worth while to make a thorough investigation of their useful properties and harmful constituents.

On the other hand the extensive use of these plants as food results in a rapid decrease in their occurrence and some of them are already on the verge of becoming extinct. Hence botanists must find out ways and means to preserve them. Similarly if some other non-indigenous plants could be grown in these areas as supplementary food, they would be a boon to the indigenous population. This can indeed be looked upon as an important adjunct to the 'Grow More Food Campaign' of the present day.

The author has recorded a number of plants used as food in the course of his study of the vegetation of this region. The information thus gathered has been counterchecked with that available in other places. The author has himself tasted most of the plants listed. Even though some of them may not be quite tasty from urban standards, they are extensively used as food in rural areas.

In this paper a brief account of some wild edible plants found within the Poona District is given. Under each species will be found (i) its botanical name, (ii) reference to Cooke's FLORA OF THE BOMBAY PRESIDENCY to which one should refer for complete morphological description of the species, (iii) the family to which it belongs, (iv) common local name, (v) habit, habitat, exact locality with frequency.

A check-list of these species and their distribution where worked out is given in this note. Further lists will be published from time to time as material accumulates.

A complete set of the species referred to in this paper is deposited in the Herbarium of the Maharashtra Association for the Cultivation of Science, Poona 4. The arrangement of families, genera, and species in the following list is according to Cooke's FLORA OF THE BOMBAY PRESIDENCY. It is hoped that this will prove useful to research workers and others interested in this particular problem.

Acknowledgements

The author is grateful to Prof. V. V. Apte, Fergusson College, Poona 4, and Rev. Father H. Santapau of the St. Xavier's College, Bombay, for kindly going through the manuscript and suggesting improvements. He is also grateful to Dr. S. P. Agharkar, Director, M.A.C.S. Laboratory, Poona 4, for his valuable guidance and encouragement from time to time.

List of Plants

1. **Nymphaea pubescens** Willd. (= *N. lotus* Hook. f. & Thoms.) Cooke 1 : 25. (Nymphaeaceae) *Kamal kakdi.*

An aquatic herb occasionally seen in tanks or in shallow wells.

Roots, petioles, and peduncles are collected and eaten locally. The roots, which contain a large quantity of starch, are usually boiled, though sometimes eaten raw; the stems are cooked in curries; the unripe fruit is eaten as vegetable and seeds are parched (Watt). Cooke states that the seeds are also eaten and this may account for the rarity of fruits.

Localities: (1) Khandala: in Khandala village tank—common, Santapau; (2) Malavli: in village tank—common, Vartak.

2. **Capparis zeylanica** L. (= *C. horrida* L. f. Suppl.) Cooke 1 : 48. (Capparidaceae) *Vaghati ; Govindphal.*

A rambling shrub armed with recurved stipular spines.

Common plant along the hedges in the low rainfall tract of the area.

The ripe fruits are occasionally used to prepare chatni which is usually used during the fasting period. The chatni is not tasty and hence not so popular among the local people.

Localities: (1) Khandala: occasionally seen, Santapau; (2) Katraj: along hedges—common, Vartak; (3) Sinhagad: along hedges—common, Vartak; (4) Nasrapur: common, Vartak.

3. **Portulaca oleracea** L. Cooke 1 : 68. (Portulacaceae) *Gholu.*

A succulent sub-erect herb; leaves obovate, sessile, fleshy.

Common in moist waste places, usually along the village streets, or in the cultivated land.

The leaves and succulent stem are used as a vegetable.

Localities: Common throughout the area.

4. **Garcinia indica** Chois. Cooke 1 : 76. (Guttiferae) *Kokam ; Amsul.*

A small evergreen tree usually seen in the ravines of high rainfall region. It bears a conspicuous spherical purple fruit, the size of a small orange, which ripens about April.

The rind of the fruit is used locally for pickling; the pulp is eaten and has a delicious flavour.

Localities: (1) Khandala: in the ravines—common, Santapau; (2) Bhutande: near Rajgad—common, Vartak.

5. **Salmalia malabarica** Schott. & Endl. (= *Bombax malabaricum* DC.) Cooke 1 : 120. (Bombacaceae) *Savar ; Katesavar ; Lal-savar.*

A tall deciduous tree usually seen along the slopes in the open forests. It is also planted along the roads, or in the cultivated land. Flowers bright red, 5-7 cm. across, arising before the leaves.

The flower buds and young fruits, locally known as *Suirdoodhe*, are used as a vegetable.

Localities: Fairly common throughout the area. (1) Khandala: common, Santapau; (2) Sakhar: fairly common, Vartak; (3) Katraj: near the base of the ghat—common, Vartak; (4) Sinhagad: in the ravines and along the roads—common, Vartak; (5) Torna: near the base—common, Razi and Vartak; (6) Malavli and Bhaja: cultivated, Razi and Vartak.

6. **Grewia abutifolia** Vent. Cooke 1 : 144. (Tiliaceae) *Makad meva.*

A straggling shrub fairly common along the nalas in moist shady places. Drupes 1.5 cm. across, fleshy, minutely stellately hairy, obscurely 4-lobed, wrinkled.

The fruits are eaten by local people. The village boys use it as a snack while tending grazing cattle.

Localities: (1) Khandala: on Monkey Hill and Battery Hill plateau—occasionally seen, Santapau; (2) Lohogad: occasionally seen along the hedges, Vartak; (3) Katraj: near Padmavati along the sides of the stream, Vartak; in ravines near Bhelare Wadi, Vartak; (4) Sinhagad: near Atkar Wadi—common, Vartak.

7. **Zizyphus mauritiana** Lamk. (= *Z. jujuba* Lamk.) Cooke 1 : 240. (Rhamnaceae) *Bora ; Ran-bor.*

A large, much-branched crooked shrub armed with stipular spines. Common in open forests, or along the slopes of the denuded hills.

The fruits are of various sizes and taste. Some agreeable types are eaten by the local people.

Localities: More or less common throughout the area. (1) Khandala: along railway line; by the side of the main road—common, Santapau; (2) Sakhar: common, Vartak; (3) Sinhagad: near Atkar Wadi—common, Vartak; (4) Katraj: along the ghat—common, Vartak; (5) Torna: near the base—common, Vartak and Razi.

8. **Zizyphus rugosa** Lamk. Cooke 1 : 243. (Rhamnaceae) *Toran.*

A rambling shrub heavily armed with spines forming impenetrable thickets along the edge of the forest.

The ripe fruits are eaten by the local people for quenching thirst. The taste of the pulp is similar to *Mimusops elengi* L.

Localities: Common, all over the region. (1) Khandala: common, Santapau; (2) Rajgad: common, Vartak; (3) Sinhagad: near Budhla Machi—common, Vartak; (4) Torna: along the slopes—common, Vartak and Razi.

9. **Rhus mysurensis** Heyne Cooke 1 : 273 (Anacardiaceae) *Amani.*

A much-branched shrub armed with spines.

Common in the open forests, along the slopes of the hills in the low rainfall tract. Drupes 3-4 mm. across, greenish brown.

The author has noted that the fruits are bitter to taste with, however, very good effect for controlling thirst. The fruits are collected and eaten by village boys.

Localities: (1) Poona: hills near about, Woodrow, Vetal Hills—common, Vartak; (2) Katraj: along the ghat—abundant, Vartak.

10. **Buchanania lanzan** Spreng. Cooke 1 : 275 (Anacardiaceae) *Char.*

A tree, 20-25 metres high, tolerably common along the hill slopes of the low rainfall region. Drupes obliquely lentiform, 1-1.5 cm. long, black, stone hard, 2 valved. The fruit is eaten by the local people.

Localities: (1) Katraj: along the ghat—Woodrow; along the northern slopes—common, Vartak; (2) Sinhagad: in the ravines—Woodrow; near Atkar Wadi—occasionally seen, Vartak.

11. **Indigofera pulchella** Roxb. Cooke 1 : 320 (Papilionaceae) *Nerdi*; *Nichardi.*

An erect shrub 2-3 metres high; flowers numerous, purple, in close short-peduncled racemes.

Common in open forests.

The flower-buds and flowers are used as a vegetable.

Localities: (1) Katraj: along the ghat, Kanitkar, fairly common, Vartak; (2) Rajgad: along the slopes—very common, Vartak; (3) Sinhagad: along the slopes—common, Vartak; (4) Raireshwar: along the slopes—very common, Vartak; (5) Torna: along the slopes—very common, Vartak and Razi.

12. **Smithia conferta** Sm. (= *Smithia geminiflora* var. *conferta* Baker) Cooke 1 : 336. (Papilionaceae) *Barka; Naichi-bhaji.*

Annual sub-erect profusely branched herb.

A common herb growing in grass fields or on grassy slopes. Usually seen growing in moist soil or sometimes in liquid mud along the banks of streams.

Leaves are extensively used as vegetable. It is said that mixed with crab legs, it makes a very palatable dish.

Localities: (1) Khandala: very common, Santapau; (2) Rajgad: near Gunjavani—very common, Vartak; (3) Sinhagad: near Poona Machi—common, Vartak; (4) Bhor hills: near Padmavati—common, Vartak; (5) Raireshwar: near Korla—common, Vartak.

13. **Phaseolus khandalensis** Santapau (= *Phaseolus grandis* Dalz.) Cooke 1 : 375. (Papilionaceae) *Ran-shevga.*

An erect woody herb, fairly common in open forests of the high rainfall region.

The seeds are eaten by the local people. It is said that frequent use of these seeds may lead to temporary blindness.

Localities: (1) Khandala: along Kune stream—abundant; Bhoma Hills—abundant, Santapau; (2) Purandhar Fort: northern slopes—abundant, Santapau; (3) Rajgad: along the slopes—common, Vartak; (4) Katraj: along the ghat—occasional, Vartak; (5) Sinhagad: northern slopes—abundant, Vartak.

14. **Phaseolus radiatus** L. (= *Phaseolus sublobatus* Roxb. = *Phaseolus trinervius* Heyne) Cooke 1 : 377. (Papilionaceae) *Ran-mug.*

A perennial herb, twining when it meets a support.

Common along the edge of the forest, and by forest paths. The seeds are eaten by the local people in times of scarcity.

Localities: (1) Khandala: very common, Santapau; (2) Rajgad: along the slopes—very common, Vartak; (3) Katraj: along the ghat—common, Vartak; (4) Sinhagad: near Atkarwadi—common, Vartak; (5) Torna: near Velhe—common, Vartak and Razi.

15. **Vigna capensis** Walp. (= *Vigna vexillata* R. Rich.) Cooke 1 : 379 (Papilionaceae) *Halunda.*

A twining herb, root fusiform.

Common in open forest, usually along the foot paths.

The fusiform roots and seeds are eaten by the local people. Boiled or roasted roots constitute one of the major food articles of the hill tribes.

Localities: (1) Khandala: common throughout the area, Santapau; (2) Rajgad: near Gunjavani—abundant, Vartak; (3) Lohagad: near Bhaja—common, Vartak; (4) Sinhagad: near Atkarwadi—common, Vartak.

16. **Cassia tora** L. Cooke 1 : 420 (Caesalpiniaceae) *Takla ; Taroti.*

An erect woody herb, fairly common in waste places along the road, or in the forest in open spaces.

The tender young leaves are extensively used as vegetable. The leaves give a typical odour which perhaps caused the elimination of

this particular type from the city markets, otherwise the vegetable is quite tasty.

Localities: More or less common throughout the area; (1) Khandala: fairly common, Santapau; (2) Rajgad: near Gunjavni—common, Vartak; (3) Sinhagad: near Atkarwadi, common; (4) Torna: near the base—common, Vartak and Razi.

17. **Acacia arabica** Willd. Cooke 1 : 443 (Mimosaceae) *Babhul.*

A middle-sized crooked tree seen usually planted along the road-side or in the cultivated land.

The raw or slightly fried gum is eaten by local peoples in times of scarcity.

Localities: A common species seen cultivated or wild in dry region of the area.

18. **Terminalia bellerica** (Gaertn.) Roxb. Cooke 1 : 478 (Combretaceae) *Beheda.*

A large deciduous tree. Fruits remain hanging on the tree for a long time.

Common in ravines of the hilly region of the high rainfall tract.

The hard seed coat is removed and the inner starchy portion is used as food in times of great scarcity. If taken in excess it is said to produce intoxication.

Localities: (1) Khandala: fairly, common, Santapau; (2) Rajgad: wild and cultivated, common, Vartak; (3) Sinhagad: near Atkarwadi—common, Vartak; (4) Ambavade: in the ravine—common, Vartak; (5) Torna: along the slopes occasionally seen, Vartak and Razi

19. **Anogeissus latifolia** Wall. Cooke 1 : 482. (Combretaceae) *Dhavda.*

A middle-sized deciduous tree.

Common along the slopes of the hills of the medium rainfall tract.

The gum after a little frying is used as food.

Localities: (1) Khandala: on Monkey Hill and Meroli Hill, Santapau; (2) Katraj: along the ghat—very common, Vartak; (3) Sinhagad: near Atkarwadi—common, Vartak.

20. **Syzygium cumini** (L.) Skeels (= *Eugenia jambolana* Lamk.) Cooke 1 : 492. (Myrtaceae) *Jambul.*

A middle-sized evergreen tree usually seen in wild condition on the hill-tops of the high rainfall tract.

The fruits of some varieties are commonly and extensively used by local people.

Localities: (1) Khandala: Forbay—common, Santapau; (2) Rajgad: near Chirmodi—common, Vartak; (3) Bhor: along the hill—common, Vartak, (4) Torna: near Velhe—common, Vartak and Razi; (5) Sinhagad: near Atkarwadi—common, Vartak.

21. **Momordica dioica** Roxb. Cooke 1 : 529. (Cucurbitaceae) *Kartoli.*

A much-spread climbing herb with tuberous roots.

Common in the crevices of rocks or boulders along the slopes of the hills in the dry region of the area.

The fruits are eaten as vegetable and are in great demand in the local market, especially by the Gujarati community.

Localities: (1) Khandala: common, Santapau; (2) Poona: near Khadakvasla, Cooke; Kothrud, 3 miles SW. of Poona, Kanitkar; Vetal Hills—occasionally seen, Vartak; (3) Katraj: along the ghat—common, Vartak.

22. **Cucumis melo** L. var. **agrestis** Naud. Cooke 1 : 535 (Cucurbitaceae) *Meki; Takmak.*

Annual climber covered with stiff hairs.

The fruit is pale green, 1.5-1.8 cm. in diameter, with 10 longitudinal stripes which are white or yellow in colour.

Common in the open forest, along the slopes.

The fruit is refreshing and is very popular by the local name *meki.* It is used extensively by the village children.

Localities: (1) Khandala: very common, Santapau; (2) Rajgad: near Gunjavani—Common, Vartak; (3) Sinhagad: Mahar-dara—common, Vartak.

23. **Melothria heterophylla** Cogn. (Lour.) (= *Zehneria umbellata* Thwait.) Cooke 1 : 539. (Cucurbitaceae) *Gomati.*

A deciduous slender climber with tuberous roots.

Usually seen near cultivated land on hedges or in open fields.

The fruits are eaten by the local people.

Localities: (1) Khandala: common, Santapau; (2) Rajgad: near the base of the hill—common, Vartak; (3) Sinhagad: near Atkarwadi—common, Vartak; (4) Katraj: along the ghat—common, Vartak; (5) Varandha Ghat: common, Vartak; (6) Raireshwar: common, Vartak.

24. **Meyna laxiflora** Robyns (= *Vangueria spinosa* Hook.) Cooke 1 : 607. (Rubiaceae) *Alu.*

A small tree armed with strong spines.

Common along the slopes of the hills.

The fruit looks very much like that of *Achras sapota* (Chikku) but is of poor quality. It is eaten by the local people.

Localities: (1) Khandala: very common, Santapau; (2) Rajgad: near Gunjavani—very common, Vartak; (3) Sinhagad: along the slopes—common, Vartak; (4) Malavli to Bhaja: along the slopes—common, Vartak and Razi.

25. **Launaea nudicaulis** Hook. f. Cooke 2 : 62 (Compositae) *Pathri.*

A prostrate or suberect herb. Leaves radical forming a rosette on the ground.

Common in waste places, weed in cultivated land; fairly common throughout the area.

The leaves are eaten mixed with the standard vegetables.

Localities: (1) Khandala: Kune stream bed—tolerably common, Santapau; (2) Rajgad: near Sakhar—common, Vartak; (3) Katraj: near Bhelerwadi—common, Vartak.

26. **Mimusops elengi** L. Cooke 2 : 95 (Sapotaceae) *Waoli* ; *Bakauli.*

A large evergreen glabrous tree. Fruit ovoid 1-1.5 cm. long yellowish when ripe.

Occasionally seen in the ravines.

The ripe fruits are eaten by the local people. Large use of these fruits causes a choking feeling in the throat.

Localities: (1) Khandala: in ravines—occasionally seen, Santapau; (2) Nasrapur: near Baneshwar—cultivated, Vartak; (3) Bhor: along the hill—occasionally seen, Vartak.

27. **Diospyros melanoxylon** Roxb. (= *D. tupru* Buch.-Ham.) Cooke 2 : 99 (Ebenaceae.) *Tamray ; Temburni.*

A middle sized deciduous tree. Fruits ovoid, 1.5-2 cm. long, yellow when ripe.

Common along the slopes of the hill in the medium rainfall tract.

The fruit, though astringent, is eaten and much appreciated during the hot season (Cooke).

Localities: (1) Katraj: along the ghat—very common, Vartak; (2) Poona: near Vetal hills—common, Vartak.

28. **Jasminum malabaricum** Wight Cooke 2 : 111 (Oleaceae) *Kusar, Ran mogra.*

A large climbing shrub. Fruits oval or globose, polished black when ripe.

Very common in ravines of the high rainfall tract.

The fruit, which is popularly known as *gugharya,* constitutes one of the important articles of food. A side dish locally called *usal* is prepared by frying and cooking the fruits.

Localities: (1) Khandala: very common, Santapau; (2) Rajgad: along the slopes—common, Vartak; (3) Sinhagad: along the slopes—

common, Vartak; (4) Raireshwar: along the slopes—common, Vartak; (5) Lohogad: along the slopes—common, Vartak and Razi; (6) Torna: along the slopes—common, Vartak and Razi; (7) Malavli to Bhaja: along the slopes—common, Vartak.

29. **Carissa congesta** Wight (= *Carissa carandas* Graham non Linn.) Cooke 2 : 124. (Apocynaceae) *Karvand.*

A large evergreen shrub armed with divaricated thorns. Fruit very variable, spherical or ellipsoid. The colour changes from deep green to purple, and purple to jet black. Some varieties have a bitter taste.

Very common along the slopes of the hills of the medium and high rainfall tract.

The fruit is eaten locally; it is collected and sold in local bazars.

Localities: (1) Khandala: very common, Santapau; (2) Rajgad: along the slopes—very common, Vartak; (3) Katraj: along the ghat—common, Vartak; (4) Raireshwar: along the slopes—very common, Vartak, (5) Malavli to Bhaja: along the slopes—common, Vartak and Razi; (6) Lohogad: along the slopes—common, Vartak and Razi.

30. **Wrightia tinctoria** R. Br. Cooke 2 : 137. (Apocynaceae) *Kala-kuda.*

A middle-sized tree, fairly common in open forests of the high rainfall region. Flowers appear generally when tree is leafless and they are very abundant.

The flowers are occasionally used as vegetable. The vegetable is slightly bitter in taste and it requires thorough washing.

Localities: (1) Khandala: from Thakurwadi to Behram's Plateau—common, Santapau; (2) Rajgad: near Gunjavani—common, Vartak; (3) Raireshwar: near Korla—occasionally seen, Vartak; (4) Hirdoshi: occasionally seen, Vartak.

31. **Holostemma annularis** (Roxb.) K. Schum. (= *H. rheedei* Wall. = *H. rheedianum* Spreng.) Cooke 2 : 156. (Asclepiadaceae) *Shindoli ; Choose.*

A large climbing shrub seen usually in lantana thickets along the slopes of the hills. The flowers are very much like *Calotropis.*

The flowers contain sweet juice and, hence, are frequently used by the local people. This may account for the relative scarcity of the plant in the district.

Localities: (1) Khandala: occasionally seen, Santapau; (2) Katraj: along the ghat—occasionally seen, Vartak.

32. **Ceropegia lawii** Hook. Cooke 2 : 175. (Asclepiadaceae) *Kharpudi.*

An erect, slightly succulent herb, 30 cm. in height. Common in open forest along the grassy slopes.

The tubers are used like potato. The plant is extensively hunted for its tubers and thus becoming gradually extinct.

Localities: (1) Khandala: rare, Santapau; (2) Purandhar: fort area—common, Santapau; (3) Sinhagad: common, Vartak; (4) Bhor hills: occasionally seen, Vartak; (5) Rajgad: very common, Vartak; (6) Torna: along the slopes—common, Vartak and Razi.

33. **Ceropegia hirsuta** Wight & Arn. Cooke 2 : 177. (Asclepiadaceae) *Khantodi.*

A slender climber, stem hirsute and much branched. Flowers similar to the previous species.

Common in open forest along the slopes of the hilly region. The tubers are used like potato. This species is also on the verge of extinction due to indiscriminate hunting.

Localities: (1) Katraj: along the ghat—very common, Vartak; (2) Sinhagad: along the ravines—common, Vartak; (3) Vetal Hills: occasionally seen, Vartak.

34. **Ceropegia oculata** Hook. Cooke 2: 177. (Asclepiadaceae) *Khantodi.*

A slender herb; twining, up to 4-5.5 metres long. Corolla 7-9.5 cm. long like the head of a snake, yellowish green in colour with purple dots in the throat. The local name is given on account of the peculiar shape of the flower.

The tubers are used as potatoes.

Localities: (1) Khandala: rare, Santapau; (2) Rajgad: occasionally seen, Vartak.

35. **Caralluma fimbriata** Wall. Cooke 2 : 180. (Asclepiadaceae) *Makad shingi.*

An erect fleshy, almost leafless herb, reaching about 20 cm. high. The plant looks like small cactus.

Common in crevices of rocks along the slopes of the denuded hills. The entire plant is eaten as a vegetable mostly by Punjabis and northern people.

Localities: (1) Parvati—common, Vartak. (2) Vetal Hills: common, Vartak, (3) Katraj: very common along the ghat, Vartak.

36. **Cordia dichotoma** Forst. (= *C. obliqua* Willd. = *C. myxa* L.) Cooke 2 : 199. (Boraginaceae) *Bhokar.*

A moderate-sized deciduous tree, reaching about 9 metres high. Common in the ravines along the streams; occasionally planted along the roads.

The young tender leaves are used as vegetable. The ripe fruit is eaten and the unripe fruit is pickled by the local people.

Localities: (1) Khandala: not common, Santapau; (2) Katraj: along the ghat—common, Vartak; (3) Sinhagad: near Atkarwadi—common, Vartak; (4) Hirdoshi: common, Vartak.

37. **Ipomoea aquatica** Forsk. Cooke 2 : 246. (Convolvulaceae) *Nalichi bhaji.*

A prostrate herb, trailing on liquid mud or floating. Leaves elliptic oblong, cordate, or hastate.

The young shoots, leaves, and roots are eaten as a vegetable.

Localities: (1) Poona: near Mutha river side—occasionally seen, Vartak; (2) Bhosari: along the margin of the tank—very common, Vartak.

38. **Solanum indicum** L. Cooke 2 : 266. (Solanaceae) *Chicharti*; *Dorli*; *Mothi ringni.*

A much-branched under-shrub armed with recurved prickles. Fruits globose, 0.8-1 cm. in diameter, dark yellow when ripe.

Fruit used in curry preparation; the chatni prepared from these fruits is very popular among the local people.

Localities: (1) Khandala: very common, Santapau; (2) Katraj: along the ghat—common, Vartak; (3) Sinhagad: along the slopes—very common, Vartak; (4) Malavli to Bhaja: along the slopes—common, Vartak and Razi; (5) Raireshwar: along the slopes—common, Vartak.

39. **Clerodendrum serratum** (L.) Moon Cooke 2 : 432. (Verbenaceae) *Bharangi.*

An erect shrub, reaching 1.2 metres in height. Flowers numerous, pale blue, showy, collectively forming a long lax terminal, usually pyramidal erect, panicle, 20-25 cm. long.

Very common along the edge of the forest or in the open forests of the high rainfall tract.

The flowers are extensively used and very popular as a vegetable among the local people. Graham mentions that the leaves are eaten as greens; like Santapau, I have not been able to confirm this particular use. However, I have seen the common use of the flowers as vegetable, and have tasted the vegetable.

Localities: (1) Khandala: common, Santapau; (2) Katraj: along the ghat—occasionally seen, Vartak; (3) Sinhagad: near Atkarwadi—common, Vartak; (4) Rajgad: near Gunjavani—common, Vartak; (5) Raireshwar: near Korla—common, Vartak, (6) Torna: near Velhe—common, Vartak and Razi.

40. **Gmelina arborea** Roxb. Cooke 2 : 425. (Verbenaceae) *Shivan.*

A moderate-sized unarmed deciduous tree reaching 8-15 metres high. The fruit is a drupe 2-2.5 cm. long, ovoid or pyriform, smooth, orange-yellow when ripe.

Common in open country along the base of the hills.

The fruit is occasionally eaten by the local people.

Localities: (1) Khandala: not common, Santapau; (2) Rajgad: near Chirmodi—common, Vartak; (3) Katraj: along the ghat—occasionally seen, Vartak; (4) Sinhagad: along the slopes—common, Vartak; (5) Poona: along the Vetal Hills—occasionally seen, Vartak.

41. **Celosia argentea** L. Cooke 2 : 485. (Amaranthaceae) *Kurdu*; *Kombda.*

An erect herb, 50-80 cm. high.

Common weed in the cultivated land, common in grass land. Occasionally seen in waste places and in the river beds.

The young tender leaves used as vegetable.

Localities: (1) Khandala: very common, Santapau; (2) Rajgad: in the cultivated land—very common, Vartak; (3) Katraj: in the cultivated land—very common, Vartak; (4) Sinhagad: in the cultivated land—very common, Vartak; (5) Lohogad: in the cultivated land—common, Vartak and Razi; (6) Malavli to Bhaja: in waste places—common, Vartak and Razi.

42. **Amaranthus spinosus** L. Cooke 2 : 488. (Amaranthaceae) *Kantemath.*

An erect woody herb, fairly common throughout the area in waste places, rubbish heaps, and in cultivated land. The plant grows well in moist damp soil.

The leaves make a fairly good spinach, though difficult to pick owing to axillary spines.

Localities: Common throughout the area. (1) Khandala: in waste land near the railway station, Santapau; (2) Malavli to Bhaja: in water-logged cultivated land—common, Vartak and Razi; (3) Torna: near Velhe—common, Vartak and Razi.

43. **Amaranthus polygamus** L. Cooke 2 : 490. (Amaranthaceae) *Tandulja.*

An erect much-branched succulent glabrous herb, seen usually as a weed in cultivated land.

The tender stem and leaves are used as vegetable.

Localities: A common weed in cultivated land.

44. **Aerva sanguinolenta** Blume (= *Aerva scandens* Roxb.) Cooke 2 : 492. (Amaranthaceae) *Mada.*

A climbing under shrub; branches straggling, more or less pubescent or tomentose.

The plant is fairly common in crevices of rocks along the slopes of the hilly tract. The plant shows luxuriant growth in shade.

The tender leaves are used as spinach.

Localities: (1) Khandala: in the dense forest and grassy banks—common, Santapau; (2) Rajgad: along the slopes—common, Vartak; (3) Sinhagad: along the slopes—common, Vartak; (4) Katraj: along the ghat—common, Vartak.

45. **Elaeagnus conferta** Roxb. (= *E. latifolia* L.) Cooke 2 : 543. (Elaeagnaceae) *Amgul.*

A large much-branched scandent shrub, often running over high trees. Fruits 1.3 cm. long, ellipsoid with 8 strong blunt ribs.

The fruit is edible and sold in the market on the hills. It has sub-acid flavour.

Localities: (1) Khandala: at the edge of the forest—common, Santapau, (2) Rajgad: near Gunjavani—common, Vartak; (3) Varandha: along the slopes of the ravine—common, Vartak; (4) Raireshwar: on the plateau—common, Vartak.

46. **Ficus glomerata** Roxb. Cooke 2 : 654. (Moraceae) *Umber.*

A large evergreen tree, receptacles from the old wood, on the trunk, clustered, at first green, later red.

Common near villages, near roadside, and along streams and rivers.

The receptacles are used in vegetable after removal of the minute flowers.

Localities: (1) Khandala: common throughout the area, Santapau; (2) Rajgad: in the ravine—common, Vartak; (3) Sinhagad: near Atkarwadi—common, Vartak; (4) Raireshwar: in the ravine along the stream—common, Vartak; (5) Malavli to Bhaja: along the side of the stream, Vartak and Razi; (6) Torna: near Velhe, Vartak and Razi; (7) Katraj: along the ghat—cultivated, Vartak and Razi.

47. **Curcuma pseudomontana** Grah. Cooke 2 : 730. (Zingiberaceae) *Kachora; Shindalvan.*

Herb with root stock; bearing small almond-like tubers at the ends of the fibrous roots, tubers pure white inside.

Common as undergrowth along the slopes in the dense forest.

Localities: (1) Khandala: very common throughout the area, Santapau; (2) Ambavada: in the ravine—common, Vartak; (3) Rajgad: in the ravine—common, Vartak; (4) Sinhagad: near Machi—common, Vartak; (5) Varandha: near Hirdoshi—common, Vartak.

48. **Ensete superbum** (Roxb.) Cheesman (= *Musa superba* Roxb.) Cooke 2: 740. (Musaceae) *Chaeen.*

A herb-like banana but not so tall.

Common along the steep slopes of the hills of the high rainfall tract.

Locally young fruits are pickled, young inflorescence (spike) is eaten as a vegetable. The sprouting buds are used as vegetable.

Localities: (1) Khandala: common all over, Santapau; (2) Sinhagad: near Kalyan gate—common, Vartak; (3) Rajgad: near the top—very common, Vartak; (4) Raireshwar: along the steep slopes —very common, Vartak.

49. **Dioscorea pentaphylla** L. Cooke 2: 758. (Dioscoreaceae) *Shendvel*; *Mohor.*

A climbing shrub usually seen overtopping the small shrubs. Bulbils many, globose or cylindrical. Staminate flowers numerous in compound racemes, pistillate flowers in pendulous spikes.

Common in open forest.

The flower-buds, especially the staminate ones are extensively used as vegetable by the local people.

Localities: (1) Khandala: fairly common, Cooke, Gammie, Meebold, Santapau; (2) Purandhar: common, Bhide, Santapau; (3) Sinhagad: fairly common, Bhide, Vartak; (4) Rajgad: near Gunjavani —common, Vartak; (5) Raireshwar: near Korla Village—common, Vartak.

50. **Dioscorea oppositifolia** L. Cooke 2: 758. (Dioscoreaceae) *Tamboli.*

A large climbing shrub, common in open forest or along the edge of the forest.

The elongated tubers are used as food in times of scarcity. Before making any preparation the tubers should be sliced and cleansed with running and salt water alternately in order to remove the alkaloid dioscorine.

Localities: (1) Khandala: common, Graham, Cooke, Garade, Santapau; (2) Sinhagad: common, Bhide, Santapau, Vartak; (3) Rajgad: Gunjavani—very common, Vartak; (5) Katraj: along the

ghat—occasionally seen, (5) Torna: along the slops—common, Vartak and Razi; (6) Malavli and Bhaja: along the slopes—common, Vartak and Razi.

51. **Smilax zeylanica** L. (= *Smilax macrophylla* Roxb. non Willd) Cooke 2: 763. (Smilaceae) *Ghotvel.*

A climbing shrub, fairly common in secondary scrub forests.

The tender young branches and leaves are used as vegetable.

Localities: (1) Khandala: very common, Santapau; (2) Sinhagad: common, Vartak; (3) Rajgad: common, Vartak; (4) Raireshwar: common, Vartak; (5) Hirdoshi: very common, Vartak.

52. **Chlorophytum tuberosum** Dalz. Cooke 2: 772. (Liliaceae) *Kulai.*

A low herb with root tubers.

Common in moist gravel soil along the slopes.

The leaves are extensively used as vegetable.

Localities: (1) Khandala: common, Santapau; (2) Katraj: along the ghat—common, Vartak; (3) Poona: along the Vetal hill—very common, Vartak.

53. **Chlorophytum** sp. (Perhaps *C. borivilianum* Santapau & Fernandes, in *JBNHS* 52: 827.) (Liliaceae) *Kulai.*

The morphological features are more or less similar to the previous species except that the roots are fascicled.

Common in moist gravel soil along the slopes.

The leaves are used as a vegetable.

Localities: Sinhagad: near Machi—very common, Vartak.

54. **Ariopsis peltata** Nimmo Cooke 2: 827. (Araceae) *Ran alu*; *Gargat.*

A small herb, tubers small, green, clustered with many slender root fibres, leaves solitary, membranous, peltate.

Common on trunks of trees or on rocks during the first half of the monsoon.

The leaves are used as a vegetable.

Localities: (1) Khandala: common, Halberg, Blatter, Santapau, (2) Ambavada: common, Vartak.

55. **Remusatia vivipara** Schott. Cooke 2: 828. (Araceae) *Rukalu.*

An epiphytic herb with bulbiferous shoots, seen quite commonly on large trees in the ravines of moist forests.

Locally the leaves are used as vegetable and occasionally the tubers are eaten, but they require careful boiling in order to free them of the crystals which may cause mouth troubles.

Localities: (1) Khandala: Bhoma hills—common, Santapau; (2) Lohogad: near the base of the fort—common, Vartak and Razi; (3) Rajgad: in the ravines—common, Vartak.

56. **Phoenix sylvestris** (L.) Roxb. Cooke 2 : 801. (Palmae) *Shindi.*

A middle-sized palm sometimes reaching 10-12 metres high, fairly common in open country. The fruit is orange-yellow, and edible.

The fruits are collected and eaten by village boys.

Localities: (1) Khandala: tolerably common, Santapau; (2) Katraj: cultivated (!), Vartak; (3) Hirdoshi: near Ambeghar—very common, Vartak.

57. **Bambusa bambos** (L.) Voss ; (= *Bambusa arundianacea* Hook. f.) Cooke 2 : 1046. (Gramineae) *Bamboo* ; *Kalak.*

A giant grass, fairly common in thick forests and ravines of the high rainfall region.

The seed resembles unhusked rice and is eaten by the local people like cereal. The young shoots are cut when tender, and eaten like asparagus.

Localities: (1) Khandala: common, Santapau; (2) Sinhagad: near the base of the hill, cultivated (!); (3) Rajgad: near Chirmodi—common, Vartak; (4) Hirdoshi: near Kalakai rahat—very common, Vartak; (5) Raireshwar: on the plateau—common, Vartak.

58. **Lastrea felix-mass** Presl. var. **cochleata** Bedd. (Filicineae) *Marud.*

A dioecious fern, fairly common as undergrowth in high rainfall region.

The tender leaves are used as vegetable.

Localities: (1) Raireshwar: on the plateau—very common, Vartak.

59. **Lycoperdon** sp. (Gastromycetes) *Bhuiphod.*

During the monsoon, little white puff-balls growing in the grass of pastures and heath-like small snow-balls, soft and spongy, and sparsely lodged with colour in the pulpy interior. It is in the group of fungi locally known as *bhui phod*, as it springs up suddenly from the soil. The puff-balls are used extensively by the local people, during the monsoon. After slightly frying they taste like well-cooked mutton.

Localities: Throughout the area.

60. **Agaricus** sp. (Basidiomycetes) *Alimb.*

This fungus is popularly known as *Alimb*. This particular species

grows extensively during monsoon and a bit after. The entire fungus is used in preparing curry. I have noted that even the raw fungus is eaten by the local people. Several members of the family to which *Agaricus* belongs are, however, poisonous and one should be very cautious about eating those that have been gathered by inexperienced people.

The author feels that there is much scope for confirming the different edible species and experimenting for good yields.

Localities: Throughout the area.

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Unusual and Supplementary Food Plants of Kumaon

BY

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India is desperately short of food. We have to depend on a variety of imports from other countries. Apart from cereals the amount of vegetables and fruits produced is also very inadequate. To most people either these are not available or, when available, they are not in sufficient quantities. These foods are almost certainly consumed in inadequate quantities. This results in malnutrition and several deficiency diseases.

The Kumaon region of the western Himalayas is very rich in vegetation. It includes three districts, namely Almora, Nainital, and Garhwal. Most of the area is mountainous and the land is not very fertile. Irrigation is also very poor. The cultivators have to depend on the monsoons or some natural springs for water. The majority of the local population is economically poor and cannot afford to purchase fruits and vegetables.

It is well known that our ancient sages lived in the forests and derived their sustenance solely from them. Many of the wild plants yield fruits and vegetables which are gathered by local people and sold in the market. There are others which are gathered but are not sold. They are utilised as a means of subsistence. Such plants have on occasion provided much needed food and variety to mountaineers, tourists, and touring officers, and the local population has to fall back on them in times of scarcity.

This investigation was undertaken in order to collect data regarding the wild edible plants of this region and to study the food value of different products consumed by the local population.

The information may help in adding variety to the monotonous diet and publicising the hitherto unknown sources of supplementary food to many visitors to this region. A beginning has already been made in this direction in our laboratory. Gupta and Gupta (1958) have studied the sugars in the fruits of some wild plants occurring in this area.

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Different parts of plants have been utilised according to their palatability and these will be taken one by one in the following order:

1. Roots, tubers, and rhizomes.
2. Shoots, including stems and leaves.
3. Buds and flowers.
4. Fruits and seeds.

Roots, Tubers, and Rhizomes

Dioscorea is an important genus supplying starchy food in normal times as well as in scarcity and famine conditions. *D. quinata* (=Magiya, Munia), *D. pentaphylla* (=Taigun, Takuli), *D. aculeata* (=Man-alu), and *D. deltoidea* (=Gun) produce underground tubers which are cut into pieces, steeped in water, and boiled. Some varieties have insipid taste and are made edible by repeated boiling and washing. Other species of *Dioscorea*, viz. *D. versicolor, D. bulbifera* (=Genthi), and *D. sagitatta* (=Tarur) produce axillary tubers. Apart from boiling, the tubers of some varieties are baked. Collectively they constitute an important article of food in times of scarcity. The tubers of *D. versicolor* also yield a food for invalids.

Another plant whose tuberous roots are much prized is *Pueraria tuberosa* (=Bilai-Kand, Biralu, Birali panwa, or Sural). Though not so tasty as *Dioscorea*, it is used as an alternative. Its tubers are considered as demulcent and refrigerant in fevers, and useful as cataplasm for swollen joints.

The rhizomes of *Nelumbium speciosum* (=Kanwal, Ambaj, Bhasinda) are eaten as a vegetable. They are collected on a large scale and sold in the market at a high price. They are either boiled and cooked, or roasted in ashes. Sometimes they are pickled. This plant comes under semicultivation for this purpose. In the absence of any vegetables, and in times of extreme scarcity, a search is made for the rhizomes of *Colocasia himalensis* (=Dhakol) which is cooked like cultivated forms.

Finally there is *Scirpus kysoor* (=Kaseru) which is significant on account of its starchy roots. It is a very rich source of starch and is eaten both raw and cooked.

Shoots, including Stems and Leaves

Young shoots of various plants form an important source of vegetables. Some are taken as delicacies, others in time of scarcity only. Fronds of *Asplenium polypodioides* (=Lingura), *Nephrodium odoratum* (=Kutra), and *Polystichum aculeatum* (=Kuthiore,

Kuthurka) are gathered in spring and sold in the market. They are cut into small pieces, boiled in water, and then made into curry. Young shoots of *Dendrocalamus polypoides* (=Bans) and *Bambusa arundinacea* (=Kanta bans) are also greedily eaten. These are cut into small pieces, cooked, and eaten in curries. They are commonly made into pickles and preserves. Young tender shoots of *Asparagus racemosus* (=Kairuwa) are a delicacy and fetch a handsome price in the market. Apart from being used as a vegetable, they are used in omelets also. *Ficus virgata* (=Beru), *F. macrophylla* (=Timila), *Paenia emodi* (=Sújuniya), and cultivated cucumbers also provide edible young shoots which are used on a large scale after cooking.

In most hilly places two shrubs, *Urtica dioica* and *U. parviflora* (=Shishona, Kaniyali), are very common. These are much shunned because of the stinging hairs. But the tender shoots with young leaves are made use of by a large number of people living in villages. Young shoots are collected with the help of gloves made of gunny bags or thick cloth and then put in boiling water for an hour or so. The water is then decanted off. It is then made into a curry by adding a little mustard oil and other condiments and eaten with the bread prepared from *Eleusine coracana* (=Mandua). Cattle are also fed on young shoots of these plants.

In extreme conditions tender shoots of *Adhathoda vasica* (=Basinga) and those of *Smilax parviflora* (=Kukar-daru) form a very good substitute. They are first boiled and then taken with common salt, sometimes mixed with curd also. Another important substitute is *Commelina obliqua* (=Kāna, Kanjura), stems and leaves of which are used as vegetables.

Leaves

In contrast to roots, rhizomes, and tubers, which are rich in starch. leaves ensure a supply of vitamins and minerals. Leaves gathered from wild herbs or shrubs provide a substitute for cultivated leafy vegetables for those who cannot afford to buy such vegetables or whenever no vegetables are available in the interior of the forests. Some are used only in time of scarcity. These are used in a variety of ways.

Leaves of *Chenopodium album* (=Bethuwa), *Amaranthus tricolor* (=Chaulai), *Portulaca oleracea* (=Kulphi, Looni), and *Brassica ramosa* (=Thechri) are used after cooking and regularly used as vegetables. When in abundance, they are also dried in the sun and kept for use in times of extreme scarcity.

Raw leaves of *Nasturtium officinale* (=Paniyan) are used in salads. Some people regard this plant as having an offensive smell.

It is then boiled and cooked as a vegetable. Leaves of *Oxalis corniculata* (=Chalmori) and *Rumex hastatus* (=Almora, Bhilmora) contain some acidic taste and are used in chatni and pickles.

Another common use of leaves of some plants is to fry them in oil or clarified butter together with gram flour (i.e. made into pakauras) which gives a tasty preparation. Young leaves (=Gaba), of *Colocasia himalensis Phytolacca acinosa* (=Jarak), *Rhubarb* sp. (=Robar, Doh), and *Vitis* sp. (=Grape) are used for this purpose by a large number of inhabitants. Young rolled leaves (=Gaba) of *Colocasia himalensis* are also eaten as a vegetable when cooked with *Raphanus* (=Mooli). Whenever available stalks of leaves (=Papar) of *Colocasia himalensis* are gathered, cut into small pieces, and dried in the sun. They are used in making curries and vegetables in winter time when very few vegetables are available in colder regions.

Leaves and young stems of *Cassia tora* (=Banar, Panwar) are used as vegetable curry while some people prepare a kind of tea from these leaves. In times of extreme scarcity pulp of *Aloe vulgaris* (=Gaikwar) is also eaten.

Buds and Flowers

Though not used as staple articles of food, buds and flowers of many plants are used as supplementary items in the diet. Tender buds of *Bauhinia variegata* (=Kachnar, Bhairal, Kweral) are collected in large numbers and even sold in the market at a high price. They are much appreciated as a vegetable and are also boiled and mixed with curds. Similarly the flowers of *Indigofera gerardiana* (=Sakina) are widely used as fresh vegetables or dried and kept for emergency periods. Various other wild species with edible flowers are *Dillenia indica* (=Chalta, Chalita), *Orthanthera viminia* (=Chapkiya), *Bombax malabaricum* (=Semal), and *Rhododendron arboreum* (=Buruns). The juice from the last named species forms an excellent jelly.

The flowers of *Berberis petiolaris* (=Kilmora) are mixed with spinach, mashed, and taken as salad, while those of *Woodfordia fruticosa* (=Dhaula) are gathered and sucked by children for the nectar.

Fruits and Seeds

Fruits and seeds of wild plants have been used in the diet from times immemorial in our country. Mostly they are eaten raw, but some of them are used in cooked preparations also. They form a very rich source of vitamins and mineral salts so essential for human

beings. Apart from being consumed at once, many of them are dried and stored.

Wild fruits which are gathered and eaten for the flavour and as an agreeable addition to the monotonous diet include *Myrica nagi* (=Kaphal), *Rubus lasiocarpus* (=Kala hisalu), *Rubus ellipticus* (=Pila hisalu), *Rubus lanatus* (=Hisalu), *Berberis aristata* (=Chuchar), *Berberis asiatica* (=Kilmora), *Fragaria indica* (=Kiphaliya, Bhiula), *Prunus armeniaca* (=Chuaru), *Prunus pudum* (=Payinya), *Pyrus lanata* (=Gilyan, Mehali), *Pyrus pashia* (=Mehal), *Pyrus vestita* (=Mauli), *Ribes nigrum*, and *R. glaciale* (=Karn dakh). Fruits of *Pyrus pashia* are gathered in large numbers, dried, and stored. They are then ground and mixed with flour of *Eleusine coracana* (=Mandua). Berries of *Rubus* spp. mentioned above are made into preserves and those of *Ribes* are dried also. Further work on these plants may throw light on the usefulness of introduction of cultivated varieties of *Rubus* and *Ribes* in this part of the country.

Other fruits which are eaten raw include those of *Leea aspera* (=Kumali, Kurmali), *Grewia oppositifolia* (=Bhemal), *Crataegus crenulata* (=Ghingaru), *Debregeasia velutina* (=Tushiaru), *Punica granatum* (=Darim), *Eugenia frondosa* (=Dabruk), *Morus serrata* (=Kimu), *Aegle marmelos* (=Bel), *Spondias mangifera* (=Amra), and *Zizyphus jujuba* (=Beri). Fruits of *Elaeagnus latifolia*, *E. umbellata* (=Ginwai), and *Cornus capitata* (=Bamaur) are either eaten raw or cooked with sugar and made into preserves.

Fruits of three species of *Ficus*, viz. *F. faveolata* (=Beduli), *F. virgata* (=Bedu), and *F. macrophylla* (=Timila), are eaten when ripe. Unripe fruits are often cooked and made into curries. Full grown fruit of *Dillenia indica* (=Chalita) is also eaten raw or cooked —chiefly in curries. It is also made into pickles or jellies.

In times of extreme scarcity, the local population is forced to collect fruits of *Tribulus terrestris* (=Gokhru) and acorns of oak (=Lekwal, Likhwal), which are ground and made into meal. Similarly *Fagopyrum tartaricum* (=Phapar) provides much needed food in famine conditions.

Among the wild plants *Bassia butyracea* (=Chiura) holds a very important position. The pulp of fruits is eaten but it yields soft vegetable butter also, which is used as a cooking medium and is largely used as an adulterant. Seed cake is also edible. Chiura jaggery (=Gur) is also sold in the market. It is very delicious.

Seeds from many wild plants are made use of in various ways. Seeds of *Pinus longifolia* (=Siyut), *Coriaria nepalensis* (=Makol), *Schleichera triguga* (=Kusum), *Paspalum longiflorum* (=Kana, Kuna). and *Euphorbia augustifolia* (=Dudhila) are eaten raw or roasted,

while those of *Bauhinia vahlii* (=Mala, Malu) are fried in butter and eaten.

Dendrocalamus polypoides (=Bans), which flowers very rarely, produces abundant seeds when it does so. The seeds which resemble wheat have proved of great value in supplementing food supplies in times of famine.

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Observations on the Mackerel Fishery of the Netravati Estuary, West Coast, South India[1]

BY

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(*With three text-figures*)

INTRODUCTION

The present communication relates to observations on an unusual fishery of the Indian Mackerel *Rastrelliger kanagurta* (Cuvier) in the Netravati estuary near Mangalore, lasting for about nine weeks from the latter half of January 1958. Normally the mackerel fishery is most active along the Konkan, Kanara, and Kerala coasts during the September-March period, and the catches comprise mostly immature forms ranging from 180-215 mm. in total length. There are no previous records of mackerel fishery of any appreciable extent from our estuaries, although Pradhan (1956) has recorded the fish entering the estuarine waters of the Kali River at Karwar, ascending along the tidal current up to a distance of 1½ miles during April and May when the range of salinity of the river is between 29.73°/$_{oo}$ and 34.6°/$_{oo}$.

The estuary at Mangalore is formed by the confluence of two rivers, the Gurpur River from the north and the Buntwal or Netravati River from the south, and is situated a few furlongs south of Mangalore town. The Gurpur River is comparatively narrower and more shallow. The active zone of the usual estuarine fishery in the Netravati River is limited to the area in between the Ullal bridge and the river mouth. The estuary is rich and supports an active fishery almost throughout the year. During the monsoon months the catches are mostly *Etroplus suratensis*, *Mugil* spp., *Gerres filamentosus*, *Sillago* spp., *Platycephalus* spp., and many species of cat fishes. In the post-monsoon months, with increased salinity and other favourable conditions, more and more marine species enter the estuary and

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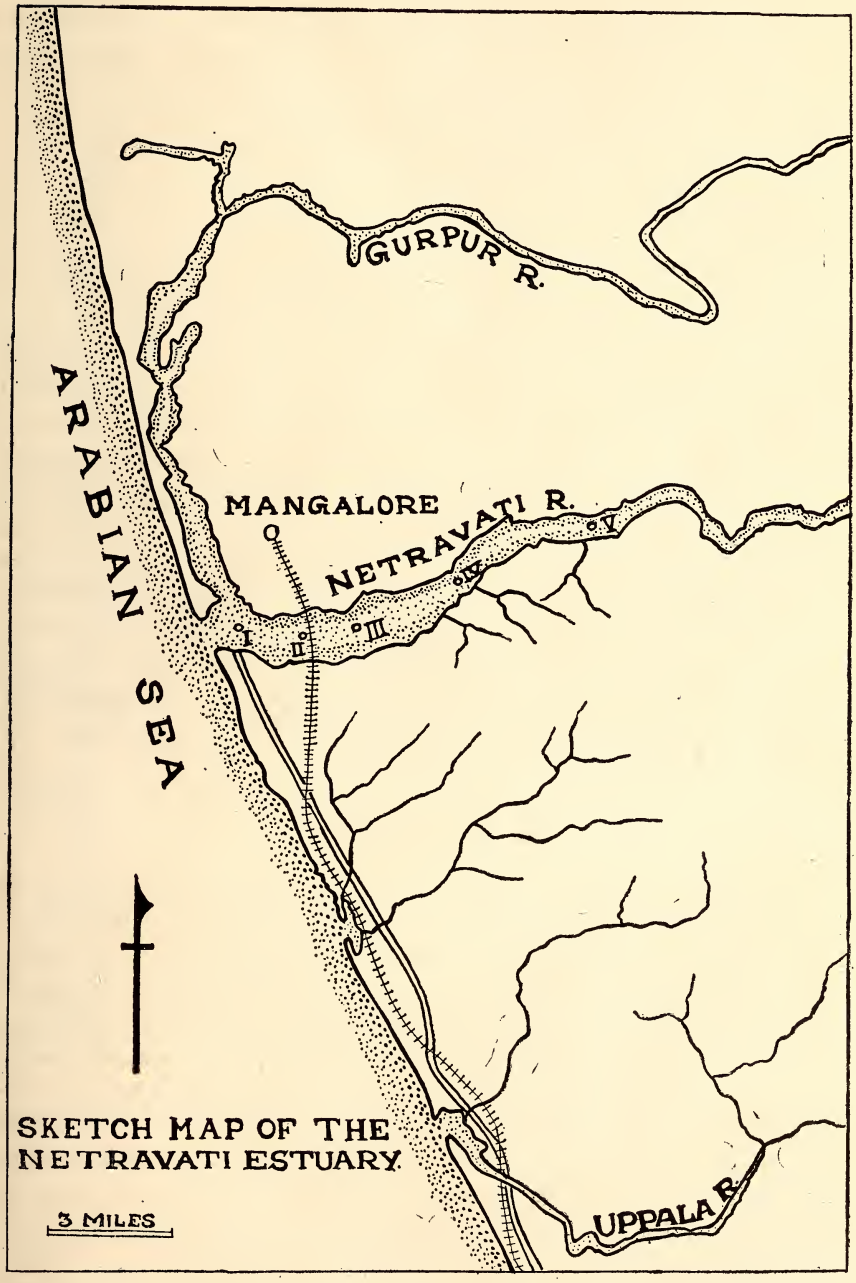

Fig. 1. Map adapted from Admirality chart No. 746 showing the Netravati estuary and observation centres.

by early January the usual fishery is supplemented to some extent by the occurrence in smaller numbers of *Hilsa kanagurta, Sardinella fimbriata, Belone* spp., smaller carangids, prawns, and crabs. Shore-seines commonly called 'kai-rampani' and cast nets operated from canoes are the more common gear in use in the estuary. Beyond the bridge area, the fishing is generally done only for pearl-spots, mullets, cat fishes, and clams and it is in this and in the upper and interior centres (Fig. 1) that the mackerel shoals were noticed.

During the estuarine mackerel fishery season, the river was never deeper than two fathoms. The fishery extended up to Pavur, a village about six miles from the river mouth (St. V in Fig. 1), but never beyond. Five stations were selected in the estuary to study the salinity influence and related conditions in the river, with the river mouth marked as station I, Ullal bridge (a distance of one mile) as station II, Adamkuduru as station III (a distance of three miles from estuary), Perivala (a distance of 4½ miles from river mouth) as station IV, and Pavur as the last station. The fishery at the river mouth up to station II near Ullal bridge was of the mixed type, including smaller numbers of mackerel. The catches except that of mackerel were poor at stations III, IV, and V. It is apparent that the shoals moving with the ebb tide in the first few hours after dusk contributed to the catches in the upper centres in the small hours of the morning. During this period no oil sardines (*Sardinella longiceps*) of any size were caught at any of the centres in the estuary, although their fishery was fairly active in the adjacent inshore seas during the period.

The Mackerel Fishery

The mackerel catches from the estuary were first noticed on 26 January when about four baskets of large-sized mackerel were found kept along with the estuarine catches in the fish market. On enquiry it was found that mackerel started appearing in the river catches in small numbers on 25 January. Field enquiries showed that fishermen from Bolar and neighbouring centres, anticipating good catches of fish based on the stray records of previous days, were making preparations to carry out regular night-fishing for mackerel in the estuary and in the sea. The goodwill of the local fishermen was made use of to conduct on-the-spot studies from the different areas of the estuary while they were carrying out fishing from midnight into the early hours of the morning. The fishery continued actively for about seven weeks bringing in an average of about two hundred mackerel each day.

About eight thousand mackerel were brought to the Mangalore main market alone from the estuary during this season. The mackerel catches from the sea of Mangalore during this period comprised purely small specimens with appreciable difference in size and maturity, as can be seen from Fig. 2. A similar phenomenon of

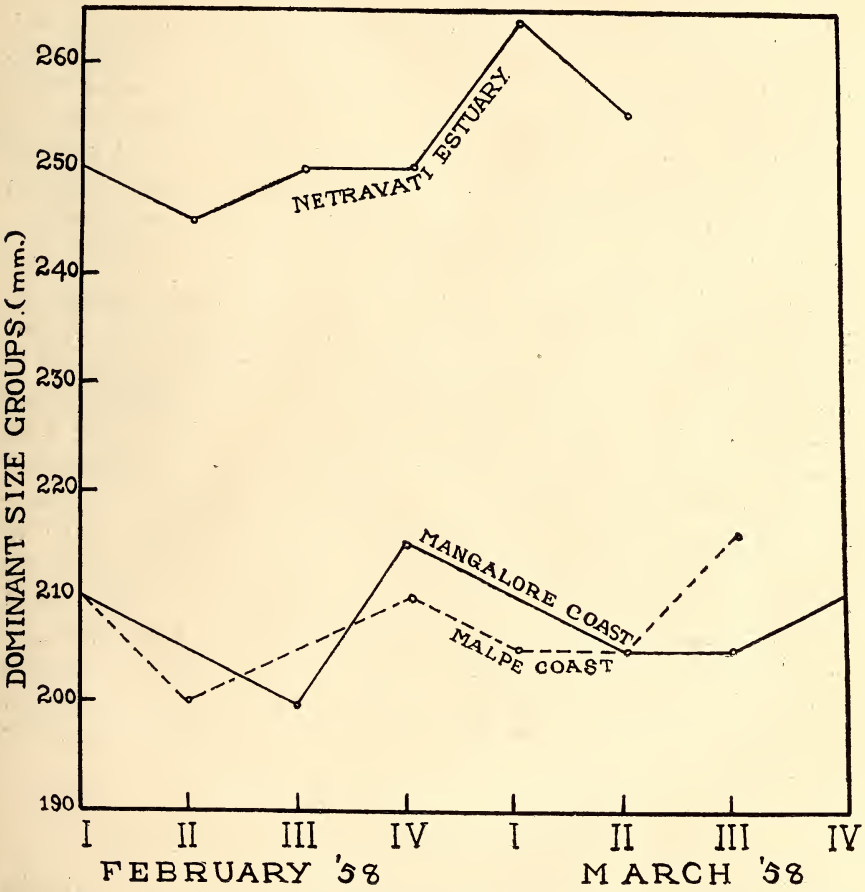

Fig. 2. Graph showing the distribution of the dominant size groups of mackerel in the Netravati estuary, Malpe and Mangalore coasts during the estuarine mackerel fishery season.

mackerel ascending the estuary was observed in the latter half of February in the Chandragiri River also at Kasargod, about thirty miles south of Mangalore. The fishery, unlike that at Netravati, was of short duration and the catches of smaller magnitude. But as regards dominant sizes, maturity conditions, hydrological and related ecological factors, they were quite comparable with the conditions observed at Mangalore. The mackerel obtained from the estuary

were considered by the fishermen to be quite distinct from those caught in the open sea during this time of the year, due to their conspicuously large size, heaviness, and high palatability on account of the increased fat content.

Size Groups: The estuarine catches were comprised almost entirely of adult-sized specimens. The smallest size recorded from the catches was 210 mm. of a stray specimen and the largest 273 mm. (total length). The dominant size of the fishery was 240-250 mm. size. The gear was not selective to include only the largest ones, since the other fishes caught along with the mackerel were of much smaller size. The size range of specimens stood in great contrast to that of the catches from the open coast centres of this zone from Malpe to Kasargod, where only mediumu-sized specimens with a dominant size range of 180-215 mm. alone were obtained (Fig. 2).

Maturity Conditions: The large estuarine mackerel revealed gonadal conditions of partially spent, spent, and also recovering stages. The presence of small gonads with a body length up to 273 mm. along with other characters indicates the possibility that these belong to a subsequent spawning generation. The testes were found to be much reduced in size, quite flabby and bloodshot, and also indicated spent conditions. The partially spent testes on teasing released sperms which under an oil immersion lens were found to be motile. It was noted that the spent testes, although collapsed and shrunk, still retained motile sperms. The scales also revealed growth checks comparable to the ones observed from the large mackerel obtained from the sea during the monsoon season. Thus the studies tend to show that these very large specimens that enter the estuaries belong to a distinct age group, different from the main catches along the coast.

Planktological and Hydrological Conditions

Water samples were collected from all the five centres of the estuary during the fishery season, both during ebb tide and also during low tide. The zone of active mackerel fishery was between stations II and III and the range in subsurface salinity was 14.10 °/₀₀ to 23.50 °/₀₀. The highest subsurface salinity noted at Station V during the season when stray specimens were collected was only 6.79 °/₀₀. The depths at all the centres were never more than two fathoms, and no difference was noted in the salinity values of the surface and bottom samples in the different centres. The planktological conditions revealed a dominance of marine conditions up to station II and slightly beyond. The significant difference from the

marine plankton of the corresponding weeks was the predominance of the copepod *Isias tropica*, and scarcity of diatoms in the estuarine samples.

Food and Feeding

The food and feeding conditions of mackerel collected from the estuary were analysed and studied to find out whether there was any significant variation in the nutrition of the fishes from the different habitats and from the observations made earlier from this coast (Bhimachar and George, 1952). The studies showed that the predominance of the respective 'edible' elements in the marine and

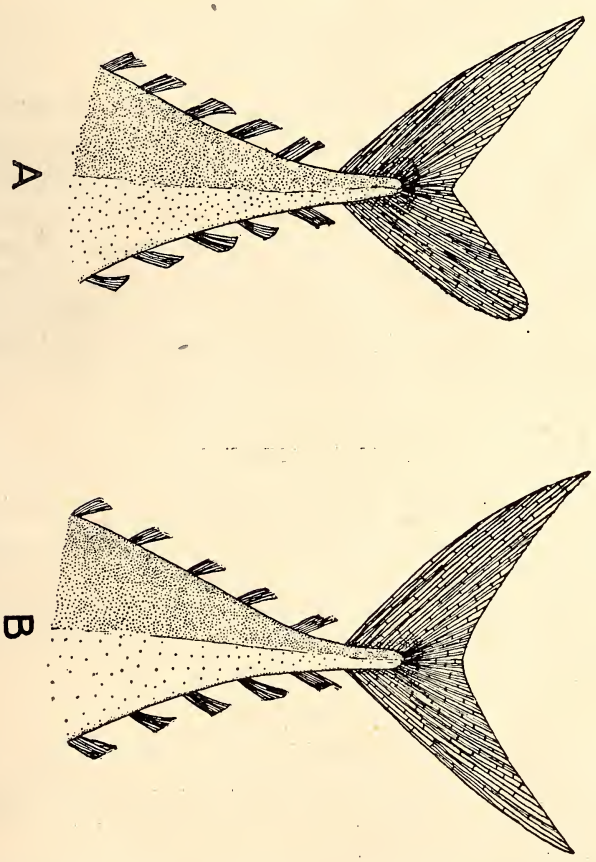

Fig. 3. Semi-diagrammatic sketches showing sub-equal and normal caudal fin lobes. A.—Sub-equal lobes. B.—Normal lobes.

riverine stations were more or less proportionately reflected in the gut-elements, and that estuarine specimens showed active feeding during their movement up the estuary.

Abnormal Caudal Fin Lobes

An unusually large number of specimens were found to have sub-equal caudal fins, the lower lobe being the shorter (Fig. 3). It is quite likely that this condition may have been formed by mutilation at an earlier stage of life, or due to pathological conditions or even to some genetic factor. In any case, it is interesting that only one lobe should be affected. The possibility suggested by local fisher folk that the lower caudal fin lobe might have been smoothly rounded off during the sojourn up due to constant friction with the sandy bottom would appear erroneous, as fin margins were not frayed nor did they show any trace of wear and tear.

Conclusion

The presence of an active and continuous mackerel fishery in the estuary indicates the capacity of the shoals to withstand lower salinity conditions. The fishery is interesting in that it is supported mostly by a larger size group distinctly different from that of the catches from the open coast centres. The occurrence of partially spent and recovering stages in very large numbers during this season indicates the possibility of a longer or subsidiary spawning season for the fish along this coast. The large incidence of sub-equal caudal fin lobes in the estuarine specimens also adds to the general interest.

Acknowledgement

The authors are grateful to Dr. S. Jones, Chief Research Officer, for his interest in the investigations, and for valuable suggestions in the preparation of this account. The helpful comments made by colleagues on the fish material exhibited at the meeting of mackerel and sardine workers at Ernakulam during March 1958 are also acknowledged.

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The Life-History and Biology of the Wax-scale, *Ceroplastes pseudoceriferus* Green (Coccidae: Homoptera)[1]

BY

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(*With two Tables and three Plates*)

CONTENTS

1. INTRODUCTION

The Wax-scale, *Ceroplastes pseudoceriferus*, was described by Green in 1935. The adult female of this species is very similar to that of the Indian Wax-scale, *Ceroplastes ceriferus* (Anderson), especially in the characters of the test and is, therefore, easily confused with it. The differences between the two species are as

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follows: In *C. pseudoceriferus* the dorsum of the denuded insect 'is less highly convex and the marginal areas are somewhat depressed and out-turned. The caudal process is shorter and conical and directed upwards, forming approximately an equilateral triangle in outline. The spines on the stigmatic areas are relatively larger, more numerous, and more crowded. The submarginal conical processes, also, are larger and more prominent.' In *C. ceriferus* the denuded insect is 'bacciform, with the sides approximately perpendicular. The caudal process is long and cylindrical. The stigmatic spines are more scattered, fewer in number, and smaller in size.'

Green recorded the species on an undetermined plant from Ceylon, and on *Azadirachta indica* and *Diospyros montana* from India. He also found a single specimen on Japanese Maple, imported into England from Japan. This suggests that the species may have a wider distribution than is known at present. Since it has for a long time been confused with *C. ceriferus*, it seems probable that in some of the earlier records this species has been mistakenly reported as *C. ceriferus*. Green himself cites one such mistaken record in his description.

C. pseudoceriferus occurs in Banaras on the following host trees: (1) *Mangifera indica*; (2) *Ficus religiosa*; (3) *F. glomerata*; (4) *F. benghalensis*; (5) *Artocarpus heterophylla* (=*integrifolia*); (6) *Madhuca indica* (=*Bassia latifolia*); (7) *Mimusops hexandra*; (8) *Terminalia chebula*; (9) *Holoptelea integrifolia.*

In addition to the above, specimens of *C. pseudoceriferus* have also been collected by the present author on *Madhuca* (*Bassia*) *longifolia* near Nagapattinam in south India. At Banaras, the infestation is severe on some trees of *Mangifera indica, Ficus glomerata,* and *Madhuca indica,* but in other cases mild (Plate 1, fig. 1).

Two other species of *Ceroplastes,* namely *C. floridensis* Comst., and *C. actiniformis* Green, also occur in Banaras, the former on mango and the latter on mango and *F. glomerata.* These two species were however found only in small numbers and therefore could not be used for detailed study.

In spite of the wide distribution and host range of the genus, our knowledge of the life-history and biology of many species of *Ceroplastes* is still incomplete. As early as 1896, Newstead (1896) gave a brief account of the young and adult females and of the adult male of *C. ceriferus,* and added that there was 'much to learn of its habits'. In his monograph on the Coccidae of Ceylon, Green (1909) describes and figures the tests and denuded females of some species of *Ceroplastes,* but gives practically no information on their

biology. Kuwana (1923) has described the biology of three species of *Ceroplastes* occurring in Japan. The life-history of *C. rubens* was studied by Blumberg (1934) in Australia; of *C. rusci* by Bodkin (1927) in Palestine; and of *C. floridensis* by Balachowsky (1933) in France. *C. rusci* and *C. sinensis* have been studied by Silvestri (1919, 1920, and 1927) in Italy. However, the accounts of the life-history by these authors are largely fragmentary and often incomplete. The life-history and biology of *C. pseudoceriferus* were studied in detail by the present author.

2. Occurrence of the Males

An important discovery in the course of the present studies is the occurrence of males in large numbers. The males of some species of *Ceroplastes* are reported to be unknown. According to Blumberg (1934) parthenogenesis is the rule in the case of *C. rubens* in Queensland, but fertilization by males is reported from Japan. Silvestri (1927) observed males in the case of *C. rusci* in Italy, but Bodkin (1927) in his short account of the life-history of this species in Palestine makes no mention of this sex. Balachowsky (1933) writes of *C. floridensis*: 'Le mâle n'a pas été observé au cours de cet élevage, ni dans la nature à l'endroit du prélèvement, la reproduction de l'espèce paraît exclusivement, parthénogénètique', and adds 'au Japon la reproduction de l'espèce se fait par voie sexuée'. Kuwana (1923) has observed the males of all the three species studied by him. Green (1909) wrote about the male of *Ceroplastes*: 'The male in any stage is extremely scarce and has been observed only by Newstead, who describes the male puparium and imago of *C. ceriferus*.' Newstead accidentally came across some males in the debris of a parcel containing females on the stems of *Asclepiadron*, sent to him from Madras in 1893. His description (1896) of the male puparium and imago, referred to by Green, is all too brief and incomplete, having been based on this scanty and imperfect material received by him. Some of his remarks and diagrams of the male scale and of the genitalia need revision.

The reason for missing the males of *Ceroplastes* may be that the larval stages of the male are often mistaken for the young stages of the female. By closely following back the immature stages of the male it is possible to distinguish the sexes in the larval stages also.

At Banaras, fertilization occurs and bisexual reproduction appears to be the only method of propagation in *C. pseudoceriferus*. Large numbers of females were dissected from the time of appearance of the males in the field, and the reproductive organs were mounted

for microscopic study. In almost every case the spermatheca was found to contain a bundle of sperms. With a view to obtain some idea of sex ratio in the population of a colony of *C. pseudoceriferus*, random samples of ten leaves of a severely infested tree of *Madhuca indica* were collected and statistically analysed. The total number of male and female larvae on each side of the ten leaves was counted with the help of a binocular microscope. The surface area of the leaf was also graphically estimated. The result are set forth below:

TABLE 1: SHOWING THE NUMBER OF MALES AND FEMALES FOUND IN A SMALL COLONY

No.	Total area of leaf in sq. inches	Underside ♂	Underside ♀	Upperside ♂	Upperside ♀
1	11.53	159	5	23	—
2	18.43	261	2	45	—
3	12.13	103	2	45	3
4	12.28	190	3	10	2
5	13.46	133	5	15	—
6	10.44	57	—	13	1
7	14.67	116	5	1	—
8	17.21	75	1	7	—
9	11.67	159	2	38	2
10	9.81	51	—	1	—
Total No. of scales examined ..		1304	25	198	8

An examination of the table shows that (1) the males preponderate in number over the females, (2) very few females develop on leaves as compared to the males, and that (3) the larvae, irrespective of their sex, show a marked preference for the undersides of the leaves. When it is considered that a sample of just ten leaves had on them 1502 male larvae, the abundance of the males in nature can easily be visualized.

3. COPULATION

Copulation takes place between December and March, when most of the males complete their development and emerge. The spermatheca of the female is small for the greater part of the third

instar and only attains its adult structure at the time of the third moult. All the females which were seen to be engaged in copulation with males in the laboratory were in the early fourth (adult) stage.

The males are active creatures with well-developed antennae, three pairs of ocellanae, three pairs of legs, and a single pair of large wings. Two of the three pairs of ocellanae are dorsal; and one pair ventral. One of the two pairs of dorsal ocellanae, i.e. that situated somewhat anteriorly, and the ventral ocellanae are large. The posterior dorsal ocellanae, being very small, are easily overlooked. The abdomen of the male terminates in a long tapering stylus and two small conical lobes, one on either side of the stylus. In repose, the wings are held over the abdomen somewhat after the manner of a housefly (Plate III, fig. 9). The males can fly short distances but are dispersed mainly by wind. They crawl about in search of the females on the twigs. On approaching a female, the male mounts on the dorsum of its test and tries to locate its genital opening. The depression at the caudal end of the test, in which the opercula are situated, is a helpful landmark which enables the male to distinguish the caudal from the cephalic end of the female (Plate III, fig. 4). Having found the caudal end, the male deflects the terminal part of its abdomen and sounds the test with the tip of the stylus at various points in the caudal region. Whenever the stylus touches the opercula the female reacts by slightly lifting the two valves of the opercula, which thereby become separated from each other. The stylus of the male may be bent down to 90° or more from its original horizontal position in level with the body. After some efforts the male succeeds in finding the opening and thrusts its stylus into the anal cleft, just below the opercula, where the female opening lies. The test is held firmly by the legs, which by re-adjusting their grip keep the body in position. The wings are held over the abdomen, as in repose. More than one male may copulate with a female. On one occasion, three newly emerged males copulated with a single female in succession, at 5 to 10 minutes' interval. The duration of copulation in these three cases was 2 to 5 minutes.

A few males were kept in covered petri dishes for determining their longevity. The males survived for 2 to 5 days.

4. Oviposition

Egg-laying commences from August and continues till the middle of November. Therefore, there is a long interval of time between copulation and oviposition. During this period there is a gradual increase in the number of ovarioles of the female rather than any marked change in the ovarioles themselves.

The process of oviposition was observed in the laboratory by removing the mature scale insects from the trees and keeping them in an upturned condition inside glass-topped pill boxes. Some of the females were fixed to pieces of micro-slides by adhesives. This permitted close observations being made through the transparent glass on the ventral side.

The first signs of oviposition are furnished by small pellicles or particles of wax secreted on the middle and the posterior parts of the venter, the appearance of pellets of powdery wax at the cephalic end of the postero-mesal furrow (which is nothing but the ventral extension of the line of the anal cleft), and a slight contraction of the venter inwards (Plate I, fig. 4). The small groups of wax particles are generally disposed in transverse rows, but in some cases they are very few in number and lie scattered at isolated places on the venter. The wax particles and pellets later get mixed up with the eggs. It is some time before the actual commencement of egg laying, and during this period, which may vary from a few hours to a day, the pellets of wax increase in number. Finally, the posterior part of the body makes movements, expelling the eggs. The rate of oviposition is very slow at first but, as the process continues, it quickens. In six of the specimens kept under observation in the laboratory, the egg-laying was completed in 8, 8, 19, 19, 20, and 26 days respectively. The daily output of eggs was estimated in four cases, and the data are given below:

(*a*) 177, 705, 1045, 979, 979, 992, 570, 118.

(*b*) 353, 1191, 1599, 1610, 1653, 1511, 927, 550, 379, 358, 290, 203, 130, 53, 32, 3, 1, 2.

(*c*) 318, 1100, 991, 709, 953, 1181, 1167, 1084, 878, 663, 510, 369, 276, 287, 180, 168, 89, 77, 5.

(*d*) 200, 310, 302, 225, 661, 976, 865, 687, 472, 605, 383, 292, 192, 157, 104, 65, 34, 12, 2.

It will be seen that the rate of egg production is slow in the beginning, rises to a peak in the first few days, and then slows down again. At first the eggs are laid singly, but as the process of laying hastens they come out in a long chain. The chain increases in length, becomes coiled, and may break up into bits owing to the agitative movements of the venter (Plate I, fig. 3). By the time oviposition is completed, the eggs lie loosely under the body of the female (Plate I, fig. 5). At the end of oviposition the body of the female is little more than a double-walled chitinous cup sheltering the eggs. The internal structures become pressed between the two

layers, disintegrate, and ultimately dry up. One or two days after the cessation of oviposition some of the scales were dissected and the viscera examined. A number of unlaid ripe eggs and immature ovarioles were found mixed up with the internal organs in a pulpy mass.

During the course of oviposition certain cottony fibres are formed by the venter at its anterior and posterior margins. The anterior fibres are few but those at the posterior end increase in length and number and form a small mesh in which some of the eggs get entangled (Plate I, fig. 3).

The total number of eggs laid by a female is subject to considerable variation. In general, small scales produce fewer eggs than the bigger ones. Many of the gravid females are parasitised and the number of eggs laid by such females is affected by this factor also. The influence of parasitism on oviposition has been discussed by the author in another paper (Sankaran, 1954-1955). Table 2 below gives the total number of eggs laid by each of 12 females:

TABLE 2: SHOWING THE NUMBER OF EGGS LAID

1.	10825	7.	8809
2.	5665	8.	4273
3.	9359	9.	4202
4.	6544	10.	1187
5.	3625	11.	10525
6.	4802	12.	5019 (Parasitised)

While more than 10,000 eggs are laid by some females of *C. pseudoceriferus* in Banaras, Newman, O'Connor, and Andrewartha (1929) recorded only 900-1000 eggs for *C. ceriferus*[1] in Australia. Blumberg (1934) found only 650-700 eggs in teased gravid females of *C. rubens.* According to Silvestri (1920), *C. sinensis* lays on an average about 2000 eggs in Italy. The same author (1927) found 800-1500 eggs in the case of *C. rusci.* The total number of eggs laid by each of six specimens of *C. floridensis* in Banaras was counted by the present author and found to be 145, 292, 132, 386, 405, and 334 respectively. When compared with all these species, *C. pseudoceriferus* is highly prolific. The eggs are ovate in shape and covered with a fine film of wax powder. They are pinkish in colour. The maximum length and width of freshly laid eggs vary from 0.3 to 0.37 mm. and 0.17 to 0.19 mm. respectively.

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[1] The species, originally recorded as *C. ceriferus,* has since been shown to be really *C. destructor* Newst. (O'Connor, 1933).

5. Eclosion and settlement of the young ones on the host.

The eggs hatch about 3 weeks after oviposition. Prior to hatching, they become flat and broader at one end than at the other. At the broader end the two ocellanae of the larva can be seen through the egg-membrane. The larva makes its exit by cracking a vertical slit on the chorion at the anterior end, and wriggling out of it. All the eggs do not hatch at the same time. The process of hatching continues for a week or more, corresponding to the duration of oviposition. The newly emerged larvae (Plate 1, fig. 8) are very active, and come out of the test through the small spaces between the test of the mother and the surface of the twig.

The larvae prefer to settle on the undersides of the leaves rather than on the upper sides. Larvae settling on the leaves orientate themselves in such a way that the long axes of their bodies are parallel to the midribs or the larger side veins of the leaves (Plate II, fig. 3). In the case of those that settle on stems and branches a similar orientation is noticeable, their bodies being always parallel to and never across the length of the stem. The orientation of larvae settling on the stems and twigs is particularly significant, as most of them are found to be females. As the females grow in size, the lateral margins of their body are applied to the sides of the stem or twig, and the shape of the test also bears a permanent impress of this curvature. This enables the females to adhere to the twig.

The behaviour of the young larvae is interesting in that the female-producing ones show a marked preference for the stems and twigs. The male-producing larvae settle down mostly on the leaves and remain there throughout their development. It may be seen from Table I that out of a total of 1535 young scales that were found on ten leaves of *Madhuca indica* only 33 were females, the rest being males in different stages of growth and development. The difference in the selection of site by the male and female larvae appears to be correlated with the subsequent career of each sex. The males are very small, with a test that never exceeds 2.5 mm. in length, and are short-lived, surviving for about three months, at the end of which they copulate and die. The females, on the contrary, live for nearly a year and grow to a large size, the test in many cases attaining a length of 10-12 mm., and a width of about 10 mm. As the female increases in size it would become difficult, on purely mechanical grounds, for the insect to maintain its hold on the even surface of a leaf. During two years, the present author came across scarcely a dozen adult females on leaves whereas countless numbers of females were collected from twigs or small branches

and occasionally from leaf-stalks. As already pointed out, females growing on stems, branches, or leaf-stalks have the advantage that the lateral parts of their body can curve round these objects and thus fix them in position. The second and early third stage females are capable of changing place. Some of the female larvae that were growing on potted seedlings were found to move from the leaves and to settle upon the main stem.

Some of the host trees in Banaras (*Terminalia chebula, Mangifera indica, Ficus religiosa,* and *Madhuca indica*) shed their leaves in the months of February and March. It is interesting to note that this phenomenon coincides with the completion of the development of the males, most of which emerge from their tests before the leaves fall. Some fallen leaves of *Terminalia chebula* were picked up and examined in February. In addition to empty tests of males some propupae and pupae were also found on these leaves. Such specimens may either complete their development on the ground or perish. The twig-infesting habit of the female has, therefore, an increased survival value in contrast to the male.

In some species of *Ceroplastes* the larvae have been reported to migrate from the leaves to the branches and young shoots. According to Newman *et al.* (1929), the newly emerged larvae of *C. ceriferus*[1] in Australia first crawl on to the leaves where they settle down and secrete their waxy coverings. Many of them fall to the ground and die, but after three weeks the surviving larvae migrate to the young wood for permanent settlement. Bodkin (1927) has also observed in Palestine that the larvae of *C. rusci* migrated to 'the stems of the leaves or to the upper, more tender portions of the young shoots' after a month following their first settlement. Silvestri (1927) has reported from Italy similar migration of the females of *C. rusci* from the leaves to the branches. In this case, however, the migration occurred about 5 months after original settlement and the females remained on the branches for the rest of their lives. Except in the case of a few female larvae, the present author has not noticed large scale migrations of the larvae of *C. pseudoceriferus* on the potted seedlings. All males which completed their development and reached the adult stage remained on the leaves right up to the time of emergence of the winged adults. This was so in the case of the trees in the field also. In the hosts which shed their leaves during February and March, the female larvae may migrate to the branches before leaf-fall. When a leaf is about to be shed the circulation of sap in its vascular system is gradually cut off owing to the formation of a

[1] See footnote on page 45.

cork-layer at the base of the petiole. The larva that grows on the leaf feeding on the sap would naturally get a timely warning of the impending danger from the cessation of sap flow. An analogous situation was found in the drying up of infested leaves which were removed from the host-tree and kept in the laboratory: this caused the female larvae to withdraw their stylets and crawl about in search of fresh spots. Such movements were exhibited only by the second and early third instar female larvae. The presence of male propupae and pupae on fallen leaves may be correlated with their dormancy and with the absence of feeding during these stages.

6. Post-Embryonic Development

The post-embryonic transformations of the male and female of *C. pseudoceriferus* were followed in the laboratory by rearing the larvae on seedlings of mango. The seedlings were grown inside a wire-net cage on the terrace of the Zoology Department. At frequent intervals the different developmental stages were examined *in situ* on the plants with a hand-lens. These observations were mainly used for general guidance and for appraising the duration of the different instars. Large numbers of scales of either sex, corresponding in age to the stages observed on the laboratory seedlings, were collected from the field and used for detailed study and for control. In the early part of the work, moulting was missed in some cases on account of aerial disturbances that caused the exuviae to be blown off. This difficulty was later obviated by smearing a thin film of vaseline on the leaves and stems, near the hind extremities of the scales. The exuviae were trapped and retained intact by the vaseline film.

(*a*) First stage larva

The newly emerged larva is very active. The body is dorso-ventrally flattened, oval, and widest in the thoracic region. The anterior end is smoothly rounded and the two ocellanae are visible as two black pigmented spots. The narrow posterior end of the body is marked off by the anal cleft into two lateral lobes. At the base of the anal cleft on the dorsal side are the two anal plates or opercula, each carrying apically a long anal filament. The larva has a pair of antennae and three pairs of well-developed legs. These, together with the mouth parts, are situated on the ventral side, but the antennae and the legs extend beyond the margin of the body while crawling. The larva measures about 0.41 mm. in length and 0.23 mm.

in breadth. It is naked, devoid of any waxy secretion, and has a brown colour.

Within 24 hours of emergence from the test of the mother, most of the larvae settle down on suitable places and commence to secrete wax. After remaining for some time at one spot, a larva may crawl away to another place, if necessary. In 24 hours after settling, two wavy median longitudinal streaks of wax appear on the dorsum, connected by thin transverse bands of the same material. A speck of wax appears at the anterior end, and two pairs of wax points just above the two pairs of stigmatic clefts. Then follows another pair of wax points at the posterior margin, a little cephalad of the caudal end. In about 48 hours the two dorsal streaks become more pronounced and show signs of becoming confluent; at the same time the lateral margins of the body bear a series of wax points including the three original ones (Plate II, fig. 1). After two days the secretion of more wax results in the formation of a single high ridge of wax on the dorsum, and the marginal points of wax grow still further and become differentiated into fifteen processes, viz. three at the cephalic end, four pairs at the two sides, and two pairs at the caudal end. In one week these fifteen processes become very prominent and the dorsum is almost completely covered by the dorsal ridge (Plate II, fig. 2). The dorsum of the insect is only visible in the form of an oval outline at the base of the dorsal ridge. Green (1909) refers to the dorsal ridge as the 'median dorsal pad of white wax', while Blumberg (1934) mentions a similar hump on the larva of *C. rubens* and calls it the 'dorsal crest'. The central one of the three cephalic processes is larger than the other two at its sides; of the four pairs of lateral processes the two anterior pairs are exactly above the stigmatic clefts and are broader and longer than the remaining two pairs behind them; and the outer two of the four caudal processes are larger than the inner ones. In the following pages the four caudal processes will be referred to as the inner and outer pairs, the term 'dorsal hump' is used for the dorsal ridge of wax, and the lateral processes are referred to as such. The term 'marginal processes' is used collectively for all the fifteen processes. The dorsal hump and the marginal processes together constitute the nymphal or larval test.

The dorsal hump of the first stage larva has a trapezoidal form in lateral view, and leans towards the cephalic end (Plate II, fig. 4). On magnification (x32 or more) it shows horizontal laminations, indicating that the hump is secreted in successive layers which are superimposed upon one another. The dorsal hump and the marginal processes are brittle and formed of white wax. In some larvae the

terminal ends of some of the marginal processes are forked. Throughout the first instar the anal filaments are retained by the larva, and are directed posteriorly, extending to some distance behind the test. The opercula are clearly exposed to view and are surrounded on all sides by the basal parts of the caudal processes and the posterior edge of the dorsal hump. In addition to the dorsal hump and the marginal processes the first stage larva also secretes a fringe of short, more or less conical processes formed by the juxtaposition of needles of wax all round the margin of the body. The marginal fringe is obscured from view by the bases of the marginal processes above them, but in the second instar male, when the larva grows in thickness, the marginal processes are raised from the leaf-surface and the marginal fringe becomes conspicuous (Plate II, fig. 6).

The first moult occurs three weeks after settlement. The anal filaments are shed off during the first moult. At the end of the first stage the test of the larva measures about 1 mm., in length. The moulted skin is pushed out of the hind extremity through a small crevice between the test and the leaf or twig.

(*b*) Male line

Second instar larva: After the first moult the growth of the male larva is rapid. Sexual differentiation becomes manifest in the second instar, and the male and the female larvae can be distinguished about five weeks after larval settlement. The male larva at this stage is longer, narrower relatively to its length, and thinner than the second instar female. Silvestri (1919) observes that in *C. sinensis* the difference between the sexes becomes evident in the third stage larvae. In five to six weeks after settling on the host plant the test of the male larva attains a length of about 2 mm. The dorsal hump and the marginal processes are markedly grown and constitute the most conspicuous features of the test (Plate II, fig. 5). At the present stage it can never be mistaken for a female larva. As a result of the addition of wax at their bases the marginal processes lengthen out and become curved, with their tips often touching the leaf-surface. The denuded insect is thin and flat with a broad median longitudinal elevation on the dorsum and a depression running round the base of the former. The dorsal prominences, which as will be seen later are so characteristic of the second and older stages of the female, are entirely absent in the male larva. Preserved specimens, when examined under the binocular microscope with transmitted light, show the presence of testes in the form of two longitudinal long yellowish bodies. The anal tube or 'organo retrattile anali' of Berlese can also be seen in such specimens.

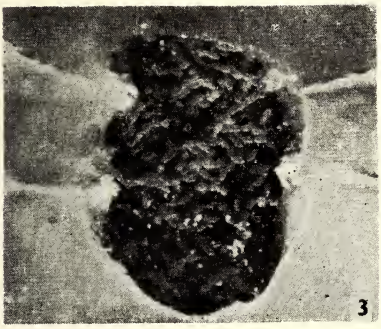

Fig. 1. A colony of adult females of *C. pseudoceriferus* on mango, showing heavy infestation. Fig. 2. Close-up of an adult female from its left side. Fig. 3. Ventral view of an ovipositing female showing the eggs laid in chains. Fig. 4. Ventral view of a mature female showing waxy secretion prior to oviposition. Note the transverse bands and the pellets of wax in the posterior region of the body. Fig. 5. Longitudinal section of a dead female with the eggs massed below the body. Fig. 6. Ventral view of a dead female with the empty chorionic cases after emergence of the young ones. Fig. 7. Ventral view of an advanced adult female showing the segmentation of the abdomen and the stigmatic bands of wax. Fig. 8. Newly hatched larvae on a mango twig before settling.

In the second instar larva the legs and antennae are closely applied to the venter. The two pairs of stigmatic furrows running transversely from the spiracles to the stigmatic clefts are filled with white powdery wax.

After six weeks of growth, the male larva begins to show a bulge on the dorsal side. This bulge is, however, confined to the anterior two-thirds of the body and is caused by the development in this region of the imaginal buds which are destined to give rise to the different appendages of the head and thorax of the adult male. As a result of this bulging, the test becomes higher and the marginal processes become raised from the surface of the leaf. The larva secretes a thin layer of transparent glassy material, which lines the inner surface, and also forms the sides of the test. This layer appears to correspond to the puparium of the males of other lecanine genera. There is, however, no indication of its division into separate areas or shields. In *C. singularis,* Newstead (1910-11) found a similar 'thin, opaque, white, glassy layer of secretionary matter' below the waxy processes. He says that 'the true character of the glassy portion can be seen only after carefully dissolving the outer waxen layer with xylol'. The test is no longer parallel to the surface of the leaf but becomes somewhat inclined upwards on account of the greater convexity of the dorsum at the anterior end.

The larva continues to feed till the end of the second instar, when the stylets and other cuticular structures are shed away with the moulted skin. The second moult occurs $7\frac{1}{2}$ to 9 weeks after settlement on the host plant. As in the first moult, the exuvium is cast away at the hind end through the space between the test and the leaf (Plate II, fig. 6). The mouth parts, opercula, and the anal tube are shed once for all.

The first and second instar male larvae show a short, stout, and conical tube of wax, protruding from below and beyond the opercula. MacGillivray (1921) reports the presence of this tube in some lecanine species and mentions that it is secreted by the anal ring cerores and that it serves to expel the honey dew secreted by the larva away from the body. The whole anal tube is often everted out by the larva, when it can be seen to carry at its distal end six radiating pencils of wax arranged in a circlet (Plate II, fig. 10). The tube of wax is seen in the females also.

Third instar male (*Propupa*): The test of the second instar male larva grows to a size of 2 to 2.5 mm. At the end of the second instar the whole test, with the dorsal hump and the marginal processes intact, can be separated from the body of the insect, which remains adhering to the leaf. Apart from the larval test with its inner

glassy lining there is no separate puparium. It seems to the present author that Newstead's description (1896) of the so-called puparium of *C. ceriferus* was based on tests from which the dorsal hump and the marginal processes had become separated. Newstead (1910-11) seems to have mistakenly regarded this condition as normal for the whole genus, and the presence of the waxy processes in the male larva of *C. singularis* as something unique and singular.

After the second moult the male enters the quiescent propupal stage. The body of the propupa is completely free from the test but the test, as well as the body, remain attached to the leaf by an adhesive substance which appears to exude from the venter and the sides of the propupa. The hind end of the test is tilted up slightly during moulting in order to let the exuvium escape.

The anterior part of the body of the propupa is narrower than the rest, and the head, thoracic, and abdominal regions are incipiently distinguishable. The abdomen bears marks of segmentation in the form of faint transverse lines. The legs and antennae are in the form of short, stout processes; the wing pads are small and applied to the sides of the thorax and the anterior part of the abdomen. Posteriorly, the abdomen terminates in three conical processes. The central one, which is broad and blunt at the tip, is the rudiment of the stylus or penis-sheath, while the other two, one on each side of the stylus, are narrow and pointed and are the precursors of the caudal tubercles of the adult male.

The propupal stage lasts for 7 to 10 days, after which the male undergoes the third moult, which occurs generally between the 65th and 70th days after larval settlement.

Fourth instar male (Pupa): The fourth instar in the male line is a typical exarate pupa (Plate III, fig. 8). The division of the body into head, thorax and abdomen is more pronounced than in the propupa. There is a constriction behind the head; the limits of the thoracic sclerites are visible; the legs and the antennae are longer and thinner. The ventral ocellanae are represented by two black spots. In very advanced pupae, the dorsal ocellanae can also be seen. The wing pads of the pupa are longer and broader than those of the propupa and are closely applied to the abdomen. The stylus and the caudal tubercles are better defined than in the preceding stage. Mouth parts are wanting in both the stages.

Adult male (Fifth instar): The pupal stage lasts for 11 or 12 days, at the end of which the fourth ecdysis occurs. The adult male does not come out of the test immediately after the last moult, but remains inside for two or three days. After this rest it lifts the posterior part

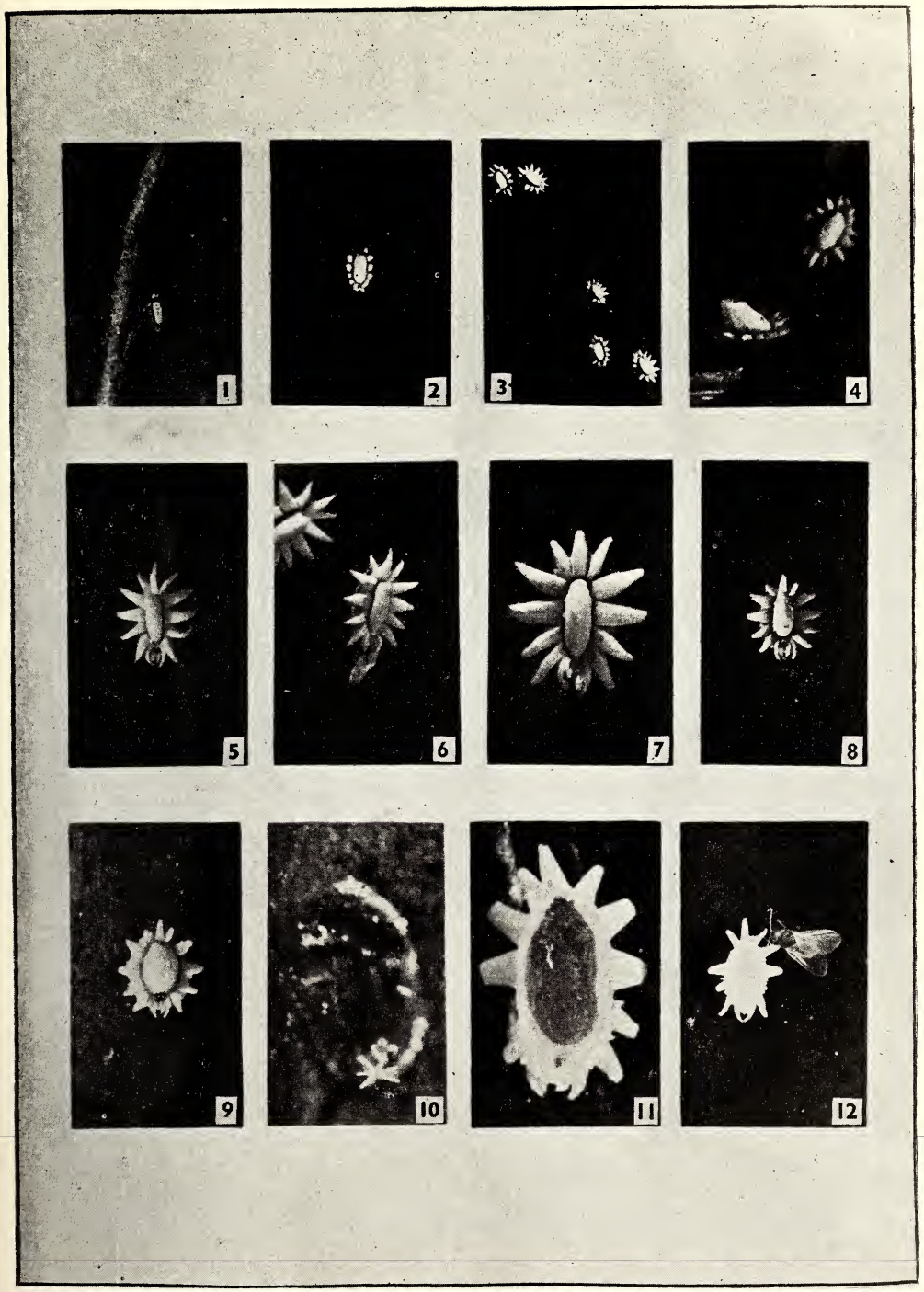

Fig. 1. Young larva on a mango leaf after commencement of the secretion of the test. Fig. 2. First instar larva about a week after settlement. Fig. 3. A group of advanced first stage larvae on a mango leaf. Note the orientation of the larvae parallel to the vein of the leaf. Fig. 4. Lateral view of a first instar larva. Fig. 5. A second instar male larva. Compare with the corresponding stage of the female shown in Fig. 8. Fig. 6. A male larva after the second moult. The cast-off exuvium and the fringe of wax processes below the marginal processes may be noted. Fig. 7. Close-up of an advanced male larva. Fig. 8. A second instar female larva. Fig. 9. An early third instar larval female after it has begun the secretion of the doughy wax. Note the doughy wax at the bases of the dorsal hump and the marginal processes. Fig. 10. A second stage male larva, divested of its test, showing the everted anal tube and the circlet of wax pencils at its end. Fig. 11. Ventral view of a male pupa with its test turned upside down. Fig. 12. An adult male just after emergence from its test.

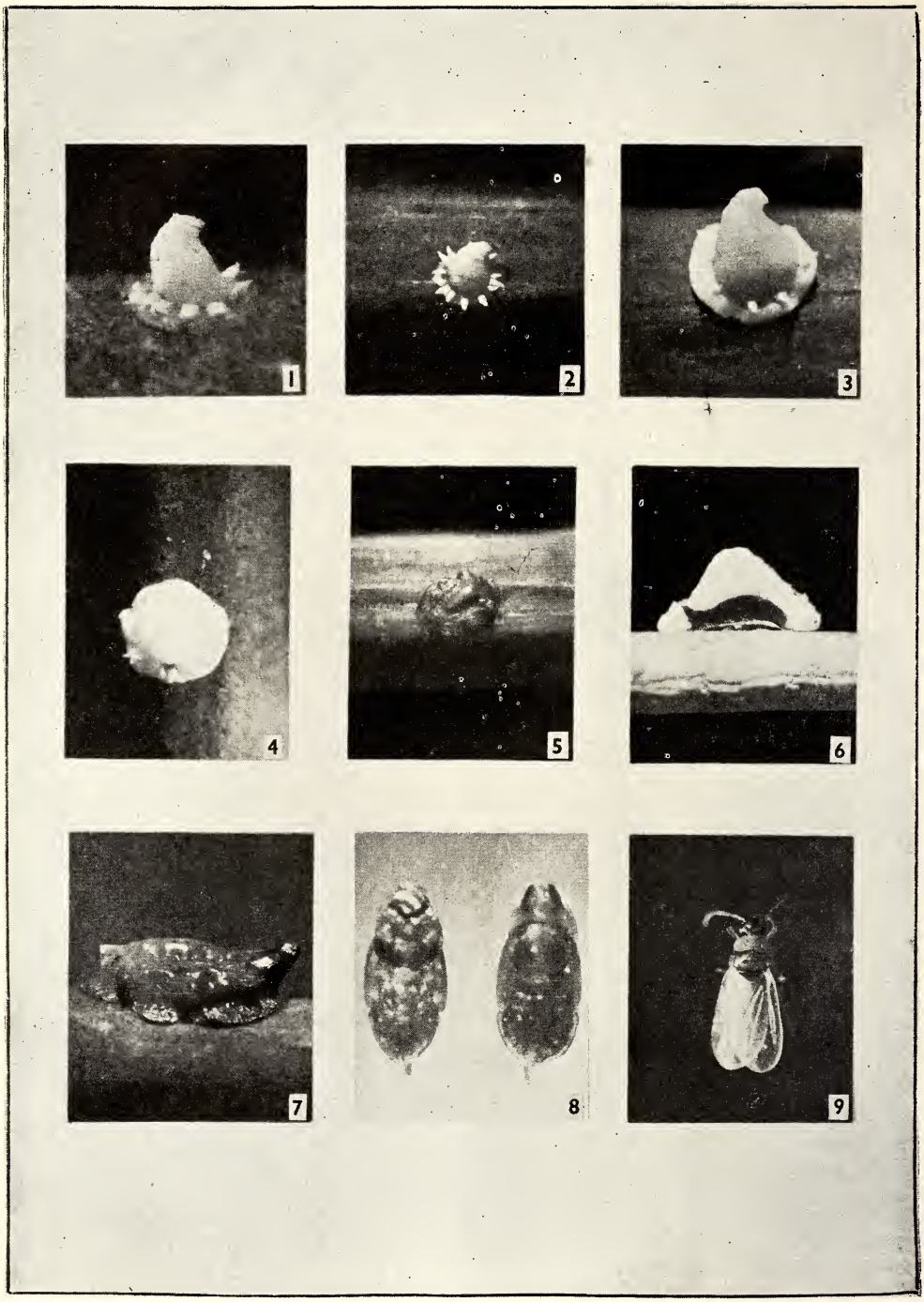

Fig. 1. Lateral view of a third instar female showing the doughy wax, the dorsal hump, and the marginal processes. Fig. 2. A later stage than that depicted in Fig. 1, in which the doughy wax has increased in volume. Fig. 3. A third instar female with a well-formed test. The dorsal hump and the marginal processes are inconspicuous, being submerged in the doughy wax. Fig. 4. An advanced third instar female with the test more or less in the definitive form. Note the depression at the caudal end. Fig. 5. A third instar female denuded of wax to show the supra-marginal prominences. Fig. 6. Sagittal section of an adult female showing the relationship of the insect with the test. Fig. 7. Lateral view of an adult female on twig, denuded of wax, showing the caudal process and the stigmatic clefts. Fig. 8. Ventral and dorsal views (left and right figures respectively) of a male pupa. Fig. 9. Dorsal view of an adult male.

of the test and crawls out. The stylus is wedged in below the test and used as a lever in the process of emergence.

Soon after emergence the males are ready for copulation, but males which are forcibly extricated from their tests immediately after the fourth moult do not copulate at once. They remain quiet for several hours at the same place. A series of males that were forced out of their tests, and fixed and mounted after staining showed that, during the quiescent period preceding copulation, the sperms descend into the seminal vesicle.

Newstead (1896) in his description of the adult male of *C. ceriferus* remarks: 'the long anal setae in life would no doubt be covered with white wax forming long white filaments, common in all the males belonging to this division of the Coccidae. In all the specimens examined the white covering was wanting and no doubt was broken away during transit.' The present author has examined many freshly emerged males of *C. pseudoceriferus* but none of them bore these thread-like filaments of wax at the caudal end (Plate II, fig. 12 & Plate III, fig. 9). Perhaps Newstead surmised their existence by analogy with the males of other Lecanine genera. MacGillivray (1921) mentions that the caudal filaments may be wanting in some genera of this group. Leonardi (1920) and Silvestri (1927) have figured a pair of caudal wax filaments in the male of *C. rusci* in Italy.

(*c*) Female line

Second instar larva: Immediately after the first moult the larvae of the two sexes do not differ in the external appearance of the test, but later it is possible to distinguish them. The second instar female is smaller in size, and the test measures about 1.2 mm. in length. The anal filaments disappear after the first moult, as in the case of the male larva. During the second stage, the body of the female assumes a more rounded and discoidal form, the naked dorsum of the insect showing itself in the form of a ring encircling the base of the dorsal hump and also through the narrow spaces between the marginal processes (Plate II, fig. 8).

In an upturned scale, the outline of the body of the second instar can be easily seen to be different from that of the male. The stigmatic furrows are filled with pulverised wax. Bordering the margin externally is a fringe of waxy processes, as in the male larva.

Denuded females of the second stage show that the dorsum is raised into a number of supra-marginal prominences. In addition to a broad, median, longitudinal ridge in the centre, there are three

anterior prominences, the central one of which is larger than the lateral ones; four prominences laterad of the median ridge on each side; and a single large prominence at the caudal end. The first two lateral prominences of each side are larger than the two hinder ones and are situated exactly above the stigmatic clefts of that side. These supra-marginal prominences correspond to and support the anterior, lateral, and caudal wax processes of the test. The caudal prominence, though single, bears all the four caudal wax processes. The opercula are at the centre of the caudal prominence, and the anal cleft extends cephalad on the latter to the region of the opercula.

The legs of the second instar female are functional and the larva can crawl slowly on the surface of the leaves and stems. The second moult in the case of the female occurs six weeks after settlement. The exuvium is pushed out from below the posterior extremity.

Third instar larva: Following the second moult, the female larva commences the secretion of wax of a new consistency, which is very characteristic of the third and subsequent stages of the female. This wax is of a doughy nature, creamy-white in colour and containing a large proportion of a watery fluid. When the wax is pressed between the fingers the watery fluid oozes out. Since the test of the adult female of *C. pseudoceriferus* consists mostly of this doughy wax, the formation of the definitive test of the adult may be said to begin at this stage. Comparing the test of the female with the ovisac of the other genera, MacGillivray (1921) says: 'In *Ceroplastes*, if the wax of the adult is considered as an ovisac, the formation of the primary plates from which the wax of the adult is derived begins in the first nymphal stage. The number of plates increases in each stage and in many species the shape and symmetry of the plates is lost by their fusion into a thick shapeless mass'. At least in so far as *C. pseudoceriferus* is concerned, it would be erroneous to say that the wax of the adult is derived from the primary plates (dorsal hump and marginal processes) of the larval test. The wax which forms the adult test is of an entirely different nature, as described above, from that of the primary plates, and is secreted only from the third instar onward. The primary plates later become submerged in the mass of doughy wax of the adult test but they constitute, if anything, only an insignificant part of the latter. Further, the primary plates are secreted by the male larva also, whereas the male never secretes the doughy wax in any stage of its life-history. These facts have been substantiated by a study of the cerores of the different stages in question.

The earliest specimen to start the secretion of the doughy wax was observed to commence the process on the 45th day after settle-

ment. There is a short lapse of time between the second moult and the commencement of secretion of the doughy wax. For example, in one case the female larva underwent the second moult on the 47th day after settlement and the secretion of the doughy wax began only on the 52nd day, showing an interval of 5 days. In another case, the process in question lagged behind and the secretion of the doughy wax began as late as on the 72nd day.

The doughy wax starts at first as a thin film on the whole of the dorsum, filling up the spaces between the marginal processes and covering the area surrounding the base of the dorsal hump (Plate II, fig. 9). The lateral marginal processes become separated from one another. The first two processes of each side, corresponding to the stigmatic clefts, travel far from each other as well as from the remaining marginal processes. The three anterior processes remain close to one another; similarly, the third and fourth lateral processes of each side remain close to each other in all the subsequent stages. The caudal processes show no change of position (Plate III, fig. 2). The approximation of the three anterior processes, and of the third and fourth lateral processes is related to changes in the position of the supra-marginal prominences of the underlying insect. If a series of denuded females of the third instar of varying ages is examined, it may be seen that the central anterior prominence becomes a large tubercle, while the two at the sides are very small and remain close to the former; similarly, the third and fourth lateral prominences may be seen to come very close to each other. The caudal prominence remains single as in the previous stages. The secretion of doughy wax increases in quantity and in another few days the test assumes the shape of a helmet, the dorsal hump being carried at the summit of it; but, for lack of uniformity in the secretion of wax, the dorsal hump may become slightly shifted to one side (Plate III, figs. 1 & 2). In any case, the apex of the dorsal hump is always directed away from the caudal end of the test. The growth of the test proceeds rapidly, and in about 15 days the marginal processes lose their identity and symmetry, being immersed in the doughy wax to more than half of their length. The opercula and the two pairs of caudal processes come to be lodged in a depression formed by the growth of wax in the contiguous areas (Plate III, fig. 4). The dorsal hump is still visible at the summit of the test which measures about 2.5 mm. in length.

During the third instar the wax forming the test often takes a pinkish tinge. It is very soft, and, therefore, the insect can be divested of it by means of a fine scalpel or any similar instrument.

Adult female (*Fourth instar*): Externally there is nothing to distinguish a late third instar female from an early fourth instar specimen. The third moult occurs about 15 weeks after settlement. The exuvium is pushed out at the caudal end of the test, through the space between the latter and the twig. The extruded skin is squeezed and dishevelled in the process of expulsion. There has been considerable speculation about the method of moulting in *Ceroplastes*. Green (1909) says: 'It is difficult to understand how any complete ecdysis can occur in such a genus as *Ceroplastes*, in which the body is always enveloped in a closely adherent waxy covering. It is possible that the ventral parts of the exuvia may be extruded from beneath the test; but the dorsal parts are probably incorporated in the waxy covering, though this has not been actually demonstrated'. MacGillivray (1921) makes more or less similar remarks about ecdysis in *Ceroplastes* and observes: 'The number of moults undergone by the individuals of this genus and the relation of the exuviae to the wax is not understood.' Blumberg (1934) has recorded that the female of *C. rubens* moults three times and that the exuvium, in the case of the first moult, is extruded from below the test at the caudal end. Presumably, the subsequent ecdyses also take place in the same manner. The female of *C. pseudoceriferus* also undergoes three moults; each time the moulted skin is pushed out at the caudal end of the test. While denuding a number of late third instar females various stages in the moulting process could be found. Some of the denuded insects were actually in the fourth instar but still enclosed within the third instar skin; in others the old skin had become ruptured on the dorsum and the greater part of the fourth stage female was exposed dorsally. The legs appear to play the main part in the process of kicking off the ruptured skin. It must be noticed that when the third and last moult occurs the test of the female is only about 3 mm. long. At this stage the opercula are situated at the centre of the caudal prominence as in all the previous stages and are more or less flush with the dorsum. A part of the caudal prominence surrounding the opercula is chitinised strongly but there is no caudal process or opercularia, as found in older adults. Impregnation of the female occurs at this time. The caudal process is a subsequent acquisition and begins to grow only when the body of the adult female increases in size and the test becomes progressively thicker owing to the accumulation of wax on its interior. The adult *C. pseudoceriferus* lives for 7 or 8 months and the fully grown female at the time of oviposition is three to four times bulkier than in the younger stages. The external changes undergone by the adult female from the time of the third moult to the time of oviposition consist

of an increase in body size, the growth of the caudal process, and the bulging of the dorsum which imparts to the female, in advanced stages, a spherical appearance. The supra-marginal prominences are pronounced in the early stages, but in old specimens they become smoothened out by the dorsal dilation referred to above. The caudal process develops as follows: in the early part of the adult stage the dorsum surrounding the opercula is raised up into a short, stout process carrying the opercula at its apex. *Pari passu* with the increase in the size of the female and in the thickness of the wax secreted by the dorsum, this process grows longer and also becomes strongly chitinised (Plate III, fig. 7). The anal tube is drawn into the caudal process and maintains its usual relationship with the opercula. The anal cleft increases in extent; commencing from the opercula, it now runs downwards on the posterior face of the caudal process and extends cephalad on the venter to about a fourth of its length as a postero-mesal furrow (Plate I, fig. 7). Since the caudal process becomes strongly chitinised the part of the anal cleft running on it is reduced to a mere suture.

The abdomen of the adult female shows marks of segmentation on the ventral side. Five abdominal segments are clearly visible, just in front of the ventral extension of the anal cleft (Plate I, fig. 7). The cephalic and thoracic regions run imperceptibly into each other. The legs and antennae are very small in proportion to the size of the body. The adult female is stationary and the only bodily movements exhibited by it are at the time of oviposition. The legs, however, are retained throughout life.

During the fourth instar, as the test increases in size, the marginal processes of the younger stages become completely covered over by the doughy wax, and the test becomes massive and irregular in shape (Plate I, fig. 2). The wax turns hard at the end of the adult stage owing to long exposure to the atmosphere and the sun and contains less fluid matter in it than in the early stages. When two or more females are close to one another their tests become fused at the points of contact. In some cases the opercula of the females are covered by the doughy wax and are no longer visible externally. The dorsal hump of the nymphal test may also lose its identity in advanced females.

After the death of the insect the empty tests may remain on the twig for a year or more. During this period they may provide shelter for various arthropods. The author has collected mites, psocids, coccinellid larvae, and pseudoscorpions under such old tests.

7. Seasonal History

C. pseudoceriferus has only one generation in the year. Egg-laying begins in the middle of August and the first stage larvae appear from September onwards. Oviposition continues till November, as females with eggs and newly hatched larvae are found as late as in the last week of November. The males complete their development in 2½ to 3 months and adults are found from November to March, being abundant in December, January, and February. During these months most of the females reach the early adult stage and are inseminated by the males. After copulation the females grow in size until they attain their maximum size and oviposit in the following laying season.

8. Summary

Ceroplastes pseudoceriferus Green occurs in Banaras on nine different species of host plants and is univoltine. Males occur in large numbers and the females reproduce bisexually. Eggs are laid from August to the middle of November, each female laying from about 1000 to more than 10,000 eggs, which are deposited below the venter. The newly hatched larva begins to secrete the waxy test immediately after settling. The larval test consists of a median dorsal hump and 15 marginal processes. The first instar lasts for three weeks. Sex differentiation sets in during the second instar. The characters of the second instar male and female nymphs and of all the subsequent stages of the two sexes are described, with special reference to the secretion of wax. While most of the males settle down and complete their development on the leaves, the female larvae show a marked preference for the stems and twigs. The males moult four times and the total time taken by them to reach the adult stage is about 2½ months. The females moult three times; the fourth or adult stage is reached in about 15 weeks after larval settlement. The test of the second stage female nymphs is essentially of the same form, i.e. with a dorsal hump and 15 marginal processes, as in the corresponding male stage. But, from the third instar onwards the female secretes on the dorsal side a creamy-white, doughy wax, which increases in all the later stages and gradually covers up the marginal processes. The males do not secrete this type of wax but change into the adult stage under the nymphal test itself. There is no separate puparium or cocoon, marked into shields, as in other lecanine genera. The adult males are similar in general appearance to those of *Lecanium* and *Pulvinaria* but the caudal wax filaments are absent in this species.

Fertilization takes place when the females are in the early adult stage; the females have no caudal process at the time of fertilization. The caudal process develops later as a backward and upward tubular extension of the dorsal area adjoining the opercula. The females retain their legs throughout life. They attain their maximum size by July and commence laying eggs in August. Immediately after completing oviposition they die but their tests remain attached to the twigs of the host plant for a long time after the young ones have hatched and crawled out.

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Some new and interesting forms of *Oedogonium* from Uttar Pradesh

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(*With* 18 *figures*)

The present communication deals with 13 forms of *Oedogonium* collected by Dr. M. S. Randhawa from Fyzabad, Uttar Pradesh, during 1937-39, including 3 new varieties and 1 new form.

1. **Oedogonium hirnii** Gutwinski. Tiffany, *Oedogoniaceae*, 1930, p. 73, t. 14, figs. 136, 137.

Monoecious; oogonium subglobose to subovoid, single, poriferous, pore superior; oospore globose, not completely filling the oogonium, oospore membrane smooth; antheridia 1-2, subepigynous, sperms 2, formed by horizontal division.

Breadth	veg. cells	7.6-15.2 μ ;	length	26.6 μ ;
,,	oogonia	38.0-41.8 μ ;	,,	38.0-45.6 μ ;
,,	oospores	30.4-34.2 μ ;	,,	30.4-34.2 μ ;
,,	antheridia	7.6-11.4 μ ;	,,	3.8-7.6 μ.

Habitat : Free-floating, Fyzabad, July 1939.

2. **Oedogonium plagiostomum** Wittrock. Tiffany, *Oedogoniaceae*, 1930, p. 80, t. 14, fig. 140.

Dioecious; macrandrous; oogonia obovoid-globose, single, poriferous, pore superior; oospore globose to subglobose, filling the oogonium, oospore membrane thickened; antheridia 1-4-seriate, alternating with the vegetative cells.

Breadth	veg. cells	22.8-26.6 μ ;	length	76.0-114.0 μ ;
,,	oogonia	45.6-49.4 μ ;	,,	53.2-57.0 μ ;
,,	oospores	41.8-45.6 μ ;	,,	41.8-49.4 μ ;
,,	antheridia	19.0-22.8 μ ;	,,	7.6-11.4 μ .

Habitat: Free-floating along with *Oe. crassiusculum* var. *indica* Venkat. Fyzabad, July 1939.

3. **Oedogonium multisporum** Wood. Tiffany, *Oedogoniaceae*, 1930, p. 131, t. 46, fig. 482.

var. **unicellularis** var. nov.

Dioecious, nannandrous, idiandrosporus; oogonium intercalary, 1-2, obpyriform, poriferous, pore superior; nannandria single-celled,

attached to the oogania; androsporangia 1-4; oospore globose, filling the oogonium; spore wall smooth (text-fig. 1-3).

Dioica, nannandra, idiandrospora; oogonium intercalare, 1-2, obpyriforme, poriferum; poro superiore; nannandria semel cellulata, oogoniis insidentia; androsporangia 1-4; oospora globosa, implens oogonium; parietibus levibus.

Breadth	veg. cells	12.0-16.0 μ ;	length	40.0-80.0 μ ;
,,	oogonia	28.0-32.0 μ;	,,	32.0-44.0 μ ;
,,	oospore	28.0-30.0 μ :	,,	28.0-30.0 μ ;
,,	androsporangia	12.0 μ ;	,,	4.0-5.0 μ .

This variety differs from the type and *Oe. multisporum* Wood var. *magnus* Ackley in its unicellular nannandria.

Habitat: Free-floating along with *Zygnemopsis splendens* Randh. Fyzabad, July 1939.

Type: Randhawa collection No. 114, Indian Agricultural Research Institute, New Delhi.

4. **Oedogonium irregulare** Wittrock. Tiffany, *Oedogoniaceae*, 1930, p. 131, t. 46, fig. 447.

var. **tenuis** var. nov.

Dioecious, nannandrous, gynandrosporus; oogonium 1-2, pyriform, poriferous, pore superior; oospore globose, filling the oogonium; oospore wall smooth; nannandria attached to the oogonia; sperms 2, formed by a transverse division (text-fig. 4).

Dioica, nannandra, gynandrospora; oogonium 1-2, pyriforme, poriferum, poro superiore; oospora globosa, implens oogonium; parietes oosporae leves; nannandria oogoniis insidentia; spermatia 2, formata per divisionem transversalem.

Breadth	veg. cells	13.5-14.9 μ ;	length	72.0-48.6 μ ;
,,	oogonia	37.8-40.5 μ ;	,,	48.6-54.0 μ ;
,,	androsporangia	10.8 μ ;	,,	8.1-9.5 μ ;
,,	antheridia	8.1 μ ;	,,	5.4 μ ;
,,	oospores	37.8 μ ;	,,	37.8 μ .

This form agrees with *Oe. irregulare* Wittrock in its dioecious, nannandrous nature, oogonia with superior pore, smooth spore wall; but differs from the same in narrower vegetative cells, pyriform oogonia, clearly globose oospores, smaller nannandria and antheridia.

Habitat: Free-floating, Fyzabad, June 1939.

Type: Randhawa collection No. 114, Indian Agricultural Research Institute, New Delhi.

5. **Oedogonium irregulare** Witt. var. **condensatum** (Hallas) Hirn. Tiffany, *Oedogoniaceae*, 1930, p. 132, t. 46, figs. 448, 449.

Dioecious, nannandrous, idiandrosporus; oogonium single and rarely in twos; oospore globose to depressed-globose, poriferous, pore superior, spore wall smooth; dwarf male on oogonia; antheridia exterior (text-figs. 5, 6).

Breadth	veg. cells	15.2-19.0 μ ;	length	30.4-38.0 μ ;
,,	oogonia	38.0 μ ;	,,	38.0-45.6 μ ;
,,	oospores	36.1 μ ;	,,	30.4-36.1 μ ;
,,	androsporangia	13.3-17.5 μ ;	,,	9.5-13.3 μ ;
,,	nannandria	11.4 μ ;	,,	22.8-24.7 μ ;
,,	antheridia	9.5 μ ;	,,	3.8-7.6 μ .

The dwarf males in this form are not found in clusters as in the type.

Habitat: Free-floating, Fyzabad, July 1937.

6. **Oedogonium rufescens** Wittrock. Tiffany, *Oedogoniaceae* 1930, p. 66 t. 11, fig. 105.

forma **minuta** forma nova.

Dioecious, macrandrous; oogonia 1-3, obovoid to depressed obovoid-globose, pore median; oospore depressed-globose, not completely filling the oogonia, spore wall smooth; antheridium 1-6, sperm single (text-figs. 7, 8).

Dioica, macrandra: oogonia 1-3, obovoidea vel depresso-obovoideo-globosa; poro mediano; oospora depresse globosa, haud penitus implens oogonium; parietes sporae leves; antheridium 1-6 seriatum; sperma unicum.

Breadth	veg. cells	4.1-5.4 μ ;	length	16.2-21.6 μ ;
,,	oogonia	20.3 μ ;	,,	17.6 μ ;
,,	oospores	17.6 μ ;	,,	14.9 μ ;
,,	antheridia	5.7 μ ;	,,	11.4 μ .

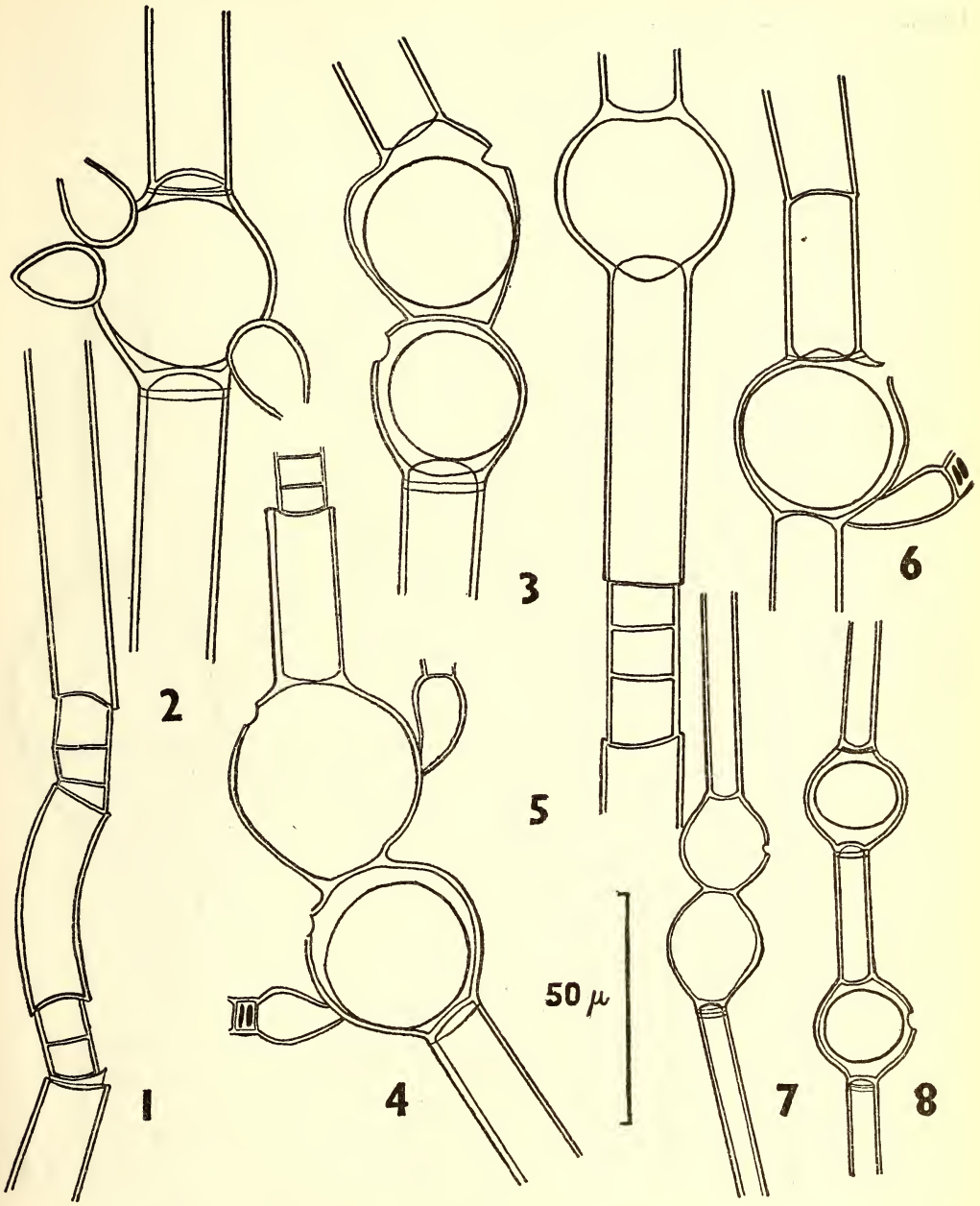
This form is characterised by its smaller dimensions, which serve to distinguish it from the type and from the varieties *exiguun* (Eg.) Tiffany and *lundellii* (Witt.) Tiffany. It further differs from the latter varieties in its oospore not filling the oogonium completely.

Habitat: Epiphytic on *Oe. multisporum* var. *unicellularis* Venkat. Fyzabad, July 1939.

Type: Randhawa collection No. 114, Indian Agricultural Research Institute, New Delhi.

7. **Oedogonium tapeinosporum** Wittrock f. **fowlingense** Jao in Sinensia 8 : 299-313, 1937.

Dioecious, macrandrous; oogonia 1-8, pyriform or pyriform-globose or depressed globose, operculate, division median, narrow but distinct;



Figs. 1-3, *Oedogonium multisporum* var. *unicellularis* var. nov. : Fig. 1, part of the male filament with androsporangia ; Fig. 2, filament with unicellular nannandria on the oogonium ; Fig. 3, oogonia showing the superior pores ; Fig. 4, *Oe. irregulare* var. *tenuis* var. nov. ; Figs. 5-6, *Oe. irregulare* var. *condensatum* (Hallas) Hirn. ; Figs. 7-8, *Oe. rufescens* f. *minuta* forma nova.

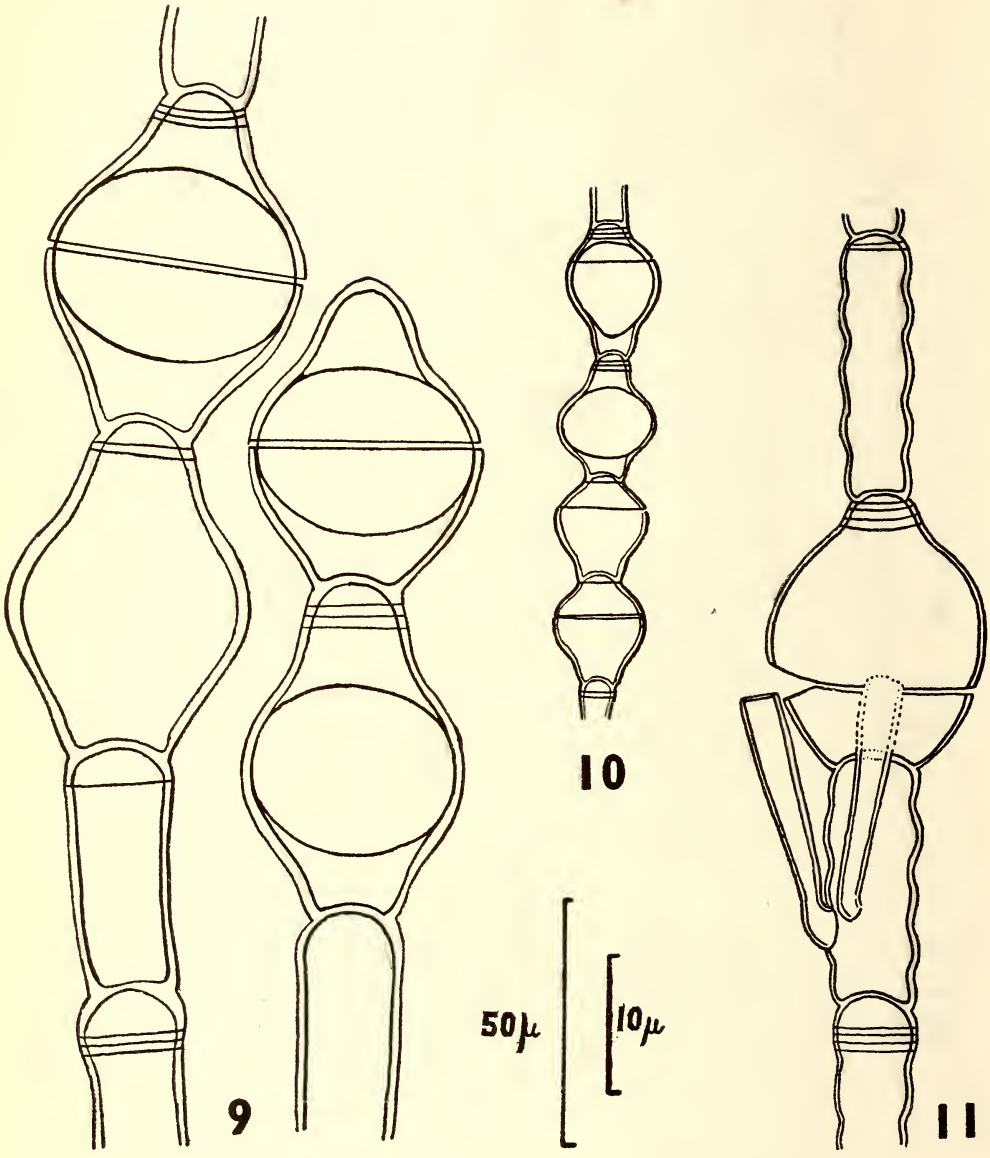


Fig. 9, *Oedogonium tapeinosporum* f. *fowlingense* Jao ; Fig. 10, *Oe. sphaerandrium* Wittrock & Lund. ; Fig. 11, *Oe. undulatum* (Bréb) Br.

oospore depressed-globose, not filling the oogonium longitudinally, spore wall smooth; basal cell hemispherical; terminal cell obtuse (text-fig. 9).

Breadth veg. cells	7.6 μ ;	length	22.8-26.6 μ ;
,, oogonia	18.2-19.0 μ ;	,,	22.8 μ ;
,, oospores	15.2-17.1 μ ;	,,	13.3-15.2 μ .

Habitat: Free-floating, Fyzabad, July 1937.

8. **Oedogonium sphaerandrium** Witt. & Lund. Tiffany, *Oedogoniaceae*, 1930, p.112, t. 36, fig. 337.

Monoecious, oogonia 1-4, subpyriform to sub-depressed-globose, operculate, division a little above median; oospore subdepressed or depressed-globose, nearly filling the oogonium, spore wall smooth; antheridium 1-6, scattered; vegetative cells capitate (text-fig. 10).

Breadth veg. cells	7.6 μ ;	length	22.8-38.0 μ ;
,, oogonia	17.1-22.8 μ ;	,,	19.0-22.8 μ ;
,, oospores	15.2-20.9 μ ;	,,	15.2-20.9 μ ;
,, antheridia	6.8 μ ;	,,	5.0-6.0 μ .

Habitat: Free-floating, Fyzabad, June 1937.

9. **Oedogonium undulatum** (Bréb) Br. Tiffany, *Oedogoniaceae*, 1930, p. 118, t. 42, fig. 407.

Dioecious; vegetative cells undulate; nannandrous, nannandria on suffultory cells; oogonia solitary, globose to pyriform, operculate, division inferior; oospore globose, nearly filling the oogonium; oospore wall smooth, terminal cell obtuse (text-fig. 11).

Breadth veg. cells	11.4-15.2 μ ;	length	30.4-68.4 μ ;
,, oogonia	41.8-45.6 μ ;	,,	41.8-57.0 μ ;
,, oospores	38.0-41.8 μ ;	,,	38.0-41.8 μ ;
,, nannandria	7.6 μ ;	,,	45.6-53.2 μ ;
,, suffultory cells	19.0-22.8 μ ;	,,	57.0 μ .

This form has much smaller dimensions than the type.

Habitat: Free-floating along with *Oe. sphaerandrium* Witt. and Lund. Fyzabad, June 1937.

10. **Oedogonium crassiusculum** Wittrock. Tiffany, *Oedogoniaceae*, 1930, p. 129, t. 49, fig. 474.

var. **indica** var. nov.

Dioecious, nannandrous, idiandrosporus; oogonium solitary, globose or globose-ovoid, poriferous, pore superior; oospore globose to globose-ovoid, nearly filling the oogonium; spore wall smooth and thickened; androsporangia 1-5; nannandria unicellular on oogonium (text-figs. 12-15).

Dioica, nannandra, idiandrospora; oogonium unicum, globosum vel globoso-obovoideum; poro superiore; oospora eiusdem formae ac oogonium, fere vel penitus implens oogonium; sporae parietes leves et crassi; androsporangia 1-5; nannandria semel cellulata, oogonio insidentia.

Breadth	veg. cells (male)	22.8-26.6 μ ;	length	34.6-76.0 μ ;
,,	,, (female)	26.6-28.5 μ ;	,,	83.6-95.0 μ ;
,,	oogonia	53.2 μ ;	,,	53.2-64.6 μ ;
,,	oospores	45.6-47.5 μ ;	,,	45.6-53.2 μ ;
,,	androsporangia	22.8 μ ;	,,	3.8-7.6 μ .

This form differs from the type in the idiandrosporus nature and unicellular nannandria. This form is readily distinguishable from var. *arechavaletae* and var. *idiandrosporum* by its unicellular nannandria on oogonium alone.

Habitat: Free-floating, Fyzabad, July 1939.

Type: Randhawa collection No. 113, Indian Agricultural Research Institute, New Delhi.

11. **Oedogonium multisporum** Wood. Tiffany, *Oedogoniaceae*, 1930, p. 131, t. 46, fig. 482.

Dioecious, nannandrous; oogonium 1-3, subovoid or subglobose, pore superior; oospore globose, spore wall smooth; dwarf male a little curved or erect on oogonium (text-fig. 16).

Breadth	veg. cells	11.4-15.2 μ ;	length	11.4-38.0 μ ;
,,	oogonia	22.8-38.0 μ ;	,,	26.6-38.0 μ ;
,,	oospores	22.6-36.0 μ ;	,,	22.6-36.0 μ ;
,,	antheridia	7.6-9.5 μ ;	,,	3.8-7.6 μ .

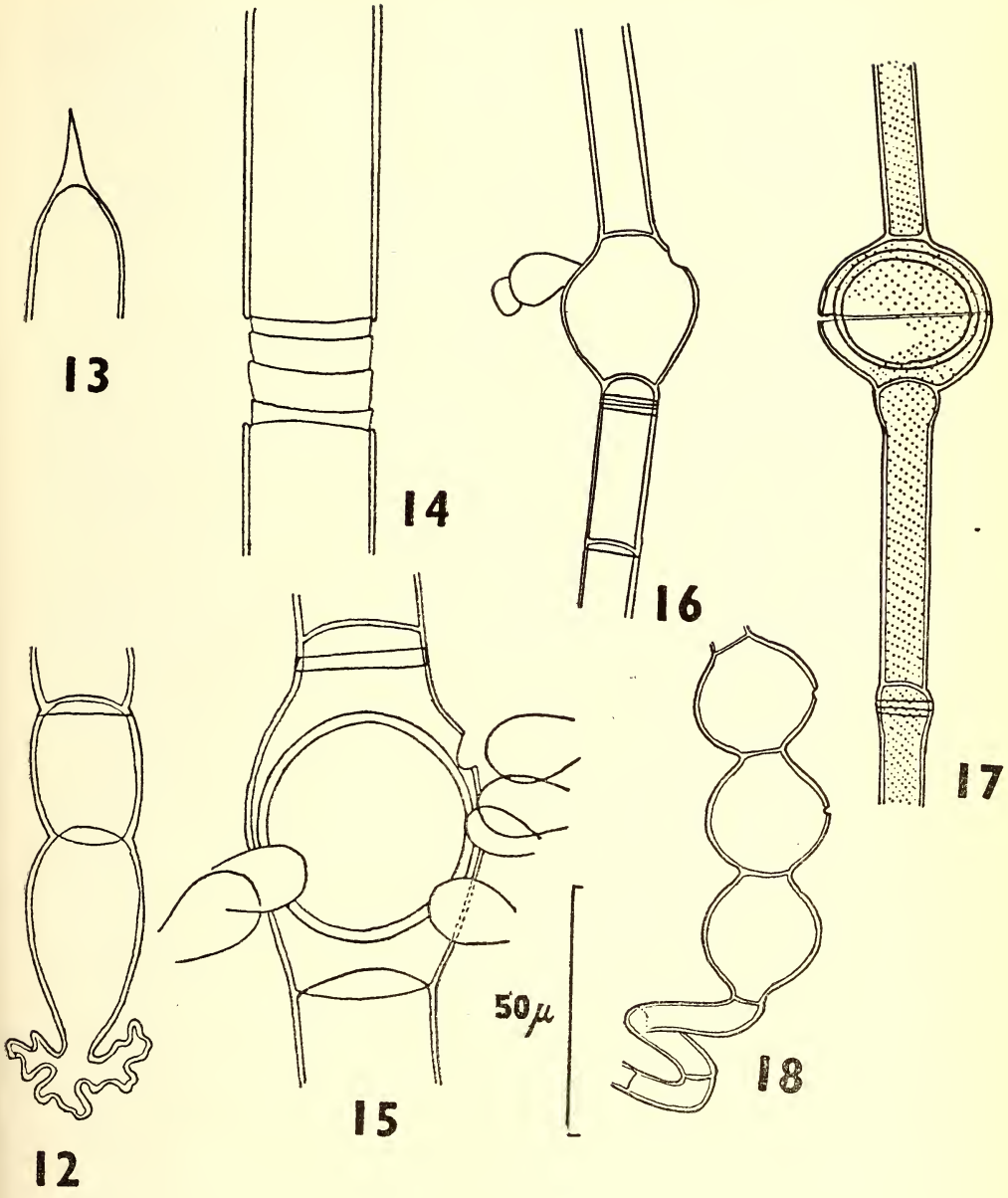
Habitat: Free-floating, Fyzabad, July 1939.

12. **Oedogonium minus** Wittrock. Tiffany, *Oedogoniaceae*, 1930, p. 103 t. 34, fig. 302.

Monoecious; oogonium single, subglobose to pyriform-globose; operculate, division median; oospore depressed globose not completely filling the oogonium, spore wall smooth; antheridia 1-6; cells somewhat capitellate; wall of the oogonium and vegetative cells spirally punctate (text-fig. 17).

Breadth	veg. cells	7.6 μ ;	length	60.8-102.6 μ ;
,,	oogonia	33.2 μ ;	,,	34.2 μ ;
,,	oospores	28.5 μ ;	,,	24.7 μ ;
,,	antheridia	5.7 μ ;	,,	3.8-5.7 μ .

Habitat: Free-floating, Fyzabad, July 1937.



Figs. 12-15, *Oedogonium crassiusculum* var. *indica* var. nov.; Fig. 12, showing the basal cell with the haptera; Fig. 13, apical cell; Fig. 14, part of the male filament with androsporangia; Fig. 15, part of the female filament with unicellular nannandria; Fig. 16, *Oe. multisporum* Wood.; Fig. 17, *Oe. minus* Wittr.; Fig. 18, *Oe. curvum* Pring.

13. **Oedogonium curvum** Pringsheim. Tiffany, *Oedogoniaceae*, 1930, p. 65, t. 11, figs. 103, 104.

Monoecious; oogonium 1-4, poriferous, pore median, depressed-globose; oospores filling or not filling the oogonium; spore wall smooth; antheridia 1-4; filaments irregularly curved (text-fig. 18).

Breadth veg. cells	5.7-7.6 μ ;	length	7.6-11.4 μ ;
„ oogonia	22.8-26.6 μ ;	„	22.8-28.5 μ ;
„ antheridia	5.7-7.6 μ ;	„	3.8-5.7 μ .

Habitat : Free-floating, Fyzabad, July 1938.

Acknowledgement

The author records his sincere thanks to Dr. M. S. Randhawa for his keen interest and for kindly placing his collections at his disposal. He is also grateful to Dr. B. P. Pal for kindly providing facilities. His thanks are also due to Rev. Fr. H. Santapau for kindly providing the Latin diagnosis for the new forms described in this paper.

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Notes on the Butterfly Genus *Ypthima*

BY

SIR KEITH CANTLIE, C.I.E., I.C.S. (Retd.)

AND

DR. T. NORMAN

(*With a text figure*)

The object of these notes is to amplify the treatment of the genus by Talbot (1947) in the FAUNA OF BRITISH INDIA.

1. Talbot calls *Y. watsoni* Moore by the name of *Y. pandocus watsoni*, but the clasp of *pandocus* of Malaya and neighbouring areas is quite different from that of *watsoni*. Talbot describes at page 323 what is really the clasp of *watsoni*, similar to that of *newara*, in error for the clasp of *pandocus*. The foundation work on *Ypthima* genitalia is the article by Elwes and Edwards (1893). They figure *pandocus* correctly, but their figure of *watsoni* is actually that of the very different clasp of the more recently determined species *akbar* Talbot. Talbot points out their error on page 324. We give the correct figure below from our own dissections. The name, therefore, should be *Y. watsoni* Moore, a reversion to the old nomenclature.

2. A small series of what appears to be a variation of *Y. watsoni* was taken by Norman near Sebong (Manipur) in April and May, and in September. No other form of *watsoni* was found flying with them. The clasp is similar to that of *watsoni*. On the upper and under sides of the fore wing the discal fascia makes a loop with the submarginal fascia towards the dorsum. These loops are a feature of *watsoni*. The under side, however, has the ground grey, without the ochreous tinge seen in *watsoni*, and is densely covered with striae. The subapical ocellus underhind is in all specimens about the same size as that in space 3. Only in a very few specimens of *watsoni* is the subapical ocellus so small. The dry season form of *watsoni*, with dots for ocelli, has a peculiar mottled appearance unlike any other species. All dry season forms of *watsoni* have been taken from November till February save one in March. The wet season form of *watsoni* has been taken throughout the period April to October, so must have several broods. Until the form taken by Norman is captured in the dry season there remains the possibility that it has a dry season form similar to that of *watsoni*, and so be a mere variation of *watsoni*. The name given meanwhile is *Y. watsoni* var.

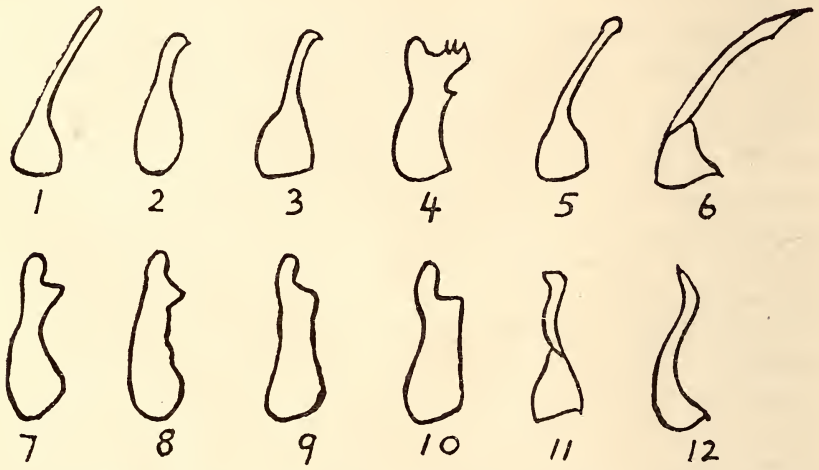
howarthi, in acknowledgement of the great help always given us by Mr. T. G. Howarth of the British Museum (Natural History). Examples have been lodged in the British Museum (Natural History) and further specimens have been set aside for the Zoological Survey of India.

3. *Y. akbar* Talbot. Cantlie found four males and three females from Shewymbin (Burma) among the part of Tytler's collection still lying in papers in the British Museum (Natural History). These all exhibit the previously unknown wet season form. Talbot's distinction that the discal line and ring of the ocellus upperfore nearly touch, whereas they are well separated in *watsoni,* is true on the average for wet season forms, although in some specimens of *watsoni* the discal line is quite as near the ocellus. The apical ocellus on the fore wing of *akbar* is very large in the dry season forms, but in these wet season ones it is not larger than that of *watsoni.* The discal line underhind in the wet season form is not more conspicuous than in *watsoni,* but is less angulated.

4. *Y. nareda nareda* Kollar and *Y. nareda newara* Moore is the nomenclature in Evans's IDENTIFICATION OF INDIAN BUTTERFLIES and it has been retained by Talbot. The clasp of *nareda* Kollar is figured by Elwes and Edwards and agrees with our dissections. It is short and stout, and the tip is shaped like a bird's head with the beak curved inwards towards the uncus. Talbot evidently describes it on page 321. But the clasp of *newara* narrows from the broad base into a slender rod which is longer than half the length of the whole. The tip varies in sharpness of point in different individuals. It is similar to that of *watsoni*: we give one figure below for both. It is not well figured by Elwes and Edwards as the clasp evidently became twisted on itself so that the tip curves the wrong way. In our opinion there is good reason to revert to the older classification used by Elwes and Edwards making these forms separate species, especially as they are distinguishable by the shape of the submarginal dark band underfore. The nomenclature should, therefore, be *Y. nareda* Kollar and *Y. newara newara* Moore.

5. *Y. newara sarcaposa* Fruhstorfer. Fruhstorfer (1908) wrote: 'As *sarcaposa* subsp. nov. the Burmese form is here separated, which is smaller and beneath lighter grey than large series of Sikkim and Assam examples. Ocelli with broader and lighter yellow bordering'. He took it in Tenasserim and says it goes north to Yunnan. The type in the British Museum has a white ground, especially on the underhind. The only other *sarcaposa* to be seen in the British Museum is a dry season form with dots for ocelli. No such insect is found in Sikkim and Assam, where all specimens of *Y. newara*

have the ground colour below ochreous. Specimens from N. Burma and Maymyo are similar to those from Sikkim and Assam. Their size is variable; small specimens occur in Sikkim and Assam as well



1. *watsoni* and *newara*. 2. *nareda*. 3. *burmana*. 4. *akbar*. 5. *fusca*. 6. *pandocus*. 7. *lisandra* (*avanta*). 8. *savara*. 9. *methora* and *atra*. 10. *dohertyi dohertyi*, *d. persimilis*, and *sakra*. 11. *asterope*. 12. *lycus*.

as larger ones, and the Burmese examples are not smaller than the small Assam ones. Evans (1932), therefore, was in error when, after saying that *nareda newara* occurs in Sikkim and Assam, he went on to say that *nareda sarcaposa* was similar to *nareda newara* but smaller and occurred in Assam and to the Shan States. Talbot follows Evans. Our opinion is that *newara newara* Moore occurs in Sikkim, Assam, and Burma and *newara sarcaposa* Fruhstorfer occurs in south Burma.

6. *Y. fusca* Elwes & Edwards. Elwes and Edwards dissected a specimen from Margherita (Assam) and found a clasp with a long slender rod like that of *newara*, but with an expanded tip. They figured it as no. 41, saying that owing to the difference in the clasp it might be a distinct species, in which case it would bear the name of *fusca*, but that they did not feel justified in separating a single specimen on an anatomical character alone. Norman has found this to be the commonest form of the *newara* group in Sibsagar District (Assam) although he has not taken it from the type locality (Margherita), where *newara newara* is the predominant form. Nor has he taken *newara* and *fusca* flying together, although it is probable that they do so from the evidence of Elwes and Edwards's type of the latter. The expansion at the tip of the clasp is like a flat serrated

cock's comb on the margin away from the uncus. It is visible when the clasp is held at an angle. In the type and in all specimens taken by Norman there is a whitish postmedian band underhind. Occasional specimens of *newara newara* have traces of a whitish area, but it is never so conspicuous as on *fusca*. The type specimen of Elwes and Edwards is in the British Museum (Natural History). Further specimens have been deposited there and others will be given to the Zoological Survey of India. (This species is not mentioned by Evans or Talbot.)

7. *Y. savara* Grose-Smith, *methora* Hewitson, *dohertyi dohertyi* Moore, and *dohertyi persimilis* Elwes and Edwards. The clasps of these are figured above. Our figures agree with those of Elwes and Edwards. *Methora* has serrations at the sloping rounded shoulder not shown in the figure. Elwes and Edwards figure only the clasp of *dohertyi dohertyi*, saying that the clasps of *persimilis* and of *sakra* are the same. The only material available to us for the clasp of *persimilis* is the clasp affixed to the card on the type specimen of *persimilis* as dissected by Elwes and Edwards, and their statement that it is the same in shape as that of *dohertyi dohertyi*. In addition to these known forms Norman took four males near Kangpokpi (Manipur, 4000 feet) in September, which we proceed to describe as a new species.

Ypthima atra sp. nov.

Male. Antenna brown, narrowly ringed with white at joints, club chestnut; head, thorax, and abdomen brown.

Upper side: Fore wing. Dark vandyke brown, without brand, outer margins evenly darker; length from centre of thorax to apex of wing 25 mm. A large bipupilled apical ocellus narrowly ringed with yellow. Hind wing. Colour as fore wing, but with a faint marginal yellow line which becomes clearer towards the tornus. Obscure subequal ocelli in spaces 6 and 5; a slightly larger prominent ocellus in space 3 contiguous to a still larger prominent ocellus in space 2; a less prominent small ocellus in space 1 contiguous tornally to a minute ocellus without pupil. (This minute ocellus is present in 3 out of our 4 specimens.) The ocelli in spaces 1, 2, and 3 have single pupils and are narrowly ringed with yellow. All ocelli on an area lighter than the rest of the wing.

Under side: Fore wing. Ground colour grey with no trace of ochreous; densely striated. Postdiscal and submarginal fasciae approaching each other towards the dorsum, the postdiscal fascia being confined to spaces 1b, 2, and base of 3. A very large bipupilled

subapical ocellus and a small ocellus with obsolescent pupil in space 2; both ocelli yellow-ringed.

Hind wing. Colour as fore wing. Prominent ocelli in 5 and 6 contiguous to each other, and prominent contiguous ocelli in 1, 2, and 3, all with yellow rings. The tornal group have their pupils in line, also the outer edges of their rings, so that the ocellus in 2, being the largest, projects inwardly. The other four ocelli are subequal, that in space 6 being slightly smaller than the rest. All ocelli single-pupilled except for that in 1c which is bipupilled, and may or may not touch the one in space 2.

Cilia: Brown.

Genitalia: The clasp is similar to that of *methora*, as shown in the accompanying illustration.

Specimens from the type series have been lodged in the British Museum (Natural History) and further specimens have been set aside for the Zoological Survey of India.

The description of the facies is applicable to the two type specimens of *persimilis* except that the colour of *atra* is darker above and the ground of the under side is grey. *Atra* would be a mere variation of *persimilis* if the clasp had the right-angled shoulder of *dohertyi dohertyi* and *dohertyi persimilis*, but to allow a constant variation in the clasp to this extent and call it a variation of *persimilis* would destroy the basis of classification by genitalia in this genus: we have no evidence that such a degree of variation exists in other species of the genus. We are well aware, however, that variation does occur in the genitalia of butterflies of the same species and are handicapped by not having a series of the very rare *persimilis* to dissect. *Methora* can be excluded because in *methora* there is a double ocellus (i.e. not a single bipupilled ocellus) in 1c underhind, which is in echelon with but not contiguous to the ocelli in 2 and 3. Also the subapical ocelli underhind are not contiguous to one another in *methora*. Apart from the two type specimens there are only four *persimilis* in the British Museum. Two are of the wet season form with large ocelli underhind, but one has the small ocelli of the dry season such as are seen in the dry season form of *methora*; these ocelli are at a distance from one another. The fourth has a very small double ocellus in 1c as is seen in *methora*: it is to be hoped that one day a dissection of this insect will show a clasp with a sloping shoulder so that it can be adjudged *methora*. If not, the main distinction between *persimilis* and *methora* would disappear and much confusion would ensue.

In the series of *dohertyi dohertyi* (in the British Museum) all ocelli underhind are large and contiguous with broad pale yellow

rings, but some papered specimens from Burma now found in the Tytler collection have small widely separated dry season form ocelli. It is strange that this form should have been unknown before.

8. The clasp of *Y. lycus* is figured. This species has been found by us only in Shillong. The striae below are so faint that a lens is required to see them adequately. A figure of the clasp of *Y. asterope* is also given since Elwes and Edwards's figure is unsatisfactory. The clasp twists over on itself, making a drawing difficult.

9. *Y. cantliei* Norman. This species was described from four males (Norman, 1958). A female was taken in the type locality on 7-5-58 and a male and female in Sibsagar District on 27-4-58. One each of the females will be given to the British Museum (Natural History) and the Zoological Survey of India, but they are so worn and tattered that we do not at present propose to describe one as an allotype.

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Zoogeographic Considerations on the Indian Avifauna

BY

S. Dillon Ripley

The following discussion will be found incorporated in the SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN, a volume which is now in press. However, these zoogeographic comments are a small part of the main text which includes a checklist, and so it appeared useful to print this section separately for the interest of those more concerned with this subject. In this discussion I have attempted to illustrate three points derived from my work with Indian birds. These are :

(1) the bird fauna of India is overwhelmingly Oriental in character,

(2) the Palaearctic Region has been a minor influence in providing resident species of birds of India, and

(3) the Ethiopian Region has played a much larger role in Indian zoogeography than previous authors have given it credit for. India shares 16 per cent of its avifauna with various segments of the African continental area.

Distribution of Bird Species

The area delimited by the above volume, including Pakistan, India, Nepal, SE. Tibet, Ceylon and neighbouring islands, includes some 1200 species. In all there appear to be 2047 forms including species and subspecies, of which the occurrence or identification of 16 is questionable. 1738 of these forms are resident, and 309 migrant. The majority of migrants are those in the traditional sense, birds which include this area in their non-breeding range. In addition, there are occasional wanderers, vagrants or rare strays which may have been recorded no more than once, far out of their presumed normal migratory pattern. Furthermore there are the pelagic families such as the shearwaters or petrels, species found only at sea, whose occurrence in the coastal waters of these countries may be unusual or sporadic. Baker (1930, FAUNA **7** : v) recorded 2346 species and subspecies from the area covered by his volumes, which, of course, included Burma, not dealt with here.

Genera of Birds in the Indian Subregion

For those interested in the statistics of taxonomic treatment of birds, it is worthwhile to record that Baker in his last two volumes of the Fauna (1930, **7, 8**) included the birds of the region treated by me hereafter in 573 genera. In the volume to come the birds listed are included in 402 genera, a reduction of thirty per cent, the direct result of the mass of literature on classification and revisionary studies of the twenty-eight years that have elapsed since the publication of these earlier volumes.

Zoogeographic Considerations

The species recorded from the Indian subregion belong to seventy-seven families as listed by me (I include as subfamilies of the Muscicapidae several families formerly listed separately by Baker). Of these, seven families represent pelagic migrants or land migrants or vagrants, leaving 68 families composing resident species. In a paper published in March, 1953 (Considerations on the Origin of the Indian Avifauna, *Nat. Inst. of Sciences of India, Bull.* 7 : Symposium on Organic Evolution), I attempted to list these families in a series of categories to show their relation to the various adjacent regions. In that paper, I was able to show a strong Ethiopian connection with the Indian fauna, a finding of considerable interest in view of the discussions of Meinertzhagen, R. (1951, *Ibis* **93** : 443-59) and Moreau, R. E. (1952, *Proc. Zool. Soc. London* **121** : 869-913) showing not only the connection between the south Asian and African fauna, but also Moreau's thesis that Africa itself has been a centre of evolution. This is a point which has never been adequately stressed in considering the origins of the fauna of the Indian subregion.

Remarkable in all this has been the influence of the Palaearctic fauna itself. In spite of the nearness of that region and its zone of overlap, relatively few Palaearctic species seem to have spread into the Indian subregion proper. Few of these species have become resident except in the northern fringing area between the Palaearctic and subtropical and tropical subregions. Sálim Ali (1949, *Proc. Nat. Inst. Sci. India* **15** : 379-86) lists only one Palaearctic avian species, *Zoothera dauma*, which has developed resident subspecies in southern India and Ceylon. This history of the Pleistocene and Recent periods in lowland and sub-montane India, the periods during which the main speciation trends in the lower categories have become established in birds, shows that the cycles of alternating warm and cold climates have never been severe enough to eliminate the subtropical avifauna. The available niches for the avifauna have always been open to incursions from neighbouring tropical areas.

In this connection, the special zoogeographic problems created by the Himalayan chain deserve further interpretation. The Himalayas are recent in a geological sense. It seems unlikely that avian endemics confined to this montane barrier area can date farther back than late Pliocene time, and may well be considerably later. The suggestion has been made by Mani, M.S. (1956, *Nature* **177** : 124) that the insect fauna of the high-altitude Himalayas represents a geographical relict fauna of the Pleistocene of Central Asia (relict in this sense means a survivor that persists locally after the extinction of its near relatives elsewhere). Mani remarks on the deep penetration of the Himalayan chain by forms of the subtropics and tropics up to high altitudes, to 11,000 feet in some cases, a phenomenon associated with local microclimates, humidity, and the penetration to relatively high altitudes of tropical evergreen forest types. This phenomenon appears to apply equally to the avifauna.

Indian Endemic Species

A brief review of the endemic species of the Indian subregion might be helpful here. (An endemic species is one which is confined only to the area in question, an exclusive or peculiar species.) By family, these are as follows:

Family	Species	Affinity
Phalacrocoracidae : Cormorants	*Phalacrocorax fuscicollis*	related to Palaearctic species
Ardeidae : Herons	*Ardea imperialis*	related to Indochinese species
Threskiornithidae : Ibises	*Pseudibis papillosa*	Indochinese
Anatidae : Waterfowl	**Rhodonessa caryophyllacea*	A relict species of the Indo-Gangetic plain and the peninsula, perhaps Mediterranean-Palaearctic in affinity. A vestige of an earlier Tertiary fauna.
Accipitridae : Hawks	*Butastur teesa*	Palaearctic
Phasianidae : Pheasants, Partridges	*Francolinus pictus*	Ethiopian
	,, *pondicerianus*	,,
	,, *gularis*	,,
	Coturnix coromandelianus	Palaearctic

*denotes endemic genus

FAMILY	SPECIES	AFFINITY
	Perdicula asiatica	Indochinese
	,, *argoondah*	,,
	,, *erythrorhyncha*	,,
	,, *manipurensis*	,,
	Arborophila mandellii	,,
	Galloperdix spadicea	,,
	,, *lunulata*	,,
	,, *bicalcarata*	,,
	**Ophrysia superciliosa*	Palaearctic relict
	Tragopan melanocephala	Indochinese
	,, *satyra*	,,
	Gallus sonneratii	,,
	,, *lafayettii*	,,
	**Catreus wallichii*	Palaearctic relict
	Pavo cristatus	Indochinese
Otididae : Bustards	*Choriotis nigriceps*	Ethiopian
	**Sypheotides indica*	,,
Charadriidae : Plovers, Snipes	*Vanellus malabaricus*	Ethiopian
	Capella nemoricola	Palaearctic relict
Glareolidae : Swallow-plovers, Coursers	*Cursorius coromandelicus*	Ethiopian
	Cursorius bitorquatus	Ethiopian
Columbidae : Pigeons	*Columba elphinstonii*	Indochinese
	,, *torringtonii*	,,
	,, *palumboides*	,,
	Macropygia rufipennis	,,
Psittacidae : Parrots	*Psittacula caniceps*	Indochinese
	,, *cyanocephala*	,,
	,, *intermedia*	,,
	,, *columboides*	,,
	,, *calthorpae*	,,
	Loriculus beryllinus	,,
Cuculidae : Cuckoos	*Cuculus varius*	Indochinese
	Rhopodytes viridirostris	,,
	**Taccocua leschenaultii*	,,
	Phaenicophaeus pyrrhocephalus	,,
	Centropus chlororhynchus	Indochinese or Ethiopian ?
Strigidae : Owls	*Otus balli*	Indochinese
	Glaucidium radiatum	,,
	Ninox affinis	,,
	Athene blewitti	,,
	Strix ocellata	,,
Podargidae : Frogmouths	*Batrachostomus moniliger*	Indochinese

Family	Species	Affinity
Apodidae : Swifts	*Chaetura sylvatica*	Indochinese
Trogonidae : Trogons	*Harpactes fasciatus*	Indochinese
Bucerotidae : Hornbills	*Tockus birostris*	Ethiopian
	,, *griseus*	,,
	Anthracoceros coronatus	Indochinese
Capitonidae : Barbets	*Megalaima zeylanica*	Indochinese
	,, *viridis*	,,
	,, *flavifrons*	,,
	,, *rubricapilla*	,,
Indicatoridae : Honeyguides	*Indicator xanthonotus*	Ethiopian
Picidae : Woodpeckers	*Dinopium benghalense*	Indochinese
	Dendrocopos himalayensis	Palaearctic relict
	Dendrocopos auriceps	,,
	Chrysocolaptes festivus	Indochinese
Pittidae : Pittas	*Pitta brachyura*	Indochinese
Alaudidae : Larks	*Mirafra erythroptera*	Indochinese
	Eremopterix grisea	Ethiopian
	Galerida deva	Ethiopian ?
	Galerida malabarica	,,
Hirundinidae : Swallows	*Hirundo fluvicola*	Ethiopian
Dicruridae : Drongos	*Dicrurus caerulescens*	Indochinese
	,, *andamanensis*	,,
Sturnidae : Starlings	*Saroglossa spiloptera*	Ethiopian
	Sturnus erythropygius	Indochinese
	,, *senex*	,,
	,, *pagodarum*	,,
	Acridotheres ginginianus	Indochinese
	Gracula ptilogenys	,,
Corvidae : Crows, Jays, Pies	*Garrulus lanceolatus*	Palaearctic relict
	Kitta ornata	Indochinese
	Dendrocitta leucogaster	,,
	,, *bayleyi*	,,
Campephagidae : Cuckoo-shrikes	*Coracina melanoptera*	Indochinese
Irenidae : Ioras	*Aegithina nigrolutea*	Indochinese
Pycnonotidae : Bulbuls	*Pycnonotus priocephalus*	Indochinese
	,, *xantholaemus*	,,
	,, *penicillatus*	,,
	,, *luteolus*	,,
	Hypsipetes nicobariensis	,,
	,, *indicus*	,,

Family	Species	Affinity
Muscicapidae.		
Timaliinae : Babblers	*Pellorneum palustre*	Indochinese
	,, *fuscocapillum*	,,
	Spelaeornis caudatus	,,
	,, *badeigularis*	,,
	,, *longicaudatus*	,,
	**Sphenocichla humei*	,,
	Stachyris pyrrhops	,,
	,, *oglei*	,,
	**Dumetia hyperythra*	,,
	**Rhopocichla atriceps*	,,
	Chrysomma altirostre	,,
	Turdoides earlei	Ethiopian
	,, *longirostris*	,,
	,, *malcolmi*	,,
	,, *subrufus*	,,
	,, *striatus*	,,
	,, *affinis*	,,
	,, *nipalensis*	,,
	Garrulax cinereifrons	Indochinese
	,, *striatus*	,,
	,, *nuchalis*	,,
	,, *variegatum*	,,
	,, *cachinnans*	,,
	,, *jerdoni*	,,
	,, *virgatus*	,,
	,, *austeni*	,,
	Actinodura egertoni	,,
	,, *nipalensis*	,,
	Heterophasia capistrata	,,
Muscicapinae : Flycatchers	*Muscicapa ruficauda*	Palaearctic
	,, *nigrorufa*	Indochinese
	,, *pallipes*	,,
	,, *poliogenys*	,,
	,, *sordida*	,,
	,, *albicaudata*	,,
	Rhipidura aureola	,,
	,, *albogularis*	,,
Sylviinae : Warblers	*Bradypterus palliseri*	Indochinese
	Prinia buchanani	Ethiopian
	,, *cinereocapilla*	,,
	,, *socialis*	,,
	,, *sylvatica*	Indochinese
	,, *burnesii*	Ethiopian
	Schoenicola platyura	,,
	**Chaetornis striatus*	A relict of uncertain affinities, perhaps Mediterranean-Palaearctic.
	Acrocephalus orinus	Palaearctic

Family	Species	Affinity
	Phylloscopus tytleri	Palaearctic
	,, *fuligiventer*	,,
	,, *subviridis*	,,
	Seicercus xanthoschistos	Indochinese
Turdinae : Thrushes	*Brachypteryx hyperythra*	Indochinese
	,, *major*	,,
	Erithacus hyperythrus	,,
	Cercomela fusca	Ethiopian
	Saxicola leucura	Palaearctic
	**Saxicoloides fulicata*	A relict species of Mediterranean-Palaearctic affinity ?
	Myiophoneus blighi	Indochinese
	Zoothera wardi	Palaearctic
	Zoothera spiloptera	Indochinese
	Turdus unicolor	Palaearctic
	,, *albocinctus*	,,
Paridae : Titmice	*Parus nuchalis*	Palaearctic
	,, *melanolophus*	,,
	Aegithalos leucogenys	,,
	,, *niveogularis*	,,
	,, *iouschistos*	,,
Sittidae : Nuthatches	*Sitta formosa*	Palaearctic
Certhiidae : Treecreepers	*Certhia nipalensis*	Palaearctic
Motacillidae : Pipits, Wagtails	*Anthus nilghiriensis*	Ethiopian
	Motacilla maderaspatensis	Palaearctic
Dicaeidae : Flowerpeckers	*Dicaeum vincens*	Indochinese
	,, *erythrorhynchos*	,,
Nectariniidae : Sunbirds	*Nectarinia zeylonica*	Indochinese
	,, *minima*	,,
	,, *lotenia*	,,
Zosteropidae : White-eyes	*Zosterops ceylonensis*	Indochinese
Ploceidae : Weaver Finches	*Passer pyrrhonotus*	Relict of Mediterranean-Palaearctic affinity
	Ploceus megarhynchus	Ethiopian
	,, *benghalensis*	,,
	Estrilda formosa	Indochinese
	Lonchura kelaarti	,,
Fringillidae : Finches	**Callacanthis burtoni*	Palaearctic
	Carpodacus rhodochrous	,,
	Pyrrhula erythrocephala	,,
	,, *aurantiaca*	,,

It is interesting to note that of the above listed 176 species endemic to the Indian subregion or its immediate environs (one or two species counted reach Afghanistan or Burma), the following affinities appear :

	No.	Per cent. of total
1. (a) Palaearctic	30	17
(b) questionable ?	2	1
2. Indochinese	109	62
3. (a) Ethiopian	30	17
(b) questionable	1	1
4. Relict species of uncertain affinities, perhaps a special Mediterranean-Palaearctic type (includes 3 of the 11 endemic Indian genera, *Rhodonessa*, *Chaetornis*, *Saxicoloides*).	4	1

There is thus no statistical difference between the number of endemic species estimated to be derived from the Palaearctic and those from the Ethiopian regions. From the above it appears that the statements of Mani (*tom. cit. supra*), Voous (1947, *Limosa* **20**: 19-21), Wadia (1939, GEOLOGY OF INDIA, London), and Pax [1926, Acer L. (1), Die Pflanzenareale, **1**, Reihe 1, Karte 4, Jena] are valid that in spite of the evidence of glaciation in the Himalayas during the Pleistocene, the recent distribution of animals and broadleafed plants (e.g. *Aesculus indica*) would indicate that climatically conditions were not too severe during the glacial periods. Furthermore, the survival of trees in this area would presuppose that the Himalayas could act as a Palaearctic *refugium*, and that many of the animal species found there today do in fact represent Palaearctic relicts, rather than end products of a continuous chain of related forms from geographically contiguous areas to the north.

Evidence from Endemic Genera

It is noteworthy in this regard that three of the endemic Indian genera are Palaearctic in origin and are found in the Himalayas. These are *Ophrysia*, *Catreus*, and *Callacanthis*. In addition, some 14 of the Palaearctic endemic species are confined to the Himalayas, without adjacent relatives, and give every evidence of being relict forms. Notable among these are *Capella nemoricola*, *Dendrocopos himalayensis*, *Garrulus lanceolatus*, *Phylloscopus fuligiventer*, *Zoothera wardi*, *Parus melanolophus*, *Sitta formosa*, and the two species of *Pyrrhula*, namely *erythrocephala* and *aurantiaca*.

The remaining endemic genera in the Indian subregion consist of one Ethiopian, the bustard *Sypheotides*, and 4 of Indochinese affinity.

Conclusions

The influence of the Indochinese elements in the Indian avifauna is thus paramount. It is this fauna which has spread west along the Himalayas, correlated in its spread rather characteristically with conditions of suitable rainfall and forest types. It is this fauna which has predominantly populated the peninsula and Ceylon, and in which the route of the Satpura chain of hills has been so clearly followed during damp or cold-wet phases of recent geological history, presumably correlated with the pluvial stages of late Pleistocene times.

These hills, with their increased elevation and chances of holding rainfall and encouraging the persistence of more moist tropical forest types, have apparently served as stepping stones for faunistic incursions of an Indochinese nature into the presently drier zone of southern India, witness the zoogeographic papers of Sálim Ali in the *Journal* for 1934, as well as subsequent papers (1948, *Gujarat Research Society, Monogr.* No. 2), Sunder Lal Hora (1938-1953, various papers), William C. Dilger (1952, *Evolution*), and the author (1949, *Evolution*). This phenomenon culminates in the high moist ranges of Kerala and adjacent Mysore and western Madras with their wealth of Indochinese and Palaearctic relict biota as well as tropical isolated forms. Ceylon has, of course, a similar zonation due to climate, orographic features, and the alternating drier-warmer, colder-more-moist, cycles presumably associated with the climatological history of late Pleistocene and recent Pluvial and inter-Pluvial times.

Finally, the Ethiopian influence is found in the open dry plains areas, the western deserts, the dry parts of the Gangetic plain and Deccan plateau, and the dry areas of the peninsula. This fauna is primarily related to the Somali Arid District of Chapin's zoogeographic divisions of Africa (1932, *Bull. Amer. Mus. Nat. Hist.* **65**: 89-91). However, certain species show a Malagasy or tropical African relationship which is presumably much older, correlated with a moist, damp late Tertiary stage. Characteristic of these forms are *Centropus toulou*, *Indicator xanthonotus*, *Saroglossa spiloptera*, *Hypsipetes madagascariensis*, and *Schoenicola platyura*. That the Ethiopian connection has existed more than once is attested by these old damp forest forms, separated from the latest Somali Arid relatives by a third type, indicative of a possible third connection, dry-deciduous or deciduous semi-moist stage species (Savannah species) such as *Treron phoenicoptera* (*vide* Husain, 1958, *Ibis* **100**: 344-347), *Galerida malabarica*,

Hirundo fluvicola, *Turdoides subrufus* and *T. nipalensis*, and *Anthus nilghiriensis*.

The above evidence, not only the high percentage of forms with Ethiopian affinity, 16%, but also the existence of forms related to more than one type of Ethiopian biota, would seem to point clearly to Africa as a centre of speciation and dispersal which has not heretofore been recognized or appreciated. There is no doubt that the African continent has provided an unexpectedly major source of the Indian fauna.

In addition, the relatively minor influence of the adjacent Palaearctic fauna should be stressed. The Indian subregion belongs conclusively to the Oriental tropical region. In spite of seasonal migrants, the avifauna is and remains primarily pan-tropical.

The Biology of the Weevil *Alcidodes bubo* (Fabricius) (Coleoptera: Curculionidae)[1]

BY

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(*With two plates*)

INTRODUCTION

Alcidodes bubo (Fabricius), commonly known as agathi stem weevil in south India, is a serious pest of 'agathi' (*Sesbania grandiflora*), a leguminous plant grown as a standard for the betel vine (*Piper betle*), a money crop grown extensively in south India. This species is preferred, as it possesses the quality of growing quick and tall and providing upright supports as well as good shade for the tender vines. Agathi is also used as fodder, green manure, and to a certain extent as a household vegetable. The weevils make their appearance even at the very early stages of agathi crop in the field causing the growth to be seriously retarded. The pest occurs throughout the year in all betel growing areas and is a serious menace to betel-vine growers. Though quite common in south India, very little is known of its life-history, habits, etc. Detailed studies on the biology of this weevil were made by the author and the results are presented in this paper.

HISTORY AND SYSTEMATIC POSITION

This weevil belongs to the subfamily Alcidodinae of the family Curculionidae.

It was originally described by Fabricius (1801) under the name *Rhynchaenus bobu*. Olivier (1807) described it as *Rhynchaenus ferox*. Later Boheman (1836) placed the species under the genus *Alcides*[2] and described it as *Alcides bubo*. Masters's (1887) description also refers to it as *Alcides bubo*. In 1900 Blackburn

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[1] Part of thesis submitted for the M.Sc. degree of Madras University.
[2] Now changed into *Alcidodes*.

Alcidodes bubo (Fabr.)

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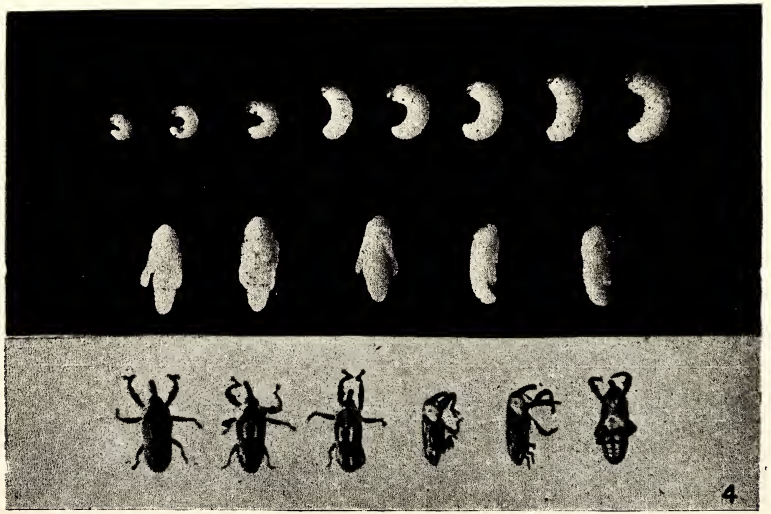

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1. Egg ; 2. Egg in situ ; 3. First instar grub ; 4. Stages of weevil.

5

5. Agathi stem showing the damage by the weevil.

described specimens collected in Australia as *Alcides terraereginae*. But Bovie (1908) in his catalogue of Alcidinae refers to the species described by Olivier and Blackburn as synonyms of *Alcides bubo*. Since then, as far as the author is aware, there is no reference to this species in any other literature until 1909 when Lefroy gave a short account of its life-history and habits. Later Fletcher (1914, 1919) and Ramakrishna Ayyar (1917, 1919, 1922, 1940) have mentioned about the distribution, host plants, and nature of damage done by this weevil, and control measures. Subramanian *et al.* (1953) published short notes on the life-history and control measures to be adopted.

Distribution

Boheman (l.c.) in his description mentions the habitat as Bengal; Blackburn (l.c.) gives it as Queensland (Australia), and Fletcher and Ramakrishna Ayyar as Coimbatore, Bellary, Madras, South Arcot, Tiruchirapally, Madura, and Tinnevelly districts. At present the weevil is distributed wherever the betel vine is grown in south India.

Host Plants

Fletcher and Ramakrishna Ayyar (loc. cit.) record agathi (*Sesbania grandiflora*), daincha (*Sesbania aculeata*), indigo (*Indigofera arrecta*), and cluster-beans (*Cymopsis psoralioides*) as hosts. During his investigation the author noted this weevil breeding on the following plants also, viz. *Sesbania speciosa*, *Sesbania aegyptiaca*, and *Indigofera tysmani*.

Nature and Symptoms of Damage

Both adults and grubs do damage to the crop, the grubs often proving more destructive than the imago. The adults, besides biting holes through the leaves, make numerous punctures on the stem thereby weakening the plant considerably. The grubs bore into the stem and make irregular galleries, eventually causing uneven growth of the stem and swellings at the place of injury. The infested plants present a sickly appearance with innumerable holes on the stem, and are stunted in growth. A large number of adult weevils may be seen clinging to the shoots of the plants. The damage is very severe when the crop is young, sometimes even killing the plants. Repeated attacks by the weevil seriously impede the quick growth of agathi, and

consequently the crop fails to serve its purpose. In cluster-beans the grubs bore the stem causing similar swellings and uneven growth, and affecting the yield of fruits very considerably. Among the various crops on which the species is recorded, agathi and cluster-beans are the more seriously attacked.

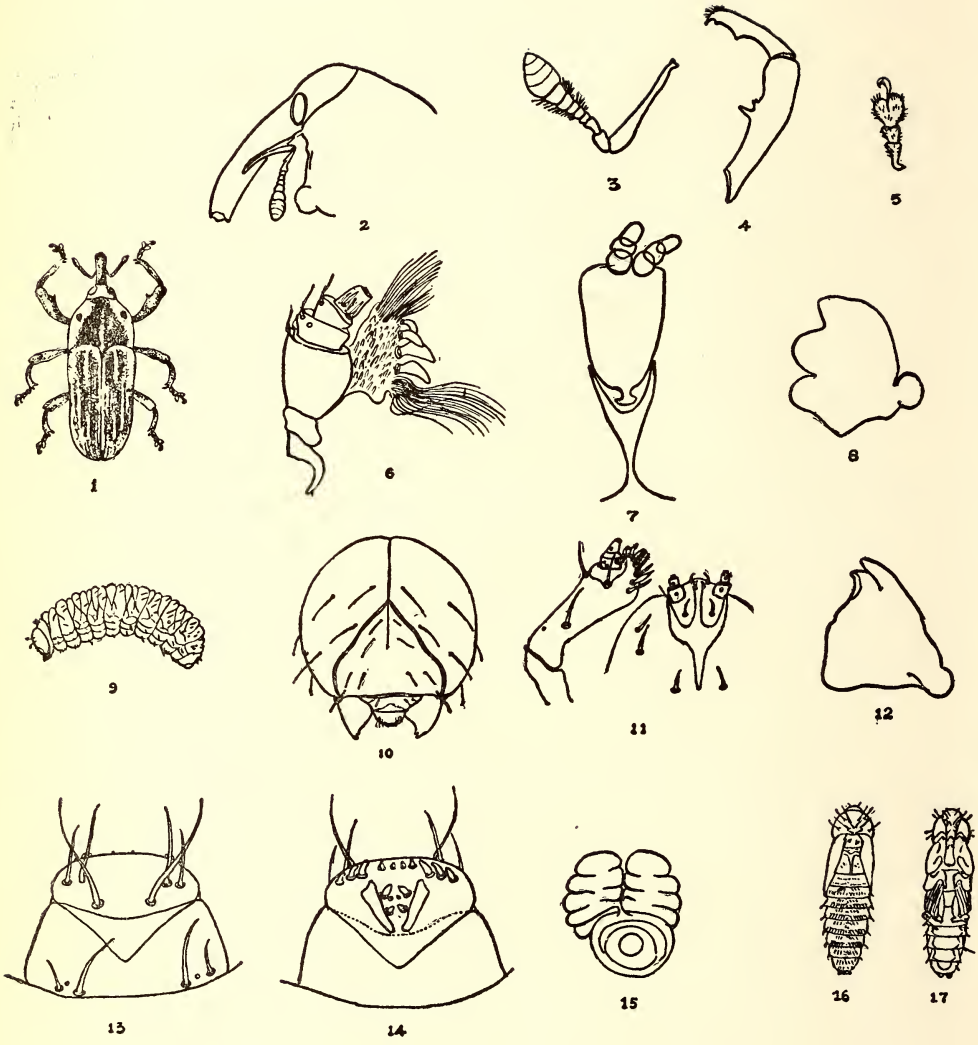
Life-History

Little work has so far been done on the life-history of this species. Lefroy (1909) gives a short summary of the life-history and habits and records that the life cycle occupies about six weeks. Fletcher (1914) gives the duration of egg and pupal stages alone as five and seven days respectively. Ramakrishna Ayyar (1917) studied the daily rate of oviposition at Coimbatore with reference to four pairs of weevils. Gardner (1934) gives a brief description of the mature grub. A more detailed study of the life-history of this weevil was undertaken by the author at Coimbatore in the years 1951 and 1952. Observations were made on the duration of various stages, instars of grub, fecundity, seasonal activity of the pest, etc.

Copulation. The weevil is often seen in the field in the act of copulation. During copulation the insects in most cases remain stationary. The male clings to the female and grasps it very firmly so that in many cases it is hard to separate them. The duration of copulation varies from 25 to 35 minutes. Several males have been noted to copulate with the same female during the course of a day. Copulation takes place 2 to 4 days after emergence.

Pre-oviposition period, period of oviposition, and fecundity. The pre-oviposition period was found to vary from 6 to 13 days with an average of 9.0 days for 25 females. This period depends upon the time at which successful fertilisation is effected. Ramakrishna Ayyar (1917) studied the egg-laying capacity of four females and found that one laid 85 eggs in 42 days, another 47 eggs in 20 days, the third 6 eggs in 3 days, and the fourth one 26 eggs in 11 days. But he has not mentioned whether the study was made on newly emerged beetles or those collected from the fields. Observations on the egg-laying capacity of 25 individuals were made. The total number of eggs laid varied from 18 to 166 with an average of 89.5, and the period of oviposition from 9 days to 82 days with an average of 49.6 days. The daily rate of egg-laying was not regular and varied from 1 to 6.

Place and method of oviposition. The mother weevil moves up and down the tender stem and shoots for more



Alcidodes bubo (Fabr.)

1. Adult; 2. Side view of head; 3. Antenna; 4. Front femur and tibia; 5. Tarsus; 6. Maxilla of adult; 7. Labium of adult; 8. Mandible of adult; 9. Grub; 10. Head capsule of grub; 11. Maxilla and labium of grub; 12. Mandible of grub; 13. Labrum of grub; 14. Epipharynx of grub; 15. Spiracle; 16 & 17. Pupa.

than fifteen minutes and finally selects a suitable place for oviposition. After selecting the place, she gradually starts gnawing that portion with her hard mandibles. She removes a small quantity of chewed material from the excavation now and then and the depth of the excavation goes as far as the length of her rostrum. At the bottom she makes a cavity of diameter slightly bigger than the size of the egg. After finishing this work she slowly turns back and lays eggs. Two to three excavations are made side by side, and eggs are laid in them. As a rule only one egg is laid in each excavation. After laying eggs the weevil packs the hole with the material that was scooped out. The whole operation has been found to take sixteen minutes in several cases. The weevil selects only the topmost tender shoots for egg-laying and the thicker portion is avoided. In agathi, eggs are laid in the stem portion only whereas in cluster-beans and daincha egg-laying has been found on pods too. But in no case has the weevil been noted to complete its life cycle in the pods in the latter two instances.

Description of Stages

Egg:

The egg is elongate, oval, broadly rounded at ends, and pale yellow in colour. A freshly laid egg measures on an average 0.91 mm. in length and 0.57 mm. in width. No change in colour is noted until hatching.

The incubation period with reference to 50 eggs varied from 6 to 7 days with an average of 6.4 days in the laboratory when the average maximum and minimum temperatures and humidity were 86.8° F., 79.0° F., and 79.8% respectively.

Larva:

The number of larval instars and the duration of each were studied in detail. The grub passes through six instars in the laboratory. There is not much difference between the general characters of the various instars. Hence the description of the first and the final instars and only the measurements of body and head capsule of the other instars are given. The duration of the instars was worked out with reference to 25 individuals.

First instar: Length of the body 1.1 mm.; width 0.5 mm. Length of head 0.43 mm.; width 0.43 mm.

Colour pale white. Apodous. *Body* curved moderately and soft with narrow posterior end. *Head* smooth, pale brown, shiny with a dark streak on the posterior end of the frontal region. *Mandibles*

prominent and dark brown and bifid. The whole body is sparsely beset with minute hairs.

The duration of the first instar varied from 4 to 6 days with an average of 5.2 days.

Second instar: Length of the body 1.5 mm. to 2.0 mm.; width 0.6 mm. Length of head 0.53 mm.; width 0.53 mm.

Colour pale yellow. Other characters similar to first instar.

The duration of the second instar varied from 5 to 7 days with an average of 5.8 days.

Third instar: Length of the body 2 to 3 mm.; width 0.8 mm. Length of head 0.84 mm.; width 0.64 mm.

Colour appears to be dark owing to the body contents being visible through the outer skin. Other characters similar to the previous instars.

The duration of the third instar varied from 5 to 7 days with an average of 6.0 days.

Fourth instar: Length of the body 3.0 to 4.0 mm.; width 1.2 mm. Length of head 1.06 mm.; width 0.78 mm. General characters similar to third instar.

Fifth instar: Length of body 4.0 mm. to 5.3 mm.; width 1.5 mm. Length of head 1.18 mm.; width 0.95 mm.

Colour pale yellow. The body contents not visible through the outer skin.

The duration of fourth and fifth instars varied from 5 to 7 days with an average of 6.2 days for the fourth, and 6.4 days for the fifth instars.

Sixth instar (*Full-grown grub*): Gardner (1934) has described the mature larva of this species. A more detailed description of the same is given below.

Length of body 6.5 mm. to 8.5 mm.; width 2.8 mm. Length of head 1.5 mm.; width 1.17 mm.

Apodous. General colour pale yellow. *Body* stout, weakly curved, subcylindrical, and wrinkled. *Head capsule* chitinised, testaceous, smooth, subcircular; cheeks broadly rounded. *Epicranial suture* not very conspicuous, slightly less than half the cranial length. *Frontal sutures* not conspicuous; each arm slightly exceeding epicranial suture in length; each side of epicranium with six setae. *Frons* subtriangular, wider than long, length slightly exceeding epicranial suture; a dark streak on the posterior end prominent extending to more than half the length of the frons; provided with five pairs of setae. *Ocellus* present, one pair on each side, one smaller and more posterior. *Antenna* with conical segment borne on a basal cushion-like segment. *Clypeus* twice as broad as long

with two pairs of rather long setae on the posterior end. *Labrum* one and a half times broader than long with posterior margin extending into clypeal zone; upper surface carrying three pairs of setae, the median pair longest. *Epipharynx* with a pair of slender slightly converging rods which do not extend into clypeal zone, anterior margin with four median short stout setae and three lateral short stout elongate ovate, somewhat curved setae arranged obliquely on each side; between the rods are two pairs of small setae; anterior pair much stouter and more widely separated; in addition a pair of tripartite pores are found between the rods. *Mandibles* strong, sub-triangular with broad base and heavy condyle, acutely bidentate; length equal to its greatest width. *Maxilla* elongate, with smooth cardo; stipes longer than broad with a basal lateroventral seta and two setae in the palpiferous regions; palpus two jointed, basal joint wider than long with a small seta and a pair of sensory pores; apical joint longer than broad and somewhat conical with small sensory pegs at the tip and a small sensory pore near the base; mala simple with 8 to 10 dagger-like setae. *Labium* longer than broad, posteriorly limited by a Y-shaped chitinised band and with one pair of setae on each labial stipe; palpus two-jointed, basal joint slightly longer than broad; with one sensory pore in the middle; apical joint as long as broad with one sensory pore in the middle and a few sensory pegs at the tip; ligula with two pairs of tiny setae anteriorly; subfascial region with two pairs of major and one pair of minor setae.

Thorax: Thorax occupies about one-fourth of total length of body. *Prothorax* one and one-eighth times longer than meso- and meta-thorax and about one and one-fourth times wider than head. Terga of prothorax simple with eight pairs of setae. Pronotum pale testaceous. *Meso-* and *meta-thorax* divisible into two distinct areas dorsally namely prescutum and scuto-scutellum; prescutum with one pair of setae and scuto-scutellum with four setae in a straight line. Pedal lobes distinct but not protuberant each with four small hairs.

Abdomen: Ten segmented, segments 1 to 8 similar in shape and size and divisible into prescutum, scutum, and scutellum; a weakly-formed intersegmental fold is also visible. The prescutum is provided with two pairs of setae, scutum without setae, and scutellum with three pairs of setae; alar area with two tiny setae. Each epipleural lobe of abdomen with one seta and hypoleural lobe with two setae; the last two segments simple with few setae. *Spiracles* small, all of equal size, present one between pro- and meso-thorax and eight in the first eight abdominal segments on each lateral side, each with a pair

of air tubes which are slightly longer than peritreme and each air tube with five incomplete annuli.

The duration of the sixth instar varied from 6 to 7 days with an average of 6.6 days.

The total larval period for the 25 individuals varied from 34 to 40 days with an average of 36.1 days.

Larval habits: The newly hatched grub starts feeding on the tissue immediately around the hole in which egg is laid. Later it bores downwards and makes irregular galleries inside the stem. In agathi the larva does not bore the stem up and down to long distances but produces a sort of big cavity inside by gnawing round the seat of injury and pupates in it. Whereas in cluster-beans it bores and travels from the top to the bottom of the stem portion inside. The grubs do not make exit holes at the sides of the stem to throw the frass as in the case of certain species of weevils belonging to this genus. By nature the grub is very sluggish.

Prepupa:

This stage is characterised by larva becoming shorter in length and the slight swelling in the thoracic region. The length at this stage varies from 7.5 mm. to 7.8 mm. and the period lasts for about 24 to 36 hours.

Pupa:

Length of the body 7.8 mm.; width 2.2 mm.

General colour pale yellow but turns darker before transformation into adult. *Body* soft, beset with moderately long hairs which are concolorous with the body. *Head* smooth, as wide as long and provided with three pairs of setae originating from minute tubercles as follows: one pair near the base, one pair immediately behind the eyes, and the third pair between eyes. *Rostrum* about one-fourth total length of pupa, four times as long as broad, placed close to the sterna, and bears three pairs of setae on small tubercles; posterior pair placed close to the eyes, middle pair between the position where the scape is inserted, and the third pair at the anterior end. *Antennae* geniculate, segments not distinct.

Prothorax one and one-fourth times as wide as long, provided with seven pairs of setae raised on tubercles consisting of two anterior pairs, three median pairs, and two posterior pairs. *Mesothorax* a little less than half the length of prothorax with two tiny pairs of setae in the middle. *Metathorax* half as long as prothorax, width one and half times its length, provided with three pairs of tiny setae.

Abdomen about five times as long as broad, nine-segmented; segments 1 to 8 with two transverse rows of setae on prominent

tubercles dorsally, one situated at the anterior margin and the other on the posterior margin; anterior row with one pair of median and two pairs of lateral setae, and posterior one with two pairs of median, four pairs of lateral, and one pair of pleural setae, the setae becoming more prominent in the last four segments; segment 9 without any curved process.

Pupation takes place inside the larval burrow. The duration of the pupal stage was found to vary from 9 to 11 days with an average of 10.1 days for 25 individuals.

The total life cycle from egg to adult was found to range from 49 to 57 days with an average of 52.8 days.

Adult:

Fabricius (1801) in his original description of the species describes the weevil as follows:

'Corpus praecedentibus magis cylindricum. Rostrum crassiusculum, brunneum. Thorax cinereo-villosus, dorso fuscescente: linea cinerea. Punctum fuscum praeterea ad latera. Elytra punctis latioribus striata, brunnea, litura transuersa, villoso-cinerea. Corpus cinereo-villosum. Pedes brunnei.'

Later Boheman (1836) described it as follows:

'Oblongus, rufo-ferrugineus, rostro modice arcuato, thorace subtiliter confertim granulato, lateribus albido-squamoso, elytris profunde punctato—striatis, punctis nonnullis sparsis in dorso et litura postica niveo-squamosis, pedibus anticis modice elongatis.'

Patria Bengalia.'

The description given by the above two authors being too short and inadequate the weevil is redescribed as follows from a number of specimens.

Female: Form subcylindrical; integument piceous; the prothorax having on either side creamy white scaling running from the apex (on a level with upper margin of the eyes) to base opposite to interval 7 of the elytra and containing two dark spots on either side and with a narrow median stripe from the base to beyond the middle; elytra with the following creamy white markings that are formed of dense overlapping broad plumose scales: one small marking at the base near scutellum in interval 2 of the length of about 0.25 mm., another of about 0.98 mm. long at the base at interval 3, the third at interval 7 in the middle of 1.25 mm. long, the fourth at interval 3 near the apex of 0.58 mm. long and small three round spots of dense pale scaling one in the middle at interval 9 another at interval 9 near the apex, the third one at interval 3 in the declivity;

stria 1 with a row of pale dots at the declivity; the lower part of the body more or less densely covered with plumose scales.

Head one and half times broader than long; closely punctate, the forehead with a shallow median fovea. *Rostrum* shorter than front femur, elongate, gently curved, longer and slender, feebly widening at the insertion of antennae and again at the apex, closely punctate throughout up to the insertion of antenna, the apical area shiny and sparsely punctate. *Mandibles* prominent, dark brown and tridentate. *Maxillae* freely exposed, elongate; palpi three segmented; segment 1 twice as broad as long, 2 and 3 slightly tilted, 2 half as long as and three-fourths as wide as segment 1, 3 one and one-fourth times longer than broad; palpifer stout, equal in length to all the three segments of palpi put together, as long as its greatest width; stipes twice as broad as long, length equal to segment 1 of palpus; cardo curved and twice as long as stipes; lacinia with numerous long bristles, lacinial teeth broad, stout and prominent. *Mentum* twice its greatest width, Labial palpi three jointed, joint 1 and 2 as long as broad and similar in shape and size, 3 longer than broad. *Submentum* with well marked peduncle supporting the mentum. *Antennae* inserted beyond the middle of rostrum with scape as long as funicle, which is seven-jointed, joint 1 as long as 2 plus 3, 3 to 6 bead-like and transverse, 7 much shorter than club and as long as the two preceding joints; club twice as long as broad and four-jointed.

Prothorax widest at the base, sub-conical about one and half times as broad as long, sides gently rounded, parallel-sided till the middle and roundly narrowed at apex; the subapical constriction feeble, the anterior dorsal margin feebly rounded; the post-ocular lobes distinct and heavily fringed, the dorsum closely set with somewhat depressed granules each bearing a recumbent seta, but the apical area closely and shallowly punctate. *Scutellum* not enclosed, subcircular, bare, smooth with a more or less distinct median depression. *Elytra* subcylindrical, not broader than the base of prothorax, basal lobes not very strongly produced, obtusely rounded at the apex; the striae with deep quadrate punctures becoming much shallower at declivity, intervals narrower than striae, shiny; each elytron more than three times as long as broad. *Hindwings* hyaline, twice longer than broad. *Legs* moderately long, piceous, shallowly punctate and rather thinly clothed with linear scales; hind legs short; the front femora with a blunt tooth at the middle and two additional small denticulations near by, the posterior ones having only one tooth; tibia more shallowly punctate, the front pair with sharp laminate tooth on inner edge about the middle and sharp tooth at

the apex; that of posterior pairs simple; tarsi four-jointed, joint 3 bilobed, 4 curved and ends in four small spines. *Sternum* with front intercoxal space narrower than the median one.

Abdomen about one and half times as long as broad; pygidium not exposed.

Measurements: Length of the body 8.5 mm., width 2.4 mm. Length of head and rostrum 2.7 mm. Length of antennae 1.8 mm. Length of prothorax 1.8 mm., width 2.4 mm. Length of elytron 5.0 mm., width 1.5 mm. Length of hindwings 7.2 mm., width 3.8 mm. Length of abdomen 2.8 mm., width 1.8 mm. (average of 25 individuals).

Male: General characters similar to female's, but smaller in size. Difference is found in the rostrum which is short and stout, and strongly and closely punctate throughout.

Measurements: Length of the body 8.0 mm., width 2.1 mm. Length of head and rostrum 2.6 mm. Length of antennae 1.6 mm. Length of prothorax 1.6 mm., width 2.1 mm. Length of elytron 4.8 mm., width 1.4 mm. Length of hindwings 6.7 mm., width 2.9 mm. Length of abdomen 2.5 mm., width 1.7 mm. (average of 25 specimens).

Habits. The adults are very active in the field during the early hours of the morning. They are often seen in the act of copulation and clinging to the tender stem and leaflets of the plants. When approached they suddenly drop to the ground and feign death. In this posture the insect remains for a long time. They usually remain at the top portions of the plants in the early hours, but as the day advances they gradually move to the lower and shady portions. The insect is capable of flying long distances and this enables it to spread to other fields. They feed on tender leaves and stems. To a certain extent the adults are attracted to light.

Longevity. Observations on the length of life of adults were made on 50 individuals in each sex, 25 without food and 25 with food. The duration varied from 37 to 98 days with an average of 62 days for males, and from 29 to 84 days with an average of 55.9 days for females with food. Without food it ranged from 4 to 10 days with an average of 6.4 days for males, and 5 to 12 days with an average of 7.6 days for females.

Sex ratio. During the present investigation out of a total of 422 adults emerged in the laboratory rearings, 212 were males and the balance females making a percentage of slightly exceeding 50 in the case of males.

Dissemination. The adults are capable of flying long distances and this is the only method by which they get easily spread from field to field.

Natural enemies

Ramakrishna Ayyar (1919, 1934) has recorded the following Hymenopterous parasites on the grubs of the weevil:

1. *Eurytoma pigra* G. (Chalcidae).
2. *Metasteanomyia julianani* G. (Chalcidae).
3. *Cambyloneurus ceylonicus* Cam. (Braconidae).

During the course of this study the following new parasites were obtained from the grubs of the weevil.

1. *Pristomerus* sp. (Ichneumonidae).
2. *Ipobracon* sp. (Braconidae).
3. *Pseudocatolaccus* sp. (Pteromalidae).

The parasitism was very low in these cases.

Hibernation

The weevil has not been noted to pass through a definite period of hibernation at Coimbatore. As the betel vine crop is left in the field for three or four years there is always continuous crop of agathi and hence the weevil is able to breed throughout the year. Even when there is no agathi crop there will be either cluster-beans or daincha crop in the field on which the weevil breeds.

Seasonal history

Agathi is sown in the middle of July at Coimbatore in betel vine gardens. The weevil appears in the field even from the first month of the crop. Egg-laying commences from August and continues for about as long as the crop is left in the field. The maximum egg-laying is noted when the crop is 3 to 8 months old, i.e. from the months of September to January. As agathi is left in the field in betel vine garden for about three or four years, there is continuous breeding during the period. All stages of the weevil are found in the field from the month of October onwards. There is much over-lapping of rapidly succeeding broods. The weevils emerge throughout the crop season without break. The pest is found throughout the year in Coimbatore.

Summary

Alcidodes bubo (Fabricius) is a serious pest of agathi (*Sesbania grandiflora*) which is grown as a standard for betel vine in south India. The grubs bore the stem and cause stunted growth of the crop, thereby making the plants unfit for the purpose for which they are grown. This weevil is found throughout south India wherever betel is grown.

Its life-history and various aspects of its biology are studied in detail. Eggs are laid on the tender shoots and stems in excavations made by the adults. The female begins to lay eggs in 6 to 13 days after emergence. The total number of eggs laid by an individual varies from 18 to 166 and the period of oviposition varies from 9 to 82 days. The period of different stages of the weevil are found to be 6 to 7 days for egg, 34 to 40 days for larva, and 9 to 11 days for pupa. The larva has six instars the duration of each varying from 4 to 7 days. The duration of adult life in captivity ranges from 29 to 84 days for females, and from 37 to 98 days for males.

Two new alternate host plants are recorded for this weevil and three new Hymenopterous parasites are also recorded on its grubs in addition to the parasites already known.

The pest occurs throughout the year at Coimbatore. Its seasonal history is described.

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Observations on the Flora of Marunduvalmalai, Kanyakumari (Cape Comorin)

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(*With a map*)

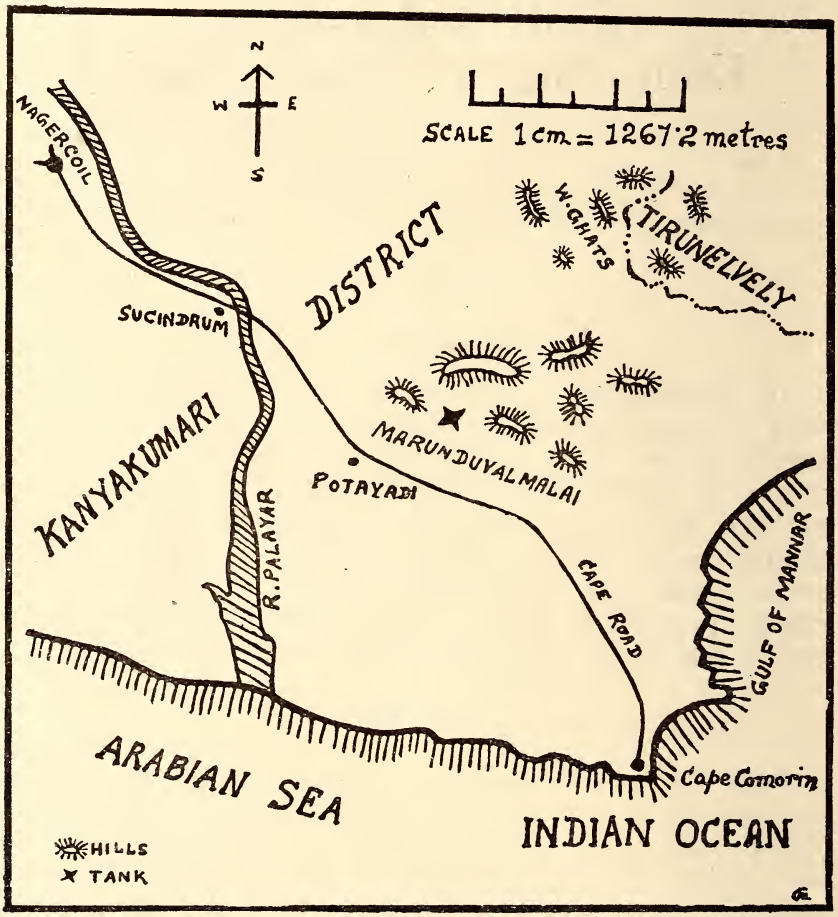
SYNOPSIS

The present paper is a preliminary study on the ecology of the plants in Marunduvalmalai, a group of hills forming the southern terminus of the Western Ghats, very close to the land's end of India. The locality is associated with many legends. The rocks are made up of quartzofelspathic granite gneiss which is highly garnetiferous. Rainfall is meagre, and it is an arid zone. The general character of the vegetation has been described. The uniformity of vegetation is due to the climatic and edaphic factors. There is little chance for migrations and invasions on the hill.

GENERAL

Marunduvalmalai (8° 9′ N. Lat. 77° 33′ E. Long.) comprises a group of hills and hillocks in Agasteeswaram taluk, Kanyakumari district. There are two shrines located at different heights on one hill. The one at the top is dedicated to Paramarthalingaswamiji; the other which is a little below is dedicated to the Lord Ganesh. In the immediate vicinity of the first temple there is a perennial spring, Indrasunai. The hill is approached from the Cape Road by a short lane of about two furlongs. Pilgrims from far and near going to Cape Comorin alight at Pothayadi, a small village near the hill, and from there proceed to the shrines on Marunduvalmalai. The hill is also a place of picnic, and from this hill one gets a panoramic view of the land's end of the Indian peninsula. According to legend Marunduvalmalai is considered to be a broken piece of Oshadhi Parvatha, which Hanuman is said to have carried from the Himalayas to Lanka to help Rama. The wall paintings in the Suchindrum temple which is just one mile away also give religious importance to the hill, by depicting it as the place where Lord Indra is said to

have done penance for purification from a curse imposed by Ahalya. In Tamil language, the word Marunduvalmalai means 'the hill where medicinal herbs live'.



Map showing Marunduvalmalai and its neighbourhood.

Physical Features

Marunduvalmalai stretches in a south-east, north-west direction, surrounded on all sides by fertile paddy fields traversed by the irrigation canals of Nanjinad. These hills represent the southern termination of the Western Ghats. Beyond this, on the south, the land is a plain peninsula projecting into the sea at Kanyakumari. The hills form a narrow ridge, about three miles long and irregular in shape, jutting in the form of promontories in several places. Towards the north-east, there is a group of hills forming a ridge running

north-east and then north, in which is the Yadamally Pass leading to Tirunelveli. But on the west Marunduvalmalai ends abruptly and the greatest continuous rise occurs.

Geology

The biggest rocks on the hills are made up of pyroxene quartzite which resists denudation. But at lower levels the rocks are of garnetiferous gneiss, charged with titaniferous iron in minute grains. The garnets are embedded in the rock and it is impossible to break them from living rock. The rocks also contain black mica. Limestone occurs in several places. 'The predominant character of the gneiss rocks in this quarter is that of well-bedded massive quartzofelspathic granite gneiss with very variable quantity of red or pinkish garnets. This is the characteristic rock at Kanyakumari and very generally throughout south Travancore and Tinnevelly District as well' (Bruce Foote, 1906).

Climate

The annual rainfall (93 cm.) is low when compared with that of other stations along the west coast. The rain-bearing monsoon winds cannot give maximum rainfall, because of the low height of the Western Ghats at this point. The south-west Monsoon is comparatively weak. But it extends over a longer period. Summer storms occur in April and May, accompanied by sudden rain.

A high temperature is recorded throughout the year. But proximity to sea renders the atmosphere humid. In summer, the day is extremely hot. Temperature gradually falls from April onwards. The lowest temperature is recorded in October when rainfall is maximum.

The wind has an average velocity of about 15 miles an hour, except during gusts and squalls and during the monsoon. Minimum velocity is recorded in October during the reversal of the wind system. In January it is almost perfect calm. Marunduvalmalai is, as the crow flies, less than five miles from the sea. Hence the air motion on the hill consists of an alternating movement between land breeze and sea breeze.

Vegetation

The vegetation represents a typical scrub jungle. The constituents are ground herbs, shrubs, and tree-like shrubs. The few trees dotted here and there include *Borassus flabellifer* Linn., *Ficus bengalensis* L.,

Eugenia jambolana Lam., and *Tamarindus indica* Linn. Bulbous and rhizomatous herbs are rare. Dwarf shrubs, creepers, and climbers are abundant. Due to excessive grazing many parts seem to be completely denuded and barren. In addition erosion has played havoc by producing rills and deep gullies. The general character of the vegetation is lithophilous even though xerophilous vegetation also occurs very prominently at lower levels.

Almost all plants in Marunduvalmalai remain in a state of desiccation until the arrival of the monsoon. Then immediately the entire hill becomes covered with vegetation. Since the substratum has been physically dry all annuals put forth their heads only at this time. Many plants exhibit adaptations which enable them to persist in this habitat. Hydrochasy is exhibited by *Selaginella rupestris* which occurs at higher levels. Felted and flattened roots are developed by *Cymbopogon flexuous* (Nees) Wats. and *Sanseviera zeylanica* Willd. *Cyperus rotundus* Linn. shows root contractility. Rigid leaves and coating of hair are notable adaptations of *Stylosanthes mucronata* Willd., *Leucas biflora* R. Br., and *Cocculus hirsutus* Diels. Prickles and thorns in *Argemone mexicana* Linn., *Opuntia dillenii* (Ker-Grawl) Haw., and *Euphorbia antiquorum* Linn. are characteristic of xerophilous habitat; *Euphorbia antiquorum* Linn. and *Cymbopogon flexuousus* (Nees) Wats. occur as co-dominants in the montane region and *Selaginella rupestris* is the dominant constituent towards the top.

Conclusion

The vegetation is more or less uniform since there is little chance for migrations and invasions on this hill. The climatic and edaphic factors also support a uniform vegetation. The constituents are well adapted for drought resistance. The majority of plants on Marunduvalmalai come under the category of Chasmophytes. They are rooted in clefts in rock that are filled with debris. They should be regarded as a unique formation since they have a locality of their own.

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APPENDIX

A complete list of plants collected by the author from Marunduvalmalai is given below. It is arranged in alphabetical order for convenience. An asterisk indicates that it is an annual springing up suddenly after the south-west Monsoon.

Chasmophytes

Abrus fruticulosus Wall.
Acacia arabica Lamk.
Acacia planifrons W. & A.
Actiniopteris dichotoma Forsk.
Adiantum caudatum Linn.
* *Aerva lanata* Juss.
* *Aerva tomentosa* Forsk.
Ageratum conyzoides Linn.
Alangium salvifolium Wang.
* *Andropogon aciculosus* Retz.
* *Anisomeles malabarica* R. Br.
Argemone mexicana Linn.
Barleria noctiflora Linn.
* *Blumea wightiana* DC.
Boerhavia diffusa Linn.
Borassus flabellifer L.
* *Bulbostylis barbata* Kunth.
Caraluma umbellata Haw.
Cassytha filiformis Linn.
Cheilanthes mysorensis
* *Chrysopogon montanus* Trin.
Cissus quadrangularis Linn.
Cocculus hirsutus Diels
* *Coleus malabaricus* Benth.
* *Commelina benghalensis* Linn.
Crotalaria albida Heyne
* *Cynodon dactylon* Linn.
Cyclea burmanii Miers
Cymbopogon flexuosus (Nees) Wats.
* *Cyperus rotundus* Linn.
* *Desmodium trifolium* DC.
Desmodium pulchellum Benth.
Digera alternifolia Aschers.
* *Eclipta alba* Hassk.
* *Emilia sonchifolia* DC.
Eugenia jambolana Lam.
* *Euphorbia hirta* Linn.
* *Euphorbia microphylla* Heyne
Euphorbia antiquorum Linn.
* *Evolvulus alsinoides* Linn.
Ficus benghalensis L.
Flacourtia sepiaria Roxb.
Hemidesmus indicus R. Br.
* *Indigofera enneaphylla* Linn.
Indigofera asphalathoides Vahl.
* *Ionidium suffruticosum* Ging.
Jatropha gossypifolia Linn.
* *Leucas biflora* R. Br.
* *Mollugo pentaphylla* Linn.
* *Notonia grandiflora* DC.
* *Ocimum basilicum* L.
* *Ocimum sanctum* L.
* *Oldenlandia umbellata* Linn.
Opuntia dillenii Haw.
Phoenix humilis Royle
* *Polycarpea corymbosa* Lam.
* *Polygala chinensis* Linn.
* *Portulaca wightiana* Wall.
Pseudarthria viscida W. & A.
Pteris quadriaurita Retz.
* *Ruellia prostrata* Poir.
Sanseviera zeylanica Willd.
Selaginella rupestris (L.) Spreng.
* *Spermacoce hispida* Linn.
Stylosanthes mucronata Willd.
Stapelia spp.
Tamarindus indica Linn.
Tephrosia purpurea Pers.
Tribulus terrestris Linn.
* *Tridax procumbens* Linn.
Tylophora asthmatica W. & A.
* *Vernonia cinerea* Less.
* *Vicoa auriculata* DC.
Zizyphus oenoplia Mill.
* *Zornia diphylla* Pers.

Lithophytes

Parmelia spp.
Ramalina capitata (Ark.) Nyl.
Riccia spp.
Usnea barbata Web.

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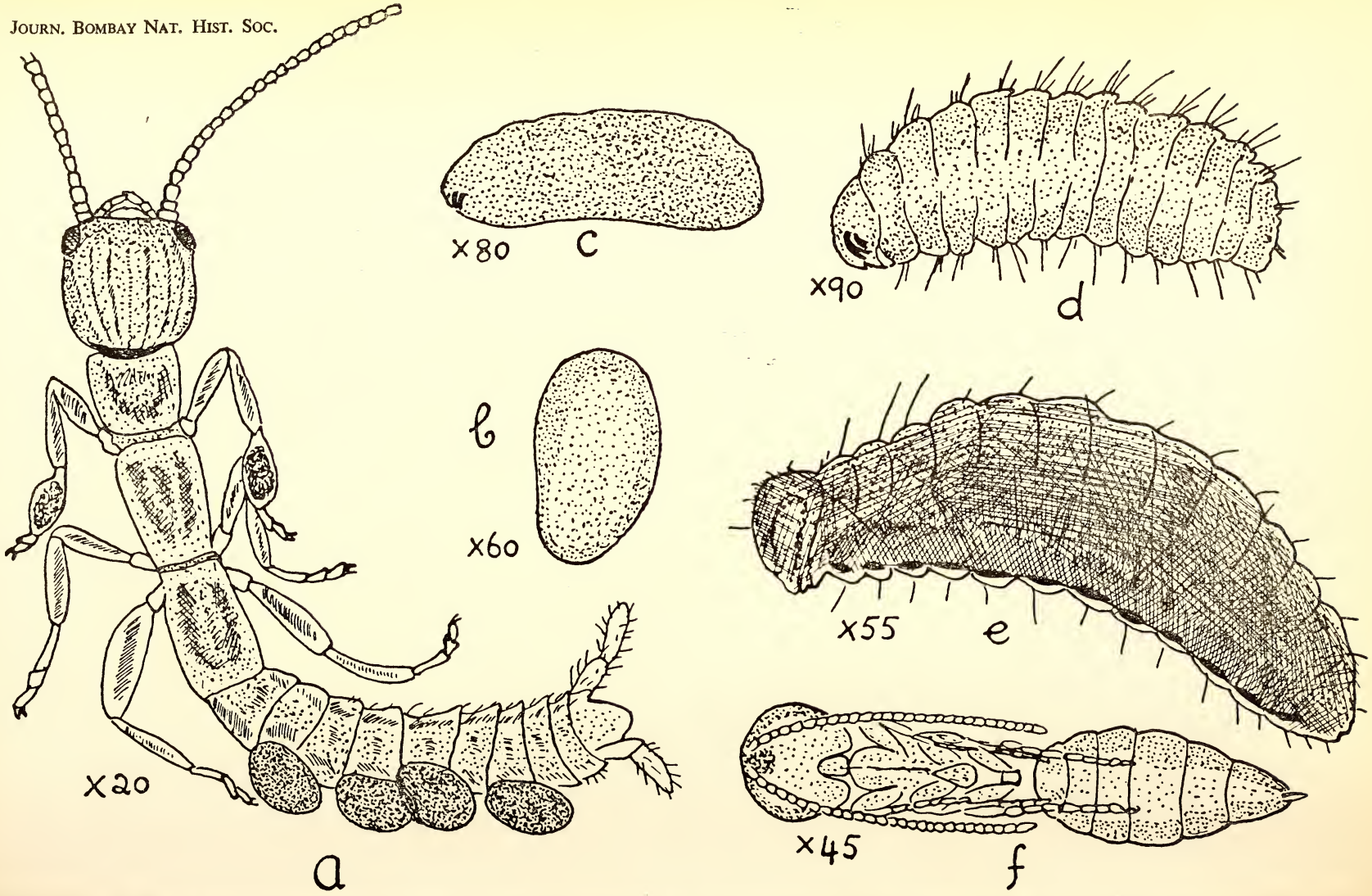

a. Larva of *Parembia* sp. carrying the eggs of *Sclerogibba longiceps*; b-f. Immature stages of *S. longiceps*: b. egg; c. newly hatched larva; d. second instar larva; e. mature larva; f. pupa.

The Biology of *Sclerogibba longiceps* Richards and *Sclerogibba embiidarum* (Kieff.) (Sclerogibbidae: Hymenoptera) parasitic on Embioptera.

BY

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(*With one plate*)

INTRODUCTION

Our knowledge of the hymenopterous parasites of Embioptera is restricted to the works of Richards (1939), Dodd (1939), and Callan (1939, 1952) who have recorded Scelionids and Sclerogibbids parasitizing the eggs and larvae respectively of some Embioptera. The discovery of *Sclerogibba embiidarum* parasitic on the larvae of *Oligotoma minuscula* Enderlein, *Sclerogibba longiceps* Richards on *Parembia* sp., and an unknown species of *Sclerogibba* on *Pseudembia flava* Ross has enhanced considerably the importance of this group. Table I lists the total number of hymenopterous parasites of Embioptera so far known.

MATERIAL AND METHODS

Both the normal and parasitized hosts commonly occur on the bark of *Acacia arabica, Enterolobium saman,* and *Peltophorum* sp., and quite a number of them were also found inside the hollow dry twigs of *Thevetia neriifolia.* It is of interest, however, that those found in the crevices of the steam of *Borassus flabellifer* in the same locality were unparasitized. The insects were removed from their webs into glass tubes of 4″×1″ capacity open at both ends and plugged with cotton. A number of parasitized host larvae of *Oligotoma minuscula* and *Parembia* sp. were kept in separate tubes with bits of bark. Present observations show that only a small percentage of the hosts were

TABLE I

Hymenopterous parasite	Distribution	Embiopteran host	Authority
Family : Sclerogibbidae			
1. *Probethylus callani* Richards	Trinidad (W. Indies)	*Pararhagadochir trinitalis trinitalis* (Saussure)	Richards (1939) Callan (1952)
2. *Sclerogibba embiidarum* (Kieff.)	India, Ceylon.	i. *Oligotoma greeniana* Enderlein ii. *O. minuscula* End.	Richards (1939) Richards (1958)
3. *Probethylus* (= *Sclerogibba*) *embiopterae* (Dodd)	Queensland (Australia)	*Oligotoma gurneyi gurneyi* Frogg	Dodd (1939) Callan (1952)
4. *Sclerogibba longiceps* Richards	Madras (S. India)	*Parembia* sp.	Richards (1958)
5. *Sclerogibba* sp.	Madras (S. India)	*Pseudembia flava* Ross	Richards (1958)
Family : Scelionidae			
6. *Embidobia australica* Dodd	N. S. Wales (Australia)	i. *Metoligotoma ingens* Davis ii. *M. illawarae illawarae* Davis	Dodd (1939)
7. *E. metoligotomae* Dodd	Australia	i. *M. ingens* Davis ii. *M. intermedia* Davis iii. *M. extoris* Davis iv. *M. pentanesiana* Davis v. *M. tasmanica* Davis	Dodd (1939)
8. *E. urichi* Ashmead	Trinidad (W. Indies)	*Pararhagadochir trinitalis trinitalis* (Saussure)	Ashmead (1895)
9. *E. longipennis* Dodd	Tasmania	i. *Oligotoma gurneyi gurneyi* Frogg ii. *Notoligotoma nitens* Davis	Dodd (1939)
10. *E. orientalis* Dodd	Ceylon	*Oligotoma greeniana* Enderlein	Dodd (1939)

normally parasitized in nature. Unparasitized host larvae were also reared in large test tubes for purposes of parasitization in captivity. On emergence, the adult males and females of *Sclerogibba longiceps* and *S. embiidarum* were paired in labelled test tubes to study their reproductive habits. After copulation, each fertilized female was introduced into a test tube containing the host larvae, in order to observe the mode of attack on the host, the ovipositing habits, and

the reproductive capacity of the parasites. The parasitized larvae were then separated and kept individually to study the duration of the immature stages of the parasites.

Immature Stages

Egg: The eggs of *S. longiceps* as well as those of *S. embiidarum* are typically hymenopteriform; the chorion is quite smooth and coloured dull-white; a considerable portion of the egg is embedded into the intersegmental membrane of the host and hence scarcely visible soon after it is laid. However, after three or four days, the eggs are quite clearly visible to the naked eye. The eggs of *S. longiceps* measure, on an average, 0.448 mm. long and 0.242 mm. wide, while those of *S. embiidarum* are slightly longer (0.500 mm. long and 0.254 mm. broad). The incubation period lasts from four to eight days in *S. longiceps* and from six to ten days in *S. embiidarum*.

A remarkable uniformity seems to exist among the species, like most Bethylids to which they are closely related, regarding the position and number of eggs laid on their respective hosts. Thus, *S. longiceps* lays the eggs always in the intersegmental regions of the abdomen towards the left or right side, slightly dorsal and longitudinal in position as in *Parasierola gallicola* (Bethylidae) (Silvestri, 1923*b*) with the posterior end directed caudad. A maximum of five and a minimum of two and, in the majority of instances, three eggs are deposited on a single host. *S. embiidarum*, on the other hand, lays a single egg whose position is invariably restricted to the cervical and the thoracic regions. The egg occupies the intersegmental groove between the neck and the protergum or between the successive segments of the thorax. A similar instance is pointed out by Dodd (1939) in *Oligotoma gurneyi gurneyi* Frogg., forming the host of *Probethylus* (=*Sclerogibba*) *embiopterae*, wherein the single egg of the parasite is attached between the prothorax and mesothorax dorsally of the Embiid larva. Similarly, Callan (1939) notes that the egg of the hymenopteran parasite *Probethylus callani* Richards 'invariably occupied a transverse position on the dorsal surface of the thorax of the host, being attached usually between the head and prothorax or between the pro- and meso-thoracic segments'.

First stage larva: The newly hatched larva cannot be easily distinguished from the egg since there is no marked change in colour or shape and also due to the fact that it never changes its position for feeding on the host but uses the oviposition puncture itself for the sucking of host fluids (Plate, fig. *c*). However, a closer observation reveals slow movements of the body at the hind end

which indicate the presence of the larva. The segmentation of the body is not well marked. The body is coloured pale white and there is a pair of distinct mandibles. After twelve hours a moult takes place and the colour changes into light yellow. The duration of the first instar is quite short in both the species of Sclerogibbids.

SECOND STAGE OF LARVA: The body grows in size and becomes distinctly curved; colour turns to light yellow. The body reveals thirteen segments besides the head which has strong mandibles. The larva is provided with three long bristles on the dorsal side of each segment and two or one per segment ventrally. Body measures 0.742 mm. and 2.00 mm. in length in *S. longiceps* (Plate, fig. *d*) and *S. embiidarum* respectively. The larvae retain the moulted skin or exuviae in the same manner as described by Hyslop (1916) for *Pristocera armifera* (Bethylidae), but with this difference that the exuviae stick on to the anterior dorsal region of the body.

MATURE LARVA: The larva grows remarkably in size by eating the host body voraciously. The colour becomes brown or dirty-black. The larva often stands erect with the caudal end turned upwards in *S. longiceps* while in *S. embiidarum* it retains its horizontal position on the host. The mature larva is arched in the middle so as to be spindle-shaped. The head bears a few bristles and each thoracic segment has a long bristle dorsally. The abdominal bristles are short or absent. The length of the mature larva largely depends on the amount of food it has derived from the host. In *S. longiceps* (Plate, fig. *e*) where the number of larvae feeding on one host varies from two to five, there exists remarkable variations regarding the size, varying from 1.00 mm. to 1.80 mm. in length. The mature larva of *S. embiidarum* grows normally to a length of 2.7 mm. to 3.0 mm.

The entire host is consumed leaving no remnants whatsoever, and the duration of the feeding phase is remarkably short varying from 24 to 48 hours in *S. longiceps* and 24 to 72 hours in *S. embiidarum*. After consuming the host, the larvae move apart from each other before passing into the pupal stage. Locomotion is very slow and the distance traversed never exceeds a few centimetres.

PUPAL STAGE: After about an hour of rest, the larva spins a cocoon which is cylindrical and oblong, measuring 1.80 mm. to 2.0 mm. in *S. longiceps*, 2.3 mm. in *Sclerogibba* sp. (bred on *Pseudembia flava*), and 3.20 mm. to 4.0 mm. in *S. embiidarum*, in length. In *S. longiceps* (Plate, fig. *f*), when the parasites exceed the number two per host, there occurs gradation in the size of the cocoons. In one

TABLE II

Table showing the measurements at different stages of *S. longiceps* and *S. embiidarum*

	Egg		First stage larva, length in mm.	Second stage larva, length in mm.	Mature larva, length in mm.	Pupa, length in mm.	Length of adult in mm.	
	Length in mm.	Width in mm.					Male	Female
S. longiceps ..	0.448	0.242	0.532	0.742	1.792	1.90	1.9—2.1	1.7—1.85
S. embiidarum.	0.500	0.254	1.00	2.00	2.99	3.40	2.9—3.5	2.6—3.1

instance, it was observed that out of the five larvae bred on a third instar larva of *Parembia* sp., two constructed cocoons of average size, two others smaller cocoons and the remaining one a very flimsy one. One end of the cocoon bears a black spot and it is by cutting through this end that the adult parasite emerges. The cocoons of the Sclerogibbids are never matted together but are always solitary. Often, they become inconspicuous when the faecal matter of the parasite adheres on the surface.

Soon after its formation the pupa is coloured white, but as development proceeds the colour turns first to light brown and eventually differentiation of the adult coloration takes place. The general shape of the pupa is similar to that of the bethylids, the only difference being in the size. The pupa of *S. longiceps* measures 1.90 mm. and that of *S. embiidarum* 3.40 mm. in length. The duration of the pupal period is rather prolonged and varies from 14 to 18 days and on an average 16 days in *S. longiceps*, and from 12 to 16 days in *S. embiidarum*. The parasite remains inside the cocoon for 1 to 3 days even after attaining maturity, probably waiting for the exoskeleton to become well hardened. All the eggs deposited on a host develop into adults at about the same time, the difference, noted in a few instances, never exceeding 12 hours.

TABLE III

showing the duration of immature stages of :

1. *S. longiceps* Richards

No.	Date of parasitization	Egg stage in days	Larval stage in hours	Pupal stage in days	Date of adult emergence	Total number of days
1	2-2-'57	4	24	18	25-2-'57	23
2	2-2-'57	4	24	18	25-2-'57	23
3	4-2-'57	5	24	16	26-2-'57	22
4	5-2-'57	8	36	16	2-3-'57	25½
5	5-2-'57	8	24	16	2-3-'57	25
6	12-2-'57	5	24	14	4-3-'57	20
7	20-2-'57	7	48	16	17-3-'57	25
8	28-2-'57	6	36	15	22-3-'57	22½
9	30-3-'57	7	48	14	22-4-'57	23
10	11-4-'57	8	48	16	7-5-'57	26

2. *S. embiidarum* (Kieff.)

No.	Date of parasitization	Egg stage in days	Larval stage in hours	Pupal stage in days	Date of adult emergence	Total number of days
1	24-3-'57	7	60	16	19-4-'57	25½
2	25-5-'57	6	48	13	15-4-'57	21
3	25-3-'57	6	48	13	15-4-'57	21
4	27-3-'57	8	48	12	18-4-'57	22
5	28-3-'57	9	48	14	22-4-'57	25
6	28-3-'57	9	48	14	22-4-'57	25
7	2-4-'57	10	72	13	28-4-'57	26
8	3-4-'57	10	48	15	30-4-'57	27
9	3-4-'57	10	48	16	1-5-'57	28
10	3-4-'57	9	24	15	28-4-'57	25

From Table III it is clear that the duration of the life-cycle is quite short, ranging from 20 to 26 days in *S. longiceps* and 21 to 28 days in *S. embiidarum*. It is also evident that the period devoted to actual feeding is quite short while the pupal stage is a prolonged one.

Adult Parasite

The females of both *S. longiceps* and *S. embiidarum* are apterous while the males are fully winged and are good fliers. The parasites are antilike and very active, moving about with extreme briskness. The males are slightly longer in both species. The males are uniformly black in *S. embiidarum* while the females are bicolorous, with the thorax brown and the abdomen black.

Feeding Habits

It is most common among Bethylids to derive their food from their respective hosts either by merely sucking the body juices leaving the hosts alive or by killing them. The Sclerogibbids, though closely related to the Bethylids, are of interest since they were not at all observed to attack the host larvae for feeding purposes. However, the parasites can be fed and kept alive under captivity with a weak solution of sugar.

Host Preference and Mode of Attack on the Host

The larvae parasitized by *S. longiceps* all belong to the subgenus *Parembia* Davis of an undetermined species which is of very common occurrence in Madras. Among the larvae, the third and fourth instars were the victims of parasitization while the other stages of larvae were not attacked. Similarly, all the specimens of *S. embiidarum* were bred on the fifth instar larvae of *Oligotoma minuscula*, which is also found in large numbers in Madras during almost all seasons of the year. However, it is of special interest to observe that the host preference of *S. embiidarum* is not very specific, for Richards (1939) has recorded this parasite from Ceylon, Madras and Mangalore, parasitizing *Oligotoma greeniana* Enderlein. This lack of host specificity seems to be quite common among the Scelionidae attacking the eggs of Embioptera, and Dodd (1939) records as many as five species of hosts for *Embidobia metoligotomae* Dodd from Australia. It is also noteworthy that one and the same species of Embioptera may be parasitized for the purpose of oviposition by two different species of parasites—one attacking the eggs while the other attacks the larvae. For instance, the larvae of *Oligotoma greeniana*, as has been pointed out, are parasitized by *Sclerogibba embiidarum* while the eggs of this Oligotomid are attacked by the Scelionid parasite *Embidobia orientalis*.

In the experiments conducted in the course of the present study, females of *Sclerogibba longiceps* were offered, besides *Parembia* sp., larvae of other embiids such as *Pseudembia flava*, *O. falcis*, *O. saundersii*, *O. humbertiana*, and *O. minuscula*, all of which are found in plenty in the same locality in Madras. It was observed that the parasite did not attack any host other than *Parembia* sp., thus showing remarkable host specificity. *S. embiidarum*, on the contrary, was noticed to lay eggs on the larvae of *Oligotoma falcis* and *Parembia* sp., when not provided with its natural host, namely *O. minuscula;* but, the position of the eggs was on the abdominal segments though the number of eggs per host was only one. However, the preference for *O. minuscula* is evident from the fact that in the field no larvae other than those of *O. minuscula* were observed to be parasitized by *S. embiidarum*. The significance of selecting *O. minuscula* by *S. embiidarum* may be that the host completes its life-cycle within the comparatively short time of 2½ to 3 months while the other species of Oligotomids require 4 or 5 months and *Parembia* sp. 7 or 8 months. Since the life-span of the parasite ranges from 30 to 40 days only, it would naturally be more difficult for the parasite to have access to the proper host larva if

the duration of life-cycle of the latter is a prolonged one and consequently only one or two generations per year. *O. minuscula* appears to have enough number of generations every year and there is no scarcity of the host at the specific larval stage during all seasons; all these factors account for the host preference of *S. embiidarum* for *O. minuscula.* In the case of *S. longiceps*, correlated with the prolonged life-cycle of the host, the parasites are not frequently met with during the major part of the year.

The mode of attack on the host by Sclerogibbids is distinctive. The host is usually confined inside its web and attacks on exposed hosts seldom occur. As described by Clausen (1940) this also appears to be the case in most Bethylids. Male parasites have not been observed to attack the host while the females do so only for oviposition. The parasite crawls over the webs and, on scenting the presence of the proper host, cuts the webs with its powerful mandibles, enters it, and attacks the host from behind by biting at various regions, an act which apparently makes the host stop its movements the antennae alone vibrating slowly. It is of interest to mention that the mode of attack on the host by *Laelius anthrenivorus trani* (Bethylidae) described by Howard (1901) is essentially the same as the one noted in the present study. The host remains partially paralysed for a short time extending from 30 minutes to an hour during which time the parasite inserts her ovipositor through the intersegmental membrane of the host and lays her eggs, anchoring them deeply with one-third of the egg embedded inside the host body. The host invariably regains consciousness and assumes its normal activities; however, the parasitized larvae become more and more sluggish as the parasite eggs hatch into larvae. The parasitized larvae of *Parembia* sp. become pale yellow in colour and locomotion is rendered extremely difficult due to the weight exerted by the growing parasites numbering from two to five, and due to the loss of body fluids sucked continuously by them. The parasitized larva of *O. minuscula*, on the other hand, is quite as active as any other unparasitized ones until the parasitic larva completes the second instar stage, because the number of parasites per host is only one and its position is on the thorax. But, ultimately, with further feeding and development of the parasite, the host loses its power of locomotion.

Longevity and Fecundity

The males of both the species of Sclerogibbids studied live for 2 to 4 days only during which time copulation takes place. The females, on the contrary, thrive for a comparatively longer time.

In captivity and with food supply, females of *S. longiceps* were observed to live for about 15 days, and without food they lived only for 2 to 5 days. Females of *S. embiidarum* could be kept alive for 10 to 21 days with food supplies. Copulation took place only once soon after the parasites emerged from the cocoons and the preoviposition period ranged from 2 to 4 days. The maximum total number of eggs laid by a single female of *S. longiceps* in captivity was only 18 deposited on 6 host larvae, while the minimum was 7 distributed on 2 larvae. The reproductive capacity of *S. embiidarum* was found to be still lower, the maximum and the minimum being 9 and 5 respectively. Thus the reproductive capacity of these parasites is exceptionally low unlike most Bethylids.

Sex-ratio and Parthenogenesis

All the eggs deposited on a host develop into the same sex, either male or female. In studying the sex-ratio, the larvae parasitized by individual females were isolated and the total number of males and females developing from them were taken into account. As in most parasitic Hymenoptera, the females always preponderate in both the species of Sclerogibbids studied, giving a sex-ratio of 2:5 in *S. longiceps* and 2:3 in *S. embiidarum.*

Table IV

showing the sex-ratio of *S. longiceps* and *S. embiidarum*

	S. longiceps				*S. embiidarum*			
	I	II	III	IV	I	II	III	IV
Total number of individuals emerged ...	18	9	10	7	9	5	8	5
Number of males ..	5	3	3	2	4	2	3	2
Number of females ..	13	6	7	5	5	3	5	3
Sex-ratio of male : female	2 : 5				2 : 3			

Parthenogenesis has been observed in *Sclerogibba embiidarum,* all the resulting progeny being females.

Extent of Efficiency in Biological Control

Among many other factors, the efficiency of biological control depends largely on the opportunities of gaining access to the proper host to ensure the production of enough number of offspring and their further multiplication. Both the species of *Sclerogibba* dealt with here, no doubt, have short life-cycles, and consequently a faster reproductive rate. But, the control of the host can be achieved only if the host is attacked at a specific larval stage. This condition, however, is not possible in *S. longiceps* since its hosts, *Parembia* sp., as already stated, have a long larval duration and but a single generation per year. It is due to this reason that *S. longiceps* is not of frequent occurrence during the major part of the year. They are to be found in Madras only from the months of January to April during which period the host is in its third or fourth larval stages and most susceptible. Attempts to collect them during the months May to December met with failure. Regarding *S. embiidarum*, its host *O. minuscula* is found in Madras practically throughout the year in the larval as well as in adult stages and this accounts for the availability of the parasite at any time, though during some months of the year their occurrence is maximum as is revealed from a study of the population count of this species in Madras in an area of approximately 5000 sq. yards with thickly crowded trees. The population count was taken for a period of 12 months—February 1957 to January 1958. Parasitized larvae of *O. minuscula* were collected regularly once each week during all months and the parasites were reared to maturity. It was found that there was a regular increase in the number of the parasites from January to April attended by a regular rise in the temperature, culminating in May when the temperature was 30.80° C. A subsequent decrease took place from June onwards till October, and in the month of November not a single parasitized specimen was noticeable. It, therefore, appears that the absence of rainfall and a fairly high temperature are conditions most favourable for the rapid multiplication of the parasites while heavy showers are inimical to them (Table V). Thus, the occurrence of the parasites throughout the year is a factor favourable in the control of the host. However, the habit of the parasite to lay only a single egg per host is no doubt a handicap.

The other factors which limit the efficiency of both the species of *Sclerogibba* under consideration are the low reproductive capacity, the very short life-span of the adults, and their susceptibility to extremes of climatic conditions.

TABLE V

showing the seasonal variation in the availability of *S. embiidarum*

Month	No. of parasites	Maximum temperature in ° C.	Minimum temperature in ° C.	Mean temperature in ° C.	Total rainfall in inches
February 1957 ..	21	29.5	20.6	25.0	0.20
March ..	26	30.5	22.5	26.5	nil
April ..	30	32.4	25.1	28.8	nil
May ..	34	34.1	27.4	30.8	0.40
June ..	14	36.1	27.1	31.6	1.39
July ..	14	34.4	25.8	30.1	5.59
August ..	8	32.9	25.1	29.0	5.58
September ..	4	33.9	25.3	29.6	3.59
October ..	4	31.4	24.3	29.9	8.59
November ..	nil	28.9	23.3	26.1	16.63
December ..	14	28.5	22.0	25.3	0.11
January 1958 ..	18	29.0	20.5	24.8	0.39

SUMMARY

The host relations of the Sclerogibbids, as far as is known from five species, reveal that they are restricted to Embioptera. While the Sclerogibbids parasitize the larvae of Embioptera, the Scelionids attack the eggs of the Embiids. The life-history and habits of two species of Sclerogibbids, namely *Sclerogibba longiceps* and *S. embiidarum* are described. The larval features in both the species are similar, while important differences could be noticed regarding the number of eggs laid on their respective hosts, their position on the host body, and the time taken in consuming the entire host. Both the species have short life-span and the feeding phase is remarkably short. The parasites exhibit host specificity to a considerable degree. The host is paralysed only temporarily for oviposition, and attack on the host for feeding purposes is not met with. The reproductive capacity of the parasites seems to be low which circumscribes to a large extent their efficiency in the control of the host. In sex-ratio, the females preponderate. Correlated with the long life-cycle of its host, *S. longiceps* is not found for the major part of the

year, while *S. embiidarum* is of common occurrence during almost all months. Field population studies of *S. embiidarum* reveal that they increase in number with the rise of temperature and in the absence of rainfall.

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Reviews

1. ANIMALS IN INDIA. By Ylla. Pp. 132 (28.8×22.6 cm.). 24 pages of colour gravure and 68 pages of monochrome gravure photographs. New York, 1958. Harper and Brothers. Price $10. Also, London, 1958. Hamish Hamilton. Price 42*s*.

This is the latest and fourteenth book by Ylla (Miss Camilla Koffler) who died as the result of an accident in India in March 1955. After becoming one of the world's greatest animal photographers through her earlier books of (domestic) dogs, cats, and zoo animals, she tried her hand at wild life photography on a camera safari in Africa in 1952, the result of which was her very successful ANIMALS IN AFRICA. The logical sequence to this was a similar book on animals in India, and she was in contact with me and others over this project during 1953-54. I was one of a number of persons who advised her of the difficulties of doing wild life photography in India as compared with Africa where it is so much easier.

With characteristic determination Ylla came to India in August 1954, and soon wrote to me from Mysore that she was finding out the truth of our advice and that she would not be able to make a full book on the wild life of India but would have to include ceremonial elephants, temple monkeys, cows in the streets, and so on. Thus it is that, unlike the book on Africa, very many of the animals depicted in this book of India are captive or domestic ones.

The text in this book is from the diary she kept during her seven months' tour in India. With the keen observation and sensitivity of a new-comer to this country, her first-impression descriptions of places and people are of great interest. At a tiger shoot in Mysore she writes: 'The dead tiger is very beautiful; poor beautiful thing, with glassy eyes, and soft paws'. At Periyar she refers to the dead trees of the lake as 'looking like tortured ghosts imploring heaven to free them'. At Kaziranga she observes: 'The early morning drives are very lovely. We are usually out in time to see the sun rise, a huge red ball that dispels the mist, low over the plains. . . There are many birds—mostly of the stork and crane family—looking fragile and mysterious in the morning mist.'

Purely from the wild life photographer's point of view there is something lacking in the book. Unlike some of her other books in which she gave full photographic data and details of her methods, there is neither of these in this book—for obvious reasons. As an art publication, on the other hand, it would be hard to find a book which surpasses this one. Printed in Switzerland, the colour and

monochrome gravure photographs and the general layout are a sheer delight to behold.

From the naturalist's point of view the book disappoints with its many mistakes. Whereas ANIMALS IN AFRICA contained a text written by an authority on the animals of that continent, apparently no effort has been made by the publishers to obtain technical advice from a zoologist or naturalist of India prior to the publication of ANIMALS IN INDIA. For instance, when on page 19 Ylla 'saw a few buffalo', one misses the necessary publisher's footnote to explain that that there are no buffalo in this part of India and that Ylla must have meant 'bison' or gaur. Similarly, when the Gir Forest is described as 'one of the few lion reserves left in India', a footnote could have pointed out that the Gir is the one and only lion reserve in the country.

In the captions to the pictures are more serious errors. For example, the horns of the Indian rhino (page 73) are not '24-inch'—the all-time record is $24\frac{1}{4}''$, while the longest ever seen in recent years in Kaziranga is $18\frac{1}{2}''$, and the average horn seen today in this sanctuary is about 8″. Again, the tick bird (page 74) is not an oxpecker but the jungle myna. Demoiselle cranes and sarus cranes are not common in Assam, but very rare. The animal (pages 122 and 123) described as 'the wild gaur of India' is in fact a buffalo.

After an elephant shoot in Mysore Ylla wrote in her diary: 'I do not understand that need in man to affirm himself heroically by killing. It seems to me that only a creative effort can give one a true sense of fulfilment. Photography fills me with a satisfaction no dead animal could possibly give'. In spite of the few defects listed above (which could in any case be remedied in a subsequent edition), this superb book with its very high standard of production is a fine memorial to a warm-hearted and gallant woman who by her artistic perception and photographic technique achieved that 'true sense of fulfilment' and will always be remembered as one of the greatest animal photographers of all time.

E.P.G.

2. BIBLIOGRAPHY OF THE ARABIAN PENINSULA. By Eric Macro. Pp. xiv+80 (28×21.5 cm.). Florida, 1958. University of Miami Press. Price?

Arabia, the land of the origin of Islam, the land made known to many by the exploits of Lawrence of Arabia has been virtually a *terra incognita* to the outside world until very recent times. The

vast desert and arid tracts of the Arabian Peninsula combined with religious and political barriers have for centuries stood against the intrusion of foreign influence. All the same it is a mild surprise to find that only 2380 books and articles have been published in the various European languages about this 'desert land' which has now come into world focus on account of its rich and unlimited oil resources. Happenings in Saudi Arabia, Kuwait, Quatar Peninsula, Trucial Oman Coast, Oman, the Aden Protectorates, and Yemen make headline news, and an easily available bibliography of the art, culture, and science of these countries will be of much more than merely topical interest.

A list of abbreviations of about 500 publications consulted precedes the main bibliography which runs into 68 pages; 2380 titles are given, all arranged alphabetically authorwise. For easy reference a 12-page author index is given at the end. It is gratifying to find many references to articles which have appeared in the *Journal of the Bombay Natural History Society*.

As the author himself admits there are many omissions. A glaring case in point, we find, is the recently published book BIRDS OF ARABIA by Col. R. Meinertzhagen, and another Dr. S. Dillon Ripley's paper 'Comments on the Biogeography of Arabia with particular reference to Birds' [*JBNHS* **52** (2 and 3): 241]. In places the bibliography is not comprehensive enough since certain papers are not mentioned separately, e.g. Scott, H., and Britton, E. B. (1941), List and Brief Description of collecting stations in Exped. SW. Arabia, 1937-38 London (Trustees, British Museum): No. 1 pp. i-xiv, map; and Trewavas, E. (1941), No. 3. Freshwater Fishes, ibid. pp. 7-15, pls. 1, 2, text figure 1 are not indicated separately, but the results of the expedition mentioned in one place as: 'Scott, Hugh—The British Museum Natural History Expedition to south-west Arabia 1937-38. London, 1941'.

This is the first serious attempt to compile a bibliography of the Arabian Peninsula. Its minor shortcomings are understandable since the author, Squadron-Leader Eric Macro, was greatly handicapped due to constant service transfers. However, it should provide an opportunity to people familiar with literature on the Arabian Peninsula to draw the author's attention to the omissions which could eventually be published as an addendum.

The present bibliography forms a useful addition to the already published five parts of Dr. Henry Field's bibliographies of SW. Asia. The stress in the latter is more on art, culture, and anthropology, and they should be specially handy to all interested in those subjects.

E.G.S.

3. THE YOUNG NATURALIST'S YEAR. By Fred J. Speakman. Pp. 176 (19×13 cm.). With 8 plates and many line drawings. London, 1958. G. Bell and Sons Ltd. Price 12*s.* 6*d.* net.

The British naturalist awakes in the early hours on a January morning to find the first snow falling from a grey sky, crystal upon crystal, on to the English city and woods. A fallow deer lifts her head, listens to the hissing snow, then sleeps again in the shelter of dead bracken fronds. A sow badger trudges back to her dark dry tunnel. A weakened hare scuttles; a hungry crow swoops; the snow slowly fills a rut recently made by an otter.

With this invocation, gentle as the snow he describes, Fred Speakman begins his personalized account of each month of the year.

The author is a teacher and lecturer who feels the breathless enchantment and yet cruel realisms of nature. He expresses these sentiments in the silvered tones of a poet—to such an extent that phrases and even pages read like free verse: 'Leave the bright morning, and come again in the dusk when in the warm air the scent of silver birches lingers sweet.' The invitation is difficult to resist.

The reader is invited to come watch the unfolding, blossoming, and dying of wild things during the year. Reading the book is like listening to a gentle conversation of this man whose profound empathy into nature shows in every line he writes. He gives each month its own particular hymn of praise and love: crisp February, when the grip of winter is weakened, and chaffinches scatter the thin snow on dead leaves to find sleeping insects. Bright April, when pools fill with frog-spawn. June woods, bursting with noise and colour. Then the grunting of badgers as they gather October bracken for their bedding.

Nature-lore descriptions are subtly mingled with a dreaming philosopher's wisdom that springs from the author's quiet thoughts and judgement. Speakman also voices his outrage against the thoughtless people's despoiling the woodlands, and their determination to exterminate the grey squirrel and the rabbit. His rebellion is inserted not loudly, not strongly, but just persistently enough to awaken in a young mind a consciousness of the injustice. Brief but interesting notes at the end of each month-chapter suggest to young naturalists what they might observe and do during each month.

Speakman is particularly appealing to both young and old young-in-heart readers in his descriptions of baby animals. There is a wonderfully humorous description of a badger cub on his first sliding venture from his burrow. And a page of breathless activity describes

a mother squirrel teaching her young to leap through trees: 'Mother is in front, right out in the leafy sprays where one second's pause will be too long. She leaps. The bunch of sprays she held is still upswinging when she lands feet away on the end sprays of a hornbeam. They sway beneath her frantically, but still she dare not pause, more than just long enough to release the bunch of leaves she has seized in forefeet. Away she goes, and two brown streaks follow, and one darker. Where she springs, they spring; where she leaps and glides with tail and legs outspread, they leap. There is no staying to pluck up courage; they follow. Up they go still higher, then down —and there is mother at the foot of the tree waiting to kiss noses. Off once more, leap-frogging over one another, cross-vaulting from side to side, till the eye can scarcely follow. This is the training that will help them a hundred times over in later life, when they must take a risk or die; when the power to do what seems impossible means the power to live.'

It was with a sigh of reluctance that this reader finished the book and left the enchanted world which Fred Speakman had brought for a few hours with his delightful commentaries.

BARBARA J. TUFTY

4. THE LOVE-LIFE OF ANIMALS. By Wolfgang von Buddenbrock. Translated from the German by J. M. Chaplin. Pp. 227 (21.6×14 cm.). London, 1956, Frederick Muller Ltd. Price 25*s*.

The author deals with sex in all its aspects throughout the animal world. After a review of the manifestation of sex in protozoa, he expounds the various features of the sex relationship among the metazoa, beginning with sexual dimorphism and working his way through mutual attraction of the sexes, sex recognition, courtship, sexual fights, the sexual union, marital co-habitation, breeding in hermaphrodites, egg-laying, brood parasitism, provision for the protection of eggs, and nest-building among vertebrates and invertebrates to the care, feeding, and training of the young. It is not possible by a list of general headings to give a complete account of the topics dealt with. The book is profusely illustrated with clear line drawings and good photographs. The author has kept steadily before him his main object of making available to the lay public an account of sex life in the animal world and, in spite of his occasional use of technical terms most of which he has carefully explained, has succeeded in presenting the general reader with a fascinating and readable book.

The subject is a vast one and opportunities for observation are largely a matter of chance. Hence specialists will welcome the co-operation of those who are prepared to take trouble, to observe closely, and to record their observations while their remembrance of them is fresh. For this purpose this book will furnish useful guidance as to where to look, what to look for, and points of importance. But the observer must remember that Nature has adopted an immense variety of ways to attain the same ends, even in closely related species. Therefore, while taking the book as a guide, the lay observer should not expect his observations to tally exactly with those related in the book—the important thing is that he should be certain about the facts seen by him and that he should record them clearly.

D. E. R.

5. THE LIVING FOREST. By H. L. Edlin. Pp. 310 (21.5× 14 cm.). London, 1958, Thames and Hudson. 25*s*. net.

In this fascinating book the author talks about the common trees of the British countryside, among other things telling us of their history and their application to the use of man, and relating some of the tree-lore that has gathered round them.

The first half of the book deals with the 'natives', the Silver Birches, the Scots Pine, the Oak, the Ash, the Willows, and other trees, trees that crossed over to the British Isles after the Ice Age while the land bridge still existed between them and the continent of Europe. The later pages tell of trees brought to Britain in historical times, the sweet chestnut, the walnut, and the sycamore, gifts of the Roman conquerors, and the Spruce, the Silver Firs, the Cedars, the Larches, the Poplars, and the rest. Although there is not a single illustration and he is talking of trees with which we are not familiar in this country, he succeeds in holding the reader's attention and makes him long for something similar about the trees growing round him in India. The whole is written with a light, humorous touch that enlivens what in less skilful hands would be merely a dull list. Thus: 'The fine whip-like twigs of birch are tough and strong, and serve for varied traditional purposes. The witches of legend flew through the air on broomsticks ending in a flourish of birch twigs, and handy yard brooms are still made by binding a bundle of such twigs, gathered in autumn and carefully seasoned, into a tight mass with a bond of green willow, and then thrusting a birch pole into the centre to form a handle. Similar bundles are used in tin-plate works to brush the scale or iron oxide off sheets of hot metal; they are gradually burned

away, but prove cheap and effective. Smaller bundles of birch were long employed in schools to promote learning by the chastisement of backward scholars, an old custom regarded by the modern schoolboy as particularly barbaric. Large tufts of birch brushwood are used on racecourses to form steeplechase jumps. The purplish-brown twigs bear an aromatic waxy bloom in spring, and this was once used by Highland maidens as a fragrant hair rinse.' The enumeration continues for some more pages for the wood and bark are of great value for many purposes. And again: 'Often a great oak was used to mark the boundary of a parish or even a shire; there is a County Oak and a Boundary Oak where Surrey meets Sussex, and a Border Oak where Shropshire marches with Wales. Gospel Oaks were used by wandering preachers, and Dool Oaks by royal hangmen! Bulls sheltered in hollow Bull Oaks, facing outwards with menacing horns. Edward I held a parliament below the Parliament Oak in Sherwood Forest, and William Wallace is said to have hidden with no less than 300 followers within the Wallace Oak at Elderslie in Renfrewshire, when pursued by Edward's forces. From the Rufus Oak in the New Forest, there glanced the arrow that laid King William II low in the year A.D. 1100.'

Besides entertainment, there is much useful information to be gleaned, e.g. the agency of trees in preventing erosion of river banks, the necessity of quarantine when introducing foreign trees, the employment of trees in reclaiming sandy areas, and so on.

D.E.R.

6. PRACTICAL ANIMAL BIOLOGY FOR THE TROPICS. By R. D. Purchon. Pp. xii+148 (18×12.5cm.). With 25 text figures. London, 1957. University Tutorial Press Ltd. Price ?

Practical work goes hand in hand with theoretical studies in biology as well as in other sciences. For students taking up biology for a university degree or for any specific profession such as medicine, it is imperative that they train their hands for clean and neat dissection, and develop a knack for accurate observation. In preparing this guide to aid students of Intermediate classes of the University of Malaya the author has had these objectives in view.

The author's concluding remark in the Preface that 'the student should be required to read the Introduction and re-read it at a later date' is pertinent as it will impress on him the major objectives of the course. Many useful and important hints regarding illustrating

the dissections are given, with a reminder that the mind should continually be occupied with thoughts about the component of the object being drawn, and understanding its functional relationship with the whole. 'Practical work is largely wasted if it is only an unthinking mechanical exercise'.

Although instructions for various stages of the dissection of animals are given, it is clear that they are intended to be used in conjunction with a suitable text book. The 25 text figures which illustrate the booklet are diagrammatic drawings of some of the systems of the animals dealt with, and are easily understandable by any student of biology.

A chapter (pp. 29-43) is devoted to histology and cytology which do not come strictly within the scope of the booklet.

Since the book is intended primarily for use in the first year course in zoology by medicine, dentistry, and pharmacy students of the University of Malaya it deals mainly with the animal types prescribed by that University. But all the major phyla are represented, and as such the booklet has a wider scope as a useful guide to students undergoing similar courses in other universities as well.

M.R.R.

7. THE WORLD OF BUTTERFLIES AND MOTHS. By Alexander B. Klots. Pp. 207 (28.5×22 cm.). London, 1958. George G. Harrap & Co. Ltd. Price 63*s*. net.

I have enjoyed studying the superb photographs, in colour and in monochrome, which illustrate this book and reading the text which they accompany. In language that any layman can understand and yet without any writing down to his audience, Mr. Klots tells in brief all about the lepidoptera, their ancestry and relationships, their general structure, their growth from egg to adult, their food habits, their relations with their food plants and with other animals on which they prey or which are their predators or parasites, their various devices for escaping the many dangers that surround them at every moment of their lives, their sensory powers, their general behaviour including courtship and mating, their migrations and distribution, and their relationship with man.

Mr. Klots explains much that we have often observed but have not understood—to mention a few items: the drop of what looks like blood which we find when a larva turns into a pupa, the way in which the larva at the time of pupating steps out of its skin, the

explanation of the Mexican jumping bean, the nature and mechanism of the brilliant colours which adorn these tiny creatures. He also tells us much that we did not know and many things the possibility of which we would not even have guessed, for instance: the elaborate way in which the Yucca Moth fertilises the flower and makes provision for its progeny, the flower that opens only to the particular moth which is privileged to fertilise it, the curious instinct of the larva which matures in a nest of tree-ants and departs just before pupating as if it knows that if it stays on the ants will kill and eat it, the successful exploitation of an insectivorous plant by the Ceylonese noctuid *Nepenthophilus tigrinus*, the existence in the feet of organs of taste which are 2400 times more sensitive to sugar than is the human tongue.

This is a book that I recommend as something which will repay perusal and which you will go back to again and again as a book of reference—this is addressed to the layman, but I have no doubt that even the specialist will find much in the book to interest him.

D.E.R.

8. THE AUTOBIOGRAPHY OF CHARLES DARWIN, 1809-1882. Edited with Appendix and Notes by his grand-daughter Nora Barlow. Pp. 253 (21×13 cm.). London, 1958. Collins. Price 16*s*. net.

The autobiography was written by Charles Darwin for his children and grand-children, and one approaches it with the feeling of being an intruder. Misgivings as to the propriety of peeping into family secrets soon vanish, however, for Darwin was one of those good and simple souls who have nothing to hide.

Although his father enjoyed considerable success as a medical practitioner, the profession did not appeal to young Charles. He turned next to the Church but, in spite of 'a bump of reverence developed enough for ten priests', again found himself unsuited. He tells us that his five years at the Edinburgh and Cambridge Universities were completely wasted so far as academical studies went. Nevertheless, he showed enough promise in Natural Science for J. S. Henslow, Professor of Botany at Cambridge, to recommend him for appointment as Naturalist on H.M.S. *Beagle*—the post was to carry no monetary remuneration. Darwin's father was opposed to his going. Thanks to the intervention of Charles's uncle Josiah Wedgewood, son

of Josiah Wedgewood the Potter, the objection was withdrawn and, in spite of a nose the shape of which did not appear promising to the Captain of H.M.S. *Beagle*, Darwin was signed on for the voyage. In due course the *Beagle* sailed and in the next five years Darwin recorded notes of observations which kept him occupied for several years to come and filled many bulky volumes. Already, while he was still on the *Beagle*, he was becoming known. Letters which he had written to Professor Henslow had been read before the Philosophical Society of Cambridge and Adam Sedgwick, Professor of Geology at Cambridge, prophesied that he would take a leading place among scientific men.

The autobiography first came before the public as part of LIFE AND LETTERS OF CHARLES DARWIN edited by his son Francis Darwin. This was in 1887 five years after Charles's death, and many omissions were necessary to spare the feelings of persons still living. In 1929 the text as published by Francis Darwin was issued as a separate volume in The Thinkers Library series. It was repeated in 1950 in a volume published by G. G. Simpson and entitled CHARLES DARWIN'S AUTOBIOGRAPHY. This is the first time that the complete text has been published.

The story, told in simple straightforward language without embellishment of any sort, is fascinating and holds the reader's attention from the first page to the last. The most striking fact appearing from these pages is the humility of this great man about his own capacity and achievements, his ready acknowledgement of the merits of other scientists, and the complete absence of the very slightest sign of jealousy. In a totally dispassionate fashion he analyses his own ability and comes to his final summing up: 'Therefore, my success, as a man of science, whatever this may have amounted to, has been determined, as far as I can judge, by complex and diversified mental qualities and conditions. Of these the most important have been—the love of science—unbounded patience in long reflecting over any subject—industry in observing and collecting facts—and a fair share of invention as well as of commonsense. With such moderate abilities as I possess, it is truly surprising that thus I should have influenced to a considerable extent the beliefs of scientific men on some important points.' It is interesting to compare this with his generous appraisal of T. H. Huxley: 'His mind is as quick as a flash of lightning and as sharp as a razor. He is the best talker whom I have known. He never writes and never says anything flat. He has been the mainstay in England of the principle of the gradual evolution of organic beings. Much splendid work as he has

done in Zoology, he would have done far more, if his time had not been so largely consumed by official and literary work, and by his efforts to improve the education of the country.'

There is much more that I would like to quote, but I feel that this is a book that my readers must read for themselves. Uncles and aunts will find it an answer to the problem that presents itself annually when birthdays come round.

D.E.R.

Miscellaneous Notes

1. URINE OF BATS AS A MEANS OF OFFENCE

Leptospirosis is an infection transmitted from animal to animal and from animal to man by the urine of the infected animal, so any observations on habits of urination are likely to be of value in the study of the disease. Surveys of mammals have shown that infection with leptospires is widespread, particularly among ground dwelling mammals, but have shown its occurrence also in such unexpected animals as bats.[1] The following observation is therefore of interest.

On entering a limestone cave in Malaya which was inhabited by horseshoe bats, I found at one point, where my body blocked the entrance to part of the cave, that the disturbed bats would fly up and flutter in front of me, a foot or so away, as if using their sound-ranging mechanism to seek a way past. Repeatedly, however, I saw the bat hovering in front of me give out a squirt of urine before retiring to the back of the cave. These squirts were well directed, and I received many on my face, hands, and the front of my shirt. Evidently the bats were using their urine as a means of offence.

I should be most interested to know of any other observations on the urination of bats, particularly any indication of their using urine on other animals, and particularly on other bats.

INSTITUTE FOR MEDICAL RESEARCH, MALAYA,
(Now of QUEENSLAND INSTITUTE OF MEDICAL RESEARCH, BRISBANE),
November 5, 1958.

J. L. HARRISON, D.Sc.

REFERENCE

Alston, J. M. & Broom, J. C. (1958): Leptospirosis in man and animals, E. & S. Livingstone Ltd., Edinburgh & London.

Smith, C. E. G., Turner, L. H., Harrison, J. L., & Broom, J. C. (in press): Animal Leptospirosis in Malaya. (1) Methods, Zoogeographical background and broad analysis of results.

Emanuel, M. L. (In manuscript): Animal leptospirosis in North Queensland.

2. THE FLYING FOX OF ADDU ATOLL, MALDIVE ISLANDS—A CORRECTION

Owing to a series of unfortunate circumstances, the fruit-bats of Addu Atoll were incorrectly identified by me on my first arrival in Gan. My note on pages 334 to 337 of Volume **55** (No. 2), published in August 1958, was written under a regrettable misapprehension.

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[1] Genera in which clear evidence of leptospirosis has been obtained are *Cynopterus* in Indonesia, *Eonscteris* and *Myotis* in Malaya, *Pteropus* in Queensland (Alston and Broom, Smith *et al.*, Emanuel)

Subsequent collecting has shown that all the common fruit-bats, previously believed to be *Pteropus hypomelanus maris,* were in fact a race of *Pteropus giganteus,* having unusual and peculiar habits and generally living solitary lives amongst the breadfruit trees and coconut palms of the villages.

Now that more careful observation and collecting has been possible and all the larger islands in the Atoll have been visited, the very unexpected fact has emerged that *Pteropus hypomelanus maris* appears to have ceased to exist in Addu Atoll and to have been replaced by the larger *Pt. giganteus.* The smaller species *Pt. hypomelanus* is not only unknown to the local Maldivians but a careful search has failed to reveal a single specimen. There is, however, the remote possibility that a colony still exists on one of the uninhabited islets, and that the Maldivians quite understandably confuse the smaller species with the juvenile individuals of *Pt. giganteus* which are frequently to be seen flying around, feeding on fruits, or resting in the heads of palm trees quite on their own.

It is curious that the habits of the common *Pt. giganteus,* as resident in Addu Atoll, should differ so greatly from the normal habits of *Pt. giganteus ariel,* as resident in North Malé Atoll. The description of the habits, as given under the name *Pt. hypomelanus maris* in my note, now under correction, should of course be read as applying to the resident *Pt. giganteus* of Addu Atoll. It is also curious that the profile of the Addu Atoll bats should appear to be so different from that of typical *giganteus.* Yet an examination of the skull shows that actually there are no essential differences between them.

It is very much regretted that my note should have been published before the identity of the species was confirmed by more adequate collecting and the critical examination and measurement of specimens in the hand.

Apologies are now tendered for any confusion that the premature publication of my first note may have caused.

C.R.O. Bungalow,
c/o R.A.F. Gan,
B.F. P.O. 180,
via G.P.O. Colombo,
Ceylon,
December 26, 1958.

W. W. A. PHILLIPS

3. 'WILD' CATTLE IN NORTHERN INDIA

The occurrence of a herd of domestic cattle gone 'wild' at Bharatpur, referred to by Mr. E. P. Gee in these pages, is a fairly widespread phenomenon in the 'khadars' and wild scrub areas of the northern rivers in the Punjab and Uttar Pradesh. I have seen herds of these cattle personally in Gurgaon, Bulandshahr, Mathura, Karnal, Hissar, and Meerut districts, and have been told by reliable 'shikaris' that they are also found in the districts which surround the ones I have seen. It appears that their occurrence is connected with, in fact due to, the habit of leaving weak plough-bullocks and off-milk cows in these scrub areas with just a few boys to look after vast numbers of them. The result is the straying and ultimate abandonment of a few each time, leading to their going 'wild'.

I have had some interesting experiences with them; there are a few big herds in the Jumna 'khadar' in Gurgaon-Bulandshahr districts which stick to a chosen bit of high ground, in sparse tamarisk scrub with patches of stunted Dhak around it. There are no solitary bulls among them or in that area, and the membership of the herd keeps shifting steadily; each year a few village cattle stray into the herd and the villagers, after some encouragement and advice from me, now manage to recover a few each year. This is done by stalking them early in the morning when they are not very wary; after cutting off their natural lines of retreat by placing a horse and rider equipped with a lasso-rope, others drive them towards these village 'cowboys' who try their best to 'rope' them, frequently with success. The 'catch' is then broken-in by being hobbled and starved till it becomes tractable, and then gradually allowed to roam with other tame cattle; they show a tendency to return to the 'wild' herd if confronted with them, but otherwise they interbreed with tame cattle and produce offspring successfully. My notes on this subject of progeny are restricted to hearsay evidence, though from dependable sources. The village shikari, to whom I first suggested this idea of catching them by using horses to run them down after separating one or two from the herd, has made a small fortune by taming and selling them to the villagers. Another herd, nearer to Gurgaon and in completely dry, cultivated land, stays below the Aravallis just beyond Sohna on the Delhi-Gurgaon-Alwar road, and poses a problem to the distracted villagers. Not only does it annually seduce numbers of domestic cattle, but it also causes much damage to the crops, being scared out of one field only to enter the next. I discovered this herd only last year while out exploring a new jheel for duck, but since there were no horses in the nearby villages I could not emulate the 'khadar' experiment here. The villagers are

not nearly so enterprising this side, but may take to the idea if help is given them.

Another curious fact about them is that they often run with herds of Blue Bull, and it becomes quite a problem stalking the Blues due to the added vigilants. The 'wild' cows are pugnacious especially when with young, and will rear back and stand their ground against intruders, snorting and scuffing like any ferocious bull in a village. The plentiful cover near which they generally stay indicates the possibility that cows may be going into hiding for the duration of calving, but I have once come across a cow with a calf at heel who was just about able to stand; she was ferocious and wouldn't tolerate a close approach, making short charges and feints to frighten me. I am sorry I didn't have a camera that time!

As for protection, until we can say with certainty that they inbreed and, given the opportunity, would develop special traits and characteristics, it seems somewhat unfair on the poor villager to allow them to persist and cause an annual loss of what to him is a fortune. But they certainly do add a picturesque and enthralling sight to our 'khadars', and can give good sport to a photographer by their constant and acute vigilance. Their resemblance to our Gaur is, to my knowledge, non-existent, at least in so far as appearance and habits are concerned. I wonder if some of the north-country members could give me any news about the presence of these cattle in their areas.

3, Factory Road,
New Delhi 3, H. K. DANG
November 24, 1958.

4. NOTES ON A TAME TAKIN

(*With a plate*)

Mr. Richard D. Estes who, with Mr. Oliver M. B. Milton, is at present engaged in making a wildlife survey of Burma has sent us the cutting of an account he recently published in *The Nation* of Rangoon (25 January 1959) of a visit to Sankawng village in the Fort Hertz-Putao area of the Hkamti region to inspect a young female Takin destined for the Bronx Zoo, New York.

The article contains some interesting information which is here excerpted with the author's permission. Both the photos, one by himself the other by his colleague, have been received through the courtesy of U Tun Yin.

The animal was captured in July, when about 2 months old, nine days' foot journey to the north, and was carried thence on the hunts-

Nine-month old tame female Takin following village cattle

Nine-month old tame female Takin

Photos : R. D. Estes

men's shoulders over mountainous country. It began grazing at this tender age and had grown into a healthy specimen when seen. During the interval (5-6 months) it had become quite tame, grazing with domestic cattle in the vicinity of the village, sparring playfully with calves much bigger than itself, and permitting itself to be stroked by humans.

'With its head held characteristically low, humped shoulders, sharply tapering hindquarters, and thick legs it looked as much like a mountain goat as anything else, a resemblance that was heightened by the way it moved, and by the stubs, as yet no more than one and a half inches long, of its just emerging horns. However, the fully developed horns are not at all goatlike, but approximate those of the wildebeeste or 'gnu' of East Africa, and those of the musk-ox. The latter, in fact, seems to be the Takin's closest relation . . . but to both Milton and myself the 'Roman nose', thick face, and prominent ears of this little Takin (calf or kid?) definitely suggested a young moose. In short, a Takin looks like almost anything but a cow.

'The general colour of this specimen was chocolate brown shading almost into black on the face, chin, and legs, with a broad saddle of buff spread across the back, and a dark dorsal stripe running from shoulders to the short untidy tail. The hair was thick, soft, and quite long. The shiny black hooves, bearing pronounced dew-claws part way up the ankle, were large and strongly curved with a wide gap between, obviously well-adapted to rocky mountainsides. The hooves lend credibility to stories of legendary prowess in leaping and climbing the steepest slopes.'

The Takin's height was twenty-seven inches at the shoulder, length forty-eight inches; weight estimated at ninety to a hundred pounds. 'Already nine months old, it had a lot of growing to do before it would reach the 600-700 lb. weight of a mature animal (according to Peacock).

'Watching it nibble grass from a few feet away, I was able to see that it had well-developed teeth in its lower jaw, none in the upper, but it resisted attempts to open its mouth for a closer examination.

'. . . I noted the powerful development even at this age of the neck, shoulders, and legs. I noted also a definite but not unpleasant odour of musk, another point in common with the musk-ox that I had not previously known.'

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, EDITORS
BOMBAY 6,
February 2, 1959.

5. DOES THE TAKIN PRODUCE TWIN CALVES?

Very little is accurately known about the breeding habits of most of our wild animals; thus the following extracts from letters received from U Tun Yin of Rangoon (Burma) concerning the Takin, *Budorcas taxicolor* (Hodgson) are of interest. Prater in THE BOOK OF INDIAN ANIMALS: 227 (1st ed.) remarks that the Takin usually drops one calf at the end of March or in early April.

U Tun Yin writes: 'The Assistant Resident, Lawkhaung (Gum Jala) informed me in July 1958 that the villagers shot a female Takin with poisoned arrows and captured two calves in March. According to the hill tribes the Takins have two calves at a time mostly. The Takins visit the salt springs when there is absolutely no moon, and in the first week of the new moon, and during open season especially from February to April. Takins live on leaves, roots, and, as they say, even on poisonous leaves and roots.'

Further enquiries initiated in response to our request for confirmation of the number of calves produced at a birth elicited the following from U Tun Yin's correspondent.

'. . . I understand from my Maru interpreter that no other Takins were caught, except two calves caught by Hkawng Hawng of Lakdang Ritjawng Kung, Saw Law Taungok's charge. Of the two, one was stabbed to death on the spot as the mother was then trying to charge him before its death. The mother was shot by poison arrow and the calves were caught simultaneously and in doing so he was nearly dragged over the cliff. The remaining calf was brought to Chipwi where it was fed on boiled rice only, as at the start of its care. It died after a month and was thereafter brought to Laukhaung, where it was showed to Assistant Resident if he would accept it for sending to the Zoo (? Museum).

'From villagers I notice (? understand) that Takins are habitually (? in habits) similar to goats or wild goats, but full-grown males are ferocious and usually charge any one. They have two calves at a time mostly.'

Mr. Saw Cushing Po, Assistant Resident, Putao, informed U Tun Yin that two Takin calves captured in Putao Sub-division were from different mothers. They were brought up on condensed milk, but did not survive long. He has never heard of a Takin having more than one calf at a time.

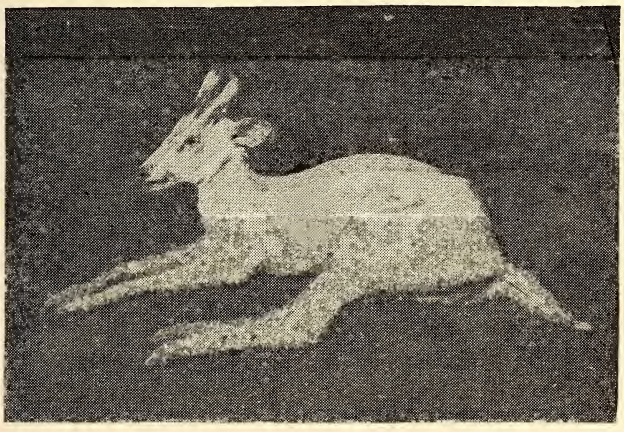
The Society would welcome more information about the habits of this interesting and little known animal. Reliable first hand notes on its ecology and habits are badly needed.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6, EDITORS
January 29, 1959.

6. AN ALBINO BARKING DEER

(*With a photo*)

Raja Chandra Chur Prasad Singh of Udaipur (Madhya Pradesh) sends us the accompanying photograph of an albino Barking Deer (*Muntiacus muntjak*) which he shot in February. He asks whether



'a similar trophy has been obtained by any sportsman'. In previous volumes of the *Journal* we find two records of albino muntjac, both from Nepal. With one of these a good photograph of the captured animal is reproduced (**16**: 742).

Other mammals in which either complete or partial albinism has been recorded in back numbers of the *Journal* are: Hog Deer (**24**: 588), Cheetal (**35**: 888), Sambar (**40**: 322), Blackbuck (**16**: 742), Gaur (**36**: 492, 985, 986; **37**: 483), Goral (**32**: 373), and Tiger (**24**: 819; **32**: 584).

Recorded in Vol. **16**: 361, with photograph, is the much rarer case of a melanistic blackbuck from Bhopal, dark-coloured all over without the usual white belly and legs.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, EDITORS
BOMBAY 6,
February 3, 1959.

7. COMMUNAL NEST-FEEDING IN BABBLERS

I have often noted more than two Jungle Babblers showing interest in building a single nest. As regards the situation when there are eggs in the nest, again I have many notes of about half a dozen, or even more, babblers protesting loudly close round me when I looked into a nest to view its contents. The clearest evidence that I have, however, of the communal interest of more than one pair of babblers in the same nest are two notes about the feeding of young birds in the nest. On May 24th last year (1957) I noted three different adult birds carrying food to the chicks in one nest; and on August 19th last year I noted four different adult birds taking food to the youngsters in another nest. In the latter case the four adults were all queued up—as I described in my talk to the Kashmir Nature Study Society—like a line of waiters bringing dishes to a group of diners.

In addition to the above, I have many notes of groups of four or six babblers staying close to fledglings after they have left their nest, bringing them food and generally looking after them. Sometimes only four adults seemed to be involved, but at other times at least five or six were concerned. I think it is probably always an even number, because the group is composed of pairs. I have even seen this company of adults attending a young Pied-crested Cuckoo and its young babbler foster-brother or sister—though the cuckoo had thrown all except the one other egg out of the nest!

I have no doubt that all this indicates that more than one pair of Jungle Babblers share the same nest; and I presume this means that the females of the pairs lay all their eggs in it.

With regard to Large Grey Babblers, four of them joined in building a nest in my garden last month. I am fairly certain from my observations that the two females both laid eggs in the nest, for I think they took it in turns to sit there. Unfortunately crows

stole the eggs very soon after they were laid, and the nest was deserted; so I could not watch the behaviour of the parents throughout incubation and the feeding of the youngsters.

2, KING GEORGE AVENUE,
NEW DELHI, MALCOLM MACDONALD
October 9, 1958.

[It is a serious blot on Indian bird students that so little is precisely known about the breeding biology of this very common and familiar bird, popularly known as 'sāt bhai' in Hindi and 'Seven Sisters' in English. In NIDIFICATION OF BIRDS OF THE INDIAN EMPIRE (**1**: 153—1932) Stuart Baker remarks '. . . I can find nothing on record about the construction of the nest and which sex is responsible for the work, nor does it seem even to be known whether both sexes do or do not incubate the eggs'.

Thus Mr. Macdonald's note is not only of great interest but a distinct contribution to our knowledge. The Indian babblers of the *Turdoides* and *Argya* groups (now lumped together under the former genus) are well known for their community life, keeping in amicable flocks and sisterhoods even when some of the members may be actually nesting—a time when most sociable species break up into aggressively territorial pairs.

One of the functions of gregariousness in birds during the breeding cycle is believed to be that the behaviour of a member, physiologically more advanced than the rest, serves as a stimulus to the backward ones, to hasten and synchronise breeding activities among the flock. Synchronized nesting is of survival value, particularly in the arctic and temperate regions where the breeding season is short and sharply delimited by climatic conditions. The visual stimulus of a bird feeding its young may similarly act as a releaser for the relevant dormant impulse in other individuals who may themselves as yet be unready for this activity. Thus the participation by more than one pair in the building of a nest, or in the feeding of nestlings in it, is understandable.

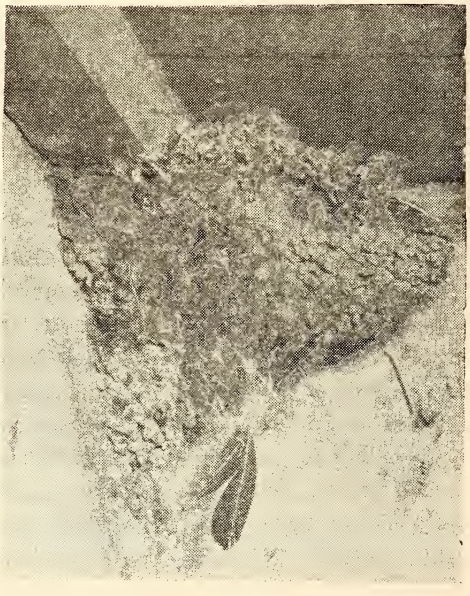
In A COMPANY OF BIRDS (p. 102) Loke Wan Tho records three or four adult New Guinea Wood Swallows (*Artamus maximus*) feeding a brood in the same nest. A. W. P. Robertson (BIRDS WILD AND FREE, p. 30) gives a fascinating account and photograph of a pair of Longtailed Tits (*Ægithalos longicaudatus*) which had their own nestlings to feed, but which in addition alternately fed unfledged hedge-sparrows in a neighbouring nest.

While it is well known that in many species, several females do in fact lay eggs in one and the same nest, we have no definite evidence so far of this sort of pooling in the case of Jungle or Large Grey Babblers, although it may sometimes well be the case. No abnormally large clutches of eggs have been noted in their nests such as could be ascribed to more than one female.—EDS.]

8. A COMPOSITE SWIFT-SWALLOW NEST

(*With a photo*)

The enclosed photograph taken by Mr. K. M. Vaid of the Forest Research Institute shows the nest of a Wiretailed Swallow in what appears to be a remarkable situation. The Swallows fastened this nest



to the nest of a House Swift, which was itself built up from a section of a nest of the Redrumped Swallow. Both swifts and swallows were in simultaneous occupation of their respective nests.

NEW FOREST,
DEHRA DUN,
October 25, 1958.

JOSEPH GEORGE

9. ARTIFICIAL NESTS FOR SWALLOWS AND SWIFTS

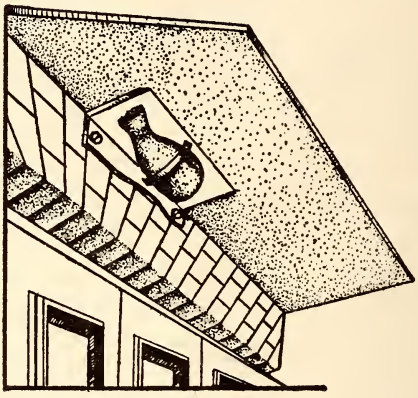
(*With* 1 *plate and* 1 *text-figure*)

A method of making artificial nests for the House Martin is described by Cohen and Campbell in *Nestboxes* (British Trust for Ornithology, Field Guide No. 3, 1957). According to this method, clay replicas of a natural nest are made and cemented to sites already favoured by Martins. It is pointed out that if the artificial nests are fixed to a board fitted with trap doors, inspection of the nests becomes possible.

When the question of making artificial nests for the Redrumped Swallow (*Hirundo daurica*) and the Wiretailed Swallow (*Hirundo smithii*) was considered, it was found that there was appreciable variation of shape and size from nest to nest of these two species. This seemed to suggest that in making artificial nests for these two species of swallows, exact duplication of natural nests was unnecessary. Artificial nests were therefore made by shaping clay by hand to more or less the same shape and size as natural nests. This was a much simpler operation than that described by Cohen and Campbell. In addition to these clay nests, 3 artificial nests for the Redrumped Swallow were carved from solid wood. Trouble from the House Sparrow was anticipated, but the entrance tube to the artificial nests for the Redrumped Swallow was not made narrower at any point than 3.2 cm. which was the measurement for the narrowest point in the entrance tunnel of natural nests examined in New Forest, Dehra Dun. Trouble was also expected from House Swifts (*Micropus affinis*), which breed in much larger numbers than the Redrumped Swallow in New Forest, but it was hoped to reduce the chances of their interference by installing the artificial nests at locations which they do not ordinarily visit. Though the artificial nests were very much stronger than natural nests, most of them were baked in a potters' oven. The baked nests and the wooden nests were painted with fresh clay.

Artificial nests for the Redrumped Swallow were fixed on boards and the boards were fastened to ceilings and to sunshades over doors at places known to be frequented by the birds (text-fig.). Nests for the Wiretailed Swallow were also fixed to short lengths of board and the boards were fastened to walls of verandahs close to the ceiling (plate). All the artificial nests were installed in February-March, 1958.

A pair of Redrumped Swallows occupied an artificial nest in February and fixed a few pellets of mud at the entrance. This nest

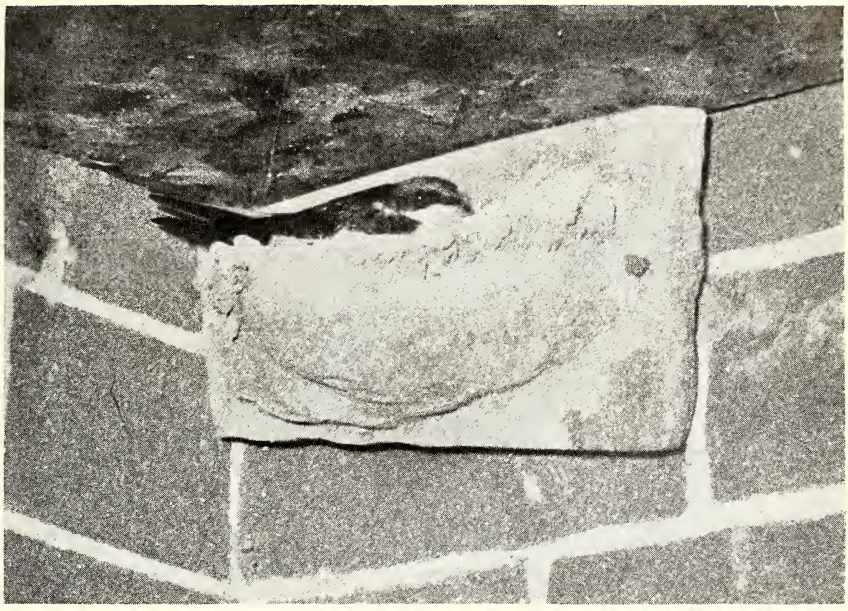


Artificial nest for the Redrumped Swallow fixed under a sunshade.

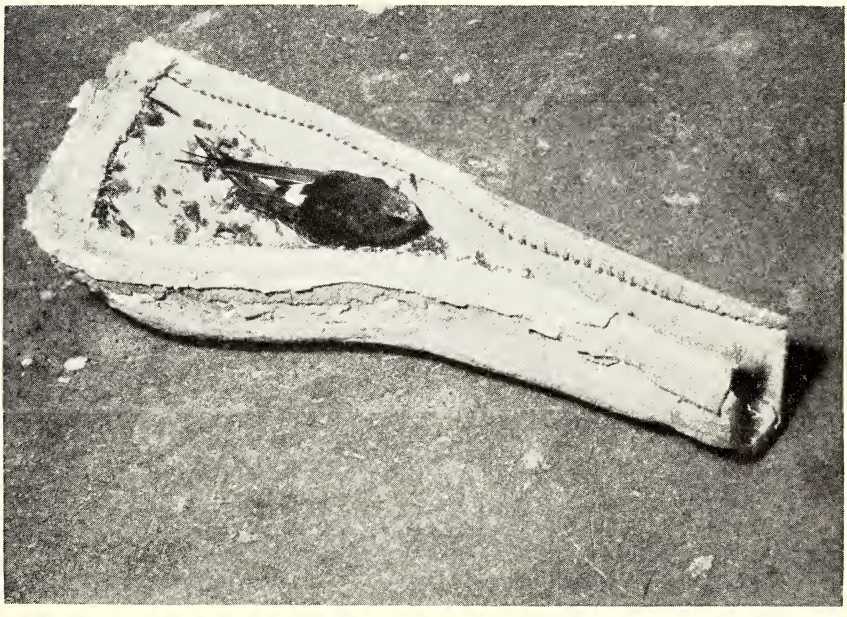
was in the garage of a bungalow situated in a well-wooded garden. One evening early in March a pair of House Swifts were seen going in and out of the garage. The swifts appeared regularly every evening thereafter and roosted in the nest. There can be little doubt that during their movements above the trees in the garden the swifts had observed the swallows going in and out of the garage and had come down among the trees with the intention of ousting the swallows from their nest. The swallows disappeared. But the temporary occupation of the nest by the swallows shows that artificial nests approximately similar to natural nests will probably be acceptable to the Redrumped Swallow.

Another nest intended for the Redrumped Swallow was also occupied by the Swift early in March. Three nests were occupied by the House Sparrow and one remained unoccupied. One of the nests taken by the sparrow was cleaned out later in the season. It was then taken up by the House Swift.

The method suggested for fixing trap doors for inspecting Martins' nests should be applicable to Redrumped Swallows' nests also. Artificial nests of the Redrumped Swallow with arrangements for inspection can be used for studying the nesting habits of both the Swallow and the House Swift. In the present experiment, the artificial nests were fixed to permanent structures where trap doors could not be provided. The nests were, therefore, mounted on the boards in an easily detachable manner. This was accomplished by holding the nests in position by a strip of thin flexible metal hinged



Wiretailed Swallow incubating in artificial nest



House Swift incubating in artificial nest from which Swallows were ejected

Photos : K. M. Vaid

to the mounting board at one end and fastened by a bolt and fly-nut at the other end.

Two of the nests occupied by the House Swift were inspected on a few occasions in July-August by removing the nests from the mounting board. The first time one nest was opened, a bird was sitting on two eggs. It stayed on the eggs till the nest was placed back in position. The bird then came out of the nest and flew off. On another occasion the sitting bird flew off the open nest. The plate shows one of the birds sitting on its eggs in the nest. Both the parent swifts roosted in the nest at night. Occasionally when the garage door was closed in the evenings, the birds would circle over the garage till the door was opened. The second nest contained 3 eggs. On a later inspection it contained two nestlings. Both the nests had feathers plastered here and there inside. The joint between the nest and the board on which it was mounted was glued all round by the birds.

Wiretailed Swallows inspected all 4 nests put up for them and finally occupied two. The birds added some mud to the edge of the nests they occupied, as seen in the photograph.

Thanks are due to the officers of the Forest Research Institute, Dehra Dun, who very kindly gave permission to install the artificial nests in the verandahs of their bungalows and at other locations. Thanks are also due to Shri K. M. Vaid of the Forest Research Institute for the two photographs.

NEW FOREST,
DEHRA DUN, U.P. JOSEPH GEORGE
November 8, 1958.

10. A LEATHERY TURTLE *DERMOCHELYS CORIACEA* (LINNAEUS) COMING ASHORE FOR LAYING EGGS DURING THE DAY

Sometime ago an interesting instance of the leathery turtle coming ashore for laying eggs during the day came to my notice and this is recorded here, since from the available literature it is seen that turtles in general come ashore for this purpose only during night time.

While at Calicut, Kerala, I received information at about 5 p.m. on 2nd July 1956 that a large turtle had come ashore at West Hill and had deposited eggs. I reached the place in a few minutes' time and found a giant specimen of the leathery turtle *Dermochelys*

coriacea (Linnaeus) hardly 50 metres from the sea surrounded by a large crowd of people. On enquiry it was learnt that the turtle first came ashore at about 3.00 p.m. nearly a quarter of a mile to the south and evidently disturbed by the presence of people returned to the sea and came up to the present spot which was comparatively a more quiet place. After scooping out sand with its flippers it had laid between ninety and hundred eggs which were immediately removed by the local people who had assembled there. As characteristic of turtles at egg-laying time it was reported to have been very little disturbed by the presence of people around or by the noise and commotion that prevailed there. The egg-laying was over by the time I reached the place and the turtle was by then making efforts to cover up the nest quite oblivious to the fact that all the eggs were already removed. It was a sunny day but the sand was moist on account of the rain during previous days. After turning over a good deal of sand with its flippers it proceeded towards the sea. On coming to the shore line which had an abrupt drop due to the wave action it slid down sideways and then steadied itself and entered the water. The first wave it confronted dragged it for some distance towards the shore but soon it appeared to recover from the initial inertia, and proceeded with ease in a north-westerly direction and gradually disappeared from sight.

The total length of the turtle from snout to tail taken in a straight line was 6 ft. 3 in. The width of the carapace along the curvature was 3 ft. 10 in. and in a straight line 2 ft. 10 in. The body was slate coloured with white spots and a mottled white patch was present on the head. Some eggs were purchased from the people who had collected them and were examined. They were white in colour, and spherical with a leathery shell, and had an average diameter of 52.5 mm. A few of the eggs were kept buried in the sand but these failed to hatch out. Those opened at periodic intervals did not show any developing embryos.

The fishing canoes belonging to the Central Marine Fisheries Research Station at Calicut are kept near the place where the turtle had laid the eggs and the fieldmen in charge of them informed me subsequently that they had seen on a few occasions in previous years young turtles proceeding to the sea from this area, pursued and harassed by crows. No one has actually seen any turtle coming ashore near this spot formerly and in the absence of specimens of young turtles it is not possible to say anything as to their identity.

Deraniyagala in TETRAPOD REPTILES OF CEYLON Vol I, 1939 has given detailed notes on the egg-laying habits of the various turtles in Indo-Ceylon waters. According to him the leathery turtle comes ashore

only during night time, generally between 9 p.m. and 11 p.m. It probably lays eggs three or four times a year but the breeding season in Ceylon reaches its peak during May and June. The incubation period is about 70 days.

CENTRAL MARINE FISHERIES RESEARCH STATION,
MANDAPAM CAMP, S. JONES
November 15, 1958.

[M. W. F. Tweedie (*Proc. Zool. Soc. London* **123**: 273-74—1953/54) gives a graphic illustrated account of the nesting and egg-laying habits of this turtle observed at night.—EDS.]

11. THE GOURAMY *OSPHRONEMUS GOURAMI* IN CEYLON

With the present accent on the increasing of fish production from inland waters, the history of the introduction of the Gouramy (*Osphronemus gourami* Lacep.) into Ceylon waters may be of some interest to Fishery Administrators in the tropics. The gouramy is widely grown in Indonesia and to some extent in Malaya, in both of which countries it is highly esteemed as a food fish. The first supplies of this fish were brought into Ceylon from Java (as the country was then known) by the late Mr. G. M. Fowler in 1900, but none of this stock survived. In 1909 a further supply was brought from Java to Colombo by the late Mr. Kelway Bamber, and these were distributed among the reservoirs at Mahavilla Estate in Ulapane, at an elevation of about 2000 ft., at Drayton Estate in Kotagala, at an elevation of 4100 ft., and at Hiyare near Galle, which is almost at sea-level. Some specimens were kept under observation in an outdoor cement-rendered tank in the Colombo Museum premises, where the heat of the sun in the shallow confines of the tank appeared to be having an adverse effect on the fish; these fish were therefore transferred to an ornamental pond lying below the Thwaites Memorial building in the Royal Botanic Gardens at Peradeniya, at an elevation of about 1500 ft.

This pond lies beside the Mahaweli river, and in subsequent years there were a number of occasions on which the river rose at flood time to such an extent that this pond at Peradeniya was submerged. It is also noteworthy that the reservoirs at Ulapane and Kotagala lie on tributaries of this same river. In 1935, it was reported that a hitherto unfamiliar fish was being taken in increasing quantities by fishermen in the flood lakes or *villus* around Mannampitiya, about 100 miles down the Mahaweli river from Peradeniya. Specimens

which were obtained for identification revealed that this new fish was none other than the gouramy. If, as was believed, these fish were the progeny of those which had escaped from the stocks introduced into Peradeniya, they had survived passage through numerous rapids and over the 50 foot drop of the Victoria Falls on their way to the lowland area where they were being captured by the fishermen.

To the present day, the gouramy has featured prominently in the catches of fishermen in the lower reaches of the Mahaweli river. A fisherman at Allai, a village situated on one of the three main branches by which this river flows into the sea, told the writer in 1952 that, though the gouramy did not make up more than five per cent of the catches in that area until about 1940, it had gradually increased in abundance and was contributing about ninety per cent of the catch. The rest of the catch is composed largely of the murral or snake-head (*Ophiocephalus striatus* Bloch), which shows that, in spite of its predatory habit, the murral has not been able to check the increase in numbers of the gouramy.

The secret behind the rapid establishment of the gouramy in Ceylon waters may lie in the fact that the principal food of this fish consists of vegetable matter, which is available in abundant quantity in inland waters at all times of the year. There is very little significant competition from other local species of fish for this type of food, and there has been a preponderance of predatory types of fish in the inland waters of Ceylon. The gouramy held virtually undisputed sway over the enormous quantities of aquatic plant life until the introduction of *Tilapia mossambica* Peters into Ceylon by the writer in 1951. Notwithstanding the introduction of this other species of vegetation feeder, the gouramy has continued to provide a significant proportion of the fish harvested from the inland waters of the Mahaweli system in particular. The distribution of the gouramy has been promoted actively by the Department of Fisheries during the past 15 years. All the major perennial 'tanks' (or reservoirs) have been stocked, and supplies have also been introduced by private agency into ponds, plantation dams, and streams, in many of which the gouramy is now breeding freely in association with *Tilapia* and other fishes.

The gouramy is a nest builder. The eggs are deposited in a nest which is constructed of strips of vegetable matter torn from aquatic or water-side plants, fibres, etc., woven into an ovoid mass about a foot in diameter, and anchored to vegetation growing by the side of the water. The eggs are released into the water below the nest and, being lighter than water, they float up into the nest and become lodged in and protected by the tangle of vegetation which comprises the nest,

Recent experiments have shown that nest-making can be encouraged by provision in ponds of suitable material such as coco-nut leaves and fibre, and by fixing short lengths of bamboo in the sides of the pond just below water level, with the exposed end split and the strands of bamboo forced apart by wedging a stone into the hollow of the bamboo. This funnel-shaped holdfast is readily adopted by breeding gouramy which make their nests out of the material which is deposited by the farmer in this frame.

The introduction of the gouramy into Ceylon and its establishment in our waters have given convincing evidence of the advantages that are to be derived by distributing vegetation-feeding fish in inland waters which are naturally well provided with aquatic plant life. The fact that the gouramy has survived and bred in environments from sea-level up to 4000 ft., where water temperatures may drop to below 60° F., demonstrates the adaptability of this fish to life in higher elevation waters in the tropics, and suggests a means of extending fish culture operations with a species that requires little or no attention, in a region which in Ceylon has hitherto been characterized by the poverty of its food-fish stocks.

DEPUTY DIRECTOR OF FISHERIES, CEYLON,
P.O. BOX 531, E. R. A. DE ZYLVA
COLOMBO,
November 7, 1958.

12. A PRELIMINARY NOTE ON THE FOOD AND FEEDING HABITS OF *PSEUDORHOMBUS ELEVATUS* OGILBY

Flatfishes are considered as prime food fishes and form an important demersal fishery in temperate waters. In tropical waters this fishery is of much less magnitude.

In Bombay flatfishes have not been regarded as of any commercial importance, for their use as a good table fish is not yet in vogue. However, with the steady increase in the catches of flatfishes taken largely by trawlers in recent years, and with the change in the tendency to regard them as good food fishes, their economic importance is increasing. Very little is known about the biology of Indian flatfishes. Among the few publications mention must be made of Jones and Menon (1951), and Seshappa and Bhimachar (1954, 1955) The present note records preliminary observations conducted on the food and feeding habits of *Pseudorhombus elevatus* Ogilby, one of the common flatfishes along the Bombay coast.

Material for the investigation was collected at random from the wall-nets locally known as *wana*, fixed not far from the lowest tidal mark on different shorestrips of Bombay.

The specimens collected were divided into four size-groups, each with a range of 5 cm., the first group commencing from 6 cm. as specimens below this could not be obtained. All the four size-groups were represented in the samples with varying percentages during the period of investigation. A qualitative and quantitative analysis of 115 females, 59 males, and 7 undeterminates was carried out during the period December 1956 to March 1957. Volumetric measurements of the stomach contents were made by means of the water displacement method.

The volumetric percentages of constituent food items in different size-groups are shown in Table below, which shows that in the case of groups I and II, crabs constitute a major item of food, and prawns and fishes together a minor item. Other types of food such as Gammarus, Mysis, polychaetes, which form an additional item of food in groups I and II, gradually disappear from the gut contents of the succeeding groups. In group III the percentage of crabs decreases and percentages of prawns and fishes rise considerably, thereby being transitional between groups II and IV. In the latter fishes appear to be the main food item.

The result of the study thus shows that the food of *Pseudorhombus elevatus* consists of four main types: Gammarus, prawns (*Asettus indicus*), crabs (*Neptunus* sp., *Matuta lunaris, Macrophthalmus* sp., *Grapsus strigosus*), and fishes (*Therapon jarbua, Boleophthalmus* sp.), and four subsidiary types: Mysis, hermit crabs (*Diogenes avaris*), magalopae of crabs, and polychaetes (*Diopatra neapolitana*). The changes in food preferences may be on account of the fact that the juveniles of *P. elevatus* (groups I & II) are very active, more free swimming, and show considerable preference for the young of the crabs of *Neptunus, Matuta, Macrophthalmus,* and *Grapsus*. With growth (groups III & IV) the fish takes to a demersal habit and appears to feed more exclusively on young fish (*Therapon jarbua* and *Boleophthalmus* sp.). This change of preference in the food is noteworthy.

I had the opportunity of making firsthand observations on the method of feeding of the adults at the Taraporevala Aquarium. When the food is introduced in the tank, the fish rises and darts forward at an angle and snaps at the morsel, and then settles at the bottom and gulps it. Whether this habit is repeated in its natural surroundings is not known, but the type of the food would suggest this to be so.

TABLE

Volumetric percentages of different food items in different size-groups of *Pseudorhombus elevatus* Ogilby

Groups I to IV	No. of specimens examined.	Average length in cm.	No. of fishes with empty stomachs.	Gammarus.	Mysis.	Prawns.	Megalopae of crabs.	Crabs.	Hermit crabs.	Polychaetes.	Small Gastropods.	Fish	Semi-digested mass of Molluscs, Crabs, & Fishes.
I 6 to 10 cm.	44	8.5	6	25	..	2	..	65	..	0.5	..	5	2.5
II 11 to 15 cm.	64	12.4	2	6	8	4	4	71	0.2	0.5	0.3	6	..
III 16 to 20 cm.	42	17.3	..	..	..	11	..	52	..	2	..	35	..
IV 21 to 25 cm.	31	21.8	1	..	..	0.5	..	0.5	..	..	..	99	..

ACKNOWLEDGEMENT

The author is thankful to Dr. H. G. Kewalramani for his helpful suggestions, and to Dr. C. V. Kulkarni for affording necessary facilities at the Taraporevala Marine Biological Station.

TARAPOREVALA AQUARIUM,
BOMBAY, M. J. PRADHAN
April 15, 1958.

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13. OBSERVATIONS ON THE BREEDING OF INDIAN CARPS IN THE GARUA NALA (BHOPAL)

(*With a map*)

The major Indian carps, Catla, Rohu, and Mrigal, grow rapidly in ponds and tanks and attain sexual maturity also but they do not ordinarily breed in such confined waters. During the monsoon months these fishes breed in riverine habitats. Location and exploitation of such natural breeding grounds have been one of the important sources of fish-seed for cultivation in ponds. One such natural breeding ground in the Garua Nala, connected to the Betwa river system in Bhopal (M.P.), was located in 1950 and has been exploited every year since. The factors believed responsible for inducing the spawning of carps in the bundh type of tanks were discussed at length during the symposium held on the subject in 1945 (1) and in subsequent papers. However, very little is even now known ot the actual factors inducing spawning in natural environments. The general field observations on the pattern of carps spawning in the Garua Nala made during the last 7 years are detailed here in the hope that these might be of some help at least in focussing attention on a set of environmental factors just preceding spawning in the particular type of habitat, and in locating similar breeding grounds and estimating the approximate time when spawning could be expected there.

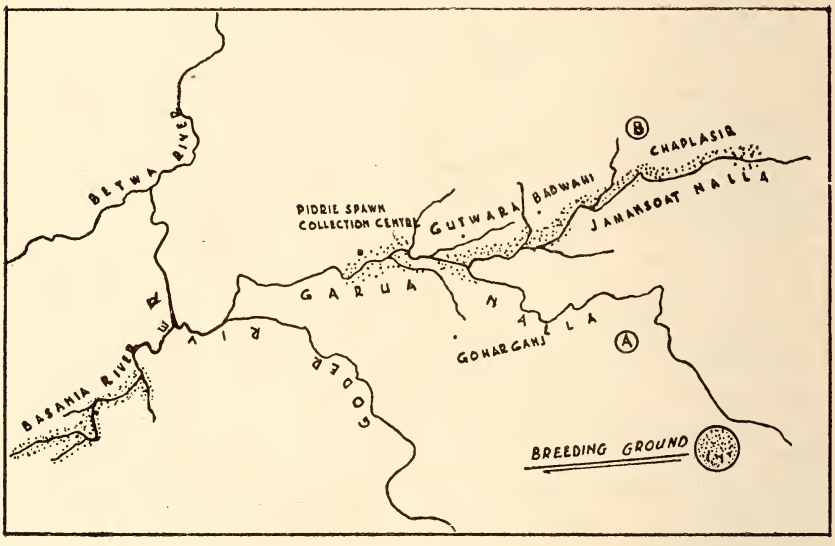
The Garua Nala is a small stream which joins the Goder Nadi and through it the river Betwa (see sketch map). It is an entirely seasonal stream, originating in the Vindhya Hills and running for about 8 miles before joining the Goder Nadi. The width of the stream from bank to bank varies in places from 8 ft. to 30 ft. Extensive fertile wheat fields are located on either side of the nala. During the major part of the year, the entire nala remains completely dry. With the early showers in June water accumulates in isolated deep pools. Every year the nala gets flooded at least three times. Ordinarily the first flood of the season comes by about the first week of July, caused by rains in the catchment areas in the Vindhya Hills. The water rushing down the hill through the nala is highly turbid. It does not usually overflow the banks during the first flood. The second flood, normally during the 3rd week of July, is heavier and the nala overflows its banks, flooding the adjacent wheat fields, drains, and shallows. The third flood occurs usually about two or three days after the second flood. Every year, when the turbid flood water from the Garua Nala rushes down and flows into the Goder Nadi, fish ascend rapidly in large numbers for breeding. During the first flood, when the water does not flood the adjacent pools, fields, and shallow areas, Catla and Rohu generally do not breed though they have been observed to ascend the nala during the first flood. Mrigal, Gonius, Wallago, and certain smaller species, however, breed even in the limited waters of the first flood. Heavy breeding of Catla, Rohu, and Mrigal takes place during the second and third floods. Breeding males and females caught from the nala or adjacent inundated pools at this time have been found oozing milt or ova as the case may be.

The banks of the nala in most places are sloping, and the rising flood water easily spreads and inundates the numerous adjoining pools and shallows. Such inundated areas are generally covered with a uniform growth of a species of grass locally called *khus khus* (*Vetiveria indica*). Fishes have been repeatedly observed to select such areas for breeding. Local fishermen believe that the fishes rub their body on the grass before spawning. The temperature of the water at the time of spawning has been found to range between 76° F. to 98° F. in different years.

Ordinarily the females first enter the spawning grounds, immediately followed by the males. The water in the spawning ground is very shallow and often the dorsal fin and portion of the back of the fishes are exposed. Spawning takes place during day-time as well as at night. Generally Catla and Rohu spawn at night. The fishes make a lot of noise splashing about in the spawning ground.

In the excitement of spawning many lose a number of scales and also sustain other minor injuries.

With the rising or falling flood-water fertilised developing eggs are washed down the nala and millions of them could be easily collected in nets fixed against the current. Collecting these eggs and hatching them in ponds, *hapas*, or tubs is a routine operation at the Pidrie Centre on the Garua Nala.



A remarkable feature of the spawning of carps in the Garua Nala is that while spawning every year is certain, and heavy along the major part of its course, there is hardly any spawning taking place in most of the numerous other nalas connected with the same river system. A critical study of the topographical conditions of the various nalas shows the following special features in the Garua Nala, which probably induce the fish to spawn:

(1) The banks of the nala are not straight and steep but are, in most places, sloping and easily connected to shallow marginal areas and inundated pools covered with bushes and grass.

(2) The marginal areas of the nala are not stony or sandy.

(3) Several smaller channels connect the nala with adjacent fields and pools and these probably serve as natural passages for the fish to reach the spawning grounds.

It may be mentioned that in the Garua Nala itself, in areas where the above facilities are not available, the fishes are not observed to breed. A near-by stream, the Basania river, resembles the Garua

Nala to some extent, and limited spawning of carps takes place in that stream.

I am deeply grateful to Shri Narayan Prasad, Assistant Fisheries Development Officer, Bhopal, for all the facilities and encouragement that made it possible for me to make the above observations repeatedly.

Asst. Fisheries Inspector,
Goharganj, MOHAMMAD SAGIRULLAH KHAN
Bhopal,
November 4, 1958.

14. TWO NEW FISH RECORDS FROM ASSAM

This report is based on a small collection of fish from the Khasi and Jaintia Hills made by Dr. H. S. Rao during the latter part of 1930, which had remained unidentified in the Zoological Survey of India, Calcutta. The country traversed by Dr. Rao was hilly interspersed with valleys and most of the specimens in the collection appear to have been taken from the slow-flowing streams in the valleys. With the exception of *Garra naganensis* Hora, the collection lacks in typical species found in torrential streams. Some of the specimens were collected from rice-fields and water-channels leading to the fields. Most of the species are well-known and call for no special comment except *Brachydanio nigrofasciatus* (Day) and *Lepidocephalus berdmorei* (Blyth), which are new distributional records for this part of Assam.

Brachydanio nigrofasciatus (Day)

Danio nigrofasciatus Day, Fish. India : 597 (1878).

Danio (*Brachydanio*) *nigrofasciatus* Weber & de Beaufort, Fish. Indo-Austral. Archipel. **3** : 85 (1916).

D. 2/6-7; P. 14; V. 7; A. 2/10-11; C. 16-17; L. 1, 30-33.

Head bluntly pointed, 2.8 to 3.1 in standard length; height at occiput 1.3, and width 1.8 to 2.1 in head length; diameter of eye 1.8 to 2.0 in length of head; snout about equal to diameter of eye; so also inter-orbital distance; mouth superior and slightly directed upwards; a pair of maxillary barbels present reaching up to middle of orbit; depth of body 3.4 in standard length; least height of caudal peduncle 1.8 in its length; dorsal fin origin over anterior half of

LIST OF SPECIES

Species	No. of Specimens	Locality	General Distribution
Barbus (*Lissocheilus*) *hexagonolepis* McClelland	8	Myntdu River	Eastern Himalayas, Nepal, and Burma
Puntius ticto Hamilton	291	Jowai, Jaintiapur, and Sillong	Throughout India and Burma
Danio (*Danio*) *dangila* (Hamilton)	87	,,	Bengal, Bihar, Himalayas at Darjeeling and Assam. Also the hills above Akyab
Brachydanio rerio (Hamilton)	71	Jowai, Myntang valley, and Nertiang	Throughout India and Burma
Brachydanio nigrofasciatus (Day)	8	Myntdu Rivér	Pegu and Maulmein, Burma
Garra naganensis Hora	1	,,	Kairong, Naga Hills
Nemachilus manipurensis Chaudhuri	10	,,	Manipur
Lepidocephalus berdmorei (Blyth)	1	Shillong	Widely distributed in Burmese waters
Channa gachua (Hamilton)	17	Jowai, Jaintiapur, Myntang Valley	India, Burma, Ceylon, and Andamans
Channa stewartii (Playfair)	1	Jowai	Cachar, Assam, and north Bengal

anal and nearer to base of caudal fin than to tip of snout; lateral line absent; $7\frac{1}{2}$ scales between base of dorsal and the anal fins; in alcohol body shows a dark broad band passing along lateral side, and a second thin line below it; dorsal with three to four black bands; anal with two to three similar bands.

Previously known from Pegu and Maulmein, Burma (Day, 1878) now the distribution of this species is extended to Myntdu River, Jaintia Hills, Assam.

Lepidocephalus berdmorei (Blyth)

Lepidocephalichthys berdmorei Hora, *Rec. Ind. Mus.* **22** : 196 (1921)

D. 2/6; P. 9; V. 7; A. 2/7; C. 16.

Head 4.8 in standard length; height at occiput 1.2 in its length; eyes small, situated almost in middle of head; diameter 2.2 in length

of snout; sub-orbital spine bifid, extending below anterior half of orbit; two pairs of rostral and one pair of maxillary barbels, extending below posterior border of orbit; mandibular flap thickened, pliated anteriorly, and posteriorly produced into three short barbel-like processes; depth of body 5.0 and length of caudal peduncle 5.2 in the standard length; least height of caudal peduncle nearly equals its length; dorsal fin origin almost midway between tip of snout and base of caudal; pectoral reaches anterior half of pelvic fins; scales minute, 38 between anal and dorsal fins; in alcohol, a rich yellowish brown with a dark line on side of body composed of dark spots; upper part of body covered with fine markings; a conspicuous black spot at base of caudal fin; some markings also found on pectoral, pelvic, and anal fins.

ACKNOWLEDGEMENT

My sincere thanks are due to the late Dr. S. L. Hora, Director, Zoological Survey of India, for suggesting the problem, providing all the laboratory and library facilities, and confirming my identifications of the species.

CENTRAL INLAND FISHERIES RESEARCH SUB-STATION,
ALLAHABAD (U.P.), K. L. SEHGAL
August 6, 1958.

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15. A QUICK AND EASY METHOD OF MOUNTING FISH SPECIMENS

(*With a text-figure*)

It is common experience that ordinary preservation of fish specimens either in alcohol or in formalin invariably distorts such external characters as are essential for their correct identification. The fins and the fin rays are the first to be affected, then come the lateral line and the colour of the body. In most laboratories and museums, whenever the need of a revised classification arises, it becomes

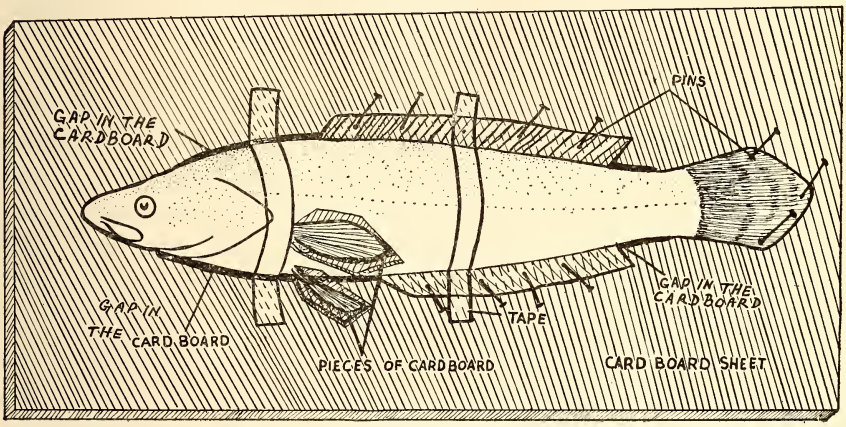
extremely difficult to trace all the diagnostic characters, particularly in specimens which have long been badly preserved, and as a result some rare and precious specimens are rendered totally unfit for critical examination. The common techniques of mounting the fish are either too rough or too elaborate—the later involving lengthy processes of fixing, stretching, drying and so on, which generally become impracticable when large numbers have to be dealt with at a time. It is, therefore, hoped that the following account will be of general interest, and that when practised regularly the method will improve the scientific value of specimens considerably.

During the study of the anatomy and bionomics of *Ophiocephalus* sp., the need of properly mounted specimens led to the adoption of the present technique. It was also tried on many other species with increasing success.

Fishes were killed in chloroform and then fixed by keeping them for a few minutes in desired strengths of formalin solution, whose concentration varied from 5% to 40%, depending upon the size of the fish. For fixing large specimens it was considered necessary either to inject a 40% formalin solution at several places in their bodies, or by applying the usual method of making a small slit in the abdomen and allowing them to stand in a 40% formalin solution for a short time. Each fixed specimen was then placed laterally on a sheet of cardboard and its body profile roughly traced, leaving out the regions of the caudal fin and the extreme tip of the snout. The area on the cardboard thus demarcated was cut out by means of a sharp knife, and the fish inserted in the gap. This method allows the bulge of the body to go through the replicate gap and bring the dorsal, ventral, and caudal fins directly in contact with the cardboard for the further manipulations required for their stretching. To keep the cardboard in vertical position strips of adhesive celluloid tape are fixed at several places, loosely passing along the body of the fish. In large specimens an additional support to the cardboard can be given, if necessary, by placing pieces of wood or bricks underneath to form a rough pedestal.

Stretching of the fins is done first by smearing them over with a thin film of gum or any commercial glue, and then pinning them on the cardboard all along their length. The use of glue has been found extremely helpful in keeping the fins in position and rendering them stiff even after the specimens have been finally transferred in preservatives. The stretching of the pectoral and the pelvic fins requires additional small cardboard pieces. These, therefore, receive the treatment noted above generally before the fish is placed within the cardboard gap.

Fishes thus mounted on the cardboard are kept for a few minutes, preferably in the sun, until the fins have dried. They are then taken off and stored in separate jars containing either 70% alcohol or



formalin solution of suitable strength, which has previously been neutralised with borax. The entire process at first takes 15 to 25 minutes with each fish, but with a little practice it can be reduced to about 10 minutes.

I am greatly indebted to Dr. S. Z. Qasim for kindly reading through the manuscript of this article.

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Department of Zoology, A. H. MUSAVI
Aligarh University,
Aligarh, U.P.,
January 9, 1958.

16. SOME LEAF-MINERS OF AGRICULTURAL IMPORTANCE IN NIZAMABAD DISTRICT OF ANDHRA PRADESH

Leaf-mining insects form an interesting group for study. The insect leaf-miners are all larvae belonging to one of the following orders, namely Lepidoptera, Coleoptera, Diptera, and Hymenoptera. Generally speaking, the majority of the leaf-miners are not of economic importance. According to Needham *et al.* (1928), in the United States of America the apple has at least ten different insect species that mine its leaves. Only two or three of them are of some importance, occasionally and in neglected orchards. Some of the leaf-miners

on agricultural crops are, however, sufficiently important to warrant control measures. Mention may be made of *Promecotheca reichei* Baly, the Coconut Leaf-miner, which is the most important pest of coconut in the Fiji Islands. In the following paper notes are given of some of the leaf-miners which are important as well as potentially important in Nizamabad district of Andhra Pradesh.

Nizamabad district which was formerly a part of Hyderabad State has a rich agricultural potential. Its importance has increased after the advent of the Nizamsagar Reservoir in the year 1950 by which three out of its five taluks have been able to get supplies of perennial irrigation water. The rainfall of the district averages 40 inches received mostly in the South-west Monsoon months of June, July, August, and September. The average maximum temperature varies from 75° F. to 106° F. and the average minimum from 50° F. to 89.9° F. The important crops grown are rice (*Oryza sativa*), jowar (*Andropogon sorghum*), and sugarcane (*Saccharum officinarum*).

Hispa armigera Ol. Rice Hispa. (Hispinae, Chrysomelidae; Coleoptera.)

The grubs of this beetle mine the leaves of rice crop grown in both the seasons, viz. *Abi* and *Tabi*. While adult beetles scrape the epidermal layers of the leaf, the grubs mine into the leaves. Both the larval and pupal stages are passed in the leaf-mine itself. The reduction in yield ranges from 39-65% on normal average yields varying between 1200-2400 lb. per acre. In Nizamabad district the insect passes through six generations in a year on both the crops.

The eggs are laid in the leaf-tip of rice crop and normally hatch in about a week's time. The grub stage lasts 15-20 days, the grub feeding throughout in the same leaf mine. When two or more grubs attack the same leaf the different mines coalesce into one. The pupal period ranges from 6-10 days. The adult beetles live in confinement for a week to ten days. The complete life cycle occupies 30-35 days and does not vary much from year to year.

The natural enemies of Rice Hispa recorded in Nizamabad district are:

(i) *Bracon* sp. (Braconidae; Hymenoptera), which is a larval parasite on hispa grubs. The incidence of parasitism in nature ranges from 15-82%. A brief account of this parasite has been already given (Khan and Murthy, 1956).

(ii) *Eupteromalus* sp. near *nidulans* Forst. This is mostly a secondary parasite on *Bracon* sp. noted above and occasionally has also been observed as a primary larval parasite on hispa grubs. The incidence of parasitism (as a primary larval parasite) ranges from 2-5%.

(iii) An unidentified Cecidomyiid larval parasite. The incidence is negligible.

Pseudonapomyza atra Meigen (?). (Phytomyzinae, Agromyzidae; Diptera.)

This insect has come into prominence since 1952, when it appeared in appreciable numbers on the rice crop in the entire Nizamabad district. Formerly it had been observed mostly on grasses, the chief of which are *Cynodon dactylon, Eragrostis pilosa*, and *Setaria intermedia*. It has a widespread distribution having been recorded from Europe, Africa, North America, India, Malaya, and the Pacific Islands on a variety of graminaceous host plants.

The damage done to the paddy crop by *P. atra* consists of light-yellow apodous maggots mining the leaves and feeding on the mesophyll. The epidermal layers are not touched. The mines are linear but may turn into a blotch when more than one mine appear on the same leaf and spread over. In case of severe infestation, the leaves wither and fall off and the tillering is affected adversely.

August and September are the months of maximal activity of the insect. Routine sampling indicated the percentage of attack as varying from 15-50% on broadcast sown crop. Generally, not more than one maggot is observed in each leaf-mine. The pupation takes place inside the leaf-mine only. The entire life cycle of the insect is completed in 12-15 days. The flies are short-lived.

The natural enemies recorded on *P. atra* (Bap Reddy, 1956) are:

(1) *Derostenus* sp.
(2) *Achrysocharis* sp. (Euliphidae).
(3) *Eucoilidea* sp. (Eucoilinae).

Apart from rice, *P. atra* is also recorded on maize (*Zea mays*) as well as ragi (*Elusine coracana* Gaert.) which is grown to a small extent in Kamareddi and Yellareddi taluks of the district.

Rhadinosa lebongensis Mlk. (Hispidae; Coleoptera).

This is a very minor insect pest of rice in the district. The adult beetle to the untrained eye resembles Rice Hispa (*H. armigera*) though the adults are smaller in size than the Rice Hispa. Body black, elytra shiny bluish black and nearly glabrous; form narrow and parallel-sided.

The life-history of *R. lebongensis* is similar to that of *Hispa armigera*. The adults scrape the epidermal layer of rice leaves while the grubs mine into the leaves. The duration of each stage noted

in the laboratory at a temperature averaging 84.5° F. (maximum) and 71.9° F. (minimum) is as follows:—

Grub stage—14 days (average)

Pupal stage—6 days (average)

The longevity of adults is 4-6 days. The entire life-cycle is roughly completed in 30-35 days.

Rhadinosa lebongensis has also been noted on *Echinocloa colonum* Link and *Panicum* spp. No larval parasites are noticed but the pupae are heavily parasitised by a chalcid (under indentification), the incidence of parasitization ranging from 20-70%.

Adult beetles of *Rhadinosa lebongensis* have been observed to scrape the leaves of sugarcane but no leaf-mining by the maggots has been observed.

Other minor leaf miners which have been observed in Nizamabad district but on which studies have not been conducted are the citrus leaf-miner *Phyllocristis citrella* S., found on young plants of Nimbu and Mosambi (*Citrus aurantifolia, C. limetioides*) and the leaf-mining weevil on Mango (*Rhynchoerus mangiferae* M.).

Acknowledgements

The author is grateful to Dr. M. Q. Khan, Entomologist to the former Government of Hyderabad, for help and guidance. Thanks are due to the authorities of the British Museum (Natural History), London, for indentification of the insects.

Glossary

Abi: Monsoon crop, sown in June-July and harvested in November-December.

Tabi: Second season crop, sown in January-February and harvested in April-May.

618, Skipp's Compound,
Malleswaram,
Bangalore 3,
September 26, 1957.

D. V. MURTHY

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17. NOTES ON THE NYMPHAL INSTARS OF *LACCOTREPHES GRISEUS* (GUER.) (NEPIDAE; HETEROPTERA) FROM INDIA

(*With six text-figures*)

Introduction

Very little is known about the different nymphal instars of *Laccotrephes* except for casual references to *Nepa cinerea* (Hamilton, 1931) and *Laccotrephes tristis* (Hale, 1924). Hafiz (1938) and Hafiz and Pradhan (1947), while recording adults of *Laccotrephes* species from Bihar and Patna, provide no information on the nymphs. An attempt is made here to study the different nymphal instars of *L. griseus* and the external changes during metamorphosis, which involves (1) increase in body size, (2) development of wings, (3) development of anal siphon, (4) structural change in forelegs, especially the femoral groove, and (5) development of the toilet organ.

Material

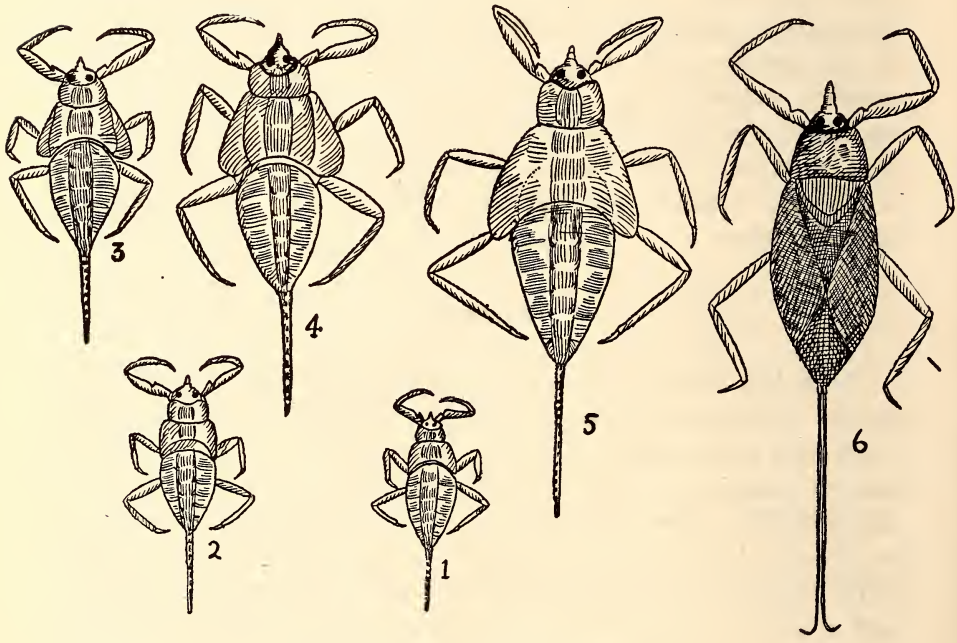
Collections were made with the aid of hand-nets in the rainy months of October and November from Tambarm (S. India), during which time nymphs are available in large numbers. They were kept alive in aquaria in pond water with sufficient vegetation, while in chlorinated tap water they did not survive for long. Preservation of the different instars was in 4% formaline. For a study of the ratio of the labial segments in the different instars, the heads were treated with a weak solution of KoH, washed in water, dehydrated, cleared in clove oil, and mounted in xylol-canada Balsam.

Nymphal Instars

I. Instar nymph: Body length excluding anal siphon 6 mm.; head brown, 1.36 mm. wide and 1.2 mm. long; rostrum short, labium three-jointed; pronotum dark in middle region, pale brown at sides; mesonotum and metanotum light brown with a pair of dark patches on either side of mid-dorsal line; abdomen short, light brown with dark shade at centre and pale towards sides; posterior segments with

distinct dark patches in mid-dorsal region; paraterga curving round and overhanging the sterna so as to form longitudinal grooves in which spiracles are lodged; anal siphon short, almost same length of abdomen; a faint line seen throughout length of tube in middle, clearly indicating its double nature; length of anal siphon 3 mm.

II. Instar nymph: Body length 6.5-7.5 mm.; head reddish brown with a pair of prominent dark eyes at sides; rostrum light brown, 0.72 mm. long; thorax paler at sides, with dark brown patches at centre throughout; wing-pads short projections from sides of meso- and meta-nota, extending as far as lateral edge of first abdominal



Instars of *Laccotrephes griseus* (Guer.)

Figs. 1—5. Nymphs (1, 4, & 5, × 3; 2 & 3, × 2·5); Fig. 6. Adult (× 2·5).

segment; abdomen with dark brown patch at middle; length of anal siphon 3.75 mm.

III. Instar nymph: Body length 8.0-9.5 mm.; pale brown with a dark shade at middle; head brown, wider than long; pronotum deeply sinuate to receive head; thoracic segments with dark patches in mid-dorsal region and pale towards lateral margins; metanotum

with two black spots; wing-pads distinct and prominent, extending up to lateral margin of second abdominal segment; siphon much longer, measuring about 5 mm.

IV. Instar nymph: Body length 10-11 mm.; black patches in many places; rostrum 1 mm. long; abdomen and siphon showing corresponding increase in length. Forelegs up to the end of instar IV are more or less distinctly mottled and irregularly barred with light colour; forefemora stout, long, with a prominent groove on its upper margin; length of anal siphon 5.5-6.0 mm.

V. Instar nymph: Body length 12.5 mm.; head with prominent eyes; thorax and wing-pads darker; wing-pads increase in size, extending up to third abdominal segment; siphon still maintaining its undivided condition, subsequent ecdysis revealing its double nature; anal siphon 6.3 mm.

Adult

Body length 14-16 mm.; abdomen fuscous brown; wings vitreous; anal siphon shorter than the body; hemelytra slightly ampliated dark brown; hind wings membranous; siphon 12 mm

Table showing measurements of different Instars.

Instar	Total body length (in mm.)	Ratio of head length/ head width	Ratio of rostrum length/ head length	Ratio of siphon length/ abdomen length	Ratio of lengths of labial segments 1st : 2nd : 3rd
I	6.00	0.90	0.58	1.00	6 : 11 : 9
II	7.25	0.91	0.60	0.82	4 : 9 : 6
III	8.60	0.91	0.66	0.86	5 : 10 : 7
IV	10.75	0.97	0.62	0.92	4 : 8 : 6
V	12.10	0.84	0.59	0.87	5 : 8 : 6
Adult	14.50	0.85	0.65	1.30	10 : 20 : 13

Discussion

From the foregoing account it is clear that the anal siphon, which is paired in the adult, appears as a single tube throughout the nymphal stages, but all along its double nature is indicated by a faint line in the middle. The siphon assumes its paired nature only after the last ecdysis. The wing-pads make their appearances in the second instar. They gradually increase in size, extending as far as the third abdominal segment in the IV and V instars, while initially they extend up to the first abdominal segment. The toilet organ, represented by a group of slender radiating spines at the distal angles of the metatibia, is present both in the nymphs and the adult.

Acknowledgement

The author expresses his grateful thanks to Professor T. N. Ananthakrishnan for the valuable help received during the present study.

Loyola College,
Madras, T. K. RAGHUNATHA RAO, M.A.
November 24, 1958.

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18. INDIVIDUAL HOST DISCRIMINATION BY BLOOD SUCKING INSECTS

Adverting to Mr. Oscar M. Root's narrative on the above subject and the editorial note thereunder in *Journal* for August 1958 (**55**: 376) it appears certain that, though reaction to insect-bites may vary in individuals, the difference in incidence has much to do with host discrimination of the insects. While in the Chanda district, where ticks are a menace in certain forests, I have on many occasions envied a guest forester going round with me and concluding the

excursion without a single tick on his body, while I invariably 'collected' at least two or three in spite of the amount of physical exposure being the same! Local *Marias* in that tract are known to be completely immune to ticks. Similarly, in the semi-evergreen forests of the Western Ghats, the local inhabitants are reported to be immune to leeches. How far it is correct to attribute this, as is commonly believed in both cases, to their habit of chewing tobacco in quantities and consequent concentration of nicotine in their systems is not known.

Bombay Forest Service,
16, Bombay Road, G. B. DASHPUTRE
Poona 3,
November 5, 1958.

19. IDENTIFICATION OF CERTAIN CRUSTACEANS COLLECTED FROM RAINWATER POOLS NEAR PILANI, RAJASTHAN

Further to my note published in the *Journal* [Vol. **54** (4): 961-2] I have been able to have the crustacean material collected from rainwater pools identified as under:

1. *Triops cancriformis* (Bosc) (Notostraca).
2. *Streptocephalus dichotomus* (Baird) (Ostracoda).
3. *Candonocypris bicornis* var. *laevis* Gauthier (Ostracoda).
4. *Caenestheriella annandalei* Daday (Concostraca).

My thanks are due to Dr. J. P. Harding, British Museum (Natural History), London, for having the material identified for me.

Department of Zoology,
J.V. College, N. S. SIDHU
Baraut (Meerut),
September 27, 1958.

20. THE LEAVES OF *ALSEODAPHNE SEMECARPIFOLIA* NEES

Recently the Maharaja of Bansda sent to the Society some leaves for identification. They have been identified as belonging to *Alseodaphne semecarpifolia* Nees, of the family Lauraceae. The tree is widely found in Bombay State, but is more abundant towards the south of the same.

Together with the leaves our correspondent sent us this note: 'If about 20 leaves are eaten, one can do without food for 2 or 3 days. Is it possible to use these leaves to lessen appetite in cases where dieting is necessitated for reduction of weight? The tubers of this plant are supposed to be efficacious in treating eczema cases; to be rubbed into a paste with very little water and applied locally.'

We find no references in the literature on the subject; this is why this note is being published to ask our readers if they have any information.

We do find in the literature references to another plant, which has remarkable properties in the sense asked by our correspondent; it is *Ilex paraguensis* St. Hil., the so-called *Mate* or *Paraguay Tea*; the dry leaves are used for the preparation of an infusion known as Paraguay Tea; the fresh or dry leaves are chewed much as betel leaves are in India, and are reported to have very striking properties, so that a person can go for several days without eating provided the person chews an occasional leaf of the plant. This tree has been seen under cultivation in some gardens in India.

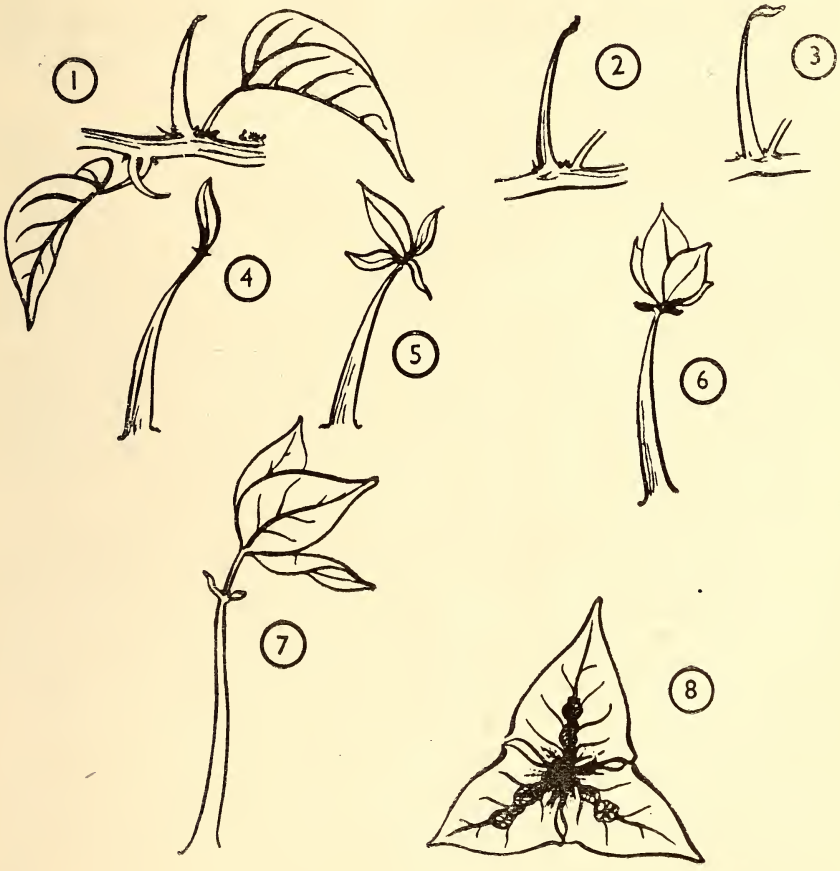
St. Xavier's College,
Bombay 1, H. SANTAPAU, S.J.
January 12, 1959.

21. THE 'RED TRIANGLE' BOUGAINVILLEA

A seedling Bougainvillea was raised in the National Botanic Gardens, Lucknow, the seed parent selfed being Lord Willingdon, a deep terracotta red, introduced by Delhi.

The seedling was grown in a ten-inch pot till the wet weather set in, when it was planted in the pot on an island in the Water Garden.

Two strong shoots developed but the Bougainvillea also carries some twiggy growth. The plant has been named Red Triangle because, when fully developed, the bracts viewed full face definitely form a triangle.



Normally flower spikes appear on the upper portions of the shoots, the peduncles taking the place of the thorns. On the strong shoots of Red Triangle, however, about five feet from the base, thorns commence to show a ragged tip, then produce two hair-like appendages and subsequent thorns develop coloured bracts, some merely a sixteenth of an inch in length, till finally the three bracts carrying flowers surmount the thorn. By this time the thorn has elongated from one inch to two and a half inches and resembles a peduncle with a thickened base. Thorns further up the shoot will be found with the small appendages.

In the attached sketch No. 1 represents the normal thorns on a shoot of Red Triangle, Nos. 2 to 6 subsequent development of the bracts, No. 7 shows the thorn elongated into a peduncle, carrying a normal group of bracts and flowers, and No. 8 is a full face view of the bracts carrying unopened flower buds.

National Botanic Gardens,
Lucknow,
November 27, 1958.

K. N. KAUL, F.L.S.
Director.

Notes and News

The Government of India is compiling a National Register of all qualified scientific and technical personnel of the country for the assessment and proper utilization of existing talent and for future planning. The following categories of personnel are being enrolled:

(1) Holders of at least a post-graduate degree in a science subject; (2) holders of at least a Bachelor's degree in Agriculture, Veterinary Science, and other specialized fields; (3) holders of a degree or diploma in engineering and technology; and (4) medical specialists (including post-graduates and those with research qualifications).

Registration is done through Card 'G' only, which is available with: (*a*) the Union Public Service Commission and all State Public Service Commissions; (*b*) all Employment Exchange Offices (employed persons may also obtain cards from the Exchanges); (*c*) all National Laboratories of the C.S.I.R.; and (*d*) National Register Unit, C.S.I.R., Old Mill Road, New Delhi.

* * * *

At the XI Conference of the International Committee for Bird Preservation held at Helsinki, Finland, in June 1958 an innovation of some significance was made. It was decided to include individual 'Contributing Members' in the Committee, whereas heretofore only official National Sections enjoyed that privilege.

Persons interested in bird protection and conservation in any part of the world can now become Contributing Members in their individual capacity by paying a fee of £5 per annum. In return such members will receive the I.C.B.P. Bulletin (No. VII now in press) and will be invited to all international conferences held in whatever part of the world. They will have all the rights and privileges of representatives of National Sections with the exception of individual voting.

The President of the International Committee (henceforth to be known as Council) for Bird Preservation will welcome persons anxious to help in the promotion of bird preservation throughout the world taking advantage of the opportunity now available for actively collaborating with the International Committee.

* * * *

The First All-India Congress of Zoology sponsored by the Zoological Society of India, which was proposed to be held last year but had to be postponed, will now be held at Jabalpur (M.P.) from 24 to 29 October 1959 on the invitation of the University of

Jabalpur. Further information may be had from the General Secretary, Dr. B. S. Chauhan, c/o Zoological Survey of India, 34 Chittaranjan Avenue, Calcutta 12 (India).

* * * *

The third award of the Zoological Society of India's Sir Dorab Tata Medal has been made to Dr. A. P. Mathew, retired professor of Zoology, University College, Trivandrum, for his important contributions to zoology during the three-year period 1955-57.

Readers of the *Journal* will recall Dr. Mathew's excellent paper on the Scorpion *Heterometrus scaber* published in Vol. **54** (4), pp. 853-857.

* * * *

The Bombay Natural History, has a project in hand for setting up a well-equipped centre for the study of bird migration on the edge of the Great Rann of Kutch. Dr. Sálim Ali's ornithological survey of Kutch, made in 1944-5, had revealed that this is a particularly suitable venue for the purpose. Before deciding on the location of the permanent station it is proposed to set up six temporary field stations strung out at every ten miles or so along the northern boundary of Kutch. These stations will operate for a fortnight during the next autumn migration and another fortnight in spring 1960, and will serve to pin-point the exact spots where the best potentialities for trapping and netting lie. It is expected that the project will have the support of the World Health Organization, which is interested in the work for the clues it may provide to the dissemination of arthropod-borne viruses by migratory birds.

CORRIGENDUM

Vol. 55 (3): 423. Lines 20 and 21. The extracts from the field notes mentioned as being given at the end of the paper were not published since the more important details were already embodied in the paper.

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Journal of the Bombay Natural History Society

Vol. 56, No. 2

Editors
SÁLIM ALI & H. SANTAPAU, S.J.

AUGUST 1959

Rs. 15

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Contributors of scientific articles are requested to assist the editors by observing the following instructions:

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS. should be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names to be printed in italics should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and subspecific names always begin with a small letter even if they refer to a person or a place, e.g. *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri*.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binomials should be used.

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6. Text-figures, line drawings, and maps should be in Indian ink, preferably on Bristol board.

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EDITORS,

91, Walkeshwar Road,
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Journal of the Bombay Natural History Society.

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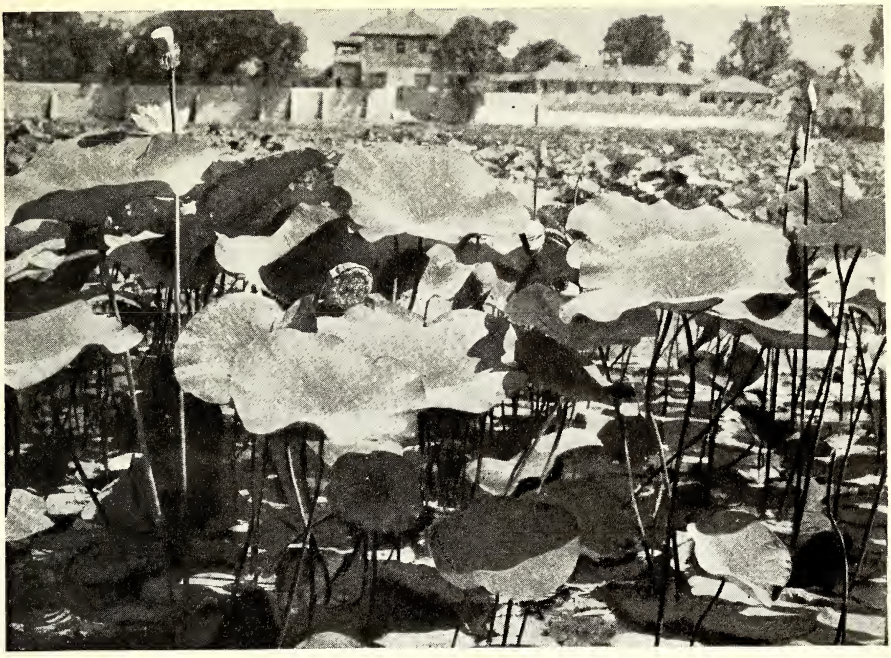


Water Dispersal
The lotus (*Nelumbo speciosa*) fruit, Bandra.

Wind Dispersal
A large specimen of Ak (*Calotropis procera*), Rann of Kutch.

Photos : C. McCann

Wind Dispersal

Ak (*Calotropis gigantea*), Salsette Island.

Bird Dispersal

This Banyan (*Ficus bengalensis*) on Salsette Island started life on a palmyra palm (*Borassus flabellifer*) remains of whose trunk are still visible. In course of time, it strangled not only the palm but also the creepers of *Calycopteris floribunda, Vitis gigantea* and *Derris scandens* growing on it. The author watched the process of strangulation for many years.

JOURNAL
OF THE
BOMBAY NATURAL
HISTORY SOCIETY

1959 AUGUST Vol. 56 No. 2

Seed Dispersal

BY
CHARLES MCCANN

(*With five plates*)

INTRODUCTION

Seed dispersal is a most fascinating subject. Its study calls for close observation and careful reasoning. However, some forms of dispersal are forcibly and annoyingly impressed upon us when we are out of doors by adherent fruits and seeds, which stick to clothing as one passes through vegetation. Further, its understanding enables us to interpret some of the problems of plant distribution, leading us into the realm of plant geography.

The presentation of a botanical subject in a popular form is often fraught with difficulties owing to the absence of or the incorrect application of popular names. Perhaps in India the difficulties are even greater owing to the diversity of language. It happens, not infrequently, that a single species is referred to by many names or a single name is applied to several species. English names, like the vernacular, can also be misleading, if not incorrect (particularly in the strictly botanical sense); for example, the word 'lily' is applied to several species which are not even remotely related to the true lilies ! Some years ago, this misapplication of names was adequately illustrated by the question : what is the Flame of the Forest ? This question was dealt with in the Answers to Correspondents section of the Society's *Journal*.[1] Nevertheless, I shall endeavour to introduce the more familiar examples of Indian plants and confine my remarks to such species as far as possible.

Next to self-preservation, the propagation of the species is the chief end of all living matter, and so it is with plants. The young of animals

[1] 1928, Vol. 33 : 218.—EDS.

are frequently tended by their parents till they are capable of fending for themselves. The more highly developed the animal in the scale of evolution the longer the parental care. In the vegetable world, seeds take the place of 'young' in the animal world. Generally, plants shed their seeds as soon as they are mature. On germination of the seed, the young plant or seedling has to make the best of life from the very beginning. In addition to the production of seeds, some plants are able to propagate themselves by various means of vegetative growth, such as runners, suckers, or budding, but this is yet another story of plant life.

If all seeds produced were to fall directly to the ground from the parent plant they would all germinate in a heap. Owing to their inability to move to a new locality of their own power, the struggle for existence would be so acute that they would inevitably crush each other out of existence. Perhaps, only one would survive the ordeal. To avoid such 'fratricide' Nature has devised various and numerous means of enabling the population to grow and find new territory.

Normally, the word *fruit* is used in its correct sense, but the popular conception of the word is not always clear and is frequently at variance with the strictly botanical meaning. For example, tomatoes or pumpkins are spoken of as vegetables whereas both are in reality fruits. The fruit is that part of the plant which contains the seed, but in the botanical sense the term is restricted to the seed itself which is capable of germinating and reproducing the species whether the fruit be single or multiseeded, and whether it is surrounded by a succulent protecting investment or not. Botanically, therefore, the definition of the term *fruit* is wider than in the popular sense. Accordingly, to the botanist a melon or a tomato is just as much a fruit as is a grain of wheat. However, the botanist has a special terminology descriptive of the various kinds of fruit and to the initiated each term has a definite significance.

Unripe fruits, as is well known, are very often hard, green, and disagreeable to the taste. They are frequently acid or bitter. These elements protect the immature seeds from the ravages of animals or birds till such time as they are ready for dispersal. On ripening the fruit generally assumes an attractive colour suited to its peculiar dispersal agent; the once distasteful juices become more palatable to the normal consumers. The plants advertise the fact that the seeds are ready for dispersal. The colours, scents, and taste of fruits are adapted to the requirements of the normal dispersal agents—the 'commercial travellers' of Nature !

In the interest of the species, it is essential that the seeds should be transported to some distance from the immediate neighbourhood of the parent plant so as to prevent overcrowding and to increase the range of the species. To ensure survival and spreading of the species, Nature has evolved many different kinds of fruits and enlisted the aid of the

elements and her creatures to assist the otherwise immobile plants in the distribution of their seeds.

The agents which assist plants in seed dispersal are : (1) *wind*, (2) *water*, (3) *special devices* of the plants themselves, and (4) *animals*. These agents may act singly, or one or more may come into play together to produce effective dispersal.

Wind Dispersal

(Plate III)

Obviously, the first essential for the wind to be an effective agent of dispersal is that the fruits or seeds must be light or provided with some form of 'sail' or 'parachute' to facilitate carriage by the wind. Secondly, the fruit or seeds must be developed on the plant in such a position as to be readily accessible to the wind, or they must be provided with some 'mechanical' device to cast the seeds upon the wind when they are ready for dispersal. The last named method is often achieved by 'explosion' or by the catapulting of the seeds by the sudden curling of the carpels. Perhaps, another important point worthy of notice is that the plants themselves must grow in a suitable position and ripen their fruit when the winds are in season.

Normally, from March to May, when the weather in India is becoming hotter and hotter, strong winds prevail—the March winds. The hot dry winds of this period contribute largely to the ripening of the fruit and the eventual dispersal of the seeds. In the deciduous forests the trees are mostly devoid of foliage at this period; there is no shading of the ripening fruit, nor obstructions in the path of the wind-borne seeds. At this period there are frequently whirlwinds. These dust-devils, as they are often called, are frequently seen along roads and are responsible for picking up quantities of seeds along with other debris and whirling them high up into the air and carrying them many miles away to be deposited when the dust-devil has spent itself. Not infrequently one reads or hears of a *rain of seeds* or other objects and even of some forms of animal life; it is these dust-devils or whirlwinds which are responsible for these phenomena.

The first requisite, lightness, is perhaps best illustrated by the seeds of orchids. The seeds of orchids are extremely minute and are blown out of the dehisced capsules, which remain on the plant, like fine dust. This 'dust' is transported on the wings of the wind through the trees and enables the epiphytic species to reach their normal habitat high on the branches of forest trees. Epiphytic orchids would stand little chance of survival if it were not for the wind.

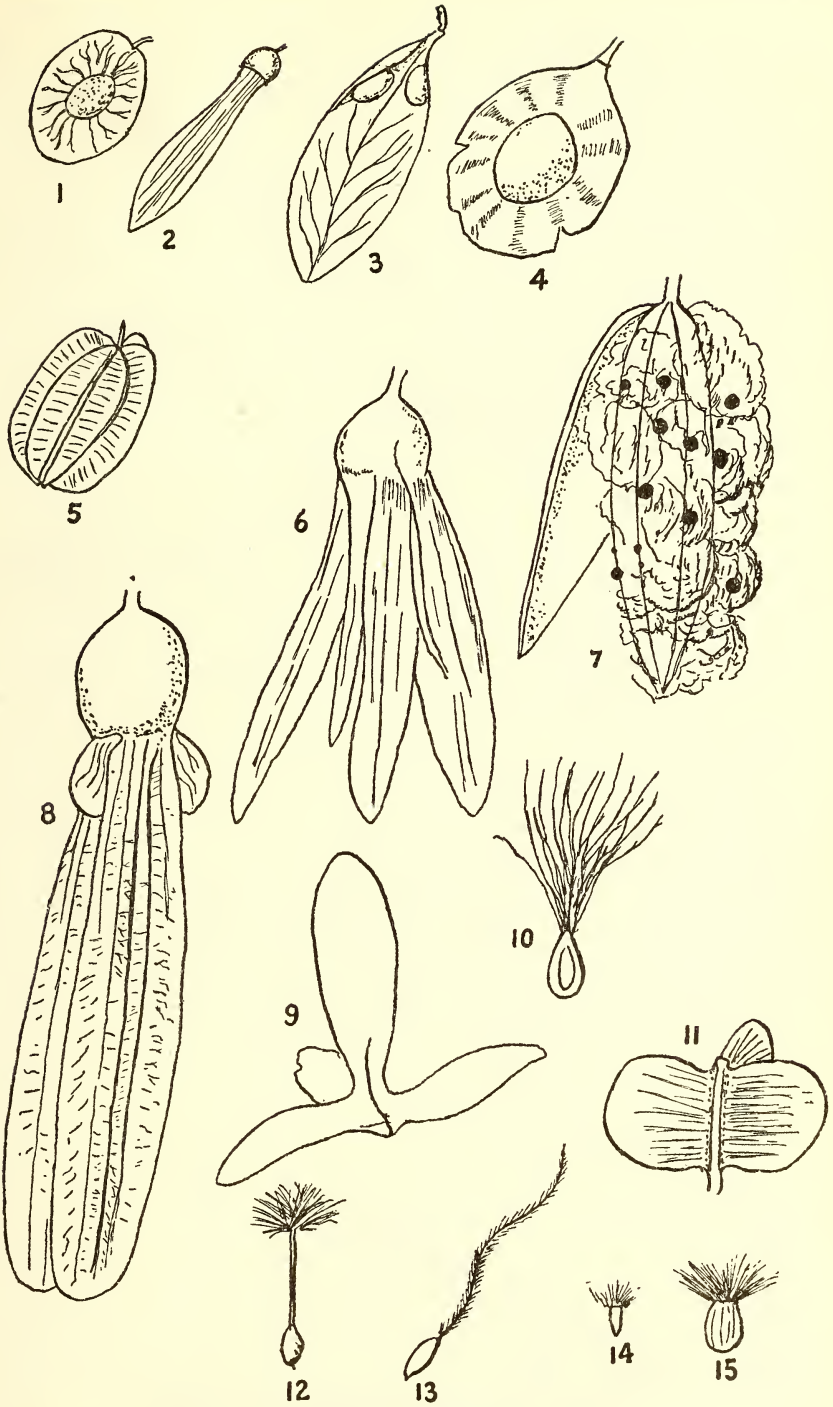
A feature of some air-borne fruits or seeds is their flatness. In many instances the seed itself or the fruit is provided with a membranous 'sail'

attached to its margin. In the case of the Indian Elm (*Ailanthus excelsa*) (fig. 1) the entire one-seeded fruit is papery and when dry is readily transported by the wind. Each strong gust of wind that rustles through the branches dislodges and bears away thousands of fruit. *Oroxylum indicum* adopts a similar method with this difference : this species, which is not uncommon in the hills around Bombay and Salsette, produces large ski-shaped fruit on the top of long stalks; the fruits contain a large number of flat seeds, each with a very thin, papery margin all round. When the fruit is dry and the seeds ready for dispersal it splits along the sutures with a small report. The seeds fall out in a shower and are wafted in all directions. More often than not the whole contents of the fruit do not leave at once, but in periodic batches at the will of the wind. Some of the other members of the Bignoniaceae disperse their seeds by the carpels twisting spirally on dehiscence.

In some trees which depend on the wind for dispersal, the seeds are tailed like a dart and on the opening of the carpels the seeds are blown off by gusts of wind. Once launched on the air the seeds travel like darts away from the parent plant. Some of the species of the Sterculiaceae exhibit this form of dispersal.

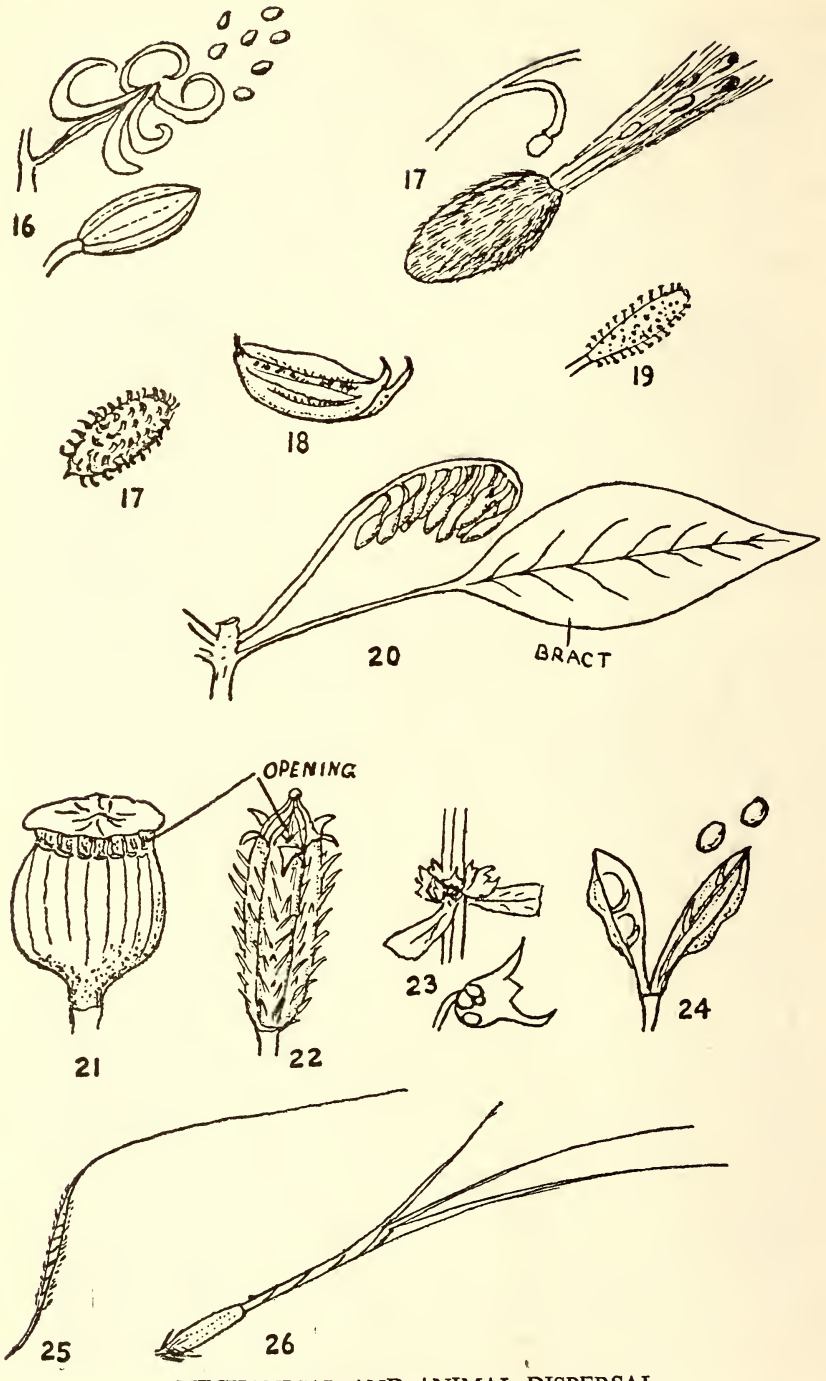
We come now to a large number of plants which have evolved various forms of 'parachutes' composed of 'silk' to assist the wind in transporting their seeds. Seeds with parachutes, I think, are familiar to most people. Frequently one sees a silky plume drifting about the garden, field, or even entering the house through an open window or door. If such a parachute were examined closely, it would be noticed that it was probably carrying a seed; if not it is a spent parachute which has already dropped its load and awaiting destruction by rain. Many members of the Compositae have adopted this form of dispersal (figs. 14, 15). The common Dandelion (*Taraxacum officinale*) (fig. 12) is a good example. This form of dispersal undoubtedly contributes very largely to the almost cosmopolitan distribution of the family.

Another successful family, the Asclepiadaceae, which uses this form of dispersal is exemplified by the *Ak* (*Calotropis gigantea* and *C. procera*) (fig. 10). Plants of this family have finger-like follicles which, when they ripen and burst, send many hundreds of seeds, each provided with a silken parachute of fine 'hairs', into the air. The duration of transport varies much with the species and the obstructions the parachutes meet with in passage. Once the seeds are dropped the parachutes continue their flight till they finally disintegrate. A closely allied family to the Asclepiadaceae, the Apocynaceae, employs much the same method of dispersal, but there are some exceptions; one genus enlists the aid of water for its purpose. Mention of this member of the genus will be made later. Some grasses have also adopted a similar means of transport for their seeds.



WIND-BORNE SEEDS

1. *Ailanthus excelsa*, 2. *Ventilago* sp., 3. *Erythropsis colorata*, 4. *Pterocarpus marsupiium*, 5. *Terminalia* sp., 6. *Shorea robusta*, 7. *Salmalia malabarica*, 8. *Dipterocarpus* sp., 9. *Hiptage madablota*, 10. *Calotropis*, 11. *Dioscorea* sp., 12. *Taraxacum*, 13. *Clematis*, 14 & 15. Compositae.



MECHANICAL AND ANIMAL DISPERSAL

16. *Impatiens*, 17. *Ecballium, elaterium*, 18. *Martinia*, 19. *Plumbago*, 20. *Hymenodictyon*, 21. *Papaver*, 22. *Argemone mexicana*, 23. *Leucas*, 24. Acanthaceae, 25 & 26. Awns of grasses.

The silk-cotton trees such as the *Simul* [*Salmalia malabarica* (fig. 7) and *S. insigne* and *Ceiba pentandra*] use silk for the dispersal of their seed, with this difference that the seeds are not attached to a parachute but are merely cradled in the silk. When the fruit is ripe it bursts, the carpels fall away leaving the central winged portion still attached to the stalk. The cotton swells up and with each puff of wind portions of the silk are carried away like drifting snow. As the cotton is shredded by the wind the seeds are shed *en route*. In some localities the silk gets piled up in fair quantities awaiting the monsoon rains to destroy it.

Incidentally, at the same time as the silk-cotton trees are fruiting the cotton-bug (*Dysdercus singulatus*) is laying its eggs on the fruit. The young bugs are eventually cradled in the cotton and wafted around the countryside. Later swarms of cotton-bugs are to be seen feeding in clusters round seeds, or individuals walking about with a seed pendant from the proboscis. These seeds appear to be their main diet at this time of the year.

There are yet numerous other examples of wind dispersal. In addition to the species mentioned above in which silk is used as a vehicle there are very many examples in which the entire fruit is provided with sails, propellers, etc. to enable the wind to carry it along. The carpels have special appendages, or they assume a special shape. A few random examples will have to suffice to illustrate this form of dispersal.

Erythropsis colorata, a fairly common tree in the Western Ghats, produces open follicles. The seeds develop on the margin of the follicle (fig. 3). The follicle itself is papery and dries hard. When the seeds are mature the dry follicles are swept away by the winds prevalent at this time of the year : thus, the papery follicle performs the function of a 'sail'.

In the family Dipterocarpaceae, of which the *Sal* (*Shorea robusta*) is a familiar example (fig. 6), the fruits are provided with two to five propeller-like blades according to the species. These appendages assist the wind in transporting the fruit. In some the form and size of the appendages direct the flight of the fruit through the air. In *Hiptage madablota* the fruit itself has three propeller-like blades (fig. 9). When the fruit is ripe it is detached by the wind and spins through the air for some distance. It descends earthwards at an oblique angle as one blade is longer than the other two. Here it lies till the next gust of wind takes it up again. Some other examples of propeller-like fruit are *Symphorema involucratum* and *Kydia calycina*. In these two species the dried calyx performs the function of a propeller.

Yet another wind dispersal device is resorted to by a grass known as *Spinifex squarrosus* ; it might well be called the 'rolling pin-cushion'. This grass is an useful sand-binder and is commonly found along sandy shores. Its seeds are tucked away in the scales or glumes which form the florets. One of the glumes in each floret is developed into a long awn,

which may reach two or three inches in length. Numbers of these florets are grouped together and the whole mass constitutes a large, spiny ball, often eight to ten inches across. This ball is the female inflorescence; the males are borne on separate spikes. The whole inflorescence breaks away from the main stalk and is blown about the sands. As it speeds hither and thither at the will of the wind, it sheds its seeds. It may chance to be blown into the sea and then be carried away by the tide to be stranded on some other distant shore. Perhaps some have had the unpleasant experience of treading or sitting on one of these vegetable 'hedgehogs' buried in the sand !

Two species of *Hymenodictyon* (Pl. IV, fig. 20), not uncommon in the Western Ghats, enlist the aid of the wind in yet another manner perhaps peculiar to themselves. When under one of these trees during the hot season when the trees are leafless, one's attention is drawn to a constant gentle rattling, as of dry leaves. On looking up it will soon be noticed that the sound is produced by stiff dry bracts scattered over the branches at the base of the now dry inflorescences. When fresh these bracts are often creamy white and would appear as banners to attract insects to the small florets. The spikes of capsules dry and remain attached to the trees. The seeds are small. The stiff dry bracts act as sails and catch every gust of wind that passes. As they do so they cause the fruits to vibrate and the seeds to be shaken out of the capsules and cast on the wind.

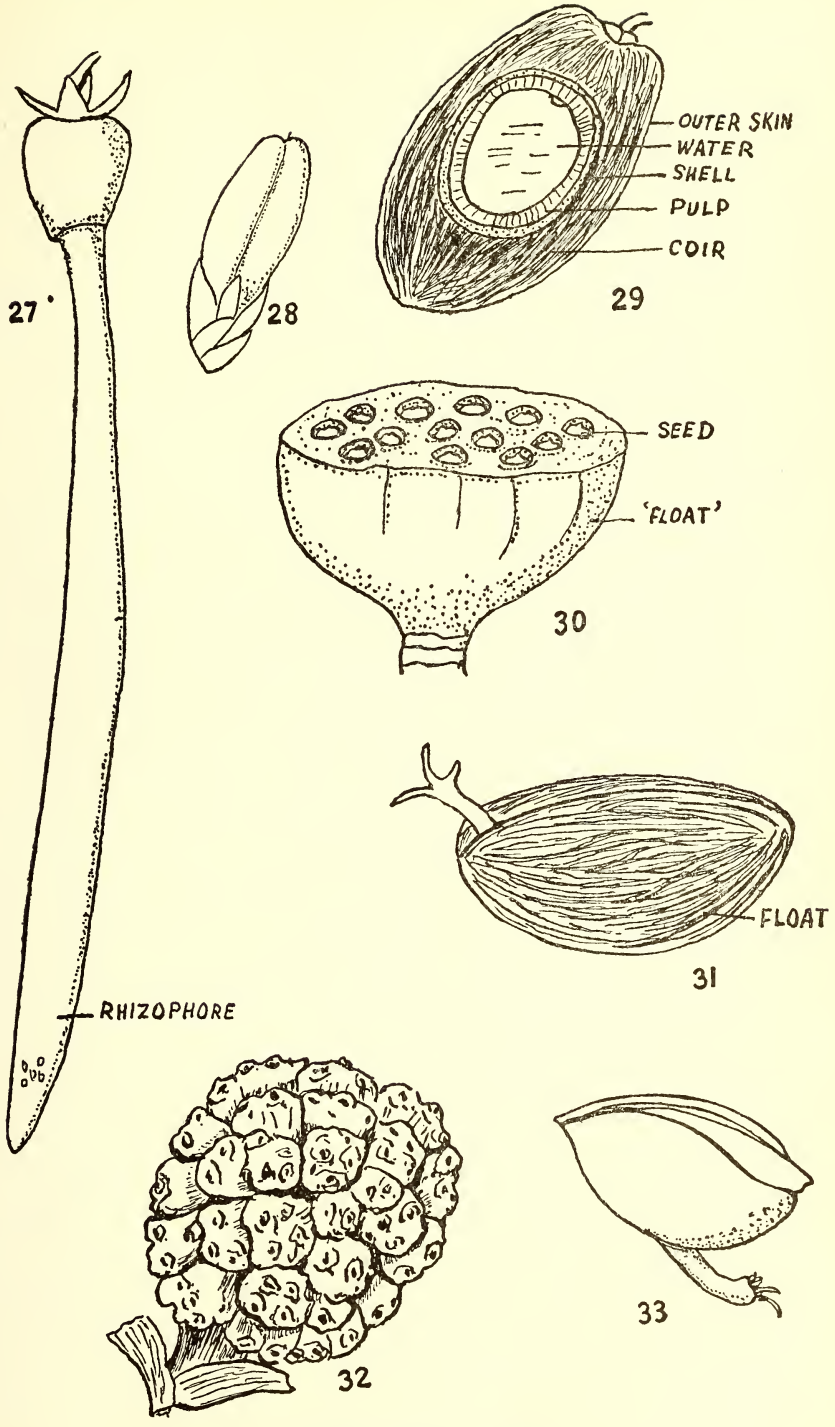
Water Dispersal

(Plate V)

Like wind-borne seeds, fruits and seeds dispersed by water are often highly specialised in structure. For one, the seed-coat or the external coat of the fruit must be impervious to water for some period before actual germination; the length of time varies with the species. Again, water-borne seeds must also be able to float for some time. The coconut is one good example of a water-borne fruit.

One may well ask why the coconut (*Cocos nucifera*) is surrounded by so much coir and such a hard shell? A section made of an entire coconut will provide the answer. The highly polished tough outer skin is waterproof; beneath it lies a thick layer of fibre, the coir, which when dry encloses numerous air spaces and 'cork' (fig. 29). This material acts as a float; internal to the coir is the hard woody shell, enclosing the pulp and the embryo plant. The shell is also water resistant for a time. When the coconut is ripe the outer coverings dry and in addition to protecting the embryo within assume the function of a float. Within these coverings the embryo lies perfectly protected and provided for for a long time. When the nuts dry they fall to the ground.

Generally, coconuts grow best near the sea and naturally on tropical



WATER-BORNE FRUITS

27. *Rhizophora* (seedling), 28. *Acanthus ilicifolius*, 29. *Cocos nucifera*, 30. *Nelumbo speciosa*, 31. *Cerbera odollam*, 32. *Pandanus*, 33. *Avicennia* (seedling).

coasts. If the nuts on falling do not drop directly into the water, they reach the sea by extraneous causes. Once in the sea they are at the mercy of the tides and wind, and so starts perhaps a long and precarious journey. In this process the nuts very often spend many months at sea, tossed about on the waves, carried hither and thither by winds and currents. Thus the nuts may travel many hundreds of miles and across great oceans. After a long and checkered career, the fruit finally settles down, like a wayward bachelor, and establishes itself, conditions permitting. It will be interesting to note that although the coconut is so common in many parts of India it is not considered to be a true native of the country.

It will not be out of place to recall a passage from the late Rev. E. Blatter's book, THE PALMS OF BRITISH INDIA AND CEYLON. He writes : ' The original home of the coconut tree and the history of its spread are not yet sufficiently known. The Sanskrit name indicates its ancient cultivation in India; it was, however, not known to classic writers, and it seems certain that it was introduced by the Portuguese into western Africa and the Cape Verde Islands and that it did not exist in the West Indies, Guiana, nor Brazil at the time of the discovery of America. It has been supposed to be indigenous in the East Indian Archipelago and on the Nicobar and Cocos islands of the Bay of Bengal—and this would explain its early cultivation on the coasts of India and Ceylon. But all the other species of the genus *Cocos* are confined to South America, and those which have been said to be indigenous in Mexico seem to belong to the genus *Attalea*. Considerations of botanical geography would, therefore, point to the west coast of Central America as its home. Martius, indeed, considers it not improbable that the original home of this palm was on the islands near the Isthmus of Panama, and the nuts were transported thence by westerly currents to Cocos Island, 200 miles west of the Panama coast, which was found densely covered with coconut trees by its first discoverer, without any sign of human habitation. From there it is not difficult to explain the further spread of the nuts by the regular currents and storms to the Sandwich, Marquesas, and other islands of the Pacific, and to the Islands of the Indian Archipelago, whence it may have been introduced into India. A. DeCandolle seems to accept the American origin of the coconut, and Griesebach entertains no doubt on the subject. Cook has recently shown that the coconut is in all probability a native of America.' Perhaps, the recent 'drift' voyages across the Pacific and more observations on the oceanic currents will go a long way to support the South American origin of the coconut.

The Brazil-nut (*Bertholletia excelsa*) appears to be another example of water transport. In this species about twenty nuts are encased in a fibrous coat with a waterproof 'skin'. It is a native of South America and the West Indies. Some years ago I picked up a complete fruit on

the Juhu sands, a beach near Bombay. As the nuts are not imported encased in their outer covering, but as individual nuts, it is reasonable to ask: how did the entire fruit turn up on Juhu Beach? And pertinent to reply: possibly by sea from its native land, a distance of thousands of miles ! How long did it travel and by what route ? True, it is wide speculation when I say from 'its native land', but how else is one to explain its occurrence on Juhu sands ?

Yet another example of water-dispersal is that of the fruit of *Cerbera odollam*, an apocynaceous plant which is a member of the mangrove formations. It is not uncommon along the coastal strips of southern India and Ceylon. The fruit is the size of a large apple. Externally it is protected by a tough waterproof skin surrounding a dense, hard coat of fibres containing air spaces. Within these protecting layers the flat, solitary seed is encased (fig. 31). The fruits, when mature, are light and are carried away by the tides. After a checkered career, at the mercy of the waves and wind, the fruits come to rest on some shore and if the conditions are favourable will establish themselves. Some may not travel far from their native swamps, but others may drift to some distant shore. On my way through Cochin and Colombo, I found numerous examples of the fruit of *Cerbera* in various stages of development among the jetsam along the shores, and some were seen far out at sea. Species of *Cerbera* are distributed throughout the Indomalayan Region and Madagascar. Although the Apocynaceae are generally characterised by plumed, wind-borne seeds, *Cerbera* has departed from the 'general rule'. It has adapted its seeds to the requirements of a marsh plant.

In these instances the fruits are admirably protected from the action of seawater as well as of fresh water. In addition they are provided with floats. Thus equipped they are able to survive long journeys tossed about by waves and winds, but just how long this immunity to the elements lasts has not been fully observed.

Before passing on to other examples of water dispersal, it will not be out of place to refer in passing to some other members of the mangrove formations and examine their mode of dispersal. The Rhizophoraceae produce seeds which germinate while they are still on the tree. The seedlings look like long pencils hanging down, this is the 'radicle' or *rhizophore* (fig. 27). When mature these 'javelin-like' seedlings fall and, if the tide is out, stick upright in the exposed mud and soon establish themselves. But if they are not embedded deeply enough the next tide will wash them out and carry them away. On the other hand if the tide is in when the seedlings fall their chances of entering the mud are greatly reduced. In either case those seedlings which have not fixed themselves firmly in the mud are invariably washed out to sea and may be adrift for many weeks. Large quantities of these seedlings are washed up along the Indian coast, particularly during the early monsoon swells.

In another member of the mangrove formation, the Sea-Holly (*Acanthus ilicifolius*), the capsule often breaks away and cradles the seeds on the waves. In this species, the embryo itself is well developed and is provided with a spongy float (Pl. IV, fig. 24). This advanced state of the embryo enables the plant to establish itself rapidly on reaching suitable ground. The capsules also explode and eject the mature 'seeds'.

The water-lilies present us with yet further examples of seed dispersal by water. In the case of the common water-lily *Nymphaea*, the flowers are usually borne well above the surface of the water and are pollinated by visiting insects. As soon as the fruit begins to form it drops just below the surface of the water and remains there till it is ripe and ready to disperse its seeds. When ripe the external coating ruptures irregularly and curls backwards freeing the seeds in the water. Each seed is surrounded by an umbrella-like aril. On contact with the water the aril expands and forms an 'umbrella' over it. The aril, together with its seed, drifts away from the parent plant. The life of the aril is short for it soon sheds its seed, but it has lasted long enough to carry the seed away from its parent. The seed sinks to the bottom and there either rests for a season or germinates. In this way the seeds are carried off and distributed all over the lake or pond. Should the lake or pond dry during the hot weather, further dispersal is effected by marsh haunting animals which wallow in the mud and carry the seeds away sticking to their bodies, by the wind in the dust on the bed of the lake, or by flooding at the break of the next monsoon rains.

The Lotus (*Nelumbo speciosa*) presents us with perhaps a unique form of water dispersal. Its flowers are borne high above the water level on long stalks. Unlike *Nymphaea* the stalk remains erect and the chalice-like fruit is borne on its extremity. The interior of the chalice is filled with spongy tissue and the spongy tissue is beset with cells in which the seeds develop. The seeds are beautifully retained within their sockets by a slight constriction of the opening of the cells, so that, even if the cup were inverted the seeds would not fall out (fig. 30).

The receptacle, as this cup is called, dries on the plant and eventually drops off its long stalk. The cup always floats the right way up. Cradled in this admirable raft, the seeds are carried and drift about at the will of the wind and the waves. After a protracted period in water the receptacle decays and the seeds sink to the bottom; but more frequently, the seeds germinate within the seed sockets and when the receptacle decomposes, the seedlings sink to the bottom and there establish a new generation.

On such rafts the seeds or young plants may travel for many weeks and journey long distances, particularly if the parent plants are growing near the banks of a slow-moving stream or if the rafts are carried along by flood waters.

The monsoon rains are responsible for the dispersal of large quantities of seeds, bulbs, and sometimes even whole plants, which lie on the surface of the parched earth just before the rains set in. With the first heavy showers 'rivers' are formed on the surface before the earth has time to absorb the moisture and before the seeds have had time to germinate—everything is swept away before the wild rush of water and lines of debris are left in many places which, if examined carefully, will be found to contain large numbers of seeds of many species.

Rivers in flood not only transport millions of seeds but, on occasion are responsible for the transfer of entire trees ! With the vegetation, the attendant animal life also finds passage to new localities. Thus we see that the elements play a very important role in seed dispersal.

Mechanical Devices of the Plants to aid Dispersal (Plate IV)

Apart from the winged seeds and fruits adapted to wind dispersal already referred to, there are numerous other devices evolved by the plants themselves to ensure successful dispersal of seed, which are purely mechanical in form. The various contrivances are far too numerous to enumerate in a short paper and the reader will have to be content with a few random examples.

There are 'explosive' fruits, which on ripening burst suddenly and expel the seeds with considerable force to a distance away from the parent plant. The common succulent *Euphorbia* (often erroneously called cactus) is one good example of this type of explosive fruit. During the months of March and April, when the fruits are ripening, one's attention is attracted to the plant by an incessant and, at first, unaccountable clicking sound going on in and around the bushes. To those unfamiliar with the habits of the plant, the clicks are puzzling. On closer observation the observer may from time to time be struck by some small object. The sound is made by the explosion of the small fruits and the missiles are no other than the seeds being forcibly ejected as the capsules 'explode'. The force of the explosion in this case is often strong enough to hurl the seeds a yard or more away from the parent plant. This form of seed dispersal is common to most of the family Euphorbiaceae.

The capsules of many of the Acanthaceae, when ripe, burst and eject the seeds in a similar manner. The two-valved seed case springs open with an audible report and hurls the seeds out to a considerable distance.

Perhaps, the most common example of the explosive type of dispersal is to be met with among the Balsams (*Impatiens* spp.). Every boy delights in touching or pressing the ripening fruit to see the carpels

recoil upon themselves and in doing so hurl the seeds out with appreciable force (fig. 16). Only the fruits ready to discharge their seeds will respond to such treatment and exhibit this phenomenon. Normally, the fruit explodes automatically on ripening. An explanation of the mechanism of the balsam fruit will not be out of place. When the fruit is ripe and ready to explode the drying up of the liquid contents of the cells produces the necessary tension. The fruit is composed of five separate carpels the walls of which are composed of three layers of cells. The layer immediately below the outermost layer (epidermis) consists of large cells charged with sap. It is called the turgescent layer. It is in a great state of tension, and when the seeds are mature the sutures between the carpels give way ; a relaxation of the tension takes place, the loosened tissue along these lines is torn, the carpels roll back suddenly upon themselves with great rapidity resulting in the catapulting of the seeds.

Incidentally, in most of the balsams the seeds are comparatively large and often shining, but in the case of *Impatiens acaulis*, a beautiful species with large flowers growing on rock faces under waterfalls in many parts of the Western Ghats, the seeds are minute and are provided with minute hooks to enable them to adhere to the substratum the species normally inhabits. The structure of the seeds coupled with the semi-aquatic habit of the species probably accounts for its fairly restricted distribution. The minute seeds could be blown up the cliffs during the dry weather or perhaps be carried adhering to the bodies of insects.

From the explosive type of fruit we pass on to another form of catapult, which, however, needs a combination of factors to make it effective. In some species it is necessary for the plant to die and remain erect. In such instances the fruits are produced at the top of the plant and remain open with the seeds loose within. The dry stems are flexible and do not break easily. The upright stems are either bent down by sharp gusts of wind or by passing animals and on release of the pressure spring back with considerable force to the erect position once more. In so doing the seeds are catapulted out of the capsules. The Mexican Poppy (*Argemone mexicana*), a common weed of waste land and dry water courses, is a good example of this form of dispersal (fig. 22).

The Common Poppy (*Papaver somniferum*) is another example of this form of dispersal, but in this case the seeds are minute and are encased in the 'pepper-caster' capsule supported on a long stalk (fig. 21). The dry stalks wave about in the wind and as they bend cast the seeds through minute holes around the rim of the capsule.

Many of the Labiatae (*Tulsi* family) exhibit a similar type of dispersal. Many of these plants produce rigid stems. In the axils of the usually whorled leaves are to be seen the open calyx with the seeds within, like minute eggs in a cup. The rigid stems are bent down by the wind or by

passing animals and as soon as they are released spring back to the erect position, at the same time catapulting the seeds which are ready for dispersal.

Yet another form of mechanical dispersal is achieved by the fruits of some plants which are able to 'creep' or 'hop' along the ground. Such fruits have stiff bristles projecting from one side of their external coats. These bristles are sensitive to atmospheric moisture and accordingly change their direction in response to the environment and by their movement propel the fruit or seed in a definite direction.

The awns which project from the glumes of many grasses and other plants are good examples (figs. 25, 26). In all these instances the hygroscopic structures are furnished with small teeth. Sometimes the teeth are on one or both sides, or they may be restricted to the tip. The position of the teeth renders retrogression impossible and accordingly determines the direction in which the fruit must move. In barley and several other species of grasses the awns from the enveloping glumes are bent elbow-wise. The part below the elbow is spirally twisted and, as the tissue is extraordinarily hygroscopic, the spiral relaxes or contracts in proportion to the amount of moisture in the atmosphere. The spiral motion causes the part above the bend to move like the hands of a watch, but now to one side or the other. In some such instances there appears little doubt that the most important function of the movements is to fix the seed in the soil, but on the other hand it cannot be denied that a limited amount of dispersal is effected by this means. The awns of the Speargrass (*Heteropogon contortus*) is a good example of cork-screw-like awns which perform the function of a 'drill' to embed the seed in the soil. We shall have occasion to refer to this species again under the heading of animal dispersal.

Many of the mechanical devices of plants are coupled with animal dispersal and will be dealt with under that heading.

Seed Dispersal by Animal Agents

(Plate IV)

In the animal world we find a whole host of dispersal agents. The service the animal agents render may be direct or indirect. By 'direct' service I mean such agents as feed on the fruit and derive some 'reward' for their service—they feed on the pulp and discard the seeds often many miles from the place where the fruit was eaten. 'Indirect' service is done by animals which more often than not accidentally transport fruit or seeds attached to their bodies as they pass through the vegetation in the course of feeding or travel. The animals of the second category derive no benefit at all; on the contrary they may suffer from wounds, or irritation caused by the spines or hairs adherent to their coats. In a few instances even death is the 'reward' for the service they render!

When animals feed on succulent fruits, the seeds are often swallowed along with the pulp. The pulp is digested, but the seeds are often resistant to the gastric juices and eventually pass out in the faeces. By the time the seeds are excreted the animal may be many miles from the parent plant. This form of transport is effected by a large number of frugivorous birds. In some instances it is perhaps essential that the seeds pass through some animal to ensure early germination.

A well-known group of parasitic plants, the Loranthaceae, is well exemplified by the common *Loranthus* and the Mistletoe (*Viscum*). These plants often parasitize many of our useful fruit and timber trees. Sometimes the infestations are so severe that the hosts are crippled or even killed in a few years.

When ripe, the fruits of *Loranthus* turn to a brilliant red or orange whereas those of the mistletoe turn whitish. In both instances the seeds are large and are surrounded by a very viscid pulp. The berries of both are eaten by many birds, particularly the little flowerpeckers (Dicaeidae). Some birds only eat the skin and pulp and the seeds are wiped off the bill on to a neighbouring branch ; others swallow the fruit whole. Each seed bears a thread-like appendage at each pole which survives the gastric juices. These threads help to secure the seeds on to the branch when voided with the faeces. In this way the seeds are often carried great distances and to fresh hosts. On germination the seed of *Loranthus* produces a radicle with a disc which attaches it to the new host.

The growth of a Banyan (*Ficus bengalensis*) or Peepal (*Ficus religiosa*) on a house-top, a wall, or perhaps on the stem of a palm or other tree is not an uncommon sight in many parts of the country. The question is : how did it establish itself in such an exalted position ?

Figs produce fruits (receptacles) which contain hundreds of seeds (as people with dentures often discover to their discomfort and perhaps embarrassment !). Figs when ripe are eaten by a large number of animals (including birds). The pulp and the seeds are ingested together, but the seeds survive the gastric juices ; in time they are voided intact. The droppings of a bird may fall on a wall or other spot, such as the leaf-stalk of a palm or in the fork of a tree. When the droppings are dry some of the seeds may be blown away by the wind or washed out by rain and, perhaps a seed or two may germinate where they fell. The seedling, in time, sends roots downwards in an effort to reach the ground. If germination has taken place on a roof-top or on a wall there is danger of the roots destroying the masonry. When the plant starts life on a palm or other tree the roots of the sapling invariably encircle the trunk of the 'host' and after a few years eventually strangle it. The 'host' plant dies and disintegrates leaving a tangled mass, often merely a lace work, of stout roots supporting the now vigorous Banyan (Plate II). Figs frequently start life as epiphytes, merely using the trees they grow

on as supports. They are not parasites. Perhaps, in India the word fig should be substituted for ivy in the common expression 'clinging like the ivy to the wall' !

On coffee plantations large quantities of the ripe 'cherries' are eaten by civets, jackals, and other animals, and birds. The sweet pulp is digested and the seeds voided. The droppings of these animals are found all over the plantations, almost entirely composed of coffee seeds. Special collectors are deputed to gather this rich harvest and Jerdon even tells us that the seeds collected in this way make the best coffee ! It is perhaps unnecessary to reassure readers that the seeds are thoroughly washed after they have passed through the animals ; they have only saved the labour of 'pulping' the fruit. In the forests surrounding the plantations 'wild' coffee plants frequently spring up. These have been derived from the excrement of animals that had been feeding in the coffee plantations.

The jackal, although mainly a carrion feeder, will also feed on fruit when available. Figs, jambools (*Eugenia jambolana*), the bitter *Olea dioica* and many other fruits are greedily eaten when in season. Some of the fruits act as a purge upon the beasts. For some unknown reason the neatly placed, white-washed mile and furlong stones along the roads seem to have a special attraction for these animals and, much to the annoyance of the P.W.D., they commonly discolour the stones with their faeces !

Many of the Mimosaceae and the Caesalpiniaceae have indehiscent fruits. When mature, the fruits fall to the ground and are eaten by many ungulate mammals for the sweetish pulp they contain. The seeds usually pass through the animal uninjured and are dropped many miles from the parent plant. Some of the Cassias and Acacias, e.g. Babool (*Acacia arabica*), are good examples. The ungulates that feed on grasses also transport the seeds of many grasses. Although the grains are usually digested, a certain number escape digestion and appear in the dung. Sick animals often void a lot of undigested seeds which are capable of germination.

Many foraging animals, such as field rats, squirrels, and ants, and birds like jays and nuthatches frequently collect large quantities of seeds and store them for lean days, and thus are responsible for seed dispersal. Some seeds are lost in the course of transport while others are abandoned in the burrows and tree-holes, the owners being killed by floods or by enemies. Under suitable conditions these stored seeds will germinate. Incidentally, some of the jungle tribes who feed on field mice and rats during times of scarcity are well aware of the habits of such animals and they will excavate the burrows and take possession of the store of grain.

In some instances there is a close link between an animal and its normal food plant, so much so that the distribution of the one is dependent on the presence of the other. An example is the distribution of the Pilu

(*Salvadora persica*) and the White-eared Bulbul (*Pycnonotus l. leucotis*). Where *Salvadora* flourishes the bulbul is usually present ; thus in the neighbourhood of Bombay the bird is found only in the salt marshes containing this plant. Likewise the distribution of the Dromedary and *Salvadora* also appears to be closely linked.

For successful dispersal it is not always necessary that the fruit should be eaten by some animal. An animal may carry seeds or fruits externally by attachment to its coat. Many who have made excursions into the country have undoubtedly experienced the troublesome burrs, awns, and other fruit and seeds adhering to clothing, particularly woollen clothing. These are the seeds of plants they have been inadvertently transporting and helping to disperse.

Many herbaceous plants, in particular, have evolved special hooks, hairs, and viscid glands to effect the dispersal of their seed. When discussing mechanical dispersal, mention was made of the awns of grasses. Besides falling under that heading, some fall into this category as well. We have also observed that some seeds have awns armed with minute teeth which attach themselves to the fur or feathers of passing animals and are thus transported from one locality to another. The common Speargrass (*Heteropogon contortus*) and its ilk are good examples (figs. 25, 26).

Among the Tiliaceae we find some burr-bearing plants, such as *Triumfetta*, a common weed in fallow or waste land. In such cases the fruit is covered with minute hooks, which attach themselves to passing animals and are carried away long distances. Among the Compositae, the fruit of *Xanthium strumarium* is distributed in the same way as *Triumfetta*. Incidentally, *Xanthium*, to the best of my knowledge, found its way into Bombay and Salsette some twenty to twentyfive years ago as a common weed. It first appeared along the railway track of the Bombay Baroda and Central India Railway (now Western Railway) entering the area. It was particularly common at first at the points where buffaloes were stabled. It seems reasonable to conclude that its arrival in the areas mentioned may be linked with fodder and buffalo traffic.

Larger hooks and other devices for attachment to animals also exist. *Martinia*, an exotic herb, now well established in many parts of India, is a good example of large hooks. Incidentally, when hat-pins were in vogue the seeds of *Martinia* were largely used to ornament the heads of the pins. It is possible that its first introduction into India may have come through the trade (?). When green, the fruits appear quite harmless as the two sharp hooks are hidden in the flesh of the fruit. During the monsoon rains *Martinia* flourishes commonly in some parts of Bombay and Salsette islands. When the rains are over, the stems of the plants dry and remain rigidly erect, just as we have observed in the case of the Mexican Poppy. The stems become very hard and the large seeds,

devoid of their covering, remain attached by short brittle stalks. The seeds are now ready for dispersal. The vicious hooks attach themselves to passing animals and are thus carried away from the parent plant (fig. 18).

Yet another means of plants affixing their fruits to passing animals is exemplified by the common garden Plumbago and several other herbaceous plants. The fruits are covered with glandular hairs which adhere readily to almost any passing object (fig. 19).

The cucumber family, Cucurbitaceae, presents us with some curious means of seed dispersal. Apart from the excellent edible qualities of some of the family, melons and cucumbers were 'evolved' to be *stamped on* ! When fully ripe the fruits become soft and watery; in this condition they are ready for action. Should a passing animal tread on one, the result is obvious—the fruit bursts and its contents are shot out in all directions. A similar result is achieved also when a ripe fruit falls to the ground from a pendant position.

The fruits of some others of this family harden with age, particularly some of the pumpkin group. The pulp dries and the seeds remain loose within the external shell. Incidentally, the 'shell' forms an excellent float. In the dry state such fruits are easily water-borne. In India these gourds are often used for carrying water and for the storage of food, and by the snake charmer or *madari* for his *bunsli* (musical pipe).

One of the most interesting examples of the cucumber family is the squirting cucumber (*Ecballium elaterium*). Its fruits resemble small fleshy cucumbers beset with bristles and are borne on hooked stalks (fig. 17). The ends of the stalks project into the interior of the fruits like a stopper. When the seeds are ripe, the tissue surrounding them is transformed into a mucilaginous mass. The tissue around the conical stopper breaks down at the same time and thus the connection between the fruit and the stalk is loosened. In the wall of the fruits there is a layer of cells which is under great tension and endeavours to stretch itself out. The fruits sever their connection with the stalks and simultaneously the expansion of the strained tissue takes place resulting in a sudden expulsion of the contents with considerable force through the opening left by the stalk. This form of seed dispersal really belongs to the section dealing with mechanical devices, but it is introduced here to show how different members of the same family may employ different modes of dispersal.

Amphibious and aquatic animals and birds, particularly migratory species, also play an important role in seed dispersal. Tiny seeds of marsh plants may be carried in blobs of mud sticking to their feet and bills. In the case of wallowing animals, the seeds are carried away in the mud sticking to their bodies.

Strange as it may seem, even carnivorous animals and birds of prey play an indirect but significant role in seed dispersal. The contents of

the stomach or crop of a seed- or fruit-eating victim are discarded, but the seeds are capable of germination under favourable conditions. I have frequently observed birds of prey tearing to pieces the crops of their quarry and scattering the contents.

Diseased animals with impaired digestion often transport a lot of seeds originally consumed as food, but voided intact.

Man as Seed and Plant Dispersal Agent

Among the animal agents, Man is perhaps the foremost in the distribution of plants and animals. Apart from the useful plants and animals, he often carries with him in his travels deliberately or accidentally a number of useless and often harmful animals and plants to 'remind' him of the homeland he left ! In a new country, after a while, the traveller often wishes he had left the 'reminders' behind—the new arrivals get beyond his control and do incalculable damage in the new environment.

As food and for other commercial purposes Man frequently transports by land and sea large quantities of seeds. The consignments are often contaminated (accidentally or sometimes deliberately) by the presence of the seeds of weeds and other useless plants which, very often, in a new habitat become pests to the detriment of the indigenous fauna and flora.

As a gardener, Man transports not only seeds, but whole plants. Many of these frequently become escapes and overrun the new country. A very good example is that of *Lantana*. The plant was first introduced into Ceylon in 1824 as a 'beautiful garden plant'. *Lantana* was well suited to the Ceylonese environment and the necessary avian dispersal agents were present. The Bulbul (*Pycnonotus*) and other frugivorous birds found its fruit excellent food and inadvertently spread the *Lantana* far and wide. *Lantana* spread like wild-fire and has become a serious pest and a menace to valuable forest, so much so that many thousands of rupees are now spent annually for its removal and control. When introducing a plant into a new country most of its natural controls are not imported with it and so, if the country is suitable, the plant spreads unhampered. Some may well ask : why not import the controls as well? In the first place we have to know all the controls and, even if this were possible, there is always the danger that some of the controls may attack something more valuable of the indigenous fauna or flora. *Lantana*, for example, belongs to the same family as the Teak or *Sāg* (*Tectona grandis*), one of India's and Burma's most valuable timber trees. As these two plants are nearly related, there is always the possibility that one of the controls of *Lantana* may attack Teak, which, as we all know, already has numerous pests to ravage its plantations. The use of biological controls is already well known and practised in almost every

country, but it has to be carried out with the utmost care and forethought.

Another classical example of the efforts of Man is the spread of the Cactus (*Opuntia*) in India and Australia. In both countries this cactus soon became a positive pest ruining thousands of acres of arable land, and sheltering noxious vermin. However, this plant was brought under control by the use of a biological control—in this case one of the *Coccidae*, a scale insect.

Yet another outstanding example of unwise human interference with the balance of Nature is the Water Hyacinth (*Eichhornia*). This aquatic plant is a native of South America and the West Indies. It was introduced into many countries as an ornamental waterplant. Its beautiful leaves, with curious floats, and colourful spikes of mauvish flowers make it most attractive. In almost every country into which it was introduced it has become a serious pest clogging up the surfaces of lakes and waterways, covering the entire surface and, in time, forming a dense mat to the exclusion of all other plant life and also animal life ! Around Bombay and Salsette I have seen many streams, lakes, and pools completely choked by water hyacinth to the exclusion of all else. The plant will not only thrive when afloat, but will flourish equally well so long as there is sufficient moisture in the soil. It is spread by suckers as well as seed.

To-day efforts to control this prolific weed are costing the affected countries enormous sums of money without much success. In some areas, slow moving rivers are being so effectively choked that the plants are interfering with navigation. Large blocks of the plants are being cut out and towed out to sea, but even this method of dealing with it is not very effective. Various methods have been tried to put the plants to agricultural use by burning and composting, but these often prove costly and of little avail to control this very prolific species.

The obvious lesson to be learned from these instances, is that Man should exercise the greatest care and forethought when about to introduce a plant or animal from one country to another. His interference with the balance of Nature will invariably boomerang; we may succeed in beating Nature for a time but she will invariably stage a come back—we cannot beat her !

Observations on the Mating and Oviposition of two land Pulmonates, *Achatina fulica* Bowdich and *Macrochlamys indica* Godwin-Austen

BY

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INTRODUCTION

Considerable diversity is encountered in the number of eggs produced by gastropods. On one side of the range stands *Doris* producing 600,000 eggs in one brood (Kroschelt & Heider, 1900), and on the other *Macrochlamys indica* and *Nassa* producing only 2 and 5 eggs respectively (Kroschelt & Heider, 1900). A relationship exists between the number of eggs laid and their size. The amount of albumen present in the egg has a direct bearing on the developmental period of an animal. A large amount of yolk is essential for the development of those where free larval stages are absent, and consequently the large size of the eggs has led to a proportionate reduction in the number of eggs produced by an individual. In addition there appears to be a correlation between the total volume of the eggs produced in one year and the size of the animal.

OBSERVATIONS

After a long period of aestivation (November to June) the snails become active with the coming of the rains. In the first few weeks they are less active and remain busy in search of food. Egg-laying usually commences when the monsoon is fairly advanced, i.e. towards the end of July to the beginning of September. Mating, though not essential for reproduction, has been described by the previous workers (Meer Mohr, 1949; Mead, 1950; Balasubramaniam, 1952; and Rensch, 1955) to be a common feature. During mating two individuals come side by side in such a manner that their genital apertures are apposed. The intromittent organ of one comes out through the genital aperture and is pushed into the vagina of the other and vice-versa. Mating is said to last for a variable period,[1] after which the intromittent

[1] About 1½ to 2 hours in *A. fulica* (Meer Mohr, 1949) and 45 minutes in *M. pedina* (Rensch, 1955).

organ is withdrawn and the animals separate. Sperms received by the partners in the act are stored in the spermathecae for subsequent fertilization of the ova.

The present author could not observe mating in these snails in spite of continued observation both during the day and in the night in caged specimens as well as in specimens in their natural habitats. In a heavily populated area, they are often found to embrace each other, and this may be mistaken as a case of mating. In certain cases, an intromittent organ was seen to protrude through the genital aperture, but no tendencies of mating were observed. The protruded organ is conical with a swollen base and bears a narrow genital pore at the tip.

During the breeding season the reproductive organs of nearly fifty snails of each species were dissected. The specimens taken were of different stages in relation to oviposition. Some of them were taken before, some during, and others after oviposition. Sperms were found both in the spermathecae and the uteri of several *M. indica* and only one *A. fulica.* The snails are protandrous, sperms develop prior to ova, and the ovotestis duct with the ovisperm vesicle remain packed with living sperms throughout the year, a state which continues during the whole life. While coming down from the ovotestis the ova are likely to be fertilized in the basal ovotestis duct since they have to pass through the swarms of sperms, and it is very difficult to conceive how the mature ova may come down unfertilized.

Embryos in different stages, from the zygote to many cell stage in *A. fulica* but only in the zygote stage in *M. indica,* are found in the eggs taken out from the apex of the apical uterus. The sperms cannot penetrate the egg membrane and, if cross-fertilization is to be effected in such cases, the sperms from some other snail must at least reach the apex of the apical uterus. In no case were degenerating sperms found in the albumen mass of the egg. The absence of sperms in the uterus is a normal feature, and it appears that self-fertilization is a common mode of reproduction in *A. fulica,* while both cross- and self-fertilization are normal in *M. indica.*

To ascertain if self-fertilization is a common mode of reproduction in them several snails were separated from the early stages (15 mm.) and reared with special precaution. Normal young snails hatched out from the eggs laid by these isolated individuals on attaining sexual maturity. Separation at early stages rules out even the remotest possibility of fertilization by the sperms received in the previous year; though the survival of sperms for a whole year in the genitalia of another individual is not expected.

The eggs are laid in batches in small holes made in damp soil by

the snail with the help of the snout and the anterior end of the foot. Oviposition usually takes place towards the evening or in the night though laying during daytime is not rare. The eggs are dropped one after another in the hole along with a profuse quantity of a slimy substance discharged through the genital aperture. Laying continues for about two hours in *A. fulica*, the period depending on the number of eggs which varies extremely. The known record in a single brood is minimum 82, maximum 315 in Sumatra (Meer Mohr, 1949) and 120 in Kenya (Rees, 1950). The present author found the number varying from 27 to 356, the average being 200. The colour of the eggshell varies from light to deep yellow, but white ones are not very rare. It is calcareous, porous, tough, and thick, needing considerable pressure to break. A non-separable shell membrane is present in most cases just inside the shell. The laying of eggs without any eggshell is not rare, and these eggs contain normal developing embryos. The number of eggs in one brood of *M. indica* varies from 2 to 35, the average being 14. The outer egg cover is smooth, tough, elastic, and translucent white in colour.

The shape and size of the eggs in *A. fulica* are also variable. Usually they are broadly ellipsoid, but a few round ones are also sometimes found. Meer Mohr (1949) found the average size 5.4×4.28 mm. and Rees (1950) 7.1×5.6 mm. In the eggs collected by the author the average maximum size is 5.5×4 mm.; and the average minimum is 3.5×3 mm. Several small eggs are found in almost every brood, and the snails to hatch out last are always from these small eggs. In *M. indica* the eggs are always round and the size varies from 1.7 to 3 mm., the former being only a few and only in some of the broods.

The eggs are covered with a thin film of mucus, which absorbs water from the surrounding damp soil and protects the eggshell from drying up. The embryos in eggs freed of mucus or removed from their damp surroundings do not hatch out. On dissection it was found that in such eggs the albumen dries up quickly and the embryos cannot develop further. The eggshells of *A. fulica* exposed to sunlight or dry air crack with a sharp click, audible from a distance of several feet. If removed from their damp surroundings the eggs of *M. indica* shrivel up due to loss of water, but they regain their normal shape and size once more if placed in contact with moist substance.

The colour and viscosity of the albumen vary considerably. The former ranges from colourless to deep yellow, and the latter from very fluid to thick state in *A. fulica*. The albumen is always very fluid and colourless in *M. indica*.

The stages of the embryos at which the eggs are laid are extremely variable in the different species. Embryos earlier to the formation of the heart (3 mm.) were rare in *A. fulica* and they were in the segmentation stage in *M. indica.* In a high percentage of cases, the embryos are found in fairly advanced stages at the time of laying and hatch out from the eggs within a day or two in *A. fulica.* Laying of eggs with very early stages of embryos is rare, and in such cases the embryos usually fail to develop. Attempts were made to obtain young snails from the eggs with very early embryos taken out by dissection of the uterus, but these were almost always infructuous. It appears that the *A. fulica* has progressed considerably towards the attainment of ovo-viviparity while *M. indica* lags far behind. The percentage of hatching in the eggs laid with late embryos is very high.

In general, it can be said that in *A. fulica,* the smaller or whiter the eggs the earlier will be the stages of embryos in them. Again, the larger and more yellowish the eggs the more advanced will be the developing embryos. No such generalisation is possible in *M. indica.*

The snails begin to lay eggs at the end of their first year. The minimum size[1], at which *A. fulica* and *M. indica* have been noted to lay eggs is 59×27 mm. and 12×8 mm. respectively (*A. fulica* bred and reared in the laboratory reached 67×34 mm. in eight months). Under no circumstances a single individual *A. fulica* laid eggs more than once in a year[2] though several broods per year are common from one *M. indica.* The number of eggs laid by an *A. fulica* in the first year of its sexual maturity is the minimum; the number gradually increases with age and is again on the decline from the fourth or fifth year, but never comes down so low as in the beginning.

Various attempts[3] to induce *Achatina* to lay eggs throughout the year met with partial success only. The earliest date of egg-laying in a caged specimen was 24th March and the latest was 29th September. *M. indica* could be induced to lay eggs throughout the year by keeping them active artificially and supplying their favourite food lavishly.

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[1] 60 mm. (Meer Mohr, 1949).

[2] Meer Mohr (1949) states that several batches of eggs are laid by an individual in one breeding season.

[3] (*a*) The humidity of the rearing chambers was controlled, and the snails were kept active throughout the year.
(*b*) Snails were awakened from aestivation by spraying of water, and the same repeated at regular intervals to keep them active.
(*c*) Fresh specimens, collected after showers, were kept active by the above processes, and some of them were released in chambers with active residents.
(*d*) A liberal supply of favourite food was maintained.

The snail waits for a few hours by the side of the eggs after the completion of laying. This may be due to partial exhaustion of the animal in the process of oviposition. After recovery, it slowly moves away from the eggs, never to turn back again. In a few cases, the snail has been noted to cover its eggs with foreign matter, like leaves or the soil pushed from the sides of the hole. Incubation by the parent is totally absent.

Table showing particulars of eggs laid in different years

Species	Year	No. of broods	Total no. of eggs	Average no. per brood	Total no. of small eggs	Percentage of small eggs	No. of broods with early embryos	No. of broods with somewhat advanced embryos	No. of broods with fully advanced embryos
A. fulica :									
	1951	4	1024	256	24	2.3	1	1	2
	1952	16	3092	193.25	75	2.4	3	3	10
	1953	15	2196	146.4	61	2.8	3	5	7
Total ..		35	6312	180.34	160	2.53	7	9	19
M. indica :									
	1951	15	251	16.7	40	15.9	4	9	2
	1952	30	385	12.8	74	19.5	6	20	4
	1953	25	341	13.6	42	12.3	6	16	3
Total ...		70	977	14.0	156	16.0	16	45	9

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Critical Notes on the Orchidaceae of Bombay State

I. THE GENUS *HABENARIA* WILLD.

BY

H. SANTAPAU, S.J., F.N.I. AND Z. KAPADIA, PH.D.

(*With six plates*)

INTRODUCTION

The Orchidaceae of Bombay were revised by Blatter and McCann in the *Journal* in the years 1931-1932 ; in our intensive work on the family we have found a number of details in which some further revision work is necessary. Except for a few isolated cases, we have not been able to study the types of the new species described by Blatter and McCann; in some cases their types were not actual specimens but careful drawings with notes taken from fresh plants at the time of collection; we have based our study on the illustrations and descriptions given by Blatter and McCann for the revision of their new species.

A number of our specimens have been checked with the types in Kew Herbarium or, where the types were not available, then with specimens critically examined by a number of authors, among them O. Kuntze, J. S. Gamble, etc. For our study we have had at our disposal photographs of many of the Kew types taken by the senior author, also photographs of most of the Bombay orchids represented in the Kew Herbarium. We have relied much on the synonymy given by Hooker f. in FLORA OF BRITISH INDIA, for it is clear from Huxley's LIFE AND LETTERS OF SIR J. D. HOOKER that Hooker spent more time and energy in the study of the Orchidaceae of India than in any other family with the possible exception of the Gramineae. Hooker's synonymy is not disputed; his choice of names is sometimes rejected in these pages.

Both of us, but particularly the younger author, have spent many days in the field all over Bombay State in an attempt to collect, as far as possible, all the orchids of Bombay in perfect condition. With but few exceptions we have succeeded in this ; the exceptions are mostly species that do not seem to have been collected by subsequent botanists after the original collection and publication of the species. Our collections, then, become important especially in cases where no type sheet was designated when the new taxon was described by Bombay botanists.

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In this our first paper of a series on the Orchidaceae, we shall deal with the genus *Habenaria*; there are quite a few changes in the nomenclature and identity of the species of *Habenaria*; in spite of the revision of Blatter and McCann; in particular we find that several of the new species described by these authors have had to be reduced to synonymy. In our revision we shall briefly give the names and some of the more important references for those species, where no change is necessary; where some change in the nomenclature or in the synonymy of the plants is required, we shall give full details to show the grounds for the change. Further we give our own key, which has been based, as far as possible, on obvious and simple characters; we have found by experience that it is difficult for students to identify plants when the basis of the identification are characters that need careful dissection of the same. Our revision covers the genus *Habenaria* in Bombay State as the latter stood prior to the re-organization of States, that is to say, those parts of N. Kanara, which formerly belonged to Bombay, are included in our review.

KEY TO THE SPECIES OF *HABENARIA* OF BOMBAY

Identification of the genus is about the easiest among the ground orchids of Bombay; identification of the species is somewhat difficult. There is little variation in the general habit of these species, except that some species have leaves flat on the ground, most species have leaves, which are either radical or cauline, but are not flat on the ground. Some of the species appear mostly on old walls; others favour an open situation in grass fields, whilst others occur in the undergrowth of dense forest; one plant of the genus is found to be epiphytic.

1. Petals 2-partite :
   2. Sepals with filiform tips; lateral lobes of lip less than half as long as midlobe .. *stenopetala*
   2. Sepals without filiform tips; lobes of lip subequal, or the lateral ones much longer:
      3. Flrs. pure green, occasionally faintly whitish or yellowish, strongly foul-scented after sunset; lower segment of petals filiform, less than (or rarely up to) half as long as the upper ones; spur scarcely clavate .. .. *digitata*

3. Flrs. pure white, greenish- or rarely dirty brownish-white, odourless or foul-scented in day time; segments of petals subequal or the lower slightly shorter, not filiform; spur distinctly clavate at apex .. .. .. *gibsonii*

3. Flrs. white or green, faintly or not at all scented; lower segment of petals 2-3 times longer than upper one; spur clavate or globular at apex :

4. Ls. several, clustered about middle of stem; flrs. brownish-green, scentless; segments of petals and of lip filiform, variously contorted .. *multicaudata*

4. Ls. few, radical; flrs. white, faintly scented; upper segment of petals somewhat triangular ovate; lower segment much longer, filiform; lateral lobes of lip filiform, as long as or longer than the broader linear midlobe :

5. Ls. 2-5, oblong or oblong-lanceolate, thin, not flat on ground; anthers rounded on top .. *rariflora*

5. Ls. 1-2, ovate to almost orbicular, flat on ground, fleshy, coriaceous; anthers distinctly tricuspidate at top .. .. *grandifloriformis*

1. Petals entire :

6. Ls. 2, rarely more, flat on ground, opposite or subopposite, coriaceous, broadly ovate to suborbicular :

7. Lip shorter than lateral sepals, 3-lobed; lateral lobes oblong, rounded, half as long as whole lip; spur twice as long as ovary or more .. .. *platyphylla*

7. Lip longer than lateral sepals, 3-partite; lobes subequal or lateral ones longer; spur about equalling the ovary :

8. Flrs. greenish-white; petals narrow, linear oblong; segments of lip filiform, the lateral ones much longer than the midlobe .. .. *diphylla*

8. Flrs. white; petals ovate or ovate-oblong; segments of lip subequal, linear-oblong .. .. *crassifolia*

6. Ls. radical or cauline, not flat on ground :

9. Ovary long-beaked; petals broad, oblong; lip 3-partite, segments filiform, lateral ones longer ; tube of anther cells long .. .. .. *commelinifolia*

9. Ovary scarcely beaked; segment of lip not filiform ; tube of anther cells short :

10. Petals narrow-linear; lateral lobes of lip with long filiform tails, midlobe 2-lobulate with minute mucro between the filiform-tailed lobules... *crinifera*

10. Petals linear-oblong, spathulate or broadly ovate or ovate-oblong; lobes of lip not tailed :

11. Flrs. white; lateral lobes of lip broader than midlobe, obliquely truncate-denticulate at apex :

12. Spur shorter than or equalling ovary :

13. Lip not at all or scarcely longer than lateral sepals; spur about as long as ovary .. *suaveolens*

13. Lip 1½-2 times as long as lateral sepals; spur much shorter than ovary .. .. *panchganiensis*

12. Spur 1½-3 times longer than ovary :

14. Ls. radical, ± spreading on ground; ovary sessile or subsessile ; lip 7-12 mm. long ; stigmatic processes somewhat oblong, white .. .. *plantaginea*

14. Ls. ± grouped at base of stem ; ovary on long pedicel ; lip 14-29 mm.

long; stigmatic processes clavate, green.. *longicorniculata*

11. Flrs. white, yellow or green; lateral lobes of lip not broader than midlobe, linear oblong to linear filiform :

15. Stem leafy upwards; flrs. white, then yellow, drying black, secund or subsecund.. *heyneana*

15. Ls. radical, clustered at base of stem (except in *H. marginata* var. *fusifera*); flrs. yellow, not secund :

16. Ls. broad, oblong with narrow yellowish margins; floral bracts equal to or longer than ovary .. .. *marginata*

16. Ls. narrow, lanceolate or linear-oblong, without yellow margins; floral bracts up to half as long as ovary .. *viridiflora*

15. Ls. clustered about middle of stem; flrs. green, not secund :

17. Floral bracts longer or shorter than ovary; midlobe of lip ovate-oblong, obtuse, inflexed, meeting dorsal sepal and petals at apex, thus enclosing column, shorter or about as long as the linear or linear-oblong spreading lateral lobes; spur longer than ovary, straight .. *ovalifolia*

17. Floral bracts longer than ovary; midlobe of lip straight, broader and shorter than the filiform spreading lateral

lobes ; spur longer than ovary, incurved ..	*furcifera*
17. Floral bracts much shorter than ovary; lobes of lip similar, straight, narrow linear or linear oblong, spreading; spur shorter than ovary, incurved	*hollandiana*

ENUMERATION OF THE SPECIES OF *HABENARIA* OF BOMBAY STATE

1. **Habenaria stenopetala** Lindl. Gen. Sp. Orch. 319, 1835; Hook. f. Fl. Brit. India 6 : 134, 1890; Cooke, Fl. Pres. Bombay 2 : 715, 1907 (excl. syn. *H. modesta* Dalz.); Blatt. & McC. in Journ. Bombay Nat. Hist. Soc. 36 : 14, t.1, 1932.

This is one of the few Bombay orchids that we have been unable to collect in the field; it seems to be a rather rare plant. Lately Vartak has collected it from Helwak in the Deccan.

Cooke gives *H. modesta* Dalz. as a synonym of this plant, but with some reservations; Blatt. & McC. consider *H. modesta* Dalz. identical with *Peristylus stenostachyus* Kranzl. Judging from Dalzell's general description, and particularly from the structure of the lip, the plant seems to be identical with *Habenaria ovalifolia* Wight.

2. **Habenaria digitata** Lindl. Gen. Sp. Orch. 307, 1835; Hook. f. 134, pro parte; Cooke 715, pro parte; Blatt. & McC. 14; Santapau in Rec. Bot. Surv. India 16(1) : 306, 1953. *H. trinervia* Wight, Icon. t. 1701, 1851. (See Plate III, fig. 7-8)

This plant has been confused with some of its allies; after examination of numerous fresh specimens, we consider the following to be the distinctive features of this species : i. Flowers pure green, fading to whitish- or yellowish-green, emitting a pungent foul scent after sunset. ii. Lateral sepals erect or spreading, not reflexed, more or less similar to the dorsal one. iii. Segments of petals unequal, the upper one about as long as the lower segment and lying along the dorsal sepal; the lower segment up to half as long as the upper one, filiform. iv. Lobes of lip linear, more or less thick, the lateral ones reflexed at right angles to the midlobe, which is straight or rarely inflexed. v. Stigmatic processes thin, lying on the lip. vi. Mouth of spur liguled, narrow, not funnel-shaped ; spur green, slightly clavate.

This is a common orchid on the Western Ghats, where it has been collected from Matheran, Khandala, Purandhar, Panchgani, Mahableshwar, etc. It is also fairly common in N. Kanara.

3. **Habenaria gibsonii** Hook. f. Fl. Brit. India 6 : 135, 1890; Santapau, Fl. Purandh. 126. *H. digitata* Cooke 715, pro parte (non Lindl. 1835). *H. digitata* var. *gibsonii* Fischer in Gamble, Fl. Pres. Madras 1469, 1928 ; Santapau 306.

Three varieties of this species have been recorded from Bombay State; they can be separated from one another by the following key :

1. Flowers scentless during the day time :
   2. Dorsal sepal broadly ovate-elliptic, up to 10-12 × 9 mm.; lateral sepals up to 18-20 × 7-8 mm.; upper segment of petals longer than the lower one .. v. *gibsonii*
   2. Dorsal sepal ovate oblong, 6-7 × 3-5 mm.; lateral sepals 8-9 × 3 mm.; segments of petals about equal, or the lower slightly longer .. .. .. v. *foliosa*
1. Flowers foul-scented during the day time; dorsal sepal broader than long, 7 × 8 mm.; lateral sepals 9 × 5-6 mm.; upper segment of petals slightly longer than lower one, 7-8 × 1-1.5 mm., the lower segment 5-7 × 0.5 mm. .. .. .. v. *foetida*

3A. **Habenaria gibsonii** var. **gibsonii** Hook. f. (See Plate II, fig. 3-4)

This is the typical variety of the species; it has been recorded from Khandala and Lonavla as common; McCann collected it from the hills east of Vehar Lake in Salsette I.

3B. **Habenaria gibsonii** var. **foetida** Blatt. & McC. in Journ. Bombay Nat. Hist. Soc. 36 : 16, 1932. (See Plate II, fig. 5)

This variety seems to be more common than the typical one; it is found in dense undergrowth in forest areas, often on sloping ground. We have recorded it from Waghai in the Dangs, from Borivli and Ghodbunder in Salsette Isl., from Khandala, Lonavla, Purandhar and Bhimashankar on the Western Ghats, and from Dapoli in the Deccan. The carrion-stench of the flowers during the day time is very penetrating and unpleasant.

3C. **Habenaria gibsonii** var. **foliosa** (A. Rich.) Sant. & Kapad. comb. nov. *H. foliosa* A. Rich. in Ann. Sci. nat. (ser. 2) 15 : 71, t. 3A, 1841; Wight, Icon. t. 1700; Blatt. & McC. 15. *H. digitata* var. *foliosa* Hook. f. Fl. Brit. India 6 : 135, 1890; Cooke 716; Fischer 1469. *H. spencei* Blatt. & McC. loc. cit. 17, t. 3, 1932. (See Plate II, fig. 6)

The flowers of this variety are much smaller and more delicate than in the typical variety; they are scentless, or at any rate, without the pronounced carrion-stench of the var. *foetida* ; the dorsal sepal is ovate-

oblong, the segments of the petals straight, the upper segment included within the dorsal sepal ; the spur is distinctly inflated in the lower portion.

This variety until recently has been considered either as a distinct species or as a variety of *H. digitata* Lindl. We consider it to be more appropriately placed under *H. gibsonii* Hook. f. and base our selection on the following characters : i. The petals are bipartite to the base, the segments being subequal, directed upwards. ii. The lip is tripartite to the base, the segments being more or less similar, uniformly linear-subulate.

Two of our specimens (*Kapadia* 614, 622) from Mahableshwar match the illustration and description of *H. spencei* Blatt. & McC. We have examined the specimens carefully and think that they belong to our new variety, and that therefore *H. spencei* Blatt. & McC. is conspecific with the new variety.

This variety is not too common ; we have recorded it from the Western Ghats and from the high hills near Poona in the Deccan; also from Karwar in N. Kanara.

4. **Habenaria multicaudata** Sedgw. in Rec. Bot. Surv. India 6 : 352, 1919; Fischer 1469 ; Blatt. & McC. 16. (See Plate VI, fig. 21)

The type was described from Guddehalli in N. Kanara near Karwar; it has also been collected from other places in N. Kanara ; Fischer has recorded it from the Nilgiri and Anaimalai hills. It has not been found in the re-organized Bombay State.

5. **Habenaria rariflora** A. Rich. in Ann. Sci. nat. (ser. 2) 15 : 70, t. 2D, 1841; Wight, Icon. t. 924; Hook. f. 136; Cooke 716; Blatt. & McC. 17, t. 2; Santapau 306 & Fl. Purandh. 127. *H. rariflora* var. *latifolia* Blatt. & McC. loc. cit. 17, 1932. (See Plate III, figs. 9-10)

During the first half of the monsoon this orchid is very common on the Western Ghats, usually growing on vertical rocks and old walls; very rarely it is found growing in the ground.

We have examined many specimens from the W. Ghats, and found that the leaves are very variable in shape, size, and consistency; the var. *latifolia* seems to be but one of the variants of this very variable plant.

The name *rariflora* was given by Richard to this plant because of the small number of flowers in each scape, usually 1-2 ; in some of the more robust specimens collected on Purandhar hill we have noted up to 13 flowers ; in these large specimens the flower and all its parts are slightly larger than in the normal few-flowered plants; the floral structure is, however, identical.

6. **Habenaria grandifloriformis** Blatt. & McCann in Journ. Bombay Nat. Hist. Soc. 36 : 17, 1932, charact. emend. Sant. & Kapad. *H. grandiflora* Lindl. in Wall. Cat. n. 7032, 1828, nom. nud.; Dalz. & Gibs.

Bombay Fl. 267, 1861, cum descriptione; Hook. f. 136; Cooke 716; Fischer 1469; Blatt. & McC. 18; Santapau 307 (non Torr. ex Beck, 1823). *H. rotundifolia* Lindl. Gen. Sp. Orch. 306, 1835 (non Rich., 1823). *H. grandifloriformis* var. *aequiloba* Blatt. & McC. loc. cit. 18, 1932. (See Plate I, fig. 2-2[1])

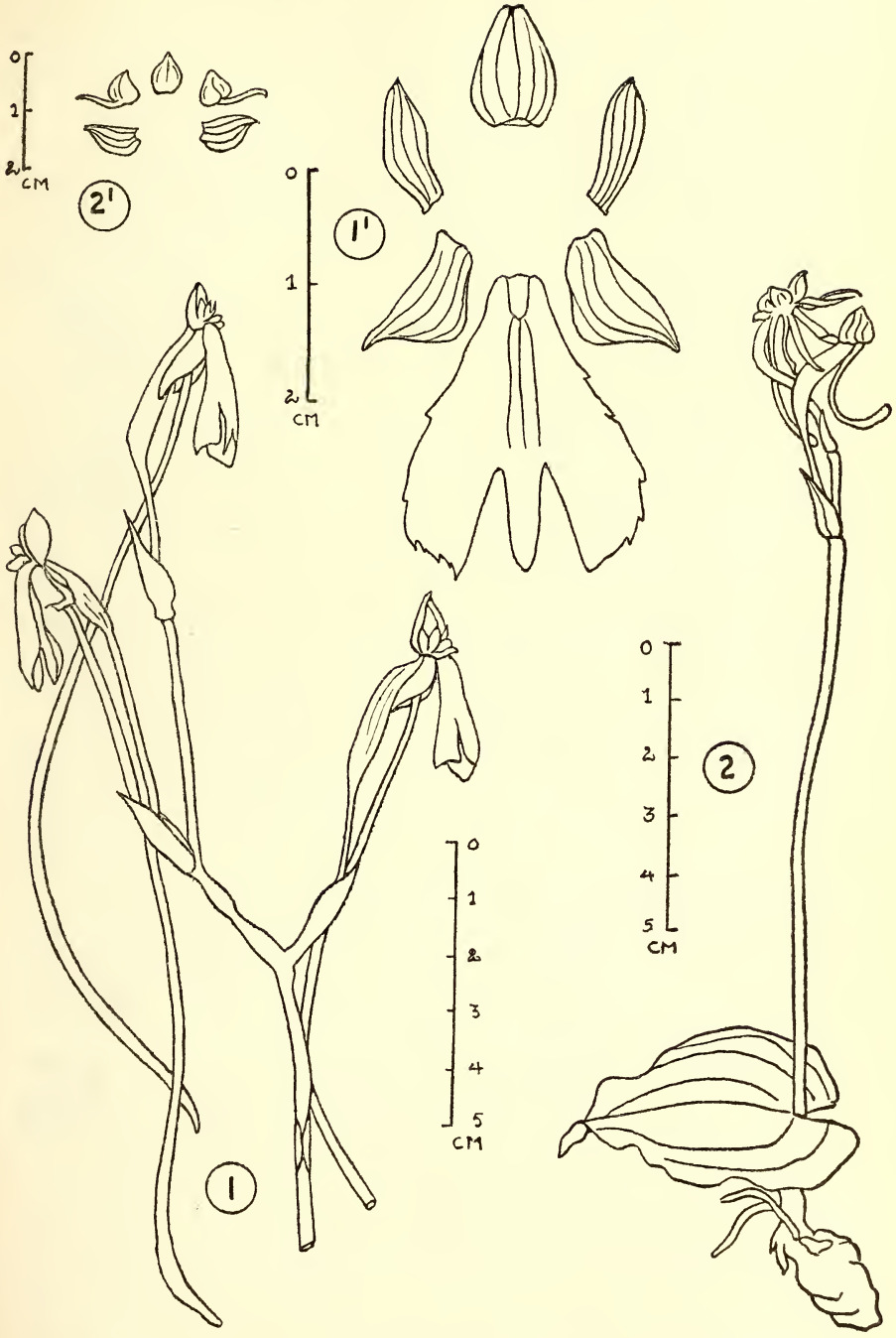
The identity of *grandiflora* and *grandifloriformis* is clear to us; the latter plant is said to have flowers slightly larger than the former, but the basic floral structure is the same in both plants. Further in *grandifloriformis*, as delimited by Blatter and McCann, there is a continuous range of variation in the size of the floral parts; it appears somewhat incongruous to make size the basis for the new species. Similar variations have been noted for *grandiflora* by Cooke and others. The measurements given for *grandifloriformis* by Blatt. and McC. are the following : lateral sepals 15 x 6 mm. ; lower segment of petals 17 mm. long; lip up to 22 mm. long. We have measured a number of specimens in the field, and our data are the following : lateral sepals 10, 12, 14, or 15 mm. long, 5-6 mm. broad; lower segment of petals 9, 12, 14, 15 mm. long; lip 9, 12, 15, 16, 17.5, 18 mm. long. Blatter and McCann in their key to the species of *Habenaria* give the length of the lip as the distinctive character between *grandiflora* and *grandifloriformis*, the former being 12, the latter 22 mm. long; if this be correct, then what is the systematic position of specimens with lips 14, 17.5, 18 mm. long ?

Given, then, that there is great variation in the size of the floral parts of this plant, we feel justified in fusing the two species into one. The question then remains about the correct nomenclature for the complex group; *H. grandiflora* Lindl. 1828 is *nomen nudum*, the validity of which dates only from the publication by Dalzell and Gibson in 1861 of the description of the plant; but by then the specific epithet *grandiflora* was not available for the genus, it being legitimately used for another plant by Torrey ex Beck in 1833. Of the names mentioned above in the synonymy only *grandifloriformis* is available, which we adopt for the plant in an extended sense, so as to include both Lindley's and Blatter and McCann's types.

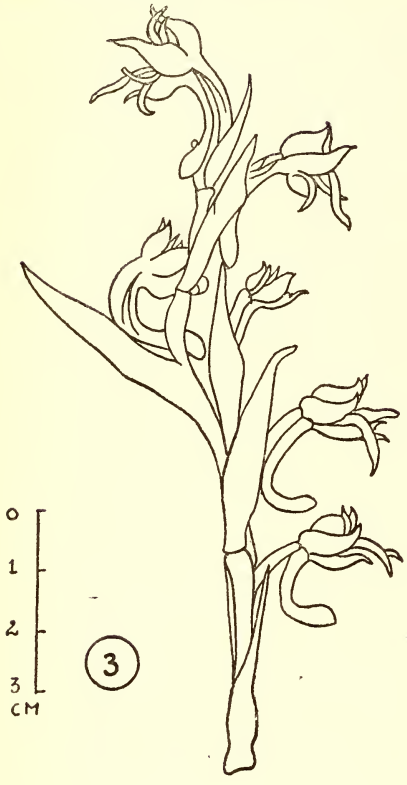
We have recorded this plant from several places in the Konkan plains, from the Western Ghats and from N. Kanara. It is common on rocky plateaux among short grasses; it is one of the first species of the genus to come into flower at the beginning of the monsoon.

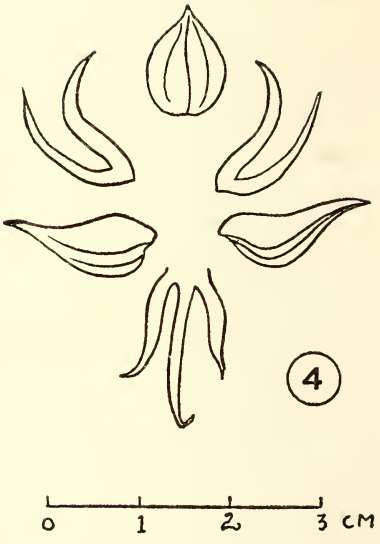
7. **Habenaria platyphylla** (Willd.) Spreng. Syst. Veg. 690, 1826; Graham, Cat. 201, 1839; Wight, Icon. t. 1709; Hook. f. 140; Cooke 717; Fischer 1470; Blatt. & McC. 18. *Orchis platyphyllos* Willd. Sp. Pl. 4 : 10, 1805. *Orchis plantaginea* Roxb. Pl. Cor. 1 : 33, t. 37, 1795 & Fl. Ind. 3 : 450, 1832.

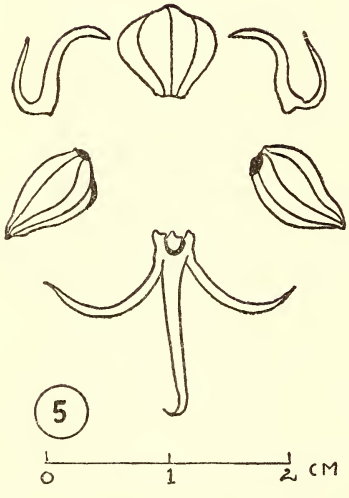
We have not seen this species from Bombay; Blatter and McCann

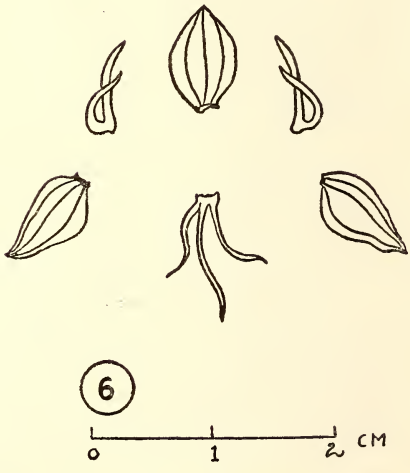


Habenaria longicorniculata Grah. : Fig. 1. Upper part of inflorescence ; Fig. 1¹. Sepals and petals dissected. *H. grandifloriformis* Blatt. & McC. : Fig. 2. Whole plant ; Fig. 2¹. Sepals and petals dissected.









Habenaria gibsonii var. *gibsonii* Hook. f.: Fig. 3. Upper part of inflorescence; Fig. 4. Sepals and petals dissected. *Habenaria gibsonii* var. *foetida* Blatt. & McC.: Fig. 5. Sepals and petals dissected. *Habenaria gibsonii* var. *foliosa* Sant. & Kapad.: Fig. 6. Sepals and petals dissected.

did not see it either. However, we have been able to study the plant in detail from specimens collected in the parts of India covered by Roxburgh's PLANTS OF THE COAST OF COROMANDEL, where it seems to be fairly common.

8. **Habenaria diphylla** Dalz. in Hook. J. Bot. 2 : 262, 1850; Dalz. & Gibs. 268 ; Hook. f. 151 (excl. *Lip. diphyllos* Nimmo) ; Cooke 722 (excl. *Lip. diphyllos* Nimmo); Fischer 1471 ; Blatt. & McC. 25 (excl. *L. diphyllos* Nimmo). *H. jerdoniana* Wight, Icon. t. 1715, 1851. (See Plate VI, fig. 22)

This is a rare plant ; it has been mentioned for the Konkan by Stocks and Dalzell; it is more common in N. Kanara where we have collected it from several spots.

9. **Habenaria crassifolia** A. Rich. in Ann. Sci. nat. (ser. 2) 15 : 72, t. 3C, 1841; Hook. f. 151, (excl. syn. *H. brachyphylla* Reichenb. f.); Cooke 722; Fischer 1471; Blatt. & McC. 25; Santapau, Fl. Purandh. 126. *Platanthera brachyphylla* Lindl. Gen. Sp. Orch. 293, 1835; Wight, Icon. t. 1694 ; Dalz. & Gibs. 269. *Habenaria brachyphylla* (Lindl.) Kränzl. in Bot. Jahrb. 16 : 153, 1893 (non Reichenb. f. 1886). (See Plate VI, fig. 23)

This is a common orchid on sloping grass fields on Purandhar Hill ; the leaves are suborbicular and rather stiff.

The name of the plant requires attention. *Habenaria brachyphylla* Reichenb. f. 1893 is a later homonym of *H. brachyphylla* Aitch. & Hemsl. 1882, which Hook. f. and Duthie list as synonymous with *H. aitchisonii* Reichenb. f. The name *brachyphylla* then is not available for this plant, although it is the oldest epithet for the plant.

10. **Habenaria commelinifolia** Wall. ex Lindl. Gen. Sp. Orch. 325, 1835 ; Hook. f. 143; Cooke 719; Fischer 1470; Blatt. & McC. 20; Santapau 308. *Orchis commelinifolia* Roxb. Fl. Ind. 3 : 451, 1832. (See Plate IV, figs. 11-12)

This is a very common ground orchid on the Konkan plains; we have recorded it from Bassein, Andheri, Tulsi Lake, Kandivli, Mumbra, etc.; we have also seen a few specimens from Purandhar and N. Kanara. The general structure of the inflorescence is typical.

11. **Habenaria crinifera** Lindl. Gen. Sp. Orch. 323, 1835; Wight, Icon. t. 926; Hook. f. 142; Cooke 718; Fischer 1471; Blatt. & McC. 20. *H. schizochilus* Nimmo ex Grah. Cat. Bombay Pl. 252, 1839. *Synmaria schizochilus* Nimmo in Grah. loc. cit. pag. ult. sine no. (See Plate IV, figs. 13-14)

A rare orchid; we have found it in the Koyna Valley; it has also been recorded from the Konkan and the W. Ghats. Our specimens were found epiphytic on tree trunks about 1 m. from the ground; Dalzell

and Gibson also recorded the epiphytic habit of this plant; this is the only species of the genus in Bombay which is truly epiphytic.

12. **Habenaria suaveolens** Dalz. in Kew Journ. Bot. 2 : 263, 1850 & in Dalz. & Gibs. Bombay Fl. 263; Hook. f. 140 ; Blatt. & McC. 19.

This seems to be one of the rarest of Bombay orchids ; after the original collection in the ' Konkan ' by Dalzell, it has been recorded only from between Vengurla and Malwan by Dalzell & Gibson ; none of the subsequent Bombay botanists have found the plant again.

13. **Habenaria panchganiensis** Sant. & Kapad. in Journ. Bombay Nat. Hist. Soc. 54 : 478, 1957. *H. variabilis* Blatt. & McC. in eodem op. 36 : 19-20, tt. 4-5, 1932 (non Ridley, 1886). (See Plate VI, fig. 24)

This species seems to be endemic on the Western Ghats of Bombay; it is one of the commonest and most abundant ground orchids of Mahableshwar and Panchgani during the monsoon.

H. variabilis Blatt. & McC., 1932, is an illegitimate name, it being a later homonym of *H. variabilis* Ridl., 1886; the latter is an Abyssinian plant. The one point in which both the Indian and the Abyssinian species agree is the great variability in the shape and size of their floral structures.

14. **Habenaria plantaginea** Lindl. Gen. Sp. Orch. 323, 1835; Wight, Icon. t. 1710; Hook. f. 141; Cooke 718; Fischer 1420; Blatt. & McC. 20 ; Santapau 308. (See Plate VI, fig. 25)

We have recorded this species from various places on the Western Ghats and N. Kanara. It usually occurs either solitary or in small groups in open, sloping ground in exposed situations; it is rarely found in the shade.

15. **Habenaria longicorniculata** Graham, Cat. Bombay Pl. 202, 1839. *H. longecalcarata* A. Rich. in Ann. Sc. nat. (ser. 2) 15 : 71, t. 3B, 1841 ; Wight, Icon. t. 925; Hook. f. 141 ; Cooke 718 ; Fischer 1470; Blatt. & McC. 20 ; Santapau 307. *H. longecalcarata* var. *viridis* Blatt. & McC. in J. Bombay Nat. Hist. Soc. 36 : 20, 1932. (See Plate I, figs. 1-1[1])

The identity of this plant is quite clear ; the name needs correction from what is usually given in our floras and from what the senior author has given elsewhere. There is no doubt that the oldest legitimate name is that of Graham, 1839 ; his description seems to be sufficient to bring out the essential characters of the plant. On a previous occasion the senior author did not adopt Graham's name on account of ' the solid weight of authority in favour of *longecalcarata*.' Herewith we reinstate Graham's specific name on the basis of priority.

The var. *viridis* Blatt. & McC. is but an immature specimen of the typical species, with which it is therefore merged. The typical species is usually green in its early stages, gradually changing to cream or pure white.

This orchid is common in sloping grass fields; the size of the plant seems to keep pace with the growth of grasses; in the early part of the monsoon, when grasses are low, this plant is but 30 cm. tall; by the end of the season it may reach beyond 1 m. in size. Very common on the Western Ghats, not so common in N. Kanara.

16. **Habenaria heyneana** Lindl. Gen. Sp. Orch. 320, 1835; Wight, Icon. t. 923; Hook. f. 148; Cooke 719; Fischer 1471 & in Kew Bull. 1928 : 284; Blatt. & McC. 22; Santapau 308. *H. subpubens* A. Rich. in Ann. Sci. nat. (ser. 2) 15 : 75, t. 4C, 1841; Hook. f. 148; Cooke 720. *H. glabra* A. Rich. loc. cit. 75, t. 5A, 1841. *H. candida* Dalz. in Hook. J. Bot. 2 : 262, 1850. *H. cerea* Blatt. & McC. 21, t. 6, 1932. *H. cerea* var. *polyantha* Blatt. & McC. ibid. 22, 1932. (See Plate V, figs. 15-16)

The senior author, in Rec. Bot. Surv. India 16 (1) : 308, 1953, has discussed the identity of the plant, after examination of the types in Kew Herb.; the plants listed above are all one and the same species, the oldest legitimate name being *H. heyneana* Lindl.

This orchid is rather variable; it grows in abundance in rocky plateaux on the Western Ghats. Locally the plant is known as ' The Toothbrush Orchid ' on account of the secund arrangement of the flowers; the pedicels, however, are arranged all round the stem, the twisting of the flowers being a later development. Flowers at first cream or white, with age they turn yellow, on drying they become almost black.

17. **Habenaria marginata** Coleb. in Hook. Exot. Fl. t. 136, 1825; Graham 201; Hook. f. 150; Cooke 721; Fischer 1471 (excl. syn. *H. fusifera* Hook. f.); Blatt. & McC. 23 (excl. syn. *H. fusifera* Hook. f.); Santapau 310 & Fl. Purandh. 127. (See Plate V, fig. 17)

The specific epithet of this plant refers to the clear margins along the edges of the leaves, the margins being whitish or yellowish. This is a common species, which we have recorded from the Dangs Forest, from various places in the Konkan especially in Salsette Isl., from the Deccan and the Western Ghats and from N. Kanara. It is found among low grasses in moist soil during the monsoon.

17A. **Habenaria marginata** f. **flavescens** Blatt. & McC. in Journ. Bombay Nat. Hist. Soc. 36 : 24, 1932. *H. flavescens* Hook. f. Fl. Brit. India 6 : 150, 1890. *H. marginata* var. *flavescens* Cooke, Fl. Pres. Bombay 2 : 721, 1907.

This is but a slender form of *marginata* with fewer flowers and an ovary that is somewhat more beaked than the typical plant. It is a rare plant, which we have been unable to locate in the field.

17B. **Habenaria marginata** var. **fusifera** (Hook. f.) Sant. & Kapad stat. nov. *H. fusifera* Hook. f. Fl. Brit. India 6 : 147, 1890.

This plant differs from the typical variety in the position of the leaves, which here are arranged all along the stem for a distance of 12 cm. from the base; in the typical variety the leaves are clustered at the base of the plant. The inflorescence of our variety is lax, the spur shorter than the ovary, thin, slightly clavate at the apex but not inflated. The whole plant grows to 45 cm. high. Leaves are margined with a yellowish strip, and are elliptic or elliptic-lanceolate, 8-15 x 1.6-3.5 cm. Flowers yellow, similar to those of the typical species.

Fischer, in Kew Bull. 1928 : 285, remarks that he has examined the type and only specimen of *H. fusifera* Hook. f. which was preserved in the Calcutta Herb.; Fischer considers the plant identical with *H. marginata* Coleb. We have found a specimen in the Dangs Forest (*Santapau* 19279) which in the structure of the flowers is definitely *H. marginata* Coleb., but the leaves are not radical, as in the typical species, but are arranged along the stem for some distance. Hook. f. placed his *fusifera* in the group with ' stem leafy upwards ', whilst *marginata* is placed in the group with ' leaves clustered at the base or middle of the stem '. We consider this arrangement of the leaves to be of sufficient importance to justify our retaining *fusifera* as distinct from the typical *marginata*.

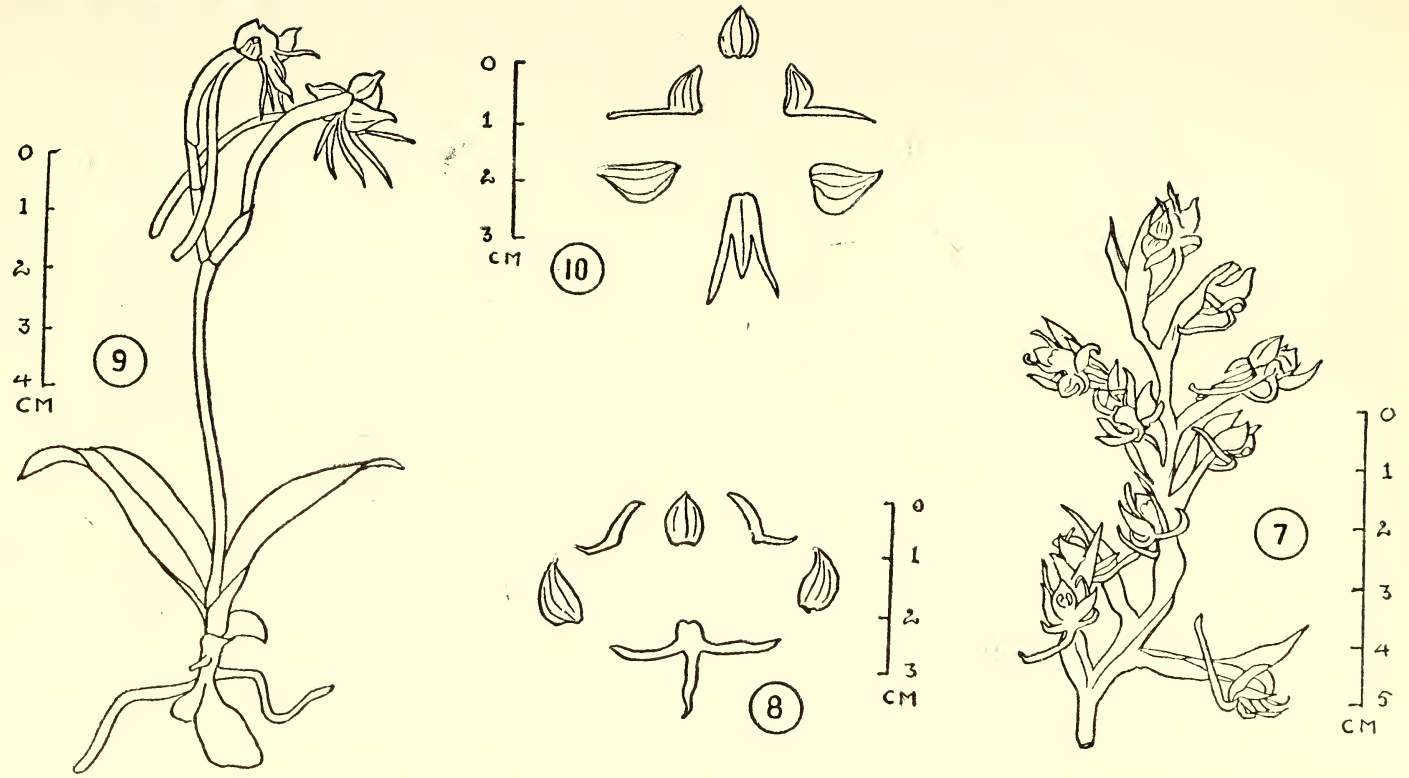
18. **Habenaria viridiflora** (Sw.) R. Br. Prodr. 312, 1810; Wight, Icon. t. 1705; Hook. f. 150; Fischer 1471. *Orchis viridiflora* Sw. in Act. Holm. 706, 1800. *Habenaria graminea* A. Rich. in Ann. Sci. nat. (ser. 2) 15 : 73, 1841 (non Spreng. 1826, nec 1835). *H. viridiflora* var. *dalzellii* Hook. f. Fl. Brit. India 6 : 150, 1890; Cooke 701; Blatt. & McC. 24. *Coeloglossum luteum* Dalz. in Hook. J. Bot. 2 : 263, 1850. (See Plate V, fig. 19)

This is another rare species; we have not seen it in the field; Stocks found it in the Konkan, Dalzell and Gibson in Malwan; no other Bombay botanist has collected it again. We have been able to study the plant from a specimen (*Fischer* 4225) from S. India.

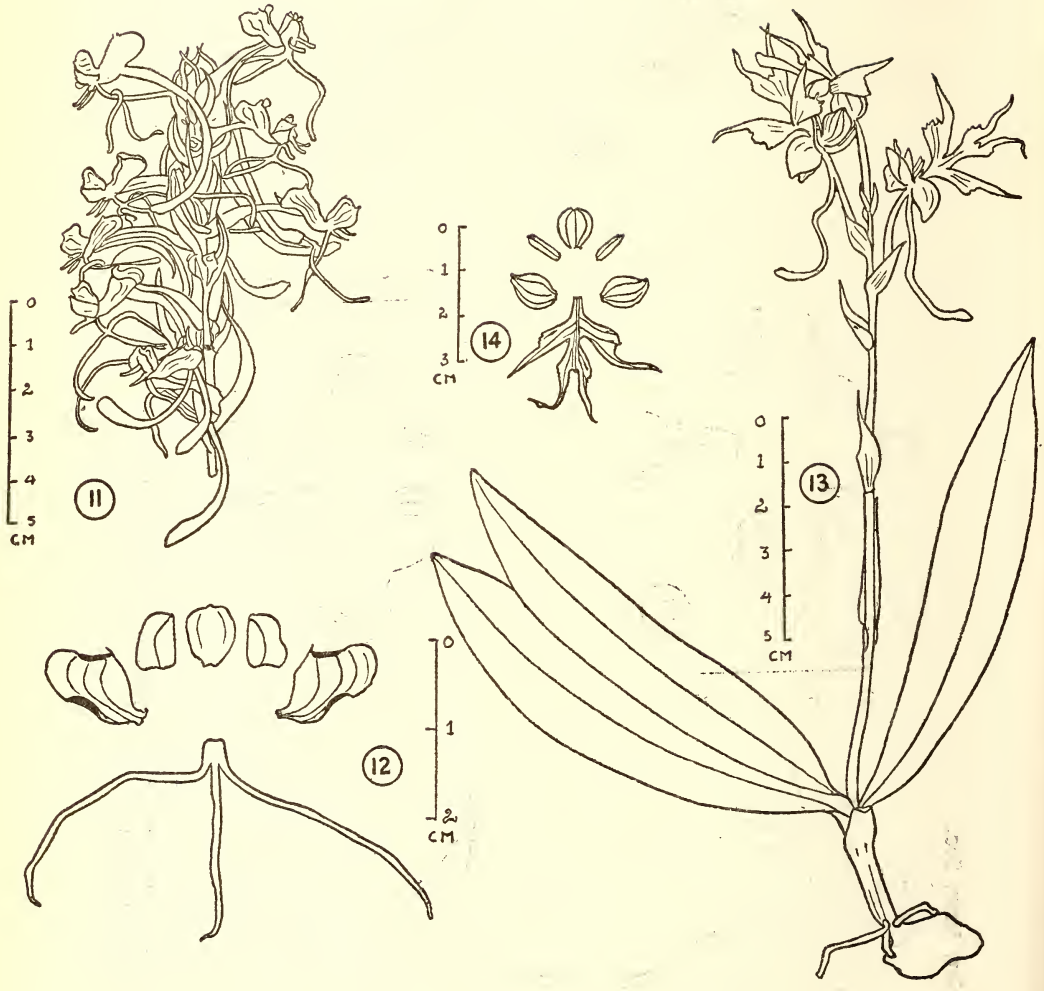
From the descriptions, and we have nothing but the descriptions to go by, of these two plants, i.e. *viridiflora* and var. *dalzellii*, we consider that the two plants are one and the same species, perhaps at most the latter plant may be accepted as a form of the former.

19. **Habenaria ovalifolia** Wight, Icon. 5 (1) : 13, t. 1708, 1851; Hook. f. 149; Kränzl. 139; Fischer 1471; Blatt. & McC. 23; Santapau 309. *H. modesta* Dalz. in Kew Journ. Bot. 2 : 262, 1850; Hook. f. 166 (?) *H. hallbergii* Blatt. & McC. in Journ. Bombay Nat. Hist. Soc. 36 : 24, 1932; Santapau 310. (See Plate V, fig. 18)

We have collected this plant from various places in Salsette Isl., from Khandala on the W. Ghats, and from N. Kanara. It is generally



Habenaria digitata Lindl. : Fig. 7. Inflorescence ; Fig. 8. Sepals and petals dissected. *H. rariflora* A. Rich. : Fig. 9. Whole plant ; Fig. 10. Sepals and petals dissected.



Habenaria commelinifolia Wall. : Fig. 11. Inflorescence ; Fig. 12. Sepals and petals dissected. ***H. crinifera*** Lindl. : Fig. 13. Whole plant ; Fig. 14. Sepals and petals dissected.

found in forest in dense undergrowth, occasionally in forest clearings; the flowers present a problem for pollination ; the pollinia and stigmatic surfaces are more or less completely covered by the sepals and petals; it appears that only very minute insects can pass through the small opening between the petals and the midlobe of the lip.

The type of Dalzell's *H. modesta* has not been available in this study; but from the description it seems to us that this plant must be fused with *H. ovalifolia* Wt. The structure of the lip, especially the midlobe, which is reflexed upwards and joins with the dorsal sepal and the tips of the petals, is very characteristic of this species. In accordance with the Rule of Priority this plant should be called by the oldest valid name, *H. modesta* Dalz. We defer to the authority of Hook. f. and others, especially since we have not been able to see the type, and leave the nomenclature unaltered; there seems to be some doubt about the identity of *H. modesta* Dalz., the evidence of the doubt being that the plant has been put under *H. stenopetala* Lindl. or *Peristylus stenostachyus* Kränzl.

On the other hand we have examined the type of *H. hallbergii* Blatt. & McC. in Blatter Herb.; the basic floral structure is identical with that of *H. ovalifolia* Wight, and in consequence we place the former name as a synonym of the latter.

20. **Habenaria furcifera** Lindl. Gen. Sp. Orch. 319, 1835 ; Hook. f. 149 ; Kränzl. 161 ; King & Pantling in Ann. R. Bot. Gard. Calcutta 8 : 313, t. 410 ; Prain, Bengal Pl. 1033 ; Duthie in Ann. R. Bot. Gard. Calcutta 9 : 184, & Fl. Upp. Gang. Pl. 3 : 225, 1920 ; Haines, Bot. Bih. Or. 1157. (See Plate V, fig. 20)

As this is a new record for Bombay, we give herewith a full description of the plant.

Terrestrial herbs, 40-60 cm. high. *Tubers* 1-2, ovate-ellipsoid, 3 × 1.5 cm. *Leaves* 13-17 × 3-6 cm., oblanceolate or obovate or elliptical, acute or subacuminate, clustered just below the middle of the stem, gradually passing into the bracts of the scape. *Inflorescence* 25-40 cm. long, stout, erect, lax, many-flowered ; scape bracteate, glabrous, at times longitudinally grooved ; bracts the lowermost 6-7 × 3-6 cm., the others 2 × 0.8 cm., lanceolate, acuminate. *Flowers* small, green, very shortly pedicelled, bracteate ; pedicels 1-1.5 mm. long ; floral bracts 1.3 × 0.3 cm., ovate-lanceolate, acuminate, slightly concave at the base, about as long as the ovary, the margins minutely papillate. *Sepals* subequal, 3-nerved ; dorsal sepal 4-5 × 1 mm., spreading, somewhat falcate and concave at the base, subacute to acute, sparsely gland-dotted. Petals 4 × 2.5 mm., broadly oblong, obtuse or subretuse Lip 6 × 6 mm., trifurcate right to the base ; lateral segments filiform, diverging, curved, much longer than the stout, blunt, entire midlobe.

Spur slightly longer than the ovary, slender, laterally compressed, involute at the base. *Anther cells* 2, touching, rather short ; pollinia ovoid with slightly curved slender caudicles, and small narrowly oblong glands ; staminodes 2, somewhat large, broadly oblong, white, glandular, placed at the sides of the column below the anther cells. *Stigmatic processes* 2, elliptic, blunt, one on either side of the entrance to the spur ; rostellum a thickened horny rim just above the orifice of the spur, from the centre of which a small ligulate projection is given out, which forms a flap over the entrance to the spur. *Capsule* 1.5 × 0.55 cm., fusiform, turgid, decurved, with strong ribs ; beak of capsule one-fourth the length of the body.

Flowering : August to September ; *Fruiting :* up to November.

Occurrence in Bombay State : The following specimens are preserved in Blatter Herbarium from the Dangs Forest : W a g h a i, *R. Fernandes* 2223, *Santapau* 19143-19144, 19204, *Kapadia* 681-683, 1411, 1438 ; A h w a, *Santapau* 19393.

This species is widespread in northern and north-eastern India ; Sikkim and Garhwal in the Himalayas, Orissa, East Bengal and Assam ; this is the first time it has been recorded from Bombay State.

21. **Habenaria hollandiana** Sant. Fl. Purandh. 126, 1958. *H. affinis* Wight, Icon. t. 1707, 1851 ; Hook. f. 149 ; Cooke 720 ; Fischer 1471 ; Blatt. & McC. 23 (non D. Don, 1825).

This is a plant of rare occurrence in Bombay ; only Woodrow and Ritchie seem to have found it in Purandhar and Belgaum respectively. Wight mentions that his sheets do not show any definite locality, but were probably received from Mr. Law of Belgaum. No subsequent botanist after Woodrow has been able to locate the plant in Bombay.

H. affinis Wight, 1851, is a later homonym of *H. affinis* D. Don, 1825, and therefore an illegitimate name. The new name commemorates the help received by the senior author in his exploration of Purandhar hill, during the time Mr. A. S. Holland was the Commandant of the Internment Camp and Parole Centre, Purandhar, during the second World War.

Imperfectly known species

Habenaria caranjensis Dalz. in Hook. Journ. Bot. 2 : 262, 1850 (' *caraujensis* ') ; Dalz. & Gibs. 267 ; Hook. f. 166 ; Cooke 723.

There are no specimens of this species in Kew Herb. or in any of the herbaria we have consulted ; the plant does not seem to have been collected by any other botanist after Dalzell. The following are the data given by Dalzell in the original description : ' Lower leaves subrotund, the upper ones oblong-lanceolate, 3-nerved. Bracts acuminate,

Habenaria heyneana Lindl. : Fig. 15. Whole plant ; Fig. 16. Sepals and petals dissected. *H. marginata* Coleb. : Fig. 17. Sepals and petals dissected. *H. ovalifolia* Wight : Fig. 18. Sepals and petals dissected. *H. viridiflora* R. Br. : Fig. 19. Sepals and petals dissected. *H. furcifera* Lindl. : Fig. 20. Sepals and petals dissected.

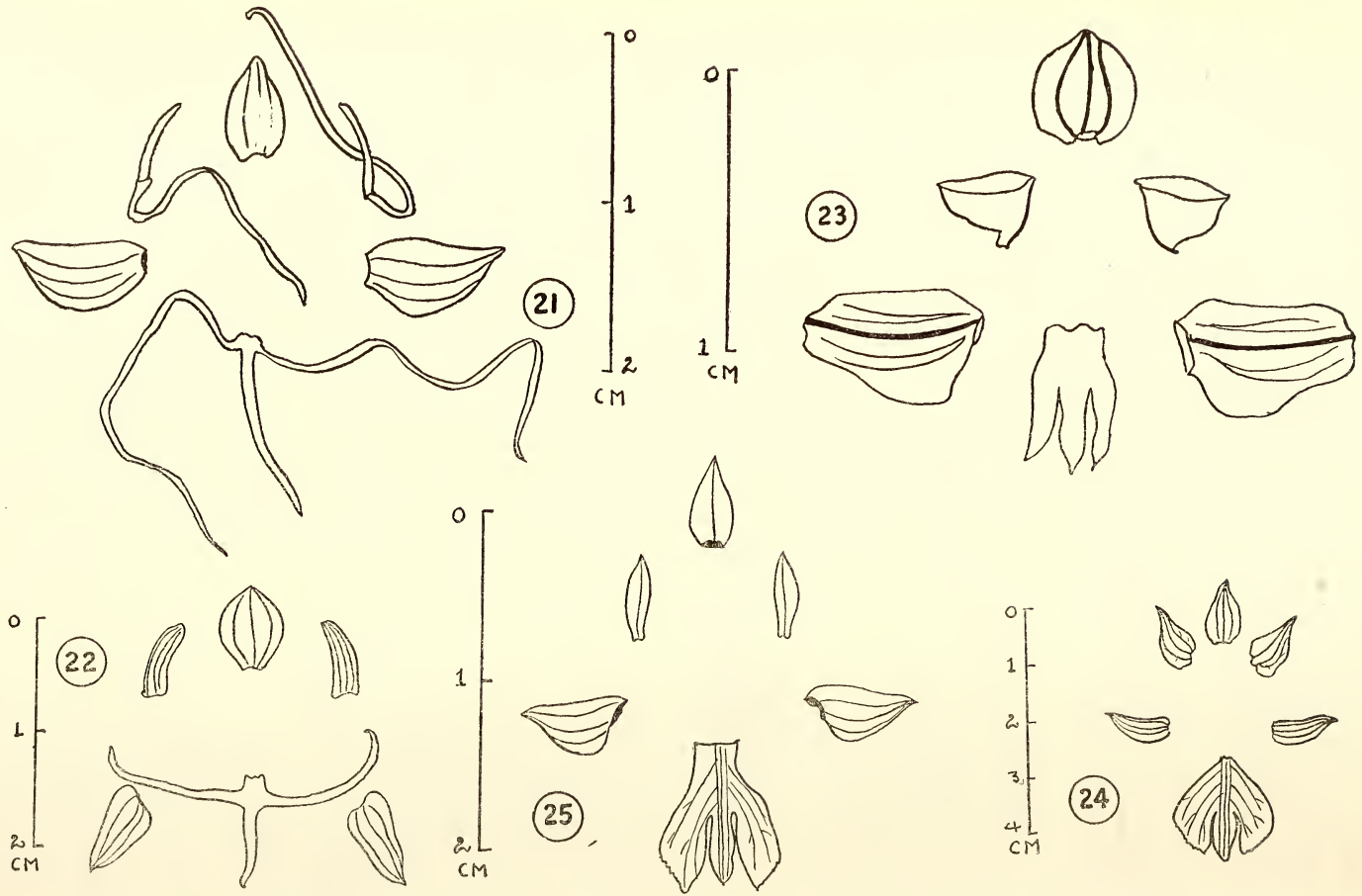


Fig. 21. *Habenaria multicaudata* Sedgw. ; Fig. 22. *H. diphylla* Dalz. ; Fig. 23. *H. crassifolia* A. Rich. ; Fig. 24. *H. panchganiensis* Sant. & Kapad. ; Fig. 25. *H. plantaginea* Lindl., showing sepals and petals dissected.

shorter than the ovary. Upper sepal rotundate ; petals semi-ovate, obtuse ; middle segment of the tripartite lip oblong, somewhat obtuse, the lateral segments shorter, cuneate, truncate at the apex ; spur clavate, shorter than the ovary. Flowers small, yellow.'

The original locality given by Dalzell is the island of ' Carauja near Bombay '. There is no place with such a name near Bombay ; there is, however, a place called Karanja or Caranja on the sea-coast across the harbour of Bombay, which seems to be the locality of Dalzell's collection.

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New Marine Nematodes of the Superfamily Enoploidea from the Arabian Sea

BY

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(*With two plates*)

A collection of large marine nematodes was sent to the author for identification by the Zoological Survey Department of Pakistan in December, 1958. The worms were taken in 1957 and 1958 from rocks and algae at low tide at Manora Island and from rocks beneath the bridge at the native jetty, Karachi, West Pakistan. Six species of the Superfamily Enoploidea are represented, four of which are new to science. The systematics of these nematodes is given below, together with the number of individuals.

Family ENOPLIDAE

Enoplus mammillatus n.sp., 4 ♂♂, 2 ♀♀.

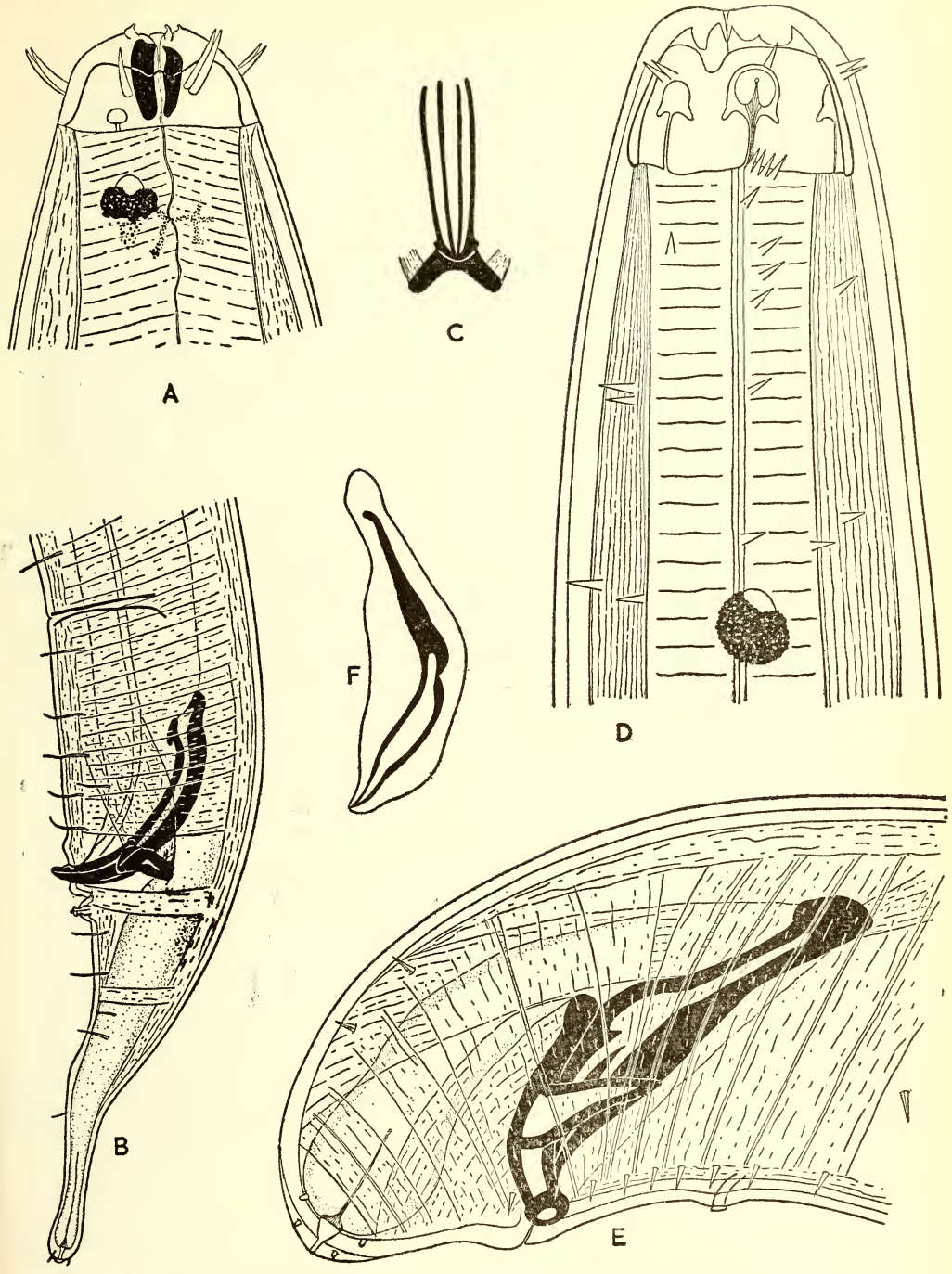
Family LEPTOSOMATIDAE

Thoracostoma karachiense n.sp., 105 ♂♂, 78 ♀♀, 70 juveniles.
Leptosomatides reducta n.sp., 19♂♂, 12 ♀♀, 4 juveniles.
Leptosomatum sp., 1 broken ♂, 1 ♀.

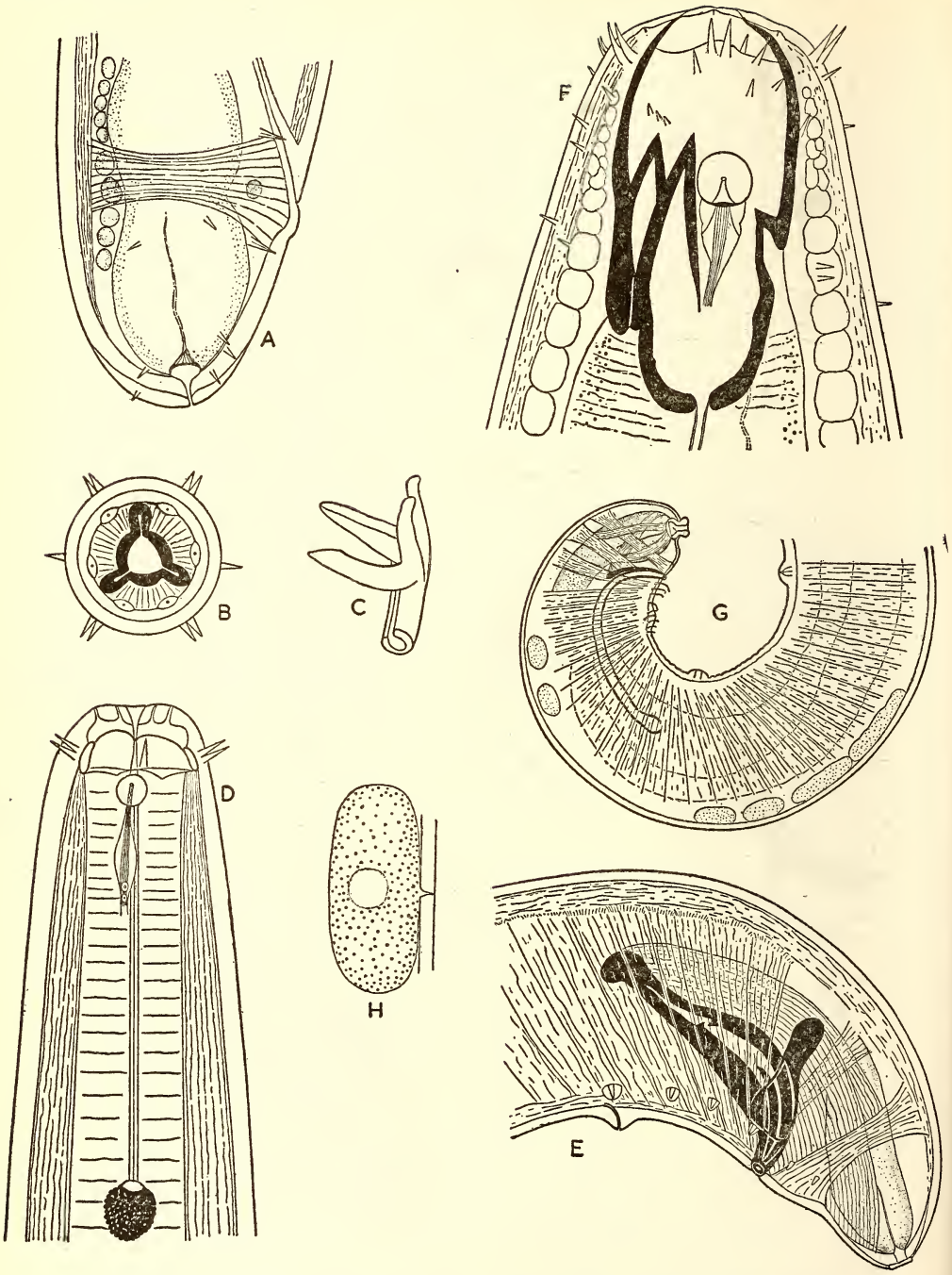
Family ONCHOLAIMIDAE

Pontonema multisetosus n.sp., 3 ♂♂.
Oncholaimus sp., 1 ♀.

The type habitat for all the new species is ' algae growing on rocks '. The type locality is ' Manora Island, Karachi '. The type specimens, mounted in glycerine jelly, are deposited in the slide collection of the Pakistan Zoological Survey, Karachi. Paratype slides and specimens are in the author's personal collection. In the descriptions of *Thoracostoma karachiense* and *Leptosomatides reducta* the numbers in parentheses refer to the mean for a particular set of measurements, based on 10 males and 10 females.



A-C. *Enoplus mammillatus* n.sp. A. Male head. B. Male tail. C. Male genital apparatus, ventral view. D-F. *Thoracostoma karachiense* n.sp. D. Male head. E. Male tail. F. Spicule dissected out (hollow part in black).



A-C. *Thoracostoma karachiense* n.sp. A. Female tail. B. Female head, *en face* view. C. Gubernaculum dissected out. D-E. *Leptosomatides reducta* n.sp. D. Female head. E. Male tail. F-H. *Pontonema multisetosus* n.sp. F. Male head. G. Male tail. H. Hypodermal gland cell.

Enoplus mammillatus n.sp. (Pl. 1, A-C)

Description.—Body short and broad, tapering little toward the head end. Colour deep reddish-brown, clearing only partially in lactophenol. Cuticle moderately thick, in 2 distinct layers. Head rounded; lips weakly-developed, surrounded by inner circle of 6 papillae or protruberances. Mandibles 16-18 μ long or 5/11 head diameter. Cephalic setae 8 + 2, 16 and 14 μ long respectively, 36% head diameter in female, 40-44% in male; few short cervical setae. Amphids transversely elliptical, almost reniform, 4 μ wide in male or 1/8 head diameter, 6 μ in female or 1/5 head diameter. Ocelli with lens 30-32 μ from anterior end; little scattered ocellus pigment. Excretory pore about 150 μ from anterior, inconspicuous. Excretory cell prominent, extending to just above oesophageal base, turned at right angles to base, as figured by Wieser (1953b) for *Enoplus benhami* Ditlevsen, 1930. Nerve ring broad, 134-180 μ from anterior or 41-47% of oesophagus. Oesophageal-intestinal valve hemispherical, 30 μ long. Male and female tails both half-conical half-cylindrical, with caudal glands extending anterior to anus and 2 spines at tip.

Female reproductive system amphidelphic; ovaries reflexed $\frac{1}{2}$ distance to vulva. Ova with clear thin shell, stacked vertically in uterus, 3 + 0 in 1 female, 6 + 5 in other, 135 + 80 μ. Vulva not conspicuously sclerotized. Tail 3-3.3 anal diameters long.

Male reproductive system double, testes outstretched; anterior testis extending almost to oesophagus. Spicules thick, with knobbed head; ventral tooth-like projection on head. Two semi-circular plates on inner margin of spicules, 1 just above tip, the other just above gubernaculum; these seem to mark attachment points of small muscles. Spicules 112-125 μ long, 83 μ in ventral view. Gubernaculum with vertical central piece and 2 side pieces, projecting posteriolaterally, attached by broad muscles leading to lateral walls anterior to anus. Narrow tubular supplement 141-144 μ anterior to anus, 55-60 μ long. Fine subventral setae anterior and posterior to anus. Mammillate supplement just behind anus, with prominent innervation. Numerous copulatory muscles extending far forward. Tail 2.3-3 anal diameters long.

Female dimensions (2 ♀♀).—Length 2.5-2.6 mm.; a, 20-20.8; b, 7-7.1; c, 11.8-12.8; V, 52-52.5%; Ov_1, 19.3-23%; Ov_2, 23.7-27%.

Syntype female.—L. 2.5 mm.; a, 20.8; b, 7; c, 11.8; V, 52%; ova 3 + 0.

Male dimensions (4 ♂♂).—Length 1.9-2.9 (2.5) mm.; a, 17-22 (19.7); b, 5.1-8.9 (6.9); c, 9.5-16 (12.5); T_1, 42%; T_2, 21%.

Syntype male.—L. 2.9 mm.; a, 22; b, 8.9; c, 16; spicules 125 μ or 1.6 anal diameters; supplement 60 μ.

Discussion.—This species falls within group C in Wieser's key to

the genus (1953b), containing only *Enoplus stekhoveni* Wieser, 1953. Our species can be distinguished easily by its mammillate supplement.

Thoracostoma karachiense n.sp. (Pl. 1, D-F; Pl. 2, A-C)

Description.—Body cylindrical, tapering gradually from base of oesophagus to narrow anterior end; male and female tails short and bluntly-rounded. Colour deep reddish-brown and completely opaque, to transparent. Cuticle thick, with 2 distinct layers. Cuticle of head with fine criss-cross striations 1 μ apart, composed of closely-set dots, extending also above cephalic capsule. Prominent longitudinal fibrils of cuticle in posterior region.

The terminology of Wieser (1953a) is followed in the description of the morphology of the head. Cephalic capsule remarkably uniform; locules and pigmentation completely lacking. Cephalic suture 33-36 μ from anterior end, usually with slight notch between incisions. Fenestrae with posterior cornua. Distance from anterior of fenestra to cephalic suture 19-21 μ. Incisions narrow (broad in one female only). Stomadeal ring asymmetrical. Amphids circular, within lateral fenestrae, 6.5-7 μ wide in female or 1/6-1/7 head diameter, 9 μ in male or 1/5 head diameter; pore at anterior of amphid. Small dorsal tooth on buccal wall and dentiform projections at anterior of buccal capsule. Internal circle of 6 small papillae and external circle of 10 cephalic setae; lateral setae single, subdorsal and subventral setae paired, 4.5 μ long or 1/9-1/10 head diameter. Group of 4 subcephalic setae just posterior to cephalic suture in line with amphids (only 3 in 2 specimens); all 4 in transverse row in 60% of specimens, and most of these with group of 3 setae directly posterior to them. Cervical setae not arranged in ranks.

Ocelli composed of crystalline lens and red pigment, half-embedded in wall of oesophagus, 115-149 (127) μ from anterior end. Ocellus pigment extending throughout oesophagus posterior to ocelli, especially dense along outer margin. Oesophagus surrounded by large cells of hypodermal chords. Nerve ring prominent, located 535-590 (554) μ from anterior end or 26.6-30 (28.3)% of oesophageal length. Narrow oesophageal-intestinal valve. Excretory pore and excretory gland cell absent. Caudal glands extending anterior to anus.

Female reproductive system amphidelphic, with ovaries reflexed 3/4 distance to vulva. Oocytes in ovary pyramidal, in 2 alternating ranks; 6-9 large brown oocytes in oviduct in single row. Usually 1 mature ovum with fully-formed shell in each uterus at a time (1 specimen with 2 in each uterus); shell thick and clear. Ova when single 392-445 x 122-148 (412 x 131) μ; ova when 2 in uterus 338-378 x 140-149μ. Vagina muscular; vulva heavily sclerotized.

Male reproductive system double; junction between testes not clearly visible. Spicules thick, with knobbed head, 192-200 μ long. Gubernaculum consisting of an unpaired basal median piece (cuneus), 2 upright pieces (corpora) 96 μ long, and 2 triangular horizontal pieces (crura) 50 μ long. Prominent muscles from spicule head anteriorly and posteriorly to dorsal wall, and from gubernaculum to ventral wall of tail. Thin bands of muscle behind anus, 2 prominent broad bands at anus, and numerous paired preanal copulatory muscles. One large tubular ventral preanal supplement 70 μ anterior to anus; 4 pairs of hemispherical subventral papillae, coloured red and warty in appearance in larger males (1 male with 5 pairs of papillae, another with only 3 on 1 side), anteriormost 840 μ from anus; 9-10 pairs of preanal submedian setae, 1 pair adanal, and 1 or 2 pairs postanal.

Female dimensions (10 ♀♀).—Length 11.2-13.7 (12.4) mm.; a, 55-83 (69); b, 5.7-6.6 (6.2); c, 107-141 (124); V, 62.1-67.7 (65.6)%; Ov_1, 15-20 (16.8)%; Ov_2, 14.1-18.5 (15.9)%.

Syntype female.—L. 11.3 mm.; a, 70; b, 5.7; c, 119; V, 66%; Ov_1, 19.1%; Ov_2, 18%; ova 1 + 1, 432 x 135 μ and 410 x 135 μ; ocelli 125 μ; nerve ring 540 μ or 27%.

Male dimensions (10 ♂♂).—Length 10-12.8 (11.4) mm.; a, 54-80 (69); b, 5.3-6.4; (5.9); c, 111-162 (135).

Syntype male.—L. 11.4 mm.; a, 60; b, 6.1; c, 105; ocelli 122 μ; nerve ring 553 μ or 30%; spicules 192 μ.

Discussion.—This species bears the closest resemblance to *Thoracostoma magnificum* Timm, 1951, from Alaska, which is over twice the size of the present species. The cephalic capsule is similar in the two species, but the group of 4 subcephalic setae just behind the amphids in *T. karachiense* is lacking in *T. magnificum*. In the latter there are 9 pairs of subventral preanal papillae, 9 pairs of submedian preanal setae, and 2 pairs of submedian postanal setae.

It should be emphasized that attaching undue importance to variation in polymorphic species can easily lead to excessive fragmentation. On the other hand, failure to recognize stable variations within different populations can lead to excessive lumping of species. The application of statistical analysis to populations from different localities, as employed for subspecific determination in vertebrate phyla, will be helpful in solving the species problem for many of the larger and more familiar marine nematodes.

Leptosomatides reducta n.sp. (Pl. 2, D-E)

Description. Resembling *Thoracostoma* but narrower and with cephalic capsule and crura of gubernaculum reduced. Body cylindrical, tapering gradually from base of oesophagus to anterior end. Male and female tails short and bluntly-rounded; male tail coiled in

half-circle. Colour light yellow, transparent. Cuticle of tail with fine transverse and longitudinal striations on surface, composed of closely-set dots.

Cephalic capsule reduced; amphids posterior to cephalic suture. Suture faint and variable in outline, marking off 6 shallow arcs, as in Pl. 2, D, with the tips of the arc occasionally extending down to the middle of the amphids. Anterior of oesophagus cuticularized as an asymmetrical stomadeal ring. Amphids circular, 13 μ from anterior in female, 16 μ in male; 7-7.5 μ wide in female or 20-23% of head diameter, 9-10.5 μ in male or 25-37% head diameter. Amphidial duct with oblong sensilla, containing 2 small nuclei at posterior. Rugose projections at anterior of head. Internal circle of 6 small papillae and external circle of 10 cephalic setae 6.5 μ or 1/5 head diameter long, situated as in *Thoracostoma*. A loose group of 3 setae (4 in 1 specimen) posterior to amphid. Cervical setae arranged in 5 or 6 longitudinal ranks, with setae loosely-organized within each rank; ranks more obvious in male.

Ocelli with crystalline lens and red pigment 94-122 (105) μ from anterior end; diffuse pigment scattered along margins of oesophagus from ocelli to oesophageal base. Nerve ring prominent, located 445-486 (457) μ from anterior, or 33-36.6 (34.3)% of oesophageal length. Small oesophageal-intestinal valve, 30 μ long. Excretory pore and and gland cell absent. Caudal glands extending anterior to anus.

Female reproductive system amphidelphic, with ovaries reflexed almost to vulva. Two-three brown oocytes in oviduct; 1 or 2 fully mature ova with shell in each uterus. Ova when single 311-460 (385) x 81-102 (92) μ; ova when 2 in uterus 300-392 (329) x 95-108 (106) μ. Vagina highly muscular; vulva sclerotized.

Male reproductive system double. Spicules thick, cephalated, 128-148 μ long. Gubernaculum with paired vertical pieces (corpora), 70-80 μ long; cuneus with sleeve around spicules; crura reduced. Muscles of spicules and gubernaculum as in previous species. One pair of muscle bands in postanal region, the *levator ani*. Large tubular ventral supplement at head of spicules, 80 μ anterior to anus; 7-9 (12 in one) pretubal hemispherical subventral papillae with setae, 3-4 smaller ones between tubular supplement and anus, and 2 pairs postanal, reduced to setae only.

Female dimensions (10 ♀♀).—Length 8.1-10.7 (9.4) mm.; a, 72-91 (80); b, 6.4-7.9 (7.1); c, 106-124 (115); V, 60-67.4 (63.7)%; Ov_1, 9-14.3 (11.8)%; Ov_2, 9-13.4 (11.7)%.

Syntype female.—L. 9.3 mm; a, 80; b, 7.3; c, 117; V, 65.6%; Ov_1, 13.6%; Ov_2, 10.7%; ocelli 95 μ; nerve ring 460 μ or 36%; ova 2 + 1, 338 x 108 μ and 324 x 102 μ.

Male dimensions (10 ♂♂).—Length 8.1-11.7 (9.2) mm.; a, 82-109 (91); b, 6.3-8.9 (7.2); c, 99-167 (127).

Syntype male.—L. 8.9 mm.; a, 81; b, 7.3; c, 110; spicules 144 μ; 8 pairs pretubal subventral papillae, 4 pairs between supplement and anus.

Discussion.—The present species in the form of the head capsule seems closest to the type species, *Leptosomatides euxina* Filipjev, 1918, although the cephalic capsule in that species is not clearly figured. The latter has smaller amphids, situated more posterior to the capsule than in *L. reducta.* Moreover, in *L. euxina* the spicules are unequal and are not distinctly cephalated. *L. conisetosa* Stekhoven & Mawson, 1955, is most similar to *L. reducta* in the structure of the male tail but the cephalic capsule in that species is well developed, with a truncate cephalic suture, situated 25 μ from the anterior end, at the posterior of the lobes.

Pontonema multisetosus n.sp. (Pl. 2, F-H)

Description.—Body once or twice coiled, practically of constant width except for a slight taper toward the tail end. Tail very short and bluntly-rounded, coiled in circle. Colour dark red, due to dense red granules in anterior half of oesophagus and in intestinal cells, except just before rectum. Granules correspond to red pigment contained in stoma and in intestinal lumen, possibly from a sponge. Cuticle of many thin layers; striation not observed.

Head truncate. Stoma 112-114 μ deep, 52-54 μ wide. Dorsal tooth short; 2 subventral teeth reaching to same level, just anterior to amphid. Inner circle of 6 small papillae; external circle of 12 setae of equal length (12 μ). Numerous scattered subcephalic setae; fewer cervical setae. Amphids circular, 16-17 μ wide or 20% of head diameter, with thickened base and central pore; sensilla broad with numerous fine terminals. Hypodermal gland cells prominent posterior to oesophagus, averaging 50 x 15 μ, with fine pore opening through cuticle. Oesophagus clavate, muscular, 1.08-1.15 mm. long, 80 μ wide at base. Nerve ring at 25%, inconspicuous. Excretory pore and duct not seen; narrow excretory cell extending below oesophageal base. Hemispherical oesophageal-intestinal valve, 30 μ long.

Male reproductive system double; testes outstretched. Spicules distinctly cephalated, arcuate, 192-208 μ long. Gubernaculum 70-74 μ long, adjacent to spicules. Three preanal ventral supplements, the first 35-45 μ anterior to anus, the second 82 μ anterior to first, and the third 135-162 μ anterior to second. Anterior supplement with a large papilla on either side, middle supplement with 2 internal setose innervations, and posterior supplement with a fine tubular innervation. Numerous fine paired subventral setae just anterior to anus, 5 between anus and first supplement, and 3 or 4 at or anterior to supplement.

Numerous copulatory muscles extending far forward from anus. Caudal glands opening by a large spinneret, with protruding lips. One pair of narrow *levator ani* muscles in tail tip; 1 vertical pair of muscles from side of gubernaculum to dorsal wall and 1 muscle from distal end to dorsal wall of tail tip; 2 pairs fine muscles from spinneret to dorsal wall.

Male dimensions (3♂♂).—Length 6-7.3 (6.4) mm.; a, 32-42 (38); b, 5.6-6.3 (6); c, 160-171 (165); T_1, 15%; T_2, 18%.

Holotype male.—L. 7.3 mm.; a, 42; b, 6.3; c, 162; spicules 192 μ; gubernaculum 74 μ.

Discussion.—This species differs from all the other species of *Pontonema* particularly in the possession of 12 cephalic setae and numerous subcephalic setae. The presence of 3 preanal ventral supplements instead of only 1 is also distinctive.

There is much variation in the genus *Pontonema*, both in the arrangement of cephalic setae and in the spicular apparatus. Therefore, particularly in the absence of the female, we are accommodating our species to this genus in spite of its differences. However, a new genus may have to be created for it in the future.

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Malayan Sambar

Civet Cat (Musang) taking banana bait. Distance 5 feet and flash synchronisation.

Photos : H. J. Kitchener

Wild Life Flash Photography[1]

BY

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(*With a plate*)

For some twenty odd years I have been a photographer of wild life in the Malayan jungle with some measure of success in the daylight field. But not until eighteen months ago did I turn my attention to night photography—after watching a large sambar stag, hind, and fortnight-old fawn one moonlight night from a hide near a a salt lick.

My cameras are an Agiflex III, $2\frac{1}{4} \times 2\frac{1}{4}$, with a 24 cm. tele lens and a 35 mm. Kine Exakta VX with a 13.5 cm. tele lens. These cameras are used side by side on a brass bar which is fitted on to a turn-tilt head on a very heavy solid tripod. The tripod is firmly established at one observation window of the hide. At the other window two flashguns are mounted either on tripods or posts driven into the ground. A third flashgun—an extension unit from one of the two main flashguns—is mounted on a post at the corner of the hide some 8 feet away from the cameras and 6 feet above them.

The equipment is assembled, all contacts checked and mounted at the hide during the day. The cameras are focused on a particular spot at the edge or centre of a salt lick or waterhole. The loading of the film into the cameras is done as late as possible during the day, for humidity is always high and the film can quickly become sticky and difficult to wind, due to absorption of moisture in the atmosphere.

The hide should be prepared with an eye to prevailing evening and night winds or breezes, which in Malaya are constant, for a gentle breeze carrying human scent across the lick or waterhole is sufficient to keep all animals away. As little clearing as possible should be done near the hide or the lick, except that any vegetation below the cameras or to the immediate right and left should be carefully removed, for when the flashbulb is fired such obstacles reflect light into the camera lens and can cause fogging.

The sequence of operation is very simple but should be practised until each movement becomes automatic, for everything is done in

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[1] Reproduced from *Oryx* **4** (6), December 1958, with the kind permission of the editor.

complete darkness. So soon as an animal appears at approximately the point of focus, the shutters of both cameras, which have been set at 'Time', are opened. A quick, quiet move to a flashgun fires its bulb and the shutters are closed. The film is then wound on to the next exposure and the fired flashbulb replaced with a fresh one. With care, it is possible to obtain several exposures in this way, the three flashguns making possible three exposures in a matter of some three or four minutes.

This method, known as 'open flash', is most suitable for this type of work, because the full light output of the bulb is used to produce a negative of good density. I have obtained satisfactory results with a G.E. No. 50 flashbulb at a range of 100-120 feet, at f 5.5, using Kodak Verichrome Panchromatic, with the Agiflex III, or Kodak Plus-X with the Exakta VX. Kodak Tri-X with the Agiflex produces somewhat denser negatives. The use of Ilford HPS in either camera resulted in very over-exposed negatives at this range, particularly with the 13.5 cm. lens on the Exakta. The use of the G.E. No. 22 flashbulb, instead of the No. 50, helped to correct this.

On a cool night, slight mist rising from swampy ground may slightly fog the negative. Attempts to take photographs during rain were disastrous; each falling raindrop registers as a streak, widest near the lens and decreasing in width as the distance from lens increases.

Sambar, seladang (*Bos gaurus*), tapir, and wild pig react rather quickly to the flash during nights when there is the slightest trace of moonlight, leaving the scene after two or at the most three flashbulbs have been fired. On the other hand, during pitch black nights, as many as eight, twelve, or fifteen exposures may be made with no reaction except the raising of a head for a few seconds. The younger animals seem to be the most suspicious of a flashbulb.

I do not think I am crediting these jungle animals with intelligence unjustifiably when I say that their disregard for the firing of flashbulbs on moonless nights is due to their knowledge of natural phenomena. In Malaya at practically any time of night flashes of lightning may be seen on the horizon or closer. During moonlight nights these flashes are distant flickerings invisible from the dense cover of the jungle, but during a storm they are almost blinding in intensity and usually accompanied by terrific claps and reverberating peals and rolls of thunder. On several occasions I have obtained quite reasonable negatives when a bright flash of lightning has beaten me to the flashgun after I have opened the camera shutters.

The animals take not the slightest notice of these storms but continue to graze and browse throughout them. They accept, as a matter of course, intense flashes in the inky blackness and, on a dark

night, likewise accept the rather similar flashes of flashbulbs. But they know enough to be extremely suspicious of an intensely bright flash when there are no clouds and when a moon is visible.

The operation of the cameras, changing of flashbulbs, loading cameras with fresh film, and other necessary movements must be carried out with the absolute minimum of noise and movement. No sounds travel further on the still, soft silence of the jungle than the click of metal on metal and the tap of a flashbulb on the metal reflector or flashbulb socket in the gun.

The equipment described for these 'open flash' photographs is only effective for the larger animals frequenting a fixed spot in fairly open ground and at a distance which permits the photographer to be present. The problem of the smaller creatures which do not visit salt licks or similar open spaces, and of carnivores, is different and after considerable experiment I found the best plan was to get the creatures to take their own photographs by using a trip thread or a bait.

The first difficulty was elephants. It would have been unwise to leave such expensive cameras as the Agiflex and Exakta with their flashguns in the jungle, for when an article belonging to a human being is discovered by an elephant, it is soon rendered useless.

After much searching and many trials I chose the Super Richoflex, a Japanese twin-lens reflex $2\frac{1}{4}\times2\frac{1}{4}$ camera. It answered all the requirements of synchronized flash and would take a solenoid in the cable release socket comfortably. It was comparatively cheap—there would be no heart-burning should elephants pass that way. I bought four of these cameras. For the same reasons I chose and adapted four Japanese flashguns, Mimiyas.

The apparatus for this synchronized flash photography consists basically of a trip thread or bait thread which works at coarse or hair-trigger setting. It runs to a trigger box in which there is a spring contact. A lead connects this contact to a solenoid which is screwed into the cable release of the camera and operated by eight to ten U2 torch cells. The flashbulb is operated by two No. 412, $22\frac{1}{2}$ volt batteries.

Pressure on the trip thread releases the spring contact in the trigger box; closing the contact closes also the circuit of the solenoid and operates the camera shutter. The camera shutter operates the flashgun and flashbulb, thus making the exposure.

For the trip thread braided nylon fishing line of 16-30 lb. breaking strain is used in preference to wire, which may well injure an animal. This nylon line is odourless, undetectable even in daylight, and stretches very little; neither sun, heat, nor wet affect it. Ordinary sewing thread was originally used to connect the trip thread to the

spring contact in the trigger box but termites showed a great liking for it and ate all they could find.

The key to success is knowledge of the habits of the animal. When these are known, a little thought and ingenuity will provide suitable adjustments to the equipment. For example, the only really effective bait for a prowling mouse-deer is a hanging bunch of leaves of the mamaya or ludai, *Sapium baccatum*, in English the Mouse-deer's Rubber Tree. A tug by the deer on the lower leaves operates the spring contacts and the photograph is taken.

It is not often possible to get a longer range than 30 feet in the jungle without extensive cutting and clearing of undergrowth, which may well disturb the animals and perhaps add an artificial look to the resulting print. The largest elephant in the country will fit quite comfortably at a range of 30 feet on the $2\frac{1}{4} \times 2\frac{1}{4}$ format, while tapir, tiger, deer, and seladang will be well covered without any bother.

For real close-up work on mouse-deer, civets, wild dog, and porcupine ranges from $3\frac{1}{2}$ feet to 8 feet are suitable. The smaller flashbulbs SM Nos. 5 and 8 are ideal for these ranges although the aperture will have to be kept well closed down if the flash factors given on the flashbulb carton are used. In this close-up photography over-exposure seems more likely than under-exposure, probably because the subject is invariably in the 'hot spot' of the flashgun reflector beam.

Many hazards and difficulties have to be surmounted in the humid rain forests of Malaya. Torrential rain and constant damp make it imperative that all cameras, flashguns, battery boxes, and trigger boxes are housed as effectively as possible. These methods of animal self-portraiture would give good results in other countries, particularly for the smaller animals in timbered or scrub country, or where animals follow well-defined trails from rivers and swamps to browse away from the water during the night. Ingenuity and a knowledge of the use of tools go a long way towards success.

Note.—The writer will be only too happy to supply wild life photographers in India and Africa with details of this equipment and the wiring plan if they consider that they will find it of any practical use in furthering their work and enable them to obtain photographs of wild life which they cannot otherwise get by ordinary daylight photography.

One small assurance will, however, be asked in this connection before details and wiring plan are forwarded.

Observations on the Taxonomic Characters of *Triops orientalis* (Tiwari), with a note on its Biology

BY

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(*With a plate*)

INTRODUCTION

The genus *Triops* Schrank belongs to the order Notostraca of Euphyllopod Crustacea with shield-shaped carapace. Keilhack (1909), Fox (1949), and Longhurst (1955) have suggested that the generic name *Apus* Schaeffer, 1765, should be rejected in favour of *Triops* Schrank, 1803. This practice will avoid further confusion of this genus with the equally well-known avian genus *Apus* Scopoli, 1777. We therefore propose to follow the above-mentioned authors in the use of the generic name *Triops*.

The great rarity of *Triops* and other branchiopods makes this group of special interest to zoologists all over the world. In India, *Triops* has been recorded from only a few places. The present work deals with *Triops orientalis* (Tiwari) specimens of which were collected from the waterpools at Panchgani, N. Satara (W. India), during the months of July to November 1956.

The taxonomy of the Notostraca has been based entirely on characters of the setae and spines which comprise the armature of the exoskeleton, and on the various body proportions. The validity of these characters have been discussed by Barnard (1929), Gauthier (1933), Linder (1952), and Longhurst (1955). Various characters of taxonomic importance suggested by these workers have been studied here separately. In addition, observations are also made on the feeding habits and the sex-ratio with a view to re-examine the findings of Gurney (1925), Fox (1949), and Tiwari (1951).

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[1] The financial assistance given to the first author (A. A. K.) during this investigation by the Sir Dorabji Tata Trust through the Bombay Natural History Society is gratefully acknowledged.

Colour

The adult body colour in *T. orientalis* is useful in distinguishing the sexes both in the fresh and the formalin preserved material. While juveniles of both sexes are more or less alike in body colour, Gurney (1925) has rightly described the adult females as deep green, the males being paler and tending more towards a brownish tinge. However, in the material we have studied, we find that the males are yellowish red rather than brownish in colour.

The colour is due to the presence of two pigments within the body and the brown pigment in the exoskeleton (Longhurst, 1955). It is also observed that in a number of specimens, particularly in females, a coating of green algae gives an added green colour to the body.

A dark blue-green pigment is generally more abundant in *Lepidurus* which is the only other genus in the order Notostraca. This may be completely absent in some species of *Triops*, but in *T. orientalis*, however, this pigment is present particularly at the basal ends of the thoracic limbs, the edges of the labrum, and the anterior ventral edge of the head. It is abundant in well-grown and healthy forms as was noted by Longhurst (1955). Fox (1945) attributed the intensity of red coloration to haemoglobin depending upon the oxygen content in the surrounding water, varying inversely with the O_2 content.

Our observations indicate that the forms that are bright red are full grown and healthy. The exoskeleton in such animals is also strong in contrast to those showing pale yellowish colour. The red coloured forms are more abundant when the conditions of the pond are more favourable, while the yellowish red forms are more abundant when the season is almost at the end and the ponds begin to dry. It would therefore appear that the difference in coloration need not necessarily be due to poor O_2 content in the surrounding water, but could be a sign of good health of the animal.

Size

Under normal conditions males and females do not show any significant difference in size. The growth rate depends upon various conditions, as was seen in animals kept under laboratory observation. Table I shows the percentage of different size groups collected at various times during the season. It will be seen from this table that the group measuring 2 cm. to 3.9 cm. is predominant and could be taken to represent the average size of the adult form.

TABLE I

showing the percentage of different size groups in a total collection made in one complete season in 1956

Size group	*Percentage*
0 cm. to 0.9 cm.	0.66%
0.9 cm. to 1.9 cm.	22%
1.9 cm. to 2.9 cm.	36.94%
2.9 cm. to 3.9 cm.	35.86%
3.9 cm. to 4.6 cm.	4.44%

CARAPACE (Fig. 1)

The size and shape of the carapace are usually considered as important taxonomic characters (Ghigi, 1921, and Tiwari, 1951), while Linder (1952) attaches little importance to these. The differences in these characters in both males and females of *T. orientalis* are not significant enough to consider them as taxonomically important.

The validity of length/width relationship of the carapace as a taxonomic character has been studied in some South African species of *Triops*. In *T. orientalis* the length and the width of the carapace is practically the same. This may be characteristic for the species.

The carinal spines (*cs*) on the carapace which are not arranged in a straight line but show various patterns are short, blunt processes, the numbers of which vary from 1 to 6. The majority of individuals have 3 or 4.

Longhurst (1955) suggests that there is a loose correlation between the occurrence of the terminal spines (*ts*) and other characters. In *T. orientalis* the only correlation that we find is between the terminal spine and the body-length. In the long-bodied forms it is usually absent but when present it is much reduced, while in short-bodied forms it is well developed.

The sulcal spines (*ss*) on the posterior emargination of the carapace show considerable variation between individuals. For this reason, Barnard (1929) and Longhurst (1955) reject its use as a taxonomic character. We find that the number of sulcal spines ranges from 42 to 71, the majority showing between 50 and 60 spines. It would appear that the minimum number of 42 spines agrees well with the condition observed by Tiwari (1952) and may be taken to represent a character of taxonomic significance. The maximum number of the spines is, however, variable.

BODY SEGMENTS

T. orientalis resembles many other species of this genus in being not nomomeristic. Both the leg-bearing segments and the apodal

segments show variations in number and are combined in different ways, so as to give a total number varying from 35 to 40. No correlation was found to exist between the total number of segments and the body length (Table II).

TABLE II

showing the body length, carapace length, and the body segment relationship

Length of animal	*Length of carapace*	*Total no. of segments*
4.4 cm.	1.8 cm.	39
4.1 cm.	1.8 cm.	38
3.9 cm.	1.7 cm.	38
3.9 cm.	1.3 cm.	38
3.8 cm.	1.6 cm.	39
3.7 cm.	1.7 cm.	38
3.4 cm.	1.4 cm.	39
3.4 cm.	1.4 cm.	38
3.3 cm.	1.5 cm.	39
3.3 cm.	1.6 cm.	38
3.2 cm.	1.4 cm.	35
3.2 cm.	1.5 cm.	39
3.1 cm.	1.4 cm.	38
3.1 cm.	1.6 cm.	40
3.0 cm.	1.5 cm.	38
2.9 cm.	1.3 cm.	38
2.8 cm.	1.3 cm.	36
2.5 cm.	1.4 cm.	38

TABLE III

A. Males

Size of animal	*Leg-bearing segments*	*No. of legs*	*Place of 30th pair of legs*
4.9 cm.	26	51	8
3.7 cm.	26	50	9
3.6 cm.	26	48	9
3.6 cm.	26	50	8
3.4 cm.	25	45	10
3.3 cm.	26	53	10
3.3 cm.	25	47	—
3.2 cm.	25	48	8
3.1 cm.	26	47	10
3.1 cm.	24	49	8
3.0 cm.	25	47	8
3.0 cm.	26	53	9
2.8 cm.	26	52	7
2.7 cm.	24	49	10
2.6 cm.	27	49	10
2.4 cm.	26	48	9
2.2 cm.	26	46	10
2.2 cm.	26	52	9
2.1 cm.	26	52	9

B. Females

Size of animal	*Leg-bearing segments*	*No. of legs*	*Place of 30th pair of legs*
3.4 cm.	28	53	7
3.4 cm.	28	55	9
3.3 cm.	26	51	9
3.0 cm.	27	51	—
3.0 cm.	28	57	7
2.8 cm.	28	51	9
2.5 cm.	28	55	7
2.5 cm.	27	58	7
2.5 cm.	26	54	—
2.2 cm.	—	—	—
2.4 cm.	27	53	8
2.4 cm.	28	55	9
2.4 cm.	27	50	—
2.4 cm.	26	50	8
2.4 cm.	27	54	9
2.3 cm.	28	51	7
2.2 cm.	27	52	8
2.2 cm.	28	51	7

Pedal segments (Table III A, B)

In *T. orientalis*, the number of leg-bearing segments ranges from 24 and 28. Usually, the females have more leg-bearing segments, varying between 26 and 28, while in the males they are 24 to 27. The high number of leg-bearing segments is correlated with a corresponding higher number of body segments, especially in females.

Exposed segments

There is a great variation in the number of exposed segments, which ranges between 15 and 27. However, in the majority of forms the number recorded is 21 to 23. Generally, in the forms measuring above 3 cm. the range of exposed segments is 23 to 27 and in those measuring below 3 cm. the range is 19 to 26. Being so highly variable, the exposed segments are not considered as of taxonomic importance.

Limbs

In *T. orientalis*, the number of legs also varies between 45 and 58 and as shown in the Table (III A, B) their number is more in females than in males. Linder (1952) has noted this phenomenon in certain N. American species of *Triops*. As will be seen from the table there appears to be no relation between the number of legs and the body length. A pair of legs, except perhaps the first few pairs, has no definite position on the segment either in the male or the female. Table III clearly shows the place of the 30th pair of legs on the body segments.

Telson (Fig. 2)

Longhurst (1955) observes that *Triops* from different regions show a strong correlation between the geographical distribution and the spine pattern of the telson. A study of the armature of the telson in *T. orientalis* reveals that this species may be related to those of *Triops* found in Europe, W. Russia, N. Africa, the Middle East, and N. India. All these forms, according to Longhurst (1955), show a small number of median spines (*ms*) arranged in a row in the centre of the telson. The furcal spines (*fs*) are few and large, while the posterior marginals (*pms*) are small and thin.

In *T. orientalis*, the pattern of the spines on the telson remains constant unlike most of the non-Indian species of *Triops*. The number of the median spines varies from 0 to 6, but generally it is 2 or 3 irrespective of size or sex (Table IV).

Table IV

showing variations in the no. of median spines in 135 specimens examined.

No. of median spines ..	0	1	2	3	4	5	6
Number of occurrences ..	1	10	39	57	19	6	3

The furcal spines are well developed and number 5 to 7. The setal spines (*sts*) do not show much variation in their pattern but their number varies from 2 to 6. The number of dorsal spines vary with the size of the individual. As many as 150 spines were counted in a specimen measuring 3.8 cm.

Second Antenna

It is of special interest to note that the second antenna is present in this particular Indian species. It is a small hook-like structure on the sub-frontal plate.

Habits

Triops inhabit temporary water pools, which are formed during the monsoon and are available from about the beginning of July to the middle of November, when the Tableland at Panchgani is covered with a large number of ponds of varying sizes. These temporary waterpools are at the most knee-deep, and therefore it is very easy to catch *Triops* and allied forms without the help of nets. These animals lay resting eggs which are able to withstand desiccation for considerable periods and may be collected during the dry season.

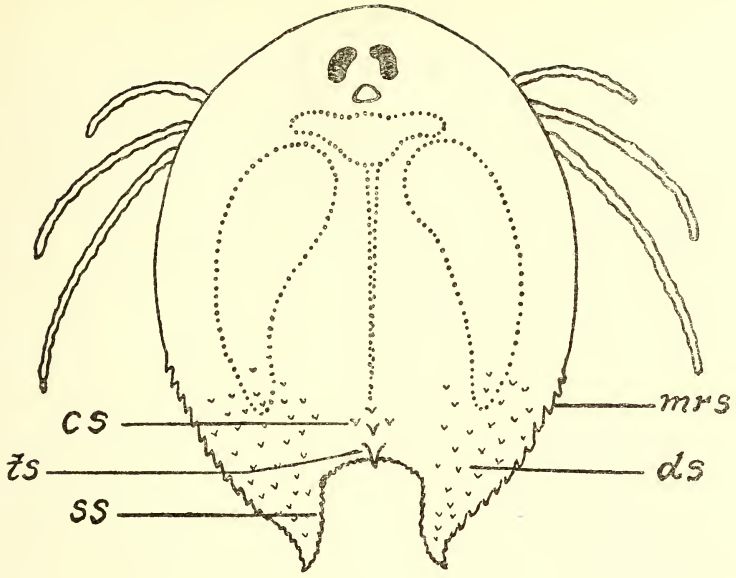

FIG. 1

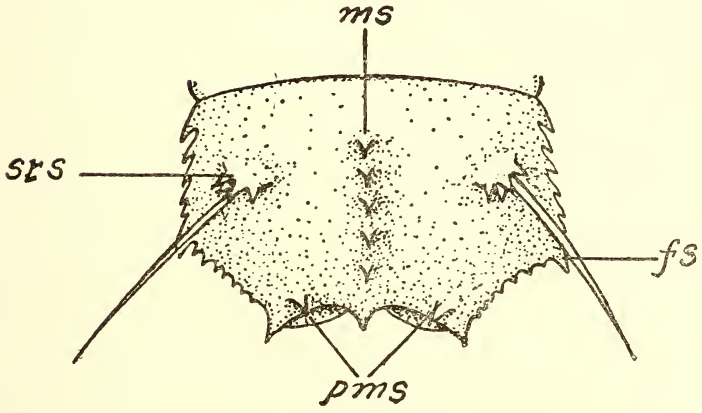

FIG. 2

Triops orientalis

Fig. 1. Carapace : *ds* dorsal spines; *ts* terminal spine; *cs* carinal spines; *ss* sulcal spines; *mrs* marginal spines.

Fig. 2. Telson : *ms* median spines; *sts* setal spines; *pms* posterior marginal spines; *fs* furcal spines. (Enlarged).

It has been observed that *Triops* feed on bacteria, protozoa, *Daphnia*, Copepoda, small oligochaetes, and also on *Streptocephalus*, and Leptestheriied forms. However, they find it difficult to eat forms like *Estheria* as the latter are covered with hard bivalve shells. Usually, it catches hold of its prey and with powerful pairs of mandibles and the first maxillary blades tears off the carapace and eats the soft parts of the body. This has been confirmed by the examination of the alimentary canals, where a large amount of semi-digested food is present. Particularly, parts like the second antenna, limbs, and the telson of *Estheria* are of common occurrence, together with shells of *Daphnia* and different hard parts of its own kind.

Triops exhibit cannibalism and it is interesting to note that even a small individual can easily eat a bigger one. It catches its prey from the dorsal side, just posterior to the carapace. It divides its prey into two parts with the powerful mandibles, and eats up everything except the carapace, mandibles, and certain other hard parts of the body. It is also observed that a number of *Triops* together attack one individual and eat it completely.

Triops is recorded as a pest of rice cultivation in different parts of the world such as Kashmir (Walton & Kemp, 1911), Spain (Font de Mora, 1923), Italy (Tassinari, 1941), and California (Rosenberg, 1946). Fox (1949) observes that *Triops* are not harmful to the plants as they do not feed on them. However, we have observed *T. orientalis* eating the blades of grasses which it bites vigorously by means of the maxillae and the mandibles. This observation is supported by laboratory feeding and the examination of a large number of alimentary canals which showed numerous fragments of grasses.

A female *Triops* starts laying eggs when it reaches 1.5 cm. in length. The number of eggs laid by a single individual at a time ranges from 5 to 20. The egg-laying capacity increases with the age of the female. The eggs in the oostegopod are red in colour, but when liberated outside the body the colour becomes pale. These eggs remain stuck to the blades of grasses, and when the ponds dry up a large number of eggs are seen buried in the superficial layers of the soil.

The genus is well known for its discontinuous distribution. A number of favourable factors help in the thriving of *T. orientalis* in the rainwater pools on the Tableland at Panchgani. Here they appear to have no enemies except frogs and nematode worms, the latter being found as external parasites on the carapace. The rainwater pools being temporary, the eggs are adapted to withstand desiccation for considerably long periods. A large amount of food

is also available in the form of estherids, copepods, *Streptocephalus*, and *Daphnia*, all of which are found here in great abundance.

Sex-ratio

With a view to re-examine the findings of Tiwari (1951) and Gurney (1911) on the sex-ratio in *T. orientalis*, more than a thousand specimens were carefully studied. As many as thirteen trips were made to Panchagani, from the middle of June to the middle of November 1956. The collected material was placed in different size groups and the sex-ratio studied group-wise for every month of the season (Table V).

In June, with the onset of the monsoon, a number of them develop from the resting eggs, the females outnumber the males, the former constituting 65.4% and the latter 34.6% of the total catch.

In July, the sex-ratio in general does not show much variation in almost all the size groups.

In August, during the middle of the season, the females are still more numerous (females 53%; males 47%). The dominance of females over males is particularly noticeable in specimens measuring below 3 cm. while in the larger forms the males outnumber the females.

In September, in almost all the length-groups, females are more than males and constitute 67% of the total collection. The variations in the sex-ratio in all the size-groups are not very large, except in the 2 to 2.9 cm. group. This is the dominant size group in September and the females here outnumber the males by a large margin showing a ratio of 4:1.

The same condition was observed in October when out of 368 specimens collected, 62% were found to be females and 38% males. Group-wise analysis also revealed that in all size-groups females outnumber males by a considerable margin.

In November, at the end of the season, forms belonging to the late generation are found. Here, also, females predominate in numbers and in some samples the occurrence of males is quite negligible. Of the total collection made for the month, 84% are females (5:1) and in the 1.0 to 1.9 cm. group the female-male ratio is 13:1.

Males are generally known to be rare in Genus *Triops*. According to Gurney (1911) *T. orientalis* (=*Apus asiaticus*) males outnumber females. Tiwari (1951) also arrived at the same conclusion after examining collections from Panchagani but observed that 'as the samples do not appear to be random no statistical inference can be derived from them beyond the fact that males are quite abundant in this species'.

TABLE V

Sex-ratio in *Triops orientalis*
YEAR 1956

Size Group	June		July		August		September		October		November	
	Female	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*
0 cm.—0.9 cm. ..	—	11.5	—	—	—	—	1	—	—	—	—	—
1 cm.—1.9 cm. ..	65.4	23.1	26.5	26.5	16.5	2.5	12.5	9.5	6	3	52	4
2 cm.—2.9 cm. ..	—	—	22.5	24.5	22.5	12.5	36.5	8.5	22	9	32	12
3 cm.—3.9 cm. ..	—	—	—	1	10.5	26.5	15.5	13.5	31.5	24.5	—	—
4 cm.—4.9 cm. ..	—	—	—	—	3.5	5.5	1.5	1.5	2.5	1.5	—	—
	65.4	34.6	49	51	53	47	67	33	62	38	84	16

Figures given represent percentages.

The present investigation, which is based on a large material (1210 specimens) collected at different periods of the season, clearly shows that the females outnumbered the males throughout the period of their existence during the season 1956. At the same time what is more striking is that the males were fairly common and not rare as in most other species of *Triops*.

We agree (Table V) with Tiwari's findings that in samples where males outnumber females the individuals are large-sized.

Summary

The material of *T. orientalis* (Tiwari) collected at Panchgani, Bombay State, and recorded in this paper has led to the undermentioned conclusions:

1. The body colour is a useful character for distinguishing the sexes.

2. The predominant size of range of both males and females is 2 to 3.9 cm. although the maximum attained may be about 4.6 cm. for both sexes (Table I).

3. No significant difference is found in the total number of segments of males and females. In view of the considerable variations, the exposed segments do not appear to be of much taxonomic value.

4. The number of leg-bearing segments and legs in females is more than in males.

5. Unlike some non-Indian species of *Triops* the carapace shape and size are of little help in distinguishing the sexes.

6. A study of the armature of the telson reveals that this species may be related to those found in Europe, W. Russia, N. Africa, the Middle East, and N. India.

7. Periodic observations based on 1210 specimens show that the number of females in natural populations is several times greater than males.

8. *T. orientalis* appears to be omnivorous and was noted to feed both on grasses as also on other Estherids, Copepods, Fairy Shrimps, *Daphnia*, even showing cannibalistic tendencies.

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A Preliminary Tagging Experiment on the Mullet, *Mugil cephalus* Linnaeus, in Chilka Lake[1]

BY

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(*With three text-figures*)

The role of tagging in fishery science to elucidate fish migrations and delineate certain vital aspects of population dynamics of fishes is well known. In spite of its immense utility in fishery management this avenue has hitherto been closed to Indian biologists largely due to practical difficulties inherent in a large country like India where the industry is worked by illiterate and very superstitious fisher folk. Chilka Lake, with an expanse of over 400 sq. miles of water area, offered a suitable habitat to perform one of the first experiments of tagging fish in an Indian water which is briefly described in this paper. The species tagged was *Mugil cephalus* Linnaeus, the most important commercial mullet of the lake, and the tags tried were of Petersen's type of local make.

Preparation and description of the Tags: Each tag consisted of four pieces, viz. two celluloid discs (one pink and the other white) 16 mm. in diameter of 0.58 mm. thickness with a hole of diameter 1.04 mm. at the centre of each; one silver disc of diameter 12 mm. and thickness 0.33 mm. with a central hole of the same diameter as in celluloid discs, and one silver pin 48.5 mm. long and 0.75 mm. thick with one end twisted into a loop and the other ending in a sharp point. The silver and the coloured celluloid discs were serially numbered the discs of a particular tag bearing the same number. The pins had sufficient temper to enable them to be pierced straight through a muscular segment of fish body without undue injury. The celluloid discs were prepared in the laboratory from celluloid sheets with the aid of a steel punch (diameter 16 mm.) and a hammer and the central holes were made with a mechanical

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drill. The numbers on celluloid discs were engraved in the laboratory with a set of steel numbering punches and a hammer. Numbered silver discs and pins were made to order by a silversmith.

Figure 1 *a* shows the tag with all its four components in position; figure 1 *b*: one of the celluloid discs with a number thereon; figure 1 *c*: a specimen of *Mugil cephalus* with the tag on the caudal peduncle.

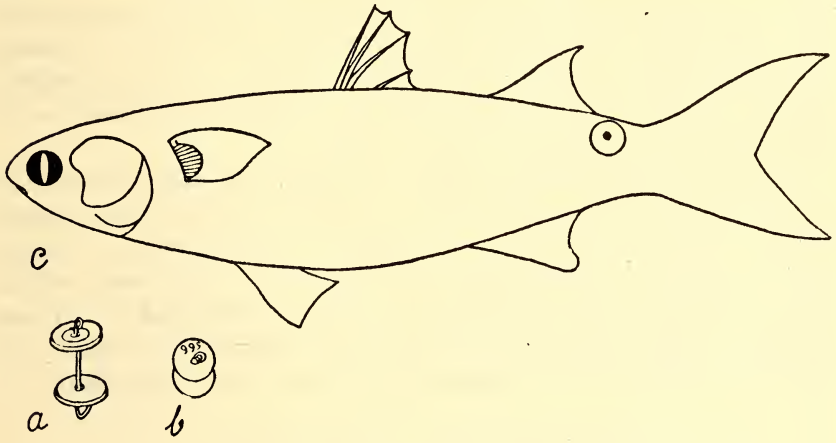

Fig. 1

Tagging operations: Live fish were procured from Nalban Jano[1] situated in about the middle of the lake and were temporarily stocked in a rectangular enclosure (called Gohora) measuring about 6.1×3.0×1.8 m. erected in a shallow region close to the source of the fish. A portion of the bamboo enclosure was cut into a window on one side both for admitting live fish into and for taking them out of the 'Gohora' for tagging. The height of the window was so fixed that its lower edge was flush with the boat deck which served as a base for tagging the fish and release into the lake. The numbered tags were serially pre-arranged and threaded through a piece of wire in bunches of 100 each. A team of four men was required for tagging: one for recapturing fish in the 'Gohora', another to hold it tight, partly wrapped in a wet towel, on a fish-measuring board in the tagging position, the third to perform the tagging operation and release the fish in the lake, and the fourth to enter the tag number and fish length in a log book and also to hand over a new tag to the tagger for the next fish. The fish lengths and tag numbers were read out by the third man, the tagger, who also gently plucked a few scales from the pectoral region of the fish which were promptly put in an envelope by the fourth man, who also quickly noted the

[1] "Jano" is the local name generally of a huge split bamboo enclosure used for trapping vast concentrations of fish in rather shallow areas, adjoining shore or round islands. See description by Devasundaram (1951), p. 24.

relevant tag number against the corresponding fish length on the cover. Tags were attached to the fish in the region just posterior to the second dorsal fin (fig. 1 *c*). In actual tagging the pin with a serially numbered coloured disc at its knotted end was pushed through the fish's flesh, and when the sharp pinpoint appeared on the other side of the fish's body, the numbered white celluloid disc followed by the silver one were quickly inserted and a knot given by twisting the pin-point with long-nosed pliers. The fish was then immediately released in the lake and was seen to swim away. In most cases the complete tagging of a fish, from its placement on the measuring board to its release in the lake, took less than a minute.

It was not found feasible to keep the tagged fish under observation for a few days prior to their release in the lake because of the danger of the water temperature in the shallow 'Gohora' rising to lethal limits. However, a week-long earlier experiment in a pond with a score of *Mugil cephalus* fingerlings with identical tags had shown that the tagged fish were healthy enough and compared favourably in vigour and vitality with untagged ones present in the same pond.

The Experiment and the Result

In the present experiment 998 specimens of *Mugil cephalus* of the total length range 264 mm. to 578 mm. (shown seriated into classes of 20 mm. interval in Table 1 and graphically shown in Fig. 2 A)

Table 1

Sizes and numbers of *Mugil cephalus* tagged and recovered

Class range in millimetres	Number tagged	Percentages of total tagged	Number recovered	Percentages of total recovered
1	2	3	4	5
261 - 280	5	0.5	—	—
281 - 300	18	1.8	1	2
301 - 320	69	6.9	5	10
321 - 340	154	15.4	11	22
341 - 360	280	28.1	12	24
361 - 380	334	33.5	15	30
381 - 400	114	11.4	5	10
401 - 420	13	1.3	—	—
421 - 440	3	0.3	1	2
441 - 460	4	0.4	—	—
461 - 480	2	0.2	—	—
481 - 500	—	—	—	—
501 - 520	—	—	—	—
521 - 540	1	0.1	—	—
541 - 560	—	—	—	—
561 - 580	1	0.1	—	—
Total ...	998	100.0	50	100

TABLE 2

Details of tagging and recoveries

Serial No.	Station location near Nalban Jano	Date of tagging	No. of specimens tagged	Percentage of total in each operation	No. of specimens recovered in weeks after tagging					Total recoveries	Percentage of total recoveries
					I	II	III	IV	later		
1	2	3	4	5	6					7	8
I	North-western face ..	3-11-'57	41	4.1	—	—	—	—	—	—	—
II	Do. ..	4-11-'57	116	11.6	2	1	—	1	—	4	8.0
III	Do. ..	5-11-'57	49	4.9	1	—	—	—	—	1	2.0
IV	South-eastern face ..	6-11-'57	78	7.8	2	1	1	0	—	4	8.0
V	Do. ..	8-11-'57	266	26.7	6	0	2	1	—	9	18.0
VI	Do. ..	9-11-'57	448	44.9	25	—	6	0	1	32	64.0
Total ..			998	100.0	36	2	9	2	1	50	100.0
Percentage of total no. tagged ..					3.6	0.2	0.9	0.2	0.1	5.0	

TABLE 3

Sites and numbers of release and recapture

Site of release & numbers released	SITE OF CAPTURE AND NUMBERS CAUGHT AT EACH								TOTAL
	Between Nalban & Parikud	Off Nuapara	Tentadhua Jano near Nuapara	Off Nalban	Off Kallikota	Off Mohasa	Off Satpara	Unknown site	
North-western face of Nalban (206)	3	2	—	—	—	—	—	—	5
South-eastern face of Nalban (792)	20	9	2	9	1	2	1	1	45
Total ..	23	11	2	9	1	2	1	1	50

were tagged from two tagging stations, situated near Nalban Jano, on six different days between third and ninth November 1957.

Table 2 furnishes the details of the number tagged on various days as well as the recoveries of tagged fish. Table 3 shows the names of sites of release of tagged fish, numbers released at each, names of sites of recapture, and the numbers caught at each. The map (fig. 3) presents the sites of release and recapture in the Chilka Lake indicating the distribution pattern of the tagged fish and their directions of movement after tagging. In all the fifty recoveries except two the tagged fish were returned by the fishermen to the laboratory and were personally examined by one or the other author. Five per cent of the total number of fish tagged in this experiment were recovered. 72% of the recoveries were obtained in the first week after tagging, 4% in the second week, 18% in the third week, 4% in the fourth week, and 2% still later. Taking each tagging operation on a different day as a separate unit the recoveries ranged in percentage from 0 to 7.1. Taking the total number of tagged fish released as the entire population, attempts were made to determine the extent to which the recovered specimens were representative of the population in so far as the size composition was concerned[1]. A fairly close correspondence is clearly brought out between the numbers of fish tagged and of tagged fish recovered in the different size-groups. Panel B of Fig. 2 gives the percentage of different size-classes of tagged recovered fish superimposed, as it were, on the percentages of different size-classes tagged. A close correspondence between the two is obvious. Chi-square test was applied to test the statistical significance of the differences between the percentage frequency of specimens of different size-classes tagged and percentage frequency of different size-classes of the total of tagged recovered fish. $P\chi^2$ works out to $> 0.158 < 0.199$ so that the differences between the two frequencies is insignificant. The conclusion may thus be drawn that the percentage frequency of each class of fish tagged is not significantly different from the percentage frequency of tagged recovered fish of each class using 95% fiducial limits.

As most of the recoveries were made during the 1st-4th weeks of tagging no idea of growth or growth rate can be got from the present experiment. In most cases the recaptured fish measured about the same as at the time of tagging, however enabling the comparisons

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[1] This comparison was attempted as recoveries were made within a short time of tagging, and the recovered fish measured about the same as when tagged.

shown in Fig. 2 to be made. Unfortunately in the case of the recovery made later than the fourth week (date of tagging: 9-11-'57 and of recovery 22-4-'58) only the tag was returned.

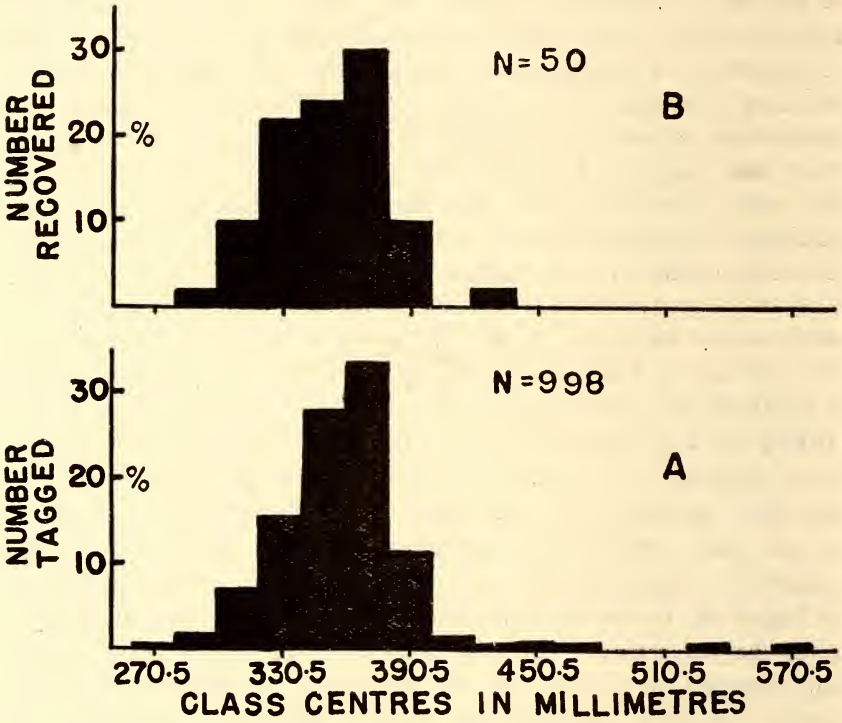

Figure 2. Comparison of size frequency distributions of fish tagged and tagged fish recovered

Conclusions and Discussion

The aim of the current experiment was to see to what extent tagging can be utilised in the Chilka Lake to elucidate fish migrations, rate of exploitation, and other aspects of the population dynamics of the lake's fisheries. Judged from the results obtained this experiment may be termed to have yielded very encouraging results especially when it is borne in mind that adequate propaganda could not be done to ensure the return of all tagged fish captured by the fishermen. A return of 5% tagged fish under these circumstances is considered high enough to attempt further tagging. However, many recovered tagged fish had developed a septic wound at the site of the application of the tag. In future experiments this will have to be safeguarded against. The source of live fish will also have to be changed because as a rule the jano owners handle the fish very roughly and many in the present experiment were not up to the mark in general condition.

In spite of all these drawbacks, on the basis of the available data in the current experiment a correlation between size groups of tagged and recovered fish, referred to earlier, is clearly seen, although to attempt such a correlation was by no means an aim of this experiment. Reports were received on several occasions that fishermen had captured tagged fish in different sections of the lake but the tags were thrown away and the fish consumed or exported. From the locations of the captured tagged fish it is inferred that the tagged fish had a tendency to spread out in different directions and mix with the population of the lake which tends to prove one of the basic assumptions of a tagging experiment (Fig. 3, map).

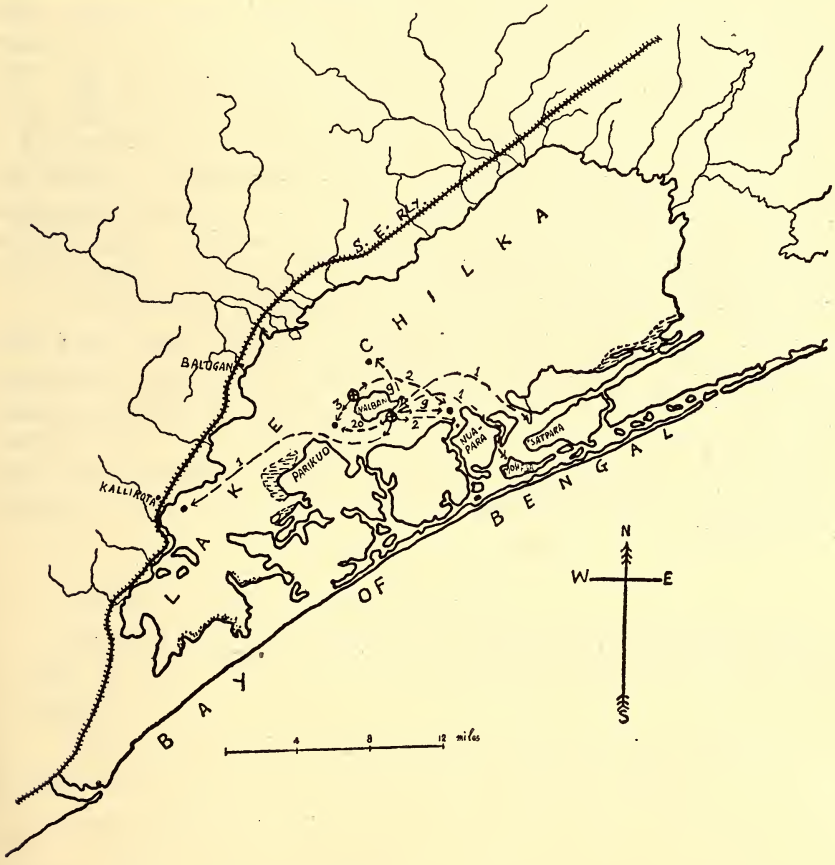

Figure 3. Map of Chilka Lake showing sites of release and recapture. The two sites of release are marked with a cross inside a circle and approximate sites of capture with large black dots. Probable routes of movement are indicated by arrows and broken lines. Numbers in the vicinity of broken lines denote the number of tagged fish collected at each site of capture.

Other sources of study in the lake have revealed that mature *M. cephalus* perform a regular seaward migration during the months

September-December. The sizes of the migrating males and females are also known. While performing tagging operations in the present experiment attempts were made to ascertain, as far as possible, the number of ripe specimens by external means. In 106 cases ripe males, and in 3 cases ripe females could be so spotted among the specimens tagged. The vast majority of the fish tagged were immature (probably I and II year classes) which on present-day knowledge are not expected to migrate to the sea. In one instance a mature male tagged specimen was caught heading in the direction of the outer channel connecting Chilka Lake with the sea, at a distance of about 15 miles from the site of tagging. In a few cases some tagged specimens (one immature female measuring 380 mm. in total length and one immature male measuring 330 mm. in total length) were found to have been caught in another jano which was installed and operated at a later date than the Nalban Jano, indicating thereby that some such fish have a tendency to move to shallow areas presumably for feeding. It is of interest to note that the majority of fish caught in janos are immature specimens. In all other cases tagged fish were recovered from deep waters of the lake in gill net operations. The present experiment may now be considered as closed because there are no more reasonable chances left of the recovery of tagged fish.

If by ample and timely propaganda in future work the Chilka fishermen can be persuaded to return faithfully or report all tagged fish found in their catches giving the locations of capture and also record the proportions of tagged to untagged fish in their catches, tagging can be successfully utilised in the lake to elucidate such vital aspects of the lake's fisheries as have a bearing on sound fisheries management.

Reference

Devasundaram, M. P. (1951) : Fishing methods for Chilka mullets. *Ind. Farming* Vol. XII, Nos. 1-2, Jan.-Feb. 1951.

Some Medicinal Weeds in and around Pondicherry

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Introduction

Our knowledge regarding the botany of this State starts in 1858 from the times of the famous French botanist M. Perottett. Achart (1905), Giboin (1949), and Parmananda (1937) have mentioned some plants from Pondicherry, but their work is not confined to Pondicherry alone. Recently Shankaranarayan and Dabholkar (1958) have given an account of the flora of this place. The present paper embodies the results of the studies of the authors on the weeds of Pondicherry, and their medicinal uses. The weeds were collected during their flowering season. The plants have been arranged according to Bentham and Hooker's system of classification and are preserved in the Herbarium of the French Institute, Pondicherry.

List of the Medicinal Weeds

Menispermaceae

1. **Cissampelos pareira** Linn.

Local name : *Vattetironpicedy*. Hindi name : *Nirbisi*. Habit : A lofty climber. Flowers : Greenish (male & female both), October to December.

Uses : Roots used to relieve pain and are useful in nephritic conditions, dysentery, heart troubles, and urinary disorders.

2. **Cocculus hirsutus** Diels.

Syn. *Cocculus villosus* DC.

Local name : *Kattukodi*. Hindi name : *Jamti-ki-leel*. Habit : A climber in hedges. Flowers : Greenish, January to February.

Uses : The juice of the leaves mixed with water coagulates in a jelly-like substance that is taken internally with sugar. Leaves and roots are used in rheumatic pains.

PAPAVERACEAE

3. **Argemone mexicana** Linn.

Local name : *Bramadandu.* Hindi name : *Sialkanta.* Habit : Erect annual spiny herb. Flowers : Yellow, throughout the year.

Uses : Oil from the seeds is purgative and used in various skin diseases. The grains are purgative and vomitory.

CAPPARIDACEAE

4. **Cleome viscosa** Linn.

Local name : *Naikadugo.* Hindi name : *Halhul.* Habit : An erect annual herb with hairs. Flowers : Yellow, in rainy and cold seasons.

Uses : The juice of the leaves is used to relieve ear-ache. The seeds are rubefacient, vesicant, and anthelmintic.

5. **Gynandropsis gynandra** (Linn) Briq.

Syn. *G. pentaphylla* DC.

Local name : *Kadugu.* Hindi name : *Karalta.* Habit : Erect annual herb. Flowers : White, in rainy season and cold weather.

Uses : Used as substitute for *Cleome viscosa.*

VIOLACEAE

6. **Hybanthus enneaspermus** F. Müell.

Syn. *Ionidium suffructicosum* Ging.

Local name : *Orle tamarecedy.* Hindi name : *Ratan-purus.* Habit : Herb. Flowers : Pink, in all seasons except driest.

Uses : Leaves and tender stalks are demulcent. The roots of the plant are diuretic.

POLYGALACEAE

7. **Polygala chinensis** Linn.

Hindi name : *Meradu.* Habit : An erect spreading herb. Flowers : Yellow, pink when unopened, July to February.

Uses : Root given in cases of fever and dizziness.

PORTULACACEAE

8. **Portulaca oleracea** Linn.

Local name : *Kogikirai* (Tamil) ; *Pourpier* (French). Hindi name : *Khursa.* Habit : A prostrate subsucculent herb. Flowers : Yellow, July to March.

Uses : Locally used in scurvy and liver diseases.

9. **Portulaca quadrifida** Linn.

Local name : *Peroumpassale cody.* Hindi name : *Chhotaluniya.* Habit : A prostrate, creeping, and subsucculent herb. Flowers : Yellow, June to February.

Uses : Leaves are esteemed as cooling and anti-scorbutic.

MALVACEAE

10. **Abutilon indicum** G. Don

Local name : *Tonttycedy* (Tam.) ; *Mauve indienne* (Fr.). Hindi name : *Kanghi.* Habit : Annual shrub. Flowers : Yellow.

Uses : The leaves are demulcent, the bark is astringent and diuretic. Infusion of the roots is given in fevers. The seeds are laxative and aphrodisiac.

11. **Sida cordifolia** Linn.

Local name : *Nilatutti.* Hindi name : *Kungyi.* Habit : An under-shrub. Flowers : Yellow, December and January.

Uses : The roots are cooling, astringent, stomachic, nervous, and cardiac tonic, diuretic, alterative, febrifuge, and demulcent. The juice of the root is a sedative and forms a soothing application for irritable surfaces ; it is also used for healing wounds and ulcers. Whole plant contains an alkaloid identical with ephedrine. The juice of the whole plant is given in rheumatism, gonorrhoea, and spermatorrhoea.

12. **Sida veronicaefolia** Lamk.

Local name : *Polampasi.* Hindi name : *Bhiunli.* Habit : A perennial herb. Flowers : Yellow, August to November.

Uses : Leaves are used as local application in cuts and bruises.

13. **Urena lobata** Linn.

Local name : *Ottatti.* Hindi name : *Bachata.* Habit : A shrubby herb. Flowers : Rose coloured, after the rains.

Uses : The roots are diuretic and used as external remedy for rheumatism.

14. **Pavonia zeylanica** Cav.

Local name : *Mammatti.* Habit : Erect herb. Flowers : Pink, October to December.

Uses : Plant is used as vermifuge and purgative.

TILIACEAE

15. **Corchorus acutangulus** Lamk.

Hindi name : *Titapat* (Bombay). Habit : An erect annual herb. Flowers : Yellow, after the rains, till March.

Uses : The withered leaves used as stomachic while dried leaves used in dysentery.

GERANIACEAE

16. **Oxalis corniculata** Linn.

Local name : *Paliakiri.* Hindi name : *Amrul.* Habit : Small herb. Flowers : Yellow, rainy and cold weather.

Uses : The leaves are considered as cooling, appetizing, and stomachic. The juice used against the cancer of rectum.

ZYGOPHYLLACEAE

17. **Tribulus terrestris** Linn.

Local name : *Nerunji* (Tam.) ; *Croix de chevalier* (Fr.). Hindi name : *Chotagokhru.* Habit : Suberect annual herb. Flowers : Yellow, throughout the year.

Uses : The entire plant and especially the fruit is extensively used in indigenous medicine. Fruits are cooling, tonic, aphrodisiac, used in painful micturition, calculus affections, urinary discharges, and impotence ; in form of infusion useful as a diuretic in gout, kidney diseases, and gravel. The seeds are astringent and used in bleeding from the nose and other haemorrhages. Fruits contain traces (0.001%) of alkaloid, a fixed oil, a small quantity of essential oil, resins, and nitrates.

VITACEAE

18. **Cissus quadrangularis** Linn.

Syn. *Vitis quadrangularis* (Linn.)

Local name : *Piranday.* Hindi name : *Hadjora.* Habit : Climbing shrub. Flowers : Red, most part of the year.

Uses : The leaves and young shoots are used in powder form in digestive troubles. Juice of the stem is used in irregular menstruation and scurvy.

PAPILIONACEAE

19. **Abrus precatorius** Linn.

Local name : *Goundoumany cody.* Hindi name : *Ratti, Ghungchi.* Habit : A perennial twiner. Flowers : Pink, October to December.

Uses : Seeds are purgative, tonic. Used in nervous disorders and cattle poisoning. The root is considered as emetic and used in the treatment of poisoning. The seeds are dangerous and should only be used under the guidance of a qualified physician.

20. **Clitoria ternatea** Linn.

Local name : *Kagnetancody.* Hindi name : *Aparajit.* Habit : A beautiful climber. Flowers : Bright blue, having an orange centre.

Uses : The dried roots and the fresh leaves, which contain a bitter resin, possess laxative and diuretic properties. They are also used in urinary disorders.

21. **Desmodium gangeticum** DC.

Local name : *Kolakan.* Hindi name : *Sarivan.* Habit : Erect shrubby herb. Flowers : Lilac, September to December.

Uses : The bark is considered as febrifuge and anticatarrhal.

22. **Indigofera enneaphylla** Linn.

Local name : *Cheppunerungi.* Hindi name : *Vasuka.* Habit : Prostrate herb. Flowers : Bright red, October to March.

Uses : Juice of plant as antiscorbutic, tonic, alterative, diuretic. Used in old venereal affections.

23. **Phaseolus trilobus** Ait.

Local name : *Panipayar.* Hindi name : *Mugani.* Habit : Trailing herb. Flowers : Yellow, October to March.

Uses : Leaves are tonic, sedative, used in cataplasms for weak eyes, administered in decoction in irregular fever.

24. **Zornia diphylla** Pers.

Habit : Low spreading herb. Flowers : Yellow, September to January.

Uses : Root is given to children to induce sleep.

CAESALPINIACEAE

25. **Cassia occidentalis** Linn.

Local name : *Payaverecedy.* Hindi name : *Kasondi.* Habit : A shrubby herb. Flowers : Yellow, rainy season.

Uses : The leaves are used as purgative in Pondicherry ; useful in cough. The plant is also used in skin diseases.

26. **Cassia tora** Linn.

Local name : *Tagarai.* Hindi name : *Chakunda.* Habit : An annual shrub. Flowers : Yellow, rainy season.

Uses : The macerated leaves used for dermatoses and antidote against snake-bite.

CUCURBITACEAE

27. **Benincasa cerifera** Savi

Local name : *Cannalapoussini cody* (Tam.) ; *Courge blanche* (Fr.). Hindi name : *Petna*. Habit : Climber. Flowers : Yellow.

Uses : It is used as tonic and diuretic. It is also considered as a specific remedy for internal haemorrhage.

28. **Cucumis trigonus** Roxb.

Syn. *Bryonia callosa* Rottl.

Local name : *Toumoutty cody*. Hindi name : *Gomuk*. Habit : Trailing herb. Flowers : Yellow, October to December.

Uses : The root, which contains bryonine, is considered as a purgative and the seeds are used in cases of uterine affections.

29. **Citrullus colocynthis** Schrad.

Local name : *Petoumoutty cody* (Tam.) ; *Coloquinte* (Fr.). Hindi name : *Indrayan*. Habit : Trailing herb. Flowers : Light yellow, rainy season.

Uses : The pulp of the fruit is described as bitter, sour and is used in constipation and fever. The root is useful in jaundice. Oil from the seeds is used to blacken grey hair.

30. **Melothria madraspatana** (Linn.) Cogn.

Local name : *Moussoumoussouque cody*. Hindi name : *Agumaki*. Habit : Climbing herb. Flowers : Yellow, rainy season.

Uses : The seeds are used in diabetes and diarrhoea. People masticate the root for tooth-ache.

FICOIDEAE

31. **Mollugo pentaphylla** Linn.

Local name : *Parpadaka pullu*. Hindi name : *Julpapra*. Habit : Erect herb. Flowers : White, September to January.

Uses : Used as antiseptic.

RUBIACEAE

32. **Oldenlandia corymbosa** Linn.

Local name : *Parpadagam*. Hindi name : *Daman papar*. Habit : An annual herb. Flowers : White, October to December.

Uses : The whole plant is often used as a bitter tonic. It is also used in fever, skin diseases, jaundice, liver complaints, and chronic malaria.

33. **Oldenlandia umbellata** Linn.

Local name : *Saya.* Hindi name : *Chirval.* Habit : An annual herb. Flowers : Bluish, all seasons except driest.

Uses : Leaves given in consumptive and asthmatic affections. Roots and leaves are prescribed in bronchial catarrh and asthma.

COMPOSITAE

34. **Eclipta alba** (Linn.) Hassk.

Local name : *Garuga.* Hindi name : *Bhangra.* Habit : Small annual herb. Flowers : White, throughout the year.

Uses : It is used in jaundice. The leaves are used as dye for hair and to cool the brain after a bath (hair tonic). It is used also in various skin diseases.

35. **Tridax procumbens** Linn.

Habit : A straggling herb. Flowers : Yellow, throughout the year.

Uses : Stems, leaves, and roots are useful in healing cuts and wounds.

36. **Vernonia cinerea** Less.

Local name : *Paitincody.* Hindi name : *Sahadevi.* Habit : An annual herb. Flowers : Pink or lilac, during rainy season.

Uses : Juice of plant given in piles. Flowers administered for conjunctivitis. The fresh juice of leaves is given in blood dysentery. Externally it is used for rheumatism. The seed for intestinal colic, for coughs, leucoderma, and other chronic skin diseases. They are also commonly used as anthelminitic (against round worms and thread worms).

37. **Sphaeranthus indicus** Linn.

Local name : *Kottakkarandai.* Hindi name : *Mundi.* Flowers : Pink or purple, January to April. Habit : Prostrate small annual herb.

Uses : Used against cough, jaundice, tumors, etc. It is a nerve tonic. Root used in bleeding piles.

38. **Xanthium strumarium** Linn.

Local name : *Marlumutta.* Hindi name : *Chhota-gokhru.* Habit : An annual herb. Flowers : Dull purple tubular florets, December.

Uses : Useful in urinary diseases.

PLUMBAGINACEAE

39. **Plumbago zeylanica** Linn.

Local name : *Velle cody* (Tam.) ; *Dentelaire blanch* (Fr.). Hindi name : *Chita.* Habit : Perennial subscandent herb. Flowers : White, December to January.

Uses : Roots are used in dyspepsia.

APOCYNACEAE

40. **Vinca rosea** Linn.

Local name : *Nittiakalianyecedy*. Hindi name : *Nayantara*. Habit : A small shrub. Flowers : White or pink, throughout the year.

Uses : Used as astringent.

41. **Rauwolfia canescens** Linn.

Local name : *Pambukalachedi*. Habit : Small shrub. Flowers : White, throughout the year.

Uses : The root-bark, stem-bark, and leaves contain an alkaloid, Rauwolfscine, which is depressent to the cardio-vascular system. It is also sympatholytic in action and abolishes the pressure effects of adrenaline.

ASCLEPIADACEAE

42. **Calotropis gigantea** R.Br.

Local name : *Eroucancedy* (Tam.); *Herbe Hirondelle* (Fr.). Hindi name : *Ak*. Habit : An erect shrub. Flowers : Purplish white, throughout the year.

Uses : The milky sap, flowers, the rind of the root, and leaves are used as purgative, antimalarial, in dysentery, in syphilis, etc. Numerous preparations are composed with calomel and antimony sulphide, against elephantiasis and syphilis.

43. **Leptadenia reticulata** Wt. & A.

Local name : *Kodipale cody*. Hindi name : *Dori*. Habit : Twining shrub. Flowers : Greenish yellow, July to August.

Uses : Root is emetic and expectorant. It is used against dropsy.

44. **Hemidesmus indicus** R.Br.

Local name : *Naneri cody* (Tam.) ; *Salsepareille indienne* (Fr.). Hindi name : *Magrabu*. Habit : Prostrate perennial herb. Flowers : Green on the outside, purple within, December.

Uses : Roots are sweet, demulcent, alterative, blood purifying, diaphoretic, diuretic, tonic. Root is useful in fever, skin diseases particularly of syphilitic origin. Externally it is used in rheumatic pains.

BORAGINACEAE

45. **Trichodesma indicum** R.Br.

Local name : *Kalhudaitumbai*. Hindi name : *Chota kulpa*. Habit : Erect annual herb. Flowers : Pale blue, October to December.

Uses : Root made into a paste applied to reduce swellings, particularly of the joints ; pounded with water, given as a drink to children in dysentery.

Convolvulaceae

46. **Convolvulus arvensis** Linn.

Local name : *Bhoomi chakra poondu.* Hindi name : *Hiranpadi.* Habit : Twining herb. Flowers : White, August.

Uses : Roots purgative. The rootstock contains about 4.9% of potent purgative resin. The root possesses cathartic properties and is regarded as poisonous because of the marked gastro-intestinal irritation it produces.

47. **Evolvulus alsinoides** Linn.

Local name : *Visnukarandi.* Hindi name : *Sankhapuspi.* Habit : Prostrate herb. Flowers : Light blue, all seasons.

Uses : Plant is bitter, tonic, and vermifuge ; made into cigarettes and smoked in chronic asthma. It is also used in dysentery.

Solanaceae

48. **Datura fastuosa** Linn.

Local name : *Oumattecedy* (Tam.) ; *Pomme epineuse* (Fr.). Hindi name : *Dhatura.* Habit : Erect shrub. Flowers : White, August to January.

Uses : All the parts of the weed are strongly intoxicant, narcotic, aphrodisiac, toxic, and antispasmodic. Their properties are similar to those of belladona. The leaves and seeds contain the drugs hyoscyamine and atropine. The juice of leaves with milk is used in gonorrhoea. The seeds are used externally for piles, tumors, and skin diseases.

49. **Solanum nigrum** Linn.

Local name : *Manattakkali.* Hindi name : *Makoi.* Habit : Annual herb. Flowers : White, after the commencement of rains.

Uses : The plant is a valuable cardiac tonic, alterative, diuretic, sedative, expectorant, diaphoretic, cathartic. The decoction is efficacious in jaundice. The juice is useful in chronic skin diseases, piles, and gonorrhoea. Externally the juice of leaves is applied in ringworm. The berries are used in fevers, diarrhoea, and heart disease.

50. **Solanum xanthocarpum** Sch. & Wendl.

Local name : *Kandan katiricedy.* Hindi name : *Kateli.* Habit : Prickly perennial procumbent herb. Flowers : Blue, purple, October to March.

Uses : The whole plant is considered expectorant, bitter, stomachic, diuretic, astringent, anthelmintic, and alterative. It is used in fevers, coughs, asthma, heart disease, gonorrhoea. Root is used locally against smallpox.

51. **Physalis minima** Linn.

Local name : *Nottou-takalicedy*. Hindi name : *Lakshmipriya*. Habit : Erect, spreading annual herb. Flowers : Yellow, September to December.

Uses : The fruit is laxative and diuretic.

PEDALIACEAE

52. **Pedalium murex** Linn.

Local name : *Perunerunji*. Hindi name : *Baragokhru*. Habit : An annual succulent herb. Flowers : Yellow, September to January.

Uses : The leaves, stems, and fruits are used medicinally. Plant mucilage is useful in gonorrhoea, spermatorrhoea, and other disorders of urinary system, impotence, and nocturnal seminal emissions. The fruit is antispasmodic, aphrodisiac, and the decoction is used in irritation of urinary organs.

ACANTHACEAE

53. **Adhatoda vasica** Nees

Local name : *Kottu-monrounguced*y. Hindi name : *Bansa, Adusa*. Habit : An erect shrub. Flowers : White, July to September.

Uses : Leaves, bark, flowers and roots are used medicinally. The leaves contain the alkaloid vasicine and are a powerful expectorant and antispasmodic. They are used in diseases of the respiratory tract, particularly in tuberculosis, all kinds of cough, bronchitis, asthma, and other chest troubles. The flowers are used as anthelmintic, and in gonorrhoea and ophthalmia.

54. **Barleria prionitis** Linn.

Local name : *Simmoulle cedy*. Hindi name : *Katsareva*. Habit : Prickly shrub. Flowers : Yellow, November to March.

Uses : The juice of leaves is prescribed in catarrhal diseases of children. The dried bark is used in whooping cough.

55. **Andrographis paniculata** Nees

Local name : *Nila-vembu*. Hindi name : *Kirayata*. Habit : An erect annual herb. Flowers : Pink, December to January.

Uses : All the parts of the herb are bitter. It is useful bitter tonic, febrifuge, and anthelmintic. It is also used in advanced stages of dysentery and fevers.

VERBENACEAE

56. Vitex negundo Linn.

Local name : *Notchimaram* (Tam.) ; *Gattlier Negundo* (Fr.). Hindi name : *Nirgandi.* Habit : An erect shrub. Flowers : Bluish purple, May to December.

Uses : All parts are used medicinally. The leaves are tonic, febrifuge, diuretic, vermifuge, and expectorant. The leaves are used against malaria. Roots are tonic, diuretic, febrifuge, and used in rheumatism, worms, leprosy, and typhus fever. The flowers are used in diarrhoea, cholera, and liver disorder. The fruits are nervine tonic.

LABIATAE

57. Anisomeles malabarica O. Kze.

Local name : *Rettepemesahycedy.* Hindi name : *Chodhara.* Habit : An erect shrub. Flowers : Pale purple, March to April.

Uses : Leaves are used medicinally. The herb is antiperiodic, carminative, stomachic, antipyretic, and sudorific. The infusion is used in intermittent fevers, catarrh, and rheumatism. It is also used in hysteria. The essential oil of the leaves is used as an embrocation in rheumatism.

58. Leucas aspera Spreng.

Local name : *Toumbecedy.* Hindi name : *Chota-halkusa.* Habit : An erect herb. Flowers : White, October to February.

Uses : The sap of leaves is used against chronic dermatoses and scabies.

59. Ocimum sanctum Linn.

Local name : *Tulasicedy* (Tam.) ; *Basilie commum* (Fr.). Hindi name : *Tulsi.* Habit : An erect hairy herb. Flowers : Pale purple.

Uses : Leaves are expectorant, stomachic, antiperiodic, stimulant, anti-catarrhal, and aromatic ; also used in malaria, cough, bronchitis, and disorder of the liver. Externally they are used against ringworm. The seeds are demulcent and are used in diseases of the genito-urinary organs.

NYCTAGINACEAE

60. Boerhaavia diffusa Linn.

Local name : *Sattaranay cody* (Tam.) ; *Herbe a cochous* (Fr.). Hindi name : *Sant, Punarnava.* Habit : A spreading herb. Flowers : Pink, all seasons except driest.

Uses : The roots are laxative, febrifuge, and diuretic. They are used in asthma, anaemia, jaundice, scanty urine. The leaves are also used in jaundice. The most important part is the root and is used specially in diseases of the heart, kidneys. It is considered a very good remedy for dropsy. Contains active constituent punarnavine (0.1%).

AMARANTHACEAE

61. **Achyranthes aspera** Linn.

Local name : *Naiourouvicedy*. Hindi name : *Apang*. Habit : An erect herb. Flowers : Greenish white, rainy season.

Uses : The herb is used as diuretic, laxative, stomachic, and astringent. Its juice is administered in diarrhoea, dysentery, piles, rheumatism, inflammation of internal organs, coughs, eruptions, etc. The root is given for night blindness and cutaneous diseases, pulmonary syphilis, and rheumatic affections.

62. **Amaranthus spinosus** Linn.

Local name : *Moullouhiray* (Tam.) ; *Amarante a epines* (Fr.). Hindi name : *Kataili-chaulai*. Habit : Erect spinous herb. Flowers : Greenish, in rainy season.

Uses : The roots are used in gonorrhoea, eczema. The leaves and roots are used as laxative for children.

63. **Aerua lanata** Juss.

Local name : *Poulacedy*. Hindi name : *Chaya*. Habit : Prostrate or erect herb. Flowers : Greenish white, August to January.

Uses: Flower top and roots are used in the treatment of headache.

64. **Celosia argentea** Linn.

Local name : *Salvalcoude cedy* (Tam.) ; *Amarante argentee* (Fr.). Hindi name : *Sufed murg ka-phul*. Habit : Erect annual herb. Flowers : Pinkish to white, December to February.

Uses : Seeds used in diarrhoea.

EUPHORBIACEAE

65. **Acalypha indica** Linn.

Local name : *Kuppaimeni*. Hindi name : *Khokali*. Habit : An erect annual herb. Flowers : Very small, rainy season.

Uses : The plant is used as substitute for senega and useful in bronchitis, pneumonia, and asthma. Leaves used in scabies.

66. **Euphorbia hirta** Linn.

Local name : *Amampatehaiarisi*. Hindi name : *Dduhi*. Habit : Annual erect or ascending herb. Flowers : Small, throughout the year.

Uses : The plant is used in diseases of children in worms, bowel complaints, and cough. Decoction of plant is prescribed for bronchial affections and asthma.

67. **Jatropha curcas** Linn.

Local name : *Kattamanakoucedy* (Tam.) ; *Pignon d mde* (Fr.). Hindi name : *Bagbherenda.* Habit : Soft wooded shrub. Flowers : Yellowish green.

Uses : The leaves and seeds are used medicinally. Milky juice is applied to check haemorrhage from wounds and bleeding surfaces ; used in piles, scabies, eczema, ringworm, and decayed teeth. It is also used as febrifuge. The root bark used for rheumatism, dyspepsia, and diarrhoea. The oil of the seed is purgative or alterative in constipation, worms, etc.

68. **Phyllanthus niruri** Linn.

Local name : *Kijanelli.* Hindi name : *Jar-amla.* Habit : An annual herb. Flowers : Small minute, rainy and cold seasons.

Uses : The plant is used as a diuretic in dropsial affections, gonorrhoea, and other affections of the genito-urinary tract. Infusion of young shoot is given in dysentery. Fresh roots as remedy in jaundice.

69. **Ricinus communis** Linn.

Local name : *Peramanakoucedy.* Hindi name : *Arand ka per.* Habit : A small tree. Flowers : Small, male with white anther.

Uses : The leaves, roots, seeds, and oil are used medicinally. The leaves used externally for boils, swellings, and wounds. The bark of the plant is used also for healing wounds and sores. The roots are efficacious in lumbago, rheumatic swellings. The seed-oil is used as purgative, it is also used in conjunctivitis and other troubles of the eye.

LILIACEAE

70. **Gloriosa superba** Linn.

Local name : *Kejangoucody* (Tam.); *Glorieux du Malabar* (Fr.). Hindi name : *Kalihari.* Habit : A large climbing herb. Flowers : Scarlet and bright yellow, October to December.

Uses : The tubers are poisonous. They are used in leprosy, piles, colic, for intestinal worms, gonorrhoea ; externally for local application in parasitic diseases.

71. **Amorphophallus campanulatus** Blume

Local name : *Karnai-kilangu.* Hindi name : *Zaminkand.* Habit : Herb with large underground tuber. Flowers : Spathe greenish-pink with pale blotches, spadix with dark purple appendage at the top.

Uses : The tuber of the plant is tonic, carminative, and used in piles and dysentery ; when fresh used in acute rheumatism.

72. **Acorus calamus** Linn.

Local name : *Vashambu.* Hindi name : *Bach.* Habit : Herb. Flowers : Green.

Uses : The rhizome is used in remittent fevers, bronchitis, and in dysentery of children.

Commelinaceae

73. **Commelina bengalensis** Linn.

Local name : *Kanavashai.* Hindi name : *Kanchasa.* Habit : Creeping branched herb. Flowers : Small with funnel shaped bracts, rainy season.

Uses : It is used as laxative and is also useful in leprosy.

Cyperaceae

74. **Cyperus rotundus** Linn.

Local name : *Pirapinkose* (Tam.) ; *Souchet* (Fr.). Hindi name : *Mutha.* Habit : An erect grass-like herb. Flowers : In spikes of 3-10 spikelets, nut greenish, November to December.

Uses : Rhizome is used medicinally. It is pungent, aromatic, acrid, diuretic, astringent, anthelmintic, and stomachic. It is used in gastric and intestinal disorders. An infusion of rhizome is administered in diarrhoea, dysentery, dyspepsia, vomiting, cholera, fevers, urinary disorders, leprosy, and blood diseases.

75. **Kyllinga monocephalla** Rottb.

Hindi name : *Nirbishi.* Habit : Annual herb. Flowers : Spike of spikelets, rainy season.

Uses : Used as antidote to poisons. It is also useful in fevers.

Gramineae

76. **Aristida adscenscionis** Linn.

Local name : *Siruthudappam pul.* Hindi name : *Ghas.* Habit : Annual herb. Flowers : Spike of spikelets.

Uses : An ointment consisting of ashes of flowers is used for itch and ringworm.

77. **Cynodon dactylon** Pers.

Local name : *Arugampullu.* Hindi name : *Dub, Harialli.* Habit : A perennial grass. Flowers : In spike on slender greenish or purplish stalk.

Uses : The juice of the plant is applied to fresh wounds and is used in hysteria, epilepsy. Infusion of root is given for stopping bleeding from piles. The juice of the plant is also useful in catarrhal ophthalmia.

Acknowledgements

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Fishing Methods for the Indian Shad [*Hilsa ilisha* (Hamilton)] in the Indian Region

BY

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PART I

(*With* 2 *text-figures and* 15 *plates*)

CONTENTS

INTRODUCTION

The Indian Shad, *Hilsa ilisha* (Hamilton), is one of the few fishes in the Indian region for which special types of nets and methods of fishing have been evolved and employed. The object of this article is to bring together the existing information on the fishing methods for this important food fish and to record the observations made on the subject in the course of my investigations on the fish and its fishery in India. The available information from the neighbouring countries of Pakistan and Burma is also incorporated for comprehensiveness and to facilitate comparison.

Among the existing records the most important are the accounts by Hornell (1924 *a*, 1950), wherein he has given information on the methods employed in the Cauveri in Madras, in the Ganges in Bengal, and the Indus in Sind, and by Kulkarni (1951) on the fishing methods in the Narbada in Bombay. In addition to the above, Naidu (1939) has given details of a number of fishing methods employed for hilsa

in Bengal and more recently Ahmad (1954) has briefly described the various hilsa fishing methods in East Bengal.

In this account the important hilsa fishing methods are described in detail while mention is also made of certain fishing methods which are of lesser importance and regarding which little has been published so far. A particular type of gear is described only once but modifications and variations, if any, observed in other zones are also mentioned under the respective zones. The various nets are classified under different heads like clap nets, gill nets, seine nets, etc. In certain cases a rigid grouping is not possible since the same net may be used in more than one way with some minor modifications. In such instances the fishing gear concerned is described in detail when first referred to. Illustrations are mostly semi-diagrammatic and are given wherever possible. A glossary of local names of fishing gear and tackle mentioned in the account is given at the end.

The same type of net is subject to variation from place to place and may even be known by different names. Two nets are seldom exactly alike even in one locality though the general pattern of construction will be the same. The mesh size given in the account is in the stretched condition unless otherwise stated. The ply number refers to the number of times the particular count of thread is twisted to make the twine used for the net.

Though no pains have been spared to collect as much information as possible from all available sources, the account is not claimed to be complete. Any additional information is welcome and it will be highly appreciated if any inaccuracies could be brought to my attention so that these may be rectified.

Considerable help has been received from a number of persons in effecting this compilation and this is acknowledged in the appropriate places. All the figures, except 5, 8 *b*, 19 *b*, and 22 which are after Ahmad (1954), Hornell (1950), and Kulkarni (1951), were drawn under my supervision and the names of the artists are given against the respective figures. I thank all of them for their co-operation and valuable assistance.

Hilsa Fishing Methods

I. INDIA

1. West Bengal

In no part of the Indian region do we find such a variety of fishing gear and tackle, particularly for hilsa, as in the deltaic region of the Ganges, lying in West Bengal and East Bengal in India and Pakistan respectively. This is obviously due to the presence of the

fish in this area in larger numbers than anywhere else, its availability practically all round the year, and the great demand for the commodity. While there are certain special kinds of nets operated primarily for hilsa, there are a number of multi-purpose nets in the catches of which this fish forms an important item in varying proportions.

Nets are made of either cotton or hemp and are used tanned or untanned. The tanning is done with a decoction of the fruits of *gab* (*Diospyros embryopteris* Pers.).

The fishing boats in Bengal are of the carvel type made locally of Sal (*Shorea robusta* Gaertn.) or Jarul (*Lagerstroemia flos-reginae* Retz.) and rarely of Teak (*Tectona grandis* Linn.) and are collectively called *jalia dinghis*, though most of them have their special local names based on the nets used.

Clap nets

Among the nets used for hilsa in the Indian region, the *shangla jal* and the *kharki jal* (Hornell 1924 *a* and 1950, and Nayudu 1939) which are both clap nets may be considered as the most specialised ones. The latter is a simpler form of the former and slightly smaller in size. Both are operated from May-June to September-October.

Kharki jal (Pl. I, fig. 1 *a*). This is a purse-shaped clap net which is so constructed and contrived as to effect its closure when desired. The frame of the net consists of two long slender arched bamboo pieces about 8 metres long tied together at both ends in the form of hinges. To this frame is attached a wide-meshed rectangular bag-shaped net having a mesh of 5 cm. to 10 cm. made of 7 to 10 ply 22 count cotton yarn about 2 metres deep. The net is said to be suspended in a horizontal position from a boat by two ropes but more often it is operated without side ropes just as the *kami jal* of Assam. The mouth is kept open with a vertical bamboo loosely passing through a ring in the upper lip and attached to the lower lip enabling it to be pushed down to the required extent. The boat is allowed to drift in the direction of the current with the mouth of the net facing downstream trapping any fish coming up. The entry of a fish into the net is felt through the bamboo which is pulled up bringing the two lips together and trapping the fish inside. Only one *kharki jal* is operated from a boat and a minimum of two persons are required for the purpose, one at the helm and the other in charge of the net. This net could be used only in the surface and sub-surface waters up to a depth of about 3 metres depending on the length of the pole.

Hornell (1950) says that it is of the 'same shape as that of the *toni jal* of Bogra from which it appears to be directly derived'. According to Ahmad (1954) the *toni jal* of East Bengal is a trawl

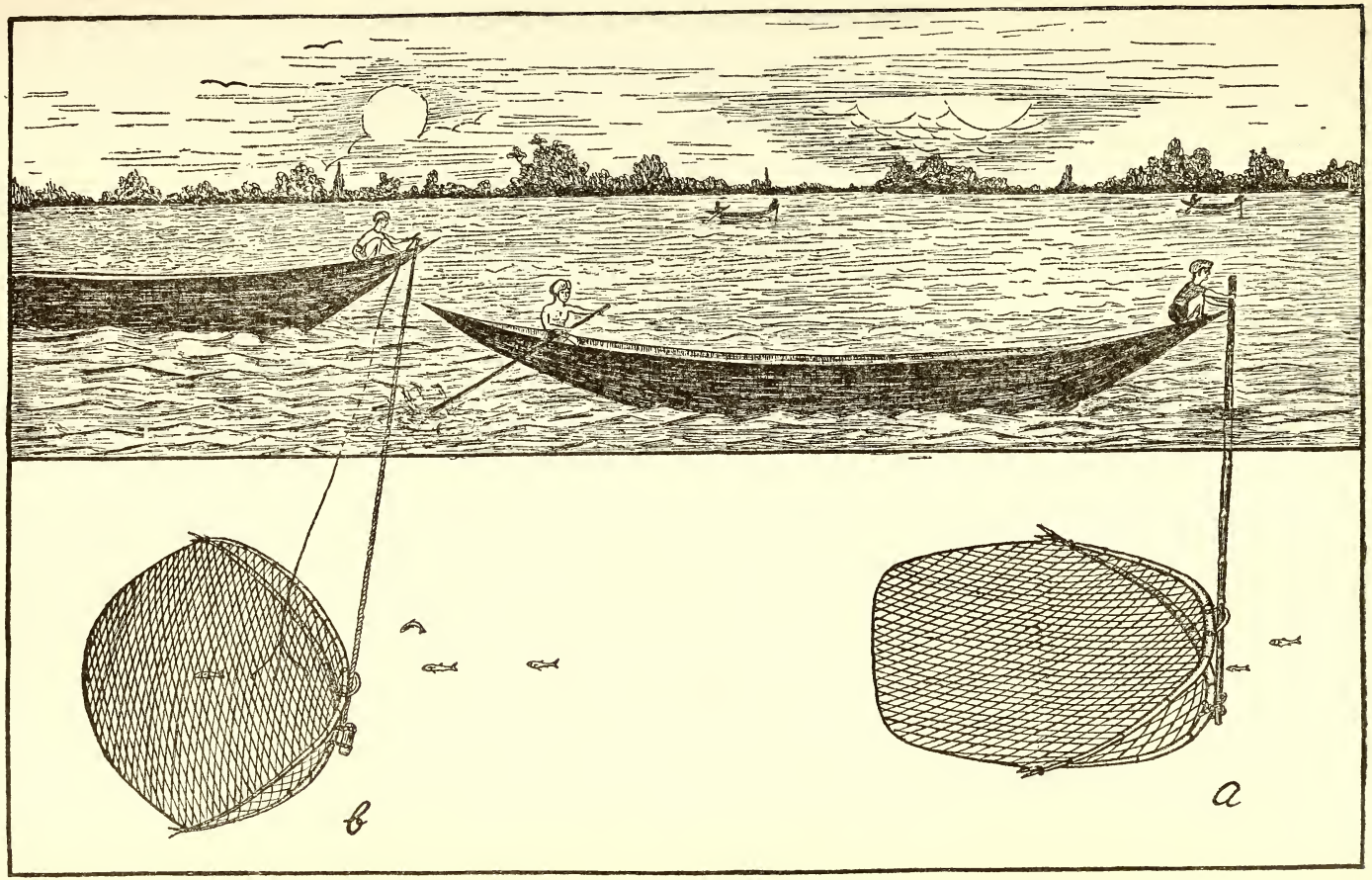

Fig. 1. a. *Kharki jal* of Bengal.
b. *Shangla jal* of Bengal. (By M. P. Lakshmanan)

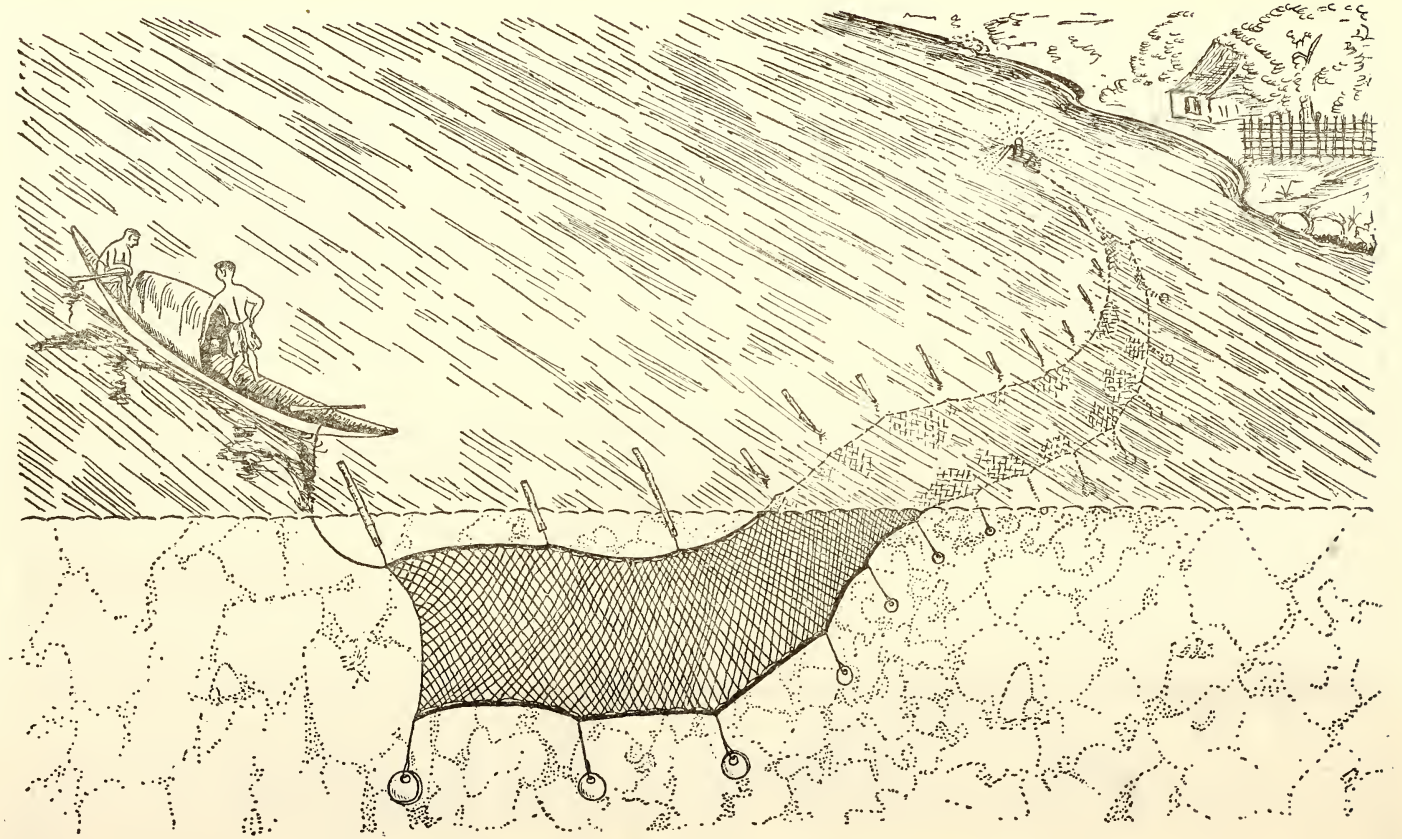

Fig. 2. *Chhandi jal* of Bengal. (By M. Mydeen Kunju)

net, about 3 to 9 metres in length and 2 to 5 metres in width having mesh from 0.3 to 2.5 cm. It is a bag-like net the mouth of which is kept open by floats and weights and is used throughout the year for catching small-sized fish. It would appear that there are two types of nets with the same name in East Bengal.

Shangla jal (Pl. I, fig. 1 *b*). This is an improved modification of the *kharki jal*. The net is generally slightly larger in size, with the bamboo lips thinner and the bag about 3 to 4 metres deep. It could be used from the surface to a depth of several fathoms. The bag portion is rounded unlike in the *kharki jal* in which it is rectangular. The netting is of cotton, 7 to 12 ply of No. 22 count and the mesh is from 8 to 11 cm. The mouth is kept open by a brick or stone weight of 8 to 10 kg. tied to the centre of the lower lip. There is a feeler cord fixed to the upper portion of the net to transmit the disturbance caused by the entrance of a fish into the net. The feeler cord is held in the left hand and the haul rope in the right. There are no balancing ropes as first shown in the figure by Hornell (1924 *a*) and reproduced in several subsequent publications. The stout haul rope is paid out to the desired depth so that the net remains suspended at about the subsurface or midwater region where according to the fishermen hilsa are present in appreciable numbers. When a single net is operated from a boat, it is suspended from the prow by a rope passing through a ring or Y-shaped piece of wood in the upper lip and attached to the middle of the lower lip immediately above the weight. Occasionally when the net is operated at very low levels it gets entangled in submerged obstructions and if efforts to extricate it are of no avail the rope is cut and the net abandoned. When two nets are operated simultaneously from a boat a minimum of 3 persons are required for the purpose, one at the helm and two others to operate the nets and assist in rowing. The boat is brought broadside to the current and the nets are shot from either end of the left side.

The boats used for operating both *shangla jal* and *kharki jal* are of the same type and are known as *dinghis*. A *dinghi* is a plank-built round-bottomed shallow boat most common in the Ganges, about 8 metres long and about 1 to 1.5 metres wide with long pointed bow and stern. The boat is strengthened by ribs and cross-beams with detachable half-split bamboo pieces in the interspaces. Long paddles are used which serve in steering. One or two spare bamboo poles are also kept in the boat. When sailing, a bamboo mast is carried in the front with thin split sail supported by a diagonal bamboo yard stepped far in front. A hood is not always used when fishing for hilsa, though there is provision for one at the far

aft. Those fishermen who seasonally migrate from distant places invariably fix one in their boats as it forms their living quarters during this period.

Gill nets

There are several kinds of gill nets, each differing from the other only in details. Some are of the drifting type, while others are fixed gill nets, and often the same net is known by two different names. The net proper may either be of cotton or hemp and tanned or untanned. Tanned nets are used in turbid waters and untanned nets in clear water. Some have sinkers while most of them have floats.

Chhandi jal (Pl. II, fig. 2.) This is a drift net and is used mainly for catching hilsa. The size of each piece varies considerably but generally each piece is about 10 to 12 metres long and about 2.5 metres broad with 6 to 10 cm. mesh. Nets used in deep areas may be over 8 metres broad. There is a thin head rope of hemp to which are attached bamboo floats at about 4-metre intervals and a stout ground rope of hemp to which are attached, by coir ropes (1 to 1.5 metres long), thick disc-shaped burnt-clay sinkers each of about 10 to 13 cm. in diameter having an eccentrically placed hole.

For operational purposes several pieces of net from 25 to 75 are tied together depending on the length required and the resources of the co-operating fishermen. To one end of the head rope a small raft of bamboo is attached and the net is paid out across the river, the other end being tied to a boat. The net as well as the boat drifts down in the current, gilling any ascending hilsa. When fishing is done at night a light is kept burning on the raft so that the men in the boat can get an idea of the position of the other extremity of the net. For day-time fishing, the raft is sometimes substituted by a long pole or any conspicuous floating object. *Chhandi jal* fishing is more often carried out at dusk or during the night when the migratory activity of hilsa is said to be at its maximum. Though the net is employed mainly for catching hilsa, other fishes also sometimes get gilled or entangled in it.

The boat used for the operation of this net is known as the *chhandi nauka.* This is a shallow plank-built boat with a rounded bottom, longer and wider than the dinghi. The stern is slightly higher than the prow and has decking throughout the length. The boat is provided with a hood and there is provision for a mast and sail. There are usually 6 to 9 persons in a boat. The net is generally used from April-May to September-October.

Ilish jal. This net, similar to the *chhandi jal* but of smaller mesh (5 to 8 cm.), is mainly employed for catching hilsa and is known as

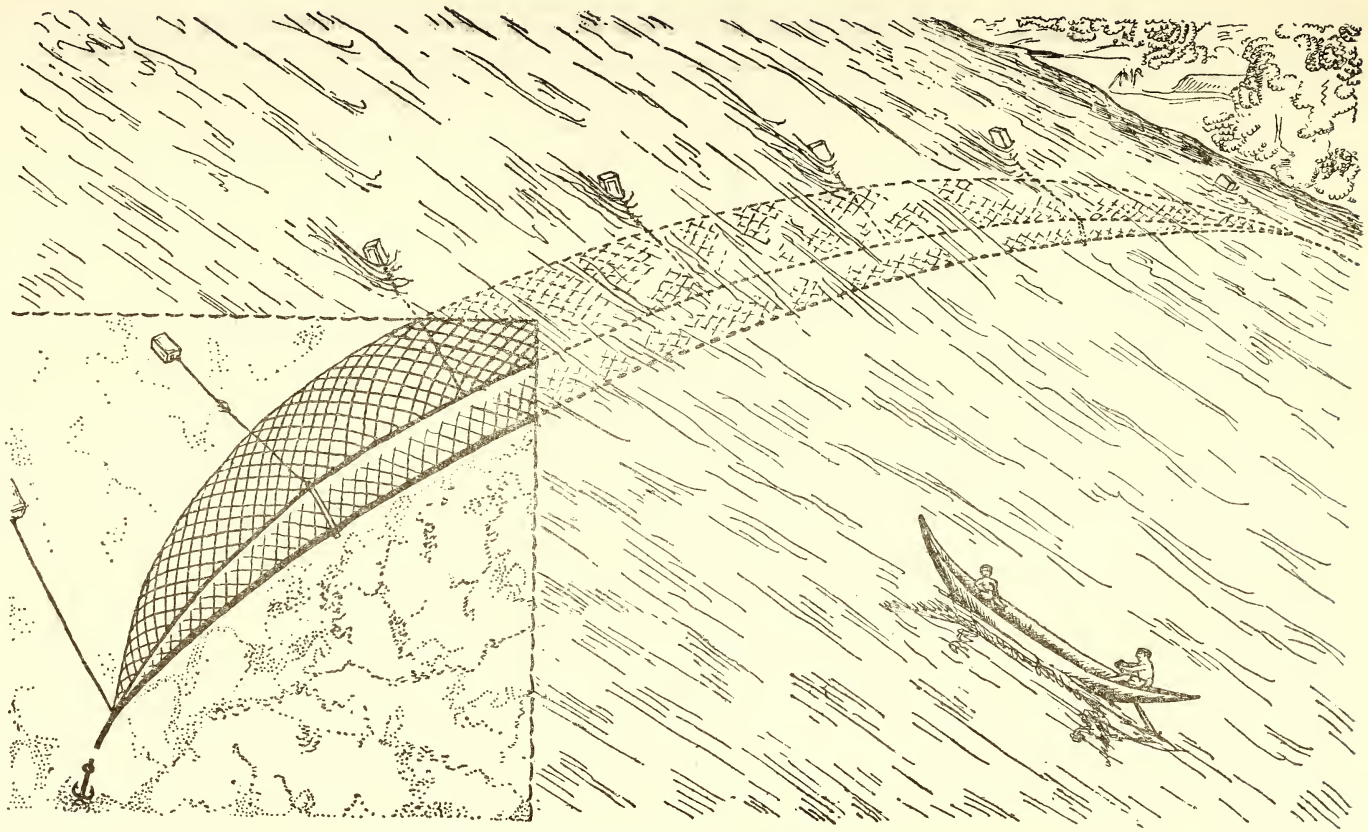

Fig. 3. *Konta jal* of West Bengal. (By M. Mydeen Kunju)

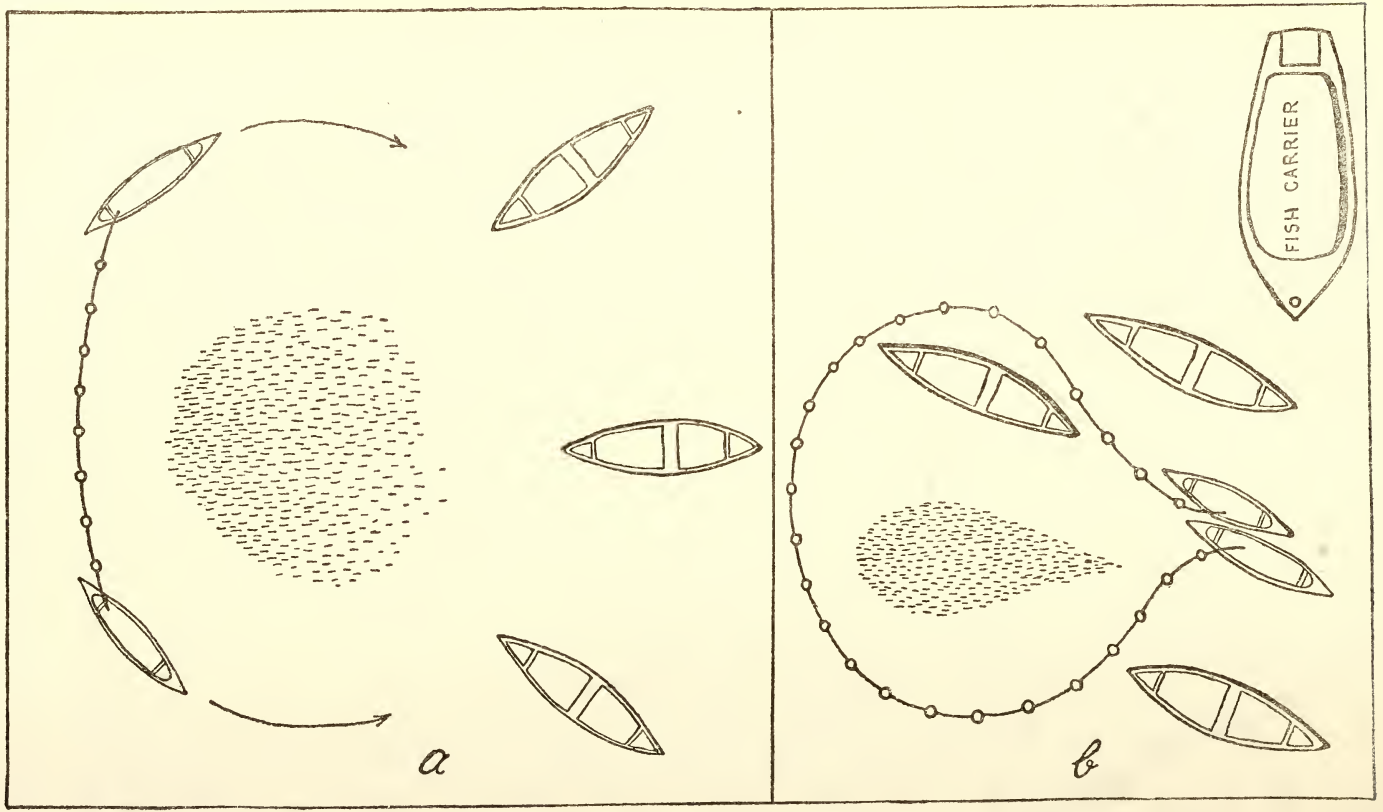

Fig. 4. Diagrammatic representation of the operation of *Kochal jal* of Bengal. (By M. Mydeen Kunju)
a. Beginning of the operation. b. End of the operation.

the *dora jal* also. The length varies from about 60 to over 300 metres and the depth from about 5 to 8 metres according to the width and depth of the river. The net is generally operated after the Pooja for a period of about 6 months from October-November to March-April and the hilsa caught is of comparatively smaller size than with the *chhandi jal.*

Two modified types of *chhandi jal* used for capturing hilsa are the *karal jal* in which there are no weights along the ground rope and the *Goolti jal* in which the lower portion is puckered and is provided with burnt elliptical-shaped clay sinkers. These are reported to be operated from May to October.

Konta jal (Pl. III, fig. 3). This is a fixed gill net used mainly for hilsa in the tidal regions. It is rectangular in shape consisting of 4 or more pieces, each 18 metres long and 8 metres deep, tied together to make an operational net. The net is made of cotton of 6 ply No. 10 thread and the mesh is about 5 to 8 cm. wide. The foot and head ropes are brought together at the extreme ends with a pair of bamboo poles each 4 metres long placed vertically to keep the net open. The net is stretched across the river and the two ends are tied to anchors, and a number of buoys in the form of kerosene drums are tied to the head rope. The current keeps the net distended like a bag and any large fish that tries to pass through it gets gilled. The fishermen inspect the net in a dinghi every one or two hours and collect the gilled fish. This net is generally operated from May-June to September-October.

Seine nets

Kochal jal (Pl. IV, fig. 4 *a, b*). Among the seine nets one that is used specially for hilsa is the *kochal jal.* It appears that similar nets probably with varying degrees of local modifications are used for hilsa fishing during the winter months along the Indo-Pakistan-Burma coast from Orissa to the Mergui Archipelago. In the Sundarbans of Bengal the *kochal jal* is used for large-scale hilsa fishing during the winter months from November to February. The net is made of cotton of 10 ply No. 20 or 22 count thread with about 8 cm. mesh towards the head rope and 10 cm. mesh towards the foot rope. Each piece has a length of about 12 metres and depth of 30 metres and about 22 such pieces are fastened together giving an over-all length of about 280 metres to make one operational unit. The middle piece of net is comparatively narrow, having a depth not more than half of the rest of the portion and is of stouter thread and smaller mesh (about 4 cm.). The head rope has wooden floats at regular intervals and the foot rope is stout and strong. A *kochal jal* fishing unit

consists of 5 or 6 boats with a complement of 5 men in each boat. For operational purposes two open dinghis sometimes smaller than the rest and connected to one another with a short length of rope are used as tender boats for carrying the net, stacked half in each. During the winter months when water in the estuaries and the foreshore areas of Bengal is calm, several hundreds of such fishing units wander about in search of hilsa shoals. As soon as a shoal is sighted the group disperses and makes an encircling movement, the two tender boats on one side of the shoal and the other boats on the opposite side. Before the shoal gets time to scatter the net is quickly paid off simultaneously from both the boats each describing an arc and the other boats converge towards the closing circle, the men in them making a mighty din by beating of poles, shouting, and striking on the water so as to scare the fish and drive them towards the nets. The two tender boats meanwhile close up bringing together the two ends of the net and drawing the foot rope of one side over the other, converting the whole net into an incomplete bag in which the fish get imprisoned. They are collected and transferred to the boats to be disposed off to the merchants who move about with supplies of ice in carrier boats to purchase the catches. A day's catch by a single unit by this method of fishing when large shoals are sighted runs to several scores of maunds whereas sometimes the men wander about for days or weeks together without catching a single fish.

Gai Ber jal. This is a very long rectangular seine net measuring 300 or more metres with puckerings in the lower portion. The simpler type of seine net without puckerings is known as *ber jal.* The net may be made of either cotton or hemp and the mesh varies from 1 to 5 cm. of 5 ply of 5 or 10 counts to 20 ply of 10 counts. The head rope and the foot rope are of the same size, very stout, and the depth of the net ranges from 3 to 9 metres. Bamboo or wooden floats are attached to the head rope. The net is either shot in the middle of the river by an encircling movement of two boats and then hauled up into the boat after bringing the two ends of the foot rope together or one end is left on the shore and the other end is brought round enclosing a very large body of water after which the net is hauled in. When pieces of bamboo are tied across the net to facilitate the hauling operation, it is known as *tana ber jal*[1]. *Ber jal* is generally operated from October-November to May, when large numbers of spent and immature hilsa are caught. The net is not exclusive for hilsa, but this fish forms one of the primary catches.

[1] The *tana ber jal* is said to be 'a favourite net with the fishermen of Dacca, Faridpur and Kushtia in East Bengal' (Ahmad 1952).

In the large rivers like the Padma and the Meghna very long *ber jals* known as *jagat ber jal*, meaning universe enclosing net, over 1600 metres in length are used. The operation lasts for several days and a large variety of fish are caught. Though the *jagat ber jal* is not used primarily for hilsa, it also forms one of the catches.

Kona jal or *Bhesha gulli* (Fig. 5). This is a boat seine with a series of bags, each with a funnel-shaped pouch inside to prevent the escape of trapped fish, at intervals of 9 to 12 metres. The length of the net varies considerably from place to place and may be anything from about 30 to 300 metres. The number of bags also varies accordingly. The net is made of cotton and the mesh is about 5 cm. The mouth of the bags is rectangular in shape, 6 to 9 metres high and

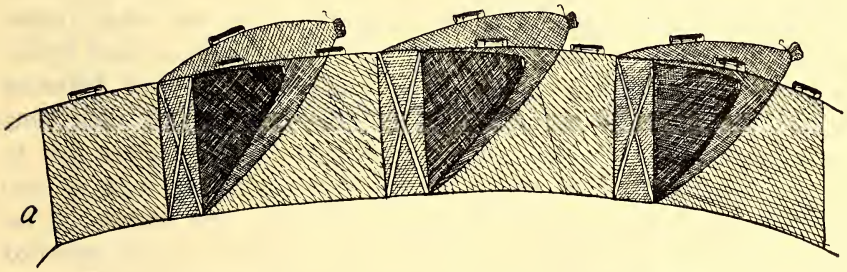

Fig. 5. A portion of *Kona jal* of Bengal

about 4 to 5 metres wide and the mesh is about 2.5 cm. The mouth of each bag is kept distended by two diagonally placed bamboo poles. The net is operated from two boats and the fish trapped in the bags are removed by untying the string at the cod end of each bag.

The net could be operated as a drag net from the shore or as a stake net by tying it to poles fixed in the river where there is strong current. The *kona jal* is generally used from May to October.

Fixed bag nets and stake nets

Behunti jal (Pl. V, fig. 6). The *behunti*, *behundi*, *bainti*, or *bim jal*, operated in the estuaries where the tidal influence is fairly strongly felt, is a multi-purpose net used for all fishes and prawns carried up and down the river by the current. Adult hilsa form only a negligible percentage of catches while in the middle reaches of the estuaries during the winter months large numbers of post-larval and juvenile hilsa are caught along with a variety of other fishes. As this net is of interest from the conservation point of view of the fishery and as no illustrated description is available it is described here.

This is a fixed bag net with a wide mouth, comparatively short wings and long cod end which is lashed with a string except when the catches have to be emptied. There is a flap on the inside near the cod end to prevent the fish from swimming out. The size of the net, the mesh opening, the thickness of the thread, etc. vary in different parts of Bengal. Those used in the lower reaches are larger while comparatively small sized ones are used in the upper zones. A typical one used in the Barrackpore-Nawabgunge area in which large quantities of juvenile hilsa are caught is shown in Plate V, figure 6.

Each wing is 9 metres and measures when fully stretched 26 metres from end to end with a mouth of 6 metres and a bag about 20 metres long. The mesh near the mouth is about 4 cm. but there is a progressive decrease in the size of the mesh opening towards the cod end where in some cases the netting will be substituted by hessian or thick canvas cloth. For fixing the net in the estuary either a pair of heavy wooden anchors are used or two stout wooden spikes are driven into the bed of the river with a specially devised 'battering ram'. A rope from the lower end of the extremity of each wing is fastened to them while a large drum is tied to the upper side to serve as a buoy. The mouth is kept open with the help of two bamboo poles each about 5 metres long. From the middle of the upper lip of the net to the cod end a thick draw rope is provided and sometimes a small empty kerosene tin or some other buoy is tied by a long rope to the cod end to facilitate the location of the cod end. Large quantities of post-larval and juvenile stages of hilsa are caught especially during the winter months.

The bag nets, *suti jal* and *bada jal* referred to in the Marketing Series No. 66 (Government of India, 1951) are evidently modifications of the *behunti jal*. They are made of cotton with about 1 cm. mesh and are comparatively much smaller in size and serve more or less as stake nets.

Suti jal (Fig. 8 *b*). Known as *soti jal* also, this is a funnel-shaped net 5 to 6 metres long with circumference at mouth about 5 metres and height of wing 1 to 1.5 metres. 'Leader wings extend from each side of the mouth and are supported on stakes. A stake passing through the centre of the mouth "anchors" the bag and serves also to keep the mouth distended. The head rope and the ground rope are tied to this stake. The posterior end of the bag is lashed with a string when in use. This net is set in river estuaries where there is a strong tidal action' (Marketing Series, op. cit.). According to Ahmad (1954) this net is common in the Rajshahi, Pabna, and Kushtia districts of East Bengal and are generally fixed in large numbers in the river side by side.

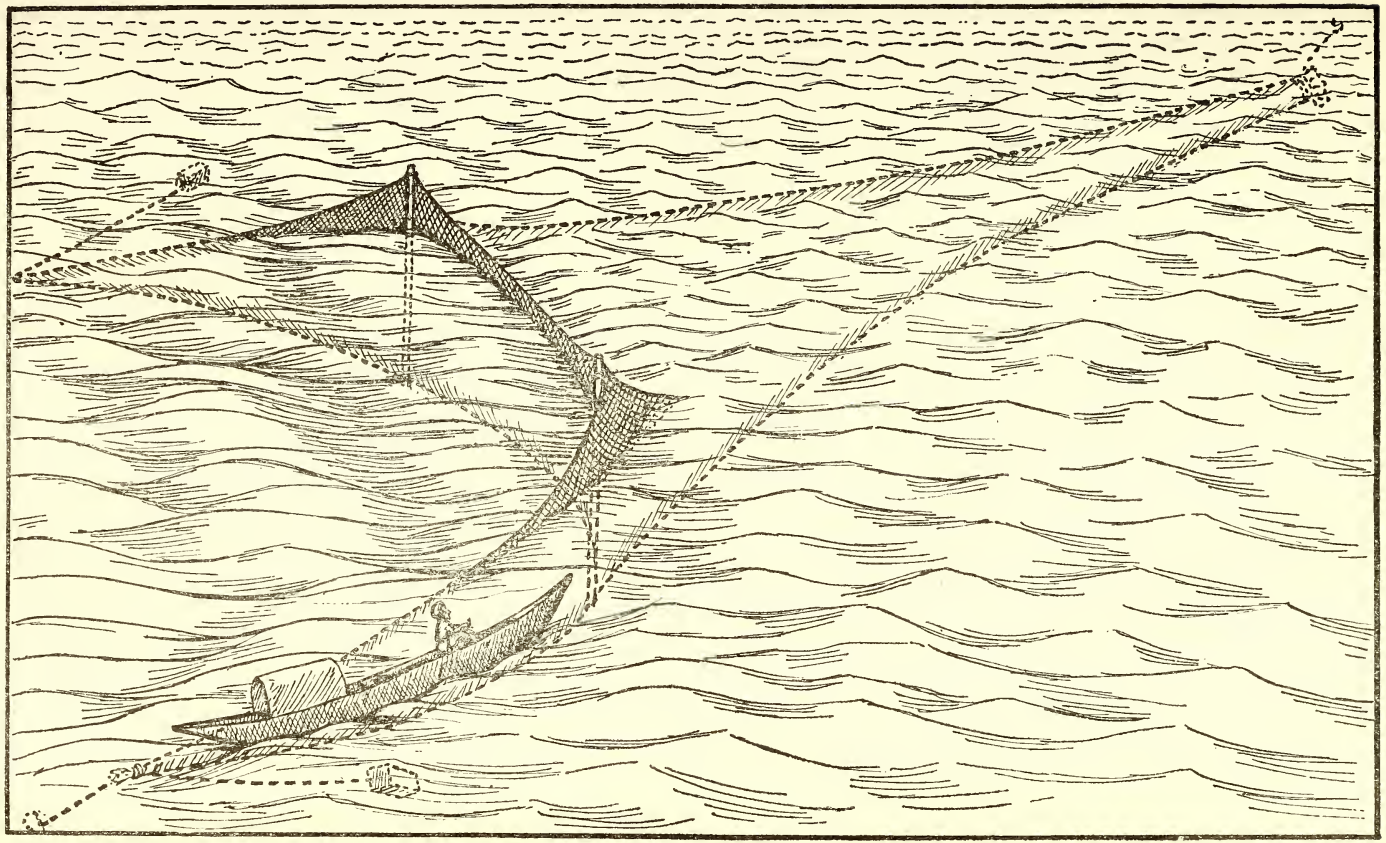

Fig. 6. *Behunti jal* of West Bengal. (By K. G. Nambiar)

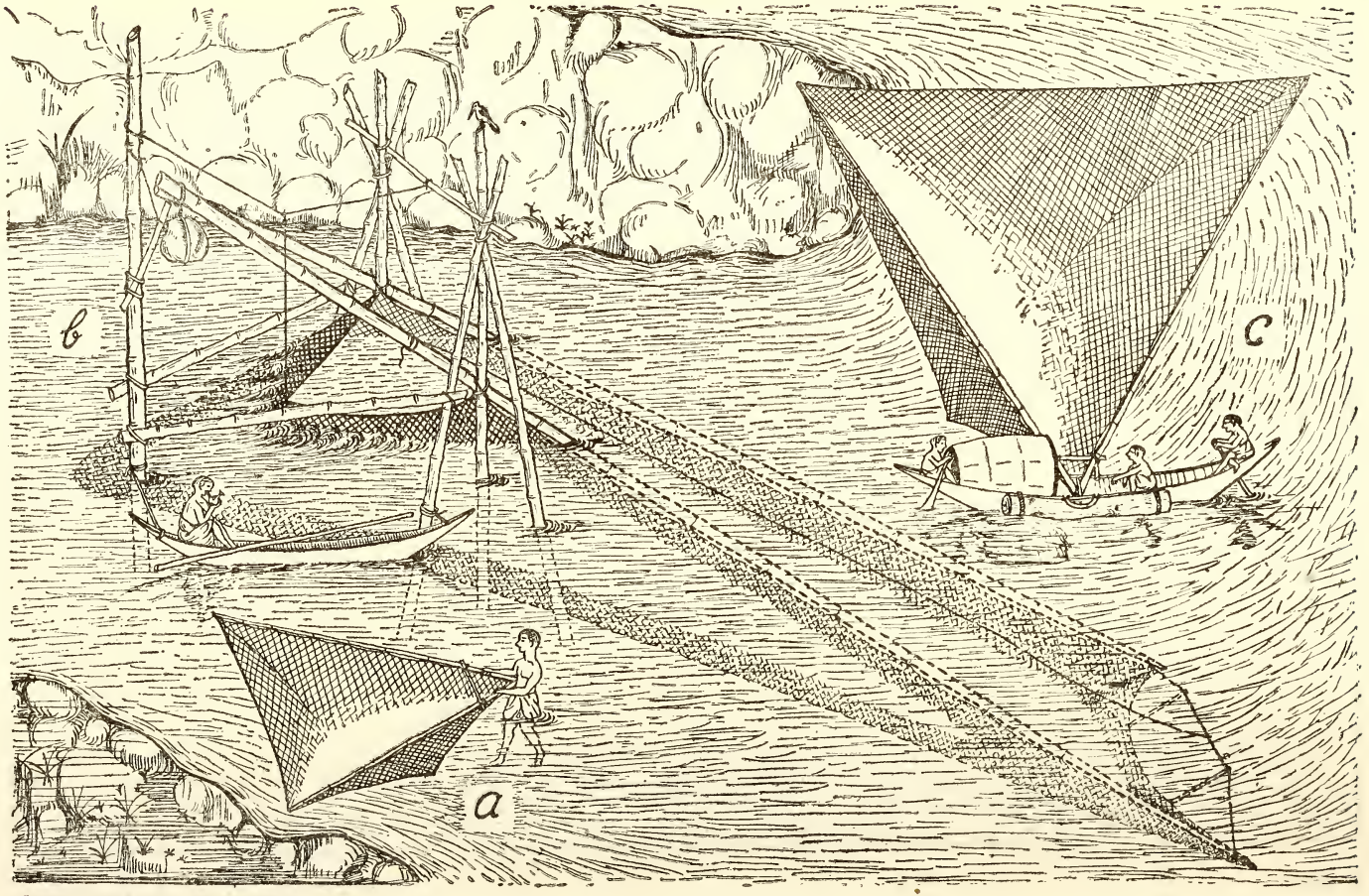

Fig. 7. a. *Hela jal* of West Bengal.
b. *Gara besal* or *gara jal* of West Bengal.
c. *Nauka besal* of West Bengal. (By M. Mydeen Kunju)

Bada jal. This is a bell-shaped net with a pouch inside, which serves as a trap. There are no leader wings but the mouth is very

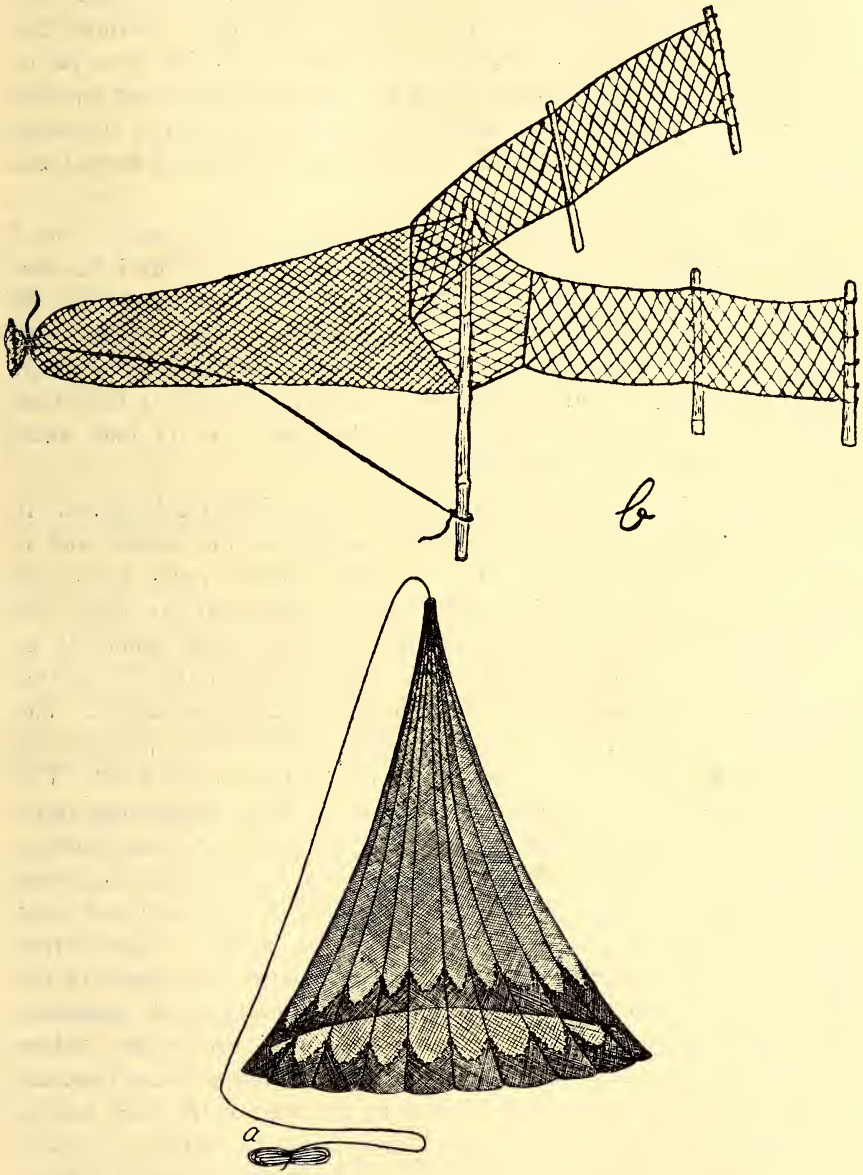

Fig. 8 a. *Kephla jal* of Bengal. (By M. P. Lakshmanan)
b. Diagram of *Suti jal* of Bengal. (After Ahmad 1954)

wide and is kept distended by two bamboo poles placed vertically on either side. A float is attached to the head rope. The net is tied to stakes, driven in the river and the wide posterior end is tied up by a string to form the cod end.

Lift nets

Lift nets are operated for all small and medium-sized surface and subsurface fishes and during certain seasons hilsa also constitutes one of the catches. The lift nets in use are the *bhasa jal, gara jal* or *gara besal*[1], and *nauka besal* or *basal jal.* All these are lever dip nets and would probably have evolved from the simpler type of hand-operated push net (Pl. VI, fig. 7 *a*) known as the *hela jal* in Bengal and *hadia jal* in Orissa.

Basa jal. This dip net is 3 to 4 metres in length and 1.5 to 2 metres in breadth, shaped like the segment of a circle, with a bamboo of about an inch in diameter on the arc side. I have never seen its operation, but Naidu (1939, p. 11) remarks: 'It is dipped into water 5 to 6 feet deep. Radius 6 to 8 feet supported by a *dingi.* Strings from all the three corners form as bridle and it is then held in hand in the manner of kite flying. Net has 1 to 1½ inch mesh mainly for hilsa and other surface fish'.

Gara besal or *gara jal* (Pl. VI, fig. 7 *b*). This is a fixed lever net. It is roughly triangular with considerable sagging in the middle and is tied to a V-shaped frame of two long bamboo poles connected distally by an apical cord. The net is connected to this cord by two short sticks. The size of the net varies from about 11 to 14 metres along the bamboo sides and about 8 to 11 metres across the cord. The mesh is about 4 cm. towards the middle. The V-shaped frame is worked on a horizontally kept bamboo pole serving as a fulcrum supported on posts fixed in the bed of the river. The two side posts are strengthened by two or three supporting posts depending on the size of the net and flow of water. A stout bamboo pole is planted vertically in a median position in line with the angle of the V-shaped frame. Horizontal cross bamboo poles are tied from the median post to the side post. A heavy stone or some other weight is tied to the angle of the frame to balance the weight of the frame on either side of the fulcrum and facilitate quick operation by a single person. A short moveable cross stick tied to the median pole serves as a 'catch' and keeps the net in position when lowered. A person who waits in a boat moored by the side of the fixed engine periodically gets up on the right horizontal cross bamboo, knocks off the 'catch', raises the net by pushing down the weighted portion and removes the fish after holding down the V-shaped frame with the left leg.

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[1] In the *gara besal* we could see a parallel of the Chinese dip net of the Far East, the *cheena vala* of the Travancore-Cochin back-waters and the *ndamtee* of the French Cameroons while the *nauka jal* is in principle similar to the *zemi* of the Kokoto tribe of Africa (Hornell 1950). *Besal* is also pronounced as *bheshal, beshal* and *veshal.*

The *gara besal* is generally fixed close to river banks where there is eddy formation. Sometimes artificial embankments are put up across creeks to create eddy and draw fish into it.

Nauka besal (Pl. VI, fig. 7 *c*). This net is similar to the previous one but comparatively smaller in size and worked from a boat, thereby increasing its range of operation. Each arm of the bamboo frame is 9 to 11 metres long with the arc about 6 metres across. The frame is worked on a short fulcrum supported on two posts fixed in the middle of the boat. A thick log of wood is tied outside the gunwale of the side opposite to the net to serve as a balancer. The distal portion of the net is wide meshed (2.5 to 4 cm.) while towards the apex it is close meshed (1.5 cm.). Usually 3 persons go about in a *besal* boat and of these one person is engaged in the operation of the net. The *besal* boat is 12 to 13 metres long, 1.3 to 1.6 metres broad, and a little over 60 cm. deep. The boat is provided with a hood of woven split bamboo or matting in a frame of semi-circular hoops of thin bamboo or rattan. A variety of surface and subsurface fishes including hilsa are caught in the *nauka besal*.

Cast nets

Ordinary cast nets known as *kephla jal* are used for hilsa in some of the smaller rivers like the Damodar and the Rypuarayan. In winter months a kind of large cast net known as the *batchari jal* is used by the fishermen to catch hilsa and other fishes from the Sundarban areas.

Kephla jal (Fig. 8 *a*). This is the ordinary cast net known by several other names in various parts of Bengal. The net is of the folding and puckering type with small cylindrical iron weights along the ground rope. From the apex to the periphery the net is about 5 metres long. It is made of 4 ply 40 count yarn with the mesh from .6 cm. to about 7 cm. Along the lower border (circumference), there are about 60 puckerings with 4 weights in each puckering. All the strings from the marginal zone converge to the centre where they are tied to a central cord 9 to 11 metres which passes through a ring forming the apex of the net.

Batchari jal or *othar jal*. This is a large-sized heavy cast net 15 to 23 metres in diameter and provided with puckerings and sinkers. Though exactly in the pattern of the *kephla jal*, it is not cast like that in view of its enormous size. It is paid out from a long narrow boat known as the *batchari nauka* having a complement of about 5 men. The net is first kept stretched on one side along the full length of the boat and dropped as the boat drifts with the current enclosing

a roughly circular space and as the apical cord tied to the centre of the boat gets taut by the drift of the boat, it is hauled up. The net is used for a variety of large-sized fishes, and hilsa which move about in shoals in the Sundarban estuaries during winter months are also caught. Generally a number of boats form a circle round a large shoal and operate the nets simultaneously so that those that try to escape from one get caught in another.

Barrier nets

Char-pata jal or *char-gherra jal* (Pl. VII, fig. 9). This net is used during the winter months in the foreshore areas of the eastern parts of the 24-Parganas where large areas get exposed during low tide. An operational net may be several hundreds of metres long depending on the strength of the participating fishermen. It is made up of a number of pieces each 7 to several metres long and 3 to 4 metres wide. The dimensions as well as the structure of the net vary considerably. It may either be of cotton or hemp or jute and sometimes a combination of any of these in which case the lower half is generally of cotton yarn. The upper portion is wide-meshed (about 5 cm.) while the lower portion is of about 1.3 cm. mesh. When made of cotton it is usually of 10 to 16 ply of No. 10 count. The ground rope is of stout jute, while the head rope is slender.

A series of poles are fixed firmly in the mud just above the low-water line sometimes extending over 1600 metres. The stout ground rope of the net is tied to the base of the poles and the whole net is left flush with the ground, with strings from the head rope attached to the top of the poles here and there to enable the net to be raised when required. At the peak of the high tide the fishermen go about in boats and raise the head rope and fix it on the poles above the water line. When the water starts receding the net forms an effective barrier preventing the escape of any fish that has moved into the flooded area. The stranded fish are collected and the process is repeated.

The net is operated especially during spring tides in the winter months when large numbers of fishermen congregate in the lower reaches of the Gangetic delta for fishing purposes. A variety of fishes are caught in the net and generally hilsa forms one of the important catches.

Mal jalo (Pl. X, fig. 12). It is reported that this net is operated on the Midnapore Coast in West Bengal where there is a wide tidal zone. It is more common along the Balasore Coast and a typical one in use in Chandipore is described under Orissa (p. 268).

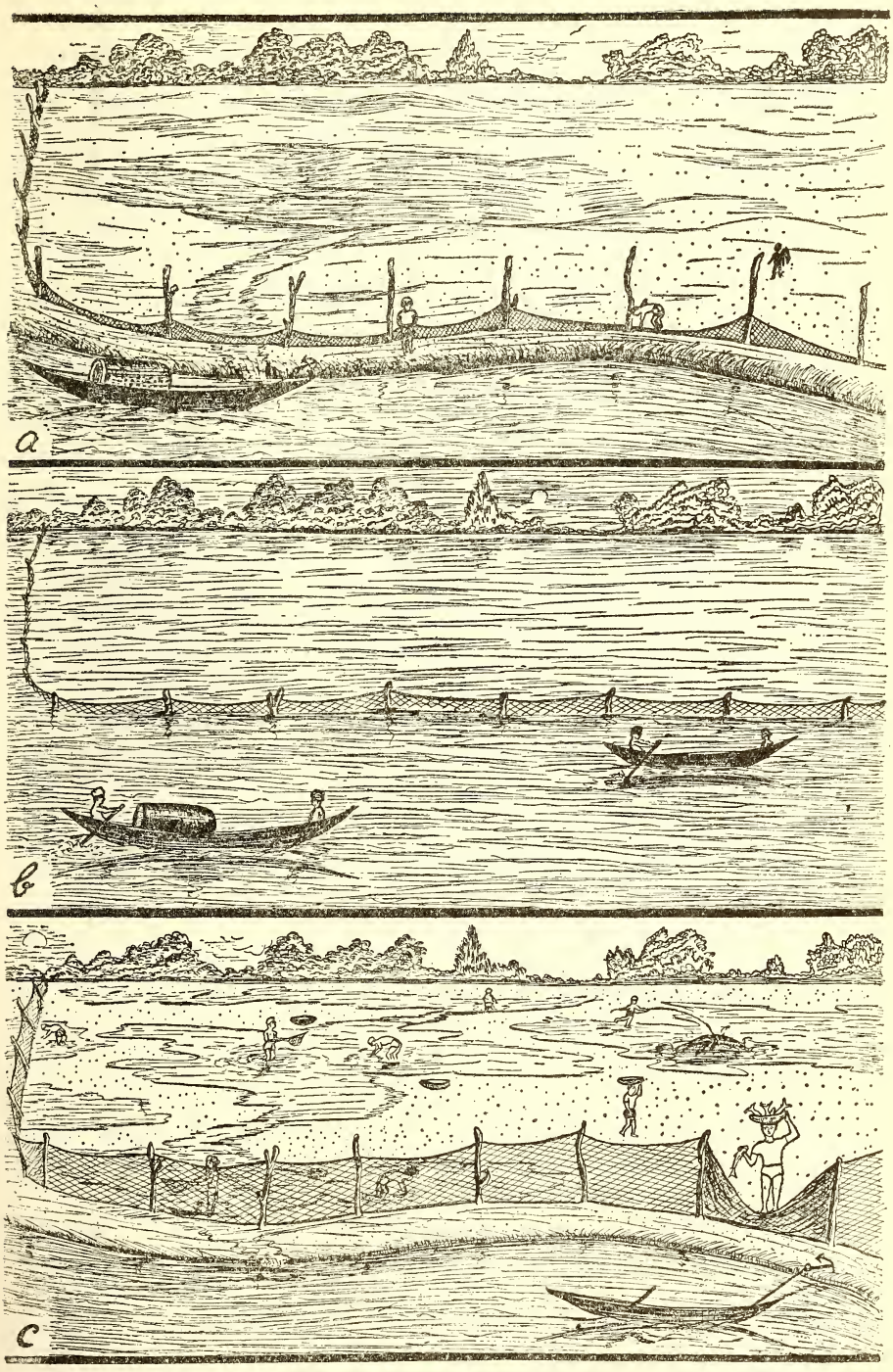

Fig. 9. Operation of the *Char-gherra jal* of Bengal. (By M. P. Lakshmanan)
a. Beginning of the operation—fixing up of the net during low tide.
b. Head rope raised and fixed on the poles at the height of the tide.
c. Fishing operation after the recedence of water.

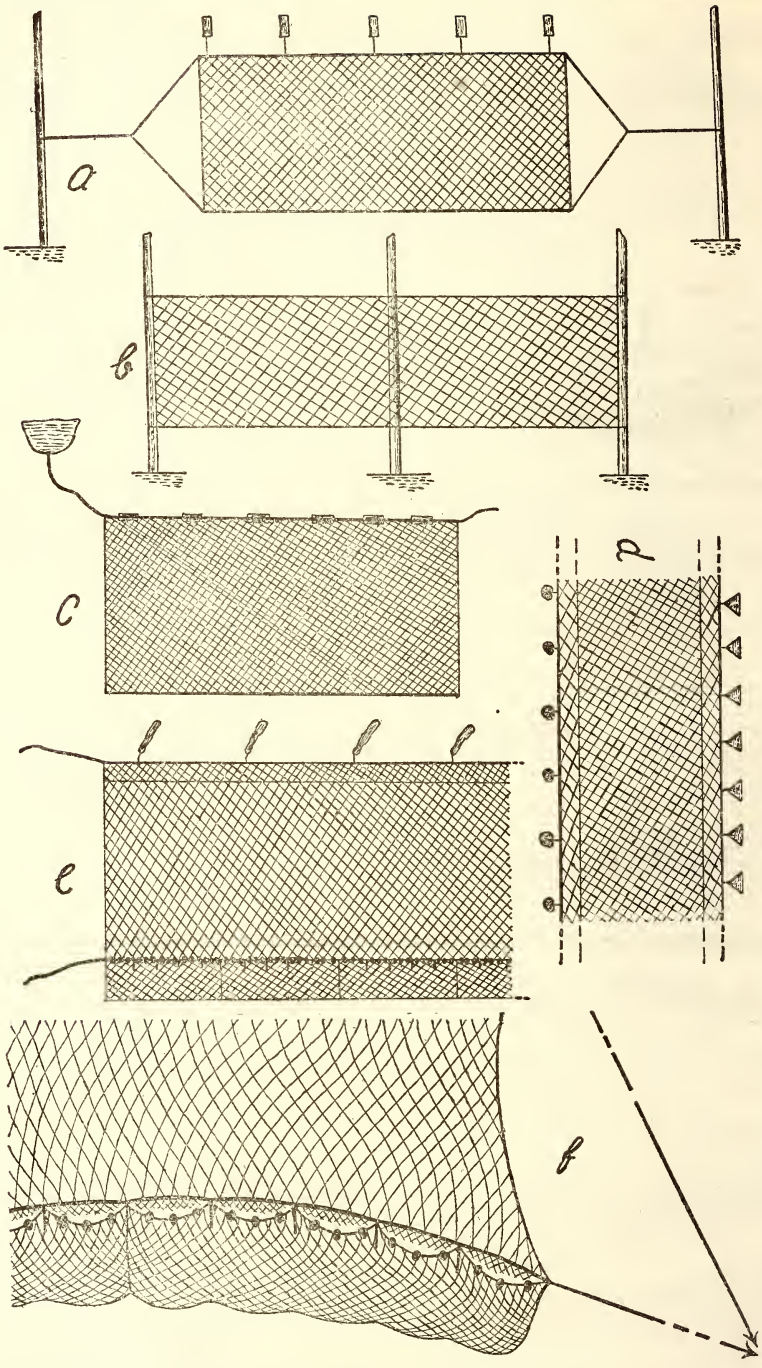

Fig. 10. a. *Ilishi phandi jalo* of Orissa.
b. *Tisto jalo* of Orissa.
c. *Chondi jalo* of Chandipore (Orissa).
d. *Bar jalo* of Chandipore (Orissa).
e. A portion of *Tangra jalo* of Orissa.
f. A portion of *Tangra jalo* in stretched condition at the time of hauling. (All by M. Kumaran)

2. Orissa[1]

Hilsa is available in all the rivers and estuaries of the State from the Subharnarekha in the north to the Chilka Lake and the Rishikulya estuary in the south. During the winter months there is a fishery in the shallow coastal waters also. As the largest river in the State, viz. the Mahanadi, is spanned by anicuts at Naraj and Cuttack there is no hilsa fishery above the anicuts.

Since the State is contiguous to West Bengal much of the fishing gear used is similar with slight modifications and known under different local names, Hilsa is known in Oriya as *ilishi* and more than one net primarily intended for this fish go under the name *ilishi jalo*. The suffix *jalo* is derived from the word *jal* in Hindi and Bengali and means net. Along the Ganjam coast in south Orissa where the sea-going fishermen are all Telugus, the word *jalo* is replaced by *vala*.

Gill nets

Ilishi phandi jalo or *ilishi jalo* (Pl. VIII, fig. 10 *a*). This is a fixed gill net operated in the rivers and estuaries in Balasore District from the middle of October to the middle of March. Each piece is about 15 metres long and 5 metres broad and two or more of such pieces joined together make one composite operational unit. It is made of either 6 ply 10 counts or 8 ply 20 counts yarn or hemp. The head rope has bamboo floats 75 cm. in length about 4 metres apart. The head rope and the ground rope are joined at one side and two ropes each about 11 metres long tied to two poles on either side help to hold the net in a stretched condition. A boat with a crew of 2 men goes about collecting the gilled fish which mainly consist of hilsa.

There is another net of larger mesh called the *bhekti phandi jalo* fixed in the sea and estuaries for large-sized fishes, such as *Lates* (bhekti), sciaenids, etc. Occasionally hilsa is also caught in this net. It is otherwise known as *bar jalo* or *bara jalo* also.

Tisto jalo (Pl. VIII, fig. 10 *b*). This is a very simple type of fixed gill net without floats or sinkers used in the tidal region of the foreshore areas in Balasore District from the middle of March to the middle of July. It has 10 cm. mesh and is made of 6 ply 20 counts yarn or of hemp. Each piece is 18 to 27 metres long, 1.4 metres broad, and

[1] Information on *bhasani jalo* and *bhiro jalo* has been collected and furnished by Mr. Ajit Banerjee of the Central Inland Fisheries Research Station. I am indebted to the late Shri Mukhram, Survey Assistant, Central Marine Fisheries Research Station, for information on other gill nets, trawl nets and drag nets recorded from Chandipore and Ganjam, Orissa.

3 to 5 such pieces are joined together lengthwise to make one operational net. It is tied during low tide to sal wood stakes fixed about 9 metres apart about 400 metres from the shore. During the high tide water rises above the net and the fish that get gilled are removed during the low tide. No boats are used for the operation of the *tisto jalo*.

Ilishi jalo. This is also a simple type of fixed gill net consisting of a rectangular piece of netting similar to the *ilishi phandi jalo*, 36 metres or more long and 4.5 to 5.5 metres broad with 7 to 10 cm. mesh. The head rope and the ground rope which are without floats or sinkers are tied to 2 poles fixed in the estuary. It is mainly intended for hilsa but other clupeoids also get gilled.

Basani jalo. This is a gill net operated along the Balasore coast mainly for hilsa from a single boat by 2 or 3 persons. It is made of 8 ply 16 counts or 10 ply 20 counts yarn or hemp with 4 to 7 cm. mesh. Total length of the net depends on the number of pieces used and may sometimes be up to 460 metres long. Each piece is about 38 metres long and 4.5 metres broad. The head rope has wooden floats 4.5 metres apart of which the first one is large and conspicuous and serves as a buoy and the ground rope has small iron sinkers.

The net is taken in a boat with a crew of 3 or 4 persons and when a shoal is sighted it is cast quickly around the shoal. When the buoy is contacted on the completion of the encircling movement, the two ends of the net are brought together and it is hauled into the boat removing the gilled fish as they come in. The net is operated from November to February and along with hilsa other fishes such as *Lates*, sciaenids, catfishes, engraulids, mullets, etc. are also caught.

Chondi jalo (Pl. VIII, fig. 10 *c*). This is a long narrow drift net similar to the *chondi jal* of Bengal. The net may be up to 370 metres long and it is 1.2 metres broad with 5 to 10 cm. mesh. There are floats on the head rope of which the one at the end is large and conspicuous and serves as a buoy. The ground rope has no sinkers. The net is held on to the boat by a long rope and is allowed to drift with the current. It is used in rivers, estuaries, and the sea. In the Dhamra and Mahanadi estuaries this is reported to be used practically all round the year except during very rough weather. Fishes other than hilsa are also caught in the net. It is used as a drag-net during the fish drives in the Mahanadi as described elsewhere (p. 269).

Bhiro jalo or *bheed jalo* or *ilishi jalo*. This is said to be a modification of the *ilishi jalo* and the *ilishi phandi jalo* with wooden floats and earthen sinkers and is operated from 2 boats. The net is

made of 6 ply 10 counts yarn with 10 cm. mesh and may be 200 metres to over 600 metres long, composed of a number of pieces 18 metres long and 5.5 to 9 metres broad contributed by the participating fishermen. The net is operated along the Balasore coast from November to March.

Two large boats, each carrying a *bhiro jalo* with a crew of 6 to 10 persons scout for hilsa shoals along the foreshore waters beyond the tidal zone. On sighting a shoal, the two boats come together, join the two nets, and make an encircling movement while paying out the net. As the two boats meet the two ends of the combined net are held together in one boat and the other boat goes inside the encircled area while the men frighten the shoal by making noise and beating the water with poles. Due to the disturbance caused, the fish scatter in all directions to get gilled in the encircling wall of net. When it is felt that very few fish are left uncaught each boat reverses the operation by hauling the net and stacking it for the next operation after the gilled fish are removed.

The above net known locally as the *bhido jalo* or *bhida jalo* is a multi-purpose gill net made of yarn or hemp used in the Chilka Lake for catching all kinds of fishes including hilsa. Each piece is about 9 metres long and about 3 metres broad with 4 to 5 cm. mesh and wooden floats 60 to 90 cm. apart along the head rope. A hundred or more pieces are joined together and loaded in two boats and cast as the *bhiro jalo*. 3 or 4 accompanying boats race into the encircled area just before the opening closes making a great deal of noise and disturbance in the water. The fish scatter in all directions and get gilled.

Gherua jalo. This is a hempen gill net similar to the *bhido jalo* used in the Chilka Lake for all kinds of fishes including hilsa.

Odi vala or *odi jalo*. This is a multi-purpose drift net used in the sea along the Ganjam coast (South Orissa) by Telugu fishermen. It is made of a single piece of netting about 60 metres long and 12 metres broad with 7 to 10 cm. mesh. It is operated from a catamaran with a crew of 2 men who allow the whole net to drift at the end of a rope about 73 metres long. The net is used from May to September and a variety of fishes including hilsa are caught.

Pelagic Trawl

Iriga vala or *irgali* or *irgal jalo* (Pl. IX, fig. 11 *a*, *b*). This is a conical bag-net resembling the *thurivalai* of the Coromandel coast (Hornell 1924 *b*). This is operated by Telugu fishermen in the sea along the Ganjam coast in south Orissa. The net is made in two sizes and the larger one is known as the *pedda irgali* or *bada irgali* and the

smaller one is known as the *sanna irgali* or *chotta irgali*. The former has a bag length of 13 metres and wing span of 27 metres on each side while the latter has a bag length of 7 metres and wing span of 15 metres on each side. Except in the difference in size both are alike in construction and mesh size. The cod end of the net has an opening for emptying the contents which is kept tied with a stout rope with a stone weight at the end to keep the net at the proper level during operation. The head rope has floats and the ground rope sinkers. A typical *pedda irgali* is figured indicating the different portions like *baromadi*, *male madi*, *sinapu vala*, *ata vala*, *waram* with the respective mesh sizes.

Two catamarans each with a crew of 2 persons proceed to the fishing ground with the net loaded in one if it is a *sanna irgali* or in both if it is a *pedda irgali*. On reaching the fishing ground which may be 2400 to 6000 metres away from the shore the bag is let down into the water and the catamarans move away from one another and in a forward direction holding the two wing ropes and stretching the net to the maximum extent. The catamarans again meet together bagging all the fish covered by the wings. The net is then quickly hauled in and the fish caught are removed. Hilsa forms one of the catches.

Often when a large shoal is sighted two nets are operated from opposite directions encircling it and the nets are then hauled into the respective catamarans.

Drag nets

Bar jalo (Pl. VIII, fig. 10 *d*). This is a very long multi-purpose drag net sometimes over 300 metres long depending on the number of pieces laced together. Each piece is about 18 metres long and 3 to 9 metres broad, made of yarn or hemp. The mesh varies from 5 to 9 cm. It has wooden floats and sinkers of burnt clay.

The net is loaded into a boat and a long rope tied to one end of the net is held by a party on the shore. The boat is rowed far out making a semi-circle and covering the maximum area possible. When it reaches the shore most of the crew leave the boat holding the rope at the other end of the net and both the parties haul it in the manner of a typical shore seine landing all fishes in the body of water covered by the net.

Fishing with this net is carried out during the winter months from November to March when the sea is comparatively calm.

Tangra jalo or *tangna jalo* or *tangni jalo* (Pl. VIII, figs. 10 *e*, *f*). This is a multi-purpose pocketed drag net, like the *ghai ber jal* of Bengal, operated in rivers and estuaries in Balasore district. The main body

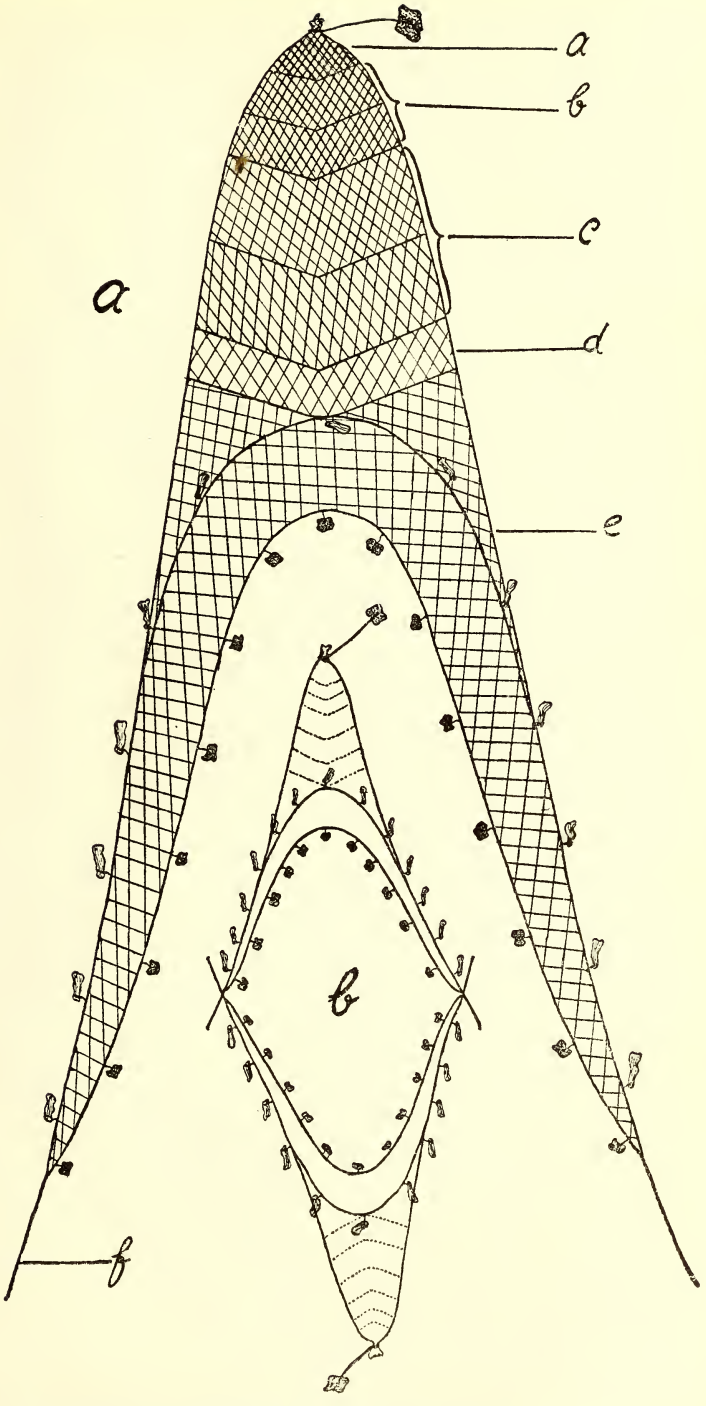

Fig. 11. a. *Iriga vala* or *irgali* of S. Orissa and Andhra.
b. Diagram showing the operation of two *Iriga valai* from opposite directions. (By M. Kumaran)
a = *Baromadi* ; *b* = *Malemadi* ; *c* = *Sinapu vala* ; *d* = *Ata vala* ; *e* = *Waram* ; *f* = *Thradu*.

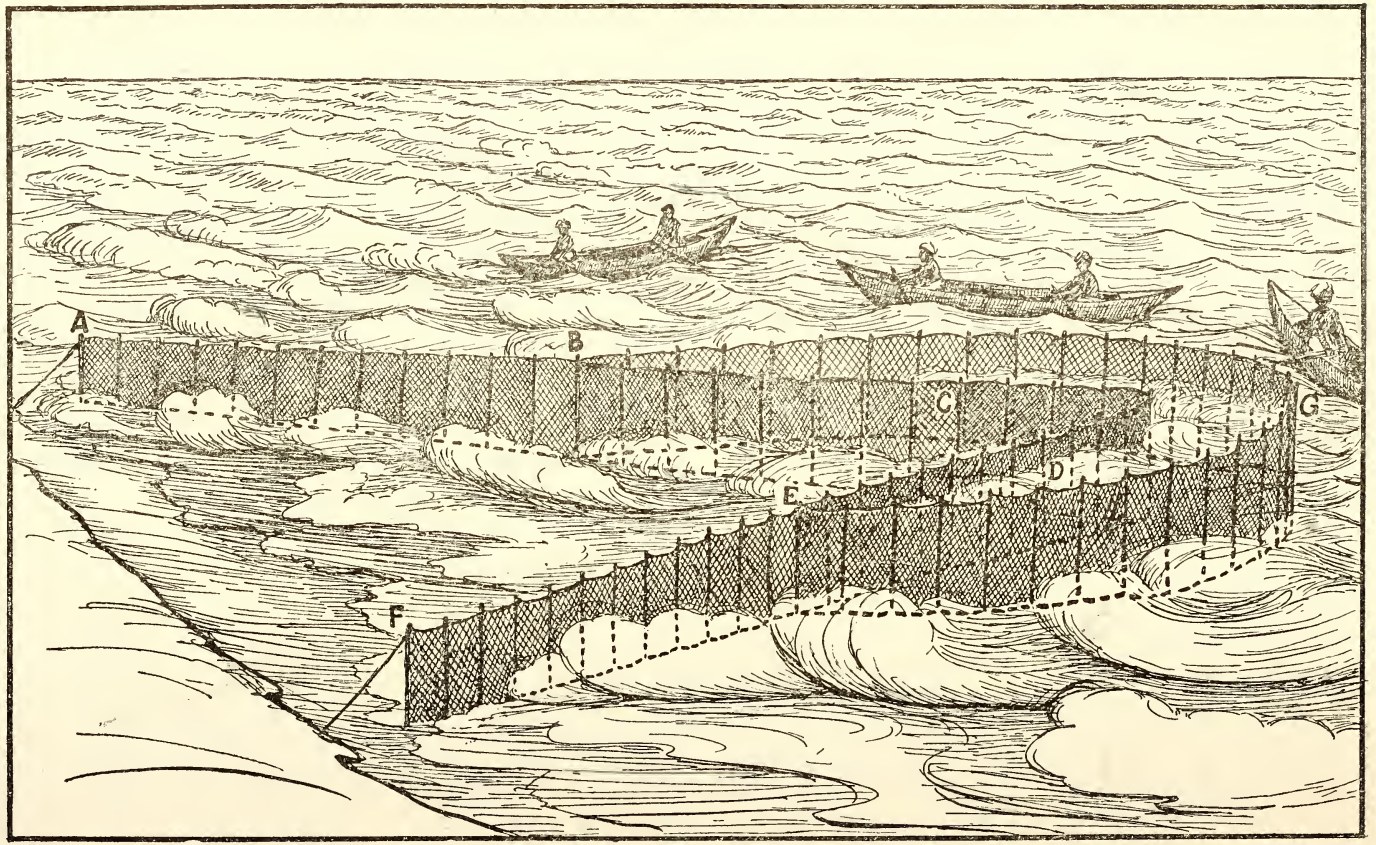

Fig. 12. Operation of *Mal jalo* of the Chandipore and Talpada areas of Orissa. (By K. G. Nambiar)
A–B and E–F=*Cuna jalo;* B–C and D–E=*Nanhya jalo ;* C–D=*Satiya jalo ;* BGE=*Chouhandra jalo*

of the net is made of 12 ply 20 count thread. Each piece is about 15 metres long and 3.7 to 4.3 metres broad. The head rope has wooden floats 1.2 metres apart and immediately below it is a narrow border or '*baranda*' of 5 cm. mesh. Below the '*baranda*' is the main body of the net about 2.4 to 3 metres broad and of 6 cm. mesh. Below this are the pockets about 45 cm. to 60 cm. deep. Each pouch is about 1.5 metres long and is subdivided into 5 incomplete pockets. Along the free margin of the pockets are burnt clay sinkers 15 for a 1.5 metres long pouch or 3 for each subdivision of the pouch.

The net is operated in the same manner as the *bar jalo* with the help of a boat with a crew of three or more persons and is hauled as any typical shore seine with the help of the head rope and the ground rope. The sinkers help to keep the mouth of the pouches open and entrap the fishes, making escape difficult. This net is used in the estuaries from the middle of October to the middle of July.

Sarni-Phasi jalo. This is a shore seine operated in rivers as a combination of two nets known as the *sarni jalo* and *phasi jalo* with about 12 pieces of the former in the centre joined to 2 or more pieces of the latter to the sides depending on the width of the river to be covered.

(i) *Sarni jalo.* Each piece is about 7 metres long and nearly 5 metres broad and made of 7 ply 20 counts yarn with 2 cm. mesh. The head rope is of hemp of 1.3 cm. thickness with wooden floats 20 to 25 cm. long and 30 cm. apart. The ground rope is also similar to the head rope and has round clay sinkers of 4 cm. diameter.

(ii) *Phasi jalo.* Each piece is about 13 metres long and nearly 5 metres broad with 5 cm. mesh. The net is made of hemp and the head rope and ground rope are as in the *sarni jalo.* The floats are 20 to 30 cm. long and 90 cm. apart and the burnt clay sinkers are almost cylindrical 6 cm. × 4 cm. with a hole in the centre.

This combination net is operated as a typical shore seine in rivers from the middle of October to the middle of July with the help of a boat. The head rope and ground rope serve as hauling ropes but the latter is pressed down by the persons in front to prevent the escape of any fish.

Patua jalo. This is a drag net operated in the Chilka Lake and is usually made of about 4 ply 10 counts yarn with hempen head ropes and ground ropes. Each piece is about 22 metres long and about 3 metres broad with 2.5 cm. mesh and with floats 46 cm. apart. 6 to 10 pieces are joined together and operated either as shore seine or boat seine. Small-sized hilsa are caught along with engraulids.

Cast nets

Khepa jalo (Pl. XI, fig. 13). When the Mahanadi is in flood the hilsa fishermen wait below the Cuttack and Naraj anicuts perched precariously like statues on tiny platforms built on poles fixed in the river bed with a cast net half spread in hand and ready for casting at any suspected movement of the fish. As soon as a fish is noticed the net will be seen describing a circle in the air and descending gracefully on the water, more often than not enclosing one migrant fish. The net is hauled up slowly and carefully and any fish caught is thrown in a small dug-out canoe moored below the platform. The cast net used is a wide-meshed one of the folding and puckering type similar to the *kephla jal* of Bengal (Fig. 8 *a*).

Dip net

Hadia jalo. This is a light triangular dip net similar to the *hela jal* of Bengal and is used at the Naraj anicut by Oriya fishermen for all kinds of fishes including hilsa. There are two sizes, a smaller one with each arm about 4 metres long and apex 2 metres with 1.3 cm. mesh and a larger one with each arm about 5 metres long and apex 3.6 metres with 5 cm. mesh. The fishermen remain in pools below the anicut and go on 'straining' the water with rhythmic regularity, in the course of which they get occasionally specimens of hilsa also.

Barrier nets

Mal jalo (Pl. X, fig. 12). This net is used in Chandipore and Talpada in the district of Balasore in Orissa and in the adjacent district of Midnapore in West Bengal where there is a very wide tidal zone. As the fixing of this net involves considerable initial labour, once it is fixed in one place it is not shifted till the season which extends from November to March is over. Two rows of stakes are fixed about 3 metres apart in the manner of an obtuse-angled V each arm of which is about 275 to 375 metres long. Behind the angle of the V a U-shaped row of stakes is fixed to look as if the V is resting on the U with the opening towards the land. The U-shaped row known as the *chouhandra* or *chonda* is about 90 to 140 metres long and has stakes more closely arranged. The above work is generally completed by the co-operative effort of at least 25 to 30 persons who own the nets and share the catches.

The net used is made of 8 to 10 ply 16 or 20 counts thread or of hemp. It is divided into 3 parts called the *cuna jalo* or *chuna jalo* at the two free ends followed by *nanhya jalo* or *naya jalo* with *satiya jalo* or *santiya jalo* in the middle covering the angle. In a

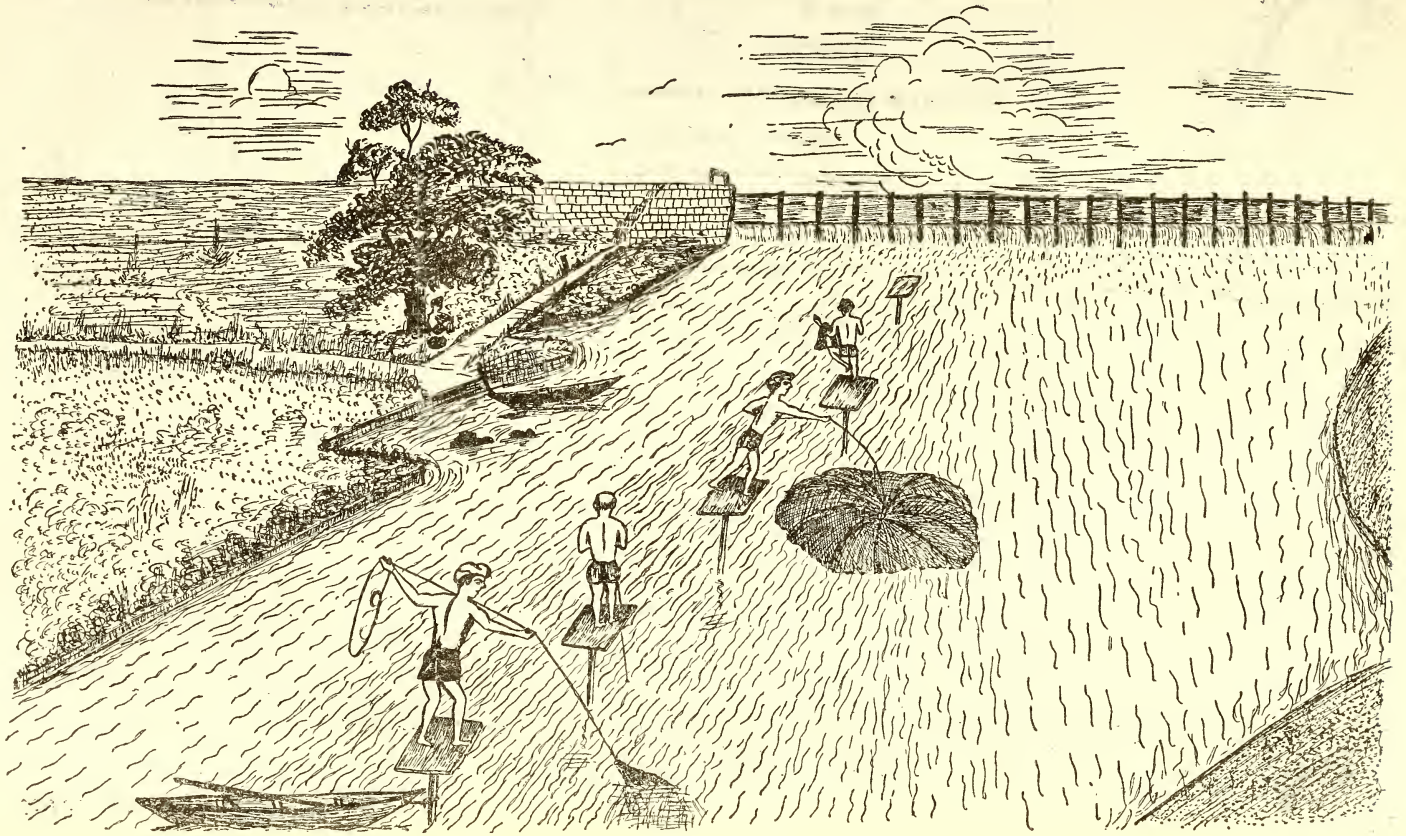

Fig. 13. *Khepa jalo* operation below the Cuttack Anicut in the Mahanadi, Orissa. (By M. P. Lakshmanan)

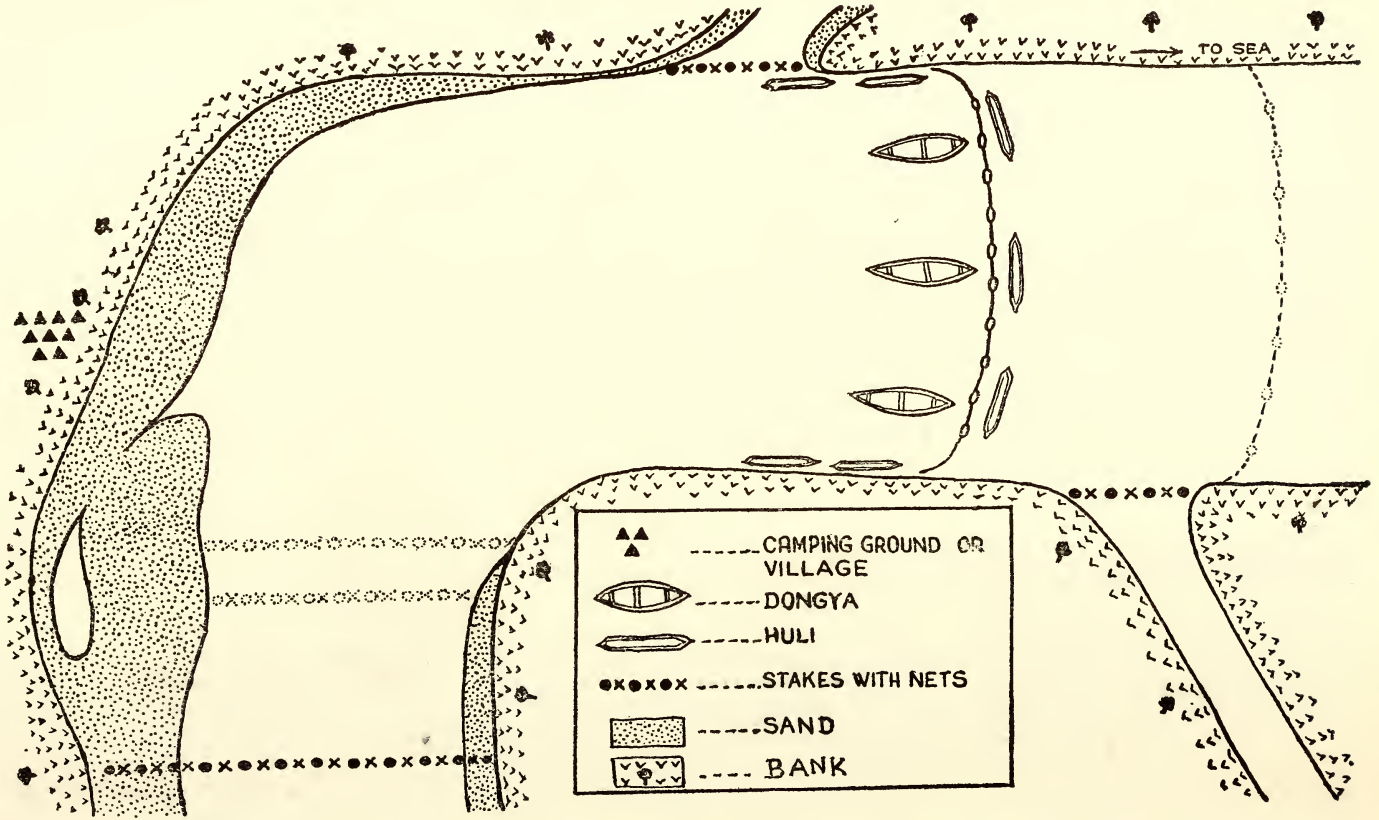

Fig. 14. Diagrammatic representation of a hilsa drive in the Mahanadi estuary. (By Mydeen Kunju)

mal jalo with an arm 300 metres long, the *cuna jalo* will be about 140 metres long of 8 or 10 ply 10 counts yarn starting with 10 cm. mesh which gradually reduces to 7 cm. where the *nanhya jalo* begins. The latter will be about 120 metres long of 6 or 8 ply 10 counts yarn with the mesh diminishing to 5 cm. where it meets the *santiya jalo*. The *santiya jalo* is of 4 to 6 ply 10 counts yarn and will be about 46 metres long up to the angle with the mesh rapidly diminishing to 1.3 cm. The *chouhandra jalo* behind the main *mal jalo* has 1.3 cm. mesh throughout of 8 ply 10 counts yarn and is about 1.2 to 1.5 metres wide. There is a progressive increase in the width of the main *mal jalo* beginning from 1 metre at the tip of the *cuna jalo* on the shore seine increasing to 4.6 metres seaward to the angle of the net.

The nets are tied to the stakes when the tide is low with the ground rope closed to the bottom and at the highest tide they are completely submerged with the tops of the poles here and there marking the lay out of the whole contraption. Fish cross over unsuspectingly and sometimes the men go in boats and any shoals sighted are driven into the fenced area. When the water recedes during low tides the fish get gilled or trapped and these are collected by the participating fishermen and shared among them.

The net is operated from November to March and actual fishing takes place only during spring tides, i.e. about 5 days before and 5 days after the full moon and the new moon which works out to about 10 days in a lunar month. When it is found that water is not high enough to submerge the nets and impound the fish, they are removed and the necessary repairs attended to.

Fish Drives (Pl. XII, fig. 14)

During the winter and summer months large shoals of hilsa frequent the estuaries of the Mahanadi and the Dhamra rivers and they are caught by collective fish drives by large groups of fishermen who gather together at vantage points carrying their nets in their 'dongyas' with the 'hulis' towed behind. A 'dongya' is a plank-built flat-bottomed boat about 11 metres long and 1.8 to 2 metres broad with a hood to accommodate about 6 persons. A 'huli' is a narrow dug-out canoe about 6 to 9 metres long and 45 to 55 cm. broad and, on account of its lightness, shallow draught, and easy manœuvreability even by a single person, is used for quick local transportation. Two kinds of nets are used, the *chondi jalo* with 7.5 cm. and 9 cm. mesh and *chawk jalo* with 5 cm. mesh. The breadth of the net ranges from 6 to 9 metres, while the desired length is made up by joining several pieces together. The head rope has wooden

floats and the foot rope brick sinkers covered with old netting. All nets are made of hemp.

Much time is taken to decide on the commencement of the fishing operations. This involves considerable waiting, consultations, arguments, recriminations, and deliberations with frequent lapses of complacency coupled with morbid inactivity. The fishermen are extremely superstitious and they wait for auspicious signs to start fishing even if it entails waiting for weeks together![1]

In spite of all this, once the decision is taken to conduct fishing, the scene gets changed to one of busy activity. A stretch of the river to be fished 2 to 4 miles long, depending on the strength of the fishing party, is selected and at the upper limit stakes are driven across the river and two layers of medium-meshed nettings are fastened to them to block any movement of the fish further upward. All side creeks and channels are likewise screened to prevent the escape of fish into them. Scores of fishermen, usually running into two or three hundred, collect together with their nets at the lower limit of the fishing stretch in their *dongyas* and *hulis* and drive in with the rising tide all the fish in the vicinity into the area to be fished and then throw across the river several layers of net completely blocking the passage of fish in any direction. The width of the net is adjusted in relation to the depth of water and the foot rope with the sinkers reaches the bed of the river and the head ropes are supported by boats above the water line. With boats in front and boats behind and men on the two banks, the dragging commences amidst lots of shouting, splashing of water, and display of enthusiasm, rising to a frenzied pitch in which both young and old join. In case the whole stretch cannot be covered within one flow tide the nets are fastened to stakes driven in across the river in two or three rows each several metres apart to prevent too much pressure on a single wall of net, and all activity is temporarily suspended till the commencement of the next flow tide as it is very difficult to drag the net against the current. Generally not more than two flow tides in all are required for the completion of the operations.

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[1] Once I had the occasion to see a large contingent of fishermen near Hadakal at Kujang in the Mahanadi with a fleet of over 50 *dongyas* and 20 *hulis* waiting in a creek for weeks together for fishing. The water in front of them was teeming with shoals of hilsa and when the men were asked why they did not start fishing they said that the auspicious sign has not been received and that it was reported that another group of fishermen camping somewhere else has done 'karab mantara' (black magic) against them and as such they did not expect any success until the evil effects had been counteracted. Some days later when they were told that another group (not the group responsible for the alleged 'black magic') a few miles away made a heavy catch of hilsa they replied with almost fatalistic resignation: 'Did we not tell you that we are under a spell. All the fish have been attracted away and there is no reason why we should spoil our nets and exert ourselves unnecessarily.'

The moving wall of net is gradually brought closer and closer to the fixed one at the upper limit and due to the congestion of the fish within a limited area the water presents the appearance of a seething mass of fish. Open *dongyas* are brought into the enclosure and the fish are collected in baskets and dip nets and transferred into them.[1]

3. Assam[2]

The Brahmaputra River before its confluence with the Ganges flows through Assam and hilsa is known to ascend as far as Dibrugarh, though it forms a sizeable fishery only in the western districts of Goalpara and Kamrup. It is fished in the Barak also which flows into the Meghna in the south. All the rivers of Assam flow into East Bengal (Pakistan) and in the border districts of these States the fishing methods should be similar.

Clap nets

Sangla jal. Same as the *shangla jal* of W. Bengal described already (Pl. I, fig. 1 *b*). The bamboo frames of the mouth are 6 to 7.5 metres long and the bag is 3 to 4 metres at the widest portion. It is made of 9 to 10 ply 40 count yarn and the mesh is 12 to 15 cm. This is operated two at a time from the layer *pansi nauka* or one at a time from the smaller-sized *kosa nauka.*

Kami jal or *ilishi jal* or *sharki jal* (Pl. XIII, fig. 15 *b*)[3]. This is similar to the *karki jal* of Bengal. The bamboo frame is 4.5 to 6 metres long with the bag about 4 metres at the broadest point and somewhat conical. The net is made of 7-8 ply 20 counts yarn or 9-10

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[1] Once the fishing is over, boats laden with fish are moored in the open near the fishing colony and the whole company retires for rest sometimes not even worrying about the immediate and timely disposal of the fish that might otherwise get tainted quickly under the tropical conditions. It is even said the middlemen who generally buy the fish for curing purposes know fully well the psychology of the fishermen and do not hasten to purchase the fish so that they can purchase the stuff ultimately at lower rates. I was informed that on one occasion the men rested too long and the whole catch got so putrified that there was no offer at all from the middlemen and the lot was thrown back into the river with an almost stoic philosophical attitude saying ' What we got from the river we consign back to the river '!

I had the opportunity to witness one fish drive in the Mahanadi near the village of Tikhri. There were in all about 25 *dongyas*, 10 *hulis*, and about 150 men excluding children. There was a catch of about 400 maunds (1 md. = 82·28 lbs.) of fish. Two weeks previously about 640 maunds were caught in the same locality by the same group.

[2] Some of the hilsa fishing methods in the Brahmaputra and the Barak are described in a ' Note on the Hilsa Fisheries of Assam ' by T. V. R. Pillay and A. N. Ghosh (1958, *JBNHS* **55** (1) : 174-177) that was published while this article was in press. Photographs of the clap net *sanglo jal* and the dip net *firki jal* or *hafa jal* are given. The latter appears to be similar to the *dui-tuni jal* of Assam described in the present article (p. 272) and the *hefa jal* or *hafa jal* of East Bengal (see Part II of this paper — still to be published). The *kona jal* (p. 257) and the *jagat ber jal* (p. 257) and a wide-mouthed cast net known as *garua ilihi* are also reported to be in use there.

[3] My thanks are due to Mr. S. R. Ahamed, Central Inland Fisheries Trainee (1955-56) from Assam, for the particulars of *kami jal.*

ply 40 counts yarn with about 12 to 15 cm. mesh. The mouth of the frame when fully opened is about 2 to 2.4 metres wide. A bamboo pole is fixed to the lower frame of the net and is lowered to about 1.5 to 2 metres of water leaving about 1/3 of the opening above the water line. The net is held at the prow of a boat by one man and another person guides it as it drifts with the current. The disturbance caused by the entry of a fish is sensed by the person holding the net and the bamboo pole is pulled up closing the mouth of the net and imprisoning the fish. The net is operated in the Brahmaputra when the river is in flood.

The *chairon jal* and *funga jal* used in the Barak in the Sylhet-Catchar area are reported to be the same as the *shangla jal* with minor local modifications. The *funga jal* also known as *honga jal* is generally used for catching large-sized fishes.

Dui tuni jal (Pl. XIII, fig. 15 *a*).[1] This is a lift net similar to the *bhahali jal* but with the collapsible frame. It consists of a Y-shaped frame of 2 bamboo poles, one about 6 metres long and the other about 4 metres long. The smaller pole is movably tied with a rope to the longer one the free end serving as the handle. A short tightening rope from the middle of the left arm of the frame is tied to the handle to keep the two arms apart. The tips of the two arms remain about 1.5 metres apart. A triangular bag-like netting about 4 metres long made of 7 to 8 ply 20 counts yarn or 9 to 10 ply 40 counts yarn with 10 to 12 cm. mesh is tied to the frame. From the middle of the bag a feeler cord is taken to the handle to be held by the person operating the net. The net is operated from the prow of a boat (Pl. XIII, fig. 15 *a*) which drifts with the current. Two other persons help to guide the boat and handle the catches. When the presence of a fish inside the net is felt through the feeler cord, the tightening rope is relaxed and the frame collapses trapping the fish inside. The net is then lifted up and the catch is removed. Some nets do not have a feeler cord and a portion of the net will be lifted up and held by the little finger of the left hand.

The net is operated in the Brahmaputra when the river is in flood.

Lift net

Bhahali jal (Pl. XIV, fig. 16).[2] In principle this is drifting push net of the lever type. It is a large bag net attached to a Y-shaped frame supported by a short forked pole at the base and operated from a boat drifting with the current. The net is generally of cotton of 12

[1] My thanks are due to Mr. S. R. Ahamed, Central Inland Fisheries Trainee (1955-56) from Assam, for the particulars of *dui tuni jal*.

[2] My thanks are due to Mr. Surendra Nath Das, Central Inland Fisheries Trainee (1955-56) from Assam for the particulars of the *bhahali jal*.

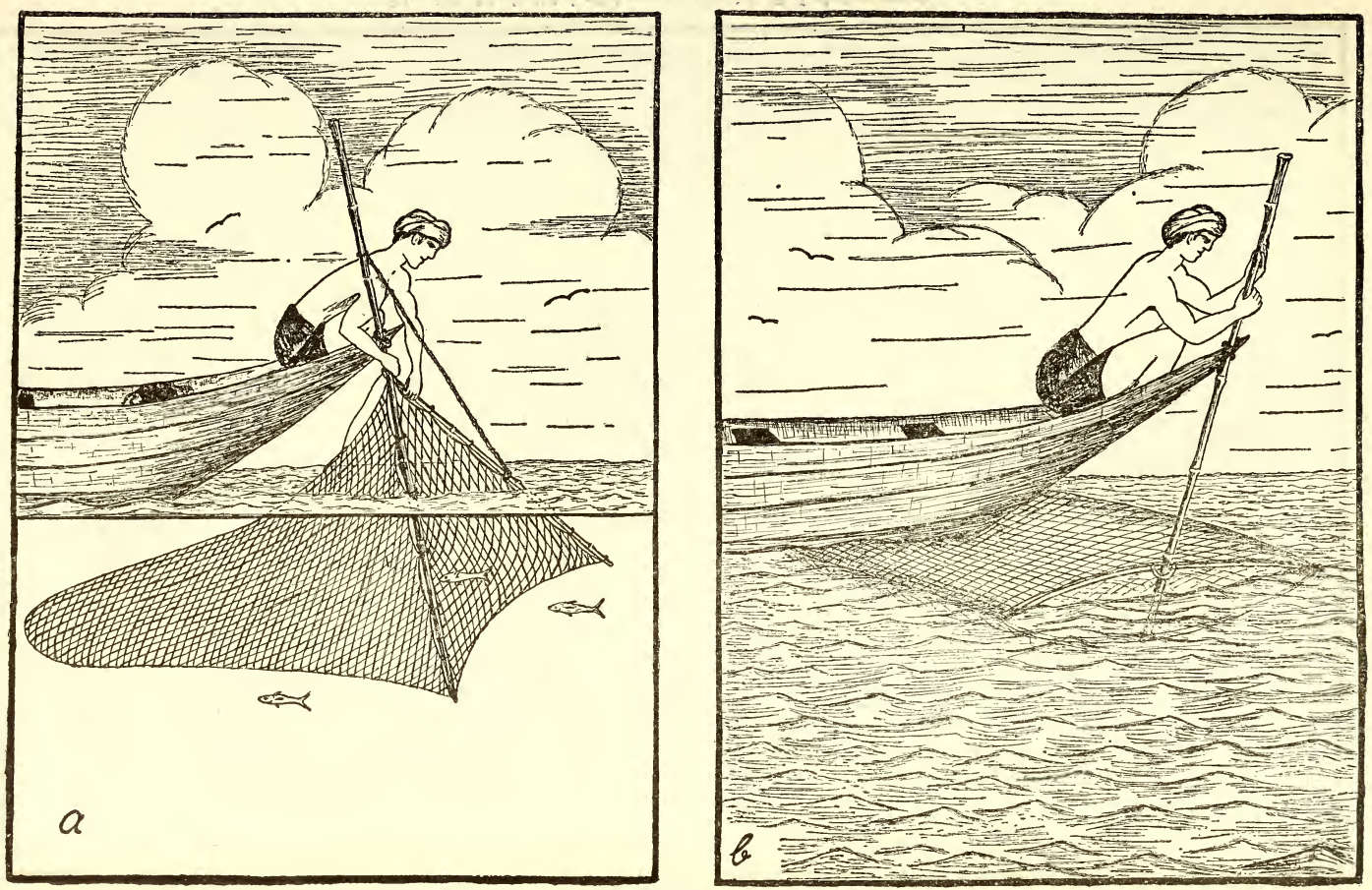

Fig. 15. a. *Dui tuni jal* of Assam ; b. *Kami jal* or *Ilishi jal* of Assam. (By M. P. Lakshmanan)

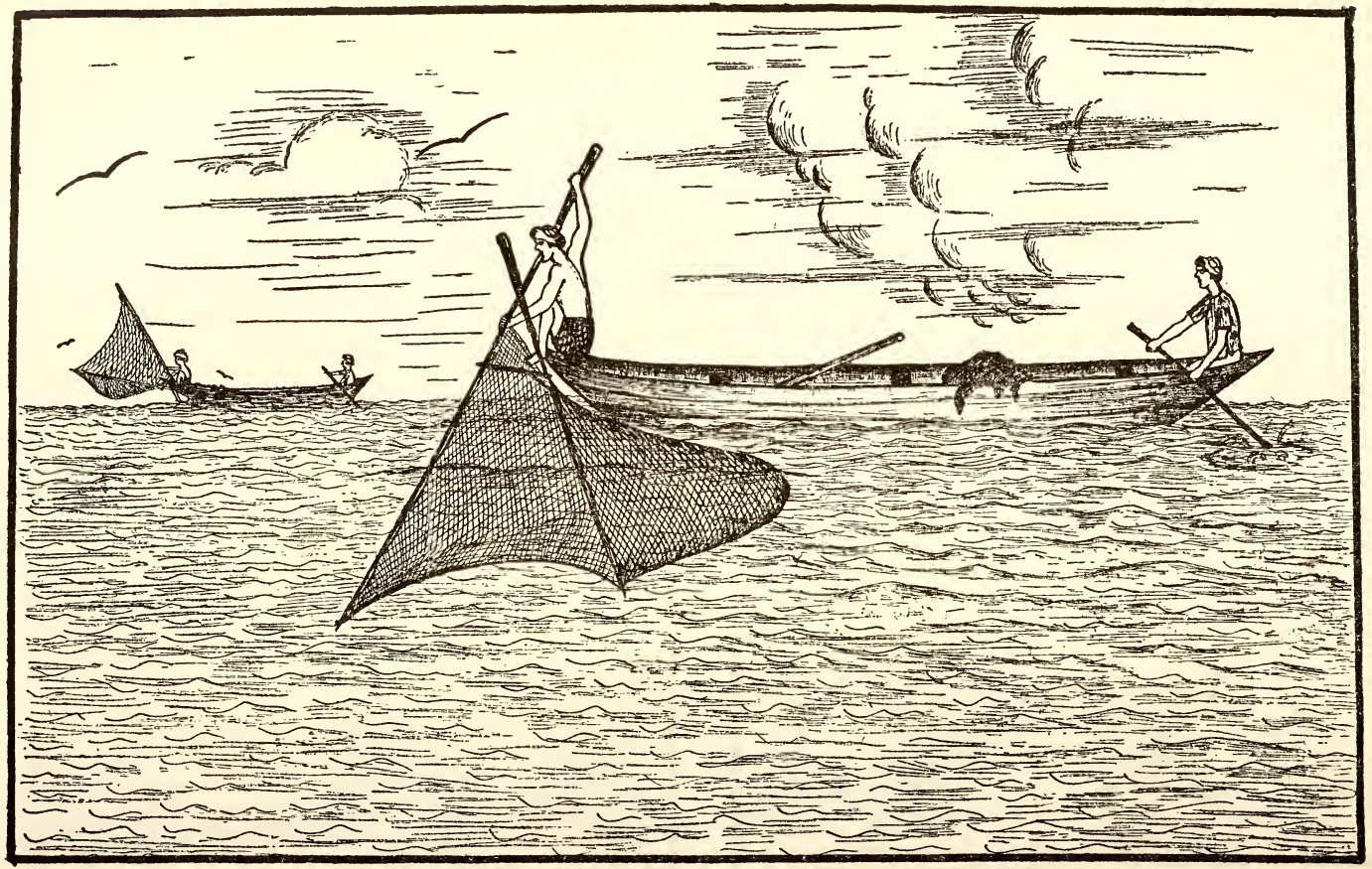

Fig. 16. *Bhahali jal* of Assam. (By M. P. Lakshmanan)

ply No. 40 counts and of 6 to 9 cm. mesh. The longest pole of the Y-shaped frame is about 5.5 metres long, the shorter one about 4.5 metres, and the forked basal pole about 1.5 metres. The two large poles are fixed by a nail or jute rope and the forked pole tied across gives rigidity to the frame. The mouth of the net is shaped like a parallelogram with the longest side about 5 metres, the shortest about 1.2 metres, and the equal sides about 3 metres each. One lb. of No. 40 thread is sufficient to make a net which is used untanned.

The net is operated from a boat by two men of whom one will be at the helm rowing and directing the boat which drifts with the current. The second man remains at the prow with the net held below water in a nearly vertical position as shown in the figure. The free portion of the frame at the base is held by the right hand and the left arm of the frame is supported by the left hand which also takes hold with its little finger of a mesh of the baggy portion of the net. The quiver caused in the net by the entry of a fish is transmitted to the little finger and the net is raised with the prow of the boat serving as the pivot.

The net is used in the Brahmaputra from Dubri to Gauhati from June to October but the peak season is June to August when the river is in flood. The distance covered by a boat each time is about a mile. It is then taken back to the starting place and the process is repeated.

4. Bihar[1]

The Ganges River flows through Bihar receiving a few large tributaries like the Sone and the Gandak before it enters the deltaic region in Bengal. Most of the hilsa catches are from the main Ganges and the most important net employed is the *sungail.*

Clap net

Sungail jal or *sungla jal* or *hilsauri.* This is the same as the *shangla jal* of West Bengal (Pl. I, fig. 1 *b*). The net is 9 metres by 4.5 metres with 10 cm. mesh and is operated all the year round. A boat about 7 metres long with a crew of 2 or 3 persons is used for fishing with this net.

Gill net

Dondi jal or *dandi jal.* This is a simple piece of netting of 2.5 cm. mesh about 2.5 metres long with two bamboo pieces along the two sides. Two persons each holding one side of the bamboo

[1] I am indebted to Mr. C. P. Varma, Fisheries Development Officer, Bihar, for the information given here on the hilsa fishing methods.

vertically in the water move or swim close to the bank in the direction of the current and any ascending fish that get gilled are removed. The net is operated from July to October when the river is in spate and hilsa fish are frequently caught.

Seine net

Joha jal. This is a large hempen round haul net of 5 cm. mesh, 90 to 1200 metres long and 3 to 4 metres broad with a bag about 4.6 metres deep and about 3 metres wide at the mouth. It is operated from December to April in the wide and deep stretches of the river with the help of 7 boats, each 7 to 8 metres long, by about 30 to 40 men.

Lift net

Bisari jal. This is a small-meshed (1.3 cm.) dip net about 5 metres long operated from a boat, presumably similar to the *bhahali jal* of Assam, and is used practically all the year round.

5. Uttar Pradesh[1]

Among the rivers in the Uttar Pradesh, from the hilsa fishery point of view, only the Ganges is of importance, the quantity caught in the Jamuna and the Gogra being comparatively negligible. The regular fishery extends up to Allahabad. The usual method of fishing is by the clap net known as the *kamail jal.*

Clap net

Kamail jal. This is the same as the *sungail jal* of Bihar and the *shangla jal* of West Bengal (Pl. I, fig. 1 *b*).

Drag nets

Maha jal. This is a large drag net operated with the help of boats in the Ganges. The total length of the net varies from 450 to 650 metres and is composed of pieces measuring 14 metres × 4.5 to 6 metres, the mesh of which will be 2.5 to 6 cm. Empty tins and dried pumpkins are used as floats and baked clay sinkers are attached to the bottom. 30 to 40 fishermen are required for the operation of the net. The net is employed all the year round except when the river is in flood. All kinds of fishes including hilsa are caught.

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[1] I am indebted to Dr. V. G. Jhingran, Research Officer, Central Inland Fisheries Research Station, Allahabad, and to Dr. D. S. Sarbahi, Deputy Director of Fisheries, Lucknow, for the information furnished on the hilsa fishing methods in Uttar Pradesh. Figure 23 is after a sketch kindly sent by Dr. M. P. Motwani, Research Officer, Central Inland Fisheries Research Station.

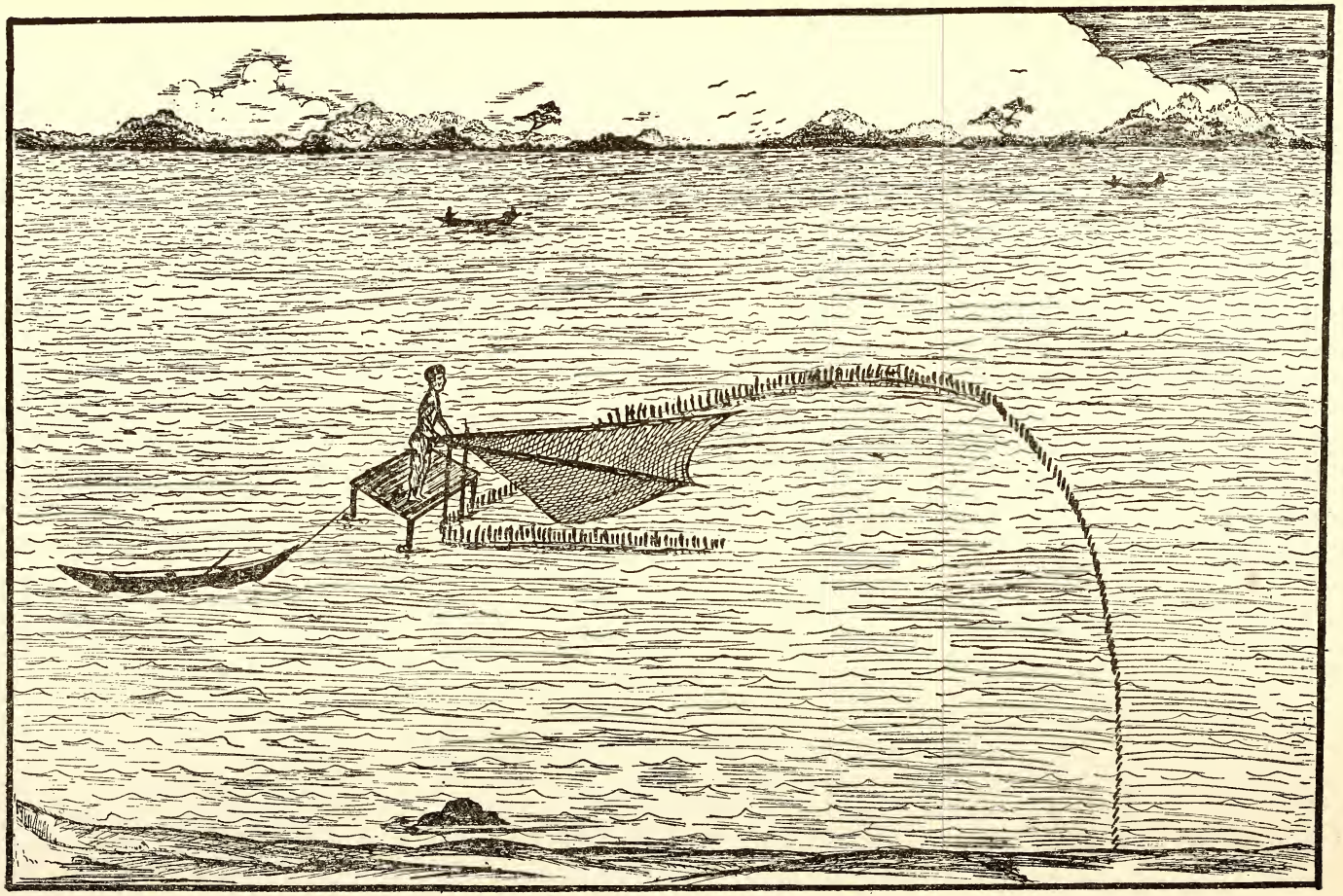

Fig. 17. Operation of *Bandal* of Uttar Pradesh. (By M. P. Lakshmanan)

Chhanta jal or *chhata jal.* This is a shore seine with two rows of pockets along the lower portion of the net used for catching all kinds of fishes including hilsa. The net is composed of 20 to 22 pieces each measuring 10 metres × 5 metres and is made of cotton thread. The mesh generally varies from 5 to 6 cm. while during the rainy season it is 10 cm. 10 to 15 men are required for its operation. The net is used all the year round.

Barrier Fishing

Bandal (Pl. XV, fig. 17). The *bandal* method of fishing is employed in Allahabad and its neighbourhood (Kaushiva 1952). In areas where the river takes a turn or in places where it bifurcates, bamboo fencing is constructed in the form of a V with one arm longer and curved towards the shore side. Hilsa coming up against the current congregate in the angle and they are removed by the help of a scoop net or lift net called *ghauch* operated from a machan or platform. When a scoop net is operated from boat it is called '*gharia ka ghauch*'.

(*To be continued*)

Lectotypes of the species and varieties described by Blatter and Hallberg in their 'Flora of the Indian Desert'

BY

H. SANTAPAU, S.J., F.N.I.

E. Blatter and F. Hallberg gave an account of their exploration of the Indian Desert from the neighbourhood of Jodhpur and Jaisalmer in the *Journal,* from 1918 onwards; in their papers they described a number of new species or new varieties. But in general they mentioned several, at times many, specimens as coming under the new taxon, without specifically stating which was the type of their new taxon from among the many specimens cited.

This method of naming new taxa is strongly deprecated by the International Code of Botanical Nomenclature, ed. 1956; Article 7 of the Code lays down: '. . . the application of names of taxa of the rank of order or below is determined by means of nomenclatural types. A nomenclatural type (*typus*) is that constituent element of a taxon to which the name of the taxon is permanently attached, whether as an accepted name or as a synonym.' Under *Note* 3 of the same Article 7, it is stated: 'If no holotype has been indicated by the author who described a taxon, or when the holotype is lost or destroyed, a substitute for it may be chosen, unless its name must already be rejected under this Code. The author who makes this choice must be followed unless his choice is superseded under the provisions of Art. 8. The substitute may be either a *lectotype* or a *neotype.* A lectotype always takes precedence over a neotype. A lectotype is a specimen or other element selected from the original material to serve as nomenclatural type when the holotype was not designated at the time of publication or for so long as it is missing.'

The 1956 edition of the Code lays such emphasis on the type, that under Art. 35 it is stated: 'Publication on or after 1 January 1958 of the name of a new taxon of recent plants of the rank of order or below is valid only when the nomenclatural type is indicated . . .' This means that it is not enough to mention in the original description that the specimen was collected, e.g. in Khandala, by Santapau, on the 15 January 1959, and that the specimen is kept in

Blatter Herbarium, Bombay; categorically it must be stated that the type is e.g. *Santapau* 12560. If the type is not indicated, publication of the new taxon, even if it be done in Latin, is not valid. Recommendation 35 A adds: 'When the nomenclatural type of a new taxon is a specimen, the place where it is permanently conserved should be indicated': this is only a recommendation; the indication of the precise specimen that constitutes the type is not a recommendation, but a categorical rule or order. Many of our Indian botanists do not seem to understand the meaning of this Article 35; this is why I have gone into some details in the matter.

Whilst going through the Rajasthan specimens of Blatter and Hallberg, many of which are preserved in Blatter Herbarium, Bombay, I found most of the sheets on which Blatter and Hallberg based their new species or varieties. In some cases Blatter left lengthy notes with the specimen, showing that his original description was based on that particular specimen. In such cases there is little difficulty about the election of the lectotype; in most cases, however, they left nothing but an indication on the specimen that the plant is a new species or a new variety.

In the following list, I have selected the lectotype in accordance with the provisions of the International Code, after careful consideration of the descriptions given by the authors and examination of all the specimens cited in the original description. A few specimens are not to be found in Blatter Herbarium; their absence cannot be explained except on the supposition that the specimens may in the course of time have been completely damaged and discarded! I have been informed by those who often accompanied Blatter in field expeditions, that the latter did not pay too much attention to careful pressing and preservation of specimens at the time of collection; when preparing the final description of his plants, he did study them carefully, and often remounted them after softening them in hot water. It is possible that some specimens may have been much damaged in the process of softening.

Lectotypes of the New Taxa

1. **Abutilon indicum** var. **maior** Blatt. & Hallb. in Journ. Bombay Nat. Hist. Soc. **26**: 226, 1918. Only one specimen is mentioned by the authors, which automatically becomes the holotype; there is no need of selecting a lectotype. The holotype is *Blatt. & Hallb.* 5644.

2. **Abutilon fruticosum** var. **chrysocarpa** Blatt. & Hallb. loc. cit.: 227, 1918. Here again only one specimen was mentioned by the

authors, and this automatically becomes the holotype: *Blatt. & Hallb.* 5660.

3. **Pavonia arabica** var. **glutinosa** Blatt. & Hallb. loc. cit.: 227, 1918. Four specimens are cited by the authors, *Blatt. & Hallb.* 5667, 5668, 5669, 5685. Of these, no. 5669 bears on the label the indication 'var. nov.' with the details 'tota planta cooperta pubescentia viscosa'. This specimen, *Blatt. & Hallb.* 5669, collected in Oct. 1917 at Kailana near Jodhpur, is hereby selected as the lectotype of the variety.

4. **Melhania futteyporensis** Munro var. **maior** (Blatt. & Hallb.) Santapau, comb. nov. *M. tomentosa* Stocks var. *maior* Blatt. & Hallb. loc. cit.: 228, 1918.

Blatter himself in this *Journal* (**34**: 883, 1931) united *Melhania tomentosa* Stocks with *M. futteyporensis* Munro, following Parker in For. Fl. Punjab 47, 1918. The variety must then be shifted, as it is being done herein.

Blatter and Hallberg mentioned three specimens as their original material, *Blatt. & Hallb.* 7286, 7295, 7296, collected from Barmer near Jodhpur in November 1917. *Blatt. & Hallb.* 7286 is hereby selected as the lectotype of the variety, the specimen being in better condition than the others and showing details of flowers and fruits.

5. **Melhania magnifolia** Blatt. & Hallb. loc. cit.: 228, 1918. Of the three specimens cited by the authors, *Blatt. & Hallb.* 7279, 7280, and 7285, the last, i.e. *Blatt. & Hallb.* 7285 is selected herein as the lectotype, the specimen being the most complete of the set, and agreeing better with the original description.

6. **Psoralea odorata** Blatt. & Hallb. loc. cit.: 238, 1918. Of the four specimens cited by the authors, *Blatt. & Hallb.* 7002-7005, I select 7005 as the lectotype.

7. **Tephrosia multiflora** Blatt. & Hallb. loc. cit.: 239, 1918. Two specimens were cited by the authors, *Blatt. & Hallb.* 6974 and 6975; of these *Blatt. & Hallb.* 6974 is hereby selected as the lectotype; the original sheet bears a lengthy description by the authors, showing that this was the specimen on which their description was mainly based.

8. **Tephrosia incana** var. **horizontalis** Blatt. & Hallb. loc cit.: 239, 1918.

Two specimens were cited by the authors, *Blatt. & Hallb.* 6976, 6977; of these 6977 bears a detailed description, showing that this

was the original sheet on which the description of the new variety was based. I select *Blatt. & Hallb.* 6977 as the lectotype of the variety *horizontalis.*

9. **Tephrosia petrosa** Blatt. & Hallb. loc. cit.: 239, 1918.

The following specimens were cited in the original description: *Blatt. & Hallb.* 6965-6966, 6968-6973. None of the specimens at present in Blatter Herbarium are in perfect condition, and this is probably due to the hurried way in which they were pressed in the first instance; however, *Blatt. & Hallb.* 6969 is in somewhat better condition than the rest, and is hereby selected as the lectotype of the species.

10. **Alysicarpus monilifer** var. **venosa** Blatt. & Hallb. loc. cit.: 240, 1918.

Two specimens were cited by the authors, *Blatt. & Hallb.* 7225, 7226; of these the latter bears a short typed note giving details of the variety. I select *Blatt. & Hallb.* 7226 as the lectotype of the variety *venosa.*

11. **Rhynchosia rhombifolia** Blatt. & Hallb. loc. cit.: 242, 1918.

Of the three specimens cited by the authors, *Blatt. & Hallb.* 6947, 6948, 6949, only one is preserved in Blatter Herb., no. 6948, which is hereby selected as the lectotype of the species. The sheet in Blatt. Herb. bears the indication 'spec. nov.' in Hallberg's hand, and '*rhombifolia Blatt. & Hallb.*' in Blatter's own hand.

12. **Rhynchosia arenaria** Blatt. & Hallb. loc. cit.: 243, 1918.

Four specimens were cited by the authors, *Blatt. & Hallb.* 6942, 6943, 6945, 6994; none of these specimens shows anything but leaves; the fruits described by the authors seem to have disappeared from the specimens. *Blatt. & Hallb.* 6942 is hereby selected as the lectotype of the species.

13. **Anogeissus rotundifolia** Blatt. & Hallb. loc. cit.: 523, 1919.

Two specimens were cited by the authors, *Blatt. & Hallb.* 6594, 6595, of which only 6594 is preserved in Blatt. Herb. and is hereby selected as the lectotype of the species.

14. **Trianthema decandra** Linn. var. **rubra** (Blatt. & Hallb.) Santapau, comb. nov. *Tr. pentandra* auct. non Linn. var. *rubra* Blatt. & Hallb. loc. cit.: 530, 1919.

The authors cited numerous specimens with the original description; *Blatt. & Hallb.* 6770-6778, 6782-6787; of these *Blatt. & Hallb.* 6772 bears an indication in Hallberg's hand '(Var I n)'; this specimen is hereby selected as the lectotype of the variety.

15. **Trianthema decandra** Linn. var. **flava** (Blatt. & Hallb.) Santapau, comb. nov. *Tr. pentandra* auct. non Linn. var. *flava* Blatt. & Hallb. loc. cit.: 531, 1919.

Two specimens were cited by the authors, *Blatt. & Hallb.* 6788, 6789; both specimens seem to have disappeared from Blatter Herb. The plant is here mentioned to adjust the nomenclature of the same.

16. **Pulicaria rajputanae** Blatt. & Hallb. loc. cit.: 535, 1919.

The following specimens are cited with the original description: *Blatt. & Hallb.* 10039, 10043-10046, 10048-10053. No. 10039 bears a label in the hand of Blatter with a lengthy and detailed description by the same author; this sheet, *Blatt. & Hallb.* 10039, is hereby selected as the lectotype of the species.

17. **Glossocardia setosa** Blatt. & Hallb. loc. cit.: 536, 1919.

Several specimens are cited by the authors, but only one, *Blatt. & Hallb.* 10083, is preserved in Blatt. Herb., identified by Blatter himself; this specimen is hereby selected as the lectotype of the species.

18. **Convolvulus densiflorus** Blatt. & Hallb. loc. cit.: 545, 1919.

Of the three specimens cited by the authors, only *Blatt. & Hallb.* 3515, is preserved in Blatter Herb. and is herein selected as the lectotype of the species. The label on the sheet is in Blatter's hand; at first the plant was identified as *Convolvulus rhyniospermus* Hochst., which identification was corrected by Blatter himself to '*densiflorus* spec. nov.'.

19. **Anticharis glandulosa** Aschers. var. **coerulea** Blatt. & Hallb. nom. nud.; cum descriptione hic data a Santapau.

When the original name was published in the *Journ. Bombay Nat. Hist. Soc.* **26**: 549, 1919, the authors gave no description of the variety, other than '*var. coerulea var. nov.*'.

Here is the description of the variety:

Accedit ad speciem typicam, a qua tamen differt colore coeruleo florum. Typus varietatis a Blatt. & Hallb. nullus lectus est; ideo lectotypus hic a me seligitur *Blatt. & Hallb.* 10284 lectus in loco saxoso ad Jaisalmer mense novembri anni 1917 et positus in Blatt. Herbario.

This variety approaches the typical species in most details, but differs particularly by the blue colour of its flowers. Blatter & Hallberg did not select any type of the variety; a lectotype, *Blatt. & Hallb.* 10284, is herein selected; the specimen was collected on rocky ground near Jaisalmer in November, 1917 and is kept in Blatt. Herb. The variety flowers and fruits in the month of November.

20. **Acrva pseudo-tomentosa** Blatt. & Hallb. loc. cit.: 817, 1919.

In Blatter Herb. there is a large number of sheets of the original material on which this species was based by the authors. The sheets are all labelled in Blatter's hand as *Aerua rajputanae* Blatt. & Hallb.; the correct name, however, is the one published in 1919. *Blatt. & Hallb.* 5962, collected at Jaisalmer in Nov. 1917 is hereby selected as the lectotype of the species.

21. **Euphorbia jodhpurensis** Blatt. & Hallb. loc. cit.: 971, 1919.

Only one specimen was cited by the authors in their original description, which thereby becomes the holotype of the species, *Blatt. & Hallb.* 9228.

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The Flora of the Scrub Jungles of Madras State

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Scrub jungles are open thickets with gnarled trees of small girth and poor density, usually associated with thorny bushes forming a distinctive type which is maintained by excessive biotic exploitation. In Madras State they are generally confined to the plains at the foot of or sometimes on the gently undulating slopes of hills hardly exceeding 1000 ft. They are common in the districts of Chingleput, North and South Arcot, Tiruchirapalli, Tirunelveli, and less so in Salem and Coimbatore districts.

The climate is tropical with a mean annual rainfall of 46″ (about 53″ in tracts near sea-coasts) and the mean annual temperature is 82°F.

Geologically speaking the greater part of these areas is covered with an archaean rock of the gneiss family. The soils may be classified into three groups namely the black or regar, red ferruginous, and arenaceous, which may again be subdivided into clays, loams, and sands. The most fertile of them are the black earths (especially the loam), the next best the red kind, and the worst the sands. The last is generally found towards strips of land along the coasts, where casuarina and cashew are grown. The soil in the majority of the scrub jungles is the red ferruginous type.

These scattered scrub jungles which are the result of anthropogenic ravages support a sparse vegetation. The number of species encountered is also very meagre. Where there exists slight protection the interesting trees met with are: *Acacia latronum, Dichrostachys cinerea, Dolichandrone falcata, Aegle marmelos, Albizzia amara, Diospyros chloroxylon, Azadirachta indica,* and so forth. Other shrubs which are quite frequent are: *Securinega leucopyrus, Randia dumetorum, Carissa spinarum, Gmelina asiatica, Maba buxifolia, Zizyphus mauritiana,* and *Euphorbia antiquorum. Cassia auriculata, Clausena dentata, Azima tetracantha, Cadaba farinosa, Capparis grandis, Capparis sepiaria, Capparis divaricata* are not uncommon.

At certain times of the year the woods are brightened by the handsome laburnum-like flowers of *Cassia fistula,* or the brilliant red

pods of *Pterolobium indicum* or the amber-coloured flowers of *Opuntia dillenii*.

The notable climbers that may be looked for in these jungles are: *Cissus quadrangularis, Sarcostemma acidum, Asparagus racemosus, Cocculus hirsutus, Ceropegia juncea, Melothria maderaspatana, Marsdenia volubilis, Tylophora indica, Ichnocarpus frutescens,* and the parasitic *Cassytha filiformis.* It will be seen that most of these plants exhibit xerophytic adaptations.

Grass is very scanty but becomes fairly dense only during the short moist season, otherwise the bare soil is exposed. Grasses commonly found are: *Aristida hystrix, Aristida funiculata, Gracilea royleana, Perotis indica, Heteropogon contortus, Bothriochloa pertusa.*

Enumerated below are the plants arranged family-wise according to Bentham and Hooker's system. The authors have tried their best to give the latest nomenclature. The herbarium specimens are preserved in Institut Français, Pondicherry. The vernacular names in Tamil are given in brackets after the scientific name.

Menispermaceae

1. *Cocculus hirsutus* Diels. (Kattukkodi). A common climber in the jungle.

Capparidaceae

2. *Cadaba farinosa* Forsk. (Kattugatti). A straggling much-branched shrub.
3. *Capparis divaricata* Lam. (Thurattu). A shrub.
4. *Capparis grandis* Linn. A tree, quite frequent in scrub jungles.
5. *Capparis sepiaria* Linn. A wiry branching spreading shrub in shaded areas.
6. *Capparis spinosa* Linn. A spreading much-branched shrub.
7. *Capparis stylosa* DC. A small spinous tree. Not uncommon.
8. *Capparis zeylanica* Linn. (*C. horrida* Linn. f.) (Adondai). A shrubby climber.
9. *Cleome chelidonii* Linn. f. A herb.
10. *Cleome felina* Linn. f. A herb.
11. *Cleome viscosa* Linn. An erect herb.
12. *Maerua arenaria* Hook. A woody climber.

Bixaceae

13. *Flacourtia indica* (Burm. f.) Merr. (Chottaikala). A spiny shrub quite common.

VIOLACEAE

14. *Ionidium suffruticosum* Ging. A prostrate herb.

CARYOPHYLLACEAE

15. *Polycarpaea corymbosa* Lam. A herb usually growing in the crevices of rocks.

16. *Polycarpaea diffusa* W. & A. A herb growing in sandy areas.

PORTULACACEAE

17. *Portulaca quadrifida* Linn. A herbaceous annual.

MALVACEAE

18. *Hibiscus micranthus* Linn. (Ciramutli). An erect shrubby herb.

19. *Pavonia odorata* Willd. (Avibattam). An erect herb.

20. *Sida schimperiana* Hochst. A woody rather prostrate profusely branching herb.

STERCULIACEAE

21. *Waltheria indica* Linn. An erect herb.

TILIACEAE

22. *Grewia hirsuta* Vahl. Quite common small shrub in the jungles.

23. *Grewia orientalis* Linn. A shrub common in scrub jungles.

24. *Grewia damine* Gaertn. Large woody shrub common on hills.

25. *Triumfetta bartramia* Linn. (*T. rhomboida* Jacq.). An annual shrubby herb. Not common.

26. *Triumfetta rotundifolia* Lamk. A shrubby herb in scrub jungle.

LINACEAE

27. *Erythroxylon monogynum* Roxb. (Cembulicham). A shrubby small tree.

28. *Hugonia mystax* Linn. A large rambling shrub quite common in the scrub jungle.

RUTACEAE

29. *Aegle marmelos* Correa. (Aluvigam). A small deciduous tree. Very occasional.

30. *Atalantia monophylla* Correa. (Katunaragam). A medium-sized thorny tree.

31. *Atalantia racemosa* W. & A. (Kattuelumichai). A middle-sized tree.

32. *Clausena dentata* (Willd.) R. & S. (*C. willdenovii* W. & A.). A large shrub fairly common in jungles.

33. *Feronia limonia* (Linn.) Swingle. (*F. elephantum* Correa). A large tree not frequent.

34. *Glycosmis pentaphylla* Correa. (*G. cochinchinensis* Pierre). A shrub common in the scrub jungle.

35. *Limonia acidissima* W. & A. (Kurangu). A small spinous tree very uncommon.

36. *Toddalia asiatica* Lamk. (*T. aculeata* Pers.) (Milakaranai). A slender common thorny shrub in the jungles.

Burseraceae

37. *Protium caudatum* W. & A. A deciduous tree very common in the jungle.

38. *Commiphora berryi* Engl. A small tree quite frequent in scrub jungles.

Meliaceae

39. *Azadirachta indica* Juss. (*Melia azadirachta* Linn.) (Veppumaram). Tree occasional in jungle.

40. *Chloroxylon swietenia* DC. (Burus). A tree quite abundant in jungles.

Olacaceae

41. *Olax scandens* Roxb. (Malliveppan). A thorny rambling shrub not common in the jungles.

Celastraceae

42. *Gymnosporia emarginata* Laws. (Kattanci). A thorny shrub quite frequent in scrub jungles.

43. *Salacia macrosperma* Wight. A diffuse rambling shrub, not common in the jungles.

Rhamnaceae

44. *Scutia myrtina* Kurz. A straggling thorny shrub. Frequent.

45. *Ventilago maderaspatana* Gaertn. (Vembadan). A climbing shrub common in hill jungle.

46. *Zizyphus mauritiana* Lam. (*Z. jujuba* Lam.). Large shrub or small tree.

47. *Zizyphus oenoplia* Mill. A straggling thorny shrub common in scrub jungle.

48. *Zizyphus trinervia* Roxb. A small unarmed tree. Occasional.

49. *Zizyphus xylopyra* Willd. Moderate-sized tree or a large straggling shrub. Quite frequent.

VITACEAE

50. *Cissus quadrangularis* Linn. (*Vitis quadrangularis* Wall.). A climbing shrub with fleshy stem. Quite abundant in scrub jungles.

SAPINDACEAE

51. *Cardiospermum halicacabum* Linn. (Mudakkatram). A climber in jungles.

52. *Dodonaea viscosa* Linn. (Virali). Stiff shrub quite common in the scrub jungle.

ANACARDIACEAE

53. *Anacardium occidentale* Linn. (Mundiri). A tree. Largely planted by the Forest Department.

54. *Buchanania lanzan* Spreng. (*B. latifolia* Roxb.) (Kattuma). A medium-sized tree.

55. *Rhus mysorensis* Heyne. A common small shrub.

PAPILIONACEAE

56. *Abrus precatorius* Linn. (Adimaduram). A twiner or climbing shrub. Quite frequent in jungles.

57. *Atylosia scarabaeoides* Benth. A climber, not common.

58. *Crotalaria fulva* Roxb. A shrub.

59. *Cylista scariosa* Ait. A woody twiner. Common on hill jungles.

60. *Dalbergia spinosa* Roxb. An erect spiny shrub common in Tinnevelly and Trichy scrub jungles.

61. *Indigofera aspalathoides* Vahl. (Civanarvembu). An undershrub common on sandy soils.

62. *Phaseolus radiatus* Linn. A twiner.

63. *Rhyncosia viscosa* DC. A climber quite frequent in the jungles.

64. *Stylosanthes mucronata* Willd. A woody undershrub quite frequent in scrub jungle near coastal areas.

65. *Tephrosia purpurea* Pers. (Kattukilinci). A shrubby herb common in the jungle.

CAESALPINIACEAE

66. *Bauhinia racemosa* Lamk. (Athi). A small tree, not infrequent.

67. *Cassia auriculata* Linn. (Avaram). A tall shrub with beautiful yellow flowers. Abundant in jungles.

68. *Cassia fistula* Linn. (Konnai). A middle-sized erect tree familiarly called the Indian laburnum.

69. *Cassia siamea* Lamk. A low tree. Artificially regenerated in scrub jungles by Forest Department.

70. *Pterolobium indicum* A. Rich. (Pilluthanaku). A very thorny climbing shrub quite frequent in scrub jungles.

71. *Tamarindus indica* Linn. (Puli). A tree, rare in scrub jungle. Escapes felling on account of its annual edible fruit.

Mimosaceae

72. *Acacia arabica* Willd. (Karuvelam). A small thorny tree. Very common in jungles near villages.

73. *Acacia caesia* Willd. (Cingai). A woody prickly climber.

74. *Acacia latronum* Willd. (Anai mullu). A thorny tree quite frequent in scrub jungles.

75. *Acacia leucophloea* Willd. (Velvelam). A thorny tree whose bark is used for extraction of liquor.

76. *Acacia planifrons* W. & A. (Kudaivel). An umbrella-shaped thorny tree. Common in scrub jungles of Ramnad District.

77. *Albizzia amara* Boiv. (Turingi). A tree quite frequent in the jungle.

78. *Albizzia lebbek* Benth. Tree. Not common.

79. *Dichrostachys cinerea* W. & A. (Vidutharan). Thorny shrub quite abundant in scrub jungles.

80. *Mimosa pudica* Linn. (Thottarccirungi). A spreading shrubby herb familiarly called the 'sensitive plant'.

81. *Mimosa hamata* Willd. A much-branched prickly shrub. Common in the jungles.

Droseraceae

82. *Drosera burmanni* Vahl. Herb with leaves arranged in tuft at the base. The insectivorous plant.

Combretaceae

83. *Combretum ovalifolium* Roxb. (Odaikkodi). A large scandent shrub.

Myrtaceae

84. *Eucalyptus* sp. A small tree. Planted in the scrub jungle at Vridhachalam.

Melastomaceae

85. *Memecylon edule* Roxb. (Kasan). A large shrub common in the scrub jungles.

Cucurbitaceae

86. *Corallocarpus epigaeus* Hook. A thick-stemmed climber. Not common in the jungles.

87. *Melothria maderaspatana* Cogn. A climber.

CACTACEAE

88. *Opuntia dillenii* Haw. (Chappatti). Stems growing in broad clumps often forming dense thickets.

FICOIDEAE (AIZOACEAE)

89. *Mollugo disticha* Ser. A herb not uncommon.

90. *Mollugo nudicaulis* Lam. (Parpadgam). Annual herb.

91. *Mollugo pentaphylla* Linn. Herb quite frequent.

92. *Trianthema triquetra* Rottl. A perennial herb. Probably an escape from ruderals.

CORNACEAE

93. *Alangium salvifolium* Wang. (*A. lamarckii* Thw.). A small deciduous tree. Occasional.

RUBIACEAE

94. *Borreria hispida* K. Sch. An annual herb.

95. *Chomelia asiatica* O. Kze. (*Webera corymbosa* Willd.). An evergreen shrub quite frequent in the jungles.

96. *Gardenia resinifera* Roth. (Kumbai). A small tree. Not uncommon.

97. *Morinda citrifolia* Linn. (Nuna). A small tree quite frequent in jungles.

98. *Morinda tinctoria* Roxb. (Mancanarri). A small tree.

99. *Pavetta indica* Linn. (Pavattan). A large shrub quite occasional in the jungles.

100. *Canthium dicoccum* (Gaertn.) Merr. (*Canthium didymum* Gaertn.). A small tree not common.

101. *Canthium parviflorum* Lamk. (Karai). A thorny shrub very common.

102. *Oldenlandia corymbosa* Linn. Annual herb, not common.

103. *Randia dumetorum* Lamk. A small tree quite frequent in scrub jungles.

104. *Randia malabarica* Lamk. (Mulpavattai). An erect shrub.

COMPOSITAE

105. *Ageratum conyzoides* Linn. Annual erect herb. A commonest weed escaped into the jungle.

106. *Vicoa indica* DC. (*V. auriculata* Cass.). An erect herb, not infrequent.

EBENACEAE

107. *Diospyros chloroxylon* Roxb. (Vakkanai). A middle-sized tree.

108. *Maba buxifolia* Pers. A shrub quite frequent in scrub jungles.

OLEACEAE

109. *Jasminum arborescens* Roxb. (Nagamalli). A large shrub not uncommon in jungles.
110. *Jasminum auriculatum* Vahl. A climbing shrub.
111. *Jasminum malabaricum* Wight. An erect or subscandent shrub.

SALVADORACEAE

112. *Azima tetracantha* Lam. (Shanganchedi). A bushy thorny shrub. Perhaps an escape from ruderals.

APOCYNACEAE

113. *Carissa congesta* Wight. (*C. carandas* auct. non Linn.). (Kala). Large shrub with paired stout spines.
114. *Carissa spinarum* Linn. (Anaikala). A large shrub. Red berries edible.
115. *Ichnocarpus frutescens* Br. (Udargodi). An extensive climber.

ASCLEPIADACEAE

116. *Ceropegia bulbosa* Roxb. A climber not common.
117. *Calotropis gigantea* Br. (Arikem). A large shrub quite common in the scrub jungles.
118. *Hemidesmus indicus* Br. (Nannari). A twining or prostrate wiry shrub. Very frequent in jungles.
119. *Marsdenia volubilis* Cooke. (*Dregea volubilis* Benth.). A large climbing shrub.
120. *Pentatropis microphylla* W. & A. (Oppili). Climber.
121. *Sarcostemma acidum* (Roxb.) Voigt. (Koddikkalli). A shrub with trailing leafless jointed branching stems. Very common on Acacias.
122. *Tylophora indica* (Burn. f.) Merr. (*T. asthmatica* W. & A.). A climber not uncommon.

LOGANIACEAE

123. *Strychnos colubrina* Linn. A lofty climber.

BORAGINACEAE

124. *Cordia rothii* Roem. & Sch. (Cirunaruvali). A small tree occasional in jungles.
125. *Ehretia microphylla* Lam. (*E. buxifolia* Roxb.). A small shrub very common in jungle.

Convolvulaceae

126. *Ipomoea sepiaria* Koen. A twiner, common in the jungle.
127. *Ipomoea staphylina* R. & S. (Onankodi). A large straggling shrub.
128. *Rivea hypocrateriformis* Chois. (Pothukkirai). A common climbing shrub.

Solanaceae

129. *Solanum pubescens* Willd. (Sunlai). A common shrub.

Scrophulariaceae

130. *Sopubia delphinifolia* G. Don. An erect herb. Only in short moist season.
131. *Striga asiatica* (Linn.) O. Kze. (*S. lutea* Lour.). An erect rigid slender herb. Not infrequent in jungles.

Bignoniaceae

132. *Dolichandrone falcata* Seem. (Kadalatti). A small tree common in scrub jungle.

Acanthaceae

133. *Lepidagathis cristata* Willd. A stiff herb, the spreading branches arising from a perennial underground plant.
134. *Stenosiphonium confertum* Nees. An erect shrub on the hill jungles.
135. *Barleria buxifolia* Linn. An under shrub. Quite occasional.
136. *Barleria prionitis* Linn. A spinous shrub in shaded rocky tracts.
137. *Blepharis boerhaaviaefolia* Pers. An undershrub, not common.

Verbenaceae

138. *Gmelina asiatica* Linn. A large shrub armed with blunt thorns. Very common in scrub jungle.
139. *Premna tomentosa* Willd. A small tree quite frequent in jungles.

Labiatae

140. *Anisomeles indica* O. Kze. (*A. ovata* Br.). A shrubby herb, an escape from ruderals.
141. *Anisomeles malabarica* R. Br. (Peymarutti). A shrubby herb.
142. *Dysophylla myosuroides* Benth. Herb. Not common.

143. *Geniosporum prostratum* Benth. A prostrate spreading herb especially in sandy places.
144. *Orthosiphon glabratus* Benth. (*O. tomentosa* var. *glabratus* Hook.). An erect herb.

Aristolochiaceae

145. *Aristolochia indica* Linn. (Eswaramooli). A twining shrub. Very common.

Lauraceae

146. *Cassytha filiformis* Linn. A leafless parasitic climber very frequent.

Santalaceae

147. *Santalum album* Linn. (Sandanum). A small tree. Very rare in scrub jungle.

Euphorbiaceae

148. *Acalypha alnifolia* Kl. A small shrub.
149. *Cleistanthus collinus* Benth. (Odugan). A small tree frequent in scrub jungles.
150. *Euphorbia antiquorum* Linn. (Kalli). A small thorny shrub or tree. Abundant in jungles.
151. *Securinega leucopyrus* (Willd.) Muell. (*F. leucopyrus* Willd.) (Mappulanti). A large stiff straggling shrub.
152. *Jatropha glandulifera* Roxb. A shrub common in low scrub jungle.

Urticaceae

153. *Plecospermum spinosum* Trecul. (Achingudi). A large rambling shrub.

Orchidaceae

154. *Eulophia epidendraea* Fischer. (*E. virens* Brown). Terrestrial orchid with bulbous underground stem. Not common.

Dioscoreaceae

155. *Dioscorea oppositifolia* Linn. (Verrilaivalli). A large climber.

Liliaceae

156. *Asparagus racemosus* Willd. A climbing much-branched spiny shrub common in scrub jungle.
157. *Gloriosa superba* Linn. A climber with handsome flowers scarlet and yellow. The root tuber is poisonous.

ERIOCAULACEAE

158. *Eriocaulon sieboldianum* Sieb. & Zucc. A low stemless tufted annual confined only to wet places.

CYPERACEAE

159. *Fimbristylis tristachya* Thw. An annual herb.

160. *Bulbostylis barbata* (Rott.) Kunth. (*Stenophyllus barbata* Rott.). A slender tufted herb.

GRAMINEAE

161. *Eragrostis pilosa* Beauv. Annual grass, common.

162. *Eragrostis tremula* Hochst. Annual, confined to coastal scrub jungles.

163. *Eragrostis willdenoviana* Nees. Annual grass not common.

164. *Eragrostis bifaria* Wight. Very common perennial grass.

165. *Heteropogon contortus* Beauv. Perennial and occasional.

166. *Manisuris granularis* L. f. Annual grass not common.

167. *Perotis indica* O. Ktz. Very common grass in the jungles.

168. *Bothriochloa pertusa* A. Camus. A perennial grass.

169. *Apluda varia* Hack. (Mungil pillu). A grass in shade of trees.

170. *Aristida funiculata* Trin. & Rupr. Annual slender grass very frequent in scrub jungles.

171. *Aristida hystrix* Linn. A perennial grass quite common.

172. *Aristida adscensionis* Linn. Annual grass not infrequent.

SUMMARY

An account of the flora of the scrub jungles of Madras State is presented. Enumeration is made of 153 species belonging to 51 families of Dicotyledons and 19 species belonging to six families of the Monocotyledons.

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Obituary

Lt.-Col. E. G. PHYTHIAN-ADAMS

It is with great regret that we have to announce the death of Lt.-Col. E. G. Phythian-Adams, O.B.E., F.Z.S., an old member of our Society. He had been ailing with a weak heart for the past twelve months, and finally succumbed on 9 February in a hospital in Mysore, aged 75 years and 6 months.

Lt.-Col. Phythian-Adams came out to India first in 1904 and joined the South Wales Borderers, from which Regiment he later transferred to the Madras Regiment. During 1916-17 he was Brigade Major to the Southern Brigade at Wellington and later rejoined his Regiment to proceed to Mesopotamia, where he was mentioned in Despatches. During 1919-20 he was D.A.A.G. to Major-General Burnett-Stuart during the period of the Moplah Rebellion. He retired in 1924, following the disbandment of the Madras Regiment, and settled down in Lovedale, a few miles outside Ootacamund, from where he subsequently moved to Kalhatty where he had purchased a home.

On the outbreak of the Second World War, though then over-age, he volunteered his services again, and in July 1940 was placed in charge of the Welfare of Indian Soldiers and their families throughout the whole of the south of India, organising in addition the States and Districts Soldiers' Welfare Boards throughout the territory. For his services in this connection he was awarded the O.B.E.

On his retirement again in 1945, he settled down in Kalhatty, a few miles from Ootacamund, and was very closely associated with both the Nilgiri Game Association and the Ex-Servicemen's Reading Room. A born naturalist-sportsman, with many fine trophies to his credit, he also interested himself with collecting stamps, butterflies, birds' eggs, medals, and coins, though it was as a shikari-sportsman that he was best known, his trophy room being visited and admired by many.

Lt.-Col. Phythian-Adams first joined our Society as far back as 1909 and was a member of the Advisory Committee for many years, and up to the time of his death. He was also a member of the Madras State Wild Life Board from its inception.

In addition to his many interests and love of sport, he compiled the following books on regimental history: THE MADRAS INFANTRY

1748-1943, THE MADRAS SOLDIER 1746-1946, and finally THE MADRAS REGIMENT 1758-1958, which last he was just able to see published during his lifetime, as also to be present at Wellington for the 200th Anniversary of the Madras Regiment. His 'Jungle Memories' appeared in serial form in the journal of our Society [Vols. 48 (1) to 50 (3)].

BRIG. S. T. APCAR

Reviews

1. AN INTRODUCTION TO BIOLOGY. By A. P. Mathew and A. Raman. Revised Third Edition (Reprint). Pp. iv+223+x (21.5×14 cm.). The Educational Book Depot, Trivandrum, 1958. Price Rs. 4.50.

The aim of this text-book on biology is clearly stated in the preface to the first edition: to give the student sufficient information about the animate world around him and acquaint him with the trends of modern biological thought. It is also hoped that this book would 'incidentally whet his curiosity to peep a little more into the mysteries of the living'.

This book, now in the reprint of the revised third edition, seems a manifestation of the aims and hopes of this basic preface, published two and a half years ago.

Dr. A. P. Mathew, professor of Zoology at the University College, Trivandrum, and Prof. A. Raman, professor of Botany at Government College, Chittur, have collaborated to produce this comprehensive and popular text-book of biology, primarily meant and approved for the University Previous Course at the University of Kerala. In this reprint the question papers of the University Previous Examination of September 1957 and March 1958 have been included to aid the students.

The book is divided into two sections: the first deals with basic information on botany, including an introductory chapter on living and non-living objects, and on the differences between plant and animal life. This botany section also includes a pertinent chapter on economic botany, describing Indian plants and their useful products—the cereals, millets, pulses, spices, and oil-, sugar-, and rubber-yielding plants, to mention a few.

The second section, on zoology, includes an introductory chapter, somewhat redundant in view of that of the botany section. Then follow nine chapters dealing with cell differentiation, reproduction, development, and other zoological patterns. A chapter on organic evolution gives the progressive development of plants and animals from ancient times up to our modern world today.

This book is a valuable contribution to students for several reasons. First, the information is intelligently arranged, in distinct analytical chapters which set forth enough but not too much information for the neophyte in biology. Second, the book is written in a

style that is clear and easy to follow. The vocabulary is relatively free from the ponderous weight of highly technical terms which can so often prevent a young mind from comprehending the subject matter, or from pursuing it further. Third, the book is brightened by 155 interesting illustrations, finely drawn with pen and ink.

But most important is the treatment of several facts that indeed should 'whet' the student's curiosity. For instance, a paragraph explains why the antelope, the cow, and the deer of the ruminant family are cud-chewers. They are described as 'comparatively defenceless animals, which are surrounded by prey-hunting carnivorous animals'. It is risky for them to graze in the open for long periods of time. Their alimentary system is specialized so they can quickly swallow their food. 'On reaching a safe spot, this hastily swallowed meal is brought back leisurely into the mouth in small masses, and chewed properly and swallowed again.'

And there is an equally good description of a bird's foot muscle and the 'perching mechanism' that prevents a bird from falling off his perch or twig when sleeping.

These are only small pieces interspersed in the main factual presentation. But they indicate a basic liberal approach to teaching biology: to make the subject matter interesting and humane enough so that the reader is inspired to inquire further into the nature of things. The authors seem interested in instilling into their students an inner desire to learn for themselves; not on offering routine, dry, and dogmatic material to be learned only by rote.

B.J.T.

2. PORTRAIT OF A WILDERNESS. By Guy Mountfort. Illustrated by Eric Hosking. Hutchinson, London, 1958. 240 pages; 130 photographs. Price Rs. 30.

This is a book about the Coto Doñana, a wild and inaccessible area in southern Spain which was for 350 years the private hunting preserve of the Dukes of Medina Sidonia. The area is now a nature sanctuary, rich in wild life where about one-half of the entire European total of bird species may be seen, and where as many as a hundred different species may be counted in a single day. 'In this wild paradise half the bird species of Europe have been seen, some in such numbers as to stagger the most blasé ornithologist. Red Deer and Fallow Deer still roam the scrub in their hundreds. Droves of Wild Boar plough the rich earth for roots, and in the springtime the blood-curdling cries of the courting Lynx still chill one's spine during the small hours of the night. Here in this ideal Afro-European climate and

vegetation the ferocious Ocellated Lizard, the Mongoose, the Polecat, the Genet, the Wild Cat, and numerous snakes compete for domination of the undergrowth, while a dozen species of vultures, eagles, and other raptorial birds contend for the mastery of the skies.' The grand total of bird species recorded by the three expeditions led by Mr. Guy Mountfort comes to the impressive number of 222. Nor is it just a matter of numbers of species, as we have read in the quotation above; examples of concentrations of individual species were a flock of 400 Coots, 75 Blacknecked Grebes, and 3000-4000 Mallards, and a single flock of Blacktailed Godwits consisting of 1500 birds.

The three expeditions visited the Coto Doñana in 1952, 1956, and 1957. A large number of well-known ornithologists and other eminent people took part in them—Lord and Lady Alanbroke, Sir Julian and Lady Huxley, Roger Tory Peterson, Max Nicholson, François Bourliere, James Fisher, and many others—so that the concentration of famous people on the ground was relatively almost as great as that of the nesting birds. The book is superbly illustrated with Eric Hosking's photographs which represent as good work as anything which this great master has ever done. The series of pictures of the birds of prey are particularly outstanding.

Mr. Mountfort writes a clear and most readable account of the expeditions and of their work, and when he writes about the birds he does so with the authority one would expect of the co-author of the FIELD GUIDE TO THE BIRDS OF BRITAIN AND EUROPE. Although the book is largely concerned with birds, it is not an ornithological treatise as its main purpose is to give a popular account of the expeditions; detailed reports for the specialists will be published in the journals of the British Ornithologists' Union and the Sociedad Española de Ornitología. The aims of the expeditions are set out by the author: 'Our principal object was to learn the status of the bird populations of the Coto. Secondly to examine their ecological relationships. Thirdly to learn what we could about their migratory movements through the Coto. A number of the rare species, which had never previously been examined in any detail, were selected for special behaviour studies and photography, for the camera today is an essential tool of science. An impression of the dimensions of the photographic task may be gained from the fact that we exposed some 6000 negatives and some 50,000 ft. of cine film in colour. Though our work was chiefly ornithological, opportunity was taken, as time permitted, also to study the mammals, reptiles, insects, and flora of the region, as all these obviously influenced the lives of our primary subjects.'

PORTRAIT OF A WILDERNESS is recommended by the Book Society.

L.W.-T.

3. AN ATLAS OF AIRBORNE POLLEN GRAINS. By H. A. Hyde and K. F. Adams. Pp. xvi+112 (24.5×18 cm.) illustrated with numerous photomicrographs. Macmillan & Co., London, 1958. Price 36*s*.

This is a dream of a book, I mean to say, the sort of book authors dream about but seldom get. It is printed on art paper throughout, so that the details of the photomicrographs come out beautifully. The book is meant for the identification of pollen grains in the fresh condition. 92 species are described and illustrated, naturally of plants found in the British Isles.

There is a short introduction dealing with methods of studying pollen grains in the living condition, on the instruments needed for examination and photography. Some short notes on the morphology of pollen grains are also given, a very necessary detail, since on the proper understanding of this part depends the proper use of the book.

The text of the book is reduced to some notes on the structure of the individual pollen grains, such as general outline, form, sizes, pores, furrows, outer and inner surfaces, etc. The illustrations are beautiful; they show the grains in optical section and in surface view, and being taken at a standard magnification of ×800 give an immediate idea of the relative sizes of the grains.

When going through the book, I am left with nothing but admiration for the work of the authors, together with some envy, just simple plain envy; the book is an invitation and a challenge to Indian botanists, to produce an equally beautiful book on our Indian plants. The book, or rather the study of pollen, is of great economic importance: in addition to the botanical side of the question, there is the fact that pollen is intimately connected with hayfever in humans, and with honey production by bees. Of the work entailed in the preparation of this book one may get an idea when one reads that the authors between 1942 and 1955 trapped and examined over 900,000 pollen grains in about 15 different stations all over the British Isles. Surely this is no work for faint hearts!

H. SANTAPAU

4. LALBAGH BOTANICAL GARDENS, BANGALORE, INDIA. 1856-1956 CENTENARY CELEBRATIONS. AUGUST 1957. Pp. 124 (18×24.5 cm.); profusely illustrated.

On the occasion of the celebrations of the Lalbagh Gardens' first centenary, the Mysore Horticultural Society has brought out an interesting souvenir, of which any society may be proud. The

souvenir takes the form of an historical-descriptive album, profusely illustrated with half-tone and full-colour blocks.

Dr. M. H. Mari Gowda, the present Superintendent, contributes a chapter on the history of the Gardens down to the present day; the official date of 'birth' of the Gardens is supposed to be 1856, when at the suggestion of Dr. Cleghorn of Madras the Gardens were re-organized. But the Bangalore Gardens had already been in existence for at least another century, under the Sultans Hyder Ali and Tippu and others, and splendid work had been done in acclimatizing fruit trees from central Asia and Persia. After the official re-organization in 1856, many more useful and decorative plants have been introduced into India through the Bangalore Gardens. It is, however, under John Cameron, 1874-1908, that the Gardens reached their zenith; Cameron not only introduced the plants, but carried out extensive field trials for their adaptation and cultivation in this country. The work is still being carried out under the present Superintendent.

M. D. Sharma, the Keeper of the Herbarium, and Librarian, writes a lengthy chapter on 'the Plant Wealth of the Lalbagh'. This forms a detailed guide to the various sections of the Gardens, and is illustrated with a number of photographs and maps. This chapter forms, as it were, the backbone of the booklet under review.

A. H. T. Rao, the Vice-Chairman of the Mysore Horticultural Society, gives an account of the activities of the Society, which lately have expanded to the publication of a quarterly journal, *Lalbagh*, which aims at making 'the layman horticulturally-minded'.

There is one point in which the present reviewer feels that more care should have been spent in the preparation of the Souvenir; this refers to the spelling of scientific names, many of which are far from correct. It is to be hoped that such mistakes will be corrected if and when a complete catalogue of the plants grown in the Gardens is being prepared for the press. Such a catalogue will be gratefully accepted by Indian gardeners, who at present do not possess any authoritative book of reference for the many foreign plants cultivated in this country.

H. SANTAPAU

5. GLOSSARY OF INDIAN MEDICINAL PLANTS. By R. N. Chopra, S. L. Nayar, and I. C. Chopra. Pp. xx+330 (25.5×16.5 cm.). Published by the C.S.I.R., New Delhi, 1956. Price Rs. 8.

This book fills a great need in our country. After the recent rediscovery of the wonderful virtues of *Rauwolfia serpentina* Benth.,

Indian medicinal plants have been in great demand among national and foreign biochemists. Further, the discovery that cortisone, which until recently had been prepared only from the bile of oxen, could be obtained from some species of *Dioscorea*, enhanced the interest in our medicinal plants.

This Glossary comes as a great help to the botanist who often may be asked for materials of all the medicinal plants of a given area. With the help of this book, it will be easy enough to select all or nearly all the medicinal plants of any district.

The plan of the book is clearly given in the introduction. 'The plants have been arranged in alphabetical order according to their scientific names so that there will be no difficulty for readers to find any particular drug on which information is required. Many of the commonly used synonyms have been inserted and cross references to their modern scientific names have been given. Abbreviations have been used to save space and to compress data into a small handy volume; a list of abbreviations used has been included for ready reference. When a number of plants belonging to the same genus is discussed, the name of the family to which the plants belong is supplied with the scientific name of the genus. Important vernacular names commonly used in different regions of India have been given and an index to these names has been provided at the end. For want of space it has not been possible to include all vernacular names, but the more common and well-known ones are given. The conditions of disease for which the particular plant is used are also briefly given.

'A special feature, which will not fail to attract attention, is the inclusion of brief descriptions of the active principles of plants so far as they have been worked out. References to the more important published papers on medicinal plants up to 1953 have been included; more recent references have been added in some cases during the course of printing of the book. For a complete bibliography on Indian medicinal plants the reader is referred to the *Review of Work on Indian Medicinal Plants* published by the Indian Council of Medical Research (1955).

'Another feature of the Glossary is the inclusion of information on the distribution of plants in different regions of India . . .'

The Glossary may be said to be the 'crowning glory' of that energetic research worker, Col. Sir R. N. Chopra, who has dedicated his life to the study of Indian medicinal plants and has published his results in a very impressive list of books and papers.

The printing and presentation of the book are of the best and do honour not only to the author but also to the printers, The Catholic

Press, Ranchi, and the publishers, the Publications Division of the Council of Scientific and Industrial Research.

Without any hesitation I recommend the book to any student of botany or of pharmacology, who is interested in the development of the natural plant resources of our country.

H. SANTAPAU

6. A HANDBOOK OF SOME INDIAN WEEDS, containing complete descriptions and short notes on some of the common weeds indigenous and introduced in South India. By C. Tadulingam and G. Venkatanarayana. Revised and enlarged by C. Rajasekhara Mudaliar and J. Sakharam Rao. Pp. xi+488, plates 3 in colour, 180 in line diagrams. Government Press, Madras, 1955. Price Rs. 7.

The second edition of this very useful book was long overdue. In this new edition the area of survey is extended to the districts of Malabar, Nilgiris, and S. Kanara. Weeds which recently have been a great source of trouble have been given due importance; some new ones have been described and illustrated. A separate chapter on the recent developments on the chemical eradication of weeds is added. Particular reference is made to hormone weedicides and their action in S. India. Hindi names have been added to the list of vernacular names, so that the book may be of use in parts of India other than the South. Most of the weeds are illustrated, a few of them in colour.

This revised edition will be found much more useful than the first by all students of agriculture and any others interested in Indian farm weeds.

There are but a few minor points which should be brought to the attention of the authors. The line illustrations are interesting, but do not show any scale indicating the size of the plant or its parts. The nomenclature of many of the plants needs revision. The practice of suppressing the comma between the name of a plant and that of its author should be followed, in accordance with the instructions of Appendix VI of the International Code of Botanical Nomenclature. The printing and binding of the book can be considerably improved.

All in all, in spite of these minor defects, the book is a good one, and will be of value not only to the South, but also to many other parts of India.

P. V. BOLE

7. FLOWERING PLANTS OF EASTERN INDIA. Vol. I. Monocotyledons. By J. N. Mitra. Pp. xx+388, 21.5×14 cm., map of eastern India. The World Press Private Ltd., Calcutta, 1958. Price Rs. 30.

This book, as the dedication seems to indicate, is primarily meant for the use of 'students of Botany of Indian Universities', and the author entertains the hope that it will prove useful not only to students but also to teachers and professional plant taxonomists.

The literature on the botany of eastern India is far from scanty, but it is found dispersed in many out-of-print books and journals, which even when available are beyond the pocket of students and professors; further since the publication of Prain's BENGAL PLANTS in 1903, many changes have been introduced in the nomenclature and systematics of those plants. The author has undertaken a difficult and responsible task; the present volume deals only with the Monocotyledons of Bengal and neighbouring regions of India.

This reviewer, however, is of opinion that the book does not quite come up to the author's expectations. The author has produced a new system of classification, on which he has spent many years; the system is claimed to be not phylogenetic, but rather aims at studying the close affinities and resemblances that may give some clue to the phylogeny of the plants studied in the volume. The reviewer has not found in the book any new or startling point; he does not see in the new system anything but a slight modification of some of the older systems. The author should clearly give the main outline of his system, pointing out how his system differs from previous attempts.

One serious deficiency of the book is that it does not give a comprehensive bibliography for the area covered in the book. It also suffers from the absence of an index of vernacular names. In the actual presentation of genus and species, the author gives the generic name followed by an appropriate full reference; specific names are given without any reference. The system followed in giving such references is somewhat strange; the recommendations of Appendix VI of the International Code of Botanical Nomenclature are far neater and clearer. The presentation of the book is pleasant, the type clean and elegant; some appropriate spacing would improve the presentation of the book.

P. V. BOLE

8. AHEAD LIES THE JUNGLE. By Suresh Vaidya. Pp. 187 (22×14 cm.). 16 black-and-white photographs. Robert Hale Ltd., London, 1958. Price 18*s*.

Books on the Indian jungle and its wild denizens have hitherto mostly been of the shikar kind, and to the present-day reader such books have become not only old-fashioned and out-of-date but often extremely boring. This book by Suresh Vaidya, however, is of quite a different type—the only shooting done by his heroine, Miss Ylla Koffler, is with the camera.

Suresh Vaidya is an experienced journalist and author who has spent much of his time away from India, in London, New York, Paris, and other such places; and yet he appears to be quite at home when back in the Indian jungle. And although he is not a naturalist, he has obviously taken much trouble to get correct information about the fauna and flora of which he writes so interestingly. There is little that one can criticise from the natural history point of view.

Of particular interest to some readers will be the parts about snakes and snake-charming. The author evidently has much first-hand knowledge of this subject and introduces it to his readers in a most interesting way.

During the seven months' photographic trip with Miss Ylla Koffler from September 1954 to March 1955, the author visited many of the wild life sanctuaries of India, and this is probably the first book yet produced on India's wild life purely from the visitor's and photographer's viewpoint as contrasted to the sportsman's. The reader is taken to the Gir Forest, Bandipur, Mudumalai, Periyar Lake, and Kaziranga, as well as to many other interesting parts of India.

E.P.G.

9. ON INDIAN INSECT TYPES—V. The Morphology and Life-history of *Leptocorsia varicornis* Fabr. (Coreidae: Hemiptera)—A pest of paddy crop in India. By S. Shujaatul Akbar. Aligarh Muslim University Publications (Zoological Series). Size 15.5×24.8 cm.

Part I. Head and Thorax. Pp. 1-53, pls. i-ix, March 1957. Price Rs. 5.

Part II. Abdomen, Internal Anatomy, and Life-history. Pp. 1-49, pls. i-vii, March 1958. Price Rs. 5.

Within the last few years many Indian Universities have adopted entomology, especially applied entomology, as part of the curriculum for post-graduate courses in Zoology. However, the paucity of detailed information in a handy form on the biology of Indian insects of economic importance prompted Prof. M. B. Mirza of Aligarh University to plan a series of memoirs on 'Indian Insect Types' and

the following eleven species were selected for monographing: *Haematopinus tuberculatus* Burmeister (Buffalo-louse), *Pyrilla perpusilla* Walker (Sugarcane leaf-hopper), *Stenobracon deesae* Cameron (Braconid parasite of sugarcane borer), *Leptocorsia varicornis* Fabricius (Paddy-bug), *Aleurolobus barodensis* Maskell (Sugarcane white-fly), *Athalia proxima* (Mustard saw-fly), *Gonioides dissimilis* (Poultry-louse), *Idiocerus* species (Indian Mango-hopper), *Platydera gossypiella* Saunders (Pink-boll-worm), *Dacus cucurbitae* Coq. (Fruit-fly), and *Utetheisa pulchella* Linn. Of the above, memoirs on the first three pests have already been published in four numbers (two on *Pyrilla*), and the one under review represents the fifth in the series and is in two parts.

In a brief introduction to Part I the author discuss the nomenclatorial status of the species and outlines the scope of the work which may be summed up as one pertaining to the skeleto-muscular mechanism of the head and the thorax with emphasis on the study of the myology to help understanding the working of the various parts of the body. A detailed survey of the various sutures and sclerites of these regions and their appendages are included, and the author uses up-to-date terminology to denote the various sutures, e.g. 'ecdysial line' in place of the older term 'epicranial suture'. Separate treatment of each region of the head is given and attention is drawn to the homologies of the different structures, especially the musculature of *L. varicornis* with those of other insects already studied in detail. The morphology of the thorax of *L. varicornis* is also reported on in the same fashion.

In Part II, a similar treatment of the morphology of the abdomen precedes the section on the life-history of the insect. The latter is more or less an elaboration of the work of H. M. Lefroy [1908, *Mem. Deptt. Agri India*, 2, (1)].

Both the parts are profusely illustrated with good line drawings which will be especially useful to the advanced student. The long lists of references given also provide a useful guide to the literature on insect morphology.

From the factual point of view this memoir should fulfil its purpose of usefulness to post-graduate students and teachers. However, a chapter on the biology of this insect, especially its seasonal abundance, natural enemies, control measures, etc., would have added to its value as being useful to all interested in applied entomology as well. The publications in this series of memoirs have maintained a high standard, for which the editor Prof. M. B. Mirza is to be congratulated.

E.G.S.

10. KINGDOM OF THE OCTOPUS: The Life-history of the Cephalopoda. By Frank W. Lane. Pp. xx+287 (23×14.5 cm.). Coloured frontispiece, 4 coloured and 48 monochrome plates, and 13 diagrams. Jarrolds, London, 1957. Price 30*s.* net.

Frank W. Lane's KINGDOM OF THE OCTOPUS is a book about cephalopods written by a layman for laymen.

In 1875 there appeared Henry Lee's THE OCTOPUS; OR, THE 'DEVIL-FISH' OF FICTION AND OF FACT. It is with the intention of bringing within the ken of the ordinary general reader the work done since then that the book under review has been written. Mr. Lane has put together from varied and extensive sources a mass of knowledge about a subject regarding which most of us know almost nothing. His statements are well documented and the chapter-to-chapter bibliography at the end of the book extends over thirty-two pages. To ensure the correctness of his statements he consulted numerous specialists and sent his manuscript, in whole or in part, to over 100 readers, most of them professional scientists. Even the serious student, therefore, will find the book a useful stand-by.

One of the few things we do know about these creatures is their trick of discharging ink when disturbed or in danger. The experience of D. N. F. Hall suggests the purpose of the discharge. He tried to catch with his hand a three-inch squid confined in a large light-coloured wooden tub. When his fingers were about nine inches away the squid 'turned dark and seemed to stay still'. Hall made a grab and seized—a blob of ink; the squid was at the other end of the tub!

Doubtless, the squid was helped in its exploit by its trick of quick colour-change. Mr. Lane's description of the colour-change mechanism of cephalopods is fascinating. This consists mainly of a system of chromatophores or pigment cells, distributed all over the surface of the body. The chromatophores expand or contract under muscular control and make possible almost instantaneous colour changes.

Another intriguing topic dealt with is luminiscence. This is at the same time a somewhat baffling problem, as luminiscence would appear to conflict with the defensive purpose of the colour-change mechanism and the ink-discharge battery.

Mr. Lane tells a pathetic story of the octopus as a mother. Mephista, as she was affectionately christened, laid forty clusters of eggs and cradled them lovingly in her arms. From then on the eggs were her all-absorbing passion. If food was brought near she blew it away with squirts from her funnel or picked it up with an arm and dropped it further off. If it was put back she 'flushed an angry brick-red' and, crawling a few paces across the floor of the tank,

hurled the food from her. In the interests of scientific truth it must be recorded, however, that in the morning only a part of the food remained, suggesting that she had no objection to eating in the dark when no one was looking on! After about ten weeks of this, the young ones emerged and went their way, but Mephista continued to nurse the empty husks. Finally, 'one morning, she was found, still on guard but no longer alert—one with the shrivelled skins for which she had vainly given her life'. This story, of course, is not to be taken as true of all octopuses, and still less of all cephalopods.

In view of a Gleaning in a recent number of this *Journal* relating to the *rena* fish I must give, though only in part, the description of the swarming of Pacific coast squids as seen by a biologist, John S. Garth, one evening in July 1951 and reported by him to the Allan Hancock Foundation, Los Angeles:

> 'He saw a school of Pacific coast squids (*Loligo opalescens*) milling in compact formation on the surface directly under the night-light hung over the ship's side. The squids were mating and were oblivious to all else. Even when touched with a long-handled dip-net they were not alarmed. Normally a squid would flash away long before a net reached it but now the crew scooped them up and dozens were landed on deck. Several mating pairs were still interlocked when they were tipped out of the net, and at least one pair continued their embrace until separated by hand.
>
> 'Garth continued to watch the school as it milled about the ship. The squids were swimming leisurely in a tight circle with the ship's light as the centre. They swam fin foremost but when a male selected a female he reversed direction and grasped her round the middle. Often a second male would cut in, and sometimes two rivals grasped a female simultaneously. Then a skirmish broke out.
>
> 'In attempting to escape the female would break the surface and the pursuing males would eject water with a whoosh that was clearly audible, as well as the stream being visible to the eye. The successful male would often retire quickly to the depths with his prize, but in the absence of a rival the mating was completed quietly on the surface.'

Cephalopods have an economic value as food for human beings and domestic animals, as manure in the fields, as fish bait, as living grapnels for raising articles from the depths, as material for research in neurology, and for the preparation of various articles including cosmetics and medicines. They are very much appreciated as an article of diet in Japan, whose known annual catch in 1952 was 646,000 tons as against India's 3,400. As there are possibilities of

increasing these catches several times over without exhausting the supply, Mr. Lane suggests this as a solution to the ever-increasing food problem. If the suggestion is followed care must be taken to learn cephalopod-cookery from an expert, for not many new initiates to the diet will have the persistence of Paul Bartsch (1917) who chewed an inexpertly cooked tentacle 'for the best part of an afternoon, and in the end had to stop because his jaws "aching from over-exertion, refused to operate more" '!

Lastly, a word of warning is necessary in view of the impression created by some writers that these creatures are harmless. There is a difference from species to species, and a particularly harmful type must have been encountered by the skin-diver Kirke Dyson-Holland, the case of whose death is dealt with in *The Medical Journal of Australia* **2** (42nd year): 429-31. Several possible defences against cephalopod attack are suggested but one does not always carry weapons when one enters the water. The unarmed man, however, is not necessarily helpless. Few of us can hope to apply the method of the Gilbert islanders described by Sir Arthur Grimble, who kill their octopus quarry by biting it between the eyes down to the brain, but we are assured by the author that, if an octopus is grasped firmly round the 'neck', i.e. the junction between head and mantle, it will instantly release its hold as this action suffocates it.

The book is illustrated by many beautiful photographs, coloured and monochrome.

D.E.R.

11. THE BIRDS OF THE PALAEARCTIC FAUNA—PASSERIFORMES. By Charles Vaurie. Pp. xii+762 (25.5×18.5 cm.). H. F. & G. Witherby Ltd., London, 1959. Price £5 5*s*.

Hartert's epoch-making work DIE VÖGEL DER PALÄARKTISCHEN FAUNA was published (in German) between 1903 and 1922, and followed up by a supplement by Hartert & Steinbacher in 1938. Only the older generation of ornithologists are in a position to appreciate the truly monumental character of that work and will remember the revolutionary impact it made upon the ornithological trends and thinking of that time. It was the first large-scale projection of the subspecies concept into bird taxonomy, and a subject of much spirited (and sometimes even acrimonious) wordy exchanges and controversy among the more conservative pandits of the day. But looking back, there is no doubt whatever that much of the enormous progress in avian systematics during the last 50 years was

made possible entirely by the universal acceptance of the subspecies concept and the trinomial nomenclature which enabled minor variations to be recorded and interpreted in a meaningful way. Hartert's publication, therefore, marked the end of an epoch in scientific ornithology no less than the beginning of a new and more dynamic one. And it is the genius of Ernst Hartert and his monumental work that have since led the way in ornithological thought and practice, in the Old World as well as the New. But the fillip that the new system gave to all branches of ornithology, particularly in Europe and Asia, led to the extension of field work into many areas till then little known and unexplored, resulting in a better understanding of geographical variations and in the description of many new forms. Thus the need of a comprehensive, up-to-date, systematic list of Palaearctic birds became insistent, and doubly so since Hartert's volumes were out of print and had become practically unprocurable. Moreover, those unfamiliar with the German and Russian languages were eagerly awaiting a comprehensive work in English that would enable them to keep abreast of the considerable advances in the knowledge of Palaearctic birds made in recent years, particularly in the Asian territories of the U.S.S.R.

Few people would have better facilities and qualifications for undertaking this stupendous task than Dr. Charles Vaurie of the American Museum of Natural History, New York. The Rothschild Collection, on which Hartert's original work was primarily based—since then vastly augmented by additional material—was at his elbow. It was suplemented freely by large-scale borrowings from, and frequent visits to, all the more important museums of Europe including the one in Leningrad. In addition to his, so to say, congenital aptitude for taxonomical work, and what the late Dr. C. B. Ticehurst called 'the eye of faith', Dr. Vaurie had the benefit of constant discussion with and advice of such savants as Erwin Stresemann and Ernst Mayr—all of which lends the impress of added authoritativeness to his volume.

The present one covers the Order Passeriformes only; the remaining orders are to follow in due course in a companion volume. The phylogenetic arrangement of families and genera follows the general lines of Wetmore's classification which, with minor internal modifications, has now come to be adopted by large sections of the ornithological world. Keys, detailed descriptions of plumage or morphology, nesting, etc. found in Hartert are omitted (excepting brief diagnoses) in order to keep the volume within manageable bulkiness (even without them it runs to 774 pages!). In addition to Range, with an indication of Extralimital where called for, a brief

description of the habitat of each species is given and, where possible, also of the nature of variation between its races, whether clinal or sharply differentiated in size or coloration, wing-length or pattern, etc. It is inevitable in a work of this kind that specialists should disagree with this or that of the author's opinions and conclusions, and with his views on individual phylogenetic relationships. These are things on which no finality is possible, and in the last reckoning must depend on individual 'taste and fancy'. But one can have no hesitation at all in welcoming whole-heartedly this much-needed work, or in congratulating the author upon the competence and thoroughness with which he has discharged his task. The selected bibliography representative of the various parts of the Palaearctic Region, a gazetteer giving the description and co-ordinates of all the places mentioned in the text, separate indexes of English, French, German, and scientific names are features which should prove of the greatest usefulness and convenience to users of the volume. Readers would have relished a general discussion of the Palaearctic Region and a consideration of its biogeography, particularly from the ornithological angle. But it may well be that such an introduction has been reserved for the promised companion volume which, though it will be the second in time, should, following the Wetmore classification, be the first—Vol. I—in place. In the meanwhile it is no exaggeration to say that THE BIRDS OF THE PALAEARCTIC FAUNA will be quite indispensable to every serious ornithologist whether his work is directly concerned with this part of the world or not.

S.A.

12. ABOUT INDIAN BIRDS. By Laeeq Futehally and Sálim Ali. Pp. 87 (18.5×14 cm.). Illustrated by D. V. Cowen. Blackie & Sons (India) Ltd., Bombay, 1959. Price Rs. 2.

This little book on the birds of India, intended primarily for a juvenile public, is written in charmingly unpretentious language. It is of course meant for use in India, and Mrs. Futehally has therefore most wisely chosen for her comparisons everyday scenes which are familiar to her audience. The colour of the Oriole, for instance, is compared to the flesh of a perfectly ripened Alphonso mango, and when she talks of town birds she says 'all these birds which are now familiar in our towns must have had an original home—a *muluk*, to which they still owe allegiance . . .' In this easy way she brings home to her readers points which she wishes to emphasize. But sometimes

she wanders further afield for her illustrations, and in this she follows in the tradition of the famous 'Eha' who claimed that he was 'an amateur philosopher . . . detecting essence beneath semblance and tracing the same principle running through things the outward aspect of which is widely different'; and so it should come as no surprise (even to this reviewer who happens to be Chinese) to be told that a Sandpiper has affinities with a citizen of the Middle Kingdom because it uses its bill like a pair of chopsticks!

The book is divided into nine chapters. The first answers the question, 'What are Birds?'; the second deals with 'Song and Courtship', the third with 'Nesting Habits', and the fourth with 'Migration'. The remaining five chapters consist of short sketches of individual species, grouped under different habitats. There are 87 pages of text, but despite its small size, the book contains a wealth of accurate and useful information. It is to be hoped that it will be widely used in Indian schools. India has one of the richest avifaunas in the world, and anyone who succeeds in imprinting in the minds of her young folk an appreciation and a love of the wild life which Nature has so bountifully bestowed, will have done a fine service for his country; I hope that Mrs. Futehally and Dr. Sálim Ali will have much success in this respect.

The sketches which illustrate the book are drawn by Mrs. D. V. Cowen, and they complement the text very adequately.

L. W.-T.

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Miscellaneous Notes

1. A TIGER'S UNORTHODOX METHOD OF COMMENCING ITS MEAL

I have examined over a score of tiger kills and in all of them the tiger's method of feeding has been from the hind quarters. But in a recent case I observed that the tiger had begun with one foreleg and the neck of a bullock, leaving the body intact together with the hindlegs and the other foreleg. It had severed the head and eaten the neck, carried off the head with horns under a tree, then come back and dragged the carcase near the head, covering up the whole lot with grass. Everything augured well for the return of the tiger to its kill. A machan was therefore constructed with great caution and the vigil taken up for three consecutive nights. But the tiger failed to show up, although it had evidently come near the machan tree, grown suspicious, and withdrawn. But what actually struck me as unusual was this tiger's method of commencing his meal from the fore-quarters. This habit is quite normal with panthers, but to my knowledge peculiar in the case of a tiger. May I know whether you have come across or heard of a similar instance? I am perfectly sure this was not the work of a leopard. Both the drag marks and the footprints clearly disclosed this. Other indications that the animal concerned was a tiger are: the bait was a big bullock weighing about 300 lb.; it was tied by the foreleg with an 'unbreakable' rope, but the rope had been broken and the leg severed; the carcase had been dragged about 60 yards into thick and high grass, and well concealed; the hoof and leg were not eaten, but were found lying some distance from the carcase in the dragged area; the stomach and entrails had not been pulled out of the kill.

15 PERUMAL KOIL STREET,
FORT, COIMBATORE, B. SUBHIAH PILLAI
May 26, 1958.

[According to Dunbar Brander, WILD ANIMALS IN CENTRAL INDIA, a tiger normally eats its kill commencing between the buttocks, often dragging out the stomach and intestines. On the other hand, in most cases a leopard commences at the fore-quarters, tearing out the inside and eating the heart, liver, lungs, and flesh on the ribs. The

kills of the two animals can usually be distinguished by this, though a large forest leopard will sometimes commence to eat behind, between the buttocks, just as a tiger does—and presumably also the converse. However, the exceptions in either case seem to be rare.—EDS.]

2. THE PRESENT STATUS OF THE INDIAN LYNX

Is the Indian Lynx (*Caracal caracal*) disappearing from our forests? Would your readers kindly enlighten me through your journal when and where this animal has been seen during the last 3-4 years? This animal was been seen by me in Hazaribagh National Park in Bihar in December 1957 and by Shri K. S. Sankhala, Divisional Forest Officer, Jaipur, in Sariska Game Sanctuary in Rajasthan on 31 October 1958. Two immature cubs were found in the Sariska Sanctuary. The cubs could not be kept alive and their carcasses were sent to the Zoological Survey of India for identification and preservation. Judging from the manner in which these cubs were abandoned by the parents it looks to me that the natural food of this animal is fast disappearing and therefore the mother not being capable of rearing the cubs abandoned them. They do not seem to have the habit of tigers and panthers of eating their cubs if food supply is difficult.

JAIPUR,
RAJASTHAN,
April 2, 1959.

N. N. SEN, I.F.S.,
Chief Conservator of Forests.

3. THE VOICE OF THE CHEETAH OR HUNTING LEOPARD (*ACINONYX JUBATUS* ERXLEBEN)

At pages 25 and 26 of his most interesting and informative *Report on the Royal National Parks of Kenya* 1957, the Director, Mr. Mervyn Cowie, informs us as to the variety of vocal noises the cheetah can make:

'They purr when contented. The purr sounds like rattling a few stones in a tin and can be heard quite far away. The most noticeable sound, however, is a whistle or squeak when they are calling to each other. It sounds more like the whistle of a bird than any mammal, and unless one knows the sound well, it is difficult to believe that such a shrill sound could possibly be made by a Cheetah.'

In all the literature regarding the cheetah, and in the upwards of 280 books on shikar in India and the East, there is not, to the best of my belief, any mention of the vocal sounds made by the cheetah.

The cheetah has been very scarce in the wild state in India for many years. At the close of the Mahratta Wars (1818) they were frequently found in packs. There is record of a cavalry officer having in one day speared six off one horse.

Personally, I have never seen a cheetah in the wild state. The purpose of this note is to afford to those having knowledge of the animal an opportunity of contributing to the Society's *Journal* such information as they possess of the voice sounds made by the cheetah in India.

c/o Lloyds Bank Ltd.,
39, Piccadilly, W. 1,
January 29, 1959.

R. W. BURTON,
Lieut.-Col., I.A., (Retd.).

4. INCREASE OF SWAMP DEER (*CERVUS DUVAUCELI* CUV.) IN THE KAZIRANGA SANCTUARY, ASSAM

Since World War II the Kaziranga Wild Life Sanctuary has been one of the few remaining strongholds in Assam for this handsome animal. Today it may well be found that this sanctuary alone contains these deer in significant numbers. The Manas Sanctuary used to hold a fair number, but recent information is not available at the time of writing.

By their choice of habitat, swamp deer present an easy target for the poacher and, for the sportsman, a trophy which is superior to the sambar of Assam. In Kaziranga, swamp deer are found near the edge of bheels and open 'maidans' which are invariably surrounded by large areas of thatch and 'elephant' grass, to which they will usually retire at the scent of danger. Unlike the sambar, they do not appear to frequent the patches of forest characteristic of the sanctuary's interior. It may be presumed, therefore, that their preference for comparatively open country, coupled with their value as a trophy, has led to an alarming decline, until last year, of their population in Kaziranga.

Previously, it was unusual to see swamp deer in groups of more than three or four during the cold weather, but while on a visit on 7th March 1959 I saw a herd of fourteen (and was told that thirty had been reported the day before). My surprise may be well imagined. It is possible that these figures may not have been exceeded within the past twenty years and, if so, they represent a credit to the vigilance and efficiency of the sanctuary's staff. The herd which the writer had the pleasure of seeing was in charge of a 'master'

stag and did not display undue alarm at our approach—a strong indication that poachers are not operating in this particular area. It is to be hoped that such encouraging signs may continue unchecked, for it is but seldom these days that wild life is 'permitted' to breed without man's hindrance.

SYCOTTA T.E.,
KHARIKATIA P.O.,
ASSAM,
March 9, 1959.

J. H. BURNETT

5. SOME SORRY NOTES ON WILD LIFE IN NW. MADHYA PRADESH

(*Plate, photo* 1)

In mid-December 1958, I was invited to a week's shoot in one of the old Rajputana States (now in northern Madhya Pradesh) and, as I had not been into that country before, I gladly accepted.

Before, in, and after we moved into camp we met the Sub-Divisional Officer, the Collector of the District, and the District Superintendent of Police, and in the course of our several conversations were jointly and generally informed that shooting from cars and jeeps was permissible and in fact the only manner in which shikar was practised. Our protest against this form of 'sport' was politely turned aside as impracticable and idealistic. More than one official claimed to have recently shot the Great Indian Bustard.

Our camp was outside a village surrounded by cultivation, and a mile away was a shallow ravine 50 to 200 yards wide and covered with thorny scrub interspersed with the dhak (*Butea monosperma*). This was said to hold tiger, and with the assistance of our host, the local landlord, three beats were arranged, one necessitating the employment of almost a hundred beaters. There were several tiger in the 5-mile length of the ravine but the beats were all made in an amateurish and haphazard manner and the animals never showed themselves. Chital were twice said to have broken back but I did not see any animals at all. Beats were arranged in forested areas further away with similar results, though chital, sambar, and nilgai were seen. The beaters always included several persons armed with muzzle-loading guns. The Indian Arms Act has recently come into operation in this area and some of these guns were not yet covered by any form of licence.

All tigers are termed cattle-lifters or man-eaters and receive no protection at all, and Government officers travelling in the districts carried loaded weapons and shot at all they saw, both by day and night.

In this area, the slaughter of cattle is prohibited and there were fewer goats and sheep than in any other place in India that I could remember. The shortage of meat was acute and formed a problem to which I had not had my attention so forcibly drawn before. Our host was a Jain landlord, and the food which he very kindly sent to camp was entirely vegetarian. The few partridge which we shot were not enough to prevent everybody from becoming meat-hungry.

Attached to our camp was an enthusiastic shikari who had done a fair amount of poaching when the shooting was controlled by the Ruler of the State, and he now shot deer and antelope at night whenever a jeep or other suitable conveyance was available.

On the first night we drove out in a jeep for about 10 miles and the local shikaris immediately produced spotlights, operated on the car battery, with which they searched the fields and forests in an expert manner. With the greatest difficulty, shooting was restrained and in the course of the drive we saw several small parties of nilgai and chital. They were distinctly alarmed by the noise of the car, but once the light was on them they could be approached within easy shooting distance. After we failed to shoot anything in the beats, the local enthusiasts took over the meat supply problem. They preferred to use our host's tractor rather than the jeep, for once the eyes were sighted, the animals could be approached in a straight line, there being less need to go round nullahs and other obstacles! The party left after supper and were back in two hours with a chital stag and doe (Plate, photo 1). Only two shots were fired, and another doe got away wounded!

We were in one of the few parts of the country where tiger and deer still existed in some numbers. But the tigers in the forest have been shot out or driven into the scrub-covered ravines where a jeep cannot reach them and which do not afford enough cover to the deer. The tigers have, therefore, to pick up cattle from the adjoining villages, while the deer that have survived the shooting are in the forests separated by miles of cultivation. Though relatively safe from the tigers, they come into the fields at night and are indiscriminately shot wherever they can be seen from jeeps or tractors. My experience is restricted to a relatively small area, but it did appear that this anomalous distribution of tigers and deer was widespread.

Unless the Indian Board for Wild Life is able to carry out more actively the work which it has undertaken, both tiger and deer will

Photo 1. The tractor and the meat.

Photo 2. Swamp Deer in Kanha Wildlife Sanctuary.

Photos : Humayun Abdulali

be completely gone in a few years. All officers no doubt have in their files cyclostyled copies of the resolutions passed at the first meeting of the Board held in 1951, stating that wild animals should not be shot at night from cars and listing the Great Indian Bustard as one of the birds which is in urgent need of protection throughout the country.

Every year we hold a Wild Life Week, presumably to draw the attention of the public to the resolutions of the Board, but seven years after the setting up of the Board we have departmental heads of districts—persons directly associated with the administration of the law and the carrying out of the Board's resolutions so ardently endorsed by the President, the Prime Minister, the Chief Ministers of States—not only ignorant of the wild life preservation laws but utterly callous and indifferent to their enforcement when their attention is drawn to them.

The need of opening up more land for cultivation is admittedly making things difficult for wild life preservation, but there can be no doubt that if an intelligent and practical approach is made we can solve the problem. Last year 120,000 deer were shot by licence holders in the State of California alone, but the report states that this was not enough and the number left over for the following year will necessitate more deer being shot to prevent there being more animals than the country can support. No attempts at the census of wild animals, other than the lion in the Gir, have been attempted in India, but though we have many areas ecologically as good as those in California I wonder if the total number of deer left over the whole of India is anywhere near the number shot there annually.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, HUMAYUN ABDULALI
BOMBAY 6,
March 10, 1959.

6. FURTHER WILD LIFE NOTES FROM MADHYA PRADESH

(*Plate, photo* 2)

After I had sent in the note on wild life in north-western Madhya Pradesh, I had the good fortune of being able to join a party of Americans shooting big game and collecting natural history material at Supkhar, 2250 ft., Balaghat District, Maikal Range, eastern Madhya Pradesh.

From Nagpur I was driven to Supkhar about 180 miles away by

the Managing Director of one of the leading shikar agencies in the country. The Society had on earlier occasions drawn attention to various irregularities committed by his clients, and I was assured by the Director that every care was now taken that no laws were broken. Panther, according to the law, could not be shot at night from or within 100 yards of the motor vehicle in which the sportsman travelled. To comply with the law, I was told that his clients were taken out in jeeps at night, but when the animal was sighted the shikari was dropped on the road, with an assistant who manipulated the spotlight worked on the car's battery. The jeep was then driven off for a hundred yards, a length of wire to feed the torch being unrolled along the road. We did not go into details as to whether the jeep reversed 100 yards into darkness if the panther was on the road, or how corners were manipulated!

When we reached camp, my hosts, who had got in about 10 days earlier, had already shot their quota of 3 tiger and 3 panther. Mr. and Mrs. M., being newcomers to India, were naturally guided entirely by the advice of the officials of the Company, and one panther at least was shot in an after-dinner drive. I was a week in camp and, though I looked carefully, I was unable to find any trace of the wire mentioned nor obtain any suggestion of this having been used when the panther was shot. During my presence in camp, several attempts were made to shoot bear at night and, though none was encountered, a pig was shot without any 100-yard length of wire.

The Supkhar Block was closed for deer, and except for a few cheetal, a pair of four-horned antelope, and a single barking deer I saw no large mammals, though the country held magnificent stands of sal forest interspersed with large maidans ideal for deer and other herbivora. I also saw no sign of tiger or panther.

During my stay (9th to 15th March 1959), we visited the Kanha Sanctuary which is only about 30 miles north of Supkhar and in the same range of hills. This is an area of about 100 sq. miles at an elevation of 2000 ft. surrounded by a range of hills. Entry by road is possible from two directions. It is well controlled at least on one side where there are two barriers and many formalities to be gone through. On the far side, exit was less formal. In one afternoon I saw several hundred each of cheetal and swamp deer (Photo 2, plate) a herd of blackbuck, several sambar, one solitary and a party of about ten gaur, red junglefowl, peafowl, painted partridge, and quail of several species.

The Kanha forests are apparently being fully worked for timber and, if in spite of this they can hold such quantities of wild life without any obvious disadvantage to the trees, I can only stress the necessity

of giving this place greater publicity and persuading other States to try and create similar conditions in their own forests. I have visited the sanctuaries at Manas, Sona Roopa, Kaziranga (Assam, 1950), Bandipur (Mysore, 1952), Dandeli (N. Kanara, 1948 and 1951), but have no hesitation in saying that none of them held a fraction of the wealth of animal life visible at Kanha. I drove back to Supkhar after an early supper and the eyes of cheetal in the maidans glittered like the lights of a large city seen from an elevation at night. Outside Kanha we drove some 50 miles to Supkhar but failed to see anything, except an occasional fox or jackal. As compared with Kanha, the surrounding areas, including the Supkhar Block where I pottered about for a week, appeared to have been completely shot out.

A recent press note (Nafen, 15th April 1959) stated that after tea, jute, and textiles, tourism was India's fourth biggest foreign exchange earner and that the number of tourists had gone up from 23,000 in 1953 to 100,000 in 1958.

The visiting shikari or safari tourist as an individual no doubt spends a larger amount of money in the country than the average sight-seer, but he can only be a small fraction of the whole number. To satisfy the visitors elaborate arrangements are made to ensure that the full quota of animals permissible is shot within the short period for which the block is held, while the average shikari seldom shoots his limit. The pressure on the game population is already excessive and it may be questioned whether in the long run it is a wise policy to 'sell' the remains of our wild life under the temptation of earning a few more dollars.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, HUMAYUN ABDULALI
BOMBAY 6,
May 28, 1959

7. A VISIT TO SOME INDIAN WILD LIFE SANCTUARIES

I have just completed a twelve-week tour of India with my wife, during which we endeavoured to see and photograph the wild life of the country. In the African and North American continents I have visited the Kruger, Serengeti, and Amboseli Parks, and the Yellowstone, Glacier, Waterton, Banff, and Jasper Parks. As a member of the Fauna Preservation Society of London and the Audubon Societies of U.S.A. and Canada, as well as of the Bombay Natural History Society, I thought that the following notes might be of interest.

Rajasthan

Keoladeo Breeding Waterbird Sanctuary, Bharatpur

This is a first-class bird sanctuary and we also photographed here Nilgai and Blackbuck. There was an unusual amount of water everywhere which made this difficult. The Maharajah lent us boats and his head shikari to overcome this problem. These were a great help, for without them we should have achieved nothing. Proper boats suitably controlled to prevent undue disturbance of the breeding birds should be made part of the regular service of the sanctuary.

One of the Sarus Crane nests near the roadside had been robbed, allegedly by soldiers from a near-by detachment. The local inhabitants do not molest the birds or animals.

The Range Officer in charge was extremely helpful and went to great pains to make our visit a success. I had written to him beforehand.

The Rest House accommodation is very good, but we had to bring our own cook, food, car, and driver, as at that time these were not provided by the Forest Department.

Kashmir

The authorities did their best to help us, but owing to the fact that the Game Warden had been changed several times during 1958 the recently appointed holder of the office had to rely upon written reports from subordinates. At the same time he was holding down another job of Soil Conservation, and arranging shoots for V.I.Ps. sent up from Delhi. All this made it difficult to arrange a satisfactory programme in advance of our arrival. And when we finally came to visit certain places, we found little or no wild life.

There is much disturbance of game by nomadic herdsmen and shepherds. We found a large herd of goats in the upper part of Desu Sanctuary the day we were there. The forest guards are afraid to take steps against these people because they are beaten up if they do. During the week prior to our visit some cattle had been confiscated in the *rakh*, and during the night the herdsman and his friends returned and reclaimed them by force. We saw their blankets being handed over to the District Forest Officer as confiscated property. We also heard a fantastic report of a member of Parliament actually obtaining a permit from the authorities to shoot a Kashmir Stag within the Dachigam Sanctuary. We were glad to hear that he missed it with all three shots, but find it hard to believe that this could have

been permitted to happen in a reserve for a rare animal which is supposed to be receiving full protection.

The only area in Kashmir which is of any real value from the point of view of wild life conservation is the combined Lower and Upper Dachigam areas. But certain restrictions must be removed if it is to be of any value to the visiting tourist. The rest house at Draphama should be made available to visitors in the same way as has been done at Bharatpur. Also the huts at Gratnar and Sangergulu should be repaired and equipped for visitors. Then the whole area should be created into a National Park. At present the argument against such a step is that Dachigam is the catchment area for the Srinagar water supply. But this is not a valid excuse as the area is freely entered by grass cutters, road makers, manure collectors, and others, whom we saw and for whom there are no sanitary arrangements. Any pollution by visitors could be prevented by the provision of adequate sanitary facilities and limitation of the number of visitors by permit.

Mysore

Bandipur Sanctuary

We saw Bison, Spotted Deer, and Sambar in this sanctuary and photographed them with some difficulty. It was difficult to persuade the Sanctuary staff there that an elephant ride at 6.30 a.m. or a noisy lorry ride at 5.30 p.m. was useless from the point of view of photography. After pressing our case we finally photographed bison in good light quite late in the morning. Quieter running lorries or small jeeps to replace the present trucks would be an improvement. And it should be possible for visitors to use their own cars on the Sanctuary roads after payment of a suitable fee, and if necessary accompanied by a member of the staff.

We stayed in both the Forest and P.W.D. rest houses. The beds are very hard in both of them, being of the solid wooden type with only a thin mattress. We were informed that preference for elephant rides was given to those staying in the Forest House.

The schedule of charges for cameras states clearly that the fee is so much 'per day'. But the official collecting the money appeared to be under the impression that a fee should be levied 'per trip', i.e. for evening as well as for morning trips.

Madras

Mudumalai Sanctuary

The administration of this sanctuary strikes one as being much more efficient than that of Bandipur. The elephant camp, the washing

and feeding of elephants and the timber extraction by elephants are good subjects for photography and could be developed as a tourist attraction. The Spotted Deer are not so wild as at Bandipur. A new rest house is being built and a 'Tree-Tops' observation platform by a water hole. The union of this sanctuary with Bandipur to form one National Park would be a good thing if the individual states concerned could come to such an agreement.

Kerala

Periyar Sanctuary

This is one of the best sanctuaries which we saw during our visit. We used the Peermade Game Association launch for three days under the direction of Mr. Wood. We were fortunate in having good opportunities for photographing elephants and bison near the water which greatly enhances the picture. There is first-class hotel accommodation at the Aranya Nivas Hotel.

On the third morning we climbed a hill to the right of the dam and photographed some sambar which we had spotted from the launch. While we were doing this we heard a tiger in pursuit of his prey in the forest on the other side of the dam. We then returned to the launch and looked for elephants in another bay before returning to the dam on our way back to the hotel. As we came in sight of the hill we were horrified to see two figures carrying rifles who were climbing up the hill from the dam. We verified this with binoculars. This confirmed our suspicions, which had been raised by shots heard at night, that regular poaching is going on within the sanctuary.

We were also reliably informed that solitary tusker elephants, which used to be seen quite frequently, are now no longer found in the sanctuary. The assumption is that they have been poached. We were further told that there is a constant traffic of honey-hunters, fishermen, and others in all parts of the sanctuary. For this reason it would appear desirable that the new Game Warden, when he is appointed, should reside in the Sanctuary and not at Peermade. Only frequent and vigorous patrolling can restore the situation.

Assam

Kaziranga Sanctuary

This sanctuary ranks equally with Periyar in being one of the best we have seen. We saw and photographed Rhinoceros, Buffalo, Swamp Deer, and Hog Deer. But there are certain criticisms worth mentioning. The first is that very few tourists see the very attractive Baguri area, and there is no illustrated booklet from which they can obtain information about different parts of the sanctuary. We heard

that such a booklet has been written for Kaziranga, but for some inexplicable reason its publication has been delayed for three years.

The second criticism is that entry of cattle and buffaloes into the Mohpara and Laodubi area is permitted. This does not actually disturb the rhino much, because we saw them grazing undisturbed near the cattle. But there is a two-fold danger from this policy: firstly the introduction of disease by the domestic animals, and secondly they represent the thin edge of the wedge of advancing 'civilization' and reduction of the grazing potential for wild animals. Although there are now only a few hundred cattle and buffaloes restricted to a certain area, yet as time goes on more and more cattle and buffaloes may be permitted to enter the sanctuary and their grazing zone may become increased until finally the sanctuary is taken over by the herdsmen. This has happened to the Serengeti National Park in East Africa during the past year as a result of such a policy being followed by the Government: in this case it was entry of the Masai cattle and herdsmen from other areas which upset the balance, as there had always been a few indigenous Masai and their cattle within the Serengeti.

The third criticism is the low standard of catering at the Tourist Lodge. When we protested at having chicken for lunch and dinner every day, we were given local fish cooked to biscuit hardness—which was worse. I complained to the Senior Conservator of Forests from Shillong, and he assured me that a new caterer with adequate facilities would be working by April. I hope this is true.

With regard to the collecting of view fees and camera fees we had the same trouble as at Bandipur—namely that the official in charge appeared to think that these fees were to be levied 'per trip' instead. When I pointed out that it was clearly stated on the back of our view permit that these fees were daily charges, he duly amended the bill.

Conclusion

Generally speaking, wild life is more difficult to find and to photograph in India than it is in Africa or North America. This is partly due to the habits as well as habitat of the animals.

Valiant efforts are being made by a few people to preserve the wild life of India. They will only succeed if the national conscience can be awakened by making the 'National Parks' idea catch on as it has done in America and Africa.

There is practically no suitable illustrated literature about the wild life sanctuaries of India. A notable exception is the very good booklet about the bird sanctuary at Bharatpur. I had great difficulty in obtaining information about the places I wanted to visit before I

arranged my tour. I should not have known of the existence of some of them if it had not been for the information provided by friends.

This is in sharp contrast to Africa and America where such information is readily available. It should be made possible to obtain illustrated booklets about every wild life sanctuary from all Government Tourist Offices in India and abroad.

The wild life of India, although much reduced from its former abundance, is still very considerable. But it is almost unknown outside India because it is much more difficult to see and photograph than that of Africa and North America. The wild life of Africa is known all over the world because it has been made accessible. The North American wild life, although less varied and numerous than that of India, has been much better developed as a tourist attraction so that anybody can see it easily.

There is, however, a bright future for the wild life of India if national parks could be created and developed in suitable areas. If this is done, India will have as much to show as the other countries, and their parks could become a great tourist attraction throughout the world.

PURITY DAIRY BUILDING,
LETHBRIDGE,
ALBERTA, CANADA,
January 29, 1959.

T. H. BASSETT

Commenting on the above note, Mr. E. P. Gee, a member of the Society's Advisory Committee, writes:

'It is most interesting to obtain the impressions of a visitor to India's wild life sanctuaries, as it is from such a person that we can notice our imperfections and rectify any defects that might exist in the administration or provision of amenities for tourists. And when the foreign visitor has had considerable experience of wild life places in other parts of the world, as Dr. Bassett has had, his remarks are of all the greater significance.

Ghana Bird Sanctuary, Rajasthan: There is no doubt that this is a good and accessible place for foreign visitors with a bent for ornithology. The provision of more amenities at the Rest House, as Dr. Bassett notes, would be a big improvement—in fact it has probably already been done by now.

Kashmir: I fully endorse all Dr. Bassett's remarks regarding Kashmir and its great potentialities—especially the advantages to

nature and wild life preservation if Upper and Lower Dachigam Sanctuaries could be made a national park.

Bandipur Sanctuary, Mysore: When I myself last visited Bandipur in 1955 I experienced the same difficulties there as Dr. Bassett found. It is to be hoped that such a fine place will receive the full attention of the State Government, so that it will be visited and appreciated by a greater number of visitors both from India and from abroad.

Mudumalai Sanctuary, Madras: I noticed great improvements in Mudumalai in 1955 (as compared with 1954), and it is gratifying to note that it is still further improving.

Periyar Sanctuary, Kerala. This beautiful wild life reserve needs better protection as Dr. Bassett points out. It is such an ideal place for visitors, that it would be nothing short of a national calamity if it were to be spoiled by poachers.

Kaziranga Sanctuary, Assam: I endorse Dr. Bassett's remarks about the lack of a suitably illustrated guide booklet for this place. Such a booklet was, in fact, written as well as approved of by the authorities at the end of 1955. But no action has been taken to get it published, although funds are said to have been available for this purpose. Several other improvements at Kaziranga are long overdue, and it is difficult to understand the delay in having these put into effect, for Kaziranga is one of the showplaces of India's wild life.

General: It is a fact that in India there is a noticeable dearth of illustrated literature for tourists and visitors who want to see the wild life sanctuaries, of this country. There are some exceptions, such as the Ghana Bird Sanctuary of Rajasthan which has an illustrated booklet, and in Kerala State the Peermade Game Association have brought out an illustrated guide booklet which includes Periyar Sanctuary. Since Dr. Bassett's visit to India, Madhya Pradesh has brought out small illustrated folders for Kanha and Shivpuri, and Uttar Pradesh also has a folder for the Corbett National Park. What is now wanted is (i) a standard type of illustrated guide booklet for each individual sanctuary of India, with maps and all other relevant information, and (ii) a comprehensive illustrated guide book to include all the major wild life sanctuaries of India. It is to be hoped that the appropriate authorities will take action in this urgent matter.'

—EDS.

8. NOTES ON THE SPINY BABBLER, *ACANTHOPTILA NIPALENSIS* (HODGSON), IN THE NEPAL VALLEY

The Spiny Babbler had for many years been considered a rare bird. It was collected by Hodgson in the 1830s. He described it as solitary. In recent years it has been collected by Dr. Ripley at Rekcha in W. Nepal (*JBNHS* **49**: 394), and in some numbers by Dr. Fleming, mostly at Pokhara and Tansen, central Nepal [*JBNHS* **51**: 941-943; *Fieldiana,* Zoology, **41** (1)]. Both these collections were made in winter, and the birds were described as being in flocks.

My observations are confined to the Nepal Valley, and the hills surrounding it. Here, once the bird's song and habitat are known, it is found to be an extremely common bird, and it is curious that it should have been overlooked for so long. I had lived for several years in Kathmandu before I realised how very common it was, although I had seen the odd bird from the time we first arrived here in 1947. The reason, I think, lies in its habitat. This is the secondary scrub which covers large areas of the hills round the valley, where the primary jungle has been cut down. This scrub (mostly on the north and east faces of the hills, the south and west faces being mostly grass with scattered bushes) is dense, hot, and shadeless, the bushes being only about 5 ft. high. It is uncomfortable to work in during the hot weather, and birds cannot be seen in the thick cover. Until the calls and songs are known it is impossible to judge the status of any species. Ornithologists with limited time at their disposal naturally prefer the wonderful forest areas with their great variety of species. During my first years here, every spare minute was spent in these forests. The scrub largely consists of *Gaultheria, Symplocos, Myrsine, Osbeckia, Camellia, Phyllanthus,* etc. Trees, such as *Schima wallichii, Castanopsis indica,* and *Quercus lanuginosa* are common, but as they are constantly cut for firewood and grazed by goats and buffaloes they seldom attain more than bush height. Sometimes a few Chir pines (*Pinus roxburghii*) have been allowed to grow into trees. Near villages the scrub is thin with open patches, where *Pyrus* and *Berberis* grow in scattered bushes. Away from cultivation it is so thick that one can with difficulty force one's way through it. The Spiny Babbler is found in all the different types of scrub, but is commonest away from cultivation. It is abundant on the Sankhu Ridge to the east of the valley at 6500 ft., and on Tokah Hill between 5000 and 6000 ft. On the Kakani Ridge, 7000 ft., I have not seen it, so perhaps 6500 is its upper limit.

I have found the Spiny Babbler to be, as described by Hodgson, a solitary bird. From March to May they are in pairs. The males sit

on some prominent bush, never on top, but on one side, usually in full view, whence they sing from morning till night. They are particularly noisy after rain, and in the middle of the day. They sing less in the early morning, when the dawn chorus, dominated by such birds as the Orangeheaded Ground Thrush and the Blueheaded Rock Thrush, is in full swing.

The singing birds can easily be approached to within 25 ft. or so. If disturbed they slip out of sight, but at this season if the watcher waits quietly for a few minutes, the bird will reappear and start to sing again from the same spot or very near it. The males have a great variety of notes, but the tone, a peculiar harsh yet ringing whistle, is always the same. It is not at all like a typical *Turdoides* call, nor does it have the beautiful pure whistle of so many *Garrulax* species. The call most often heard starts with a few fine whistles and then continues up the scale:

"tee ter ter tee ter ter etc."

It also has, in the breeding season only, a very distinctive and peculiar call *down* the scale:

tee tee ker chee ker chee ker chee".

This is sometimes preceded by a running trill. There are many other combinations of whistled notes. As soon as one bird starts to call, it is answered by another and another, usually about 200 yards apart. They can be heard answering each other for long distances, and the total number of birds must be very great. Day after day I would find a given pair in the same place, often in the same bush.

The sexes are not distinguishable in the field, and where in the following notes I speak of the female it is merely on presumption from behaviour. During March and April, the singing male is usually accompanied by a female, low in the scrub. She spends a good deal of time preening herself, uttering low churring cries, but it is usually very difficult to see her, and only by the calls can she be located. I have never heard her sing, but in addition to the *churrs*, she has a loud call: *wick-er-wick-er-wick-er.* If she leaves the bush where the male is singing, he will stop and follow her, and the two will sometimes burst out in a wild crescendo of screaming calls when they do sound very like the typical Jungle Babbler of the plains. I have seen the male pick up a leaf and offer it to the female, but she did not take it. While they are moving together through the bushes, she frequently picks up dead pine needles and leaves, and then carries

them for a short distance before dropping them; the male occasionally does the same. I was never able to see them actually building. Occasionally they would fly, just skimming the bushes, sometimes for a considerable distance, but in an awkward top-heavy manner. I have seen a pair sitting close beside each other in a bush preening themselves and occasionally preening each other, uttering low churring notes and raising the feathers of the head into a crest. I have also often seen the female drooping wings and tail and begging for food like a young bird. The male would then become very excited, but I never saw him attempt to feed her, nor have I seen them actually mating.

Later, at the end of April and May I have seen only singing males. The females may have been incubating, but I never found a nest. In June, July, and August, the males continue to sing, but now from deep within a bush. They sing in short bursts, and if approached become instantly silent but remain in the same area, for if the watcher moves away the song is presently heard again from the same place. The call down the scale is not now often heard. They are silent for long periods but when one sings it still stimulates others to reply, sometimes from a considerable distance.

A singing male, shot on the 26th July, had the breeding organs slightly enlarged and tail feathers very worn and frayed. Another shot on August 4th was in beautiful fresh plumage; the testes were not at all enlarged, but nevertheless he was singing with great zest. I did not wish to disturb the breeding birds, so did not shoot any during the spring.

In September the birds are still in full song, especially during intervals in the monsoon showers. In October they are occasionally heard, and from November to February not at all.

During the winter they are impossible to locate in the thick scrub and would certainly be regarded as very rare birds. In thinner scrub, in areas where I had found them to be common in summer, they can still be seen, especially in the evenings. They now keep almost entirely to the ground, searching for food amongst low bushes, but occasionally appearing in the open, to peck at a patch of dried cow-dung, or turn over dead leaves. They may then be in small flocks, but I have never actually seen more than two birds together.

My only note from outside the valley is from my husband, who found a bird singing in a bush in typical scrub country, just under 6000 ft. in the Trisuli valley, near the village of Grang, May 26.

BRITISH EMBASSY,
KATHMANDU, NEPAL,
January 31, 1959.

DESIRÉE PROUD

9. A NEW WHITE-THROATED RACE OF THE BABBLER *DUMETIA HYPERYTHRA*

Stuart Baker in the Fauna (Vol. I, p. 228) accepted two species in the genus *Dumetia:*

D. hyperythra Franklin, 1831, *P.Z.S.*: 118, (Ganges near Benares), with chin and throat rufous, and

D. albogularis Blyth, 1847, *J.A.S.B.* **16**: 453, 'southern India', restricted to Mysore by Baker, 1921, Handlist: 24, with chin and throat white.

In the white-throated group he included Harington's race *abuensis* (1915, *JBNHS* **23**: 429) from Mt. Abu, which differed from *albogularis* in having the whole crown chestnut and the underparts much darker. This form was stated as occurring from Mt. Abu and Deesa, down to Mahableshwar.

Whistler examined this question at length [Eastern Ghats Report (*JBNHS* **35**: 743-5)], and rightly opined that the evidence for *hyperythra* and *albogularis* both occurring in the same area was unsatisfactory. He therefore reduced the latter to a race of *hyperythra.* He synonymised *abuensis* with *albogularis* as being inseparable, thus expanding the latter's distribution to 'a strip of country down western India from Mt. Abu and Deesa extending through Baroda, Western Khandesh (Dhulia, Nandurbar, Khondabhari Ghat), Nasik and the whole range of the Sahyadris (Khandala & Mahableshwar) with their adjoining districts, to the south of the Peninsula'. He drew attention to Fairbanks's statement that it (the white-throated form) is very definitely a bird of the Ghats which did not extend into the Deccan tableland. In south Konkan and Kanara it was scarce though apparently commoner in Mysore where, in the valley of the Kistna, it occurred directly opposite the southernmost limit of the typical race (*hyperythra*). South of this *albogularis* was again widely, though not uniformly, distributed in the rest of the Peninsula and Ceylon. (Later the birds from Ceylon were separated as *D. h. phillipsi* by Whistler, as having a heavier bill.)

Whistler also changed the type locality of *albogularis* from 'Mysore' in the Fauna to 'Taipoor Pass and near Jaulna'. Curiously the original reference quoted by him (1847, *J.A.S.B.* **16**: 453) does not mention these places. Blyth there writes of the white-throated form of *Dumetia hyperythra*: 'I find that *T. hyperythra* of Jerdon inhabiting India and Ceylon differs from true *hyperythra* which I obtained from the Midnapore jungles in having the chin and throat white . . . . Should it be considered separable as a species from its representative in Southern India, the latter may stand as *M.* (?)

albogularis nobis.' The name *albogularis* therefore obviously applied to the south Indian form which was restricted to Mysore by Stuart Baker in the Handlist and Fauna. This removes a considerable source of ambiguity and confusion, particularly if the geographical variations listed in this note are accepted.

In subsequent years the position as interpreted by Whistler stood. But I recently had occasion to handle a few specimens and was struck by the very pronounced rufous cap which separated birds from the north-western parts of its range from others in peninsular India. The feathers of the forehead are longer and a brighter chestnut, in which the pale shafts show up as distinct streaks. Mr. Sálim Ali who obtained several specimens in his Gujarat Survey agrees with me that *abuensis* of Harington is a perfectly good race which extends along the foothills and coastal plains as far south as Bombay city.

In the course of the same investigation I noticed that some birds from Khandala *c.* 2000 ft., Western Ghats, were markedly different from others, and was fortunately able to supplement the series with several additional specimens from that area. These differ from both *abuensis* and *albogularis* in the following characters:

1. The upper parts are suffused with olive and lack the rufous tinge of the other two races.

2. The feathers on the forehead form a cap smaller than that in *abuensis* and which is a dark brown rather than chestnut. The pale shafts to these feathers are also less prominent than in *abuensis.*

3. As a series the rufous underparts are duller than in *abuensis* and *albogularis.*

4. The upper mandible is dark horny or blackish as against yellow, which latter, incidentally, has been given as one of the characters of the genus.

5. The legs, feet, and claws have a greenish tinge as against yellow.

Differences 4 and 5 were not noted in the field; in made-up skins the colour of the bill and legs enables one readily to pick out specimens of the new form from a mixed lot. The colour of the bill and feet should, I believe, be possible to tell in the field. Its measurements do not differ from those of the other races.

On 20th May 1959, Br. Novarro obtained a juvenile with a half grown tail at Khandala. The colours of the bill, legs and feet agree with those of the adults, but there is *no* trace of any cap on the forehead.

On the above differences I have no hesitation in describing a new race.

Dumetia hyperythra navarroi subsp. nov.

Type: A male collected by Br. Navarro at Khandala *c.* 2000 ft., Western Ghats, Poona District, Bombay State, on 22-5-1958. *B.N.H.S.* Coll. No. 20120.

Named in honour of Br. A. Navarro, S.J., of St. Xavier's High School, Bombay, who procured the specimens at Khandala, and who has in other ways helped the Society with ornithological and other material over the last 30 years.

Four more from Khandala, two from Kihim (Alibag Taluka, Kolaba District), and one from Padhga (Bhiwandi Taluka, Thana District), have all the characters on which this race is described.

Distribution: Four specimens from Bombay and Salsette Islands are nearer *abuensis*. The two specimens from Kihim, which is on the mainland about 6 miles south across Bombay harbour, are definitely *navarroi*. Of two collected around Bhiwandi, which is on the mainland 20 miles north of Bombay, only one has all the characters, while the other may pass as *abuensis* except for the colour of the bill and legs. The distribution in the Konkan, as also around Khandala, needs to be worked out and it could form the basis of an interesting ecological study.

While handling the *Dumetias* in the Bombay collection it was apparent that there were several variations in the forms without the white throat, i.e. *hyperythra*. The scarcity of fresh material deters one from attempting to separate any geographical forms, but they will no doubt repay further taxonomical study.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, HUMAYUN ABDULALI
BOMBAY 6,
May 20, 1959.

10. ON THE VALIDITY OF *HARPACTES ERYTHROCEPHALUS HODGSONI* (GOULD) [AVES: TROGONIDAE]

(*With a text-figure*)

The Redheaded Trogon was first described as *Trogon erythrocephalus* by Gould (1834) from specimen (s) obtained in Rangoon, Burma. The Himalayan bird from Nepal was later separated by him (1838) as *Trogon* (*Harpactes*) *hodgsoni*. The indiscriminate use

of these two names in the literature has led to a great deal of confusion in the nomenclature. The following are some examples:

(*a*) *hodgsoni* used for the Indian and *erythrocephalus* for the Burmese birds (Gould, 1838, 1865, 1869);

(*b*) *hodgsoni* used for the Burmese bird without any reference to *erythrocephalus* (Blanford, 1870; Blyth, 1875);

(*c*) *erythrocephalus* and *hodgsoni* treated synonymously, the former being used for both the Indian and the Burmese birds (Oates, 1883; Hume, 1890; Ogilvie-Grant, 1892; Blanford, 1898; Baker, 1927; Peters, 1945);

TABLE I

Measurements in mm., of specimens of *Harpactes erythrocephalus* (Gould)

Locality	Sex	Wing	Tail	Bill	Wing-Bill Index[1]
Kumaon ..	♀	153	201	21	13.7
Nepal ..	♂	153, 154, 155.5	182, 195-, —	21, 21, 21.5	13.5, 13.6, 14.1
	♀	151, 152.5, 153, 154	180, 183, 188-, 190	20, 20.5, 21, 21	13.2, 13.4, 13.6, 13.7
Sikkim ..	♂	149, 149, 150, 151, 154	176, 176, 178, 190, 190	21, 21.5, 21.5, 22, 22	13.9, 14, 14.4, 14.7, 14.8
	♀	150, 151	182, 185	20, 21.5	13.2, 14.4
Assam ..	♂	145, 145, 147, 147, 148, 150, 150.5, 151, 151	179, 179, 180, 181, 182, 182, 187, 191, 192	21, 21, 22, 22, 22, 22, 22, 22.5, —	14, 14.5, 14.6, 14.6, —, 14.9, 15, 15, 15
	♀	143, 146, 146, 146, 149	172, 173-, 175, 200,—	19, 20, 20, 25.5, 21	13, 13.4, 13.7, 14.3, 14.4
Upper Burma ..	♂	151.5	182	22	14.5
	♀	146, 148	189, 189	23, —	15.5, —
Lower Burma ..	♂	143, 145, 146	177, 186, 201	21, 21, 22	14.5, 14.8, 15
Southern Tenasserim ..	♂	144, 145	180, 182	22, 22.5	15.2, 15.6
	♀	148, —	182, 187	21, —	14.2, —

[1] Wing-Bill Index = $\frac{\text{Bill}}{\text{Wing}} \times 100$

(*d*) *erythrocephalus* and *hodgsoni* treated synonymously, the latter, in spite of its later date, being used for both the Indian and the Burmese birds (Hume & Oates, 1875; Jerdon, 1877; Hume & Davison, 1878);

(*e*) *hodgsoni* used for both the Indian and the Burmese birds, even accepting the Nepal and Sikkim birds as different from the Burmese (Horsfield & Moore, 1858);

(*f*) *hodgsoni* used for Indian birds alone, without any reference to *erythrocephalus* (Hume, 1875).

The main point at issue is the taxonomic status of the Indian bird.

A critical comparison of material from Kumaon, Nepal, Sikkim, Assam, and Burma at once reveals that the Himalayan bird is indeed different from the southern Burmese bird in being much larger, in having a smaller wing-bill index (Table 1), and a shade deeper coloration. The Assam-Upper Burma populations are, as may be expected, intermediate between the Himalayan and the southern Burmese populations (Fig. 1). It seems necessary, therefore, to resuscitate

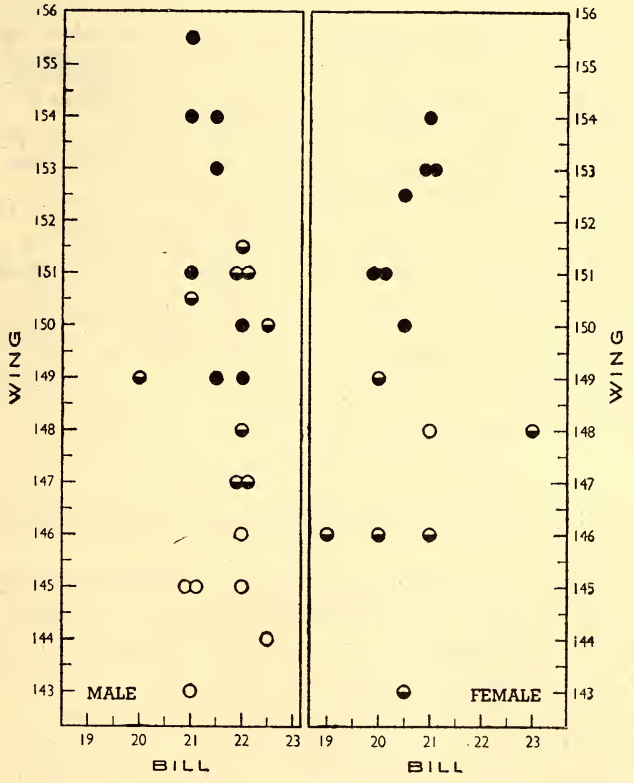

Fig. 1. Lengths of wing and bill in specimens of *Harpactes erythrocephalus* from India and Burma

● Kumaon-Sikkim. ◒ Assam-Upper Burma. ○ Lower & Peninsular Burma

Gould's name *hodgsoni* for the Himalayan bird which should now be known as *Harpactes erythrocephalus hodgsoni* (Gould). Its type locality may be restricted to Hitaura, Chisapani Garhi Province, Nepal.

My grateful thanks are due to the authorities of the American Museum of Natural History, New York, for extending me all facilities to work on their material on which the above observations are based.

c/o Zoological Survey of India,
Indian Museum,
Calcutta 13,
April 8, 1959.

BISWAMOY BISWAS

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11. EDIBLE-NEST SWIFTLETS IN BURMA

I was glad to read Mr. Sálim Ali's contribution of notes on the above by the late Mr. S. F. Hopwood in your *Journal* Vol. **54**, No. 4.

Although suggestions for some form of control had been made pre-war, nest collection until 1951-52 was an annual affair, the right to collect being sold by tender—nothing else was done.

During December 1956, I happened to be touring in the Tavoy Forest Division with U Kwet Kaw, A.T.M., Conservator of Forests, Maritime Circle, to revise the working plan and we hit upon the formation of a 'Working Circle'. This is quite a novelty in this part

of the world as working circles are formed of forests to 'work' the timber, firewood, grass, bark, etc. I give below extracts from the revised divisional working plan for the period 1951-52 to 1964-65 embodying certain pre-war data and those collected largely at the instance of U Kwet Kaw:

'HGNETTHAIK WORKING CIRCLE

(*Hgnetthaik* is the Burmese for edible birds' nests)

'General Constitution of the Working Circle

'This working circle is constituted to protect the swift (*Collocalia francica*) and to collect edible birds' nests of commerce on a sustained yield basis. Another species (*Collocalia innominata*) is also found nesting in the caves along with the former. *Innominata* produces black nests of little commercial value. The islands on which these swifts nest are listed below:

Serial No. (1)	Names of islands or rocks (2)	Situation (3)	Group (4)	Area in acres (5)
	TAVOY DISTRICT			
	Hnget-thaik-kyun Reserve Block II			
1- 3	Kyauk-bu-taung (Bird's nest Rock) consisting of three unnamed islands or rocks (2.05 acres, 4.20 acres, and 2.90 acres respectively).			
4- 7	Hnget-thaik-taung (Cradle Rocks) consisting of four unnamed islands or rocks (15.24 acres, 12.80 acres, 28.16 acres, and 9.60 acres, respectively).	Lying to the east of Maungmagan islands (Middle Moscos) between long. 97°50′ and 55′ and lat. 14°15′ and 5′ of Survey of India Map, Sheet No. 95F/16.		215.75
8	Hnget-thaik-kyun(140.80 acres).	Lying between Atet Bok (North island) and Auk Bok (South island) of Launglon Bok (South Moscos islands) between long. 97°50′ and 55′ and lat. 13°55′ and 50′ of Survey of India Map, Sheet No. 95 G/13.	Moscos Group	
			Total ..	215.75

Serial No. (1)	Names of islands or rocks (2)	Situation (3)	Group (4)	Area in acres (5)
	MERGUI DISTRICT			
	Hnget-thaik-kyun : Reserve Block I			
1 2 –5	Mali Kaing Hngetthaik (North Rocks) (5.12 acres). Peinne kyun or Paine (Great Canister) Island (889.60 acres). Mali Don or Mali Taunggyi (Hngetthaik Birds-nests Islands) (including two rocks) (23.34 acres).	Lying to the west of Tavoy islands (Mali) between long. 98° 10′ and 20′ and lat. 12° 50′ and 13° 0′ of Survey of India Sheet Map, No. 95 L/1 and 5.	Mali Group	917.76
6–11	The Ye-E group Hngetthaik taung (Marble Islands) consisting of six unnamed islands or rocks (332.80 acres, 2.50 acres, 2.50 acres, 63.80 acres, 15.36 acres, and 30.70 acres respectively).	Lying to the east of Domel Island between long. 98°-15′ and 20′ lat. 11°-35′ and 30′ of Survey of India Map, Sheet No. 96 I/6 and I/5.		
12–14	Turrets Islands consisting of Pulo Beba, Pulo Salangin (hnget - thaik kyun), and Pulo Prewang (6.50 acres, 16.80 acres and 9.72 acres respectively).	Lying off the coast about 3 miles from " Salangin " between long. 98°-25′ and lat. 10°-35′ and 30′ of Survey of India Map, Sheet No. 96 J/6.		
15–18	Panthun kyun (Pickwick Group) consisting of four unnamed islands or rocks (15.40 acres, 5.12 acres, 12.80 acres, and 10.24 acres respectively).	Lying to the west of Sellore Island and north of Parker Island between long. 98°-15′ and 20′ and lat. 12°-5′ and 0′ of Survey of India Map, Sheet No. 96 L/8.	Mergui Group	577.69
19–22	Pulo Tica (Nine-pins) consisting of four unnamed islands or rocks (10.80 acres, 3.20 acres, 1.05 acres and 38.40 acres respectively).	Lying to the west of Lampi Island between long. 98°-0′ and 5′ and lat. 10°-50′ and 45′ of Survey of India Map, Sheet No. 96 J/1.		
23&24	Kawnga island (Acreage not available).	Lying to the west of St. Mathew's Island about 30 miles west of Kawthaung. (The name of islands not shown on Survey of India one inch to a mile map.)		
			Total ..	1495.45
			Grand Total ..	1711.20

'Nest Collection

'The swifts visit the caves on the islands in the middle of the cold season and make their nests which are the edible birds' nests prized by epicures. On the Mali group the first collection of nests is made in the first week of March. The second and third collections are made at approximately 25-day intervals. Towards the middle of May the birds are allowed to lay their eggs in the nests made for the fourth time. It takes about 1½ months for the eggs to hatch and the young birds to be able to migrate with their parents to avoid the heavy monsoon weather. Nests are collected finally for the fourth time in the first week of July. On the Mergui and Moscos groups of islands, the season is said to start two to three weeks earlier.

'The islands frequented by swifts are sparsely covered by valueless scrub which, however, provides resting places for falcons. According to nest collectors tree cover provides falcons with shelters in which they lie in wait and prey upon swifts. The Ye-E group of islands which was almost bare 30 years ago and gave record outturn of nests is now fully under tree growth and is rarely visited by the nest-making swifts.

'As a result of over-collection, the number of swifts is dwindling.

'The following shows the weight of nests collected as furnished by the monopolist, and the monopoly fee received from him:

Year	*Viss*[1]	*K*	*Year*	*Viss*	*K*
1927–28	361	No record	1941–42 to 1944–45	No record	
1928–29	578				
1929–30	84		1945–46	No record	3,150
1930–31	85		1946–47	125	5,400
1931–32	No record		1947–48	482	8,150
1932–33	188	6,458 average	1948–49	299	12,750
1933–34	199	for 10 years	1949–50	231	30,050
1934–35	244		1950–51	319	31,800
1935–36	206		1951–52	250	
1936–37	281		1952–53	240	1,41,000
1937–38	45		1953–54	175	
1938–39	285	No record	1954–55	170	
1939–40	1461	,,	1955–56	338	1,05,000
1940–41	281	,,	1956–57	..	

'Protective Measures

'While on humanitarian grounds complete protection to the birds would be desirable, such protection for the scattered positions of the islands would be both difficult and very expensive on account of the trade demand for the nests. The problem therefore resolves itself to arranging the nature and degree of protection deemed necessary to

[1] 1 Viss = *ca.* 3½ lb.

During 1956, the collections were reported to be:

Collection (1)	Date (2)	Group of islands (3)	(4)	(5)	Weight (viss) (6)	Remarks (7)
First ..	5th March	Mali	—	—	60	Mainly second quality nests.
	5th February	—	Moscos	—	6	
	,,	—	—	Mergui	10	
				Total ..	76	
Second ..	1st April	Mali	—	—	125	Mainly first quality nests.
	1st March	—	Moscos	—	10	
	,,	—	—	Mergui	20	
				Total ..	155	
Third ..	26th April	Mali	—	—	40	
	26th March	—	Moscos	—	7	
	,,	—	—	Mergui	15	
				Total ..	62	
Fourth ..	4th July	Mali	—	—	30	Mainly third quality nests.
	20th June	—	Moscos	—	5	
	,,	—	—	Mergui	10	
				Total ..	45	
				Grand Total ..	338	

prevent these birds from being exterminated by ruthless exploitation while at the same time seeing that the State gets its due revenue, in increasing amounts if possible, from the trade.

'Measures proposed to be adopted are:

(i) the employment of an armed patrol consisting of forest subordinates and boatmen,

(ii) the persistent and repeated killing or cutting back of tree growth on the nest islands of *C. francica*,

(iii) the departmental shooting of falcons and offering of rewards to villagers,

(iv) the enforcement of a close season for two months, say during May and June when the birds will be allowed to make nests and lay their eggs without molestation,

(v) the rotational collection of nests. The Game Warden suggested pre-war, the following programme of open and close coupes:

Year (1)	Open (2)	Close (3)
First ..	Mergui group, Moscos group, and Mali group except Tayoktwin and Nattwin.	Mali group Tayoktwin and Nattwin only.
Second ..	Mergui group, Moscos group, and Mali group—Tayoktwin and Nattwin only.	Mali group except Tayoktwin and Nattwin.
Third ..	Whole of Mali group.	Mergui and Moscos groups.

'Prescriptions

'The following prescriptions are laid down:

(i) An armed patrol of forest subordinates and boatmen will be formed as soon as possible, their principal duties will be to enforce game laws, detect poachers, fell or kill as many trees as possible on nesting islands, and to shoot falcons. They will also assist the monopolist and supervise his work.

(ii) To encourage the shooting of falcons, suitable rewards will be given to villagers.

(iii) As a start a close season of two months—May and June—is prescribed. Studies of the birds' habits will reveal whether the period of this close season is adequate or not.

(iv) The programme of rotational collection requires further knowledge and will be considered after sufficient investigations have been made by gazetted officers.

(v) The right to collect birds' nests will be sold by tender for a period of 3 or 6 years so that the monopolist can:

(*a*) assure himself of a reasonable security of tenure,

(*b*) improve the nesting caves by arranging to fell trees and shooting falcons,

(*c*) do the patrolling in his own interest.'

I may add that the prescriptions of the Working Plan are carried out to the extent funds and security conditions permit.

Nest collection was also done pre-war on a very small scale in the old Bassein Forest Division. To quote from the Working Plan for the period 1929-30 to 1938-39: 'The present lease for edible birds' nests expires on the 30th of June 1931. The revenue from this source has fallen off in recent years and persistent collection appears to be reducing the number of birds. When the present lease expires, the collection of nests should be closed down for five years in order to give the birds a chance of breeding. When a lease is again given out the confinement of nest collection to the period from November to January should be considered.' No fresh lease appeared to have been issued since 1931.

Nos. 25-26, Randeria Building,
Phayre Street,
Rangoon,
July 3, 1958.

T. CHEIN HOE,
Chief Conservator of Forests, Burma.

12. REMARKS ON THE SUBSPECIES OF THE GRASS OWL, *TYTO CAPENSIS*

Recently I was able to study the material of this species in the British Museum (Natural History). This has necessitated some changes in my earlier conclusions (Amadon & Jewett, 1946, *Auk*: 551-558) as to the Asiatic and Australian subspecies. As in the earlier revision I still believe it is best to unite the grass owls of these areas with the African ones to which the older name *capensis* pertains. The African forms are not treated here except to state that they are distinct racially from the others.

Tyto capensis longimembris (Jerdon)

This race is found in suitable areas in India, Burma, and northern Indochina. Those from Indochina, judging from the two or three

specimens examined, are somewhat buffier than is usual, and hence are intermediate toward the following race.

Tyto capensis chinensis Hartert

Synonyms: *T. c. albifrons* Caldwell & Caldwell, and *T. c. mellt* Yen.

This race is found in southeastern China (Fukien, Kwangtung, and Kwangsi). It is the size of *longimembris* but is typically entirely tawny buff ventrally. Occasional examples of *longimembris* and *chinensis* may be rather similar but most specimens are readily separable.

Tyto capensis pithecops (Swinhoe)

In the earlier revision I tentatively placed Formosan birds with *longimembris* of India, despite the intervention of the range of *chinen*sis. The only specimen examined was inseparable. After examining four Formosan skins in the British Museum and one recently collected for the American Museum by Myles Walsh III, I question the locality of the specimen examined earlier and believe that a Formosan race should be recognized. Formosan birds on the average are buffier and more richly coloured than *longimembris* though less uniformly so, as a rule, than *chinensis*. From either of these races, *pithecops* may be told by its larger size and more robust proportions. Measurements of wing in millimetres follow. Presumably the larger birds are females, but too few specimens are sexed to permit segregation.

Formosa: 344, 352, 353, 360, 363 (354.4).

India and Burma: 18 specimens, 318-347 (330.2).

Tyto capensis amaurnota (Cabanis)

The Philippine race, like *pithecops*, is of larger size and with a more robust bill than *longimembris*. It lacks the buffiness of *pithecops*, however, and is exceedingly close to *longimembris* in colour and pattern. Slight average differences in the size and distinctness of the tail bars are set forth in the earlier review.

Tyto capensis papuensis Hartert

This race inhabits the New Guinea grasslands. It is a well-marked form. The back is a clearer darker gray than in any of the other non-African races, and the dorsal markings are narrow white shaft streaks, not spots. The last character it shares with some specimens of *longimembris*. In size *papuensis* approaches or equals *pithecops* and *amauronota*. The wing lengths of four recently collected, well-prepared specimens in London are: ♂, 347, 348; ♀, 356, 357.

Tyto capensis walleri (Diggles)

Synonyms: *T. c. oustaleti* (Hartlaub) of Fiji, and *T. c. georgiae* Mathews, of Victoria, Australia.

Range: Northern and eastern Australia. The racial allocation of birds from Celebes and the near-by island of Kalidupa (one known from each) is in doubt, but they are best assigned to *walleri*.

The species formerly occurred in New Caledonia and on Fiji but has not been found in either area in many years. To be sure, the hot tall grasslands it inhabits are often shunned by collectors.

I have examined one specimen from New Caledonia in New York and another in London and also a specimen from Fiji in London. So far as I can determine from such meagre and, in this case, ancient material it is best to place the New Caledonia and Fiji birds under *walleri*. Even Australian specimens are by no means common in collections. I saw only one in London; the Mathews Collection in New York has four or five.

The race *walleri* is exceedingly similar to *longimembris* of India; in fact, if their ranges were continuous there could be no thought of separating them. It is possible that comparison of really adequate material might reveal further differences. Perhaps the species has spread comparatively recently from India to Australia and may still be recorded from some of the intervening areas, for example Sumatra. The recent astonishing discovery in Africa of another tytonid *Phodilus* shows how much is still to be learned about some of the more elusive owls.

On present appearances *walleri* differs from *longimembris* only by having, on the average, more dorsal and ventral spotting, and perhaps by averaging a little buffier.

American Museum of Natural History,
New York, DEAN AMADON
February 7, 1959.

13. LOCAL MOVEMENTS OF RESIDENT WATERBIRDS

Very little accurate data exist on the local movements of resident Indian birds within the country. We do not know for instance what happens to waterbirds like storks, herons, and egrets during years of scanty rainfall or drought in their nesting areas: whether these birds skip an unfavourable season altogether, or find alternative breeding areas elsewhere, and what distances they travel in the search. Neither do we know on what pattern the dispersal of the young takes place

after a successful nesting season, how widely they disperse, and whether they return to their natal jheels to breed in due course.

In an attempt to answer some of these questions I have for several years past been doing a limited amount of ringing of nestlings, particularly painted storks, openbilled storks, and white ibises, with a few egrets, grey herons, darters, and cormorants. The work so far has been done only in the Keoladeo Ghana Breeding Waterbird Sanctuary of Bharatpur, with the assistance, whenever obtainable, of ornithological friends visiting the Ghana during my annual visits.

While the total number of birds thus ringed perhaps hardly exceeds 500 to 600, four of the recoveries, all of openbilled storks (*Anastomus oscitans*), are of special interest, the last coming from over 500 miles away.

It is hoped to intensify the ringing work in Bharatpur commensurately with the vast opportunities the Keoladeo Sanctuary offers.

No.	Date	Ringed by	Date and Place of recovery	Distance and direction flown
6516	23-9-56	SA, Mr. & Mrs. Peter Jackson, Mrs. U. Ganguli	25-11-'56 Sandila, Hardoi Dist., U.P.	*c.* 180 miles E. of Bharatpur
6204	26-9-57	SA	Jan. '58, Gorakhpur, U.P.	*c.* 350 miles E. of Bharatpur
6508	23-9-56	SA, Mr. & Mrs. Peter Jackson, Mrs. U. Ganguli	*c.* Feb. '58 Deori, U.P.	*ca.* 380 miles E. of Bharatpur
6481	23-9-57	SA	31-1-59 Darbhanga (Bihar)	*c.* 510 miles E. of Bharatpur

It will be noted that in all cases the dispersal has been eastward.

33, Pali Hill,
Bandra,
Bombay 20,
May 29, 1959.

SÁLIM ALI

14. DROWNING OF AQUATIC BIRDS

In the *Journal* for August 1958 (**55**: 353) Mr. Humayun Abdulali and the Editors comment on various instances of the deliberate drowning of aquatic birds (ducks, coots) by raptorial species. This act required in the several instances 'some time,' 'four minutes,' and 'a couple of minutes'. While in each case the victimized bird was seen

to be dead at the end of the attack, it may be questioned whether death was in fact due to drowning. The seizure of a bird in the strong grasp of a predator would have a strangling effect quite apart from immersion, so that respiratory movements might be impossible in any event. In addition it is possible that one or more of the sharp talons would pierce vital organs or vessels, producing shock and haemorrhage.

Aquatic birds, as well as mammals such as seals and whales, are adapted for holding their breath longer than their terrestrial relatives. The physiology of these diving forms has been investigated rather extensively, and it has been found that some of them have anatomical adaptations for storing an excess of oxygenated blood. It would therefore be conceivably more difficult to drown a coot than a sparrow. In shooting birds for museum specimens I have followed the practice of killing wounded birds by compressing their bodies between the axillae ('armpits') with thumb and forefinger; within seconds a sparrow gasps a few times and dies. Finding an oiled Razorbilled Auk on the New Jersey coast many years ago, I attempted to dispatch it the same way. It regarded me with no apparent concern while the muscles of my forearm slowly gave out. (I was obliged to knock its head on a stone.)

It may be as well to leave the question unanswered, for I do not recommend the unsavoury experiment of determining the drowning time of various birds merely to satisfy our curiosity.

P.O. Box 1038,
Johannesburg,
South Africa,
February 16, 1959.

C. BROOKE WORTH

[Allowing that, on account of its special physiological adaptation a healthy diving bird, or one that has not been vitally wounded, may take a longer time to drown than a non-diver, it is possible that under the influence of fright and in the stranglehold of a predator, possibly with some of its vital organs pierced, the time necessary for drowning would be shorter. In any case, the eagle's manoeuvre of holding its quarry submerged, whether intentional or not and whether learnt by experience or not, would, certainly help to hasten the victim's end.—Eds.]

15. A FLYING ACCIDENT TO A SWIFT

Sálim Ali, my husband Loke Wan Tho, and I were looking at a bungalow in Fraser's Hill (a holiday resort in Malaya) at about dusk on 20th November 1958. There were swarms of swiftlets (*Collocalia*) flying about and feeding themselves, and we remarked that they looked very like locusts or falling leaves. Suddenly, at 7.40 p.m. when almost dark, I saw out of the corner of my eye an object falling on to the road about 15 feet from the house. I walked to the spot and found a dead swiftlet which was still warm when I picked it up. The only conclusion I can draw from this extraordinary incident was that the bird had collided with another swift and thus met its death. The sky was quite open except for the swifts flying about, and there were no trees or wires above the spot where the bird had fallen. The skin of the swift (*Collocalia esculenta*) is now with Mr. Sálim Ali in the Bombay Natural History Society's collection.

'Mallaig,'
Gallop Road,
Singapore,
June 15, 1959.

CHRISTINA LOKE

[Collisions among birds in flight are rare, but not unknown. In swifts, which are exceptionally dextrous fliers, the cases must be rarer still. The incident reminds us of a very extraordinary collision, albeit man-made, that took place on a Bombay cricket field a few years ago while a match in progress was at a critical stage for the batting side. The 'hope' of the side was facing the bowling of the opposing 'hope'. The ball left the bowler's hand and the batsman stepped out to swipe. Both players and spectators were however left agape with wonder since the ball never reached the other end! What had happened was that a sparrow flying across the pitch was luckless enough to reach just the wrong spot at just the wrong time and fell dead, the impact diverting the ball off its course. It was an happening that one would have to live a million years to see repeated, yet all that the bewildered batsman could think of at the time was calculated malice on the part of his opponents!—Eds.]

16. A PYTHON'S MEAL

Two days ago a python was killed here. It measured 11 feet. It had swallowed a fully grown male chinkara with 9½ inches horns. It is interesting to note that this was the fourth python killed here which had swallowed a chinkara but never such a full-grown animal.

I am sending this information to find out if you have other similar records. I was told by a local villager that some years ago he had seen a python coiled round a fully grown panther cub.

HINGOLGADH CASTLE,
JASDAN, KATHIAWAD,
September 25, 1958.

RAJA OF JASDAN

[In a previous issue (**51**: 945) the same writer has described a python capturing and coiling itself round a chinkara doe.

In Volume **54** (p. 196) appears a note by U Tun Yin with photograph of a python in Burma that had swallowed a small thamin (*Cervus eldii*) shortly before. But of the many other notes published in the *Journal* on the food of the python perhaps the most remarkable is that by Major Arundel Begbie (**17**: 1021) who cut out of a snake 18 ft. long a well-grown leopard measuring 4 ft. 2 in. from nose to rump. The tail was too decomposed to be accurately measured. The panther had been swallowed head first with its forearms stretched out in front.—EDS.]

17. VOCAL SOUNDS FROM SNAKES

Note 16 in Volume **55** reporting vocal sounds from a python (*P. molurus*) and a dhaman (*Ptyas mucosus*) reminded me at once of an occasion in 1930 in Wad Medani in the Sudan when I seized with a pair of metal forceps a young lined house snake, *Boodon lineatus*. It squeaked once, quite definitely, the noise being suggestive of something between the squeak of a mouse and that of a press-the-button toy animal.

Some years back, I seem to remember correspondence, in *The Field* I believe, about booming or bell-like noises from puff-adders, *Bitis arietans*. In the Sudan, in southern Kordofan and elsewhere there is, or was, folk belief of snakes making noises to lure animals as prey, but few except the simple took this as other than fairy tale.

ADEN PROTECTORATE HEALTH SERVICE
HEADQUARTERS,
KHORMAKSAR, ADEN,
March 13, 1959.

N. L. CORKILL

18. A NOTE ON *HYDRACHNA* SP. PARASITIC ON *RANATRA FILIFORMIS* AND *RANATRA ELONGATA*

It is well known that the larvae of *Hydrachna* prefer insect hosts for parasitisation. In course of examination of the nymphs and adults of different species of *Laccotrephes*, *Ranatra*, and *Spherodema*, it was observed that only the nymphs and adults of *Ranatra* were parasitised by the larvae of *Hydrachna* sp. A number of these mites have been reported as parasites on *Nepa* from Britain and the preference exhibited for *Ranatra* sp. is indeed striking.

About 6 to 18 red, oval masses were found attached to the various regions of the body of the nymphs and adults. The regions most commonly infested by these parasites were the base of the thorax and abdomen, the former being more heavily parasitised. The larvae, soon after attaching to the host, changed into oval masses. In the course of two to three weeks the adult mites dropped off to the bottom of the pond and led a free life.

Table showing No. of parasites and their place of attachment on individual hosts

Place of attachment	No. of immature *R. filiformis*	Stages on *R. elongata*
head ..	2, 1, 3	4, 2, 2, 2, 2
thorax ..	2, 2, 3, 3, 3, 1	14, 6, 2, 4, 4, 5, 2
legs ..	5, 4, 1	4, 6, 3, 4
abdomen ..	1, 1	4, 1, 2

DEPT. OF ZOOLOGY,
LOYOLA COLLEGE,
MADRAS 31,
October 15, 1958.

T. K. RAGHUNATHA RAO

19. ON THE OCCURRENCE OF *NEBALIA LONGICORNIS* IN INDIAN WATERS

(*With a plate*)

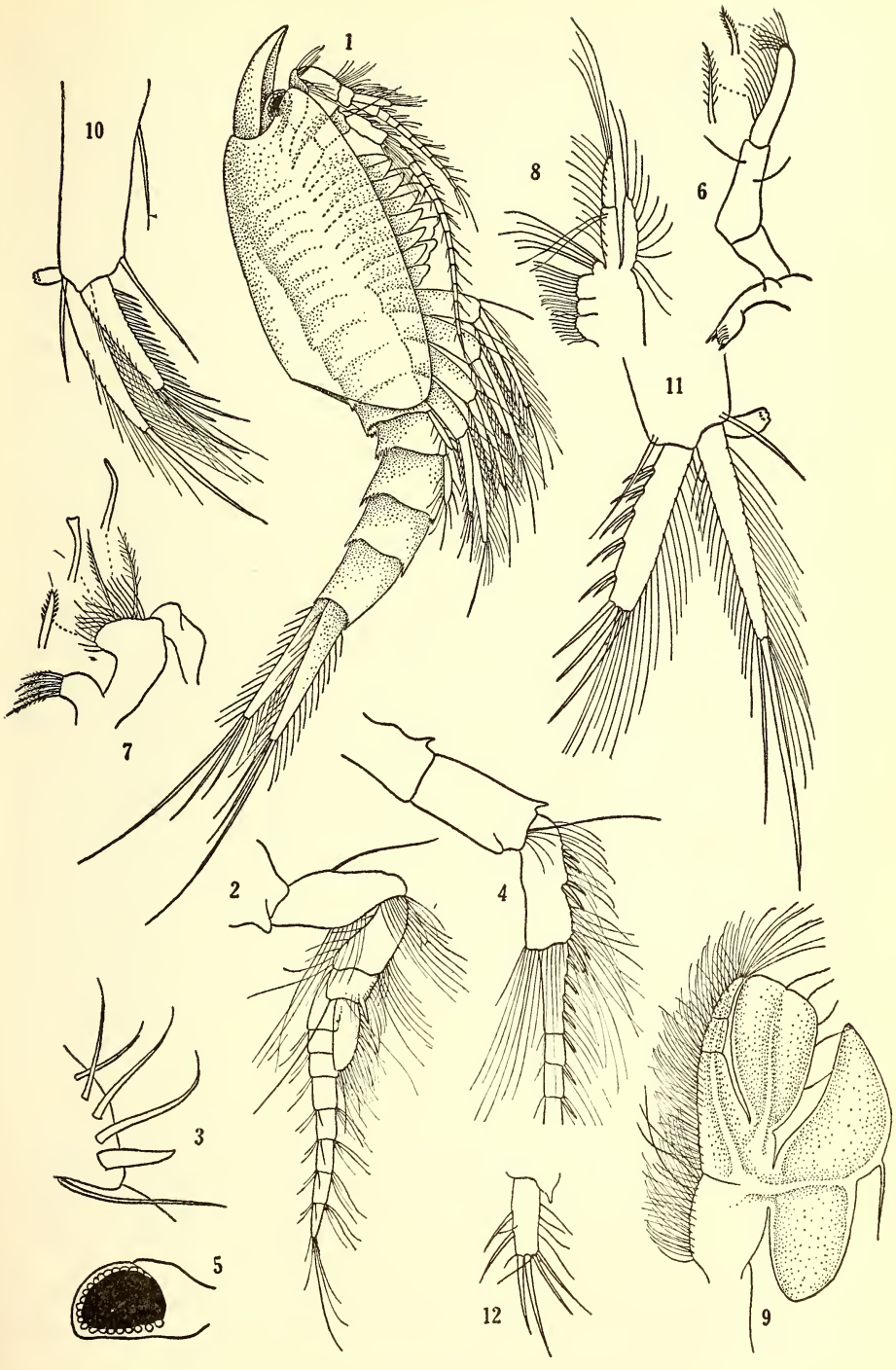
From the Indian waters the only record of a Phyllocarid is that of Prof. W. M. Tattersall (1906) who recorded *Nebalia bipes* from Ceylon. The present collection, I am informed, was very rich and consisted of a huge swarm of hundreds of specimens found in shallow water at Krusadai Islands. The locality was of a swampy nature with clayey bottom and mangrove-like growth of green algae. The pre-

sence of the animal was noticed due to the slight 'boiling' of the water surface.

Species of *Nebalia* have been recorded from all over the world. Thiele (1904) assigned all the species recorded from the northern Seas to *N. bipes* and those from the southern Seas to *N. longicornis*. Based on the character of the rostrum, eyes, and the antennular peduncle, he recognised several subspecies. According to Calman (1917) and Cannon (1931) some of the characters on which the subspecies were created are unimportant and variable, and a detailed study of the various species is necessary for establishing their validity. In view of the dearth of information on the genus, a detailed description of the present specimens is included. I am deeply indebted to Shri Sivaprasad of S.N. College, Quilon, for the two specimens, and to Dr. C. C. John of the University of Kerala for help in their study.

Nebalia longicornis G. M. Thomson

Carapace about twice as long as broad, anteroinferior parts produced forwards. Rostrum rather broad, about a third of the length of the carapace, 0.8 mm. long and 0.3 mm. broad. Posterior border of abdominal segments serrated on the dorsal and ventral sides. Caudal rami flattened, as long as the last two abdominal segments combined, with an outer row of spines and inner row of long setae; distal border with three long spiny setae, one of them longer than the ramus. Cornea of the eye occupying slightly more than half the length, sensory tubercle not discernible. Antennule with four segmented peduncle, first segment stout, with a lower distal process, second segment large, with a long dorsal seta, fourth segment short, with one stout spine and row of five to six stout setae. Mobile scale with its upper border thickly setose, flagellum stout, eight segmented; distal segments with a pair of olfactory setae. Antennal peduncle four segmented, segments one and two with an upper distal spine, segments three and four coalesced, with three pairs of stout spines and a distal row of long setae; flagellum nine segmented, first segment a composite one, each segment with an upper distal spine. Mandible slender, incisor much reduced, molar strongly toothed, palp three segmented, third segment with an inner row of long pectinate setae and a short apical row of barbed spines. Maxillule with two endites, first small, with a row of pectinate setae, second endite with various types of setae as shown in the figure; palp long and indistinctly segmented, with long setae. Maxilla with four endites, fourth very small and with long setae, endopod two segmented, with a row



Nebalia longicornis G. M. Thomson.

1. Entire animal; 2. antennule; 3. same, fourth segment enlarged; 4. antenna; 5. eye; 6. mandible; 7. maxillule; 8. maxilla; 9. first thoracic limb; 10. first pleopod; 11. second pleopod; 12. fifth pleopod.

of setae, basal segment with two and distal segment with four long setae; exopod two-thirds as long as endopod, with long setae, epipod absent. Thoracic limbs with coxa and basis indistinctly separated, latter continued as the endopodite; endopodite indistinctly segmented; exopodite lamellar, distal border obliquely subtruncate and prominently bilobed, with five setae; epipod bilobed, proximal lobe rounded behind, distal lobe apically acuminate and with a stout proximal seta. First four pleopods subsimilar, protopodite with an inner and an outer distal seta, exopod of first pleopod with an outer row of spines and inner row of setae, distal border with four stout spines; endopod with setae on outer and inner borders, apex with a long spine. Appendix interna apically trilobed and with three subapical teeth. Exopod of pleopods two to four with five pairs of stout spines instead of a row as in the first. Pleopods five and six uniramous and very short, with two apical and two outer spines and several setae. Length 4.9 mm. excluding the caudal furca.

The present specimens closely resemble *N. bipes* as described by Claus (1889) but the nature of the fourth segment of the antennular peduncle is exactly like that of *N. longicornis megallanica* Thiele (1904). The fourth segment of the antennular peduncle has a strong spine and five to six stout setae, but the sensory tubercle on the ocular peduncle is insignificant or even absent. According to Calman (1917) and Cannon (1931), of the several characters on which Thiele created the subspecies, that of the antennular peduncle alone is reliable and hence the present specimens could be assigned only to *N. longicornis megallanica* Thiele. The ratio of the length to breadth of the rostrum in the present specimens is 2.67 : 1 which is almost the same as given for *N. bipes* by Tattersall (1906) and for *N. longicornis* by Calman (1917) and Cannon (1931). Evidently the character of the rostrum is very variable.

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Marine Biological Laboratory,
Trivandrum,
March 17, 1959.

N. KRISHNA PILLAI

20. ON SOME LONGICORN BEETLES OF DHARWAR (MYSORE)

Except for stray records of a few species of this region made by Beeson and Bhatia (1939) in their account 'On the biology of Cerambycids', there is no complete list of species of this economically important group. Hence a detailed survey of the Cerambycids was undertaken during 1953-55, mostly in Dharwar and neighbouring centres like Kyarkop, Mugad, and Navalur.

I am grateful to Dr. M. Puttarudriah, Government Entomologist, Mysore State, for his unfailing interest and also for going through the manuscript and offering helpful suggestions and criticism.

Family CERAMBYCIDAE

Subfamily CERAMBYCINAE

Cantharocnemis downesi Pasc.

Collected near a tamarind tree. It is also known from North Kanara Division. Rare.

Diorthus cinereus Fab.

Collected under light soon after rains in the summer season. Beeson and Bhatia (1939) have also recorded it from Dharwar.

Hypoeschrus indicus Gahan

Beetle obtained on *Acacia arabica*. Gahan (1906) has recorded it from Belgaum. Rare.

Neocerambyx paris Wied.

Noticed on a decorative pine tree in a garden in September. It is also reported from Bangalore, Coimbatore (Fletcher, 1914), and Mysore. Common.

Pachydissus parvicollis Gahan

Collected in the winter season. Rare.

Pachyloceros corallinus Hope

Beetle collected during rainy season. Gahan (1906) has reported it from Bombay, Nilgiri Hills, and south India.

Stromatium barbatum Fab.

Obtained from an old teak log in August. Heavy damage is reported to have been caused by this beetle to the teak forests in the district of Dharwar.

Usman and Puttarudriah (1955) report the beetle as 'Common on forest timber and furniture throughout Mysore State'.

Xylotrecheus semi Lap. et Gory

Beetles collected from *Salmalia malabarica* round about Dharwar in March.

Beeson and Bhatia (1939) have also recorded it from Kirwatti. Dandeli, Nagargali, and Belgaum division. Gahan (1906) records it from Bhutan, Calcutta, and Deccan.

Xystocera globosa Oliv.

Encountered in the guava orchards around Dharwar. Fairly common between May to September. It is recorded also from Dandeli, Nagargali, and Belgaum regions. Usman and Puttarudriah (1955) have reported it from Mysore.

Zonopterus consanguineus Ritsema.

The only beetle was found on *Pongamia glabra* in late October.

Subfamily LAMIINAE

Apomecyna pertigera Thoms.

Beetles fairly common on cucurbits from June to September; and failure of cucurbit crop by these species was observed in the Dharwar region. Fletcher (1914) records it from Coimbatore.

A. saltator Fab.

Was also obtained on cucurbits. Rare.

Batocera rubus Linn.

Common on *Mangifera indica* at and around Dharwar from April to September.

Celosterna spinator Fab.

Beetle collected in a garden in October. Rare.

Beeson and Bhatia (1939) and Usman and Puttarudriah (1955) have recorded it from Bangalore.

Coptops aedificator Fab.

Collected on *Acacia arabica* in May; seems rare in the Dharwar area.

Beeson and Bhatia (1939) have also reported from Kirwatti, Nagargali, and Belgaum Division.

Dihammus spp.

Collected under light in September. Rare.

Machrochenus tessellatus Guer.

Collected during the rainy season.

Monochamus nivosus White

Beetle common in the Dharwar area during April to October; the larva tunnels into the stem of *Calotropis gigantea.*

Olenocamptus bilobus Fab.

Found on *Ficus glomeratus.*

Beeson and Bhatia (1939) have recorded from east Kanara and Belgaum Division.

Pharsalia proxima Gahan

Beetle observed on *Mangifera indica* in November. Rare.

Tetraglenes spp.

Collected on a climber. Rare.

Subfamily PRIONINAE

Acanthophorus rugiceps Gahan

Obtained on *Mangifera indica* and *Melia azadirachta* in early June. Gahan (1906) reports it from Bombay.

A. serraticornis Oliv.

Collected on *Mangifera indica* and *Salmalia malabarica* in August. Recently it was collected on coconut palm in the South Kanara District. Patel (1951) reports that the beetles caused damage to unarmoured lead-coated telephone cables and this appears to be incidental. Fairly common in rainy season.

Dorysthenes rostratus Fab.

Collected from shrubs in October. Rare.

Macrotoma crenata Fab.

Collected on *Salmalia malabarica.* Rare.

M. plagiata Waterh.

Collected in rainy season.

M. spinosa Fab.

Collected often in casuarina plantations between June and August.

Usman and Puttarudriah (1955) have recorded this species from Bangalore.

Prionomma atratum Gmelin.

This common species was obtained on *Ficus glomeratus.* It usually comes to light from June to September. Beeson and Bhatia (1939) have recorded from Belgaum, Nagargali, Kirwatti, and east Kanara.

CENTRAL MARINE FISHERIES RESEARCH UNIT,
MANGALORE, M. H. DHULKHED
March 5, 1959.

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21. A NEW BUTTERFLY FROM ASSAM

(*With a text-figure*)

Isma bonota sp. nov.

Three females and one male of the species we are about to describe have been collected by Norman in the thick forest bordering the Naga foothills in Sibsagar District of upper Assam. These were caught respectively on 29-vii-'54, 17-x-'54, 15-vii-'56 (♂), and 29-iii-'58. The first two females were shown in 1955 to the late Brig. W. H. Evans who expressed the opinion that they would turn out to be an undescribed species of *Isma*. The subsequent collection of a male and another female has confirmed this opinion. Specimens from the type series have been lodged in the British Museum (Natural History) and further specimens have been set aside for the Zoological Survey of India.

Description

Antennae long, lower part of club whitened. Apiculus moderately hooked. Palpi third segment short, protruding.

♂ *Upperside*: Fore wing. Ground colour dark brown. An oval brand over the basal third or vein 1, raised and covered with scales and hard to see. Two spots in cell, the lower one larger and much elongated. Two small subapical spots. A tiny spot in space 4; a larger oblong spot in space 3, interior to the spot in 4; a very large spot in space 2, quadrate but with the inner side wedge shaped at the bottom, the tip of the wedge extending to the inner edge of the cell spots; a quadrate spot in space 1, its outer edge in line with the inner edge of the spot in 2. All the spots are white. The fore wing is indistinguishable from that of *I. bononia bononia* Hewitson.

Hind wing. Discal spots in spaces 2-6; those in spaces 2 and 3 much elongated, that in 4 a right angled oblong, the spot in 5 small and in 6 minute.

Underside: Ground colour brown with ochreous scaling. No tuft

underfore. All the spots show through from above as they are hyaline.

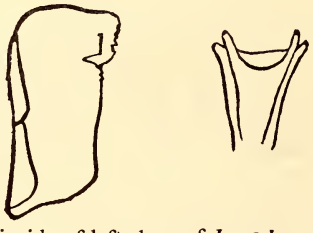
♀ *Upperside*: Fore wing. Similar to the male except that there is no brand, and the large spot in space 2 is oblong with a concave inner edge. (In one specimen the outer edge is also concave.)

Hind wing. Spots only in spaces 2-5, i.e. 4 spots instead of the 5 in the male. (In one specimen the spot in space 4 is vestigial.)

Length of fore wing from base to apex 15 mm., but 18 mm. in one large female.

Cilia hindwing, grey to pale yellow.

Genitalia: Uncus and the inside of the left clasp as figured below.



Uncus and inside of left clasp of *Isma bonota* sp. nov.

From the key in Evans's 'Catalogue of the Hesperiidae of Europe, Asia and Australia' (1949) and from inspection of the specimens in the British Museum it is found that the only species of *Isma* with these general characters is *bononia bononia* Hewitson from S. Burma, Malaya, etc., but *bononia* has only three discal spots upperhind in the male and two in the female. The clasp and uncus of the specimen we are describing also differ from those of *bononia.*

It is a pleasure to acknowledge our gratitude to the authorities of the British Museum (Natural History) who have allowed us to examine the specimens in their care.

SELENG T.E.,
SELENG HAT P.O.,
UPPER ASSAM,
March 15, 1959.

KEITH CANTLIE
T. NORMAN

22. BUTTERFLIES OF BOMBAY AND SALSETTE—FURTHER ADDITIONS

Mr. Basil W. Wirth of 21 Colaba Chambers, Bombay 5, sends us a list of butterflies obtained by him in Bombay and Salsette of which we find the following not recorded by A. E. G. Best in his recent notes (*JBNHS* **50**: 331-9 and **53**: 282-4):

NYMPHALIDAE

Neptis jumbah Moore: The Chestnut-streaked Sailer.

Taken at Tulsi Lake on 5 June 1958. Rare.

Neptis nandina Moore: The Clear Sailer.

Taken at Colaba in 1956. Rare.

LYCAENIDAE

Amblypodia centaurus (Fabricius): The Centaur Oakblue.

Quite common at Tulsi Lake. These butterflies seem to have a favourite tree around which they fly very rapidly, suddenly settling. When disturbed they dart off, returning in about ten minutes to settle again.

Tajuria cippus (Fabricius): The Peacock Royal.

Rare. One specimen taken at Elephanta in 1956.

Rapala melampus (Cramer): The Indian Red Flash.

Fairly common seasonally (November). Rare at other times.

PIERIDAE

Appias wardi (Moore): The Lesser Albatross.

A very rare butterfly in Bombay. One taken in Colaba in March 1956 and since then another not seen either in the city or suburbs. However, seen on the Ghats.

HESPERIIDAE

Matapa aria (Moore): The Common Redeye.

One caught 19-9-1958 at Colaba. Another seen 21-9-1958.

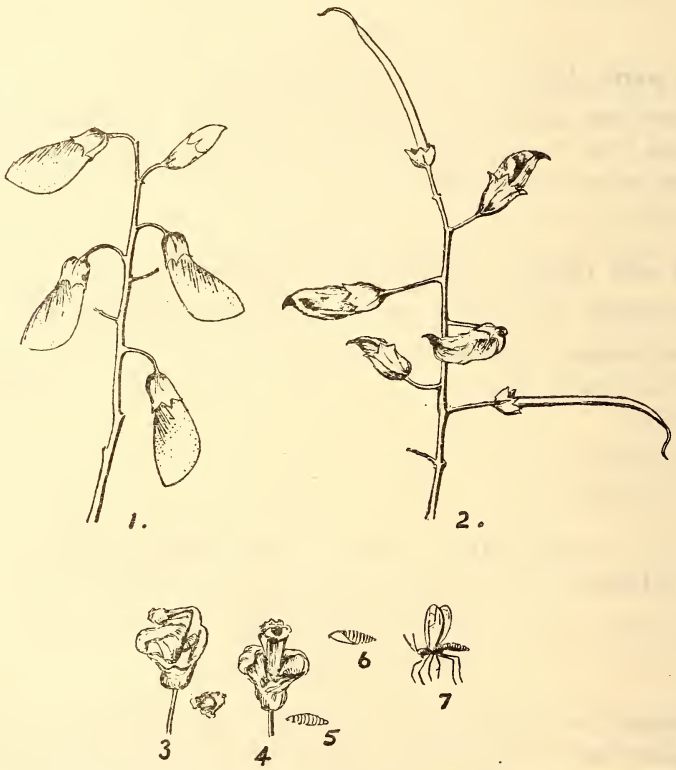
BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, EDITORS
BOMBAY 6,
June 1, 1959.

23. *ASPHONDYLIA* SP. A NEW RECORD OF A CECIDOMYID ON *SESBANIA SPECIOSA* FLOWERS IN MADRAS STATE

(*With a text-figure*)

Sesbania speciosa is a very important and popular green manure crop grown very extensively throughout the State for manuring paddy crop. This crop which was once considered to be free from insect pests is of late subjected to some important insect pests which do

substantial damage at some growth phase of the crop and they are *Hyposidra successaria* Wlk., *Empoasca* sp., and *Azygophleps scalaris*. The author during the course of his investigations on this crop noted for the first time the occurrence of a gall fly *Asphondylia* sp. causing great havoc to normal flower formation and which ultimately resulted in the lower output of seeds. The newly hatched orange coloured maggot of this fly makes a tunnel inside the flower bud as a result of which a gall-like swelling accompanied by twisting of the terminal portions of the petal occurs. The full-grown maggot is creamy white in colour and measures about 3 mm. in length with inconspicuous semicircular head region (fig. 5). The maggot pupates inside a flimsy whitish silken cocoon inside the terminal twisted portion of the petals. The pupa is oval and light brown in colour and measures 2 mm. in length (fig. 6). The adult fly is very active and emerges by means of a semicircular hole in the pupal case. The abdomen and thorax are orange coloured with dirty greyish wings (fig. 7). As the damage to flower buds is sometimes very heavy it has



(1) Normal flowers, (2) Flowers affected by the gall fly, (3) Flower showing the location of fly maggot, (4) Flower showing the position of pupa, (5) Fly maggot, (6) Fly pupa, (7) Adult fly.

to be reckoned as a major pest, and timely remedial measures have to be undertaken by using insecticides like DDT or BHC. Further studies are in progress on this pest.

The author is deeply indebted to the Government Entomologist for affording all facilities during the course of this preliminary investigation.

ENTOMOLOGY SECTION,
AGRICULTURAL COLLEGE, S. VENUGOPAL, M.SC.
COIMBATORE,
April 13, 1959.

24. SOME PRELIMINARY NOTES ON THE INSECT LIFE IN SAMBHAR LAKE

The Sambhar Lake, the largest inland water lake in India and situated somewhat east of the Aravalli Range (20° 58′ N. and 75° 55′ E.), is about 35 kilometres long, 10 kilometres wide. It has an average depth of 0.61 metres during the rains. At the height of the rainy season, the lake covers an area of nearly 2300 square kilometres. It drains an extensive area, totalling nearly 56,300 square kilometres, and is fed by four main streams, viz. Rupnagar, Kharian, Menda, and Khandel. The bottom mud is soft, black, and has a pronounced odour of hydrogen sulphide gas. The water contains in solution chloride, sulphate, carbonate, and bicarbonate of sodium and only traces of calcium carbonate in colloidal form in suspended mud. It differs from sea water in lacking magnesium sulphate, potassium chloride, and magnesium chloride. There is considerable fluctuation in the salinity of water during the year; the salinity may vary within wide limits, from 0.93% to over 16.0% (*vide* Table I below).

TABLE I

Showing the minimum and maximum concentration of various compounds of salt water of the Sambhar Lake, Gudha

	pH	Halogen content %	Salinity %	CO_2 as H_2CO_3 mg/L	O_2 mg/L	Na_2SO_4 %	NO_3, CO^2 %	NaCl %	SO_4 %
Minimum ..	7.4	0.52	0.93	34.9	13.8	2.41	0.66	0.89	0.6
Maximum ..	9.5	7.10	16.40	135.4	45.0	6.6	3.94	14.6	9.1

I have been studying the insect life of the lake for the past several years and have made large collections and observations on their habits

and ecology. The insect life of the lake falls under two broad categories, viz. the true lake forms and the shore inhabitants. Among the true lake species we have the aquatic Heteroptera like *Cydnus ater*

TABLE II

Seasonal distribution of various insects with reference to salinity in different months

Name of species	Salinity				
	July-Aug. 0.0-0.96%	Sept.-Oct. 2.81-4.61%	Nov.-Dec. 7.2-8.6%	Jan.-Feb. 9.9-10.4%	March-Ap. 11.1-16.4%.
OLIGOHALINE SPECIES					
Cybister tripunctatus asiaticus ..	———	——			
Eretes stiticus ..	———	———			
Hyphoporus severini ..	———	———	—		
Cydnus ater ..	———	———	———		
Cydnus pilosus ..	———	—— ———	———		
Sphaerodema rusticum ..	———	———			
Hydrometra greeni ..	———	——			
Sigara jeistanensis ..	———	———	—		
Sigara substriata ..	———	———	———		
Enithares indica ..	———	— — — —	—		
Anisops sardea ..	———	— — —			
Micronecta proba ..	—— ———	—— — —	— —		
EURYHALINE SPECIES					
Berosus indicus ..	——	— — — —	——— —	———	——
Ephydra macellaria ..		— — —	——— —	—— ——	— ——
Eristalis sp. ..		——	——— —	———	——
Chironomus indent ..		——	— — —	———	— —
Polypodium sp. ..		— ——	——— —	—— —	——

Dist., *Cydnus pilosus* H.S., *Sphaerodema rusticum* Fabr., *Hydrometra greeni* Kirk., *Enithers indica* Fabr., *Sigara jeistanensis* Dist., *Sigara substriata* Dist., *Anisops sardea* H.S., and *Micronecta proba* Dist.

These species are oligohaline and thus occur in the lake only during the rains, viz. from July to November. Of the four species of Coleoptera so far collected by me, *Cybister tripunctatus asiaticus* Reg., *Eretes stiticus* Linn., and *Hyphoporus severini* Reg. are also oligohaline and occur only up to October. *Eretes stiticus* is a widely distributed species, known from Africa, tropical and subtropical Asia, Australia, and the Pacific coast of America. The beetle *Berosus* (*Enophlurus*) *indicus* is euryhaline and is known from the Indo-Australian and Ethiopian regions. The Diptera include the euryhaline *Ephydra macellaria* Eggers, *Eristalis* sp., *Chironomus* sp., and *Polypodium* sp.

In addition to these true aquatic forms found in the lake proper, we also find a large number of shore insects, which move seasonally from the shore into the nearly dry lake bed. As the water of the lake evaporates during summer, these species move with the receding edge of the water to the centre of the lake, and with the onset of the rains and the filling up of the lake again move back to the periphery. They are all hygrophile forms and include *Opatroides punctulatus* Bould., *Coniocleonus* sp., *Pycnodactylus* sp., *Cicindela catena* Fabr., *Menochilus 6-maculatus* Fabr., *Isoloxantha fuscipennis* Blair, *Graptostethus dixoni* Dist., *Ectomocoris cordiger* Stal., *Labidura riparia* P., *Gryllotalpa africana* Bean., and *Chrotogonus trachepterus* Blach.

The oligohaline species, being unable to tolerate high salinity, naturally occur in the lake only during the rains, when the salinity is relatively low. After October, with the cessation of the rains, the salinity increases with the evaporation of water, and most of the oligohaline forms disappear as adults and larvae from the water. There is then a succession of the euryhaline forms. The occurrence of different insects at salinities ranging from 0.96% to 16.4% in the lake shows that insects are capable of inhabiting highly saline waters. Mere salinity does not seem to be an insurmountable barrier to their distribution.

The work is still in progress. The author thanks the authorities of the British Museum for identification of material. He is also indebted to Prof. Dr. D. K. Mathur and Prof. Dr. D. V. Bal for useful suggestions.

INDER CHAND BAID

RAJ RISHI COLLEGE,
ALWAR,
September 29, 1958.

25. ROSE VARIANT OF *POLYGALA ERIOPTERA*

I was interested in reading the note 'A Red or Rose variant of *Polygala erioptera* DC.' by Phatak and Oza recently published in the *Journal* [**55** (3): 593—December 1958]. The authors claim that the rose-coloured flowers of *Polygala erioptera* are recorded by them for the first time. I would refer the reader to 'Flora of the Indian Desert' [*JBNHS* **26** (1): 223—1918] where Blatter and Hallberg write as follows:

'*Polygala*—223 *P. erioptera* DC.

Note.—Cooke (F.B.P. Part I, 60) says flowers of this species are yellow. Our species have pale rose-coloured flowers with the tip of the keel petals and the crest darker. There is little doubt that our specimens belong to the same species as Cooke's and we have consequently placed them under *P. erioptera*, though provisionally.'

This shows that Blatter had seen this variant as early as 1918 and it is but fair that this fact should be brought to the notice of readers.

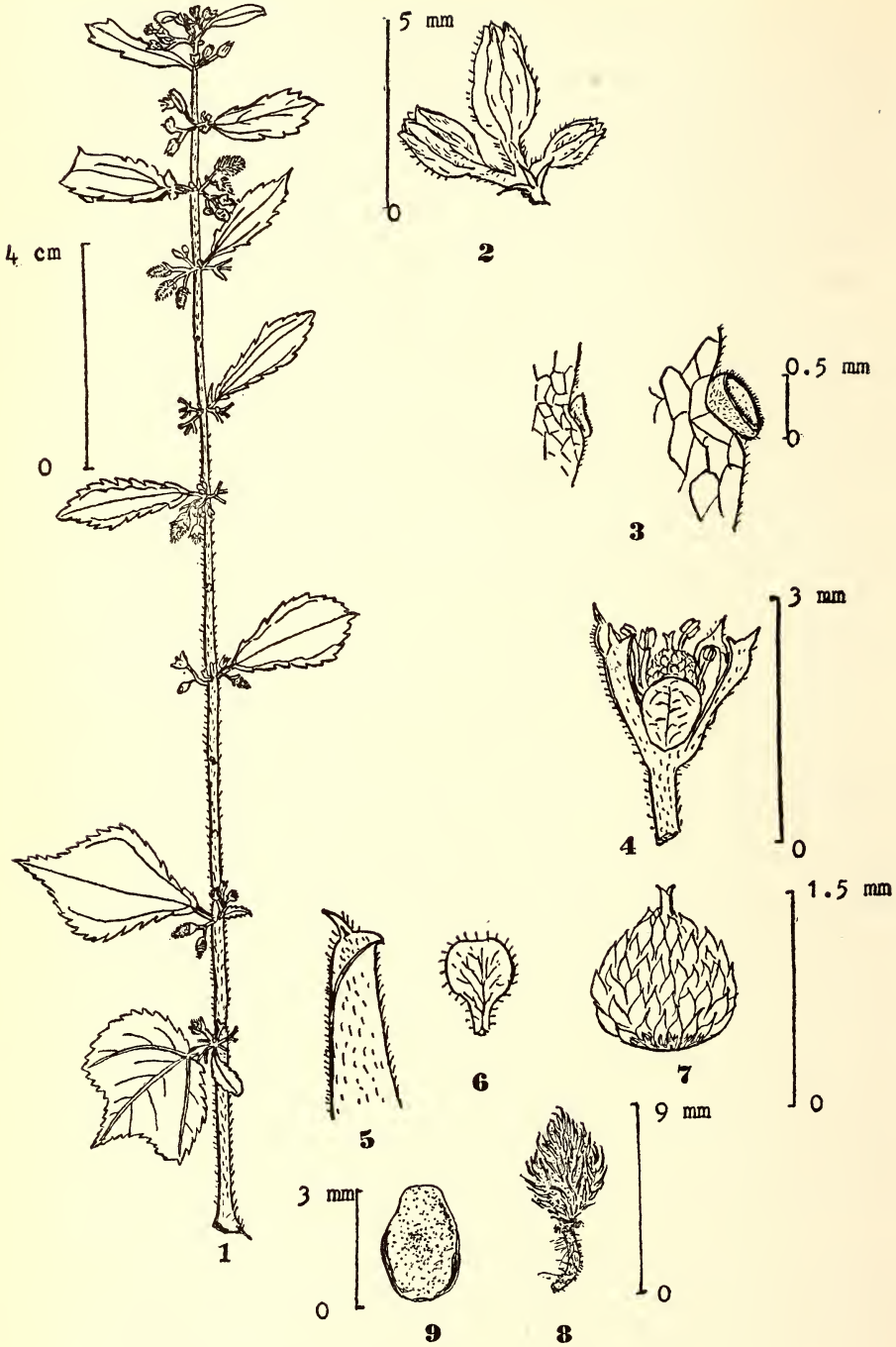
P.M.B. Gujarat College,
Indore, R. M. PATEL
March 6, 1959.

26. *SALMALIA MALABARICA* AND *S. INSIGNIS* IN BOMBAY

These two trees are common in Bombay State; the first is typical of the Konkan plains, and of Bombay streets and gardens; the second is typical of the Western Ghats. When the trees are in leaf, it is practically impossible to tell one from the other, except perhaps on account of their geographical distribution; but, when in flower, the trees can be very easily distinguished.

In general the flowers of *Salmalia malabarica* are smaller than those of the other species, and they come out towards the end of February and March; the number of stamens is about 60-75 in number. *Salmalia insignis* comes into full bloom towards the end of December and January, the stamens being 400-500; both flowers and fruits are much larger than in the Konkan species.

On the 14th of February this year I noted several trees of both species on the slopes of the Ghats, about half way between Khandala and Khopoli, the meeting place of the two species; both trees were completely leafless and had an occasional flower, but with this striking difference: *Salmalia insignis* was mostly in fruit, with but an



Triumfetta pentandra A. Rich.

(1) Twig with leaves and flowers, (2) Part of Inflorescence, (3) Cup-shaped gland, (4) Flower, (5) Sepal, (6) Petal, (7) Ovary, style, and stigma, (8) Fruit, (9) Seed.

occasional flower that obviously had been lagging behind the rest of the flowers on the tree; *Salmalia malabarica* was mostly in bud, the buds being generally small and far from ready to open, with an occasional flower that had clearly raced and outstripped the others in opening out. When the two trees grow side by side, this difference is very remarkable.

Incidentally both trees are now leafless, but from far away may seem to be clothed with plenty of leaves: both are much affected by the parasite, *Dendrophthoe falcata* Etting. (*Loranthus longiflorus* Desr. of Cooke's FLORA), and in many instances the leaves of the parasite are massed on the host, in large pendulous clumps.

ST. XAVIER'S COLLEGE,
BOMBAY, H. SANTAPAU, S.J., F.N.I.
February 15, 1959.

27. THE OCCURRENCE OF *TRIUMFETTA PENTANDRA* A. RICH. IN BOMBAY STATE

(*With a plate*)

A suberect herb much branched from the base; stem cylindrical, woody, covered with dense, stellate and bulbous-based simple hairs. Leaves simple, alternate, stipulate, palmately nerved, aromatic. Lower leaves large; petiole 4-5.5 cm. long, angular, covered with stellate hairs; lamina ovate, rhomboid or somewhat round, 4-6 by 4-6 cm., usually 3-lobed, serrate, stellately hairy on both surfaces, densely so beneath; cup-shaped glands produced by few basal teeth of the lamina. Upper leaves become more narrow, short lanceolate; the younger leaves subsessile, narrow.

Flowers small, in extra-axillary umbellate clusters; pedicels 2-3 mm. long, covered with dense stellate hairs. Sepals 5 free, 1.5-1.7 mm. long, linear, cucullate with conical tip, hairy outside. Petals 5, free, 0.75-0.85 mm. long alternating with the petals. Stamens 5, free, slightly longer than the petals; anthers basifixed, quadrilocular. Ovary superior, covered with smooth hairs, 2-celled; one ovule in each cell; style very short; stigma bifid. Fruit oblong, ellipsoid, 3 mm. long, covered with hooked or straight spines; usually one seed is developed at maturity. Seed smooth, pale brown.

The plant is not mentioned in Cooke's FLORA. From the key given for the genus *Triumfetta* in Cooke's FLORA, the above-mentioned species shows some affinity towards *T. bartramia* Linn. (*T. rhomboidea* Jacq.). However, it differs in the following points: (1)

Inflorescence extra-axillary umbellate clusters, (2) Stamens number only 5, (3) Fruit one or rarely two-seeded, (4) Leaves strongly aromatic like camphor.

I was shown this plant for the first time by Prof. P. B. Vaidya, Ahmednagar College. The plant grows quite well in waste places along the Mutha Left Bank Canal in Fergusson College campus. It is very difficult to locate the plant as from a distance it shows much resemblance with *Malvastrum tricuspidatum* Gray, and stunted *Hyptis suaveolens* Poit. The author has tried to locate the species in similar habitat in Poona Corporation campus and near about but failed to procure even a single specimen as yet.

The author is thankful to Dr. S. K. Mukerji for confirming the species.

Flowers: September to November. Fruits: October to December.

Locality: Poona: Fergusson College campus along Mutha Left Bank Canal, *Vartak* 14241-43.

General Distribution: Northwestern India; Bihar; east Coast in Guntur; Tinnevelly; Abyssinia; Senegal.

MAHARASTRA ASSOCIATION FOR THE
CULTIVATION OF SCIENCE,
LAW COLLEGE BUILDINGS,
POONA-4,
December 22, 1958.

V. D. VARTAK

[*T. pentandra* A. Rich. has already been mentioned by Blatter among the plants of Bombay; this is, therefore, not a new record; the Editors, however, welcome the detailed description of the plant, which is not listed in Cooke's FLORA OF THE PRESIDENCY OF BOMBAY. See Blatter's Revision in the *Journal* **34**: 890, 1931.]

28. A REMARKABLE CASE OF TWINING OF A BRANCH IN *PINUS CANARIENSIS* C. SMITH

(*With a photo*)

Pinus canariensis C. Smith, popularly known as the Canary Islands Pine, is native of the Canary Islands situated at about latitude 29° N. and longitude 15° W. In its native home it grows on dry and exposed slopes at altitudes ranging between 3700-6600 ft. (1).

This pine was imported from the Canary Islands and planted both in Sim's Park, Coonoor, and in the Government Botanic Gardens, Ootacamund, about the year 1919. During the forty years these trees

have been growing in their adopted home, they have become fully adapted to the ecological conditions of the Nilgiri Hills. For example, the physiognomy of these trees has not undergone any change.

Their crown is loose irregular with excurrent columnar trunk. Branches are sparse and irregular; and branchlets are ascending, clothed with abundant spur-shoots each with three needles, yellow when young.

In one of the two trees growing on a slope in the Government Botanic Gardens, Ootacamund, it has been observed that a branch arising from the foot of the main columnar stem has twined round the main shaft of the stem like a liane (see photograph).

The direction of the twining is counter-clockwise, characteristic of the Northern Hemisphere (2). Such a character or indeed any kind of twining is unknown amongst the conifers. Therefore, this observation is of special interest. The liana-like twining branch is normal in all respects.

Department of Botany,
Annamalai University,
Annamalainagar,
March 25, 1959.

T. C. N. SINGH

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29. OCCURRENCE OF *CURCUMA INODORA* BLATT. AT PAVAGADH (GUJARAT)

Curcuma is one of the most difficult of our Indian plant genera. Plants of this genus are found all over India. In course of time we shall have to revise the genus *Curcuma* for the general flora of India. In view of this, and in response to Rev. Father H. Santapau's appeal (*JBNHS*, 1957) for more information, these observations on *C. inodora*, a new species described by Blatter in 1930, may be of interest. For a full description of the plant see Santapau, H. (1952): 'On a common species of *Curcuma* of Bombay and Salsette Islands' *JBNHS* **51**: 135-139.

This is a monsoon herb about 50 cm. high, sprouting up in Pavagadh after the first few rains some time about July and August. Usually the leaves and spikes come out at the same time, or leaves come out before the flowering. The position of the spike in relation to the leaves is at first lateral. Later on in the season this lateral spike decays and gives way to a central one. The size of the spike is 8-10 cm. long and 5-7 cm. in diameter with a peduncle 4-6 cm. long; colour of the flowers: corolla purplish with a yellow streak on the lip, bracts green with a purplish to rosy tinge. The underground system is composed of long fibrous roots spreading up to 18-20 cm. from the rhizome, tubers 3×2 cm., elliptic or globose at the end of the root fibres, the inside of the tubers is white. A few decayed tubers have also been noted at the end of these roots.

During the last two years, these plants have been observed and collected at the beginning, middle, and end of the monsoon from about the same spot on Pavagadh Hill, 29 miles NE. of Baroda. The plants are noted in rocky places near Machi at about 461 metres (1500 ft.), a small plateau surrounded by dense forest. The identification of the plant has been checked and confirmed in Blatter Herbarium. This species seems to be recorded from here for the first time.

We wish to record our gratitude to Rev. Father H. Santapau, S.J.,

St. Xavier's College, Bombay, for helping with the identification of the plant and going through the MS. of this note.

Department of Botany,
M.S. University of Baroda,
Baroda,
January 13, 1959.

V. G. PHATAK, D.Sc.
G. M. OZA, M.Sc.

30. NEW RECORD OF *MARISCUS PANICEUS* VAHL AND *CYPERUS LEUCOCEPHALUS* RETZ. FROM GUJARAT

Mariscus paniceus Vahl is a slender, stolon-bearing perennial sedge which flowers in the months of August and September. The stem is 25-30 cm. high. This plant is found under the shade of forest trees or rocks. Cooke[1] mentions its occurrence in the Konkan. Saxton and Sedgwick[2] have not reported it from any place in north Gujarat but Sedgwick[3] records it from the Ghats and Carnatic Mallad Tracts in his Revision of the Cyperaceae of Bombay Presidency. Blatter[4] mentions six species of the genus *Mariscus* as occurring in the different parts of Bombay Presidency but none of them is reported from Kutch, Kathiawar, Khandesh, or Gujarat. Even in the more recent publications on the flora of Gujarat[5] in general and that of Pavagadh Hills[6] in particular, the presence of this plant anywhere in the area is not recorded.

During one of our recent excursions to the Pavagadh Hills (865 metres above mean sea-level), Panchmahal District, we came across a few plants of *Mariscus paniceus* Vahl, growing under the shade of forest trees at Machi (400 metres above mean sea-level), a place in the central region of the hill. This plant is confined to a very small area, on the way leading to the point of emergence of the river Vishwamitri and is not to be found either at the foot of the hill or anywhere above Machi. This plant was also collected from a similar type of habitat from Chhota Udepur (145 metres above mean sea-level), Baroda District, and Devgadh Baria (215 metres above mean sea-level), Panchmahal District.

The other plant, *Cyperus leucocephalus* Retz., has also not been reported earlier from the Gujarat region. It resembles the genus *Kyllinga* in habit and is generally found in 'open spaces in the forest in heavy rainfall belt on the crest of the southern ghats.'[3] This plant was collected from both Chhota Udepur and Devgadh Baria during the early and mid-monsoon periods.

The distribution of both the plants, according to Blatter[4], is restricted to the forest areas of the Bombay Presidency such as Konkan, S.M. Country, Western Ghats, and North Kanara. Now that these plants have been observed as normal components of the deciduous forests of Gujarat, the forest flora of Gujarat should be more thoroughly explored so that the old works on the flora of Gujarat may be supplemented to make them as comprehensive as our present-day information would permit. Work in this direction is under progress and the results will be published in due course of time.

We are indeed thankful to Shri M. B. Raizada, Forest Research Institute, Dehra Dun, for the identification of the plants and for making useful suggestions in the preparation of this note.

Department of Botany,
M.S. University,
Baroda,
February 5, 1959.

A. R. CHAVAN
S. D. SABNIS

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31. *KHAYA SENEGALENSIS* A. JUSS.—A NEW PLANT RECORD FROM PONDICHERRY, SOUTH INDIA

(*With a text-figure*)

A few plant specimens in flowers and fruits were sent to me for identification by Mr. P. S. Thejomurthy from the Botanical Gardens, Pondicherry.

On investigation the plant turned out to be *Khaya senegalensis* A. Juss. (Meliaceae), which has been confirmed by the Director, Museum National d'Histoire Naturelle, Paris. Since this plant is not described in any of the common Indian floras, it is a new record for south India or possibly even for India. The specimen is preserved in the Herbarium, Institut Français, Pondicherry.

1. Branch and inflorescence. 2. Woody capsule. 3. Capsule split open showing seeds. 4. Winged seed.

Occurrence

A few lofty trees occur in a row at the entrance of the Botanical Garden here leading towards the office of the Director of Agriculture. A native of West Africa, this plant presumably was introduced in the Botanical Gardens about seventy years back.

The following is the description of the species under consideration. A large tree with fissured bark sometimes ash-coloured, other times brown, an effect perhaps edaphic. On cutting the bark there can be seen rose-coloured wood with a light rose-coloured liquid oozing.

Leaves compound (35 cm. average when mature), alternate, generally grouped together at the extremities of the branches. Leaflets opposite to alternate, elliptic or ovate-elliptic, obtusely shortly acuminate, glabrous, pale above and below, slightly shiny above. Lateral pairs of nerves 10-12 conspicuous in mature leaves.

Inflorescence a panicle with numerous small white flowers (about 0.5 mm.) arising from the axils of the leaves. Calyx consists of 4 sepals, green in colour. Petals 4 imbricate white. The staminal tube is white tinged with yellow having 8-10 teeth. Sessile anthers 8-10, disposed at the junction of two teeth of the tube. Disc conspicuous, red or orange in colour. Ovary emerges from disc, glabrous, 4 lobed. Style short; stigma disc-shaped. The latter emerges out of the staminal tube when the flowers open.

Fruit a woody capsule about 6 cm. diameter, breaking open by 4 valves. Seeds brown, flat, winged, about 10-12 in each loculus, attached to the central column, and resting on the border of the valves. Each seed is about 4 cm. broad including the narrow wing all round. Flowers—May to June. Fruit—July to September.

Geographic Distribution

Abundant in the Savannah forests of Senegal, Haute Volta, North Guinea, Sudan, Nigeria, Uganda, and Ubangi Cheri. Locally in French the tree is called Cailcedrat or Senegal mahogany.

Ecology of the original natural habitat of *Khaya senegalensis*

The original home of *Khaya senegalensis* is a strip of belt between south of Sahelo-Sudan and north of Sudano-Guinea and is situated between 10°-20° latitude. The climate of this tract is continental except at the extreme west where it gives place to the maritime climate. Aubreville (1949) gives the following climatic data:

Temperature: The mean annual temperature ranges between 26°-31.5° C. The mean monthly minimum temperature fluctuates between 24°-28.2° C., while the mean monthly maximum temperature is about 30.5°-36.5° C. The latter is generally obtained in April-May.

Vapour Pressure: The mean annual vapour pressure is 9.7-16 mm. Whereas the mean monthly minimum vapour pressure is 3.5-8.5 mm., that of mean monthly maximum is 18-22 mm.

Rainfall: The total annual rainfall in this particular tract ranges between 900-1500 mm. The rainy season is very short with two or three months of heavy rain, the maximum being in August. It remains dry for six to eight months.

The meteorological data for Pondicherry are not available. Therefore, the climatic data of the nearest station, viz. Cuddalore, are taken as representative of Pondicherry:

Temperature: The mean annual temperature is about 29.7° C. While the mean monthly minimum temperature is 23.4° C., the mean monthly maximum is 32.4° C., the latter being in May.

The Vapour Pressure and the Relative Humidity are 20.25 mm. and 67% respectively.

Rainfall. The mean annual rainfall is about 1383.3 mm. The heaviest rains are in the months of October-November brought about by North-east Monsoon. It remains practically dry for six to seven months.

On comparison it is seen that the original habitat of this plant and Pondicherry possess more or less similar amount of rainfall and dry period. It is, therefore, not surprising that *Khaya senegalensis* has thrived well here.

Khaya senegalensis inhabits places with deep wet soils especially alluvium or red loam or laterite on the slopes of forests very near streams and water courses.

This plant is said to be economically very important from the forestry point of view. It has a remarkable capacity for facile regeneration both naturally and artificially and its timber is considered good like the 'Mahogany'. The physical and mechanical properties of the timber are discussed by Normand and Sallenave (1958).

It is suggested that where (in south India or India) such climatic conditions as described above prevail, *Khaya senegalensis* may, with advantage, be introduced. There is one snag reported about this plant from Africa and that is the susceptibility of the buds of young trees to insect borers which result in stunted growth. However, this phenomenon is not observed on the trees here, perhaps because of the absence of these borers.

The author wishes to thank Mr. P. Legris for providing all facilities to work. Profound gratefulness is expressed to Mr. M. Viart for his valuable suggestions in the preparation of this paper. To the Director, Museum National d'Histoire Naturelle, Paris, I am highly indebted for confirming the identity of the plant. Thanks are due to Mr. Thejomurthy for kindly placing the material at my disposal.

Institut Français,
Pondicherry,
April 29, 1959.

K. A. SHANKARNARAYAN

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The Non-violent Scientific Study of Birds

BY

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(*Based on a lecture given in Bombay on* 17 *January* 1959)

I am very ignorant about birds, largely because I am unmusical and most British birds are small and inconspicuous, so that their songs and call-notes are more distinctive than their colours or shapes.

In the nineteenth century it was hard to study birds without killing them. The first job of an ornithologist is to identify species; and in order to be sure that we have, for example, three and only three species of kingfisher in the suburbs of Calcutta it is necessary to kill a number, and find that all can be assigned to one of these species. This phase is now fortunately nearly over. One can learn to assign a bird to its correct species without killing it.

What is the next step? It is, I think, to find the distribution of species and subspecies in India at different times of the year, and also their local habitats, names, and so on. Here Ogniev's great Zoology of the U.S.S.R. could be a model. Ultimately we should look forward to a time when there will be an ornithologist for every hundred or so square miles of India capable of enumerating the local species, and a central organization such as the Bombay Natural History Society to make maps showing the distribution of each species in India. As, however, this would require ten thousand or so ornithologists it is not immediately possible. But a start can be made.

The next question to be asked is, perhaps, how many birds of one or more species there are in a given area. At first sight this is a very difficult question, as birds are so mobile. But as eggs they are

extremely immobile. I hope that, if we develop statistical biology at the Indian Statistical Institute, we may make the attempt to enumerate all the nests of some conspicuous species, such as vultures, night herons, and cattle egrets, in an area of ten square miles or so. When this has been done for thirty or so representative areas in India we shall be in a position to estimate, no doubt very roughly, the total population of these species in India.

The total numbers of breeding adults of a few local species are roughly known (see Fisher and Lockley 1954). Thus for the gannet, *Sula bassana*, the number of nests in the East Atlantic area (Britain, etc.) was about 70,000 in 1939 and had risen to 82,000 in 1949. In the West Atlantic (Newfoundland, etc.) it was about 13,000 in 1939. Thus at present there are about two lakhs of mated birds, and perhaps as many juveniles. They live on a small number of precipitous rocks, mostly on small islands. There are fifteen 'cities' of 17,000 to 1200 nests, and fourteen 'villages' of 500 nests or fewer. These numbers are fairly accurately known. James Fisher had counted thousands of nests on cliffs from small boats. He was able to induce the British Naval Air Force (Fleet Air Arm) to photograph many of these sites as part of their training. The exact numbers of nests could be counted at leisure from the photographs, and the results compared with those obtained by cheaper methods. Few of the latter were incorrect by ten per cent.

This 'urbanization' is characteristic of sea birds, and is carried to greater lengths in more numerous species. The extreme example is furnished by *Uria lomvia*, Brünnich's Guillemot, of which there appear to be four or five million on the coasts of Greenland, about half of which breed on a single rock Agpar-s-suit. This is one extreme of bird behaviour. Most small song birds keep a "territory" round their nests private by singing and quarrelling with intruders, even if they are more sociable when not breeding, while others, such as the Indian weaver bird, live in 'villages' of a few tens or hundreds of nests.

Is there any possibility of counting all the breeding members of an Indian bird species? I suggest that the most hopeful targets are the large flamingo *Phoenicopterus antiquorum*, and the smaller species *Phoeniconaias minor*. The former breeds in the Great Rann of Kutch and the latter possibly in the Little Rann. The Lesser Flamingo, which lives on unicellular algae, is not apparently found in many other localities except Sambhar Lake in Rajasthan. The Rann of Kutch is unsuitable for walking but, owing to the absence of trees, it should be possible to photograph nesting birds from

the air. This can of course only be done by the Indian Air Force. In peace time the armed forces have to carry out exercises of various kinds. Their efficiency can be better gauged from their performance against natural forces, for example the rapid replacement of bridges destroyed by floods, or the landing on a difficult coast, than by their prowess against 'enemies' who they know will not hurt them. Hence such co-operation would, I believe, increase the efficiency of our Air Force.

So much for mere populations or densities per square mile. But how do these increase or decrease? Observations on a few hundred or even a few dozen nests of any species will tell us the average number of eggs laid per year. More careful, but not very arduous, watching will tell us how many young birds per nest survive to start flight. On the whole tropical birds produce fewer eggs in a clutch than birds of the same species or a closely related species in a temperate climate. This is at least partly due to the shorter tropical days, which do not give the parents time to feed a large brood. Most of the comparisons have been made by Moreau with African birds, but Lack (1950) points out that in India *Parus major* (the Great Tit) has an average clutch of 3 compared with 10 in England. This difference must be compensated in one of two ways. Either the average number of clutches in India must be greater or the mortality less. There must be a balance because if, for example, the numbers in an area increased by only 10% per year for a century, the density would increase 13,781 times. This can of course happen when a new species occupies a country, but not with established species. In only one case has this balance been directly demonstrated by comparison of statistics. In Switzerland the Starling (*Sturnus vulgaris,* a bird very similar to the myna) lays more eggs than in England, but dies younger. It will be easy to get data on numbers of broods in India, not so easy to get data on mortality. Before I speak about mortality, let me say a few words on the feeding of young.

What do they get to eat? One can of course kill parents and examine their crop contents. Apart from ethical considerations this means that one can only get one piece of information from a bird. Several other methods are available. Lack found that if he caught parent swifts (*Apus apus*) they might desert their young. So he waited until a parent bird fed a baby and departed, and then pressed the baby's throat, getting a pellet containing about 600 insects entangled in the parent's sticky saliva. They were largely flying aphids, so swifts eat insects which compete with men for food plants, and what

is more, eat them while they are moving to new food plants and invulnerable to sprays and other insecticides. Thus swifts seem to be wholly favourable to agriculture, whereas some other bird species live largely on seeds and lower agricultural output, while other insect eating birds eat some insects, such as bees, which assist in the pollination of plants and thus help human horticulture and even agriculture. We should certainly encourage the birds which are helpful to man, even if we do not massacre the others. A second non-violent method has been used in the Soviet Union. The nestlings are replaced by models which, when a watcher pulls a string, open mouths and may emit a suitable noise. The food falls into a bag, and I hope is given to its legitimate owners after the insects, molluscs, seeds, and so on, have been assigned to their correct species.

Do young birds get enough to eat? Lack (1954) found that when the brood size was less than the average, the number of young starlings surviving for a few months was roughly proportional to the brood size. However this was not so when the brood size exceeded the average. Even if the excess young survived to fly, they did not survive much longer. Presumably their parents could give them enough food to fledge, but not enough to get an adequate start in life. The technique consists of ringing nestlings. But of 15,000 starlings ringed in this research, only 346 or 2.3% were recovered, that is to say found dead and the rings returned.

The ringing technique was invented by Mortensen in Denmark to study migration. As you know, several ducks ringed in India have been picked up in Siberia and vice versa, and one German-ringed stork in India. Ringing birds does not harm them. One ringed robin (*Erithacus rubecula*) in Eire lived for eleven years, though nearly two-thirds of all robins die each year, so only about one robin per lakh is expected to live so long. It is a fortunate and peculiar fact that birds' legs are fully grown before they start flying. A metal or plastic ring can therefore be put on a nestling and remain on its leg for life. The rings usually carry a request to send them to a certain address if found. There may be a small reward. In Western Europe population density and literacy are both so high that as many as 15% of the rings on large birds are returned. We cannot yet hope for such good results in India. But we may reach them when our children are educated.

Table I gives data on *Vanellus vanellus,* the lapwing, a British crested bird of about the size of the hoopoe, and which our great British naturalist William Turner thought to be a hoopoe four hundred years ago, since ancient authors of about two thousand years ago had

described only one crested bird of this size. Then he went to Central Europe and saw a hoopoe, which agreed very well with the Latin description. He realised that there were birds in Britain of which the ancients knew nothing, and started to describe them. That was the beginning of scientific ornithology in Britain.

Each ring is recorded on a card in an office at the British Museum of Natural History in London, and I analysed all the cards recording rings put on nestling birds before the year 1940 (Haldane 1955). I made the table in 1954, so, as one bird had lived for fourteen years, if I had included birds ringed, say, in 1950, many would still have been alive. Following a method due to Lack, I omitted all birds picked up in the same year when they were ringed. Their number is large, but it is misleading because a man who has taken the trouble to ring fifty little lapwings will probably notice dead ones in his neighbourhood, and hence the apparent mortality in the first eight months will be too high (Table I). The first column is the year of the bird's life in which it was

TABLE I

x	d_x	xd_x	$\mathfrak{S}(d_x)$	Δ	x^2
1	2	3	4	5	6
1	194	194	206.38	−12.38	0.74
2	145	290	136.21	+ 8.79	0.57
3	90	270	89.90	+ 0.10	0.00
4	54	216	59.33	− 5.33	0.48
5	48	240	39.16	+ 8.84	2.00
6	25	150	25.85	− 0.85	0.03
7	24	168	17.06	+ 6.94	2.82
8	9	72	11.25	− 2.25	0.45
9	6	54	7.43	− 1.43	0.28
10	5	50	4.90	+ 0.10	0.00
11	5	55			
12	7 { 1	12			
13	0	0	9.53	− 2.53	0.67
14	1	14			
	607	1785	607.00	0.00	8.04

picked up. Thus if a bird was ringed in 1930 and found dead in 1931 we say that its age $x=1$. d_x is the number of birds found dead in the xth year of their life. For example 54 rings were from birds dying in their fourth year (e.g. birds ringed in 1940 and picked up in 1944). The third column is the product of the first two. Now suppose that in each year a constant fraction m of all birds dies, we

find that 607/1785 (the ratio of the totals of columns 2 and 3) gives us an estimate of m, namely .340 or 34.0%. Now this seems a very simple theory, too simple to be true, for we know that in human beings a bigger fraction die in their sixtieth year than their sixth, in other words m is not constant. If m is constant we expect that 607 m, or 206.38, birds died in their first year, leaving 400.62, and 400.62 m, or 136.21, died in their second year. In this way the expectations in column 4 were calculated. Column 5 gives the differences of columns 3 and 4. If m increased with age, as in man, the values would at first be positive, and later negative. We can make a further test. Dividing Δ^2 by $\Sigma(d_x)$ we get the last column. If m is constant we should expect the total to be 9; it is rather less. There is no reason to doubt the constancy of the mortality. In other words all birds after their first year died of accident. There is no evidence that any small bird dies of old age in nature, for other species have yielded similar results. I dealt in a similar way with the figures for 120 birds ringed from 1940 to 1951. The mathematics are much more complicated, and give m=.372, which is close enough to the former value to give me some confidence in my calculations. The annual mortalities range from about two-thirds for very small song birds to about a tenth or less for large sea birds. But in some ways the results obtained about migration are even more interesting. Dr. Sálim Ali tells me that systematic work is at last being started to map out migration routes between India and Siberia.

How do bird populations change? This could be studied in India as easily as anywhere else. When a species is introduced into a new habitat it may increase very quickly. Figure 1 shows the rate of increase of *Phasianus colchicus* on an island off the American coast. Four pairs were introduced. The biennial census shows the effect of juvenile mortality. The population increased from two to four times annually, and showed some signs of stabilizing, until a very formidable predator, the American soldier, was introduced, and further observations were useless. But the population had increased from 8 to 1325 in five years. Figure 2 of *Parus major* in a British wood is more typical. The increase was due to the installation of nesting boxes. The population increased violently each spring and fell back in autumn. Some birds left the wood each winter, and they or others returned before the nesting season. Similar observations could be made in India, even on the same species.

If there are enough ornithologists in India ten years hence we shall be able to begin observations like those recorded in Fig. 3, which gives the population of herons (*Ardea cinerea*) at a number of

English nesting sites. A very cold winter, such as that of 1947, reduced the number of birds, probably because a great deal of water was frozen. But they regained their original density in two years or so, and showed no tendency to increase indefinitely. If we knew how

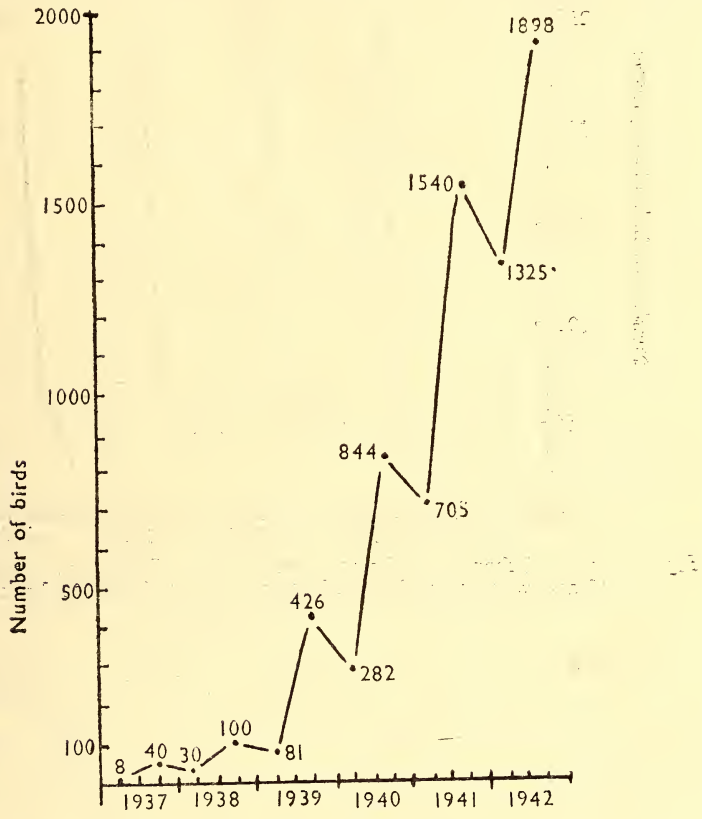

Fig. 1. Increase of pheasants (*Phasianus colchicus*) on Protection Island, Washington, U.S.A. After Einarsen and Lack (1954).

they achieved this stability we human beings might take some hints from them. It seems likely that marriage is postponed where there is a shortage of nesting sites. Other bird populations, especially in northern regions, show cyclical fluctuations with a period of about ten years, but the figures are not very satisfactory.

Such investigations take some time; Dr Sálim Ali may wish me to suggest topics which would give results in a year or two, and thus secure a M.Sc. Bird behaviour offers many such possibilities. One of our English song birds, the thrush (*Turdus ericetorum*), leaves a record of its predations, as it breaks snail shells on stones or tree stumps before giving their contents to its young. Table II is a record

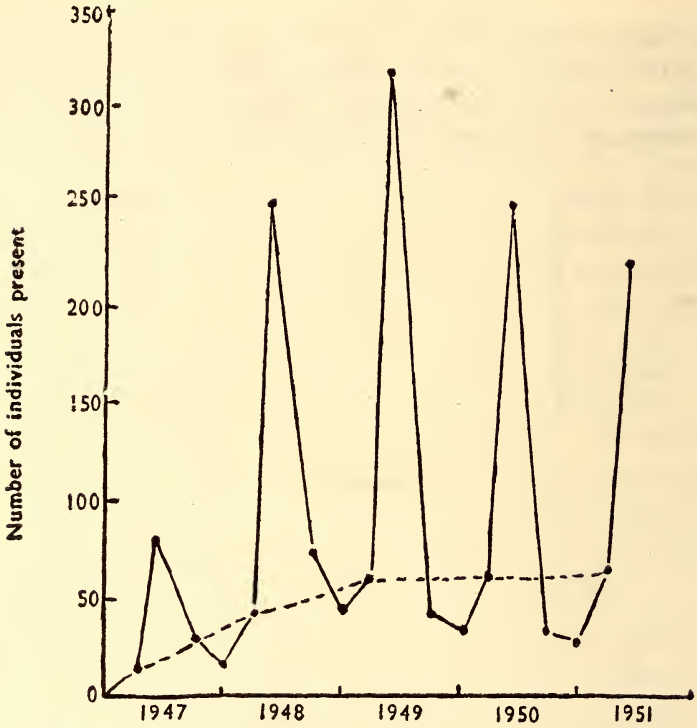

Fig. 2. Seasonal changes in the numbers of Great Tits (*Parus major*) in a 63 acre wood near Oxford, England. After Gibb and Lack (1954).

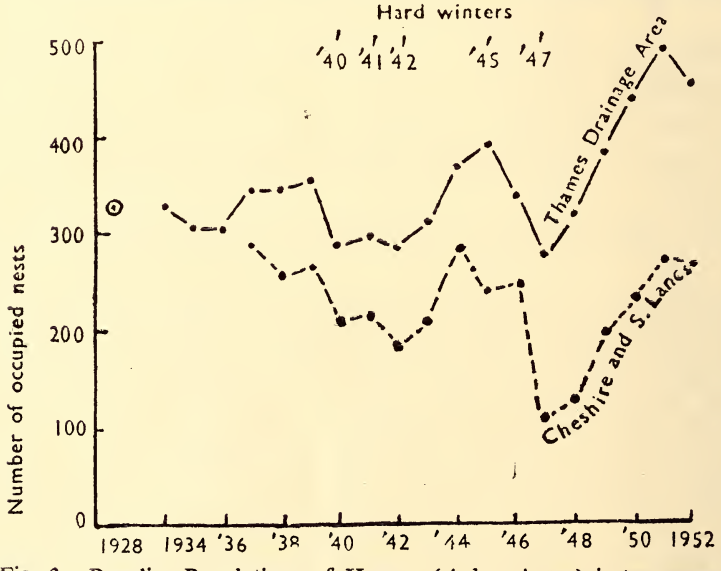

Fig. 3. Breeding Populations of Herons (*Ardea cinerea*) in two areas of England. After Lack (1954).
The 'hard' winters are those in which water was frozen for long periods, rendering fishing difficult.

of its behaviour. The snail species *Cepea nemoralis* has several colour forms, which can be classified as yellow and not yellow, the former being recessive. On a brown background of dead leaves the yellow snails are conspicuous to the human eye, while they are less conspicuous among green leaves. They are also commoner on green backgrounds such as grass which does not dry up in summer, than on

TABLE II

Snails *Cepea nemoralis*, collected by men and killed by thrushes in Marley Wood, near Oxford

Data of P. Sheppard

Date	Yellow	Not Yellow	% Yellow	..
14. 4. 50	80	250	24·2	Human
26. 5. 50	57	147	27·9	collections
6 to 11. 4. 50	3	4	43	Killed by
-23. 4. 50	7	10	41	*Turdus*
-30. 4. 50	11	21	34	*ericetorum*
- 7. 5. 50	9	25	26	
-19. 5. 50	3	16	16	
-22. 5. 50	1	6	14	
-26. 5. 50	2	12	14	
6. 4. 50 to 26. 5. 50	36	94	27.7	Total bird-killed

brown ones such as the floor of beech woods. Sheppard (1951) made counts of snails killed by thrushes during the breeding season of 1950 in a wood where there were few green leaves in early April, and many in late May. We see that the thrushes collected more of the snails which were conspicuous to the human eye at the times in question. But their overall bag favoured neither type of snail, so it looks as if they were responsible for keeping the observed proportion of yellow snails. This is an example of Natural Selection in action. Similarly Kettlewell (1956) has shown how birds act as agents of natural selection in transforming the colour of the moth *Biston betularia*. I have little doubt that similar studies of choice by birds in nature could be made in India. My colleague Sri K. R. Dronamraju is now making one at Calcutta, but in his case the choosers are butterflies, not birds.

Here is another example of bird behaviour which could and should be studied statistically. Moreau, Purchon, and others, in a series of

papers in the *Proceedings of the Zoological Society of London*, have studied the visits of birds, both in Africa and Europe, to their nests when brooding eggs and feeding their young. Unfortunately they never give all the figures needed for a complete statistical analysis. It is however clear that in several species the time spent on the nest per day rose during incubation, and then fell again as the young demanded more and more food but less and less warmth. The durations of absences were less variable than those of stays on the nest. This can be interpreted as meaning that the parent bird has a strong urge to return after five minutes or so, even if it has found little food, and no strong urge to leave the nest after a standard time. However, it would be most valuable to collect such data in such a way that they could be given adequate statistical treatment. This would mean observation throughout the hours of daylight during a nesting period, which would require the co-operation of at least two men. Moreau however was very satisfied by the performances of illiterate African assistants, and I have no doubt that equally reliable Indians are available. If the data are complete, the Indian Statistical Institute can analyse them.

I am not musical, and cannot detect slight difference in bird songs and calls. Their full investigation demands the rather expensive apparatus used by Thorpe (1955). But this is not essential. Marler (1952) wandered about Britain with no apparatus beyond two ears and a note-book, and found differences in the song of the same species, *Fringilla coelebs*, in five different areas. He also studied it in the Azores islands, while Promptoff had previously done so in two areas of the Soviet Union. The differences were quite marked. The most complicated song, on an average, was sung in Scotland. But the birds of the Thames Valley were more variable, and included the finest songsters. In the Azores where there is no other species with a similar song, and therefore no biological need for a species-specific song, the performance was much simpler and cruder. Similar work could and should be done in India. Are there, for example, Marathi and Gujarati songs in the same bird species?!

From a cursory reading of Tinbergen's (1951) work you might think that birds respond to very crude stimuli. Like men they sometimes do so, but not always. Migratory birds have definite routes which generally avoid long ocean and desert crossings, and often follow coast lines and large rivers. In Scandinavia and Germany most small song birds which winter in tropical Africa follow the Atlantic coast. But *Sylvia curruca*, the Lesser Whitethroat, flies southeast from Germany to Turkey, and then south along the Nile

Valley. They mainly fly at night, and birds in their first year can find the way. How do they 'know' it? I end up by introducing you to one of the most amazing stories in the whole of biology, a story which I hope, but am not certain, is true, though I have the greatest respect for its author. But scientists are human, and even the greatest of them make mistakes. Sauer hatched birds in the laboratory and kept them in cages where they never saw the sky. They became restless at night for two or three weeks at the normal migration times in autumn and spring. If they can see even a part of the sky, they attempt to fly approximately southeast.

Now comes Sauer's (1958) amazing discovery. The birds responded perfectly well in a planetarium, that is to say a dome in which the stars are represented by points of light. Now in such a planetarium we can alter the apparent position of the stars in two ways. We can alter them as they would alter at the same place during one night. For example in Germany in late October Rohini (Aldebaran) was well up in the sky when the stars were first seen after sunset, while Kalpurush (Orion) was just rising. If the planetarium was arranged to show the stars in this position the birds tried to fly southeastwards, as they should. Now the planetarium was altered so that Kalpurush was high in the sky, and Sinha (Leo) rising, in fact the stars as they would be seen about 11 p.m. The birds tried to fly westwards. Now at that moment they would have seen the stars in those positions if they had been near lake Balkhash in Kazakhstan, and their best way to western Turkey would have been to fly west. At intermediate star positions they flew southwest and south. The pole of the planetarium can also be shifted so that the stars appear as they would from another latitude. Sauer changed the apparent position of the stars to that which would be seen at the same time in Egypt. Achernar was shown in the south, the Saptarshi (Ursa Major) were below the northern horizon. The birds flew south, as they would have done in Egypt.

Of course I have over-simplified Sauer's account. Perhaps Matthews's results on solar navigation are equally remarkable, though they are still not universally accepted. But it does appear that some birds have, if not an innate knowledge of astronomy, at least an innate capacity for responding to certain star patterns. Presumably some kind of pattern develops in their brain which corresponds to that of the stars, as of course feather patterns develop on their skins. Probably Matthews's work will be easier to repeat in India, but somehow Sauer's seems to me more exciting, if only because it suggests that birds may have knowledge which has not come to them through their senses. And if birds, why not man?

I must apologize to Dr Sálim Ali for the numerous inaccuracies which I am sure have crept into this lecture. But this is inevitable if I am lured into speaking on a subject to which I have made no serious contributions. I close with the hope that in his old age he may be able to introduce scientific ornithology, to which he has made such notable contributions, into the curriculum of our universities.

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The Vegetation of Kodaikanal Grassy Slopes

BY

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INTRODUCTION

Kodaikanal, on the Palni Hills of south India, is situated at an altitude of 6000-7000 ft. Its flora is very rich, as can be made out from the many references in Gamble's FLORA OF THE PRESIDENCY OF MADRAS, and particularly from Fyson's THE FLORA OF THE SOUTH INDIAN HILL STATIONS. Throughout the preparation of this paper, I have made constant use of these two books; but the paper is mainly based on the data that I have collected personally in the field, paying particular attention to the precise dates of flowering and fruiting, the exact distribution, and relative abundance of the various plants studied.

This study is restricted to the angiospermic vegetation of the grassy slopes about Kodaikanal. One full year has been spent in an intense examination of the various species occurring on such slopes and on the phenology of the same.

In the enumeration that follows, lengthy descriptions have been omitted on purpose; interested readers are referred to the standard works just mentioned. The notes given for each plant are meant to bring out the more important features of the same. In this paper the two terms *abundance* and *distribution* are not considered synonymous; a plant is said to be abundant when large numbers of the same occur at a particular spot; on the other hand, a plant is said to be widely distributed when, without regard to the large or small number of specimens, the plant is found to occur in many spots or places within the given area. Such data I consider of importance, particularly when it is a question of plants that may have some economic importance, medicinal or otherwise; this detailed information may materially reduce expenses, should it become necessary at any later time to collect the plant for commercial exploitation.

In this paper 154 species belonging to 114 genera and 47 Families are mentioned. The order of the Families is the same as in Gamble's FLORA; however, a few Families have been split into more uniform

groups following Hutchinson's FAMILIES OF FLOWERING PLANTS. Within the Family both genera and species are given in alphabetical order. The common English names, occasionally mentioned in my list, are mostly taken from Fyson's book.

METHODS OF STUDY

Three plots of land on open grassy slopes were selected for intensive study from March 1956. The plots were all in the neighbourhood of Shembaganur, just below Kodaikanal, at an altitude of about 6000 ft. I identified all the plants in these plots as they appeared, and in my fortnightly visits took careful notes of their phenology. The study was not restricted to these three relatively small plots; comparison was constantly made with other parts of the same hilly slopes, particularly to find out the distribution of the plants and their size and to note differences in their flowering and fruiting seasons, especially as affected by altitude.

SOIL AND CLIMATE

As regards soil, the plateau is made up of a special kind of gneiss, called charnockite, consisting of blue-coloured quartz, felspar, and mica in varying proportions. The soil is mostly yellow composed of bauxite, hematite, magnetite, and aluminous sediments. This soil is almost entirely covered by a layer, 25-60 cm. thick, of compact, water-holding, black mud.

Though Kodaikanal lies within the monsoon zone, its climate is greatly modified by altitude. Among the hill stations of India, Kodaikanal is said to have the lowest maximum temperature in summer and the highest minimum in winter, as may be seen from the following table, which records the monthly average maximum and minimum temperatures in °C. for Shembaganur for the years 1953-1957.

TABLE I

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Max.	17.4	19.8	21.3	22.5	21.9	20.6	19.4	19.2	19.4	19.2	18.4	17.3
Min.	10.2	11.8	13.5	14.5	16.2	15.1	13.9	14.1	13.6	13.7	11.9	10.7

As regards climate, Kodaikanal has four fairly clearly defined seasons: (1) *The Dry Season*, January to March, during which rain is rare and the sun hot, and in consequence tender annuals are often severely damaged. (2) *The Hot Season*, April and May, during which showers are frequent, and annuals thrive. (3) *The South-West Monsoon Season*, June to September: many plants come into bloom, conditions are ideal for most plants; the rainfall is somewhat erratic due to the fact that Kodaikanal lies within the rainshadow region of the Cardamom Hills of Kerala. (4) *The North-East Monsoon Season*, October to December: showers are more regular and frequent than during the rest of the year.

The annual average rainfall of about 185 cm. is more or less distributed throughout the year, and this keeps the vegetation of Kodaikanal fresh without the drastic monsoon and dry season fluctuations that are so striking for most parts of peninsular India. The following table gives the average monthly rainfall in cm. for Shembaganur for the years 1953-1957.

TABLE 2

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
7.25	2.87	8.00	27.15	10.87	10.37	12.72	14.00	18.22	36.1	22.9	12.9	183.35

ENUMERATION OF SPECIES

BERBERIDACEAE

1. **Berberis tinctoria** Lesch. The Common Nilgiri Barberry

An evergreen thorny shrub, about 90 cm. high. The stem is hard, and bright yellow inside. Inflorescence many-flowered; flowers bright yellow. Flowering February-March. Fruits ripe by May: at first green, then red, finally dark blue.

Fairly common on slopes, though never abundant.

VIOLACEAE

2. **Viola patrinii** DC. The Spear-leafed Violet

A perennial herb with a thick rootstock, without runners. Leaves radical, lanceolate; petioles long, winged, sheathing at the base. Flowers solitary, white. The first showers in March bring out an

abundance of flowers; stray ones may be seen almost throughout the year. Capsules common by June, oblong, splitting into 3 boat-shaped valves.

Common and abundant, though not easily noticed, being hidden by grasses.

3. **Viola serpens** Wall. The Common Wood Violet

A perennial, creeping, uniformly pubescent herb. Leaves ovate, on slender petioles 6-8 cm. long. Flowers solitary, 1-2 cm. across, pale blue to white, abundant during May-June; stray ones throughout the year. Capsules globose.

Strictly this is not a plant of open grasslands, but of the 'sholas', where the plant is abundant.

POLYGALACEAE

4. **Polygala bolbothrix** Dunn.

A small, densely pubescent, spreading herb. Leaves alternate, lanceolate-acuminate. Inflorescence few-flowered; flowers drooping, pink. Flowering probably throughout the year.

Abundant in one of the three areas under study, but restricted in distribution. It is more common at lower elevations. Not mentioned by Fyson.

5. **Polygala persicariaefolia** DC.

A thin, scarcely branched herb, 25 cm. high. Leaves narrow, elliptic to linear, 3-4×0.4-0.5 cm. Racemes up to 6 cm. long, mostly lateral. Flowers 6-12 on each raceme, rose-coloured, available from September to January with a peak in October-November; in places not exposed to strong sun, flowers may be had even in March-April. Fruit an oval capsule.

Abundant locally on grass slopes, but not widely distributed; more robust specimens occur at lower elevations. Not mentioned by Fyson

6. **Polygala rosmarinifolia** Wt. & Arn. The Rosemary Milkwort

An erect, scarcely branched annual, 25-30 cm. high. Leaves linear, 2-3×0.5 cm. Racemes few-flowered, short. Flowers greenish, throughout the year, but abundant from June to August. Pod elliptic; seeds two, black, covered with short white hairs and capped by a conspicuous aril.

Abundant and common. More robust specimens occur at lower elevations.

7. **Polygala sibirica** L. The Common Milkwort

A small herb from a woody, perennial stalk. Branches many, spreading. Racemes short, from the axils of the upper leaves. Flowers purple, seen throughout the year. Capsule winged.

Common along cattle tracks or among low vegetation; this seems to be the lower limit of the distribution of this plant.

HYPERICACEAE

8. **Hypericum japonicum** Thunb. The Marsh St. John's Wort

A slender, erect herb, often tufted, up to 10 cm. high, growing in marsh. Leaves sessile, ovate, entire, more or less reddish brown. Flowers terminal, yellow. Flowering February-October. Fruit a capsule, red; common from November to January.

Abundant in marshy places, rare elsewhere.

9. **Hypericum mysorense** Heyne The Common St. John's Wort

A rough shrub, 90 cm. or more high. Young branches 4-angled; leaves conspicuously decussate. Flowers large, showy, bright yellow, terminal. Flowering October-May, abundant in March-April. Fruit oval, surmounted by 5 persistent styles.

Abundant and common on slopes. During the flowering season, this plant is one of the most conspicuous species on these hill slopes.

10. **Hypericum wightianum** Wall.

A slender herb about 15 cm. high. Stems terete, branches spreading. Leaves ovate, 1.5×0.5 cm., often reddish brown.

Flowering etc. as for *H. japonicum* Thunb.

TILIACEAE

11. **Triumfetta pilosa** Roth.

A perennial undershrub 60-90 cm. high, uniformly hirsute. Lower leaves 3-lobed, upper ones ovate-acuminate, 10×4 cm., coarsely serrate. Inflorescence of 3-10-flowered axillary cymes. Flowers yellow. Flowering September-November. Capsules covered with long, soft spines; common in December-January.

Abundant, often gregarious, along roadsides, in waste land, etc., but not common.

LINACEAE

12. **Linum mysorense** Heyne

A slender, erect annual, 20-40 cm. high. Branches corymbose; leaves sessile, linear. Flowers terminal, yellow, solitary or in racemes

of 3-5. Flowering November-January; in shaded spots flowers may be seen till March-April. Capsules globose.

Abundant in places, but not common.

Geraniaceae

13. **Biophytum intermedium** Wt.

A small herb, often less than 8 cm. high, with a woody rootstock. Stems unbranched. Leaves 4-5 cm. long, paripinnate; leaflets 10-15 pairs, slightly sensitive. Flowers yellow, small, 5-6 on a peduncle. Fruit an ovoid capsule enclosed in the persistent sepals.

Abundant locally but not common; in crevices of rocks, walls, etc. Flowering more or less throughout the year, but scarce in the cold months.

Balsaminaceae

14. **Impatiens goughii** Wt. Gough's Water Balsam

A slender, much-branched annual, 10-25 cm. high. Stems fleshy, reddish. Leaves ovate, opposite, exstipulate; petioles 2-4 cm. long. Flowers pink, corymbose, each on a slender or filiform pedicel 1-1.5 cm. long; usually 3-6 pedicels supported on a peduncle 4-6 cm. long, axillary. Fruit an ovoid capsule.

Abundant on wet rocks, rare elsewhere. Flowers almost throughout the year, with a peak in November.

15. **Impatiens tomentosa** Heyne The Red Liberty Cap

A slender, pubescent, annual marsh herb. Stems red, pubescent, 30 cm. long, rooting at the lower nodes. Leaves narrow, acute, 4×0.8 cm., on short petioles. Flowers pink, 1-3, axillary, on pedicels about 2 cm. long. Flowering September-May; stray flowers throughout the year. Capsules pointed at both ends; seeds 3-5, black.

Abundant in marshes, not seen elsewhere. Gamble reports 70 species for Madras, and Fyson 31 for the south Indian hill stations, but I have noted only about 12 about Kodaikanal.

Papilionaceae

16. **Crotalaria albida** Heyne

A low, diffuse plant, branching abundantly but only from below. Leaves simple, subsessile, 1-1.5×0.5 cm., cuneate, thick, pubescent. Inflorescence of terminal racemes 4-5 cm. long. Flowers yellow, 6-8 in a raceme. Flowering nearly throughout the year with

occasional interruptions. Very few flowers seem to run into fruit. Pods glabrous.

Not abundant but widely distributed.

17. **Crotalaria calycina** Sch. Rabbit's Ears

An erect annual 10-60 cm. high, profusely covered with brown hairs. Stems cylindrical, flexuous. Leaves oblanceolate, 4-6×0.6 cm., densely hirsute on the lower surface. Flowers in loose racemes, distant from one another. Calyx 2 cm. long, densely tomentose. Corolla yellow, not exserted from the calyx. Flowers abundant in September-October; stray ones and pods nearly throughout the year. Pods 2 cm. long, dark brown; seeds over 20.

Fairly abundant and widely distributed. Probably the name "Rabbit's Ears" comes from the two ear-like upper lobes of the calyx.

18. **Crotalaria fysonii** Dunn.

A small, trailing, perennial herb, with a thick rootstock. Upper leaves ovate, lower ones orbicular, all usually pubescent. Racemes terminal, leaf-opposed or erect. Flowers 4-6, showy, yellow. Flowers throughout the year, but few of them seem to run into fruit.

Widely distributed along the slopes, and fairly abundant. There is one form of the plant with perfectly glabrous leaves.

19. **Crotalaria leschenaultii** DC.

An erect, branched undershrub, 90 cm. high, or higher. Leaves oblanceolate-cuneate, glabrous on the upper surface, silky on the lower, 8 cm. long. Racemes many, large, bright yellow tinged with brown, which turn black when dry. Flowering starts in August, and continues for most of the year. Ripe pods 5-6 cm. long.

Common but not abundant.

20. **Crotalaria ovalifolia** Wall.

A low, diffuse, pubescent herb from a perennial rootstock. Branches 20 cm. long, wiry, more or less erect among grasses. Leaves simple, ovate. Stipules broad at the top and decurrent along the stem. Racemes terminal, of 2-3 flowers. Flowering more or less throughout the year, with a peak in September-November.

Common and abundant.

21. **Crotalaria wightiana** Grah.

A conspicuous, pretty shrub, 100-120 cm. high. Leaves 12×9 cm., elliptic-ovate, obtuse at the apex, densely pubescent; stipular wings prominent. Racemes few-flowered. Flowers conspicuous. Flowering June-November. Flowers and pods are seen on the same plant

for most of the year, except perhaps in April-May. Pods 4-5 cm. long.

Common, at times fairly abundant. This seems to be the upper limit of the distribution of this plant.

22. **Desmodium parvifolium** DC.

A low trailer often hidden in the surrounding herbage. Fresh leaves in June-July. Stems thin and pubescent when young, red and glabrous when old; lateral branches many. Leaflets 3, often not more than 0.5 cm. long. Racemes terminal, densely pubescent. Flowers pink. Flowering September-December. Pods from January onwards. Even after dehiscence, the pod persists on the plant, at times even for months.

This is sometimes so abundant as to form the dominant ground vegetation, but not widely distributed. Stray flowers seen even after January in shaded places, but the statement 'Flowers March-October' of Fyson seems to be incorrect.

23. **Desmodium rufescens** DC.

An erect, tall, twiggy shrub, up to 150 cm. high; young parts brown pubescent. Leaflets 3, obovate, the underside covered with silky pubescence. Racemes mostly terminal, 8-15 cm. long. Flowers blue-purple, crowded on the upper part of the raceme. Flowering August-January. Pods and stray flowers from February onwards.

In thickets, in clumps.

24. **Desmodium scalpe** DC.

A shade plant, young parts pubescent. Leaflets 3, the middle one rhomboid, lateral ones oblique. Stipules prominent. Inflorescence up to 30 cm. long, a lax terminal raceme. Flowers brick red, abundant September-January.

Not a plant of the open grassland, but of shaded woods.

25. **Flemingia grahamiana** Wt. & Arn.

An erect shrub, with the fresh leafy branches rising above the surrounding grass by April, after the first showers. Leaflets 3, thick; the terminal one ovate-cuneate, 8×4 cm.; lateral ones oblique, smaller. Flowers in dense axillary spikes; calyx densely covered with red glands; corolla rather yellow than pink. Flowers common from September onwards. The last flowers may be seen from December to January along with pods which are also covered with red glands. Pods may be seen as late as May.

Abundant and common everywhere on grassy slopes.

26. **Indigofera pulchella** Roxb.

A shrub 30-180 cm. high. Leaves imparipinnate, with 11-15 leaflets. Racemes 7-12 cm. long. Flowers purple, appearing before the leaves, September-May. Pods narrow, straight, 4-5 cm. long.

Not abundant but widely distributed. The stem is often covered with galls.

27. **Leptodesmia congesta** Benth.

A perennial, diffuse, trailing herb. Stems thin, young parts pubescent. Leaves abovate, pubescent. Inflorescence a terminal raceme. Flowers crowded in the raceme, which appears whitish on account of the dense pubescence of the calyx. Flowers May-December. Pods common from January onwards.

Abundant in certain places, but not common.

28. **Shuteria vestita** Wt. & Arn.

A slender twiner. Stems thin, pubescent. Leaves pinnately trifoliate, leaflets ovate. Racemes up to 12 cm. long; calyx densely pubescent; corolla purplish. Pods flat, pubescent. Flowers November-January; pods till March.

Common in thickets, not in open grasslands.

29. **Tephrosia tinctoria** Pers.

An undershrub with imparipinnate leaves; leaflets 9 or more, their undersurface pubescent. Racemes mostly terminal. Flowers red, October-December. Pods flat, slightly curved, about 4 cm. long. The empty pods persist on the plant after dehiscence.

Abundant only in certain places; commoner at lower elevations.

Caesalpineaceae

30. **Cassia leschenaultiana** DC.

A low, diffuse or decumbent perennial herb. Leaves 3-5 cm. long, paripinnate; leaflets 16-24 pairs. Flowers on pedicels up to 1.5 cm. long, solitary, axillary, yellow. Flowering more or less throughout the year, abundant from August to September. Pods hairy, throughout the year.

Both abundant and common. It is easily distinguished from *C. mimosoides* L., a similar plant, which has 30-50 pairs of leaflets and glabrous pods.

Rosaceae

31. **Rubus ellipticus** Sm. The Yellow Raspberry

A large gregarious straggling shrub. Stems armed with curved prickles; tender parts covered with white tomentum and red hairs.

Leaves pinnately trifoliate, rugose, obovate; the middle one the largest, 9×7 cm.; lateral ones 6×4 cm.; margins serrate. Flowers white, in terminal or axillary clusters, drooping; abundant in September, less so during the rest of the year. Fruit a globose aggregate of drupes, yellow when ripe. The fruit of this and the two following species are delicious when ripe.

Abundant and common along roads, paths, and edges of forests.

32. **Rubus fairholmianus** Gardn. The Purple Bramble

A large, prickly shrub, about 2 m. high, gregarious. Stems, chiefly the young parts, covered with dense woolly tomentum. Leaves simple, 3- or more-lobed, up to 25×10 cm., rugose, cordate at the base; undersurface tomentose, almost black when dry. Stipules fimbriate. Inflorescence terminal; flowers white, throughout the year. Fruit an aggregate of drupes, dark purple when ripe.

Gregarious, but not common; this seems to be the lower limit of the distribution of this plant.

33. **Rubus niveus** Thunb.

A very prickly straggling shrub, with prickles along the stem, petioles, even along the midrib of the leaf. Leaves of 5-7 ovate-acute, serrate leaflets, covered with dense white tomentum on the undersurface. Inflorescence terminal or axillary; flowers pink, throughout the year with a peak in September. Fruit an aggregate of drupes, purple when ripe.

Often in groups in moist surroundings.

Saxifragaceae

34. **Parnassia mysorensis** Heyne The Grass of Parnassus of Kodaikanal

A slender herb with a perennial rootstock, occurring in clusters on wet rocks or in marshes. New shoots by August. Leaves radical, petioles 4-6 cm. long; lamina cordate. Scapes 12-20 cm. long, with a long bract about half way up; flowers white, from November onwards.

Only in moist places. The plant dries up early in January except in shady places, where it may be seen in flowers much later.

Crassulaceae

35. **Kalanchoe grandiflora** Wt. & Arn.

A stout, succulent herb, in dense clusters on or near rocks. Stems thick, cylindrical, with prominent leaf-scars. Leaves thick, orbicular-

ovate, 8×5 cm., opposite. Inflorescence terminal, 45 cm. or longer, branched. Flower buds appear by October; dense clusters of yellow flowers are abundant from December to March. Fruits are enclosed in the dry, persistent corolla tubes.

Abundant in clumps, chiefly along the edges of rocks; rare elsewhere.

Droseraceae

36. **Drosera burmanni** Vahl The Common Sundew

A herb of moist ground, often concealed by surrounding grass, with a permanent rootstock and no stem. Leaves red, spathulate, with long-stalked glands, forming a rosette on the ground. Scape 8-12 cm. Flowers white, in a scorpioid cyme. Flowers were collected in May, but data insufficient to determine the flowering season.

In moist ground; rare elsewhere.

37. **Drosera peltata** Sm. The Moon-leaf Sundew

A perennial, slender herb. Stems thin, up to 30 cm. long. Leaves peltate, alternate, cauline, dark, fringed by long-stalked glands. Flowers terminal, white; abundant after rains, fewer during the year.

Both common and abundant, especially in damp soil. Stains the paper red when dried for the herbarium.

Melastomaceae

38. **Osbeckia wightiana** Benth.

A well-branched, hardy shrub or small tree. Young parts densely pubescent. Leaves ovate-oblong, 3-8×2-5 cm., silky with white tomentum on the undersurface. Inflorescence of up to 5 flowers; calyx densely pubescent; corolla purple, 2-4 cm. across. Flowering starts by August; flowers abundant till October, persisting occasionally till May.

Abundant and common.

Cucurbitaceae

39. **Melothria leiosperma** Cogn.

A scabrid climber. Tendrils simple. Leaves very brittle, shallowly lobed. Female flowers solitary, male ones fascicled, yellowish; seen almost throughout the year. Fruit globose, green with white streaks when young, red when ripe.

Common at lower elevations; on rocks, in thickets, etc.

UMBELLIFERAE

40. **Bupleurum mucronatum** Wt. & Arn. The Common Hare's Ears

A slender, branched herb, 60-150 cm. high, with green, knotted stems. Leaves narrow, lanceolate, 6 cm. long. Umbels compound, terminal. Flowers yellow, from May onwards, quite abundant in September, scarce by January when the plant begins to dry up.

Fairly common but never abundant.

41. **Centella asiatica** Urban

A prostrate herb. Stems wiry, reddish, rooting at the nodes. Leaves orbicular with narrow sinus, 2×1 cm., larger in shady places. Umbels simple, peduncles 1-2 cm. long, few-flowered; flowers pink.

Both common and very abundant on any type of soil. The size of the plant varies much according to surroundings.

42. **Heracleum rigens** Wall. The Common Cow Parsnip of Kodaikanal Downs

An erect, branched herb, up to 150 cm. high. Rootstock thick. Stems pubescent, brittle. Leaves large, of 3-5 rounded leaflets with serrate margins. Umbels compound, terminal, spreading. Flowers yellow, June-September. The peduncle elongates much when in fruit. Fruit a double mericarp, elliptic, flat on drying. The plant is dry by November.

Fairly common and abundant.

43. **Pimpinella candolleana** Wt. & Arn.

An erect herb, up to 50 cm. high. Stem unbranched, slender. Basal leaves cordate, petioles 8 cm. long; cauline leaves with sheathing bases, 3-lobed. Umbels compound, terminal. Flowers white, July-November. Fruit papillose.

Common and abundant on slopes.

RUBIACEAE

44. **Anotis leschenaultiana** Wt. & Arn.

A perennial, procumbent herb, rooting at the nodes, densely tomentose throughout. Leaves ovate-acute, 2×1 cm. Inflorescence of trichotomous cymes, terminal. Flowers pink. Flowering August-December; but in moist surroundings, flowers may be seen almost throughout the year. Fruit a capsule.

Abundant in moist soil, especially on rocks, occasionally elsewhere.

45. **Galium asperifolium** Wall. The Indian Bedstraw

A scabrid, wiry climber often seen on shrubs, walls, etc. Stems rough, thin, 4-angled. Leaves opposite, oblanceolate, with 4-6 leaf-

like stipules. Fresh leaves appear in April, flowers are common in July-August and abundant in September. Flowers minute, yellowish. Fruits common in December; by January the plant dries up.

Common and abundant. The 4 or 6 leafy stipules are often mistaken for leaves (Gamble and Fyson). It has been noted that the leaves and stipules dry only after the stem has dried.

46. **Knoxia mollis** Wt. & Arn.

An erect herb, up to 90 cm. high. Stems cylindrical, or slightly 4-angled. Leaves ovate-acute, 6×2 cm., pubescent. Inflorescence in small terminal corymbs. Flowers bluish, abundant March-October. The large ellipsoid fruits, though few, are conspicuous.

One of the commonest and most abundant of the grassland plants.

47. **Oldenlandia herbacea** Roxb.

A small, branched, erect, annual herb, 10-25 cm. high, with small narrow leaves and small white flowers. Flowering October-December, after which the plant dries up.

Gregarious, often on rocks and in wastelands. This seems to be the higher limit of the distribution of this plant. Not mentioned by Fyson.

48. **Oldenlandia swertioides** O. Kuntze The Ground Lilac

A small shrub, up to 60 cm. high. Stem 4-angled, glabrous. Leaves sessile, ovate, 6×2 cm., yellow when dry. Inflorescence mostly terminal, at times axillary; flowers lilac, April-November; later in the year, stray flowers and fruits may be occasionally seen.

As common and abundant as *Knoxia mollis* Wt. & Arn. Conspicuous on slopes, above the surrounding grasses.

49. **Wendlandia notoniana** Wall.

A shrub or small tree. Leaves ternate, elliptic-lanceolate, 9×4 cm., pubescent on the undersurface. Inflorescence in dense, terminal panicles; buds appear by December, flowers are common by February, white, scented. Fruits from May onwards.

Abundant in certain places, but not common; it is much more common at lower elevations.

VALERIANACEAE

50. **Valeriana hookeriana** Wt. & Arn.

A slender, softly pubescent, annual herb. Stems 40 cm. long, often unbranched. Leaves opposite, the radical ones pinnate with

7 leaflets; odd leaflet ovate, lateral ones lanceolate. Inflorescence a profusely branched corymbose panicle. Flowers small, pink-white, April-October, abundant in September. Fruits crowned by white pappus.

Fairly common and abundant on grassy slopes. Young plants are seen from November onwards.

COMPOSITAE

51. **Ageratum conyzoides** L. The Floss Flower

An annual, 30 cm. high. Stems branched, pubescent. Leaves opposite, rugose. Inflorescence a homogeneous head; florets all tubular, light blue or purplish. The protruding purple styles are characteristic. Flowers abundant January-April, less so in the rest of the year. Achenes black.

Abundant but not common. A troublesome weed along roadsides, in wastelands, plantations etc.

52. **Anaphalis aristata** DC.

A viscid, green herb, up to 40 cm. high. Stems woody at the base, supporting many erect, pubescent, flowering branches. Leaves many, close, narrow, acute, clasping the stem with acute auricles; undersurface white. Heads many, homogeneous; bracts pink when young, bleached at the tip when old. Flowering November-January. Plants dry up by February.

In rather dry places; common but not abundant.

53. **Anaphalis beddomei** Hook. f.

A gregarious undershrub. Main stem decumbent, brown, with erect, ascending branches 30-60 cm. high, clothed below with the older leaves. Leaves oblanceolate, thin, 10×2 cm., with a layer of white tomentum on either surface, and with 5 prominent veins. Heads white, corymbose, with the outer peduncles longer so that the corymb is depressed in the centre. Flowering July-November.

Abundant in moist surroundings, especially near rocks, where they occur in groups.

54. **Anaphalis lawii** Gamble

An annual herb, very variable in size, 10-60 cm. high, the size depending on the kind of soil. Stems cottony, unbranched, bases covered with dead leaves. Leaves sessile, oblanceolate, 2-4×0.6-1.4 cm., cottony. Inflorescence in terminal heads, bracts rose-coloured.

Flowers abundant April-September; the dry, bleached bracts persist for a long time.

Not only common and abundant, especially on exposed poor soil, but one of the commonest herbs of the area.

55. **Anaphalis travancorica** Sm.

Resembles *A. beddomei* Hook. f., except for the noticeably larger, closer-set, thicker and silky leaves, and larger inflorescence heads. Flowering November-January.

Occurs in dense clumps on wet rocks and on moist earth banks; occasionally elsewhere.

56. **Artemisia parviflora** Roxb.

A perennial undershrub, 120 cm. high, conspicuous above the surrounding vegetation. New shoots from April onwards. Lower leaves cuneate, upper ones deeply pinnatifid; both with a pair of narrow stipule-like segments each at the base. Buds from July onwards; flowers August-December, on a panicle 30 cm. long. The dry panicles persist till March.

Common but not abundant. This seems to be the higher limit of the distribution of the plant. Gall formation on the stem is characteristic.

57. **Bidens pilosa** L.

An erect herb, up to 60 cm. high. Stem 4-angled, glabrous. Leaves opposite, pinnately trifoliate, leaflets serrate. Inflorescence a heterogeneous head, flat, with yellow discs and conspicuous white ray bracts. Flowers throughout the year. Achenes black, narrow, angled, surmounted by 2 barbed spines.

A very common and abundant wayside weed. Its wide distribution may be accounted for by the barbed spines on the achenes that cause the latter to penetrate into, and adhere to, the clothing of man and the limbs of animals, thus ensuring their dispersal.

58. **Blumea neilgherrensis** Hook. f.

An erect, aromatic herb, 60 cm. high, glandular-hairy all over. Leaves obovate-acute, up to 8×3 cm., smaller below the flowers. Heads without rays, in panicles; florets purple. Flowering April-June, probably at other times also.

Rare in distribution and numbers; always in shady places.

59. **Cnicus wallichii** DC. The Common Indian Thistle

An erect, stout herb, 90-180 cm. high, spiny all over. Stems branched. Leaves sessile, decurrent, variously lobed, margins armed

with sharp spines. Inflorescence terminal, on short, axillary, leafy branches, of homogeneous heads; outer involucral bracts spiny. Flowers June-September; florets purple. Achenes with feathery pappus.

Common, not abundant.

60. **Conyza ambigua** DC.

An erect herb, up to 90 cm. high. Leaves alternate, narrow, linear, up to 6 cm. long. Heads terminal, cylindrical; involucral bracts narrow, green. Florets yellow. Flowers July-March.

A wayside weed, abundant but not common. An introduced plant.

61. **Conyza japonica** Less.

An erect herb, up to 35 cm. high. Leaves sessile, spathulate, coarsely serrate. Heads nearly sessile, in terminal, rounded corymbs. Florets pinkish.

Rare.

62. **Conyza stricta** Willd. The Kodaikanal Groundsel

A branched herb, up to 30 cm. high, pubescent throughout. Leaves numerous, closely-set, entire, oblanceolate, 3-5×0.4-0.6 cm. Heads very numerous, terminal, in corymbs; florets yellow; flowers throughout the year.

One of the commonest plants in the area; occurs even in very poor soil.

63. **Emilia scabra** DC.

A herb with alternate, pinnatifid, basal leaves when young, and leafy throughout the stem when old. Stems 30-75 cm. high. Heads solitary on slender stalks; florets red. Flowers throughout the year.

Common but not abundant.

64. **Erigeron mucronatum** DC. 'Swan River Daisy' (Lloyd, 1909)

A perennial herb with slender branches spreading flat, from a woody base. Leaves narrow, oblanceolate, 2-4 cm., often 3-lobed. Flower heads terminal, often in pairs, peduncles long. Ray florets at first white, turning pink when old. Flowers February-May, fewer later. Stray ones throughout the year.

A very abundant plant all over the area, particularly along the sides of streams, on earth banks, etc. Fyson states that this is originally a Mexican plant, often in south India erroneously confused with *Vittadenia australis* A. Rich., an Australian plant.

The plant is supposed to have been introduced by Sir Vere Levinge, Governor of Madras (Lloyd, 1909).

65. **Eupatorium glandulosum** H. B. & K.

An erect shrub, 50-100 cm. high. Stems branched, reddish, glandular. Leaves opposite, ovate-acuminate, serrate. Flower heads homogeneous, in terminal corymbs. Florets white, scented. Flowering February-April. Achenes black, surmounted by white pappus.

A native of Mexico, now found as an escape, often growing in large numbers along the wayside etc., but not common. Not mentioned by Gamble.

66. **Laggera alata** Sch.

A scabrid, stout herb, up to 60 cm. high. Stems and branches angled and winged. Leaves alternate, oblanceolate, 7×1.5 cm., decurrent, sharply serrate, pubescent above, tomentose beneath. Flower heads drooping in the axils of the upper (smaller) leaves, forming a terminal panicle. Florets purple. Flowering November-April.

Fairly common and abundant, especially at slightly lower elevations. Conspicuous above surrounding grasses. Dry plants with the discs of the heads persist for months after flowering is over, sometimes even till the next flowering season.

67. **Senecio wightianus** DC.

A slender plant, 1 m. high. Stems slender, geniculate, scandent, prominently ribbed, profusely branched. Leaves simple, alternate, hastate, up to 7×3 cm., sharply dentate. Heads 12-20, on axillary corymbs; florets yellow. Flowering January-March. Small achenes with copious pappus.

Abundant in thickets, but not common.

68. **Vernonia fysoni** Calder

A straggling shrub, 120-150 cm. high, with cottony hairs throughout. Leaves elliptic, acute at both ends, 10×4 cm., green on the upper and yellowish on the lower side. Flower heads in terminal corymbs; florets purple. Flowering February-May.

Common but not abundant, on slopes, even in poor soil.

CAMPANULACEAE

69. **Campanula alphonsii** Wall.

A small, wiry, spreading herb, from a perennial rootstock, often on wayside walls. Stems slender, up to 30 cm. long, branched. Leaves obovate, with white tomentum on the undersurface. Flowers

mostly terminal, blue, few. Flowers were collected in December and May, but data insufficient to determine the flowering season.

Rare.

70. **Campanula fulgens** Wall.

An erect herb, up to 60 cm. high. Stems slender, usually unbranched. Leaves mostly crowded at the base, distant higher up the stem, elliptic, narrowed at both ends, serrate, pubescent. Spikes terminal; flowers often in whorls at irregular intervals along the spike. Flower buds start opening from the top. Flowering June-October; stray ones up to January. The colour of the flower varies from purple to almost white. Capsule 5-celled, opening by slits at the side.

Common and abundant on slopes. The opening of the flower buds from the top downwards is usual, but is this so constant as Fyson states?

71. **Wahlenbergia gracilis** DC.

A slender, perennial herb. Stems wiry, sparingly branched, up to 30 cm. high; many from the same perennial rootstock. Leaves linear, 2-3 cm. long, alternate. Flowers terminal on pedicels up to 15 cm. long. The size of the flower varies; the colour is deep blue to pure white. Flowers abundant in March-April after the first showers, less during the rest of the year.

At times one of the commonest and most abundant plants in open grasslands, with poor vegetation.

Lobeliaceae

72. **Lobelia excelsa** Lesch. The Giant Lobelia

A conspicuous, coarse herb, 1-4 m. high. Stems cylindrical, up to 5 cm. diameter, with soft pith inside. Leaves alternate, serrate, simple, villous, up to 35×5 cm., oblanceolate, persistent on the stem even after drying, giving the plant a shabby look. Flowers purplish brown, in dense terminal, solitary spikes 30-150 cm. long. Flowers December-March. Fruit globose, enclosed in the calyx tube. The dry inflorescence with the fruits and the persistent calyx tubes present an untidy sight, and remain long after the flowering is over.

Common and gregarious along roadsides, shola edges, etc., but is restricted in distribution. A solitary terminal spike is the rule; but if the terminal spike is cut in the bud stage, a dense cluster of smaller spikes spring up from near the apex of the plant.

73. **Lobelia nicotianaefolia** Heyne

Similar to the preceding, but with white flowers. Leaves glabrous, oblong, 12×4 cm.; spikes looser and thicker. Flowering February-March.

Rare at this altitude; more robust specimens at 4000-5000 ft.

ERICACEAE

74. **Gaultheria fragrantissima** Wall.

An erect shrub, 100-120 cm. high. Stems rough, branched, brittle. Leaves simple, alternate, ovate, 6×4 cm., coriaceous; petioles thick and red. Young shoots smooth and red. Flowers small, in axillary racemes, November-May; stray ones during the rest of the year. Calyx persistent as a fleshy coating around the fruit. Corolla white, egg-shaped, fragrant especially when crushed, with 5 small recurved lobes. Fruit a berry, blue when ripe, with a red stalk.

Common at edges of sholas, along waysides, etc., but restricted in distribution.

75. **Rhododendron nilagiricum** Zenk.

A tree 4-6 m. high, with rough and thick bark. Branches very brittle, usually only from the upper half of the stem. Leaves elliptic, 9×3 cm., acute at both ends, coriaceous, dark green on the upper surface, silvery when young and rusty brown when old on the lower; margins recurved. Flowers crowded in dense terminal bunches which are 10 cm. across, red. Flowers abundant December-February; stray ones till May. Capsule oblong, 2×1 cm., woody, opening from the top downwards into the component carpels, but leaving the central axis.

The only tree noted in the area under study. Conspicuous on slopes for the dense clusters of red flowers. Widely distributed.

PRIMULACEAE

76. **Lysimachia deltoidea** Wt. The Creeping Jenny

A slender, pubescent, trailing herb. Stems prostrate, 15-25 cm. long. Leaves opposite, ovate, 2×1 cm. Flowers yellow, solitary; pedicels up to 3 cm. long. Flowers April-July. Fruit a capsule, opening by valves.

Abundant in shaded, moist places; rare elsewhere.

ASCLEPIADACEAE

77. **Ceropegia hirsuta** Wt. & Arn. var. **stenophylla** Hook. f.

A thin, pubescent twiner, with a tuberous rootstock. Stems slender, twining on grasses, 30-40 cm. long. Leaves linear, 5-10×0.2 cm. (the

trinomial *stenophylla* refers to the narrowness of the leaf), pubescent. Flowers in 2-3-flowered axillary, peduncled cymes. Pedicels 1.5-2 cm. long, pubescent. Flowers reddish brown, with purplish spots; corolla 2-2.5 cm. long, narrow in the middle, inflated at both ends; lobes 5, connate by their tips, leaving 5 lens-shaped openings. Flowers August-October. Follicles not seen.

Fairly common on grass slopes, though not easily noticed, except when in flower. This seems to be the higher limit of the distribution of this plant. Not mentioned by Fyson.

78. **Tylophora fasciculata** Ham.

A slender plant with thick, fascicled roots; branches many. Lower leaves elliptic-acute, 5×2 cm.; upper ones lanceolate, 3×1 cm.; all opposite, glabrous. Flowers deep brown, small, crowded in umbelliform cymes, at times axillary, oftener terminal. Flowering April-May. Follicles not seen.

At times fairly common among grasses, though not easily noticed owing to the small size of the plant and flowers. Commoner at lower elevations. Not mentioned by Fyson.

Gentianaceae

79. **Exacum wightianum** Arn. The Giant Field Gentian

An erect, branched, leafy shrub, 40-120 cm. high. Stems square, winged, glabrous. Leaves lanceolate, 5-10×3-4.5 cm., 3-nerved, opposite, glabrous. Flowers blue, many, terminal or in the upper axils; pedicels up to 4 cm. long, recurved in fruit. Flowers mostly March-April, stray ones later on.

Gregarious here and there on slopes.

80. **Gentiana pedicellata** Wall. var. **wightii** Kurz.

A perennial herb, 6-12 cm. high. Radical leaves form a rosette on the ground, obovate, 1-1.5×0.5 cm. long. Flowers terminal, solitary, bright blue; common March-April, stray ones for the rest of the year. Fruit a capsule, dehiscing longitudinally into 2 valves, the empty capsule-valves persistent on the plant for some time.

Common everywhere, but plants occurring on moist ground are more robust, with more flowers. Ordinarily the flowers are only 5-6 mm. diameter, but Fyson reports flowers up to 15-20 mm.

81. **Swertia corymbosa** Wt.

An erect herb, with several shoots from a perennial rootstock, 15-45 cm. high. Stems cylindrical, ridged by decurrent leaves. Leaves

opposite, sessile, obovate, acute, narrower and shorter upwards. Flowers in the axils of the upper leaves, in pairs of corymbs. The colour of the flower is of various shades of blue; corolla marked with glands and blue nerves; flowering October-March.

Common and abundant. Very variable in size.

SCROPHULARIACEAE

82. **Calceolaria mexicana** Benth. The Common Slipper Flower

An erect herb with fleshy stems up to 45 cm. high. Stems and leaves covered with glandular hairs. Leaves opposite, deeply serrate, the basal segments even pinnatisect. Flowers axillary; corolla tube short and lips saccate, closed; colour bright yellow. Flowering October-December.

A native of Mexico, naturalized and common along shady banks of streams, as a weed in gardens, sometimes in waste lands. Locally abundant but not widely distributed.

83. **Pedicularis zeylanica** Benth. The Pink Rattle

A perennial herb up to 50 cm. high, often with many shoots from a single rootstock. Leaves alternate, oblanceolate, 2-5 × 1 cm., the margins variously cut and curved backwards. Flowers in the axils of the upper leaves, 2-lipped, pink; flowering October-December.

Common but not abundant; often found in moist localities, less often in drier areas. The many incisions on the lamina remind one of some fern-fronds. From a distance the inflorescence is often mistaken for that of *Satyrium*.

84. **Sopubia delphinifolia** G. Don

An erect herb up to 80 cm. high. Leaves opposite, the upper ones 1-2 cm. long, simple, linear; the lower ones pinnatisect with 2-4 pairs of filiform segments. Flowers axillary; corolla longer than broad, narrow below, inflated above, pink. Flowers were collected in November, but data insufficient to determine the flowering season.

Occurs in grass fields, a root parasite (Fyson). It is a plant of lower elevations.

85. **Sopubia trifida** Ham.

A pretty herb, 30-50 cm. high. Upper leaves simple, linear, 1.5-2 cm. long; lower ones larger, each with one pair of narrow segments. Flowers axillary, one or more in an axil; corolla broader than long, yellow with a purplish eye. Flowering starts with the first showers in March-April, and continues till December.

Common and abundant in grass fields.

86. **Striga lutea** Lour.

A scabrous herb, parasitic on roots of grasses, 10-15 cm. high. Stems sparingly branched. Leaves narrow, 3-4×0.5 cm., opposite. Flowers in the axils of the upper leaves; corolla yellow or white. Two sets of flowerings have been noticed: one from May to July, the other from November to January, probably depending on the rains.

Common and abundant in grass fields. Plants are more robust at lower elevations. Are the yellow-flowered and white-flowered plants just 2 forms of the same species?

Lentibulariaceae

87. **Utricularia graminifolia** Vahl The Common Blue Bladderwort

A slender water herb, 7-12 cm. high. Leaves linear, from stolons provided with small, dark purple bladders. Scape erect; flowers 1-3, purple, terminal or subterminal. Upper corolla lip obovate, lower one broadly arched in the middle; spur slender, pointing downwards. Flowers nearly throughout the year.

Plentiful in marshy soil, not seen elsewhere.

Gesneriaceae

88. **Didymocarpus tomentosa** Wt.

A ground herb with radical, broadly elliptical, rugose and densely tomentose leaves. Flowers bluish purple, on a branched, densely tomentose scape. Flowering May-December, depending on the rains. From time to time fresh blossoms have been noticed. Capsules 2 cm. long. The plant dries up by January.

Distribution poor, but abundant on rocks.

89. **Klugia notoniana** A. DC.

An erect herb with fibrous roots. Stems fleshy, smooth, 20-60 cm. high, swollen at the nodes. Leaves alternate, very oblique at the base, pubescent, up to 12×6 cm. Flowers conspicuous, bright blue, in racemes. Capsule spherical.

Found on rocks near streams in the shade; not seen elsewhere.

Acanthaceae

90. **Andrographis neesiana** Wt.

A hardy herb, 30-50 cm. high. Leaves ovate-oblong, 10×6 cm. Flowers in one-sided racemes crowding in dense terminal clusters.

Flowering starts in September, reaches a peak in January-March, and may last till June. Corolla purplish, the lips widely separated. Stamens 2, with broad, white filaments and black anthers. Capsules oblong or ellipsoid. By June the capsules dehisce, and the plant dries up.

One of the commonest and most abundant plants in the area, found even on very poor soil.

91. **Justicia simplex** Don

A herbaceous, pubescent, diffuse plant, from a perennial rootstock. Branches procumbent, geniculate. Leaves entire, ovate, pubescent. Spikes terminal, about 5 cm. long. Flowers throughout the year, with a peak in November. Bracts and sepals very hairy; corolla pink. Fruit an elliptic capsule.

Common even on poor soil. The size of the plant varies according to surroundings.

92. **Strobilanthes kunthianus** T. And. The Common Strobilanth of the open hill sides. The Great Blue Flower of the Nilgiris (Robinson, 1935).

A branched, gregarious shrub, 50-150 cm. high, varying considerably in size according to localities. Stem cylindrical in old parts, angular in the younger, swollen at the nodes. Leaves elliptic, acute at both ends, 4-6×2-3 cm., serrate, rough, greenish on the upper and whitish on the lower side. Flowers in dense terminal, usually branched, cone-like spikes, 6-14 cm. long. Corolla pale blue, 2-3×1.5 cm. Stamens 2. Capsule oblong.

Very abundant all over these hills, dominating the slopes along with the bracken. The periodical general blooming, clothing the slopes in blue, renders this plant a favourite of all. The local name of the plant literally means "The Flower of the Hills", and the plant is referred to in one of the Tamil classics. Records of eleven consecutive geneal bloomings at regular intervals of 12 years are at hand: 1838, 1850, 1862, 1874, 1886, 1898 (Robinson, 1935), 1910, 1922, 1934, 1946 (Anglade, unpublished), and 1958. However, stray flowers have been noted almost every year from 1950-1957.

Verbenaceae

93. **Clerodendrum serratum** Moon.

A robust, scarcely branched shrub, up to 180 cm. high. Stems 4-angled. Leaves ternate, serrate, elliptic, narrow at both ends,

16×6 cm. Inflorescence terminal, 8-12 cm. long. Flowers blue. Flowering April-November; stray flowers throughout the year.

Fairly common, but never abundant. This seems to be the higher limit of the distribution of this plant.

94. **Lantana camara** L. var. **aculeata** Mold. The Lantana

A strongly aromatic, straggling shrub, with recurved prickles along the angles of the stem. Leaves opposite, rugose, cordate, serrate. Flowers in corymbose spikes, pink, or blue and yellow at this altitude (orange-coloured at lower elevations). Flowers more or less throughout the year. Fruit a berry, black when ripe.

Common and abundant in waste land, in masses along the main road.

95. **Lantana trifolia** L.

A pubescent, hispid undershrub, up to 50 cm. high. Leaves subsessile, 8×3 cm., cordate, dentate, often ternate, at times opposite. Spikes terminal, short, or at times up to 5 cm. long. Bracts conspicuous, boat-shaped. Flowers pink, common in June; stray ones throughout the year. The axis of the spike seems to elongate in fruit. Fruit a berry, bright red when ripe, well protected by the boat-shaped, persistent bracts.

Not very common, though abundant in certain places. Not mentioned by Fyson.

Labiatae

96. **Anisochilus dysophylloides** Benth.

An erect, thick herb, 25-40 cm. high, silky all over, from a perennial rootstock. Leafy shoots appear in September. Stems tomentose, decumbent, branches ascending. Leaves opposite, elliptic, 2-5×1.5 cm., thick, aromatic. Inflorescence a spike, 3-8 cm. long. Flowers purple, strongly-scented, crowded along a cylindrical, erect axis. Flowers November-January; the dry spikes seen even in May.

Gregarious in dry places, on rocks, exposed summits of hills, etc.

97. **Calamintha umbrosa** Benth. The Catmint

A spreading herb. Stems angular, up to 80 cm. long. Leaves ovate, dentate, 3×2 cm., slightly pubescent, petioles 1 cm. long. Flowers purplish, in terminal and axillary whorls. Calyx tomentose, 2-lipped. Corolla with a flat upper lip and 3 spreading lower lobes. Flowers September-December.

Abundant in moist places, borders of sholas, but not common.

98. **Coleus barbatus** Benth.

A tomentose, aromatic, erect herb, up to 45 cm. high, from a perennial rootstock. Leaves alternate, 10×3 cm., lanceolate, slightly oblique. Flowers blue, in whorls on an elongated spike, May-October. Calyx distictly hairy.

Widely distributed, never abundant; commoner at lower elevations.

99. **Leucas linifolia** Spr.

A branched, erect herb, up to 45 cm. high. Leaves entire, linear-lanceolate, 8×0.5 cm. Inflorescence of terminal whorls. Calyx tube with a very oblique mouth, the upper lip conspicuously long and pointed. Corolla white, with a long lower lip.

Often gregarious on rocks, in waste land, etc.; it is a plant of lower elevations.

100. **Leucas ternifolia** Desf.

A branched, often gregarious plant, 30-40 cm. high, from a stout rootstock. Branches and leaves often in threes, covered with a velvety pubescence. Leaves elliptic, 1.5×0.4 cm., strongly one-nerved. Flowers often in 2 whorls about 3 cm. apart. Flowering starts in September, reaches a peak in October, and may last till June.

Common and abundant on slopes.

101. **Leucas vestita** Benth.

A robust herb, 60-120 cm. high, with brown pubescence all over. Leaves elliptic, 7-12×3-5 cm., coarsely serrate, tomentose. Inflorescence of large, spherical whorls, axillary or terminal. Bracts ciliate, 1 cm. long. Calyx slightly shorter. The brown upper lip of the corolla distinguishes this species from all the others. Flowers more or less throughout the year.

Along roadsides, etc. in moist soil. Locally abundant but not common.

102. **Micromeria biflora** Benth. The Lemon-scented Thyme

A strongly aromatic herb with a stout woody rootstock and many ascending wiry stems, 10-15 cm. long. Leaves ovate-acute, subsessile, 0.5 cm. long. Inflorescence normally in 3-flowered axillary cymes; flowers purplish, strongly scented. Flowering starts in February and continues till the rains.

Common, at times abundant, chiefly in grass fields, on walls, etc.

103. **Plectranthus coetsa** Buch.-Ham.

A stout herb, 60-150 cm. high, with densely villous stems. Leaves opposite, ovate-acute, 6×3 cm., densely pubescent, white on the

undersurface. Flowers in crowded terminal compound panicles up to 15 cm. long; flowers blue, October-January.

Abundant along roadsides, streams, but not common.

104. **Plectranthus wightii** Benth.

A pubescent herb, 30-60 cm. high. Leaves 10×6 cm. ovate-acute, dentate. Flowers white, speckled with red spots, arranged in spreading panicles with foliaceous bracts. Flowers December-February.

Abundant in moist areas, rare elsewhere.

105. **Scutellaria colebrookiana** Benth.

An erect, slender herb, up to 35 cm. high. Leaves deltoid, 2.5×2 cm., petioles 2 cm. long. Spikes 8-18 cm. long. Flowers September-November, probably at other times also.

Rare at this altitude; commoner and more robust lower down.

106. **Scutellaria violacea** Heyne

A sparingly pubescent, fleshy herb, 25-60 cm. high. Leaves ovate, crenate, 6×3 cm.; petioles 4 cm. long. Spikes 8-25 cm. long. Flowers white tinged with purple; July-January.

Abundant in shaded and moist places; rare elsewhere.

Amarantaceae

107. **Allmania nodiflora** R. Br. var. **angustifolia** Hook. f.

An erect herb, with many sparingly branched shoots from a perennial rootstock. Stems 6-20 cm. long. Leaves alternate, entire, 4×0.3 cm., acute, glabrous, brownish. Flowers in axillary sessile clusters, white; more or less throughout the year.

Common in dry places on rocks etc., but not abundant.

Polygonaceae

108. **Polygonum chinense** L.

A rambling stout herb, often semi-scandent along walls or in thickets. Stems reddish, swollen at the nodes; the ochreate stipules 1.5-2 cm. long. Leaves 7-12×3-5 cm., ovate-oblong, finely serrate. Flowers white, with a pinkish tinge, clustered in terminal panicles; nuts enclosed in fleshy perianth; both flowers and nuts seen throughout the year.

Abundant on hedges, at the edges of woods, etc.

THYMELEACEAE

109. **Lasiosiphon eriocephalus** Dcne.

A large, branched shrub, up to 180 cm. high. Leaves linear-oblong, 5×1 cm., entire, glabrous. Flowers in terminal, silky, globular heads; perianth tubular, 1-2 cm. long, densely woolly except for the yellow lobes. Flowers December-May.

Scarce at this altitude; more common and abundant at lower elevations where thickets of this plant dominate the hill slopes.

EUPHORBIACEAE

110. **Phyllanthus gardnerianus** Baill.

A very variable herb, about 15 cm. high at this altitude. Branches slender, numerous. Leaves oblong, 1×0.4 cm., green to brown, subsessile. Male flowers numerous, short pedicelled; female ones fewer, on filiform pedicels 2-3 cm. long. Flowers and capsules throughout the year.

Common and abundant. Though at this altitude the plants are dwarfed, specimens reaching 40-50 cm. high have been collected at lower elevations.

URTICACEAE

111. **Pouzolzia wightii** Benn.

A gregarious herb, 45-80 cm. high. Leaves lanceolate, 5×2.5 cm. strongly 3-nerved, ternate or opposite, gradually passing into floral bracts. Flowers pedicelled, on an axis 25-40 cm. long. Male flowers rounded, flat topped; female ones flask-shaped with a contracted mouth from which the stigma projects. Flowers almost throughout the year except during the cold months, when fruits are common.

Gregarious in cool places.

BURMANNIACEAE

112. **Burmannia coelestis** Don

A slender herb about 10-15 cm. high, occurring in very moist soil. Leaves reduced to ensiform, radical scales. Flowers solitary or a few, blue; were collected in June, August, and January-March. Probably throughout the year.

Only in very moist places, often along with *Utricularia*,

ORCHIDACEAE

113. **Aerides crispum** Lindl. The Common Pink Rock Orchid

A robust, usually epiphytic orchid. Stems stout, 5-25 cm. long. Roots thick, greenish white, clasping the host firmly. Leaves distichous, thick and close-set, 12-18×3 cm., notched into two unequal lobes at the tip. Racemes axillary, 25 cm. long or longer. Flowers large, rose-coloured. Flowering May-June. Once 4 stray racemes were noted in March. Few flowers seem to run into fruit.

This once common orchid has unfortunately practically disappeared from these hills!

114. **Cheirostylis flabellata** Wt.

An inconspicuous ground orchid of shady woods. Stems succulent, greenish and thickened at the base. Leaves 3-5, thin, brownish, ovate-acute, sheathing at the base. Scape 8-16 cm. high, with 5-8 flowers; the bifid, well-fringed lip is characteristic. Flowering January-February.

Abundant in the Eucalyptus forest at Shembaganur.

115. **Coelogyne glandulosa** Lindl. The Plantain Orchid

A ground orchid, the creeping rhizome bearing annually renewed pseudobulbs that carry 2 terminal leaves. Pseudobulbs 6-12×3 cm., green. Leaves 10-30×4 cm., green. Scape almost fully sheathed by bracts; flowers about 6, lasting for about 3 weeks, white, except for an inside yellow patch on the lip. Flowering March-April.

Gregarious on rocks; rare elsewhere.

116. **Eulophia nuda** Lindl.

A ground orchid, with tuberous rhizomes, 45-60 cm. high when in leaf. Leaves from a lateral bud, elliptic, lanceolate 30-40×6-8 cm. appearing after the flowering, and lasting till December. Scape brown, 30 cm. long, bearing a raceme of 6-15 flowers; flowers purple. Flowering March-May. Fruits 4 cm. long.

Gregarious locally, but not widely distributed.

117. **Eulophia pratensis** Lindl. The Yellow Ground Orchid

Vegetative parts and habitat similar to that of *E. nuda* Lindl., but seldom gregarious, and slightly smaller in size. Scape 15-25 cm. long, bearing a raceme of 4-8 yellow flowers. Lip broader than long. Flowering December-February.

More widely distributed than the preceding species. The plant is very variable in size apparently on account of the kind of soil,

118. **Habenaria crassifolia** A. Rich.

A ground orchid with an ellipsoid tuber. Stems slender, up to 30 cm. high, with sheathing, lanceolate bracts. Leaves only 2, fleshy, radical, flat on the ground 2-3.5 cm. diameter. Racemes 12 cm. long with 15-25 flowers; flowers small, 0.6 cm. across; ovary and club-shaped spur 1-1.5 cm. each.

Abundant but restricted in distribution; occurs also in poor soil.

119. **Habenaria digitata** Lindl. var. **travancorica** Fischer

A slender ground orchid, 15-30 cm. high. Leaves spirally arranged; lower ones ovate-acute, 3-4×1.5-2 cm., upper ones narrower and acuminate. Racemes 8-15 cm. long, with 6-20 nearly green flowers, matching in colour with that of surrounding grasses. The plant is easily distinguished by the filiform segments of the petals curving upwards horn-like. Spur shorter than the ovary, both enveloped by a long bract. Flowers August-November.

Abundant in grass fields, and widely distributed.

120. **Habenaria longicalcarata** A. Rich. Elephant's Head

A ground orchid, 30-60 cm. high, from an oblong tuber. Leaves radical, 3-5, oblong-acute, 5-10×1-2 cm., mostly near the ground. Flowers terminal, 3-5 only, white. Spur 10-15 cm. long, green, thick. Flowering June-October.

Common but not abundant; more abundant at lower elevations.

121. **Habenaria longicornu** Lindl.

Plant similar to the preceding species, but smaller (20-35 cm. high), and occurring in clusters. Leaves cauline, 4-8, narrow 3-7× 1-1.5 cm., from near the ground. Flowers more numerous than in the preceding (3-8), lip 3-partite, ivory white, the side lobes finely toothed. Spur up to 10 cm. long. Flowers August-November.

Gregarious, often in thin soil on rocky ground.

122. **Habenaria perrottetiana** A. Rich.

A stout ground orchid, 30-60 cm. high. Leaves elliptic-acute, 4-8×2-3 cm., closely set, gradually passing into floral bracts. Flowers 4-12, yellow, nearly covered by the large foliaceous bracts. Sepals obtuse, concave, 1.5×0.8 cm.; petals erect; lip longitudinally folded. Flowers in November.

A rare plant.

123. **Habenaria rariflora** A. Rich.

A ground orchid, 8-12 cm. high, occurring in large numbers. Leaves basal, 4-5×1-1.5 cm., oblong-lanceolate. Flowers white, 3-4

in a raceme. Petals 2-partite, segments curved backwards. Spur slender, curved, 6-9 cm. Flowering July-September.

In large numbers on thin soil on or near rocks.

124. **Microstylis densiflora** Fischer

A brownish ground orchid, only up to 12 cm. high. Stems slender, bare below the flowering axis. Leaves usually 2, plaited, 6-8×2-3 cm., ovate-acute. Racemes many-flowered, often under 6 cm. long. Flowers purple. Lip reniform, finely dentate. Flowering June-September.

Common, at times gregarious.

125. **Nervilia carinata** Sch.

A low ground orchid, often hidden by grasses, with a single, long-petioled (6-8 cm.), orbicular leaf 4×4 cm., which appears in June after the flowering and remains till December. Flowering April-June. Scape about 10-15 cm. long, bearing 3-5 small, purplish flowers supported by long bracts. Sepals and petals pale green; lip yellow, with purple veins and spots.

Common and abundant about Shembaganur, hidden among grasses. Not mentioned by Fyson.

126. **Peristylus goodyeroides** Lindl.

A ground orchid 20-30 cm. high. Leaves on the lower half of the stem, oblong, 8×3 cm. Spikes 6-10 cm. long, many-flowered; flowers greenish white, small, with characteristic globose spurs. The sepals and the lateral petals form a hood over the rest of the flower. Flowering July-November.

Common, especially in dry places; more common at lower elevations. Not mentioned by Fyson.

127. **Phyllomphax obcordata** Sch. The Common Purple Ground Orchid

A ground orchid, 10-25 cm. high. Stems leafy throughout. Leaves ovate-acute, green with a purplish base, 4×1.5 cm., passing into bracts. Bracts leafy, longer than the ovary. Spikes of 6-12 flowers; flowers vary from purple to white. Spur short and broad. Flowers May-August, with a peak in July-August.

Common and at times very abundant; very variable in the size of the vegetative parts and in the colour, shape, and size of the floral parts, especially the lip.

128. **Phyllomphax obcordata** Sch. var. **jantha** Hk. f.

Similar to the preceding species but a larger plant, up to 35 cm. high, found in cool, moist places. Stems purplish, leaves green with

purplish nerves, and larger flowers. Lip 2.5 cm. across, purple. Flowers June-August.

Less common and abundant than the preceding species.

129. **Platanthera susannae** Lindl.

A robust, leafy, gregarious, ground orchid. Stem leafy, up to 120 cm. high. Leaves ovate-oblong, 6-15×3-8 cm., passing into leafy bracts. Bracts lanceolate 9×3 cm. Flowers 3-6, white, fragrant, 5-9 cm. across; lateral petals linear; lip very large with pectinate side lobes; spur 12-15 cm. long, hidden within the bracts. Flowers September-November.

Poorly distributed. The size of the whole plant and structure of the lip make this a very conspicuous ground orchid.

130. **Satyrium nepalense** Don The Pink Twin-Spur

A ground orchid, 25-60 cm. high. The lowest 2 leaves radical, large, 10-16×6-10 cm., broadly ovate, with a sheathing base, spreading flat on the ground. Spikes stout, 10-25 cm. long, many-flowered; bracts larger than the flowers. Flowers pink to white. Lip erect, with a spur hanging from either side. The ovary is not twisted. Flowers August-November. The dry scape sometimes remains for months.

Common and abundant. A very variable plant, but the variations do not warrant the splitting into varieties.

131. **Spiranthes australis** Lindl.

A slender ground orchid, 15-25 cm. high, with a bulbous rootstock and thick, white roots. Leaves 4-5, clustered at the base of the stem, oblanceolate, 5-10×0.8-1.2 cm. Scape 15-25 cm. high, slender; spike spirally twisted, 6-9 cm. long, bearing 30-35 flowers. Flowers small, white, spirally arranged. Flowering March-June.

Abundant in moist ground, but not well distributed.

Hypoxidaceae

132. **Curculigo orchioides** Gaertn. The Yellow Ground Star

A small herb, with a stout, vertical rootstock, with radical, plaited leaves. Leaves lanceolate, 10-14×1.5 cm. Flowers solitary, or a few, bright yellow, stellate, close to the ground. Flowers appear soon after the first showers in March-April. Stray ones throughout the year.

Fairly distributed and abundant. An abundance of flowers with the first showers after the dry months is characteristic.

LILIACEAE

133. **Disporum leschenaultianum** D. Don The Nilgiri Solomon's Seal

An erect, profusely branched herb, up to 120 cm. high, with a creeping rhizome. Leaves broadly ovate, 7×4 cm., glabrous. Inflorescence often of sessile, terminal umbels. Flowers white, pendulous or drooping from curved pedicels. Flowering May-August. Berries dark blue when ripe, by November.

In moist places, in sholas, but not well distributed.

134. **Iphigenia indica** Kunth.

A wiry herb, up to 20 cm. high, often hidden in the grass. Corms globose, covered with brown scales, 1×0.5 cm. Leaves linear, 12-15×0.5 cm. Flowers terminal, solitary or in pairs; deep purple; perianth segments filiform. Flowers with the first showers in March-April. Fruit an oblong, 3-valved capsule, 1×0.5 cm., ripe by August-September.

Well distributed, but not abundant. Not easily noticed in the grass except when in flower.

135. **Lilium neilgherrense** Wt. The Nilgiri Lily

An unbranched, erect, leafy herb, 60-120 cm. high. The underground bulb sprouts with the first showers in March-April. Leaves lanceolate-acute, 8-10 cm., sessile, glabrous. Flower buds appear by June; flowers 2-4, white, 15×10 cm., terminal, spreading, trumpet-shaped, strongly scented; flowering August-October. Fruit an oblong, loculicidal capsule 6-9 cm. long, dehiscing by January.

Common on slopes, the large flowers render this plant conspicuous.

COMMELINACEAE

136. **Aneilema dimorphum** Dalz.

A decumbent herb, with a non-tuberous rootstock; roots fibrous; the plant spreading by the lateral branching of the rootstock. Stems 10-15 cm. long, leafy at the base. Leaves 4-6×0.5-1 cm. Flowers bluish, regular, in terminal dichotomously branched panicles; from July onwards, with a peak in December; the plant begins drying up by January. In the shade flowers are seen later in the year. Capsule oblong.

Common in moist surroundings.

137. **Commelina clavata** Clarke

A decumbent herb, with slender, geniculate stems. Leaves 4-6×0.6-1 cm., alternate, with sheathing leaf bases which are

noticeably ciliate. Flowers blue, in scorpioid cymes, protected by a spathe. Flowers most of the year, with a peak in August-September. The plant dries up by December. Fruit a 4-angled, oblong capsule.

Common and abundant.

138. **Cyanotis arachnoidea** Clarke The White Spider Legs

A decumbent herb, covered all over with silky pubescence. Stems stout, 25-40 cm. long. Leaves 4-5×0.6-1.5 cm., acute. Flowers bluish, in terminal, subsessile cymes with bracts below. Flowers nearly throughout the year. Fruit an oblong capsule.

Common and abundant even in dry places.

Palmae

139. **Phoenix humilis** Royle var. **pedunculata** Becc.

A perennial, erect shrub, up to 150 cm. high at this altitude. Stems marked with numerous leaf-scars. Leaves up to 120 cm. long, pinnate; leaflets 30-45 cm. long; spadix yellow, branched, monoecious; fruits orange when young, deep purple when ripe.

This is a plant typically belonging to lower elevations; one flowering was noticed in October. Only 3 plants were noted in the area under study. Not mentioned by Fyson.

Araceae

140. **Arisaema leschenaultii** Bl. The Common Cobra Lily

A juicy herb with a tuberous rootstock. Stems 60-90 cm. high, greenish mottled with purple spots. Leaf solitary, palmately compound; leaflets about 9, elliptic-lanceolate, 14×4 cm. The plant sprouts with the first showers in March-April; flowering May-July. Spadix enclosed in the spathe; sterile appendix stout, blunt. Fruits conical, on a fleshy receptacle, at first green, then red.

In shady places.

141. **Arisaema tortuosum** Sch. The Ratstail Cobra Lily

Very similar to the preceding species except for the sterile appendix of the spadix exserted from the spathe, resembling a rat-tail.

Same habitat as the preceding, but is less abundant.

Eriocaulaceae

142. **Eriocaulon brownianum** Ruhl. The Black-backed Hatpin Flower

A marsh herb with a thick rhizome. Leaves radical, linear, acute, 12-15×0.5-1 cm., tomentose. Scapes slender, 2-3 per plant, each

25-50 cm. long, tomentose, with a sheath 10-15 cm. long. Flowering March-June; flower heads flat. Involucral bracts appear whitish grey, but actually they are black, covered with silky tomentum.

Gregarious in marshy soil.

Cyperaceae

143. **Kyllingia cylindrica** Nees

A perennial herb, with a thick rhizome, 2-4 cm. long. Stems 10-15 cm. high. Leaves radical, linear, 5-15 cm. long. Heads of white spikelets terminal on the stem, cylindrical, protected basally by leaf-like bracts. Flowering July-December, after which the plant dries.

Common, and fairly abundant in places.

144. **Mariscus cyperinus** Vahl

A perennial herb, with erect stems 15-25 cm. high. Leaves radical, linear, 15-25 cm. long. Spikes divergent, 2-5 cm. long, with leaf-like bracts at their base. Flowering June-December.

Common and very abundant in places.

Gramineae

145. **Andropogon lividus** Thw. The Purple Grass

Culms usually 25-30 cm. high, smooth, thin but rigid. Leaves radical, linear, acuminate, 5-8 cm., erect. Spikes 2 only, 2-4 cm. long, terminal, divergent, purple; spikelets in pairs. Flowers May-December.

Common and abundant.

146. **Arundinella fuscata** Nees

An erect, stiff, perennial grass, 30-45 cm. high. Leaves mostly basal, narrow, linear 5-15×0.5-1 cm. Panicles 8-10 cm. long with a dense cluster of spikes. Spikes stiff, 3-4 cm., spikelets crowded along one side only of the spike, often in pairs, one spikelet having a longer stalk than the other. Flowering June-September.

Common and abundant.

147. **Brachiaria semiundulata** Stapf

A decumbent, villous grass. Leaves ovate, 1.5-4.5 cm. long, densely pubescent. Spikes 1-2 cm. long, few; spikelets irregularly arranged. Flowers August-November.

A shade weed. Common and abundant.

148. **Chrysopogon orientalis** A. Camus

A tall, handsome grass. Culms slender, up to 90 cm. high, with glabrous nodes. Leaves basal, 4.5-24×1-1.5 cm., acute, pubescent. Panicles 12-18 cm. long, branches ascending, bearing red hairs at the base of the spikelets. Spikelets in threes, middle one sessile and fertile, pale yellow, 0.6 cm. long; lateral ones pedicelled and sterile, 1.2 cm. long, red. The yellow anthers and stigmas against the red glumes, all raised up on a tall culm, make the plant conspicuous on the slopes. Flowers July-December.

Common and abundant.

149. **Eulalia phaeothrix** O. Kuntze The Auburn Tresses

A stout grass; culms 45-60 cm. high, with brown, tomentose, leaf-sheaths crowded at the base. Leaves slender, very sharp at the edges, acuminate, 15-45 cm. long. Spikes 5-10 cm. long, brown. Flowers June-September.

In large clusters near rocks.

150. **Heteropogon contortus** Beauv. The Spear Grass

A gregarious, variable grass; culms about 30-45 cm. high. Leaves from the middle of the culm, distichous, rigid, 3-7×0.4 cm. Spikes grey, 3-6 cm. long, with about 10 pairs of spikelets and a terminal odd sessile one. The spike terminates in a 'spear' made up of many awns twisted together. Flowers nearly throughout the year, with a peak in July.

Common and abundant. A troublesome weed, on account of the sharp and barbed awns which penetrate into the clothing of men and hairs of animals.

151. **Setaria pallidifusca** Stapf

A gregarious grass; culms about 30-40 cm. high. Leaves linear, 14-20×0.5 cm. Spikes cylindrical, usually 6 cm. long, pale yellow to reddish brown; spikelets dense, ovate-elliptic, 0.3 cm. long, deciduous, with about 10 barbed awns. Flowers September-November.

Abundant as a weed in gardens, scarce elsewhere. A fodder grass.

152. **Themeda cymbaria** Hack.

A robust, perennial grass; culms erect, up to 3 m., clothed with broad, coriaceous leaf-sheaths at the base. Leaves linear, up to 120 cm. long. Inflorescence 30 cm. or longer, a decompound spike; the individual spikes have each a spathe-like bract at the base and

consist of 6-11 spikelets. Flowers July onwards. The plant dries up or is burnt by January. Fresh leaves with the first showers.

Common on slopes.

153. **Themeda triandra** Forsk.

An annual, erect grass; culms up to 3 m. tall. Leaves linear. 25-50 cm. long. Spikes crowded, drooping in globose fascicles. Flowers July-November.

Common.

154. **Tripogon bromoides** Roth.

A slender, tufted grass; culms 10-40 cm. high, slender but rigid. Leaves 8-20 cm. long, rolled. Spikes 6-10 cm. long; spikelets 1.5 cm. arranged closely in two rows.

Gregarious near rocks.

Acknowledgements

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Fishing Methods for the Indian Shad [*Hilsa ilisha* (Hamilton)] in the Indian Region

BY

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PART II

(*With 3 text-figures and 7 plates*)

(*Continued from Vol. 56, page 275*)

6. Andhra Pradesh

The most important rivers in Andhra Pradesh where hilsa fishing is carried out are the Godavari and the Krishna. Hilsa is caught from the sea also along the Andhra Coast.

Gill net

Rangoon vala (Rangoon net). This is a drift net introduced from Rangoon, Burma, and is used below the anicuts in the Godavari and Krishna rivers for catching hilsa. In the Godavari, I have seen it being used below the anicuts at Bobberlanka, Maddurlanka, and Bigneshwaram, and I was informed that it is used in a similar manner at Dhowleshwaram also. Each net is 30 metres or more long, about 5 to 5.5 metres broad, and of fine netting with 10 to 13 cm. mesh. The head-line has a series of floats of *Avicennia* roots at regular

intervals while the lower portion is free. At one end of the head-line is a buoy of gourd and the other end is tied to the boat. The boat is manned by two or three persons and one person is in charge of the net. The boat is taken towards the anicut along one side of the river and, on approaching the eddies in the vicinity of the foot of the fall, the buoy is thrown into the river and then the net is paid out, the boat in the meanwhile proceeding to the opposite side trying to keep a course parallel to the anicut. What actually happens is that by the time the whole net is paid out, the boat as well as the net has drifted down a considerable distance. The fish ascending the river towards the anicut get gilled in the net that drifts down in the opposite direction. When the desired distance is traversed downstream, the boat is rowed back towards the opposite shore (from where it first started) hauling in the net and collecting all the gilled fishes. The process is repeated, the catches being more when the flood level is high and the current strong. The whole operation is diagrammatically represented in Plate XVI, fig. 18.

Seines[1]

Pedda ayilu or *Pedda vala.* This is a drag net composed of 6 to 10 pieces, each 30 metres long and 18 metres broad with 2 to 2.5 cm. mesh. The head and ground ropes are made of coir and are provided with wooden floats and brick sinkers respectively. Two six-ton boats pay out the nets simultaneously as they proceed towards the shore describing a semicircle. The end ropes are given to two groups of 30 to 35 men on the bank to be dragged as a typical shore seine. The net is operated in the estuaries of the Godavari River and is reported to bring in heavy catches of hilsa.

Vusa vala. This is a drag net about 460 to 600 metres long and about 3 metres broad with floats about 1.5 metres apart along the head rope. The mesh is about 10 cm. and the ground rope has burnt bricks as sinkers. The net is cast by a couple of boats and then hauled from the bank of the estuary as typical shore seine.

Thelu vala. This is a boat seine about 530 metres long and 2.7 metres broad with 10 to 13 cm. mesh and 350 floats along the head rope and brick weights along the ground rope. It is operated in combination with *kettu vala* below the Godavari anicut when the level of the water begins to fall after the floods. *Kettu vala* is a wall net about 460 metres long and 1.5 metres broad with about

[1] My thanks are due to Mr. I. Ram Mohan Rao, Deputy Director of Fisheries, Andhra, for kindly arranging to furnish the information on the drag nets used for hilsa fishing in Andhra State.

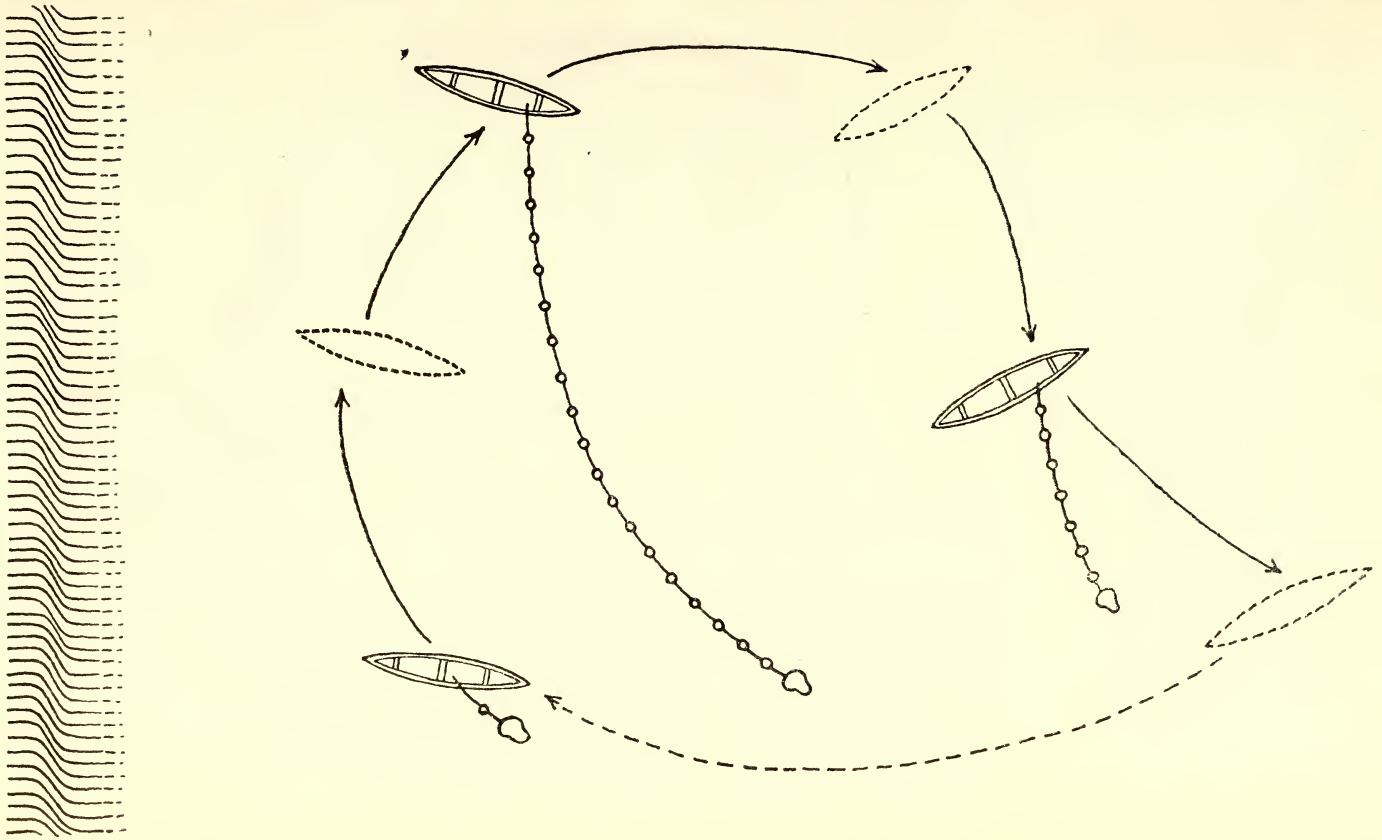


Fig. 18. Diagrammatic representation of the operation of the *Rangoon vala* in the Godavari (Andhra). (By M. Mydeen Kunju).

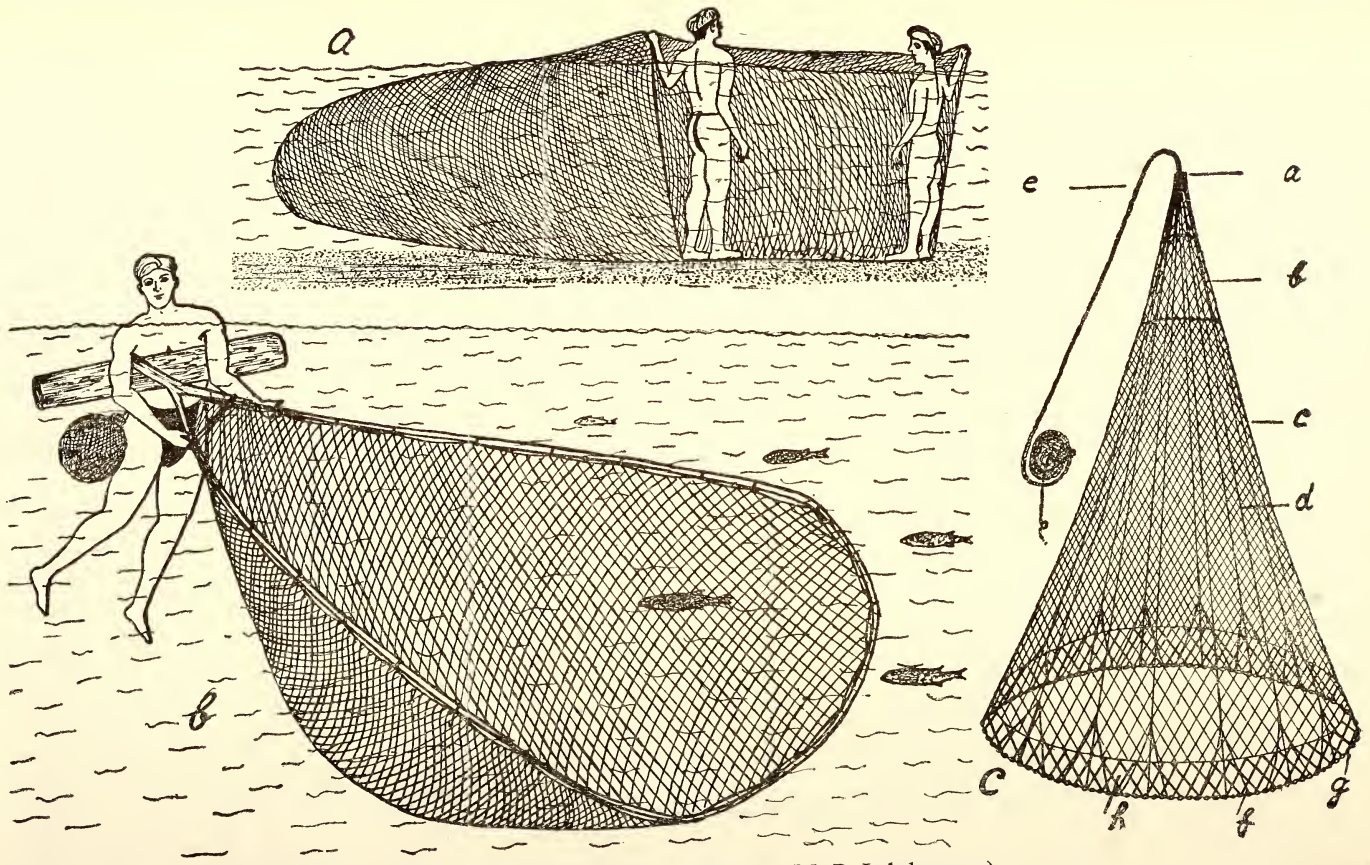


Fig. 19. a.—*Thuri valai* of the Coleroon, Madras. (M. P. Lakshmanan).
b.—*Kappu valai* in the Coleroon, Madras. (Modified from Hornell 1950).
c.—*Veechu valai* of Cauveri Delta. (By M. Kumaran).
a=*Mothiram;* b=*Patsipathal;* c=*Mal;* d=*Vanku-kayir;* e=*Ul-kayir;* f=*Kala-kayir;* g=*Mani;* h=*Velladi.*

10 cm. mesh with coir head rope and ground rope without floats and sinkers. This net is firmly tied to poles fixed across the river below the anicut with the bottom rope close to the river bed. The *thelu vala* is loaded in two boats of 4 to 6 ton capacity with about 6 men in each and is cast some distance away from the *kettu vala* and the two boats proceed towards it making an encircling movement. The *thelu vala* is dragged close to the *kettu vala* and the fish that congregate in the diminishing space are hauled into the boats. The operation is repeated till most of the fish in the particular area are caught.

Pelagic trawl

Iriga vala (Pl. IX, fig. 11 *a*). This has already been described under Orissa (p. 265).

Cast nets

Vessur vala. Two ordinary cast nets are joined together side to side and cast in a circle with the help of two boats. The water is disturbed with bamboo sticks when one side is still open. The nets are then hauled out of water into the respective boats and the fish, if any found inside, is taken out.

7. Madras[1]

The important hilsa ascending river in the Madras State is the Cauveri and its main deltaic branch, the Coleroon. Most of the fishing is done below the lower anicut in the Coleroon. Hilsa is caught during certain months from the sea also. Both *Hilsa ilisha* and *H. toli* occur in the sea off the Coromandel Coast. The *Kappu valai* fishing and the fish drives in the Coleroon have already been mentioned by Hornell (1946 and 1950).

Gill nets

Kanni valai. This is an untanned gill net about 55 metres long and about 3 metres broad. It is made of 14 ply 20 count cotton thread and the mesh is of 3 inches. The head rope has floats of *Calotropis gigantea*, locally known as *erukh* or of *Erythrina indica.* There are 70 floats in all tied at intervals of 12 meshes. The ground rope has weights of burnt clay (5 cm.×2 cm.) at irregular intervals. At one end of the head rope is a long pointed threading peg or

[1] I am indebted to Mr. Ranganathan, Assistant Director of Fisheries, Tanjore, Mr. Balasubramanian, Inspector of Fisheries, Kumbakonam, and Mr. Kesavan, Inspector of Fisheries, Negapatam, for local assistance rendered during my visit to the Cauveri Delta to study the hilsa fishing methods.

korpan-kutchi of the Portia Tree (*Thespesia populnea*) measuring about 50 cm. which is used for gathering the net in folds. The net is held against the current by 8 to 12 persons who stand in a row along the entire length of the net treading on the foot rope. The net portion, known as the *maal*, curves in the form of a bag by the force of the current.

Kettu valai. The *kanni valai* mentioned above is used without the floats and sinkers as a fixed gill net. The head and ground ropes are stouter and these are tied to stakes and fixed in the bed of the river. For a single net about 55 metres long, 8 stakes are fixed equidistant from one another, and the length of one operational unit will depend on the stretch of river to be covered.

Quite often *kanni valai* and *kettu valai* are operated in combination and invariably so at the time of regular fish drives referred to on p. 428.

Rangoon valai or *Ulla valai* or *Ullam valai* or *Kanni valai* (Drift net). This is a drift net of the type used in the Godavari and the Krishna rivers. It is operated in the lower reaches of the Cauveri and its deltaic branches during low tides. Formerly the net was obtained readymade from Rangoon, Burma, and hence the name *rangoon valai.* At present they are made locally from mill-made yarn (equivalent to 10 count 6 ply thread) and is said to be not as effective as the imported ones. The mesh size is 11.5 cm. and an operational unit consists of 6 pieces, each 27 metres long and about 5 metres wide joined together. The head rope has small floats of *Avicennia* roots, 2 metres apart from one another. There are no weights or ground rope. The net is cast across the river and is allowed to drift down with the boat during low tide. Small nets operated in canals are sometimes known as *ulla thundu* or *ullathundu valai.*

Thedachi valai. This is a gill net operated along the Coromandel Coast for all kinds of fishes. During the months of April and May some quantities of hilsa, presumably both *Hilsa ilisha* and *Hilsa toli,* are caught from the sea with this net. In some places including Cuddalore and Pondicherry this is also known as *kanni valai.*

Thedachi valai is a long untanned gill net of 11 cm. mesh made of 3 ply 10 count or 9 ply 20 count cotton yarn. Its length varies from 185 to 460 metres and the breadth is about 3 metres (covered by 24 meshes). The head rope has wooden floats 4 metres apart and the ground rope has stone weights alternating with them. The net is operated from a catamaran with a crew of 3 or 4 persons during night time. After the whole net is paid out, the catamaran is anchored and the fish that get gilled are removed from time to time.

Thuri valai (Pl. XVII, fig. 19 *a*). The net known by this name in the Lower Anicut is quite different from the well-known *thuri valai* of the Coromandel Coast operated in the sea like a pelagic trawl with a pair of catamarans. The *thuri valai* of the Lower Anicut is a simple dome-shaped net of about 7 metres in circumference and shaped into a bag about 1.5 to 2 metres deep when set against the current. It is made of 20 count 12 ply or 10 count 6 ply cotton yarn with a stout cord along the circumference which prevents the net from getting unduly stretched out. The net is held against the current by two persons who tread on the lower margin to keep it close to the bed of the river. It is used close to the anicut and all fishes including hilsa that are carried down by the force of the current get gilled.

Push nets

Kappu valai (Pl. XVII, fig. 19 *b*). This is the simplest type of net in operation and consists of a large oval ring net fixed to the V-shaped (forked) branch of some hardwood tree like *Thespesia populnea*. The height of the net including the handle is from 3 to 3.5 metres and the greatest width from 1.2 to 1.5 metres. The ring is made up of a pair of small bamboos, split or whole as the case may be. The handle is about 46 cm. long and the fork about 30 cm. In some a cross bar is tied across the extremities of the fork to give strength to the frame. The net is made of 20 count 6 ply or 40 count 8 ply cotton thread. The size of the mesh varies from 2.5 to 6 cm., the larger meshed ones being used when operated for hilsa.

The *kappu valai* is used in two ways. When specially used for hilsa at the time of high floods, it is used as drifting push net by a person who floats down the river on a log of wood with the net held in front in which the ascending fish get gilled. The gilled fish are removed and deposited in a palm leaf bag with a detachable lid having a *chevaux de frise* opening which prevents the escape of a fish, or it is killed by biting and threaded on to a cord tied to the waist. After covering some distance the person gets on to the bank, retraces the distance on foot and repeats the process.

It is also used in the manner of a typical dip-net by fishermen who remain standing in the water by the side of open sluices. All varieties of fish including hilsa that congregate in such places are caught.

Cast nets

Veechu valai (Pl. XVII, fig. 19 *c*). This is extensively used in the Cauveri system and perhaps the largest group of fishermen operating

this net is at the Lower Anicut. All kinds of fishes from tiny carp minnows to large sized catfishes are caught with the help of this net. The mesh is quite variable but when mainly used for hilsa large meshed ones are used. The *veechu valai* of the Cauveri Delta is essentially the usual type of cast net of peninsular India. It is made of 20 count 10 ply cotton thread with 6×8 cm. mesh. The depth is about 3 metres and the circumference about 13 to 15 metres. There are about 150 iron weights of about 3 cm. length and 1.5 cm. thickness. Each part of the net has a name and these are indicated in the diagram. It is generally used untanned.

The *veechu valai* is operated in two ways. The commonest method is to remain on the bank or up to waist-deep water close to the shore and cast the net as usual and collect the caught fish in the palm leaf basket hung at the waist. Generally ten to twenty men stand more or less *en echelon* on either side of a pool near the sluice gate and cast the net giving very little chance for any fish in that stretch of water to escape. The other method known as *theppam* veechu (Pl. XVIII, fig. 20) is followed when fishing in deeper waters by a fishing unit of two persons. The fisherman stands on a raft made of about 5 or 6 logs of light wood locally known as *kalyanamaram* (*Erythrina indica*) and another person who wades in the water pushes the raft to the desired place.

Fish drives (Pl. XIX, fig. 21). The fish drives in the Coleroon in the Cauveri delta were events of considerable local importance in former days with the semblance of a *mela* when, unlike as at present, there was greater flow of water and more frequent floods in the river. With the construction of a number of dams and anicuts in the upper stretches of the Cauveri and its tributaries for diversion of water for irrigational purposes, floods are rare and even where they occur are only of very short duration reducing the hilsa fishery to an ephemeral feature.

The method generally adopted is as follows: Stakes are fixed across a selected portion of the river and *kettu valai* is tied to them so as to prevent the escape of fish. A number of *kanni valai* are joined together to cover the width of the river and the whole net is dragged towards the *kettu valai* by a number of fishermen. As hilsa collect together in large numbers in the diminishing space between the two nets, they are removed with the help of dip nets, scoop nets, etc. When the *kanni valai* meets the *kettu valai* the former is lifted up bringing into it most of the remaining fish. Auxiliary nets are brought behind to ensure the capture of the fish that escape from the net in front.

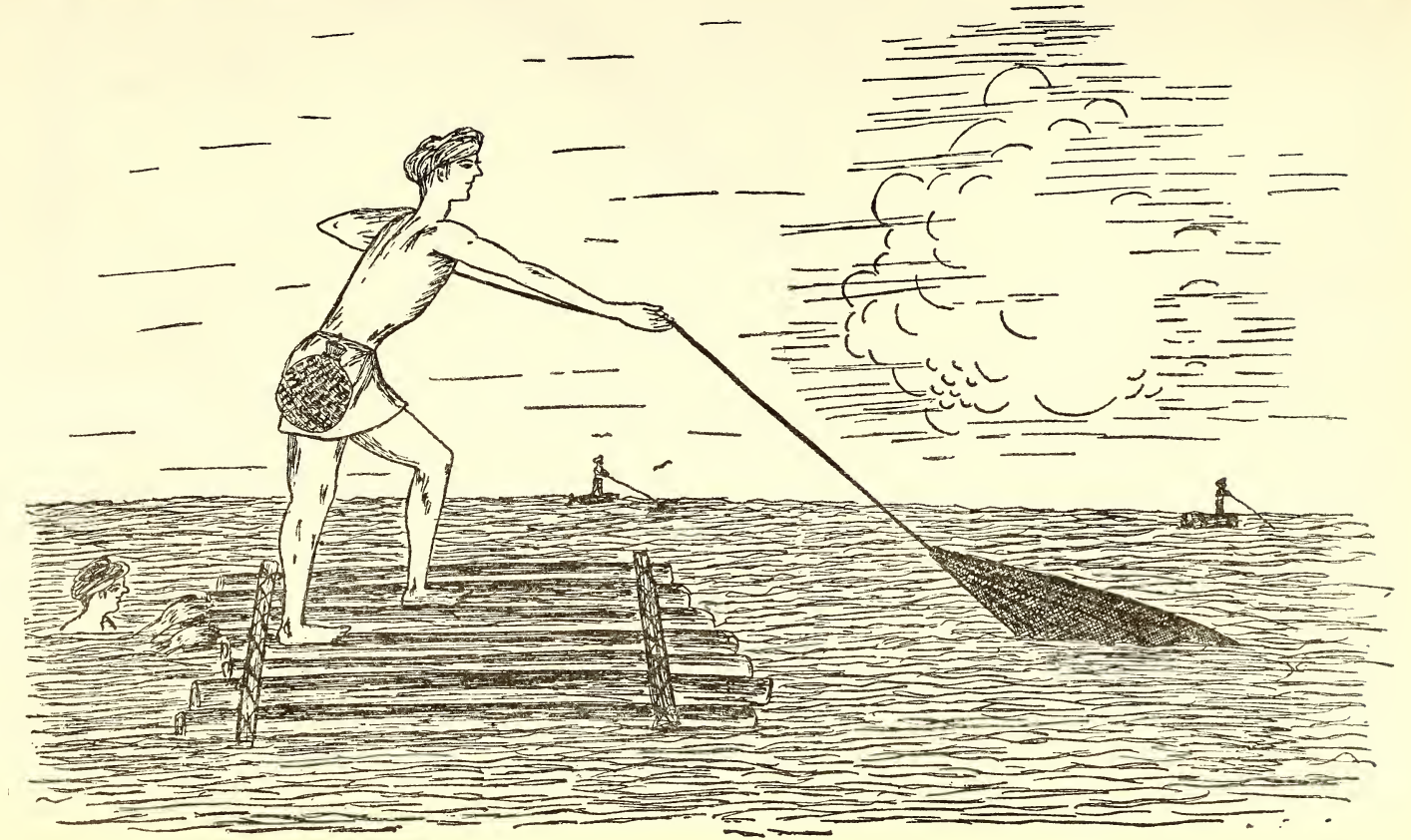


Fig. 20. *Theppam veechu* below the Lower Anicut in the Coleroon, Madras. (By M. P. Lakshmanan).

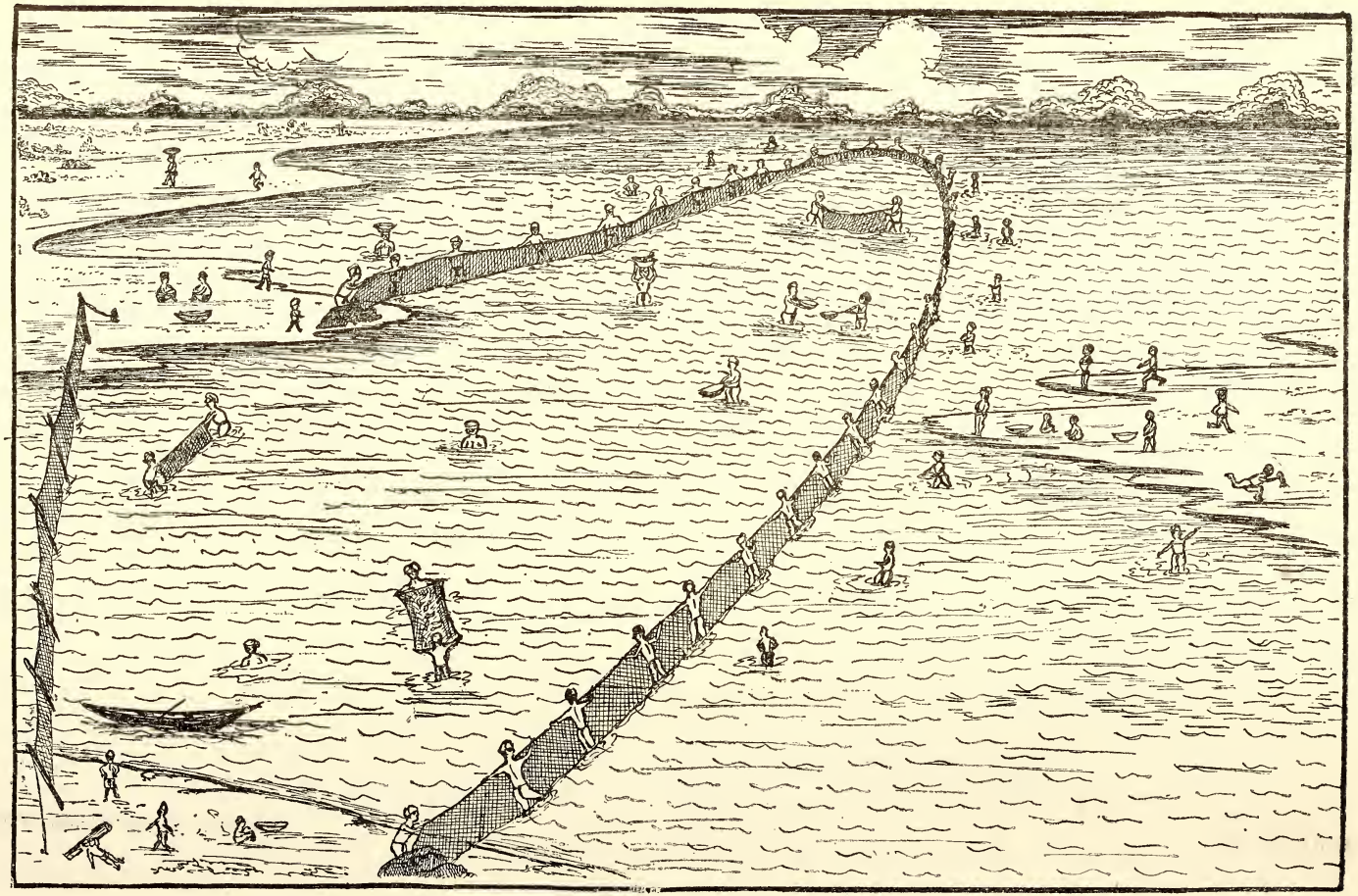


Fig. 21. Fish drive below the Lower Anicut in the Coleroon, Madras. (By M. P. Lakshmanan).

The operation is repeated whenever appreciable quantities of hilsa are known to be present in the river. The fishing rights in the river system are auctioned by the Government and the fish drives are organised by the lessees concerned.

8. Bombay

Kulkarni (1951) has given in fair detail, the methods employed for catching hilsa in Narbada River and its estuary. The fishing methods by the Bhils in the Narbada River have very interesting parallels in the Cauveri and Indus rivers in Madras and Sind respectively.

Gill nets

Budichi jal (Pl. XX, fig. 22 *a*). The fishing done in the Narbada estuary with this sunken drift net has been described by Kulkarni (1951 p. 619) as follows:

'The usual gear employed for large scale capture of hilsa in the Narbada River is sunken drift-nets. They are ordinary drift-nets, but, instead of floating near the surface they are set almost near the bottom and drift at that level. Each piece is about 72 feet long and 7 feet deep. Ten or twelve such pieces are joined together end to end as a single unit and are allowed to drift as a vertical wall. The nets are generally made of twisted hemp with a mesh of 5 inches (stretched mesh). Triangular pieces of burnt clay with a hole in the centre or some other similar articles are tied to the lead line and used as sinkers. About 16 floats, generally made of dry gourds are tied to the cork line (head rope) to keep the entire net erect in the water. The net is similar to the "Palwa jal", or "Hilsa net" described by Pillay (1948), which fishes at the surface. The position of floats on the surface gives the impression that the net is on the surface but actually there is a long string between the floats and the net (text-fig. No. 2). This length is adjusted according to the depth of the water fished so that the net remains in reality near the bottom of the river. In some places the earthen sinkers dangle half a foot below the head line (foot rope), so that the chances of the net getting entangled in bottom debris are reduced.'

'The boats used for the fishing are all flat bottom boats of about a ton in capacity varying from 20 to 30 feet in overall length. Each boat has a crew of three or four, one of whom is a skipper ("tindel") who manages the boat while the others operate the nets. After the net is cast, one end of it is tied to the boat which also drifts along with the net. It is paid out across the stream almost at right angles to the current so that it drifts downwards slowly and the fish swimming

upstream are enmeshed in it. After about half an hour, the net is hauled up to remove the catch and is paid out again for further operations. During spring tide period, these operations are continued day and night, and are suspended only when the catches dwindle towards the end of spring tide period.'

Palwa jal. This net is operated at Kodinar on the Kathiawar coast (Pillay 1948). It is a cotton drift net of 5 cm. to 6.3 cm. mesh made up of 30 to 50 pieces, each piece 28 metres long and 2.7 to 3.7 metres deep with a number of wooden floats tied to the head rope which is about 1.5 cm. thick. The foot rope is thin and without sinkers. The different pieces of netting are tied together by means of the free ends of the head and foot ropes and the composite piece is paid out so as to form a long wall of net drifting with the current. Fishing is carried out in the sea and the net is operated both day and night.

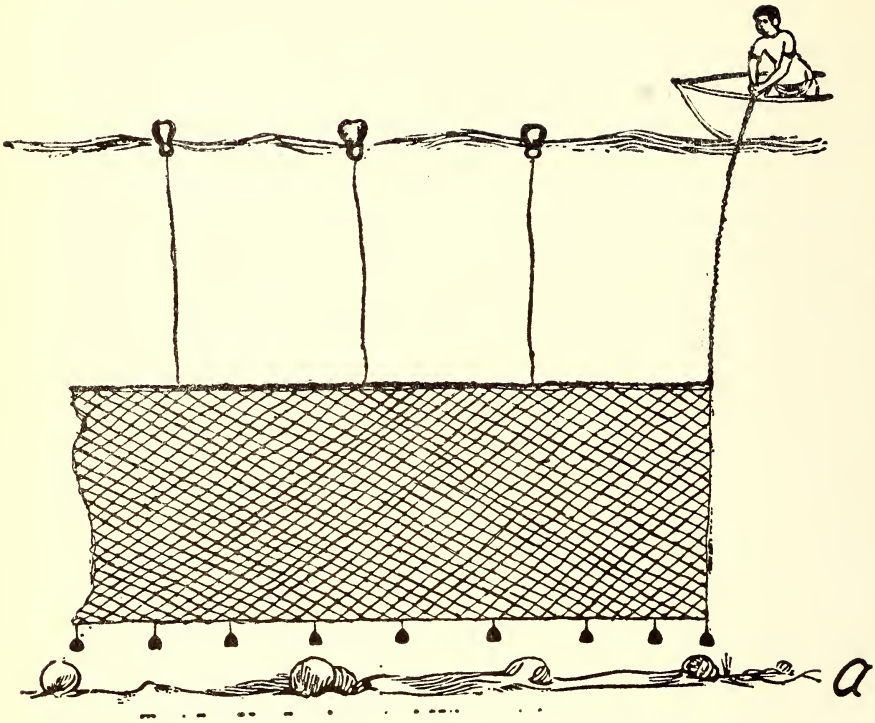
Valli jal. This is a fixed gill net operated in the marine and inshore areas of the Veraval and Porbunder coasts in Kathiawar. The operational net used in the Veraval zone consists of 30 to 40 pieces, each about 31 metres long and 2 metres broad with 10 cm. mesh. The head rope has wooden floats of about 30 cm. long and 7 cm. thick at about 2 metre intervals. The foot rope has no sinkers but the two ends are anchored and buoyed. Yarn of 12 ply 20 counts is used for the net and 12 ply 6 counts for the head line. The fishing season is from August to October and March to May. The net is operated in the early hours of the morning and hilsa is caught along with other fishes.

The *valli jal* of Porbunder zone is a multipurpose drift net operated in the sea from September to November and April to June. Each piece is about 77 to 86 metres long and 3 metres deep with 15 cm. mesh made of 12 ply 20 counts yarn and 7 such pieces are laced together to make one operational net. The head rope has cylindrical wooden floats at 2.5 metres interval.

Khanderi jal[1]. This is a gill net operated during the rainy season in the estuaries and creeks of the Veraval zone. Each piece is about 130 metres long and 3.7 metres deep with 7 cm. mesh made of 6 to 9 ply of 40 to 20 counts yarn. This is also a multipurpose net and hilsa forms one of the catches.

Pankha rach[1]. This is a fixed gill net operated in the estuarine areas of the Jamnagar zone. Each piece is about 29 to 36 metres long and 4.7 to 5.5 metres deep with 9 to 10 cm. mesh and 7 to 8

[1] Information on *valli jal*, *khanderi jal*, and *pankha rach* has kindly been furnished by Mr. K. R. Srivatsa, Director of Marine Products, Rajkot, Saurashtra.



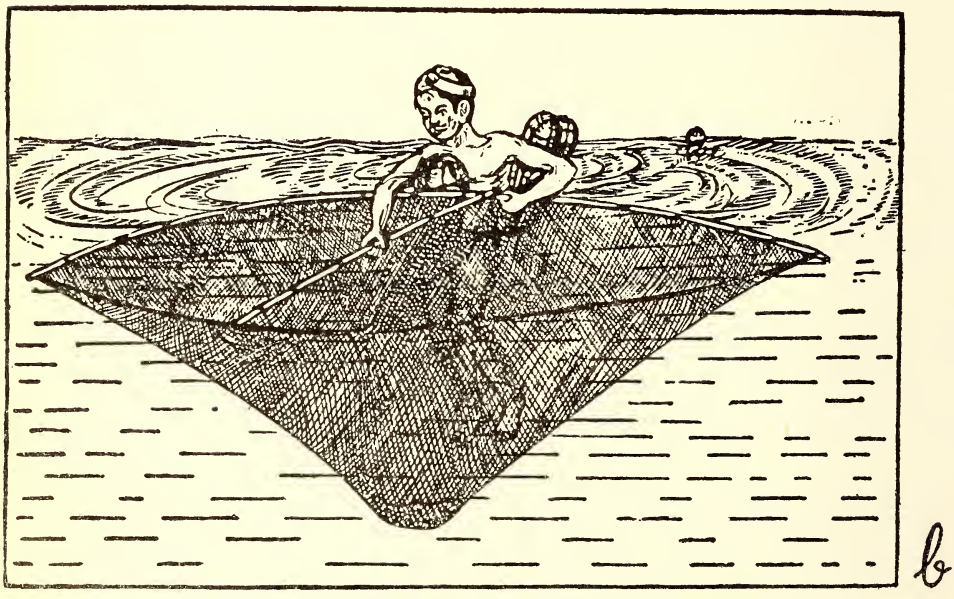


Fig. 22. a.—*Budichi jal* of Bombay. (After Kulkarni 1951).
b.—Operation of the *Jamda jal* of Bombay. (After Kulkarni 1951).

such pieces are laced together and used at a time. The head rope is tied to two poles fixed in the estuary while the ground rope which is provided with sinkers remains pressed against the mud at the bottom. All kinds of fish including hilsa are caught.

Lift net

Jamda jal (Pl. XX, fig. 22 *b*). In principle this is similar to the *kappu valai* fishing by the Cauveri (Madras) fishermen and the *sumbokee* and *matlee* fishing by the Sind fishermen. The fishing has been described in detail by Kulkarni (1951). The 'Bhil' fishermen catch the ascending hilsa with *jamda jal* during high tide when the maximum movement of the fish is expected. The *jamda jal* is a dip net with a loose bag-like net portion and a wooden cross bar across the centre (see Kulkarni op. cit. for particulars). The fisherman with the net in his hands drifts with the current supported on a float of dry gourds encased in a meshwork of coir. As soon as an ascending hilsa strikes the net, it is lifted and the fish is retrieved and secured to a cord with a float at the end tied to the waist of the fishermen. Eight to ten fishermen drift down in a line and cover in one operation a stretch of river about 5 miles long and then walk back to the starting place. Each fisherman gets five to ten fish a day.

II. PAKISTAN

In Pakistan from the hilsa fishery point of view, East Bengal constituting the eastern wing of the country is the most important while Sind lying in the western wing comes next in order.

1. East Bengal

As stated already under West Bengal the fishing methods employed in the two Bengals are the same in principle as well as in details. All the methods enumerated under West Bengal are employed in East Bengal also, except that in view of the vastness of the fishing areas and greater fishing activity, a number of modified methods are in vogue. Ahmad (1952 & 1954) in recent accounts on the fishing gear of East Pakistan and Hilsa Fishery of East Bengal has described briefly the methods employed there for catching hilsa and the relevant extracts from it are quoted here. The description of the *bundh jal* is based on the information furnished by a fisherman who migrated from East Bengal.

Clap nets

Kharki jal. See under West Bengal (p. 252). This is known as *sharki jal* in Pabna and the dimensions of the net which vary in different districts (Ahmad 1954 *a*) are given below:

Rajshahi.—3.7 to 5.5 metres by 3 to 3.7 metres, with mesh of 4 cm.

Pabna.—6.7 to 7.3 metres by 4.5 metres, with mesh of 6.3 cm.

Kushtia.—8.2 metres by 1.8 to 4.2 metres with 5 to 7.5 cm. mesh.

Faridpur.—7.3 to 9 metres by 7.3 to 9 metres with 9 cm. mesh.

Dacca.—9 metres by 4.5 metres with 5 cm. mesh.

Tippera.—6 metres by 7.3 metres with meshes from 4.5 to 5.7 cm.

Shangla jal. See under West Bengal (p. 253). This net is known as *khosh jal* in Bakarganj, *hilsa jal* in Mymensingh, and *lawa jal* in Sylhet. The dimensions of the net in the different districts as reported by Ahmad (1954) are as given below.

In Rajshahi it measures 4.5 to 5.5 metres by 3 to 3.7 metres with 4 cm. mesh, in Rangpur 4 to 4.5 metres by 5.5 to 6 metres with meshes from 5 to 6.3 cm., in Pabna 7.3 by 3.7 metres with 5 cm. mesh, and in Khulna 9 metres by 2.1 metres with 2.5 to 4 cm. mesh. In Kushtia it is 6.2 to 8.2 metres by 1.8 to 2.7 metres with 5 to 7.5 cm. mesh, in Tippera 7.3 to 8.2 metres by 3.7 to 4.9 metres, with 2.5 to 6.3 cm. mesh.

Biri jal. This in principle is similar to the *shangla jal.* Ahmad (1954) has described this net which is used in Mymensingh throughout the year for catching small-sized fish. It is 9 metres long and 14 metres wide, the meshes of the upper part of the net being 6.3 cm. while the meshes of the lower part are as small as .3 cm.

Honga jal. 7 metres long, 3 metres in breadth, with 5 to 10 cm. mesh, is used in the district of Sylhet from April to November for catching hilsa and is similar to the *biri jal* (Ahmad 1954).

Gill nets

Apsha jal has weights attached to its lower rope and nets used in Bakarganj measure 274 metres in length, 6 metres in width, with 2.5 cm. mesh. It is used from November to March for fishing hilsa (*Hilsa ilisha*) and some other species. *Apsha jal* is also used in Faridpur.

Barain jal. 9.5 metres long, 7.5 metres deep, with mesh size of 4 cm. This net is employed in the district of Chittagong in September and October for capturing hilsa.

Chhandi jal. See under West Bengal (p. 254) for the description of the net. In East Bengal it is employed for gilling hilsa from May to October in the districts of Chittagong, Noakhali, Bakarganj, Pabna,

Dacca, Tippera, and Faridpur. The net is laid at night and hauled in the morning (Ahmad 1954).

Chapila jal. Measures 150 metres by 27 metres with 1.3 to 2.5 cm. mesh and is used in the district of Mymensingh throughout the year for catching chapila (*Gadusia chapra*), bhangon (*Mugil* sp.), pangas, and hilsa (Ahmad 1954).

Dar jal measures from 5.4 to 9 metres in length, 4.5 to 8 metres in depth, and has meshes from 4 to 5 cm. It is used in the district of Tippera from April to November for catching hilsa (Ahmad 1954).

Dora jal or *Ilish jal.* See under West Bengal (p. 254).

Era jal is made of Sun-hemp and is used in the district of Bakarganj. It measures up to 723 metres in length, 12 metres in depth, with meshes from 9 to 12.5 cm. It is employed for catching hilsa from May to November (Ahmad 1954).

Har jal is used in the district of Bakarganj by joining a number of pieces to form a net 610 metres long and 22.4 metres deep. The meshes of the nets are 5 cm. It is operated for catching hilsa, silond, pangas, etc., from June to November (Ahmad 1954).

Khot jal is 15.2 metres by 4.5 metres with 5 cm. mesh and is used in the district of Bakarganj from June to November for capturing hilsa (Ahmad 1954).

Pye jal. According to Ahmad (1954) this net is used in Bakarganj throughout the year for catching a variety of fishes including hilsa. It is 274 metres by 6 metres with 2.5 cm. mesh.

Tuni jal is used in the district of Tippera for catching hilsa during the months from April to June. It is 13.7 metres by 6.7 metres and has a mesh of 5 cm. (Ahmad 1954).

Seine nets

Bara jal. See *jagat ber jal* under West Bengal (p. 257). According to Ahmad (1954) this net is also known as *jagat ber*, *gogar* and *maha jal.*

Ber jal. This net is reported to be used both as a drag net as well as a seine net. See under West Bengal (p. 256).

Kona jal or *Bhasha gulli.* See under West Bengal (p. 257). The size of the net differs considerably in the different parts of the country. In Faridpur this net has only one pocket situated at one end. The net alone measures 9 to 10 metres by 6.3 to 11 metres with mesh of 5 cm. (Ahmad 1954).

Chhota ber jal. From the name (*chhota*=small) it means a small *ber jal.* This is used for catching a variety of fishes except in

Bakarganj where this is employed for catching hilsa. The net is about 91 metres by 4.6 metres with mesh of about 4.5 cm.

Dhop jal. This net is used in the district of Bakarganj for catching pangas and hilsa. It is 36 metres by 9 metres with 2.5 cm. mesh and has both floats and sinkers. A number of pieces are joined together for operation and is hauled while still afloat (Ahmad 1954).

Ghai ber jal. This is a very large seine net measuring up to 723 metres long and about 13.7 metres deep with 2.5 cm. mesh used for catching hilsa in the district of Bakarganj from November to April (Ahmad 1954). It has a series of pockets which prevent the fish from escaping.

Gulti jal. The net measures 305 metres in length, 6 metres in depth, and has mesh of 6 cm. It is used in the district of Bakarganj from June to November for catching hilsa. It has both floats and sinkers and has pockets (*ghai*) at the lower end which are formed by doubling up about half metre of the lower margin (Ahmad 1954).

Gultin jal is a hilsa net used in the district of Bakarganj, from April to September for catching hilsa. It is 46 metres long, 13.7 metres deep, with 5 cm. mesh. Like *gulti jal* it has pockets at the lower extremity and is also provided with floats and weights (Ahmad 1954).

Jangla jal. This net is used in the districts of Bakarganj, Pabna, Jessore, and Faridpur. In Faridpur it is 12 metres by 7.3 metres with mesh of 6 cm. and is operated from December to April for catching hilsa and a variety of other fishes. In Pabna the dimensions of the net are 9 metres by 3.7 metres with mesh of 1.3 cm. and the net is used from October to December for catching prawn. A number of pieces of the net are often joined at the time of operation. The lower end of the net is doubled up and is sewn to form pockets. The net is known by the name of *jangalia jal* in Bakarganj. In Pabna the *jangla jal* is used for catching hilsa (Ahmad 1954).

Kochal jal. See under West Bengal (p. 255). 'This net is called *kochal* in Kusthia, Pabna, Rajshahi, Bogra, and Dacca; *dora* and *kochal* in Jessore; and *kochal* and *jangil* in Bakarganj' (Ahmad 1954).

Patan jal. This net is used for catching hilsa in the districts of Pabna and Bakarganj. In Pabna it is 61 metres by 6 metres with 5 cm. mesh and is used from June to August, whereas in Bakarganj it measures 274 metres by 13.7 metres and has 5 cm. mesh. It is used for catching other fishes also (Ahmad 1954).

Tana ber jal. See under West Bengal (p. 256). This net is used in Dacca from September to May for capturing carp and hilsa and measures 152 by 4.6 metres with 5 cm. mesh. It has no sinkers (Ahmad 1954).

Drag nets

Ber jal. See under seine nets (p. 256).

Dara jal. This net measures 274 metres by 4.6 metres and has mesh of 6 cm. and is used for catching hilsa from November to April in the district of Bakarganj (Ahmad 1954).

Trawl net

Jangalia jal. This is a simple type of hand trawl. About a third of a rectangular netting is doubled up and sewn to form a long pocket. The free side of the netting is lashed to a long bamboo pole and sinkers are attached to the doubled up edge which help to keep the mouth of the bag open when the net is operated. Two short ropes with brick weights are tied to the two extremities of the bamboo pole and this helps to keep the upper part of the net at the desired depth when it is pulled along the water. This trawl net is used in Pabna for catching hilsa (Ahmad 1954). It may be recalled here that there is a seine net, a modification of *jangla jal* known by the name of *jangalia jal* in the district of Bakarganj (see p. 434).

Dip nets

Chhakni jal (Fig. 25). This is a small dip net used in the district of Faridpur for capturing hilsa when the fish swims near the banks of rivers (Ahmad 1952).

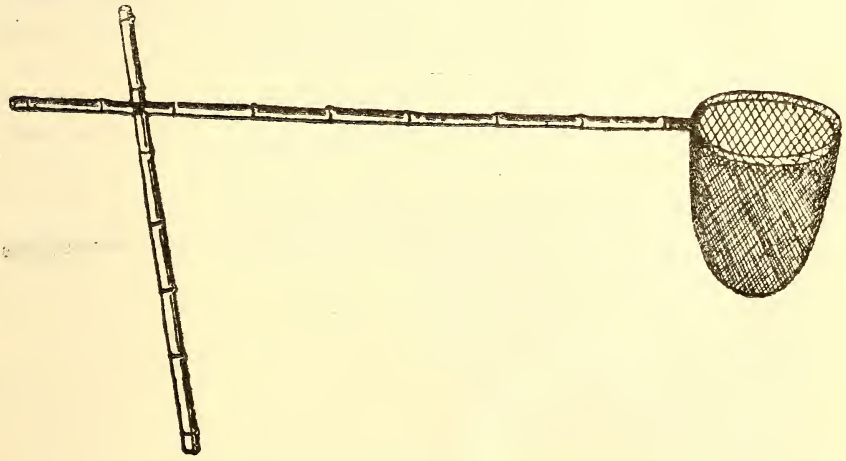


Fig. 25.—*Chhakni jal* of East Bengal.

Bheshal jal or *Khara jal* or *Kadra jal* (Fig. 24). This is a large triangular net with mesh from 1.3 cm. to 4 cm. worked from a bamboo platform erected on the bank of the river or in shallow water.

According to Ahmad (1952) the net is used in Jessore and Tippera for catching hilsa. In principle this is similar to the *gara besal* of West Bengal (p. 260).

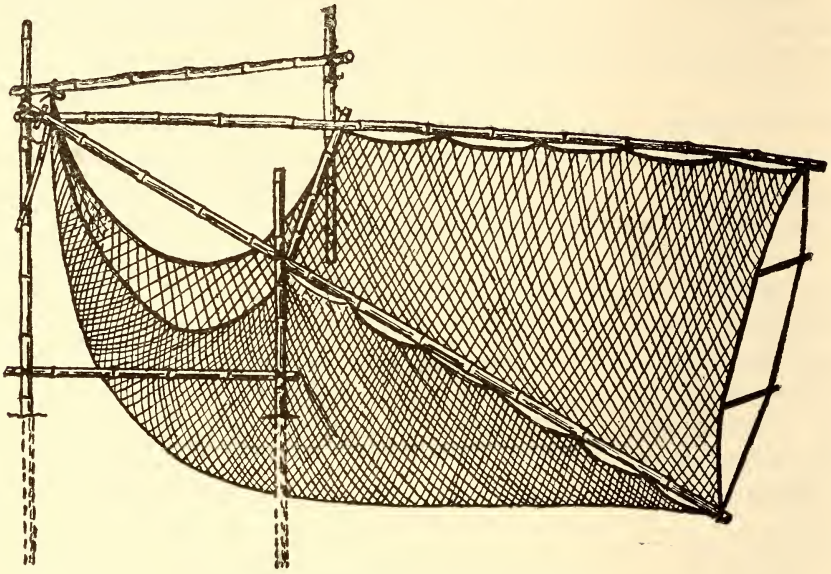


Fig. 24.—*Bheshal jal* of East Bengal.

Hath Bauli jal. This is a small *bhesal jal* of 5 cm. mesh worked by hands from a boat for catching hilsa in the districts of Rajshahi and Pabna during rainy season (Ahmad 1954). Further details about this are lacking and it is not known in what manner it differs from the *nauka bhesal* described under West Bengal p. 261.

Hefa jal or *Hafa jal* (Fig. 26). This is a triangular dip net about 7 metres in length and 3 metres broad at the distal part having a mesh

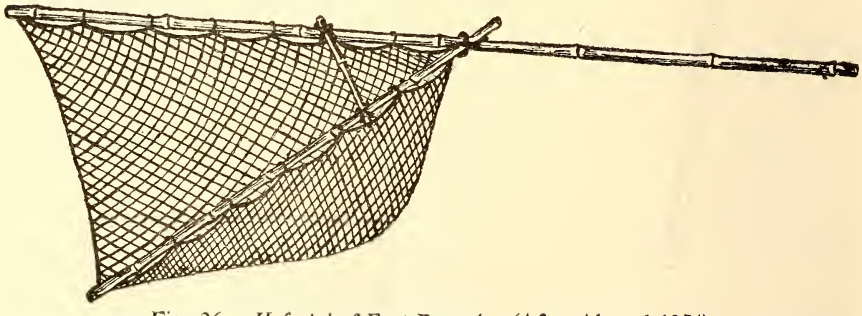


Fig. 26.—*Hefa jal* of East Bengal. (After Ahmad 1954).

of 10 cm. This is used in the district of Sylhet from April to May for capturing hilsa.

Fence net or Pound net

Bundh jal (Pl. XXI, fig. 23[1]). In principle this is somewhat similar to the pound net used for shad in the United States. *Bundh jal* is a fixed net and is generally constructed across large rivers like the Meghna and the Padma. This method of fishing is done from February to May and the most important fish caught in the pound is hilsa. The stakes are removed towards the end of May by which time the effect of monsoon rains begins to be felt in the river.

Long stakes are driven in the form of an arc from one shore across the greater part of the river leaving one side for the passage of boats and launches. In between long stakes shorter ones are fixed and all these are bound together by horizontally placed pieces of sticks. To give additional stability the whole fence is held in position by a series of anchors fixed upstream, their number depending on the force of the current. The end of the fencing away from the shore curves inwards in the form of a circle leaving a small passage for the entry of fish. Close meshed (about 1.3 cm.) netting is fastened to the stakes up to the water line like a wall obstructing the passage of fish either way. Above the water line wide-meshed netting is tied up to a height of about 90 cm. Another wide-meshed netting is tied about 46 cm. above the water line and this is folded over and stretched and attached to distantly placed poles as the chord of an arc leaving a sagging bag-like space in the form of a *verandha* net. The enclosure or the pound at the inner end consists of a single net in the form of a trough with an opening on one side for the entry of the fish. It is open above the water line.

The *bundh jal* is intended to capture fish that migrate upstream against the current. Fishes such as carp, coming against the obstruction, try to overcome it by jumping and get caught in the verandha net. Hilsa on the other hand move along the fence and eventually enter the pound where they remain circling round and round with very little chance of escape through the passage by which they had entered. To remove the fish, the 'pound' is untied from the supporting stakes and the contents emptied into a boat.

Fish drives. Mojumdar (1939) refers to fish drives in the eastern part of the Bay of Bengal during winter months which he describes as follows: 'The other way of catching the hilsa in this part of the country is to drive the shoals into the branch rivers opening in the

[1] The figure is based on a model shown to me by Shri Lakhi Kanth Burman, a refugee fisherman from East Bengal now employed at the Central Inland Fisheries Research Station, Calcutta.

sea by the beating of tins or drums. When they are up in such a *Khal,* their way to the sea is obstructed with nets and they are caught for days together.'

2. Sind

The fishing method for hilsa in the Indus is very similar in principle to that in the Narbada in Bombay and the Cauveri in Madras, but looks somewhat queer and hazardous. The method has attracted the attention of early European travellers as far back as the first half of the 17th century, as is evident from the writings of Sebastien Manrique (Luard and Hosten, 1927) during his travels between 1623-43. In describing the voyage down the Indus to Bakhar he writes:

'We sailed on peacefully in this way, keeping careful watch at night, finding as we advanced on our road an abundance of good cheap provisons in every place we anchored at. In some places, where the stream was shallow, we met many fishermen who furnished us with most excellent shad very cheaply . . . They dispense with the encumbrance of nets and assistants as they go out fishing on large earthen vessels with the circumference of ten to twelve palms in breadth, flattened at the rim, and open at the top in a big, circular aperture just of a size to receive the front of a man's stomach, which being pressed into it checks the ingress of the water. It thus serves as a safe receptacle for the fish as well as a steady base and support for the fisherman, who lies upon it directing his earthen ship with his legs, his hands being busy with the spear, piercing the scaly swimming fishes . . . This abundance of fish was most welcome . . .'

From the above report it appears likely that hilsa was abundant at one time near the surface to be available for spearing and that the water was clear to see the movements of the fish. Spearing is not done now but a modified hand net with a long shaft is used by fishermen who drift on earthen vessels and other floats. Rarely, fishing is also done from boats.

It appears from Day's report (1873) that a triangular type of lave-net known in Sindhi as '*Sumbokee*' which could be closed like a purse net is also in use. He says: 'A species of lave-net is also used and in various ways; their plan of construction is in a triangular frame. In Sind, the fishermen float down the Indus on a gourd or hollow earthen pot, and this net is let down below him; as a hilsa fish, ascending up the muddy stream, strikes against the net, it is

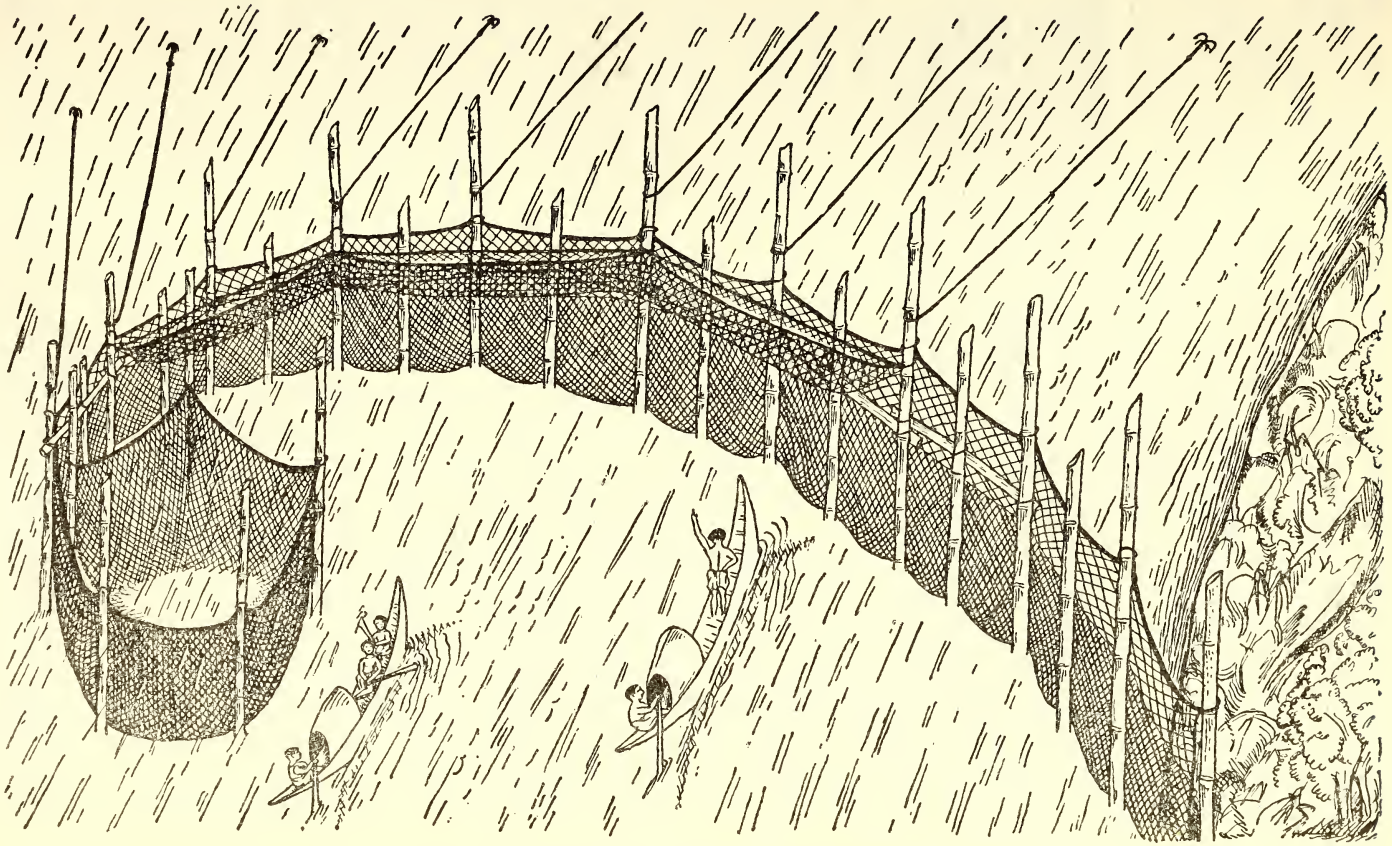


Fig. 23. *Bundh jal* of East Bengal. (By M. Mydeen Kunju).

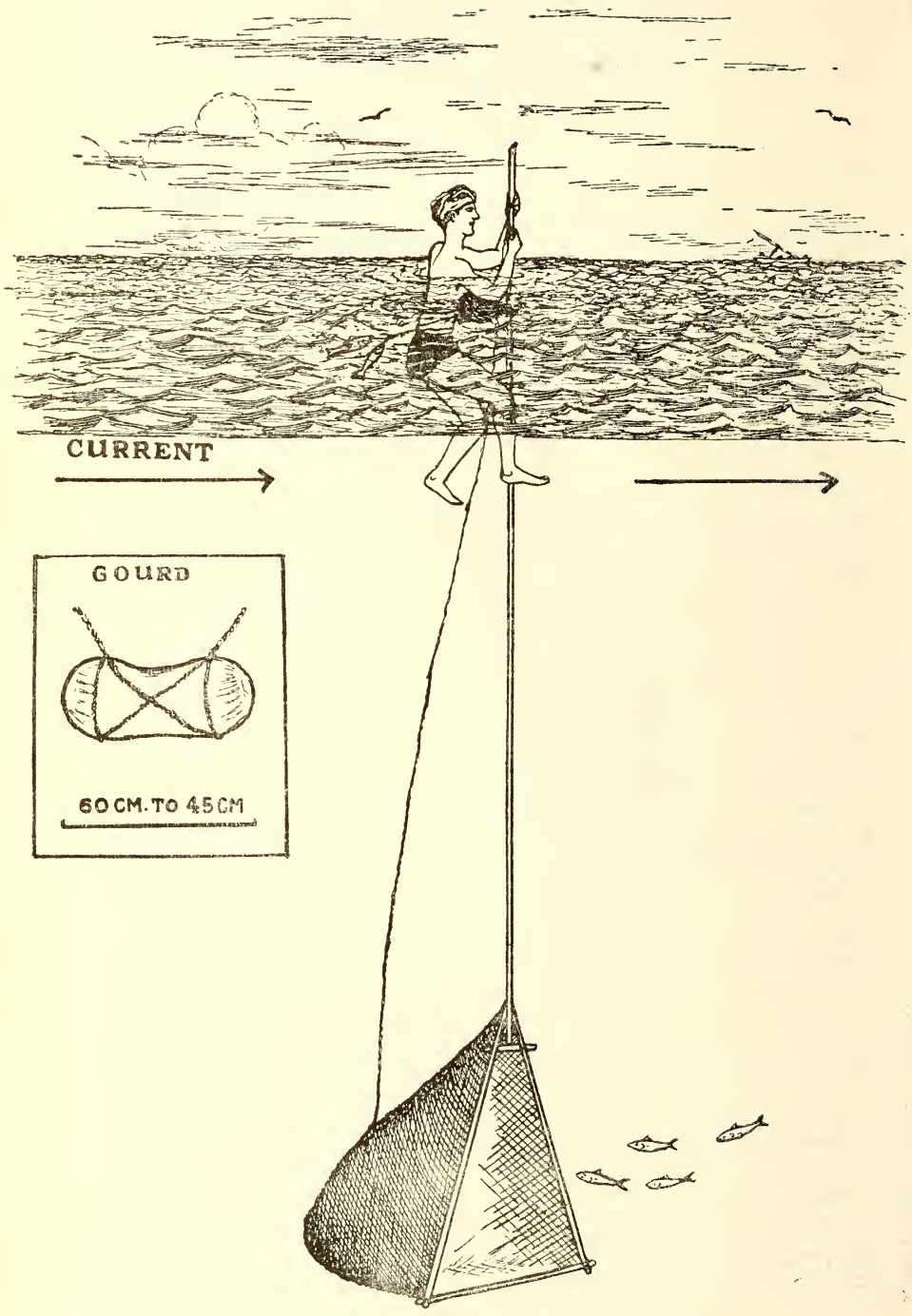


Fig. 27. *Sandh jal* of Sind. (By M. P. Lakshmanan).

made to contract like a purse by means of a string the fisherman holds in his hand.' The observation is repeated in his subsequent account on Indian fish and fishing (Day 1883).

Sandh jal (Pl. XXII, fig. 27[1]). This appears to be the same as the *Sumbokee* referred to by Day (op. cit.). The handle of the net is about 6.5 metres long and each side of the triangular frame is of equal length measuring a little over 2 metres. The mesh size of the net is about 5 cm. The fisherman drifts with the current supporting himself on a dry gourd 45 cm. to 60 cm. in length with the net held almost vertically down. A string tied to the deep bag of the net is held by him and the entry of any fish is communicated through this. By a twist of the handle the fish is imprisoned. The net is lifted up and the captured fish threaded on a string tied to the waist of the fisherman.

Matlee (*Palla pot*). While describing hilsa fishing in the Indus Hornell (1950, p. 109) makes mention of the *palla pot* method. He summarises the fishing activity as follows: 'But the excitement of hilsa-fishing in the Cauveri is as nothing compared with the animated scenes on the Indus, where the Hilsa gives employment to hundreds of fishermen the whole length of Sind. The usual device is a development of the Cauveri one. The net used has grown, however, into the form of a gigantic landing net, with a shaft 20 feet long and with a bag much deeper in proportion. Armed with this the fishermen float downstream, either seated in the bow of a small raft-like punt, or supported by gourds, enveloped in netting and strapped to his back. Or he may, when the fishing reach is short, elect for a third, still more primitive method, and float down the river balanced precariously over the mouth of a great globular chatty or earthenware pot made for the purpose by the village potter. The net is used as on the Cauveri, but in a nearly vertical position. The hilsa, pushing upstream in vehement haste to reach the spawning grounds, blunders into the net and in spite of the extraordinary agility of this fish, man triumphs, being prepared; a sharp twist of the shaft imprisons the fish in the tail of the net and the fisherman, cautiously shortening his grip, finishes it with a knife and consigns it to the bottom of the boat or the depth of the chatty beneath him; if his support is gourds, a needle is passed through the eyes or the gills and

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[1] My thanks are due to Dr. M. R. Khan, Assistant Regional Fisheries Officer, Food and Agriculture Organisation of the United Nations, Bangkok, for having kindly taken the trouble of arranging to get information on hilsa fishing in the Indus, and to Mr. Agha G. Hussain, Deputy Director, Central Fisheries Department, Pakistan, for furnishing a sketch on which Figure 27 in this article is based.

the fish is threaded on a string with the previous victims in tow beside the float.'

'In specially favourable spots, where the river is deep alongside one bank, the fisherman with his net immersed walks downstream along the shore, adjusting his pace to the speed of the current. In the vicinity of towns both the gourd-float and the chatty are preferred to the punt; they give better results and involve practically no expense. The chatty is considered the better killing method, but where the reach within which the fish are caught is long, the fisherman prefers the gourds—their weight is less for the long weary tramp back to his starting-point.'

The *palla pot* has a flattened spheroid shape and is neckless with a comparatively small mouth on which rests the stomach of the fisherman closing it effectively, the latter directing his movements with his hands and legs in a froglike manner. Earthen vessels of smaller size without any opening on which the fishermen float down in a sitting posture is also reported to have been employed (Burns, 1834). The fishermen who cannot afford the 'luxury' of a '*Palla pot*' use a bundle of dry reeds to float down which is discarded on getting water-logged (Wood, 1841). This has the advantage that it need not be carried back but the problem of making a fresh bundle every time remains. A more convenient and perhaps safer alternative commonly employed is the use of a netful of dried gourds strapped to the body. In view of its lightness no serious problem of transportation arises during the trek back to the starting point. The method is very similar to the one followed by the 'Bhil' fishermen of the Narbada.

III. BURMA

Hilsa occurs along the entire coastal waters of Burma from Arakan in the north to the Mergui Archipelago in the south and ascends the rivers for spawning purposes. The information we have on the fishing methods is very meagre and is mainly confined to the observations of Kyaw (1953).

Gill nets

Hmyaw paik[1]. This is a drift net used all round the year in rivers and estuaries of Burma. It is made of cotton yarn and the length varies from 15 to 90 metres and width from 2.7 to 3.7 metres. The mesh is about 10 to 12.5 cm. There are floats along the head rope

[1] The information regarding this net was furnished personally by U Ba Kyaw, Fisheries Officer, Burma.

but no ground rope or sinkers at the bottom. The net is allowed to drift with the current and the gilled fish are periodically removed. Fishes other than hilsa are also caught in this net. It appears that the net is sometimes provided with a ground rope also to which weights of lead pieces and burnt clay are attached, as stated by Khin (1948).

Nga-thalouk paik. This net is reported by Kyaw (1953) as being used in the Mergui Archipelago. Each operational net is about 550 metres long and 11 metres deep consisting of 3 sets laced together, each set having 20 separate pieces of netting of about 9 metres in length. The mesh size varies from 10 to 15 cm. according to the size of the fish available in the different seasons. The net is operated by three open boats with a total crew of 12 persons. Two boats are of 2 tons capacity each and are used as net boats, while the third one is of 6 ton capacity and serves as the mother boat. When a shoal is sighted it is encircled by the net which is paid out simultaneously from the two small boats. After the two ends of the net meet, the boats go about scaring the fish by beating the water with poles. The net is then hauled up into the two small boats which traverse the circle in the reverse direction and the gilled fish are removed. Each operation takes 2 to 5 hours depending on the catch.

Summary

The methods of fishing for the Indian shad, *Hilsa ilisha* (Hamilton), in India, Pakistan, and Burma are described in fair detail. Some of the nets are specially devised for catching hilsa while the others are multipurpose nets in which this fish forms one of the catches. In all, about 102 nets are classified and dealt with, and of these most of the important ones are illustrated. A glossary of local names of fishing gear and tackle is given with explanation.

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Glossary of local names

Jal means net in Hindi and other north Indian languages and the term is current in the states of Bengal, Bihar, Uttar Pradesh, Assam, and Bombay in India and in East Bengal and Sind in Pakistan. This is modified into *Jalo* in Oriya (Orissa). *Vala* and *Valai* mean net in Telugu and Tamil in Andhra Pradesh and Madras respectively.

Local name	Page	State or Country	Meaning where known	Explanation
Apsha jal ..	432	East Bengal		Gill net
Ata vala ..	266	Orissa		A portion of *Pedda irgali* near the wing
Bada irgali ..	265	Orissa	*Bada*=big	Large conical bag net
Bada jal ..	259	West Bengal	Big net	Stake net
Bandal ..	275	Uttar Pradesh		Method of fishing after blocking with bamboo fencing
Barain jal ..	432	East Bengal		Gill net
Baranda ..	267	Orissa	border	Border meshes of *Tangra jalo*
Bara jal ..	433	East Bengal	big net	Big seine net. Known also as *Jagat ber*, *Goger* and *Maha jal*
Bar jalo ..	263 & 266	Orissa		Long drag net
Baromadi ..	266	Orissa		Bag portion of *Pedda irgali*
Basa jal ..	260	West Bengal		Lift net
Basal jal ..	260	,,		Lift net
Basani jalo ..	264	Orissa		Gill net operated from boat

Local name	Page	State or Country	Meaning where known	Explanation
Batchari jal ..	261	West Bengal		Large sized cast net. Also known as *Othar jal*
Batchari nauka ..	261	,, ,,	*Nauka* = boat	Boat used for the operation of *Batchari jal*
Behunti jal ..	257	,, ,,		Fixed bag net. Also known as *behundi jal*, *bainti jal*, or *bim-jal*
Ber jal ..	256 433	West Bengal & East Bengal		Seine net
Ber jal ..	435	East Bengal		Drag net
Bhahali jal ..	272	Assam		Lift net operated from a drifting boat
Bhasa jal ..	260	West Bengal		Lever dip net operated from a boat
Bhekti Phandi-jalo	263	Orissa	Bhekti = *Lates calcarifer*	Large meshed gill net
Bhesha gulli ..	433	East Bengal		Seine net. Also known as *Kona jal*
Bheshal jal ..	435	East Bengal		Large lever dip net. Known also as *Khedra jal* or *Kedra jal*
Bhido jalo ..	265	Orissa		Gill net. Known also as *Bhida jalo*
Bhiro jalo ..	264	Orissa		Gill net. Known also as *Bheed jalo* or *Ilishi jalo*
Biri jal ..	432	East Bengal		Clap net
Bisari jal ..	274	Bihar		Dip net
Budichi jal ..	429	Bombay		Sunken drift net
Bundh jal ..	437	East Bengal	*Bundh* = embankment	Fence net
Chairon jal ..	272	Assam	Four-finger-meshed net (*Chairon* derived from *char* = which means four)	Clap net
Chapila jal ..	433	East Bengal		Gill net
Char-pata jal or *Char-gherra jal*	262	West Bengal	*Char* = Mud-flat exposed during low water	A type of barrier net
Chawk jalo ..	269	Orissa		Drag net used for fish drive
Chhandi jal ..	254 432	West Bengal & East Bengal		Gill net
Chhandi nauka ..	254	West Bengal	*Nauka* = boat	Boat employed for using *Chhandi jal*
Chhakni jal ..	435	East Bengal		Dip net
Chhanta jal .. or *Chhata jal*	275	Uttar Pradesh		Shore seine net
Chhota ber jal ..	433	East Bengal	*Chhota* = small *Ber* = encircle *jal* = net	Small seine net
Chondi jal ..	264	Orissa		A kind of drift net.

Local name	Page	State or Country	Meaning where known	Explanation
Chondi jalo ..	269	Orissa		Similar to *Chondi jal* used as drag net during fish drives in the Mahanadi
Chotta irgali ..	266	Orissa	*Chotta*=small	Small conical bag net. Known also as *Sanna irgali*
Chouhandra ..	268	Orissa		Small meshed net behind *Satiya jalo* of *Mal jalo*
Cuna jalo ..	268	,,		Free ends of *Mal jalo*. Known also as *Chuna jalo*.
Dandi jal ..	273	Bihar		Gill net. Also known as *Dondi jal*.
Dara jal ..	435	East Bengal		Drag net
Dar jal ..	433	,, ,,		Gill net
Dhop jal ..	434	East Bengal		Seine net
Dinghi ..	253	West Bengal		Round bottomed boat
Dondi jal ..	273	Bihar		Gill net. Known also as *Dandi jal*.
Dongya ..	270	Orissa		Flat bottomed boat
Dora jal ..	433	East Bengal		Gill net. Also known as *Ilish jal*.
Dui-tuni jal ..	272	Assam	Two poled net (*Dui*=two & *tuni*=pole)	Lever type of clap net
Era jal ..	433	East Bengal		Gill net
Erukh ..	425	Madras	*Calotropis gigantea*	Name of a tree. Timber used as floats
Funga jal ..	272	Assam		Clap net
Gai ber jal ..	256	West Bengal		Seine net
Gab ..	252	West Bengal	*Diospyros embryopteris*	Name of a tree, the fruits of which are used for tanning nets
Gara jal or *Gara besal*	260	West Bengal		Lever dip net fixed in the river
Ghai ber jal ..	434	East Bengal	*Ghai*=bag or pocket	Seine net with pockets
Gharia ka ghauch	275	Uttar Pradesh		The term used for the operation of scoop-net from a boat
Ghauch ..	275	Uttar Pradesh		Lift net used in the Bandal method of fishing
Gherua jalo ..	265	Orissa		Hempen gill net
Goolti jal ..	255	West Bengal		Gill net
Gulti jal ..	434	East Bengal		Seine net
Gultin jal ..	434	,, ,,		Seine net
Hadia jalo ..	268	Orissa		A triangular dip net operated by hand
Hafa jal ..	436	East Bengal		Same as *Hefa jal*
Har jal. ..	433	East Bengal		Gill net
Hath bauli jal ..	436	,, ,,	*Hath*=hand	Triangular dip net operated by hand

Local name	Page	State or Country	Meaning where known	Explanation
Hefa jal ..	436	East Bengal		Triangular dip net operated by hand from a boat
Hela jal ..	260	West Bengal		Hand operated push net
Hilsa ..		Bengal	*Hilsa ilisha* (Hamilton)	The Indian shad
Hilsa jal ..	432	East Bengal	Hilsa net	Clap net
Hmyaw paik ..	440	Burma		Drift net. *Paik* which means net in Burmese is written as *Paikgyi* also
Honga jal ..	432	East Bengal		Clap net
Huli ..	269	Orissa		Dug-out canoe
Ilihi ..	271	Assam	Hilsa	
Ilish ..	254	Bengal	Hilsa	
Ilishi ..	263	Orissa	Hilsa	
Ilihi jal ..	271	Assam	Hilsa net	Clap net. Known also as *Kami jal*.
Ilish jal ..	254 & 433	Bengal	Hilsa net	Gill net. Also known as *Dora jal*.
Ilishi phandijalo	263	Orissa	Hilsa net	Fixed gill net. Also known as *Ilishi jalo*
Iriga vala ..	265 & 425	South Orissa & Andhra Pradesh		Conical bag net. Also known as *Irgali* or *Irgal jalo*
Jagat ber jal ..	257	Orissa	*Jagat*=universe *Ber*=enclose or encircle	Long seine net
Jal ..		W. Bengal, E. Bengal, Bihar, Uttar Pradesh, Assam, and Bombay	net	A Hindi term meaning net common throughout north of peninsular India
Jalia dinghi ..	252	Bengal	*dinghi*=small boat	Fishing boat used in the rivers of Bengal
Jalo ..	263	Orissa	net	Common term for net in Oriya
Jamda jal ..	431	Bombay		Purse-like hand net
Jangalia jal ..	435	East Bengal		Hand trawl net
Jangla jal ..	434	East Bengal		Pocketed seine net
Jarul ..	252	West Bengal	*Lagerstroemia flos-reginae*	Name of a tree. Timber used for constructing boats
Joha jal ..	274	Bihar		Seine net
Kala-kayir ..		Madras	*Kala*=bull; *kayir*=rope	Cord along the circumference of the cast net
Kalyanamaran ..	428	Madras	*Erythrina indica*	Name of a tree. Timber used for making rafts
Kamail jal ..	274	Uttar Pradesh		Clap net
Kami jal ..	271	Assam		Clap net. Known also as *Ilihi jal*
Kanni valai ..	425	Madras	Meshed net (*Kanni*=mesh)	Gill net

Local name	Page	State or Country	Meaning where known	Explanation
Kappu ..	427	Madras	fork	Forked branch of tree used for making *Kappu valai*
Kappu valai ..	425	,,	Fork net	Push net
Karal jal ..	255	West Bengal		Gill net
Kephla jal ..	261	,, ,,		Cast net
Kettu valai ..	424 & 426	Madras	Fixed net (*kettu*=tie)	*Kanni valai* without floats and weights
Khanderi jal ..	430	Bombay		Gill net
Kharki jal ..	252	West Bengal		Clap net
Kharki jal ..	432	East Bengal		Clap net. Also known as *Sharki jal*
Khepa jalo ..	268	Orissa		Cast net
Khosh jal ..	432	East Bengal		*Shangla jal* of Bakarganj
Khot jal ..	433	,, ,,		Gill net
Kochal jal ..	255	West Bengal		Fixed gill net
Kona jal ..	257 433	West Bengal & East Bengal		Seine net. Also known as *Bhesha gulli*
Konta jal ..	255	West Bengal		Fixed gill net
Korpan-Kutchi ..	30	Madras	*Korpan*=threading, *Kutchi*=peg	Threading peg
Kosa nauka ..	271	Assam		Small sized fishing boat
Lawa jal ..	432	East Bengal		*Shangla jal* of Sylhet
Maal ..	30	Madras	*Maal*=net	Net portion of cast net
Maha jal ..	274	Uttar Pradesh	Big net (*Maha*=big)	Large bag net
Mal jal ..	262	West Bengal		Barrier net
Mal jalo ..	268	Orissa		Barrier net
Male madi ..	266	Orissa		One portion of *Pedda Irgali* in front of *Baromadi*
Mani ..		Madras		Lead weight of *Veechu valai* of Cauveri Delta
Matlee ..	439	Sind		Earthenware pot used as a float in hilsa fishing
Mela ..	33	'Hindi'	Procession or festival	
Nanhya jalo or *Naya jalo* ..	268	Orissa		Portion of *Mal jalo* near the *Cuna jalo*
Nauka ..	261	West Bengal	boat	Name for boats in general
Nauka-Besal ..	261	,, ,,		Lever not operated from boat
Nga-thaloukpaik	441	Burma	Hilsa net (*Nga-thalouk*=Hilsa, *paik*=net)	Gill net
Odi vala ..	265	Orissa	*Odi*=prevent or obstruct	Drift net. Known also as *Odi jalo*
Othar jal ..	261	West Bengal & East Bengal		Large cast net

Local name	Page	State or Country	Meaning where known	Explanation
Palwa jal ..	430	Bombay	*Palwa*=hilsa Hilsa net	Drift net
Pankha Rach ..	430	Bombay (Gujarati)	*Rach*=net	Fixed gill net
Pansi nauka ..	271	Assam	*nauka*=boat	Large sized fishing boat
Patan jal ..	434	East Bengal		Seine net
Patua jalo ..	267	Orissa	*Patua*=Engraulid	A type of drag net
Pedda ayilu ..	424	Andhra Pradesh	*jalo*=net	Seine net. Also known as *Pedda vala.*
Pedda irgali ..	265	Orissa		Trawl type of net. Also known as *Bada Irgali*
Pye jal ..	433	East Bengal		Gill net
Rangoon vala ..	423 & 426	Andhra Pradesh	Rangoon net	Drift net formerly imported from Burma. Known also as *Ulla* or *Ullam valai* or *Kanni valai*
Sal ..	252	West Bengal	*Shorea robusta*	Name of a tree. Timber used for constructing boats
Sandh jal ..	439	Sind		Dip net
Sangla jal ..	271	Assam		Clap net
Sanna Irgali ..	266	Orissa	*Sanna*=small	Small conical bag net. Also known as *Chotta Irgali*
Sarni-phasi jalo ..	267	Orissa		A combination net of *Sarni jalo* and *Phasi jalo*
Satiya jalo or *Santiya jalo*	268	Orissa		End portion of *Mal jalo*
Shangla jal ..	253 432	West Bengal & East Bengal		Clap net
Sinapu vala ..	266	Orissa	Small meshed net (*Sinapu*=small meshed)	Middle part of *Pedda irgali*
Sumbokee ..	439	Sind		Small hand net
Sungail ..	273	Bihar		Clap net. Also known as *Sungla jal* or *Hilsauri*
Suti jal ..	258	West Bengal		Funnel shaped bag net. Also known as *Soti jal*
Tana ber jal ..	256 434	West Bengal & East Bengal	*Ber*=enclose	Seine net
Tangra jalo ..	266	Orissa		Pocketed drag net. Also known as *Tangna jalo* or *Tangni jalo*
Thedachi valai ..	426	Madras		Gill net
Theppam veechu ..	428	,,	*Theppam*=raft, *veechu*=cast	Casting net from a raft
Thelu vala ..	424	Andhra Pradesh		Drag net

Local name	Page	State or Country	Meaning where known	Explanation
Thuri ..	427	Madras	bag	The cod end of a bag net
Thuri valai ..	427	,,	Bag net	Gill net (not the typical *Thuri valai* of the Coromandel coast)
Tisto jalo ..	263	Orissa		Fixed gill net
Toni jal ..	252	East Bengal		A kind of trawl net
Tuni jal ..	433	East Bengal		Gill net
Ul-kayir ..		Madras	*Ul*=inner, *kayir*=rope	Drawing rope of cast net
Ulla-or *Ullam valai*	426	Madras	*Ulla or Ullam*=hilsa	Drift net. Known also as *Rangoon valai* or *Kanni valai.*
Ulla thundu or *Ulla thundu Valai*	426	,,	*Thundu*=piece	Small *Rangoon valai* or *Ullam valai*
Vala ..	423	Andhra Pradesh	net	Telugu term for net
Valai ..	425	Madras	net	Tamil term for net
Valli jal ..	430	Bombay		Fixed gill net
Vanku kayir ..		Madras	*Vanku*=receive, *kayir*=rope or coir	Gathering or receiving rope of cast net
Veechu valai ..	427	Madras	Cast net (*Veechu*=cast)	Cast net
Vessur vala ..	425	Andhra Pradesh	Cast net (*Vessur*=cast)	Used as a combination of two cast nets
Vusu vala ..	424	,,		Drag net
Waram ..	266	S. Orissa & Andhra Pradesh	side	Wing portion of *Pedda irgali*. Telugu word.

William Jack, the Botanist (1795-1822)

BY

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Botanists and plant-geographers who are interested in plant life and its distribution in Malayasia must have come across the name of Jack in various books. Jack was indeed one of the pioneer naturalists who explored the virgin forests of India, Malaya, and Sumatra. Unfortunately, he died at the young age of twenty-seven years and it is perhaps for this reason that he is not much known to our botanists of today. Yet, from the few scattered papers and memoirs, it was felt that a short biographical account of Jack would perhaps be well worth publication even after such a long period, as it would stimulate the minds of our younger field botanists.

William Jack was born on the 29th January 1795[1] at Aberdeen, Scotland, where his father Dr. William Jack was the principal of a College. Young Jack was unusually intelligent from his boyhood and joined a grammar school at the age of six. While in school, he almost always kept the top position in his class. He soon became a scholar in classics, French, and natural science and commenced the study of medicine at the age of fourteen. He completed his studies and passed the M.A. examination at the age of sixteen. He then wanted to continue his medical studies in Edinburgh but could not do so for a year as he was attacked by scarlet fever. During this time, he taught classics for sometime in his own school, studied Italian and Spanish, and attended classes on Divinity. He came to London in 1811, i.e. before completing his seventeenth year.

In London, he continued his studies in medicine and botany and he soon came in contact with such eminent persons as Sir Joseph Banks, Robert Brown, and G. Anderson. After attending hospitals and lectures in medicine and surgery he appeared for his F.R.C.S. examination and duly passed at the young age of 17. He communicated the good news of passing the medical examination to his father in a letter dated the 1st February 1812. He wrote: 'Yesterday, I passed as Fellow of the College of Surgeons and with flying colours.

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[1] The year of birth given by Burkill (*JBNHS* **51**: 868; 1953), i.e. 1773, is evidently incorrect. The year of birth was, however, correctly given by him in his earlier paper (*Gard. Bull. Str. Settl.* **4**: 125; 1927).

Five days were all I had in which to prepare and go through the previous business. I appeared before my examiners with all the courage I could muster, and having evaded in the best way that I could, the demand for a certificate of age, they agreed after a little consultation to examine me. Sir William Blizard questioned me, and as it was an extra-ordinary meeting, the whole court were judges. My trial was short and they seemed so well pleased with my replies, that Sir William Blizard said that it was unnecessary to put any more questions as it was evident I understood my subject. Sir James Earle agreed and obligingly declared that not one in five hundred would answer so accurately. I retired for a while, and when I returned, the Master put a few questions as to my period of study etc. and informed me that I had passed. They then congratulated me on my success; one observed that I should be an honour to the Company's service and paid me such compliments as modesty forbids me to repeat.'

Jack then went back to Aberdeen and spent a few months at home with his parents. He returned to London and secured an appointment of a surgeon in the Bengal Establishment of the East India Company and sailed for India on board the Company's ship 'Baring' on his eighteenth birthday, i.e. on 29th January 1813.

On his arrival in India, he was posted as a surgeon in the East India Company's army at various places like Dum Dum (1813), Nepal terai with Ochterlony's army (1814-15), Bettiah (1815), Bechiaco (1816), Dinapore (1816-17), and Calcutta (1818). Jack visited the Botanic Garden at Calcutta on the 19th July 1818, and wrote: 'I have paid a visit to Dr. Wallich at the Botanic Garden, a short distance from Calcutta; he received me with great kindness and warmth, and insists on my coming to stay with him while I remain here. He is not only a good botanist but an excellent physician, and much inclined to assist me in obtaining some situation which may open a field for botanical research and connect me with himself in that department.'

During this time, Sir Thomas Stamford Raffles, Governor of the East India Company's establishment in Sumatra, also visited the Botanic Garden and met Jack at Calcutta. At the request and recommendation of Dr. Nathaniel Wallich, Sir Stamford very willingly agreed to take Jack with him to Sumatra. The party soon sailed in the Company's cruiser 'Nearchus' and, besides Jack, contained two French zoologists. On their way, the party spent a few months in Penang and Jack collected a large number of plants. From this collection, Jack described 130 plants of which about 80 were considered new. In Sumatra, they stayed at the headquarters at Bencoolen. From Bencoolen, Jack made several trips to the interior of Sumatra

including a climb on the Gunong Benko peak. He worked hard and made exhaustive notes and descriptions of these plants, many of which proved new to science.

Sir Thomas Stamford took keen interest in the natural history and social customs of the people of Sumatra. It may be noted that it was mainly due to his interest that the wonder plant *Rafflesia arnoldi* R. Br., which commemorates his and Dr. Joseph Arnold's name was first discovered in 1818 and made known to science. The plant, as is well known, is a root parasite and bears gigantic flowers, about three feet across and the largest in the vegetable kingdom. Since the discovery of this plant, Jack visited the type locality and other areas and collected considerable additional information about this species which was duly published in his *Malayan Miscellanies.* Jack continued his botanical activities in the midst of various official assignments and by March 1822 he had described seventy-five new plants, including fifteen new genera.

Although Jack's indomitable energy continued, his health was not keeping very good. On April 8, 1821 he wrote in his letter to his parents: 'I have lately had a return of the old complaint in my lungs, which laid me up for some time; but by dint of bleeding, blistering and starving, I got over it pretty well, and have now only to recover strength which I shall do very fast, I feel no doubt.' Towards the end of August 1822 Jack returned from a trip to Java, and at that time he was definitely very ill. In view of his failing health, Sir Thomas Stamford Raffles agreed that he should go to the Cape (South Africa) for a change of air. He boarded the ship 'Layton' but unfortunately died the next day (15th September 1822) while the ship was still anchored at Bencoolen. Jack thus died prematurely at the young age of 27 years.

Soon after Jack's death, Sir Stamford Raffles wrote a letter to the East India House in London. An extract of this letter dated the 15th September 1822 was as follows: 'We were to have embarked this morning for Singapore, but the wind has proved foul, and it was ordained that we should remain another day to bury our dear and invaluable friend, William Jack. Poor fellow! a finer head or heart there never was and whether as a bosom-friend or a scientific assistant he was invaluable to me.'

About that time, Dr. Wallich of the Calcutta Botanic Garden was on tour at Singapore. The ship touched there on the 10th October 1822, and Dr. Wallich heard the sad news from Sir Thomas Stamford Raffles. Dr. Wallich was so moved that he thought it fit to send a

letter of condolence to Jack's father. He also agreed to erect a monument in the Calcutta Botanic Garden in memory of Jack.[1] The letter of Dr. Wallich to Jack's father was as follows:

'When I wrote you last, I had hopes of being shortly able to convey to you more welcome intelligence. Alas! it was otherwise ordained, and it has become my lot to condole with you on the untimely departure of your most excellent son, my dear and beloved friend, William! This sudden and most melancholy intelligence was communicated to me by Sir S. Raffles who landed here this morning and who deeply participates in our deplorable loss. Your son's spotless integrity, his excellence of character, and of heart and of universal esteem which he enjoyed here, have now their reward. It is, therefore, only my bitter loss and that of his revered and afflicted parents, that distresses me, and which recent as the shock is, almost overcomes me while I pen these words. Forgive me, therefore, for dwelling in this manner on this sad event. I should endeavour to console you—and I cannot console myself.'

Principal Jack received a similar letter of condolence from Sir Thomas Stamford Raffles. All friends and admirers of Jack were convinced that he was an indefatigable worker and a most zealous contributor to science. His premature death was a great loss to Malayan botany. The major part of his plant collection and various manuscripts and drawings, which were being sent to England after his death and whose posthumous publication would have further added to the magnificent record of Jack's scientific attainments, were unfortunately destroyed. This happened in 1824 when the ship in which Sir Thomas Stamford Raffles was returning home on leave caught fire at sea. Ironically enough, the name of the ship was 'Fame'.

Jack was elected a fellow of the Geological Society of London where he submitted a paper on the Geology of Sumatra for publication. His name was commemorated in the genus *Jackia* in the family Rubiaceae by Dr. Wallich. Blume also honoured him by naming another genus *Jackia* in the family Polygalaceae. *Jackia* Bl., being a later homonym and congeneric with *Xanthophyllum* Roxb., the latter generic name has to be followed.

His other papers were as follows:

(1) *Malayan Miscellanies* 1 & 2, Bencoolen, (1820-22).

Note. In view of the excellence and rarity of the above publication, it was reprinted in various journals, e.g. (*a*)

[1] For some unknown reason this monument was never erected.

Calcutta J. nat. Hist. **4** : 1-62, 160-231, 305-374 (1843). (*b*) Comp. volume to Hooker's *Bot. Mag.* **1**: 147-157, and 253-272. (*c*) Hooker's *J. Bot. Ser.* 2. **1** : 358-380 (1834).

(2) On the Malayan species of *Melastoma. Trans. Linn. Soc. Lond.* **14** : 1-22 (1825).

(3) On Cyrtandraceae, a new natural order of plants. *Trans. Linn. Soc. Lond.* **14** : 23-45 (1825).

(4) Account of *Lansium* and some other genera of Malayan plants. *Trans. Linn. Soc. Lond.* **14** : 114-130 (1825).

Besides these Jack prepared a few other memoranda dealing with certain socio-economic aspects about the native people of Sumatra.

Biographical notes on Jack appeared earlier in the following:

(*a*) Comp. Vol. to Hooker's *Bot. Mag.* **1** : 121-147 (1835; (*b*) *Gard. Chron. Ser.* 3; **26** (2): 252-53 (1899; (*c*) *Gard. Bull. Str. Settl.* **4** : 125 (1927); (*d*) *Flora Malesiana* **1** : 256-57 (1950).

Below is reproduced the text of a letter from William Jack to Dr. Wallich, mainly concerning the discovery of *Rafflesia* in Sumatra, together with a photostat facsimile of its last page:

Bencoolen,
1st June, 1820.

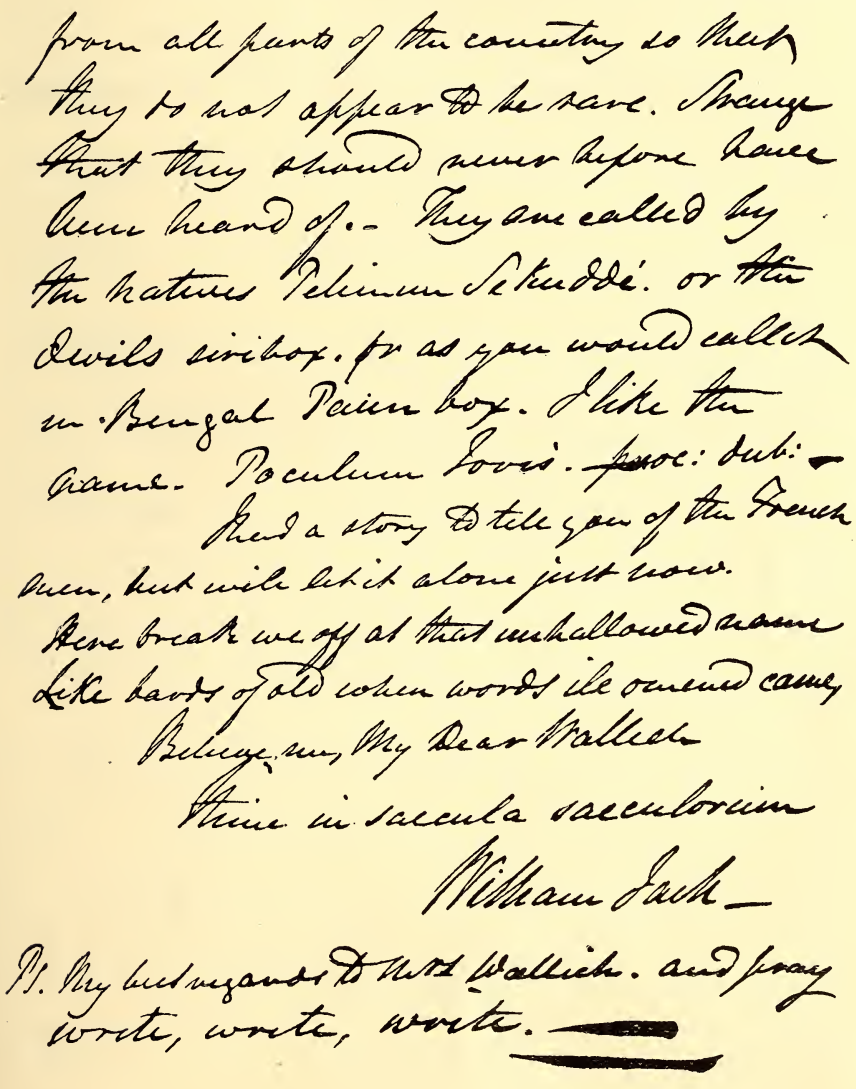
'My dear Wallich,

'I have been much disappointed at not having a single opportunity of writing you for a long period and now I have nothing better than the circuitous route of Batavia. I must, therefore, content myself with a few lines and trust that ere long, I shall have some direct opportunity. I am very anxious to hear from you and learn your plans for the ensuing season. The time of your proposed voyage is fast approaching and I am desirous of learning your arrangements regarding it. I do hope on your own account that you will put it in execution, it will relieve you from a great deal of tiresome worrying business, and a year passed in amusement and pleasure in an alpine region like Napaul will be as good as a voyage to Europe and be an epoch from which to date the commencement of a new lease of life. If you could have made a voyage here in place of the Napaul trip, it would have been to me still more delightful. But we are seldom fated to have all we wish in this world and happy is he who looks at the brightest side of the present whatever it be, and takes the honey of every flower he finds without repining that it is not the wished-for rose. I think, there are few people who

have more the means of being independent of circumstances than ourselves and such as like us can turn from any prospect, however dark, to that of nature which is always the same, fresh and bright. But stop, good Mr. Pen, not so fast, as Fielding says, we have got on the top of a hill and how we are to get down again is the question. I believe, he does it by ringing the bell for breakfast and though I have not that resource at hand just now, I must somehow contrive to descend to matters of fact. And first for domestic news; I have a new character to introduce on the stage in the presence of lady Raffles's second son who made his debut about a week ago with great applause. Capt. Watson's lady also presented him with a girl a few days before. In short, increase of population is the order of the day in more ways than one. Sir Stamford's ever indefatigable mind is now turned to the improvement of this place and to drawing forth its resources whatever they may be. It could be too long to give you here a detail of all he has done and all he is doing. Suffice it to say that the very aspect of the place is changed and in spite of all its natural disadvantages, there are good hopes of its rising. Natives and Europeans all seem to awake to the new impulse they receive, and I really think the former more readily and fully than the latter. It is hardly possible to conceive the apathy and *vis inertiae* of the Europeans who have been trained up and imbibed the spirit of the old school of this place. The last 20 years of Bencoolen have been its age of Gothic darkness. It was far better before the time of its old Government but has declined ever since it fell under Bengal. *Nunc vedit ad pristinam dignitatum*, yea it revives in more than pristine splendor.

'I have just concluded the second and longest part of a zoological paper, the Birds. The remainders will not be given so much in detail and will, I hope, be soon finished. Then for botany anew. It has been almost suspended by these and other occupations. I have got numbers of the great flower and have at length satisfied myself upon every point. I have corrected many of the first ideas of it. I mean to send you a specimen. How to send it living is more puzzling. I find, it is parasitic on a species of *Cissus* with quinate and ternate leaves, which I cannot ascertain as yet for want of Roxb. These leaves are serrate and smooth. From the stems of this woody *Cissus* which run either on or under the ground, spring these gigantic flowers at first a round knob, enveloped in a number of calycine or bracteal leaves, which open as the flower enlarges and mostly drop off as it gets ripe. The flowers are unisexual

? *ergo* dioecious. The male has the globular anthers disposed round the margin of the central column as I have already described. The female wants them, but is otherwise similar, and the center of the column is occupied by the minute seeds which are not exactly undulant but disposed on the surfaces of a number of fissures which traverse the substance of the column, without any order or regularity. We get them in numbers from all parts of the country



so that they do not appear to be rare. Strange that they should never before have been heard of. They are called by the natives

Pelimun Sikuddi or the Devil's siribox or as you would call it in Bengal Paun box. I like the name. Poculum jovis. proc. dub.

'I had a story to tell you of the Frenchmen but will let it alone just now.

Here break we off at that unhallowed name
Like bards of old, when words ill-omened came,
Believe me, my dear Wallich,
Thine in saecula saeculorum.

William Jack.

'*P.S.* My best regards to Mrs. Wallich and pray write, write, write.'

Observations on Finn's Baya (*Ploceus megarhynchus* Hume) re-discovered in the Kumaon terai, 1959[1]

BY

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AND

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(*With 2 plates and 5 text-figures*)

CONTENTS

[1] Dedicated with deep admiration to Professor Dr. Erwin Stresemann on his 70th birthday.

I. Introduction

1. Previous knowledge of the Species

In December 1866, 93 years ago, the celebrated ornithologist A. O. Hume obtained from 'Kaladoongee' two examples (both female or male in winter plumage) of a previously undescribed weaver bird which on account of its strikingly massive bill he named *Ploceus megarhynchus* (1869, *Ibis:* 406). In the original description Hume mentioned that his specimens differed from females of the large-billed eastern form of *Ploceus philippinus* from Sikkim terai, East Bengal, and Burma, not only in being larger and darker but in the more rufescent tone of the entire plumage and in other details.

It was not until 1901 that the breeding plumage of the male first became known. Frank Finn, then a Superintendent in the Indian Museum, procured two live birds in the Calcutta market said to have come from below Naini Tal. Finn's description of the breeding male, quoted by Stuart Baker in FAUNA OF BRITISH INDIA, BIRDS **3** : 69, emphasizes the large amount of yellow in the plumage. Finn observed his birds, apparently both males, moult from the bright yellow breeding dress to the dark brown plumage described by Hume earlier. His coloured plate in the *Ibis* (1901 : 29) depicts one of his birds when it was in breeding dress, and the same bird after it had gone off plumage. Curiously enough, during the next 50 odd years practically nothing further was added to our knowledge of the species with the exception of the finding of a breeding colony in the Bhutan duars by C. V. O'Donel in 1912 (NIDIFICATION **3** : 4) the identity of whose owners was refuted by Whistler. Indeed though a few birds turned up from time to time in the Calcutta bird market, their exact provenance was in doubt, and mystery continued to surround the species which was believed to be exceedingly rare. So much so that some 4 years ago the Indian Board for Wild Life entered it on the list of rare and vanishing species whose export, dead or alive, was totally prohibited.

As Humayun Abdulali (1952) has since shown, much of the mystery and confusion that has surrounded this species was due to the unwarranted doubts cast by Whistler and Kinnear (1933) upon the identity of the breeding specimens of *P. megarhynchus* collected by C. V. O'Donel in the Bhutan duars in 1912 which, they maintained, were nothing but the eastern form of the Common Baya, namely *Ploceus philippinus burmanicus* Ticehurst. However, in his MS. notes (now in SA's possession) Whistler himself gives the diagnosis of *P. p. burmanicus* male, as differing from

philippinus in 'the total or almost total absence of yellow on the breast, and no yellow on the mantle; throat variable and may be almost whitish to almost as dark as in *philippinus;* underparts rusty or tawny white. Female, juvenile, and non-breeding male, with more rusty supercilium; underparts and flanks more tawny than in *philippinus.*'

Later Whistler had the opportunity of examining at least one of O'Donel's breeding specimens, a female collected in the Bhutan duars on 25-5-1912 obviously at the very colony referred to by Stuart Baker and upon which the latter's description of the breeding female is based (F.B.I. **3**: 70). On this specimen Whistler reported as follows (personal communication to SA, see *Indian Forester*, June 1935 : 372): 'The crown and nape and sides of the face are olive-brown, strongly washed with yellow and practically unstreaked, these parts contrasting with the rest of the plumage. The chin, throat, breast and flanks are largely canary yellow. In all other respects the bird . . . agrees entirely with the rest of the series (of *burmanicus*), and I have no doubt it is the same form.' In view of his own description of female *burmanicus* as having no yellow on the underparts it is difficult to understand Whistler's conviction that the above specimen was the same form nevertheless!

Humayun Abdulali (1954) has further shown that in view of the good series of undoubted *megarhynchus* recently collected by Dr. Walter Koelz at Agia, near Goalpara in western Assam, Whistler and Kinnear were definitely mistaken in considering O'Donel's breeding birds to be *P. p. burmanicus.* Abdulali draws attention to certain differences in coloration between on the one hand live birds obtained from the Bombay market (said to come from Kumaon terai) together with those recently procured in Calcutta (said to come from Gorakhpur via Bareilly), and on the other O'Donel's specimens from the Bhutan duars together with those collected by Koelz in Assam. If these differences can be sustained on further material it may be worthwhile to recognize an eastern race of *Ploceus megarhynchus.*

2. Rediscovery in Kumaon, 1959

This being the unsatisfactory state of our knowledge, it was felt imperative that a well-organized effort be made to re-discover the species in its natural habitat, and to collect fresh breeding specimens and data on its ecology and habits. One of us (JHC) has been studying the ethology of the Ploceinae in Africa and is now in India to continue his researches on the Indian weavers. We welcomed the opportunity of making a concerted attack on this elusive creature,

Our field trip[1] in the Rampur and Haldwani districts of Kumaon (U.P.) lasted from 10 July to 8 August 1959. One of us (SA) returned to Bombay on 23 July, leaving the other to continue investigations by himself thereafter. While together, our base of operations was Fatehpur (*c.* 10 km. from Haldwani). Later work was done mainly from the Forest Rest House at Lalkua. A car made daily visits to the colonies possible, as also the exploration of an extensive tract of the surrounding terai and bhabar country. We wish to record our thanks to the Chief Conservator of Forests, U.P., for the helpful co-operation and facilities we received during the field work from him and all officers of his department, in particular from Shri S. S. Bahadur, Wild Life Warden, Western Circle.

It may be recalled that as far back as 1934 a special expedition to Kaladhungi[2] to re-discover *Ploceus megarhynchus* had failed to locate the bird or to procure any workable clue concerning its whereabouts. (Ali, Sálim, 1935). In September 1953 Mr. Horace Alexander and one of us (SA) made a second fruitless quest in the terai around Bilaspur (Rampur dist.) where Mr. Alexander had definitely seen 12 to 15 birds while motoring through on 24 June of the same year. Since then correspondence with various residents in the Rampur area had elicited only diffuse vicarious information concerning the species, but all the same it was encouraging that at least professional bird catchers did distinguish a larger 'Pahāri Baya' from the Common, Striated, and Blackthroated species inhabiting the same area, which confirmed the fact that the bird did exist in the locality.

However, were it not for a lucky accident on our very first day while still *en route* from Rampur to Fatehpur, the finding of the bird would not have been quite such a simple affair. When about 40 km. out of Rampur City, and 3 beyond Bilaspur, on the Naini Tal road a largish weaver with conspicuous yellow rump and underparts suddenly flashed past in front of our car and into some tall grassland. A follow-up on foot failed to flush the bird again, but presently a second bird was seen to fly out of the grass and up into the leafless top of a Silk Cotton tree about 10 m. high growing alongside the road. Binoculars revealed this to be a male *megarhynchus* in breeding plumage, and the roughly woven blobs and tangles on the bare branches there to be nests in various stages. Soon several more of the weavers appeared on the tree-top with strips of grass, intertwining them

[1] Aided in part by a Rockefeller grant through the Bombay Natural History Society.

[2] An obscure little village at the foot of the hills on the old Moradabad-Bazpur-Naini Tal road which, by the sensational success of the book MAN-EATERS OF KUMAON has shot into fame as the home of the legendary Col. Jim Corbett. His cottage, now in changed ownership, stands there crumbling in decay.

laconically into the part-built structures. Since this first unexpected discovery and the many other nest colonies thereafter, it is no longer difficult to understand how the bird—which actually proves to be not at all rare or uncommon in this locality—could have been overlooked on previous quests. Indeed, but for the builders in attendance among the tree-top one would have hardly thought of looking for a nest colony in such a situation, or recognized such completely unorthodox structures as nests of an Indian weaver bird.

3. Field Recognition, and Particulars of Specimens collected in 1959

Adult Male (breeding): *Above*, head and nape bright yellow with contrasting dark brown ear coverts. Back and upper parts dark brown, broadly streaked. Rump yellow. *Below*, from chin to vent, including flanks, bright golden yellow (richer and deeper than in the Baya). Beginnings of a dark brown collar or breast-band on sides of neck.

Adult Female (breeding): *Above*, head and nape pale canary yellow, or brownish heavily suffused with yellow. Rest of upper parts rich brown, streaked darker. *Below*, pale canary yellow or yellowish white. First year male in breeding season exactly like female. The latter can be distinguished in the hand by smaller overall proportions, and slenderer bill and tarsus.

First year males in this plumage were observed collecting grasses and weaving them into partly built structures giving the illusion that females also build. We have no evidence that these rough and formless tangles are ever completed or functional.

Specimens collected:

	Wing	Bill	Tar.	Tail
2 ♂♂ ad. (breeding)	78.5–80	22–23*	25	56–60 mm

*Depth of bill at base 15-15.5 mm.

Iris orange-brown; bill blackish horn, paler at base; legs and feet brownish flesh. Testes 10×7, 10×8 mm.

	Wing	Bill	Tar.	Tail
2 ♂♂ (first year)	77–79	21*	25–26	57 mm.

*Depth at base 14-15 mm.

Iris hazel/orange-brown; bill horny brown, paler (whitish) at base and chin; legs and feet brownish flesh. Testes minute *c.* 2×1 mm.

	Wing	Bill	Tar.	Tail
1 ♀ ad. (breeding)	74	20.5*	23.5	54 mm.

*Depth at base 11 mm.

Iris orange-brown, duller than in ad. ♂; bill: upper mandible horny brown, lower pale flesh, brownish at tip; legs and feet brownish flesh.

In this species the tail is rounded and almost fan-shaped.

In non-breeding plumage male and female are alike and separable from *Ploceus philippinus* only by their somewhat larger size, darker coloration and larger bill. Definite field identification, however, is not always possible.

The facts that *P. megarhynchus* builds a type of nest very different from that of any other Indian weaver of the genus *Ploceus*, and that the female is seasonally dimorphic in such marked degree, suggest the need of a deeper study of its proper systematic status.

II. Breeding Ecology

1. Habitat

Finn's Baya inhabits pure terai country in which marshes and extensive stands of sarpat (*Imperata arundinacea*) and munj grass (*Saccharum spontaneum*) are sparsely dotted with isolated trees, particularly *Salmalia malabarica*, and occasionally interspersed with patches under rice or sugar cane cultivation. Nest colonies were found perched in the topmost twigs of trees in limited areas locally distributed within the terai as a whole. The largest number were located along a four mile stretch of road starting just north of Bilaspur and extending to about a mile north of Rudrapur on the main Rampur to Naini Tal highway. Here some twenty colonies were seen, mostly containing some 15-20 nests each, but in a few cases with many more—up to 200 at least in one colony. A further two colonies were found at about 1.5 and 7 km. respectively from Rudrapur on the Bazpur road, and several further colonies were located on the Lalkua-Bareilly road near Kitcha. The latter group lay close to the borderline between the terai and the bhabar country that lies between it and the Himalayan foothills. Several colonies normally occur together but always with wide stretches of intervening country between them and other groups.

It seems certain therefore that, at least in the breeding season, the species is not found in the bhabar. The two females obtained by Hume from Kaladhungi in typical bhabar in December 1866 were therefore probably from the scattering of the birds in the non-breeding season. Alternatively the locality name on the label may have been meant only as a broad indication of the general area in which the birds were shot. After our present experience of the species in the terai it is understandable why the quest for the birds in their published

type locality in 1934 (Ali, 1935) failed. A brief visit to Kaladhungi during our present investigation again failed to reveal the birds. Certainly Stuart Baker (F.B.I. **3** : 70) is quite incorrect in stating that the species breeds up to 3 or 4000 feet. His information is obviously based on O'Donel's breeding record and specimens from the Bhutan duars labelled 300-500 feet, and the Rudrapur area also lies at *ca.* 700 feet elevation only. Kaladhungi itself is not more than 1300 feet.

2. Colony Sites

All the breeding colonies located by us were in tree-tops, almost all of *Salmalia malabarica*, at about 9 or 10 metres from the ground. In a very few cases other trees were favoured and the main observations on behaviour were made on birds building their nests in a *Dalbergia sissoo*. The birds strip the leaves off all the twigs around the nests so that the upper part of the canopy is normally completely denuded and the colonies thus stand out prominently against the skyline. O'Donel in the Bhutan duars found the species nesting 'in a vast area of grass more or less intermixed with scrub'. In Kumaon nest building was also observed in reeds and rushes over standing water, but since most of the birds concerned were first year juvenile males and these reed beds were also roost sites, it is likely that the activity was no more than 'doodling'. The nests observed here were never complete, and may simply be the results of excessive building energy having no certain connection with definitive breeding. Similar observations have been made on this species in Dr. S. C. Law's aviary in Calcutta in 1936 or thereabouts, and on other weavers in captivity. Also on wild first year males of *Ploceus philippinus* in India (Ali, 1931, p. 958) and on *Quelea quelea* in West Africa (Morel & Bourliere, 1957; Crook in press). Thus while nests are certainly sometimes built in reeds it is not yet certain to what extent such sites are actually used for breeding.

The smaller *Salmalia* trees probably provide the birds with some degree of protection from terrestrial predators by virtue of their extremely spiny trunks and branches. It was in fact a major operation to obtain nests and eggs from one of these trees, and the climber had to use every possible caution. Further many of the colonies were situated near water in land which after heavy rain is mostly flooded.

Five out of seven colonies in which birds were observed were built in trees in which a pair of Black Drongos (*Dicrurus adsimilis*) were also nesting. The drongos were extremely alert to all approaching birds, attacking especially crows (*Corvus splendens*) and birds of prey with great effect. They also drove off birds of other species that

approached the tree including Common Mynas, Redvented Bulbuls, Yellow-eyed Babblers, and Rufousbacked Shrikes. There is no doubt that the weavers derive great benefit from the dash and audacity of their neighbours. In all cases noted the young of the drongo were much older than those of the weaver, suggesting therefore that the drongo had occupied the tree site prior to the arrival of the weavers.

3. Breeding Season

On our arrival in Kumaon on 12 July it was at once apparent that breeding was largely completed. Out of the many nest colonies located on the Bilaspur-Rudrapur road only two were fully occupied, and, in the only one that could be closely observed, the birds were already busy feeding young. In two further colonies a few nests were being visited. Later on nest construction and courtship were seen in a fresh colony between 22 July and 5 August. These nests were, however, never finished and pair formation never attained. Ultimately the nests were deserted. At Kitcha a colony with well-incubated eggs was found on 2 August. It is thus clear that Finn's Baya breeds very early in the rainy season well before the main breeding period of the other Ploceines[1] in the area. The colonies found abandoned on 12 July still sat among bare twigs and as it was ascertained that *Salmalia malabarica* puts out new leaves on the defoliated branches within a week of the birds' departure, we can say the colonies could not have been left for longer than that time. We were told that heavy rains fell in the area near the end of May and it is probable that these marked the onset of the birds' breeding. During SA's preliminary enquiries, one correspondent had furnished information obtained from a local bird catcher apparently familiar with the bird under the name of 'Pahāri Baya', that the species breeds twice in the year—in July and again in September, i.e. it has two broods. Our experience indicated that this information is probably quite correct.

4. Flocking, Feeding, and Food

The species is at all times gregarious moving in flocks about the grassland, feeding in company and coming to the colonies and departing therefrom in well integrated groups. The flocks fed in the tall grass and sugar cane stands where insects were apparently taken. Also on ploughed fields and on the roadsides where seeds appeared to constitute the food. Parents were once seen feeding their young on seeds pecked up on the roadside. On the ground the birds walk well, but when moving at speed they hop.

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[1] *Ploceus philippinus*, *P. manyar*, and *P. benghalensis*.

The crops and gizzards of the shot specimens contained entire husked rice grains probably gleaned on the road, other smaller seeds, and brown chitinous insect remains (ants?). One female shot at a nest colony with an insect in her bill for the young had insect remains in the crop.

III. The Breeding Colony

1. Colonies particularly observed

Since we had arrived after the main breeding period it was not possible to observe the development of a colony from its first visitation by a flock throughout reproduction to the departure of the young. It is not possible therefore to assign time periods to the different phases of life in the colony. Thus unfortunately we do not yet know how long it takes to construct the nest, at what stage in its construction the female accepts it and lays eggs, the incubation period, or the fledging period. These must await a further study in which observations should be started by the middle of May. The following account has thus been constructed from notes taken at three different colonies each at a different stage in the reproductive cycle. The colonies observed, in chronological order, were as follows:

(i) A colony in a *Salmalia malabarica* tree on the Bilaspur road, approximately half way to Rudrapur (Plate I).
Here young were in the nest on 12 July; by 25 July only a single nest was still occupied at which a female was feeding well-fledged young. A week later the colony was deserted and the old nests partly obscured by new green shoots. At this colony observations were made on parental care.

(ii) A colony in a *Dalbergia sissoo* tree on the Rudrapur- Bazpur road. Nest construction and courtship were observed between 22 July and 5 August. The colony was ultimately deserted before pair formation occurred.

(iii) A colony in a *Salmalia malabarica* near Kitcha on the Lalkua-Bareilly road in a site difficult of access, on the far side of a river. Here behaviour during incubation was observed on 2 and 4 August.

2. Nest site, Structure, and Building behaviour

The nests of Finn's Baya are unlike those of any other Indian weaver. They are large gobular structures, untidily but firmly woven with long strips of coarse grass, and the entrance is at one side near the top. Often a porch-like projection surrounds the entrance forming

a small papilla as often seen in munias' nests. The structures are usually firmly knotted to upright twigs which are often worked into the fabric and also support the body of the nest from below. Occasionally the nests are slung sideways on to a twig or two so that the nest chamber hangs free below it. In no case, however, are the nests truly suspended from fine single twigs as is normally the case for the Common Baya, *Ploceus philippinus* (Ali, 1940). The nests thus most resemble those of the *Quelea* in Africa (Morel, Morel, & Bourliere 1957) both in form and in the method of attachment to the supporting vegetation, as well as in the progressive stages of construction. Silhouetted against the sky in the distance, a nest colony looks rather like a cluster of honeycombs in the bare tree-top. In Asia the only other species with a comparable nest would appear to be the Golden Weaver (*Ploceëlla chrysaea* Hume) of Burma which, however, builds mostly in small trees and bushes (Stuart Baker, NIDIFICATION 3 : 12). All other Asian species have nests normally slung or suspended from fine twigs (*P. philippinus*) or from grasses or rushes (*P. benghalensis* and *P. manyar*) and with vertical tubular entrances opening below.

A feature of especial interest is that many of the nests form composite units being linked together with connecting walls or flanges of material, or by long separate strands bound in firmly at each end to different individual nests. Usually these composite structures (2, 3, or 4 nests) belong to a single male, but at the larger nest composites at least two males were often responsible (see below). The linkage of the structures is due to the extreme proximity of the building positions at which the birds begin construction. Loose strands from one nest are thus pulled across into the neighbouring nest and the ends tied in. With repetition of this behaviour, together with indiscriminate building on flanges and sometimes even on a neighbouring male's nest, a partial fusion of the individual nests occurs. This is a rare condition in the Ploceinae the only other recorded case being for *Malimbus rubricollis* in Southern Nigeria (Crook, 1958 *a*) and infrequent cases in *Quelea* colonies. It occurs only in species in which the area defended around the nest during its construction (i.e. its territory) is extremely small (see below) and it appears to mark a half way step in the evolution of the giant fused nesting structures, such as are found in other Ploceidae (*Philetairus socius*, Friedmann 1949; *Bubalornis albirostris*, Crook 1958 *b*).

The individual nests are constructed by the male birds. Building started in the *Dalbergia sissoo* with the tying together of twigs into the shape of a ring (the initial ring, Skead 1947) that forms the foundation of all weaver nests. The birds perch on one twig and repeatedly

Silk Cotton Tree with nest colony at top.

Photo : Sálim Ali

Close-up of the nests.

Photos : Sálim Ali

lean out to grasp another in the beak. This is then pulled close to the body and held under the feet. Many such isolated movements are made until ultimately the twig is bound to the perch by a knot of grass tied around it by movements of the bill. In cases where the twigs are too stiff for bending, as is usual in *Salmalia* trees, separate twigs are simply linked up with knotted strands of material which eventually complete the circular shape of the ring. When the initial ring is finished, it is thickened at the sides by the twining in of fresh grass strands. At the same time separate strands are looped across from one side to the other at any angle and at random so that a kind of trellis-work or net gradually appears. At this stage the bird pushes the material with its beak, head, and breast so that it becomes curved outwards from the usual working position at the base of the initial ring. The horizontal depth of the nest is thus determined by the reach of the bird during the performance of the shaping movements. All the while the bird is actively engaged in snipping off the leaves on the twigs near the nest and these then fall from the tree. Some leaves very close to the developing nest are, however, sometimes incorporated in the structure. The nest now develops by repeated additions of long strands of grass (30-60 cm. in length and up to 1 cm. in breadth) each taken to the site singly held in the beak of the builder. These strands are loosely looped across from side to side of the initial ring or between it and other supporting twigs that are incorporated into the developing walls. Thus on arrival the male first ties the end of a strand to the side of the initial ring by inserting it through the accumulated material, pulling it through and reinserting it several times until it is firmly fixed; the free end is then taken in the beak, twisted once or twice around the various supports and either laid against or interlaced with the developing trellis-work and then, if long enough, tied in again firmly to the far side of the initial ring. After each bout of knotting and twining, a bout of shaping movements usually occurs. The bird then sits on or near the nest titivating with loose pieces of his own nest and those projecting from his neighbours'. Also sometimes he hops on to a neighbouring structure where he performs further in the same way. He may also steal materials and take them to his own nest or take loose ends left hanging from a neighbour's nest and tie them in to his own. In this way the interconnections between neighbouring structures are established. Sometimes one bird alights on its nest with a long strand the end of which hangs temptingly near another builder. The latter then often seizes it and pulls. At once a vigorous tug-of-war ensues, each bird straining to gain the prize. Several times the grass strands broke under

the strain. Curiously enough, these intensely fought competitions never ended in fights, perhaps because the birds always had the full length of the grass between them.

As the framework develops, the strands are pushed downwards and twined around supports below the building position and also to the lower rim of the initial ring itself. The chamber thus begins to bulge below the original ring (fig. I) in a rough kidney shape. As the whole structure is being fitted throughout to supporting twigs, its shape is normally somewhat irregular conforming to the disposition of the various twigs bound into the frame. Further to these movements, wet mud blobs are carried to the nest in the beak and fixed either to the sides of the fabric of the initial ring or amongst the various strands of the chamber walls. Some of these blobs were very large and others were clearly mud-covered lumps of sodden wood. One mud covered twiglet was also used (5-7 cm.). By this time the nest is nearing its definitive shape and the entrance (the initial ring) has come to lie at the side near the top. There are, however, often gaps in the fabric which remain open and the birds occasionally enter by them. Occasionally a bird may sit in such a gap and carry out building and shaping movements from there exactly as if it were the initial ring. When the framework is complete the fabric is thickened by the addition of further strands.

The majority of observations on which this account is based were made on 12 nests in active construction in Colony ii. Since this colony was abandoned it was not possible to see how soon after the completion of the first nest a male begins another. One case was, however, observed in which a well-established ring was abandoned and destroyed and a new one built among twigs a few inches below. The nests were never properly completed and we cannot say how long a nest takes to construct when building motivation is at its maximum earlier in the season.

Females were observed titivating and shaping the nests very actively during their 'inspection' visits to the colony. Often a female would give several nests this treatment before leaving the colony. After egg laying, females were seen bringing soft grass heads (sp. ?) to the nests using them to line the interior. Nests obtained from Colony iii were however not fully lined, the base of the egg chamber and the area near the entrance having received the greatest attention. Apart from these activities the females, as in other weavers, did not take further part in nest construction.

3. Polygamy

Finn's Baya is polygamous and evidently attracts his wives to nests built in succession. As it was not possible to observe the whole process, we estimate the sex ratio of adults breeding in the colony from a few careful counts made in Colonies i and iii.

In Colony i there were 15 units of nests made up of 7 single nests, four units of two joined nests, two units of three joined nests, and two units of four joined nests. At two carefully observed units of two nests each there were single males with two females each. At a unit of four nests there were two males (one for the upper two nests, one for the lower two in the unit) and four females. At Colony iii single males respectively were recorded at three units of four nests each, one unit of three nests and one of two nests all of which had females. In a further twenty nests repeated counts revealed only seven males. Thus at forty-five closely observed nests in the two colonies only 16 males were present to match the 45 female occupants. This gives us an average of 2.8 females and nests to a male. The above observations thus suggest that while cases of single males with only one nest and female, and of males with as many as four females were recorded, the usuai number is probably two or three.

4. Eggs, and Clutch size

Eggs were obtained from six nests cut down from Colony iii. As in other Indian weavers, they were of a plain white coloration. There were four clutches of two eggs and two of three. The egg measurements, taken with a vernier calliper, are given in Table I. In a sample of 12 eggs the mean length was 20.95 mm. (maximum 23.6 mm., minimum 19.8 mm.); mean breadth 15.28 mm. (maximum 15.7 mm., minimum 14.8 mm.). Some of these eggs have been presented to the Bombay Natural History Society together with a group of nests.

IV. Agonistic and Reproductive Behaviour

1. Territorial Behaviour

At a colony under construction the males come and go in groups. On arrival the birds at once separate to their nest sites giving loud songs in a chorus. Approach to the nest by other birds is never tolerated and aggressive behaviour is at once shown. The defended area is however extremely small, at no time consisting of more than the nest site itself and, unlike most other weavers which tend to have their nests well spaced at least at the commencement of breeding, the

TABLE I

Egg measurements of clutches of *Ploceus megarhynchus* obtained near Kitcha on August 3, 1959

Clutch No.	Clutch size	Egg measurements in mm.
I	2 eggs	20.0 × 15.0 19.8 × 14.8
II	2 eggs	20.0 × 15.0 20.7 × 15.4
III	2 eggs	23.1 × 15.4 23.6 × 15.3
IV	2 eggs	Broken
V	3 eggs	20.1 × 15.7 20.9 × 15.6 21.2 × 15.2
VI	3 eggs	20.0 × 15.1 20.7 × 15.4 21.3 × 15.5

sites are so crowded as to be often within the stretching distance of the neighbouring birds. The distance between nest sites is in fact hardly greater than the normal 'individual distance' of the birds in a flock.

(i) *The Lunging Match*

The two factors, extreme crowding of nest sites and intensively aggressive reaction to the approach of other males, produce an unusual form of territorial defence almost all of which occurs on the nest itself, the defenders each perched in his proper nest ring and lunging as hard as possible at each other. These 'Lunging Matches', of which variants are found in many other weaver species, have the following form (see fig. I):

(1) The two combatants turn and face each other.

(2) Both raise wings above back but without at first extending (spreading) them, and begin quivering them at considerable speed. Sometimes the wings are simply raised, and quivering does not develop.

(3) One bird lunges at the other in an attempt to peck the beak or face of the opponent. The latter at once recoils its head into its shoulders and may move the whole body backwards pivoting on the hips. The feet do not change position. Immediately the lunge is completed the opponent at once retaliates with an identical pecking movement and it is now the turn of the first bird to recoil. Alternate lungings and recoilings occur repeatedly until the birds tire and one of them turns sideways and titivates its nest or hops into a different position on its nest or twigs near by. Sometimes the match is again renewed in the changed position.

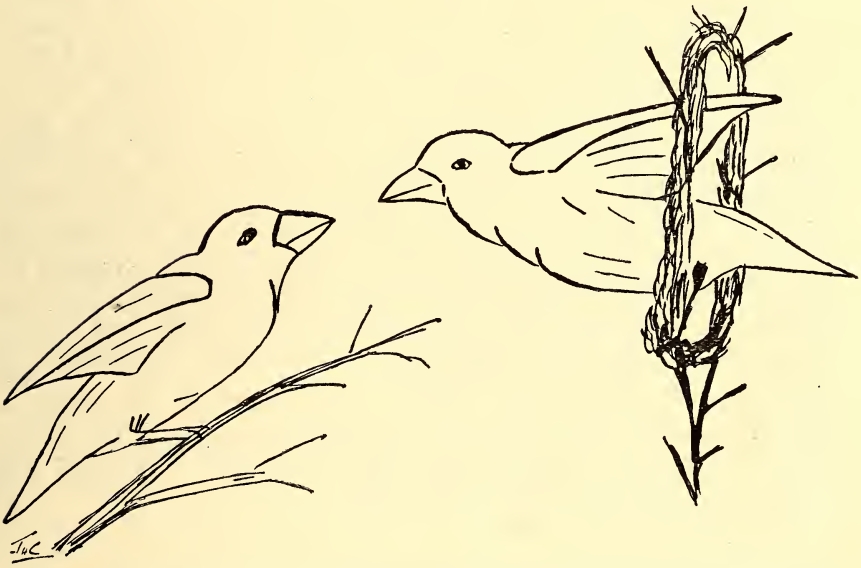

Figure I. Lunging Match between two males, the bird at right being perched in the Initial Ring.[1]

(4) The degree of wing spreading and the amplitude of the movements both increase with the intensity of the encounter. The movement varies from a simple wing quivering in which the wings are raised just above the line of the back and not spread at all, to an intense wing beating with partial wing spreading ('fluttering') in which the amplitude of the movement is greater, the wings moving from a position well above the line of the back to just below back level. Thus the more intense (i.e. longer and

[1] All figures drawn by JHC from sketches in field notebooks.

fiercer) the encounter, the greater is the spread of the wings and the amplitude of the flutter. The wing elevation is also higher. Wing movements of this kind during Lunging Matches have not been recorded previously from other Ploceine species although wing raising is given in the context by *Quelea quelea.*

(5) In the majority of Lunging Matches the combatants were both perched in the rings or on their developing nests. In some cases one of the birds was on a twig near its nest, while in a few further cases both the birds were perched on twigs near their nests.

(6) Occasionally these Lunging Matches lead to actual combat. On these occasions the wings are fully spread and elevated and beaten at high speed. Sometimes the birds fall from their perches clawing and pecking at one another.

There is a good deal of variation in intensity throughout these performances. Often the start is relatively quiet and the birds relax and separate after a few lunges. Usually, however, there is a quick build up to a fierce encounter. During prolonged encounters of several minutes there are several peaks of high intensity separated by periods of partial relaxation in which the birds may merely fixate one another with wing quivering. One particular male would peck fiercely at the twigs round him throughout an encounter apparently in 'redirection' of his pecking response. At the end of one match a male spread his wings out at the sides momentarily. The above account is based on detailed observation of sixteen encounters and incidental notes on many others by JHC.

(ii) *Supplanting*

Males sometimes 'supplant' one another (i.e. one bird fixates another and flies at it normally replacing it on its perch). This occurs particularly when the males follow prospecting females around part of the colony and thus repeatedly approach both one another and each other's nests. Supplanting of prospecting females is also common (see below).

2. Mobbing

The male Finn's Bayas at colonies with eggs and young sometimes perform mobbing attacks on human intruders. The bird concerned starts calling a loud *skeer skeer skeer* on the tree and then flies out repeatedly over the head of the intruder repeatedly calling. We have

no experience of other weavers' behaving towards a human being in this way. The behaviour resembles that of the drongos, who also had nests in the trees concerned, though it lacks the proficiency of the latter. The behaviour was not observed towards birds such as crows, normally so admirably driven away by the drongos.

Once a flock of Common Babblers (*Turdoides caudata*), the pair of drongos in occupation, a Redvented Bulbul (*Pycnonotus cafer*), and a pair of Yellow-eyed Babblers (*Chrysomma sinensis*) began mobbing a snake in a bush near the colony. During the commotion a dozen or so Finn's Bayas flew down into the same tree giving their mobbing call. On the hurried departure of the snake the bayas returned to their nests.

3. Pair formation

As in the majority of colonial weavers, courtship and pair formation are preceded by nest invitation during which the male attracts a prospecting female to his nest, at which he later courts and finally mates with her. From the present field observations a detailed account of nest invitation can be presented. Unfortunately we did not observe sufficient courtship to be sure of the actual details of the process. The greeting behaviour of pair members during brooding was, however, well observed and, since in other species this is often identical to postures seen in courtship, we can suggest the probable course of events.

Females normally first visit a colony when the nests are at an early stage of construction (Colony ii). They arrive singly or in small groups and soon some at least fly off with the males in foraging parties so that they accompany them back to the colony after feeding. In any event the arrival of females in the colony occasions great excitement among the males many of whom cease building and approach the females displaying (see below).

On arrival in the colony a female hops about among the nests in an apparently unconcerned manner although the sleeked plumage and crouched posture indicate a strong tendency to flee. She also avoids all males that approach her. During this exploration she hops on to many of the developing nests and performs shaping movements and titivation or merely examines them closely, peering about in and around the structures. During this activity the owner is in close attendance giving a particularly intense display (see below). Occasionally the female may respond with a little wing quivering, but in all observations she hops out of the nest again after a few seconds and taking no notice of the male proceeds to a further structure. Occasionally

two females approach a nest at the same time, there is then either a brief fight or one bird supplants the other.

The male's response to the approach of a female is an elaborate display with several degrees of performance intensity depending on the female's proximity to his nest. As soon as a female alights near an area of nests, most of the males hop down from their sites and approach her fixating her closely all the while. They finally stop advancing at a distance of one or two feet from her position. All the time they are giving the 'Wing Undulation Display' of the following very variable components:

(1) The bird faces the female fixating her with the body slightly crouched or else leaning forward or upward slightly from the hips in the direction of the female. The plumage is not fluffed except on the crown and nape.

(2) The tail is widely spread and often slightly depressed especially when the wing movements are fastest.

(3) The wings are undulated with a very slow and often irregular rhythm. They are normally fully spread and well elevated above the back. They are beaten through an arc of some forty-five degrees, between 45° and 135° to the dorso-ventral line of the body (see fig. IV); they thus move between a position roughly half elevated above the back to a drooped position at the side of the body. Often during the course of these undulations movement ceases for several seconds and this may happen with the wings either elevated or drooped (fig. II). Often the movements give place to wing quivering following partial closure of the wing. Wing quivering occurs at very low display motivation and often precedes it. Also males just beyond the immediate circle of displaying birds may show some wing quivering without leaving their nest sites.

(4) Song is given (see under Vocalisation, below).

During the performance the males may shift their positions, stop and start the display several times, and frequently change to wing quivering. There is a great deal of excitement and loud singing. The males, having left their nest territories, now frequently pass each other's nests while moving towards the female and this occasions many supplanting attacks. Further two displaying males may approach each other in their excitement, and a brief fight then follows. Every time the female moves there is a great commotion as the quarrelsome males change positions and approach her again. After a time the female flies on to a nest. At once the owner, who has been wing undulating

near it or among the circle of 'admirers' flies up to his site and perching on the exterior near the entrance, at the side of the entrance or on a twig near it, performs the 'High Speed Wing Beating Display' of the following components:

(1) Posture as in Wing Undulating.

(2) Tail widely spread and either straight or slightly depressed, rarely slightly elevated.

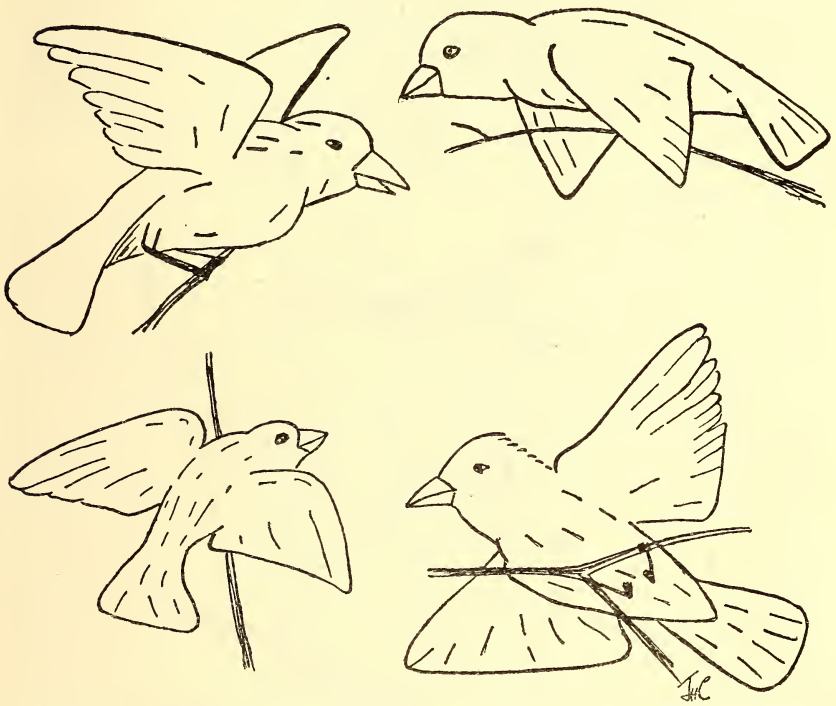

Figure II. The Wing Undulating Display : wings shown in differing positions with performers facing different directions. Top left and bottom right, wings well elevated ; bottom left, wings at the side ; top right, wings drooped. See text.

(3) The wings are fully elevated above the back and beaten at high speed (10 beats in 1.2 secs. mean of four readings, minimum 1, maximum 1.4) through a small arc above 135° to the dorso-ventral line of the body (fig. IV).

(4) Sings loudly at the female. Occasionally at the most intense moments of display a loud *skee skee* termination to the song was heard.

These displays last a few seconds only, the male then hopping to a fresh twig near the nest where he resumes wing quivering or undulating all the while watching the female closely. After several seconds he again flies to the nest and gives the High Speed Wing

Beating Display. This alternation continues until the female leaves the nest or until the male tires and sits near by wing quivering. Occasionally neighbouring males also fly to a twig near the nest and give the High Speed Wing Beating Display. They are at once supplanted by the owner.

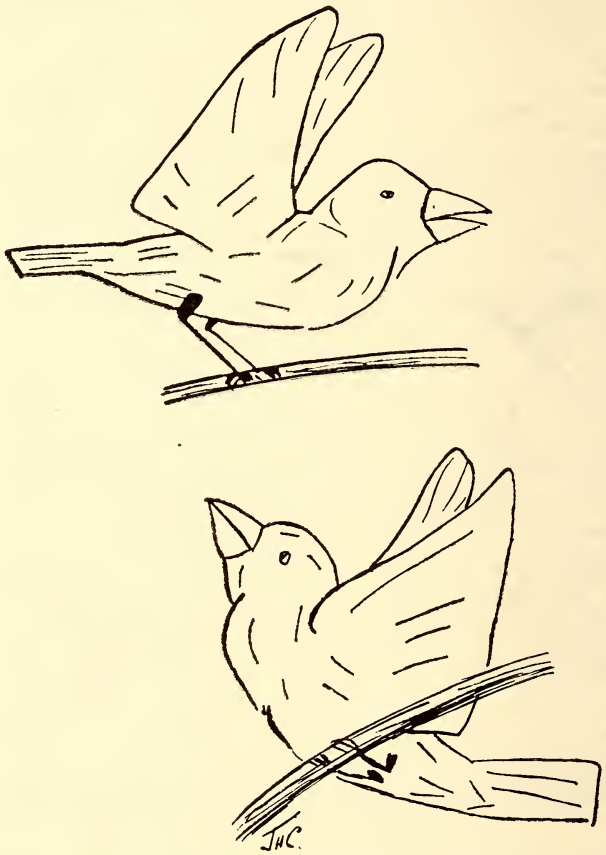

Figure III. The High Speed Wing Beating Display. Bottom bird displays to a female in nest above his position.

The females are not always greeted with display; frequently a male may supplant females approaching his nest and occasionally pursues them for a short distance within the colony tree. More rarely a female lunges at an approaching male away from his nest and forces him to retreat.

128 behaviour sequences shown by the males on the arrival of females among their nests were observed in detail and recorded on tape for later analysis.

The 'Wing Undulation' and 'High Speed Wing Beating' displays are clearly both forms of advertisement and resemble the nest invitation displays of other weavers, particularly the *Quelea* which also displays in an upright posture on a globular nest. However, the female visits nests irrespective of the male's display so that the display probably functions also as part of courtship. The 'High Speed Wing Beating' display in particular resembles a mounting attempt complete with the flutter of wings above the back. During display at the nest several copulation attempts were seen, none of which were however apparently successful, and, at the time, no solicitation by the females was observed. Pair formation was thus never completed in the colony (ii) and the nests never accepted.

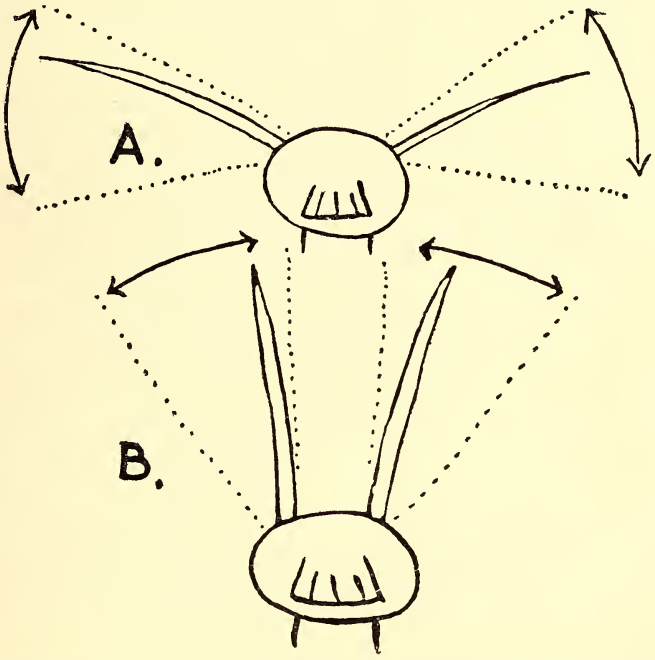

Figure IV. Diagram showing arc and elevation of wing movements in A, Wing Undulation and B, High Speed Wing Beating.

Comparing the two displays with those of other species, the 'Wing Undulation' seems homologous with the many other Wing Beating advertisement displays while 'High Speed Wing Beating' completes and terminates the display in a similar manner to the 'Wings rigid' postures with which it may be homologous (Crook, 1958 *a*, and in preparation). The motivation of these various postures will be further analysed (by Crook) in a later comparative publication.

In several highly colonial weavers, for instance *Ploceus cucullatus* in Africa and *Ploceus philippinus* in India, the performance of nest advertisement displays is highly contagious so that if one male displays to a female a large number of birds, if not all of them, will fly to their nests and display in the same way (i.e. social facilitation). In the present species however this does not happen. Only the males in the vicinity of a female display to her, and they only fly to their nests for the performance of the 'High Speed Wing Beating' after her arrival there. The female is, moreover, very rarely chased (a common occurrence in other species) either within or beyond the colony and as soon as she leaves one area of nests the males return to building and titivating on them while a neighbouring group of males begins displaying to the female. Thus when a female moves through a colony she is always closely attended only by those males to whose nests she is closest (4-6 birds). Males slightly peripheral to her position merely wing quiver while the others are busy at their nests. When several females are present in a colony at once a group of males forms around each one and in the jostling about that follows, consequent upon the various movements of the females around the nests, a great deal of excited supplanting and lunging near the nest sites occurs.

The final stages of pair formation and successful copulation were not observed. It is likely however that after visiting a large number of nests the female finally chooses one and responds to the male's displays there with wing quivering and also the solicitation posture observed later during the mutual greeting of pair members during brooding (see below). On flying to the nest the male would then approach the female in the entrance and, instead of giving the 'High Speed Wing Beating' display, mount her and copulate with wings beating in the usual ploceine manner. Following repeated sequences of this kind the pair bonds would be established. Further observations are required.

4. Behaviour during brooding

At Colony iii incubation was well advanced by the time of the observations on 2 and 4 August. The males sat about their nests occasionally titivating on them and bringing in new grass strands which were added to the exterior. These fresh green strands were not observed at nests with young inside in Colony i. The birds came and went in groups as before, producing loud twittering choruses on arrival and departure. The females were very active about the nests; some were incubating and others flew to and fro transporting flowery grass

heads into the nest. They confined their attentions now to their own nests.

The males showed lunging behaviour only very occasionally and it was clear that this had largely ceased. They frequently trespassed on one another's nests, however, but a brief supplant sufficed to remove an intruder and no fighting was seen. The males also occasionally supplanted females who had perched on a nest other than their own. Usually the males welcomed females returning to their nest groups by turning to face them and wing quivering. Only rarely were some Wing Undulation movements seen, and there was none of the displaying so characteristic of the pre-mating period. Sometimes when a female had entered a nest the male flew to the entrance wing quivering and sang loudly into it. When wing quivering, a male may advance towards a female and sing, whereupon she usually disappears into the nest in a hurry. The males were not seen entering the nests.

On arrival at the nest unit a female usually wing quivers intensely to the male who may be greeting her in the same manner. Both birds then wing quiver together for a few seconds before the female passes to her nest (cf. *Quelea quelea*, Crook in press). Frequently however the female may show a posture which, through comparison with other weavers, can only be called a 'Solicitation Posture'. This has the following components:

(1) Body crouched on perch.

(2) Wings are slightly spread out at the side of the body and quivered.

(3) Tail slightly raised (*circa* 30° to the line of back) and tremored in the dorso-ventral plane.

From time to time during certain of these posturings a further more intense posture is given. This has the following further features:

(1) The body is closely squatted on the perch. The head is suddenly raised and the bill is pointed upwards.

(2) At the same time as the bill raising and squatting, the wing quivering suddenly ceases and the wings are spread out at the side of the body in a slightly drooped position (figure V).

(3) The tail remains slightly raised or is yet further raised above the back and the tremoring is continued.

This posture usually occurs during a spell of wing quivering or ordinary solicitation, and may recur three or four times before the female flies to the nest. Occasionally it is given without prior wing quivering or solicitation. Some females seemed more disposed to give the postures than others.

In other weavers this type of greeting behaviour closely resembles sexual behaviour prior to copulation, and we thus have every reason to suppose that these solicitation postures also occur prior to copulation in this species. The particularly intense form of the posture probably accompanies mounting itself. During brooding the postures probably prevent the expression of aggressive responses by the male on the female's approach. The male in fact was never seen to respond to

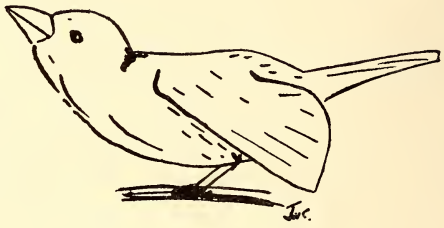

Figure V. The female ' Solicitation Posture ' in the intense form with momentary sideways spreading of the wings in a slightly drooped position.

these postures with any behaviour other than wing quivering, but the occasional supplant and the approach to the nest with loud song indicate the infrequent activation of a tendency to attack the approaching bird.

5. Care of Young

Although both sexes feed the young in the nest and also remove faeces, the females are the more active. The males spend much time simply sitting near their nests singing and driving off females (other than their own) that come near them, and in occasional supplants against neighbouring males. When a male alights at a nest containing young he frequently sings, and he also wing quivers (as above) when a female alights there with food. No complex 'greeting' behaviour with female solicitation was however observed during this phase, the females merely showing occasional wing quivering on arrival with their tails slightly raised. The food appeared to be mainly insects carried in the beak.

After the young have left the nests they follow their parents. On 3 successive mornings a group of adults, both male and female, were seen on a roadside, each adult followed closely by one, two, or three full fledged young, wing-shivering and begging food. The adults were picking seeds from the road surface and giving them to the young. At least on these occasions regurgitation was not recorded.

6. Behaviour of First year Juveniles

We observed many first year juveniles (males?) in company with some adult males building nests (or perhaps merely 'doodling'?) in rushes and reeds at two different night roosting sites. The nests were all at a very early stage in construction being either rings or partially developed chambers, or just formless tangles. The birds were seen bending down leaves of rush and tying their ends into the structure. The standing reed stems are tied together with grass strands transported to the site by the builders. As in the definitive tree-top colonies the nests were often only a few inches apart and Lunging Matches were seen at the sites. The whole behaviour was however irregular with individuals frequently building actively on several nest sites, and at any one site several birds may come and build. No females were seen visiting these nests. This type of irregular building activity together with failure to complete the nests and an absence of clearly defined ownership and territorial defence is characteristic of reproductive behaviour at low motivation in several weaver species. In particular it has been recorded for *Quelea* at a midday roosting site in the Senegal in the month preceding actual breeding (Crook, in press). First year juveniles of *Ploceus cucullatus* and *Ploceus philippinus* while yet in 'sparrowy' plumage also build nests, that are inadequately completed and never occupied by females. Whether actual breeding colonies of *P. megarhynchus* here are also sited among reed beds, as recorded from the Duars, remains to be ascertained.

7. Vocalisation

The voice of Finn's Baya is louder, harsher, and more 'nutty' than that of *Ploceus philippinus*. We heard the following cries uttered, some of which have been recorded on tape for further analysis:

(i) A twittering cry given on take-off and alighting. This is particularly noticeable during group flights and appears to play a role in flock integration.

(ii) The *skeer skeer* (or *tseer tseer*) mobbing calls. (p. 472)

(iii) A high pitched alarm note.

(iv) The song given by the male during Wing Undulation, High Speed Wing Beating displays, and Lunging Matches, and also when sitting still in the territory. The majority of birds utter the song as a continuation of the twittering upon arrival in the colony during nest construction (Colony ii), and thereafter it recurs in sporadic choruses, the song of one bird starting the others singing. The song

may be rendered: *twit-twit-tit-t-t-t-t-trrrrr wheeze whee wee we.* The complete phrase is not always given. Occasionally a high pitched *seep seep* either followed the song or occurred during the High Speed Wing Beating displays.

V. Summary

Due to lack of knowledge about its ecology and habits since first described in 1869, *Ploceus megarhynchus* was hitherto considered one of the rarest Indian birds, a notion that now proves to be erroneous. Previous quests for it had failed mainly because of the false scent laid by the published type locality 'Kaladoongee' which is actually situated in the forested country of the Kumaon bhabar at the base of the W. Himalayan foothills, whereas the bird is restricted to the vast swampy grasslands of the terai at a lower elevation. The present investigation first discovered the bird's true habitat by accident, thus removing the major obstacle in its field study. Paucity of correct information may also be due in part to the difficulty of distinguishing this species in the field from the Common Baya in non-breeding plumage.

Unlike all other Indian members of the genus, *Ploceus megarhynchus* builds untidy coarsely woven globular nests in colonies among the topmost twigs of Silk Cotton (*Salmalia*) and other trees which are deliberately denuded of foliage. Incomplete nests were also found among marshy reed beds. In form and details of progressive construction the nests resemble those of *Quelea quelea* of Africa.

Ploceus megarhynchus differs from other Indian Ploceinae also in the fact that the female, in addition to the male, is seasonally dimorphic and acquires a distinct yellow breeding dress, but which is less bright than the male's.

Its general breeding biology resembles that of the Common Baya, *Ploceus philippinus.* The males, wholly responsible for nest building, are successively polygamous having from 1 to 4 females each. The eggs are white, and two or three constitute a normal clutch. Both parents, but chiefly the female, feed the young in the nest and later outside.

Some incomplete observations are recorded on voice, courtship, pair formation, and other behaviour.

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The Great Indian Rhinoceros (*R. unicornis*) in Nepal[1]

Report of a fact-finding Survey, April-May 1959

BY

E. P. GEE, M.A., C.M.Z.S.

(*With 3 plates and 3 maps*)

CONTENTS

I. INTRODUCTION

Chitawan and neighbouring areas of Nepal have long been famous for their abundance of big game, including the Great Indian One-horned Rhinoceros, *Rhinoceros unicornis*, which is now one of the vanishing species of the world. For many years this part of southern central Nepal was the strictly guarded shooting preserve of the rulers of that country; but with the advent of democracy and unsettled political conditions in 1951, the exact status of the area and of the rhinoceros in it has not been clear to the outside world. Reports were in circulation of alarming slaughter by poachers in recent years, especially in the year 1958-59; but lack of authentic information prompted the Survival Service Commission of the International Union for the Conservation of Nature to ask me to investigate the distribution and status of the Rhinoceros in Nepal, and to suggest measures for the preservation of this species in Nepal.

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[1] The Bombay Natural History Society, as a token of its deep concern in the reportedly serious plight of the rhinoceros in Nepal, had contributed towards the expenses of Mr. Gee's survey promoted by the Survival Service of the International Union for the Conservation of Nature and Natural Resources. This report, first published in *Oryx*, the journal of the Fauna Preservation Society, is here reproduced by courtesy of the editor, the IUCN, and the author.—EDS.

As it was not possible for me to visit the area concerned until the end of March, 1959, which is the start of the hot weather, when dust, heat, and flies render camping difficult, and as facilities for investigating the problems were somewhat restricted due to the short notice given, the duration of the survey was not extensive. Sufficient time was, however, found to spend two and a half weeks in the Rapti Valley, to traverse almost the whole area, to visit typical localities within the rhinoceros area, both inhabited and uninhabited by rhinoceros, and to obtain first-hand information about the administrative and ecological aspects of the problem.

Having had considerable experience of the Great Indian Rhinoceros and its preservation in Assam and Bengal, I found it most interesting to study the same animal and its habitat in Nepal—where conditions turned out to be very different from those in India.

II. General Review and Summary of Report

The rhinoceros area in Nepal covers approximately 1250 square miles, comprising the valleys of the rivers Narayani, Rapti, and Reu. Although it is *dun* country, it contains most of the sub-tropical vegetation usually associated with *terai* country, and can roughly be divided into (1) riverain, (2) grassland above flood level, and (3) *sal* forest. The hills are almost entirely under *sal* (*Shorea robusta*), a valuable hardwood.

During the cold weather months from November to April, the rhinoceros live mostly in the thick tree and scrub forest of the riverain tracts, whereas in the rainy season from June to September, many of them move away from the partly flooded riverain tracts into grassland or forest. Competition between human settlers and wild life for the grassland area has reached a critical stage, in which wild life has retreated further and further into the unexploited parts of the area and into the thick riverain scrub forest.

As the result of many years of being shot both by sportsmen and poachers and of being driven by villagers from cultivated areas, the rhinoceros of Nepal has adopted a mode of existence and a temperament different from those observed in north-east India where, during the present century, rhinoceros have been strictly protected in their natural habitat. In Nepal they have become nervous, frightened of the sight of human beings, and almost entirely nocturnal. A number of years of strict protection and the allocation of 'living space' in riverain and grassland tracts are needed to enable them to settle down to a normal and peaceful existence.

Poaching remains a serious problem, although the rhinoceros receive much protection from the thick cover, which is not their real habitat, and from the Rhinoceros Protection Department. But a more serious problem is that of increased and increasing influx of both authorized and unauthorized human settlers from the hilly regions of Nepal into the plains which form the rhinoceros area.

I consider that the position is not nearly so hopeless as recent reports had made it out to be, and that in spite of poaching, the number of rhinoceros is in the region of 300.

The Nepal Government has wisely constituted a national park and has plans for a wild life sanctuary. But, unfortunately, the national park in its present form is not an ecological unit in which the animals would have full scope to behave normally, nor is it of sufficient area to include a reasonable amount of rhinoceros habitat and their lines of seasonal and local migration. Apparently the wild life sanctuary now proposed by Government would not enjoy the permanency so necessary for nature conservation. While immediate human needs of land for cultivation and grazing are paramount, the essential long-term need for water and soil conservation and for a specified area to be set apart for the preservation of wild life in its natural habitat, as a wise form of land-use, must not be lost sight of. It is not too late for these very necessary steps to be taken. The area proposed in Section VIII of this Report, to be added to the present national park, contains the greatest possible number of rhinoceros in their natural habitat. At the same time it is almost entirely free from human occupation and consequently there would be a minimum of administrative work.

III. History of the Rhinoceros Area

The present rhinoceros areas of Nepal, in fact the whole of that country, have been up till recent times a closed book to foreigners. Visits by outsiders were discouraged, even forbidden. Perhaps the first foreigner to tour in the Nawalpur, Chitawan, and Reu Valley areas was Mr. E. A. Smythies who, during World War II was Forest Adviser to the Nepal Government. In the course of his duties Smythies visited almost all the submontane tracts along the 500 mile *sal* belts of the Nepal *terai*.

There is some historical evidence that the Rapti Valley, as Chitawan is usually known, was once much more thickly populated than at the beginning of this century, and it is possible that malaria was the chief reason for any subsequent depopulation of the area.

The Rapti Valley has remained closed even to most prospective Nepali settlers, not only because of malaria, but because it was strictly protected as the special shooting preserve of the rulers of Nepal, whose huge camps and elephant beats were known the world over. Up till recent years almost the only people living in the area were simple 'Plains Nepalis'—the Tharus, who appear to have become immune to malaria and who incidentally provide practically all the elephant drivers of that country. These people also provided the labour required for making rough cross-country tracks in the dry cold-weather months and for preparing shooting camps.

A special department of armed men has existed for many years to protect the rhinoceros, tiger, and other game. At the time of my visit it consisted of: 1 Commander (Captain), 1 Assistant (Lieutenant), 4 Subedars, 24 Havildars, and 122 Rhino Guards.

Mr. E. A. Smythies in his book, BIG GAME SHOOTING IN NEPAL (1942), and his wife Olive, in her TIGER LADY (1953) speak in glowing terms of their trips to the Narayani, Rapti, and Reu valleys in the years 1941-1945. They found that, whereas in the rest of the Nepal *terai* there was practically no game left, here was still a sportsman's paradise, with uncounted numbers of rhinoceros and other big game, and comparatively unspoiled habitat.

In 1951 as a result of the political upheaval in which the Rana regime came to an end and democracy came into being, the area underwent a change. Poaching increased to an alarming extent—in fact this seems to have been the peak year for illegal slaughter of rhinoceros.

From 1951 onwards the weakening of protection in the big game reserve meant that malaria was now the main, if not the sole, deterrent to settlers coming from the hills into the Rapti Valley. It was not possible in such a mountainous country as Nepal to prohibit indefinitely the influx of human settlers into grasslands suitable for cultivation of crops. 'Hills Nepalis,' Gurungs, Magars, and others, started to come down into the Rapti Valley unofficially; and officially the Rapti Valley Multi-purpose Development Project began in 1955 to settle cultivators from the hills in the western portion of Chitawan south of Narayangarh, at the rate of 2500 persons a year. By March, 1959, 12,000 persons had been settled on grasslands once occupied only by rhinoceros and other species of wild life, and 52½ square miles had been thus opened up and developed. It is proposed to settle a further 25,000 persons in the Rapti Valley in the near future.

A new gravelled road from Hitaura to Bharatpur and Narayangarh has been constructed jointly by the United States Operations Mission

and the Nepal Government, and this was completed by March 1959, except for a bridge and the big causeway near Hitaura. It was claimed that recent malaria control measures had succeeded in making the valley considerably safer for human occupation.

Besides the 12,000 persons officially settled by the R.V.M.-P. Development Project, a large unspecified number of people from the hills have settled unofficially in various parts of the Rapti Valley during the last few years. It is obvious that if the influx of human settlers continues unchecked wild life will ultimately disappear from this renowned place.

The Nepal Government has been aware of this danger, and during the winter of 1957-58 steps were taken to allot a part of the north of the valley as a national park. In January, 1959, the Mahendra Mriga Kunja (Mahendra Deer Park), or Mahendra National Park, of 68 square miles was formally opened by King Mahendra. It is proposed that a 'Wild Life Sanctuary' (possibly for 10 years only, after which it may revert to shooting blocks) shall be created south of the national park to include most of the rhinoceros area as well as cultivation and grazing areas. Another area has been allotted as 'King's Reserve' and another as 'Shooting Blocks' (see map No. 2).

IV. Geography and Ecology

The present rhinoceros area comprising the valleys of the rivers Narayani, its tributary the Rapti, and the Rapti's tributary the Reu, is often loosely spoken of as part of the Nepal *terai*. *Terai* in northern India and Nepal is, strictly speaking, moist country a few miles from the base of the Himalayas, below the *bhabar*, which is dry country with a subsoil of boulders right at the foot of the Himalayas. Chitawan, or the Rapti Valley, is a *dun*—a plateau or flat valley inside the foothills of the Himalayas; its altitude is between 900 and 1000 feet above sea-level, and it has most of the typical vegetation of the *terai* which is usually at 350 to 600 feet.

The *dun* of the Rapti Valley is approximately 40 miles long from east to west, and varies from 4 miles wide at Ramoli at the eastern end, to about 16 miles at its widest, in the west near the Narayani River. This is the main rhinoceros area, bounded on the north by range upon range of the Mahabharat (Himalayas) and on the south by the Churia Range (Siwaliks). Another area with similar vegetation lies west of the Narayani River and down the bank of that as far west as Tamashpur. A third area is the Reu Valley which is divided from the Rapti Valley by a ridge of the Churia Range. The scenery,

Sal trees in the *dun* of the Rapti Valley, with Himalchuli (25,800 ft.) in the distance.

The River Narayani (or Gandak) near Deoghat in the Mahendra National Park.

Photos : E. P. Gee

Indian rhinoceros in typical grassland habitat in Nepal.

Cow and calf rhinoceros in typical grassland habitat in Nepal.

Photos : E. P. Gee

climate, and vegetation of the Rapti *dun* is very similar to that of the beautiful Corbett National Park of Uttar Pradesh in India.

Records of rainfall for this area are scanty, and have only been kept during the past three years. It appears that 65-70 inches, falling mainly between June and September, is the normal rainfall of Bharatpur at the western end of Chitawan.

The terrain of these three valleys can be conveniently divided into riverain, grassland, and timber forest:

1. Riverain, comprising all the low-lying strips along the river beds as well as the islands in the river beds.

2. Grassland, above flood level, most of which is either being or is about to be occupied, cultivated, and grazed by human settlers.

3. Timber forest, mainly on the higher undulating portions of the *dun*, and covering most of the hills of the area.

Riverain

The Narayani (or Gandak) is a huge river, and occasionally washes a live rhinoceros down into India. In this area it widens out to a mile or two and has islands (*tapoos*). To get over it one often has to cross three, four, or five channels as well as the islands in between, and this takes about half a day. In addition to this mile or more of channels and islands, there runs along each bank a strip of riverain forest and savannah which varies in width up to a mile or more. The low lying islands in the river, which could be classed as sand banks, become flooded during most of the rainy season, June to September. The higher islands and most of the low-lying strips of forest and savannah along the banks get flooded during peak floods of the monsoon. All this area is excellent rhinoceros habitat, containing the water, grasses, reeds, and forest cover they need—particularly during the dry weather, November to May.

The Rapti River is small compared with the Narayani, and in the dry weather can be crossed by jeep at many places where its shingly bed widens out. It too has islands, particularly in its lower reaches, and strips of riverain forest and savannah on either bank, varying in width from a furlong to a mile or so. The Reu, main tributary of the Rapti, is much the same as the Rapti but very much smaller, and the valley very much narrower.

The vegetation of the riverain tracts consists of tree forest and savannah.

Tree Forest.—The trees are mainly of flood resisting species such as *simul* (*Salmalia malabarica*), *sheesham* (*Dalbergia sissoo*), and

khair (*Acacia catechu*). There is a tangled mass of undergrowth, much of which is evergreen and much of which is also thorny, affording the fullest shelter for rhinoceros during the day time, especially in the dry weather.

Savannah.—The vegetation of the savannah varies a great deal according to whether it is above or below the river level of normal rains. It consists mainly of the reeds and grasses usually found in this part of the world, viz. *ekra* (*Erianthus* spp.), *khagri* (*Phragmites karaka*), *nal* (*Arundi donax*), and *thatch* (*Imperata cylindrica*). Frequently there is an intermingling of forest and savannah, forming dense scrub thickets with plenty of cover.

Nearly all the savannah areas of the riverain tracts are burnt off annually by the local villagers to improve the grazing for their cattle —and incidentally, for the wild herbivorous animals. This has been taking place, at least to some extent, for thousands of years, and has become part of the ecological pattern.

Whenever a small stream, known locally as a *khola*, flows out of the hills, or through grassland into a river, there is to be found a small riverain tract usually thickly forested, of varying width according to the size of the tributary. These *kholas* provide corridors for movement of game away from the main rivers as well as thick cover during day time.

Hardly any of the riverain tracts of the three rivers contain houses or even cultivation, as they are liable to flooding during the monsoon months. Practically all of them are made use of by villagers for firewood-cutting, thatch-cutting, and grazing. The thickest of the tree forest and scrub forest areas are seldom interfered with, due to thorns and impenetrability.

Grassland

On leaving the low-lying riverain tracts one finds flat grasslands above flood level stretching for a furlong or two in the Reu Valley, for a mile or two on the west bank of the Narayani River at Sandhna, and for anything up to seven or eight miles in the *dun* north of the Rapti River. These grasslands contain the same reeds and grasses as the savannahs of the riverain tracts, with the addition of other high-ground vegetation which is not flood resistant. The soil is richer and more suitable for the growing of crops at the eastern end than at the western end, where it is lighter and more sandy in composition.

Nearly all the grasslands of the whole rhinoceros area have either been occupied by human settlers for cultivation or grazing, or are

just about to be, with the notable exception of the south bank of the Rapti from Jaimangala village westwards past Darbar (a disused shooting lodge built for King George V when he visited Nepal in 1911) towards the junction of the Reu River and southwards to the Churia range. This is so far mostly unspoiled by human settlers.

Of the grasslands which have for some time been occupied by settlers, in some places the effects of continuous annual burning, overgrazing, cattle-tread, and exposure to increased evaporation, are becoming evident from decreased fertility and increased desiccation.

Timber Forest

In this area the sub-montane timber forest is mainly *sal*, which is to be found growing on some of the well-drained higher grassland, as well as on most of the surrounding hills. It is a tree of great beauty of form and colour, and contributes much to the aesthetic enjoyment of the place, especially when the snows of the Himalayas some 50-80 miles away are visible. The *sal* forests of the area are mostly virgin and contain some of the best trees of this species in the world, rising to 160 feet, especially in the north of the Rapti Valley, in what is now the Mahendra National Park. The *sal* is being exploited by the Forest Department only in the east towards Hitaura. At present there is no exploitation west of Debichor, except some cutting by new settlers.

Most if not all of the *sal* forests are under the jurisdiction of the Forest Department, and are regarded as Reserved Forests. Unfortunately, however, it appears that the boundaries of some of these Reserved Forests have not been clearly demarcated, and unauthorized persons are said to be settling in parts of them with the usual accompaniment of felling and burning for cultivation and grazing. If this is true, it deserves the urgent attention of the authorities, especially as there are so many parts of these forested hills which, forming the catchments of the streams and rivers, need careful conservation in order to avoid soil erosion and desiccation.

V. Administrative and Political

Administration will be considered only as far as the rhinoceros and its preservation are concerned. Three different divisions of the Forest Department are involved. The Rapti Valley is under the Divisional Forest Officer of Chitawan residing at Hitaura; the Nawalpur area (west of the Narayani River) is under the D.F.O of that district residing at Parasi, a journey of some distance from the rhinoceros area with

no roads for travelling; the Reu Valley is under the D.F.O. of Birganj. From the rhinoceros preservation aspect it is unfortunate that this area of Nepal should fall under the jurisdiction of three different D.F.Os., under two separate Circle Conservators, with no means of communication between them except via Kathmandu. The D.F.O., Chitawan, residing at Hitaura, is in charge of the whole Rhinoceros Protection Department which operates in all the three areas; but he is unable officially to visit the Nawalpur or the Reu Valley areas except by arrangement with the D.F.O. of the district concerned. All this is not a criticism of the Forest Department: it merely states the position as it happens to be today. The Narayani River is possibly too great a physical barrier for both sides of it to be under one D.F.O.

Poaching of Rhinoceros

The Rhinoceros Protection Department, the personnel of which has already been given, mans 42 *chowkis* (posts), 26 in the Chitawan area, nine in the Reu Valley, and seven in Nawalpur. Poaching, as has been said, was probably at its peak during 1951. Accounts differ as to the intensity of poaching during the years 1952-58: some people informed me that the position was static, becoming no better and no worse, while others said that during the last three years there has been a slight improvement. Probably official statistics do not give a true picture of the actual amount of poaching during any particular year.

I was told that in 1958, 60 rhinoceros were officially listed as poached: 52 in Chitawan, 6 in Reu Valley, and 2 in Nawalpur. Of these 60 rhinoceros killed by poachers, 24 horns were recovered, and 13 persons arrested and gaoled. In 1959, twelve cases had been detected by the end of March—Chitawan 6, Reu Valley 2, and Nawalpur 4. Of these eight horns had been recovered and seven men arrested.

I had discussion with many people, particularly with the Divisional Forest Officer of Chitawan, who had been for four years in charge of that division, and with Captain Gyan Bahadur Basnayt who had been for two years in charge of the Rhinoceros Protection Department, and there appears to be no evidence of any real organization behind the poachers. Most of the poachers of the Nawalpur area are said to come from the hills, while many of the poachers of Reu Valley and Chitawan come from the south, including India. Some of the poachers are also said to be new settlers from the hills in the Rapti Valley, Magars, Gurungs, and others. The Tharus, 'plains Nepalis', and original inhabitants of this area, are mostly simple and innocent folk,

Cow rhino with her newly born calf in the Rapti Valley, Nepal.

Rhino guard stands near the carcase of a rhinoceros killed by poachers. (Note the skull with horn removed.)

Photos : E. P. Gee

and are believed not to be involved to any great degree in the poaching of rhinoceros.

Most of the rhinoceros poachers in Nepal take refuge first of all in the hills, and then make their way to India, where the horns probably pass through the port of Calcutta to the Far East, particularly to China. The possession and sale of rhinoceros produce is illegal in India—if the place of origin is Bengal or Assam. But if the origin is Nepal, it is probable that its transit through and export from India would not be considered illegal under existing laws and rules. I therefore recommended, while in Kathmandu, that the Government of Nepal should try to effect greater co-ordination of protective measures with the Government of India, in order to prevent this traffic. I now suggest also that the Excise Posts on the India-Nepal border should be kept constantly on the watch for the same purpose.

Development

The last bridges and causeways of the fine gravelled motor road from Hitaura in the east to Bharatpur and Narayangarh in the west are nearing completion. Apart from this there are no all-weather roads. In the dry weather (November to May) all villagers and even isolated houses are connected by bullock-cart tracks which are motorable for jeeps and other high-clearance vehicles.

Since 1955 the Rapti Valley Multi-Purpose Development Project has opened up 53½ square miles of grassland, formerly the home of rhinoceros and other wild life, for 12,000 human settlers, mostly from the hills (see Map No. 2). The implementation of the proposal to settle a further 25,000 persons in the Rapti Valley, combined with the influx of unauthorized settlers, if allowed to continue at its present rate, would mean that hardly any part of this once famous big-game preserve will be left for wild life.

The Mahendra National Park

In its present size and shape, this national park contains about 50 square miles of hills and almost virgin *sal* forest, with a few *kholas* which are dried up in their middle reaches from March till June, and about 18 square miles of mixed evergreen and deciduous forest and grassland with plenty of water in the *kholas* and swamps.

There are villagers with their houses, cultivation, and cattle at Narayangarh, Tikoli, Jirwan, and Jurpani, who still have to move from the national park to alternative sites, with promised assistance from Government. The D.F.O. informed me that he was experiencing some difficulty in enforcing this order, and that the matter was

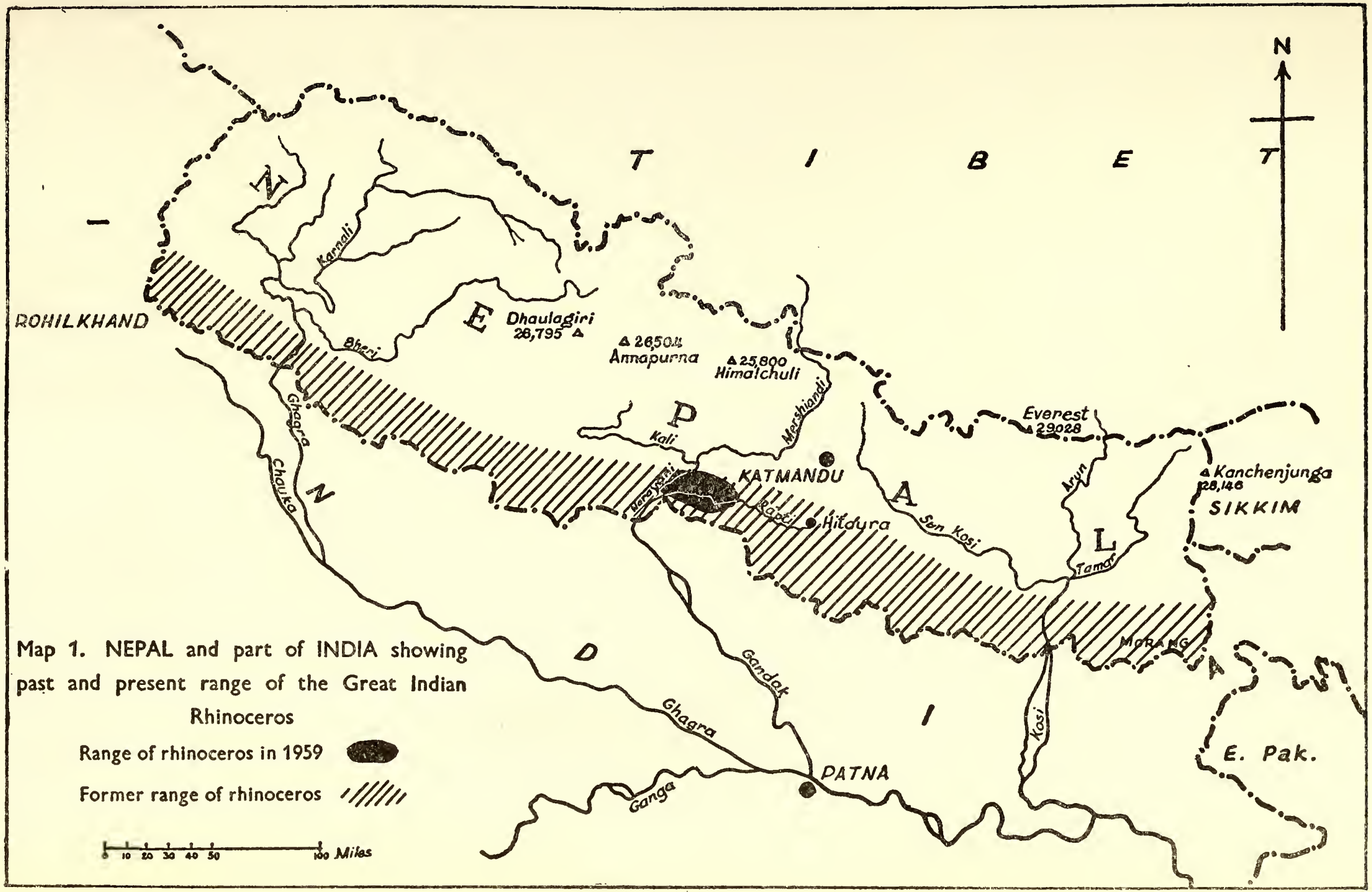
urgent in view of the approaching season for seed-sowing. While I was there the Tikoli villagers expressed their willingness to leave the park area if they were given some of the areas to be re-settled near by. I duly passed on this information to the authorities on my return to Kathmandu.

Necessary additions to the Park.—North of Narayangarh up to Deoghat, the road runs along the river bank from which the mountain and river scenery is very beautiful. When I was there the red-flowering bush *Woodfordia floribunda* was in full bloom, as were several flowering trees; and the *kusum* tree, *Schleichera trijuga*, was in new leaf, shimmering in pale mahogany—all these as well as the *sal* trees in their transition stage from old to new foliage added to the beauty of the scene. But the majestic and unspoiled sal-forested mountains on the opposite bank west of the Narayani and north of the confluence of the rivers Kali Gandaki and Mershiandi, although they contain numbers of gaur, deer, and other wild life, have not been included in the national park. As these parts are mountain and virgin forest almost totally unoccupied by human settlers, they would make a very fine addition to the park without the difficulty of removing human inhabitants.

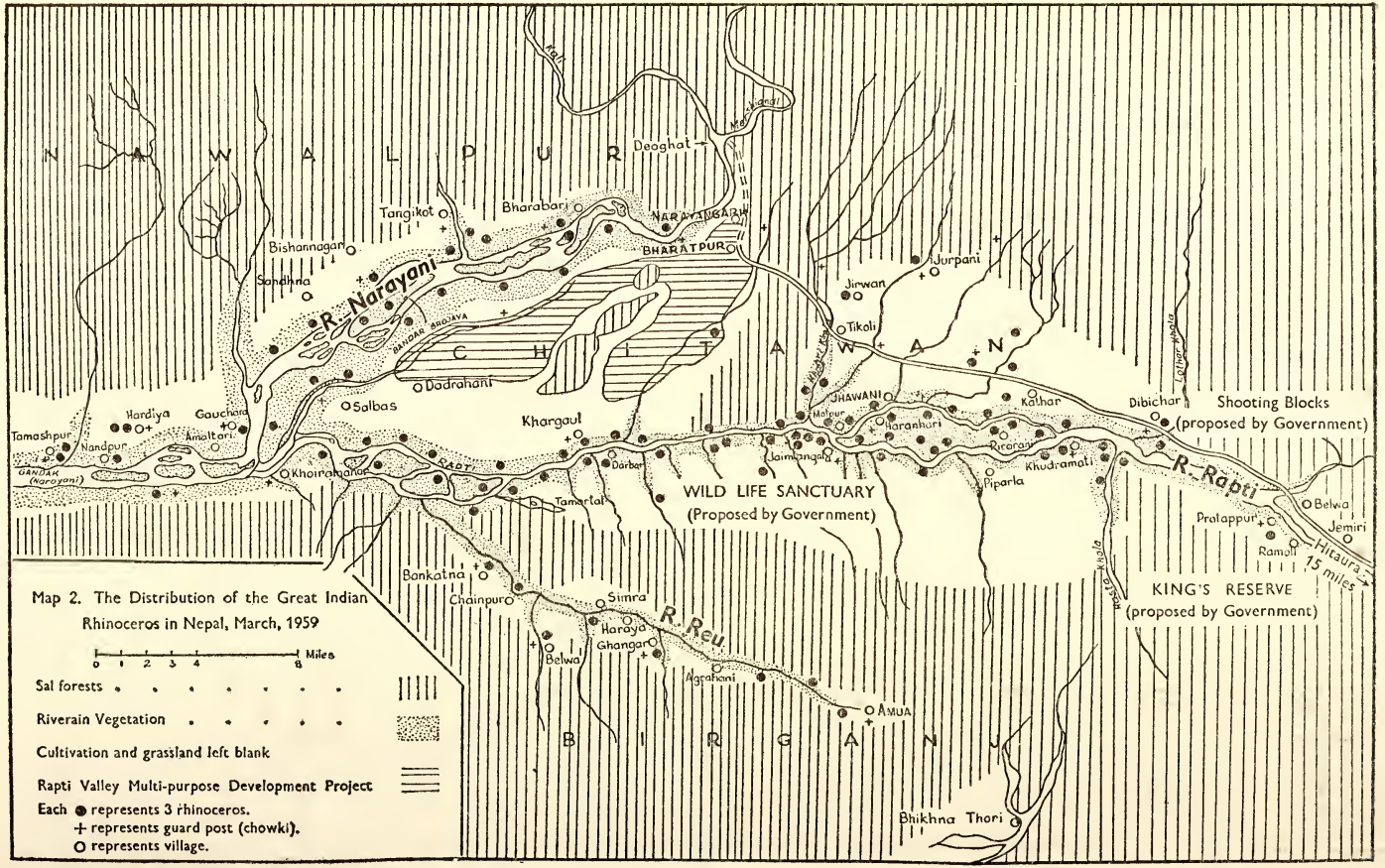
South of the park, from where the new road forms the southern boundary at Tikoli, there is a four to six mile wide strip of comparatively unspoilt *sal* forest and grassland along the Khagri Khola stream down to the Rapti River, where the majority of the rhinoceros are. This strip forms a natural corridor for local seasonal migration of rhinoceros and other animals—but it has not been included in the park.

Without these two additions—the southward corridor for wild life movement along the Khagri Khola to and from the Rapti, being far the more important—the national park is not a viable ecological unit. But if this corridor be included, then it is only one step further to extend it southwards, to include both some of the best rhinoceros country south of the Rapti River and also the upper reaches of the Reu Valley. If this were done, a large percentage of Nepal rhinoceros population would be included in the national park (see Map No. 3). A further advantage of this north-south extension, fully protected under national park rules, would be that wild life could move into it, as the land to the east and west becomes occupied by settlers.

The 'Wild Life Sanctuary' which the Government of Nepal proposes to establish south of the Mahendra National Park (see Map 2) cannot be regarded as a potentially true sanctuary, for a considerable amount of it is already under human occupation, cultivation, or



Map 1. NEPAL and part of INDIA showing past and present range of the Great Indian Rhinoceros


N A W A L P U R
Deoghat
Tangikot
Bharabari
NARAYANGARH
BHARATPUR
Bishannagar
Sandhna
R. Narayani
BANJAR BHOJAYA
C H I T A W A N
Jirwan
Jurpani
Tikoli
DHAWANI
Dadrahani
Salbas
Khargaul
Hardiya
Gauchara
Amaltari
Tamashpur
Nandpur
GANDAK (Narayani)
Khoinahanar
GAPTI
Darbar
Tamartal
Jaimangal
Malpur
Haranhari
Kathar
Dibichar
Shooting Blocks
(proposed by Government)
Ricrari
Khudramati
Piparla
R. Rapti
WILD LIFE SANCTUARY
(Proposed by Government)
Belwa
Pratappur
Jemiri
Ramoli
Hitaura
15 miles
KING'S RESERVE
(proposed by Government)
Bankatna
Chainpur
Simra
Haraya
Ghangar
R. Reu
Belwa
Agrahani
AMUA
B I R G A N J
Bhikhna Thori
Map 2. The Distribution of the Great Indian Rhinoceros in Nepal, March, 1959
0 1 2 3 4 8 Miles
Sal forests
Riverain Vegetation
Cultivation and grassland left blank
Rapti Valley Multi-purpose Development Project
Each ● represents 3 rhinoceros.
+ represents guard post (chowki).
O represents village.

grazing. Moreover, it is proposed in some quarters that this area be a sanctuary for ten years only, after which it is to be opened up again as shooting blocks. Thus during the ten years as a 'sanctuary' it would merely have the dubious status of shooting blocks temporarily closed to shooting. If the best and unspoilt portion of this proposed sanctuary were added to the present national park in order to make a viable unit, then after allowing for reasonable belts of country on either side, as buffer belts where grazing and firewood or thatch cutting are allowed, but in which no settlement or shooting except bona fide crop protection is permitted, the rest of the area might be opened as shooting blocks under strict control with full protection for rhinoceros and other rare species.

Shooting Blocks and King's Reserve

The area north of the Rapti at its eastern end, which the Government proposes should become 'Shooting Blocks', consists mainly of foothills of the Mahabharat Range, and is under *sal* forest. The area south of the Rapti proposed as 'King's Reserve' is part of the Churia Range, and also forested with *sal*. Both these propositions appear reasonable (see Map No. 2). They contain a few rhinoceros at their western extremities, under the protection of the Rhinoceros Protection Department.

A project believed to be in the blue-print stage is to divert the water of the Khagri Khola from a point about one mile north of Tikoli in the Mahendra National Park, and also the water of certain other streams in the vicinity, to irrigate part of the newly-settled grassland south of Bharatpur. If this were done, some of the rhinoceros area in the south of the present Mahendra National Park would dry up. Moreover, the only stream in the 'corridor' needed for extending the present park southwards to the Rapti river, would cease to flow in the dry weather. This project is a serious threat to nature and wild life preservation; it is to be hoped that it will be shelved or modified.

VI. General Account of the Survey

After a brief halt in Calcutta to discuss with Dr. Roonwal (Director of the Zoological Survey of India and Secretary-General of the Indian Board for Wild Life) ways of assisting Nepal to stop any possible traffic of rhinoceros produce through India, I arrived at Kathmandu by air on 15th March. There I spent six days before going into camp in the rhinoceros areas, which are a day's journey

by road. This period was very usefully employed in making contact with officials and non-officials, and in obtaining information of every description. These contacts included: General Kiran, S.J.B.R. (Shumshere Jung Bahadur Rana), who is the present authoritative and acknowledged leader in all matters pertaining to sport and wild life in Nepal; Field Marshal Kaiser, S.J.B.R., who, though he has not visited the rhinoceros area since 1933, has a vast store of knowledge of *shikar* and natural history; Mr. Balarama Paul Baidya, Chief Forest Officer; Major Lok Bikram, in charge of elephants (Government and others). Captain Tej Jung Thapa, Circle Conservator; Colonel and Mrs. Proud of the British Embassy; Mr. N. Pal, Adviser on Forests, India Aid Mission; and Mr. Boris Lissanevitch, of the Hotel Royal, who knows the rhinoceros area.

This period of six days was also necessary to procure permits and letters of introduction to officials in the rhinoceros area—without these it would not have been possible to proceed.

On 22nd March I motored along the Tribhuvan Raj Path, the new road built by the Indian Army, over the Simbanjong Pass (8162 feet above sea-level), to Hitaura at the eastern end of the area. Here I met Mr. Sudhir Jung Thapa, the Divisional Forest Officer in charge of the Chitawan (Rapti Valley) Division, with whom I was to spend most of the subsequent sixteen days touring.

The following day we jeeped westwards along the new Rapti Valley road, with the proposed King's Reserve on our left and the proposed Shooting Blocks on the steep hills on our right, both mainly under *sal* forest. Here in the upper reaches of the Rapti the riverain strip is narrow. After crossing the gravelly bed of the Rapti River at the tiny villages of Ramoli and Pratappur we made two tours into the forest along rough forest roads used by timber contractors. This gave me an idea of the terrain of the King's Reserve, at the western end of which about six rhinoceros are believed to exist. Rhinoceros wander far afield during the monsoon months, even into the town of Hitaura, I was told.

On 24th March we went into camp at Tikoli, which is at the south-eastern point of the newly-constituted Mahendra National Park, and a convenient centre for seeing the area where the rhinoceros density is greatest—Jhawani and neighbourhood. Here we were joind by Captain Gyan Bahadur Basnayt and Lieutenant Gaj Raj Joshi of the Rhinoceros Protection Department. Although our food, luggage, and camping equipment had not yet arrived, I took an elephant out in the afternoon southwards along the Khagri Khola stream towards the Rapti. To the east of the Khagri Khola all is

cultivation and villages, while to the west of the stream it is mainly unspoilt *sal* forest with patches of savannah. We saw tracks and dung of rhinoceros and found two of them in a secluded wallow in the thick scrub forest of the riverain tract of this stream. On our approach they immediately made off into cover.

Shortly after arrival at Tikoli, I opened up a large map of the area, and questioned the two officers of the Rhinoceros Protection Department about the numbers of rhinoceros at each *chowki* (post), sometimes at each part of each *chowki*. After explaining to them that conservative figures were required, I compared their figures place by place with those given by the D.F.O., and then reduced them in all cases. I also obtained from them all the information I could on the types of terrain, localities of cultivation, grazing, and unspoiled grassland or forest. Then I was able to re-plan my tour programme so that I could visit a sample of each rhinoceros area, and a sample of each type of terrain. So my tour was not a 'conducted one'—in fact, I often later insisted on going to a spot other than that recommended for finding the greatest numbers of rhinoceros.

On the morning of 25th March we went to the Chitawan *hatisar* (elephant station) and took two elephants southwards to the Rapti River, to a riverain area near Malpur and Haranhari. Here we located six rhinoceros, including a cow and young calf, all of which appeared very frightened. On 26th March we again went to the *hatisar* and proceeded with three elephants to another area west of Haranhari. Here we found 10 rhinoceros, including 2 cows and young calves, also 3 young two-year-olds in a 'school' of their own. Rhinoceros of this age are usually found still with their mothers, and I presume that these three had been driven off by their mothers when new calves were born. Nearly all these 16 rhinoceros were in dense scrub riverain forest, which is not the real habitat of this species. They were in thick cover even in the early morning. Although most of the grasslands had been burnt off, and although the young shoots were coming up—so palatable to herbivorous animals—no rhinoceros were found grazing in the open grassy areas, as one would have found in Kaziranga and other sanctuaries of Assam. There were also many fewer mud or water wallows than I expected. This might have been partly due to the sandy nature of the soil, and partly to the fact that a wallowing rhinoceros falls an easy victim to poachers. The rhinoceros in Nepal appeared to be very much more nocturnal than those in Assam, and very much more shy of human beings. Their droppings were scattered in small heaps or as single droppings

instead of the large heaps found in Assam, where they lead a more natural and peaceful life.

As all the villagers of the area build *tands* (look-out towers for frightening away crop-raiding rhinoceros) both in their fields and also actually in their village vegetable gardens—in Assam the similar *tongis* are only built in the fields near a sanctuary—and as rhinoceros ditches are built round most vegetable gardens, it was abundantly clear that the rhinoceros roamed far and wide over cultivated areas during the night, and lay up in hiding during the day. This was borne out by reports from the villagers, and from fresh rhinoceros tracks and dung seen near the villages.

The riverain forest in places is very thick, often with thorny and evergreen bush, providing ideal, though unnatural, cover for the rhinoceros. Visibility was very limited. Consequently numbers of rhinoceros we observed depended largely on the number of elephants we could muster on each visit. An observer on a single elephant could only find rhinoceros within a strip of country extending sometimes ten, sometimes twenty, yards on each side of him during a traverse in such forest. A party with three elephants could naturally traverse an area about three times as great. It is, therefore, not only for display that the rulers of Nepal have always employed a great number of elephants, over fifty at a time, for their shoots: a large number of elephants is actually required to locate and drive the game in such thick country.

Incidentally, the last of the big shoots, in January 1959, had taken place in this very area, and over fifty elephants had driven a different square mile on three consecutive days in order to catch rhinoceros calves for foreign zoological gardens. They circled 5, 7, and 13 rhinoceros respectively on these three occasions. Although this year no cow rhinoceros were shot, as has been done in previous years in order to obtain the calf, the disturbance and fright caused to the rhinoceros of this particular place must have been considerable.

Several participants of this shoot informed me that between 50 and 60 different rhinoceros had been counted in the area covered by the shoot, which was spread over some 40 square miles (about 4 miles north to south by 10 miles west to east) between the Khagri Khola and Kathar.

The Mahendra National Park

While in camp at Tikoli, I was able to pay three visits to the Mahendra National Park. In the afternoon of 25th March, we went by jeep via Jurpani across the *kholas* and back by Narayangarh. The

chowki (post) at Tandkhola was a very beautiful site with a fine view of *sal*-forested hills, but there was no water in the stream. In fact, there was no water in any of the four bouldery and sandy *kholas* we crossed, although there reportedly had been during previous months. I was informed that there was a little water higher up, and that it runs underground at this point, to reappear again lower down in the rhinoceros area of the national park. One or two water-holes provide water for gaur, sambar, chital, and other animals in this northern portion of the park.

In the afternoon of 26th and in the morning of 27th March, I made two extensive trips on an elephant into the south-east part of the park, where there were reported to be 12-30 rhinoceros. Although I found a few fresh tracks and droppings, I could find no rhinoceros on either of these trips, but on my return to camp I was informed that many were to be found here during the rains, though I could get no exact information about local or seasonal migrations. As this was ideal rhinoceros habitat with plenty of grassland as well as water and cover, I was puzzled as to why they should have migrated southwards to the Rapti, where there was less grazing and more human interference. My elephant on these two trips had been greatly worried by large horse-flies or gad-flies (locally known as *dans*), and possibly this may at least partly provide the answer to this puzzle.

The D.F.O. assured me that the previous year he had visited the area in the middle of April and had seen rhinoceros; and both the lieutenant and the havildar of the Rhinoceros Protection Department said that a considerable number of rhinoceros come here in the monsoon months. I therefore became convinced that a corridor for migration of rhinoceros between the national park and the Rapti River was urgently needed, and that the national park could well be extended southwards to make it. An extract from my diary reads: 'As there is forest and little or no cultivation west of the Khagri Khola, the national park could be extended southwards in a corridor about four miles wide, to include the Rapti area (near Jhowani) . . . and then southwards to the Siwalik Hills, possibly to include the rhino of the Reu Valley.' As my tour progressed, I became more and more sure that the above measure was urgently necessary if the rhinoceros of Nepal were to be preserved.

I was disappointed with my first three visits to the national park, but on 27th March, I visited Deoghat after visiting Mr. Malla, Chief of the Rapti Valley Multi-Purpose Development Project. Motoring from Narayangarh along the bank of the Narayani, I was much

impressed by the magnificent river and mountain scenery. The *kusum* trees were coming into new leaf and were a blaze of pale mahogany colour, and the bright red of the *Woodfordia floribunda* was much in evidence, both adding to the beauty of the *sal* trees now in their transitional stage. It then occurred to me that the forested mountains to the west of the Narayani River and also those north of the confluence of the two rivers at Deoghat, almost totally uninhabited as I was told, could well be added to the national park. I also found that the national park idea seemed to have caught on in the district, and frequent references were made to the 'national park' rather than to the 'mriga kunja'. I think that this should be encouraged, and that Mahendra National Park should be this park's permanent name.

Shortly after midday the D.F.O. returned to Hitaura, and I went with the officers south-westwards through the recently settled area to Dadrahani, in order to cross the Narayani River to Sandhna in Nawalpur District. Very few people ever go to this 'remote' and inaccessible area. It took us half a day to cross the different channels and islands of the river, and we reached our camp site long after dark, having travelled by truck, dug-out boat, elephant, bullock-cart, and on foot.

On the 29th we visited the riverain forest near Sandhna with one elephant, and found one rhinoceros in thick cover. Then we crossed to Bandar Bhojaya *tapoo* and found 4 rhinoceros in a wallow, including a cow and tiny calf. This cow charged us twice in the thick forest. During the second charge my elephant tried to bolt and my hat and lens hood were knocked off. After we had dismounted to look for the lens hood, back came the irate rhinoceros for a third charge! In the afternoon we visited more riverain forest, and saw 3 rhinoceros. None of these 8 rhinoceros had been listed by us on the map at Tikoli.

On 30th March plans were made for me to visit an area south-west of camp, where they were anxious to show me a great number of rhinoceros. After my three recent visits to riverain tract of the Narayani, I was able to take their word for that and we visited instead the *sal* forest and hills to the west, to see that kind of terrain. Here I found tracks and droppings of rhinoceros in the *kholas*, and saw one animal. In this range of hills there are patches of grassland, *kholas* with water, and a belt of swampy ground all along the base between the hills and the $1\frac{1}{2}$ mile wide strip of cultivation. This was useful information, proving that these hills could and did hold rhinoceros, and that during monsoon floods they migrated to the higher hilly region.

Having made a sample survey of the comparatively 'unknown' Nawalpur area, I re-crossed the wide Narayani River back into the Chitawan District, to camp at Dadrahani. In the afternoon I took an elephant into the mile-wide riverain strip on the east bank of the Narayani, and saw tracks and droppings of rhinoceros. Six, including two cows and calves, were said to be here. The D.F.O. had rejoined us from Hitaura. On 1st April I went to see the area at the junction of the Rapti and Narayani rivers, and also the *tals* or small lakes on the south side of the Rapti. All round here is magnificent thick rhinoceros habitat, and we saw fresh tracks and droppings, though no rhinoceros. The *tals* turned out to be small and disappointing—no comparision with the *bheels* of Kaziranga where so many rhinoceros and other species are to be seen grazing out in the open.

On 2nd April we jeeped through cultivated land, through a belt of unspoilt *sal* forest, and through more cultivated land to camp at Khargaul. This *sal*-forested portion of the *dun* contains some unspoilt country with swamp deer, chital, pig, and other animals. As it apparently contains no rhinoceros in the dry weather, I have not included it in my recommendations, but the Nepal Government could well consider creating a small wild life sanctuary here.

After a night at Sandhna of unexpected and unseasonal rain, the snows of the Himalayas were a magnificent spectacle—this was the only day on which they were clearly visible in a cloudless and hazeless sky. Only a tiny peak of Dhaulagiri (26,795 feet) was visible behind a nearer range, but the whole massifs of Annapurna (26,504 feet) and Himalchuli (25,800 feet) towered in splendour before our eyes—more than ample compensation for being washed out two nights before.

I particularly wanted to see the country round Darbar, and also another and larger lake called Tamortal, and the connecting corridor through the Churia Range from the Rapti to the Reu Valley. The riverain forest and grassland near Darbar are comparatively unspoilt and ungrazed, but I saw no wild life. The *tal*, set in the midst of *sal* forest, was also disappointing, but north of the Rapti on our way back to camp on three elephants we found 4 rhinoceros within half a mile of our tents, a not unusual phenomenon as both in Nepal and north-east India rhinoceros seem to prefer the vicinity of villages and cultivation to unspoilt country.

The cart track from Darbar, past Tamortal, leads from the Rapti Valley into the Reu Valley; and while at Tamortal we were only a few miles from the Reu river. I would have liked to have had the time to visit the Reu Valley, but this could not be done. I was,

however, informed by the D.F.O. that he went there as recently as November 1958, and saw 8 rhinoceros. He described to me all the conditions of the place—similar to those in the Rapti and Narayani valleys, only on a smaller scale.

The next morning we took two elephants—one had broken loose during the night and disappeared into the forest—and traversed some more riverain country north of the Rapti, finding two rhinoceros. In the afternoon I took one elephant, the 'escaped' one which had been recaptured, into the riverain belt near the camp, and photographed 2 rhinoceros.

Having seen a sample of the country round Darbar, both north and south of the Rapti, I said I would like to drive through the middle of the belt of *sal* forest and grassland that would, if approved of by the Nepal Government, be such a useful addition as a corridor to the Mahendra National Park. I also wanted to see the country to the south of this corridor, south of the Rapti. Accordingly on 4th April, we jeeped through this corridor at a point where it must have been about 6 miles wide. It consisted of comparatively unspoilt *sal* forest with patches of grassland, swamps, water holes, and of course the Khagri Khola on the eastern side. It proved to be ideal habitat for rhinoceros, deer, and other animals.

Eventually we arrived at Jaimangala and camped there, in spite of the fact that cholera and smallpox were in epidemic form near by. In the evening we took out four elephants and within one mile of camp found 9 rhinoceros. I personally saw 5, including 2 cows with young calves, and I have no reason to doubt the veracity of the others who saw an additional 4; for, on the following day I saw different rhinoceros on this very same spot. While trying to photograph a rhinoceros cow and calf, our four elephants at one time were encircling 4 rhinoceros, 1 sambar stag, 2 hog deer, and 2 bears. From Jaimangala westwards, most of the country appeared to be unspoilt and unoccupied by villagers, confirming my opinion that this area should be included in a southward extension of the national park.

On the following day we explored, on three elephants, the area westwards on the south bank of the Rapti, and returned along the north bank through the corridor. On the way out in the early morning I inspected and photographed the carcases of 2 rhinoceros shot this year by poachers. I was told that the poachers themselves might have been shot had not 7 rounds of ammunition fired at them failed to go off.

Although we had seen 9 rhinoceros near the camp on the previous day, yet in this wilder country further away from the camp we saw

nothing—until finally we came across a cow rhinoceros defending her pink, newly-born calf against a tiger. Our approach apparently frightened away the tiger, The rhinoceros with characteristic lack of gratitude then charged my elephant two or three times. Photography was rendered very difficult by the fact that in Nepal the elephants are trained to charge back at a rhinoceros. In spite of this commotion, and in spite of the waving arms of the excited and gesticulating elephant-driver, I managed to secure some photographs of the newly-born calf with its mother—they must be unique.

On our return along the north bank of the Rapti, we suddenly saw, peering out of the tangle of unburnt grass, the head and horns of a solitary bull gaur (*Bos gaurus*), which immediately made off. We then searched without success for rhinoceros in two *kholas,* which had water and evergreen forest suitable for these animals. When we were near camp I dismounted from the elephant, stalked and photographed on foot 5 of the rhinoceros seen by us on the previous day, as they lay in their wallows. There were also four sambar hinds within a mile of the village.

In the evening I visited a riverain area north-east of the camp with one elephant, and found 4 rhinoceros including a cow and a young calf. Three of these were in thick grass within one furlong of our tents. The experience of this day in this area, as in all the other areas I visited, shows that rhinoceros and other wild animals prefer the vicinity of villages and cultivation to the unspoilt forests and grasslands. The existence of thick cover in the form of evergreen and thorny scrub forest enables them to do this. The probable reasons are firstly and mainly a predilection for man-grown crops, secondly a certain amount of safety from predators, both human and feline.

On the morning of 6th April, we struck camp and proceeded to the house of the captain of the Rhinoceros Protection Department, where I was shown some of the rhinoceros horns and personal possessions recovered from poachers. Thence back to the main road and eastwards past the proposed 'Shooting Blocks' and 'King's Reserve' to Hitaura. After discussions with the D.F.O., I returned the following day over the Simbanjong Pass to Kathmandu. There I spent three days discussing my observations in the rhinoceros area, with the people whom I had met earlier. Finally I flew from Nepal to India on 11th April.

VII. Status, Distribution and Future of the Rhinoceros in Nepal

It is difficult to obtain accurate information about the former range and distribution of rhinoceros in Nepal. W. T. Blanford, in THE FAUNA OF BRITISH INDIA, MAMMALIA, Part II (1891), wrote of it as being found in 1850 '. . . . along the base of the Himalayas in Nepal and as far west as Rohilcund' (a district of India near the border of West Nepal). From information obtained in Kathmandu it appears that the last rhinoceros in the Morang District of south-eastern Nepal was shot at the turn of the present century, and that the last rhinoceros in the area immediately east of Chitawan was killed in 1927. It would be safe to say that about 100 years ago rhinoceros were found all along the southern border of Nepal. Since 1930 they have been confined to the area covered by this Report.

Referring to the rhinoceros population of Nepal in 1942, E. A. Smythies wrote: 'It is estimated that at present the total number is between 300 and 400.' In 1953 the Forest Department of Nepal estimated that there were 1000 rhino, and in 1957, 600. Considering the extent of the rhinoceros area and the thick cover of the riverain tracts into which the rhinoceros can and do retreat, these estimates are not beyond the bounds of probability. Unfortunately, however, no serious attempt ever seems to have been made to estimate the numbers scientifically by sample surveys, by studying seasonal migrations, and so forth. A census is not possible owing to the density of the riverain scrub forest.

In a Miscellaneous Note published in the *Journal of the Bombay Natural History Society* in August 1957, P. D. Stracey, who is Director of Forest Education in India and had been on an official visit to Nepal in April of that year, gives an estimate in the region of 400. He based this figure on a brief visit to the area and on talks with Forest Officers and others. It appears to have been a reasonable figure, though the 'rhinoceros area' map supplied to him was inaccurate.

In Kathmandu, before my tour, I noted down the estimates of rhinoceros population made by various people. These included:

General Kiran, S.J.B.R. ...	... 250-300
Chief Forest Officer ...	... 300-400
Captain Tej Jung Thapa ...	... 320

On arrival at the rhinoceros area, I was given the following estimates:

Divisional Forest Officer ...	... 320
Captain Gyan Bahadur Basnayt	... 530
Lieutenant Gaj Raj Joshi ...	... 380

On the 13 elephant trips on which I saw rhinoceros, the number of elephants taken out averaged 2.15. This is important, as the larger the number of elephants used in such thick country, the more chance there is of rhinoceros being encountered. On these 13 trips I personally counted 43 rhinoceros, of which 9 were young calves. On the same trips, other members of the party on other elephants saw an additional 14, bringing the total to 57 rhinoceros seen, including 12 young calves. Visibility varied from between 5 and 20 yards in the thicker forest to between 20 and 100 yards in the more open areas; so the actual ground covered in each traverse was not great and I do not believe I actually saw one-tenth of the ground inhabited by rhinoceros.

From the detailed information supplied to me by the D.F.O., Chitawan, and by the officers of the Rhinoceros Protection Department and others, which I checked in sample surveys on 18 elephant trips in different parts of the rhinoceros area, I estimate that there are now about 300 rhinoceros in Nepal. I have marked their approximate distribution as in March-April 1959 by black dots on Maps 2 and 3, each dot representing 3 rhinoceros. Should my figure of 300 be an overestimate—I do not think that it is—or an underestimate, which is quite possible, the numbers represented by each dot can be adjusted. The pattern of distribution would remain, subject to seasonal local migrations.

It will be noticed that the distribution of rhinoceros when I was there, the dry season of March and April when the burnt-off grassy areas were beginning to appear green with young shoots, was almost entirely in or very near the riverain tracts. This, I consider, was not so much due to scarcity of water and grazing in other areas, as to the thick cover provided by the evergreen and thorny scrub forest in these tracts. It will also be seen that rhinoceros in Nepal, as in NE. India, show a marked predilection for man-grown crops and vegetables, and therefore choose a habitat as near as possible to villages and cultivation. They do not object to sharing their grazing with domestic buffaloes and cattle, though it appears that in Nepal these common grazing grounds are grazed by domestic beasts by day and rhinoceros by night. In Kaziranga Sanctuary of Assam also, the regions of greatest density of rhinoceros population are nearest to the largest areas of cultivation and villages. It is an inescapable fact that whatever areas of unspoilt country may be set aside for rhinoceros preservation, they will probably continue to inhabit those riverain tracts which are nearest to cultivated land. The presence of *tands* (look-out

towers) and rhinoceros ditches in the fields and vegetable gardens over the whole area considered in this Report would alone prove the presence of rhinoceros—if such proof were needed in addition to tracks, dung, and the animals themselves.

With regard to movements of rhinoceros, I was informed that there has been a noticeable shift from the area now being settled by the Rapti Valley Multi-purpose Development Project to the Nawalpur district and to other parts of the Rapti Valley. From all accounts, the grasslands south-west of Bharatpur down to Salbas, along the east bank of the Narayani River, used to be the best tracts for rhinoceros; but they are no longer so. There is little or no information to be had on local migrations, though this seasonal movement is bound to take place each monsoon as the riverain tracts become partly or wholly flooded. The general direction of this movement would be away from the rivers towards the grassy tracts and *kholas* at the foot of the *sal*-forested hills. The most important line of migration, as has already been pointed out, is along the Khagri Khola and the belt of unspoilt country on its western bank. It is very desirable that local officers should study these seasonal movements.

The great danger to rhinoceros from poachers, on account of the horns which are sold and commercialized as an aphrodisiac, exists and will continue to exist. It is being dealt with by the Rhinoceros Protection Department which is doing good work in difficult circumstances. In fact, it is surprising that more rhinoceros are not shot by poachers. The officers in charge possess no maps, and appear to have no instructions to observe or study the habits, distribution, numbers, or movements of rhinoceros. Many of the rhinoceros guards (sepoys) have received no training. The service conditions of these guards, Rs. 30 per month Nepal currency (£1 7*s*. 0*d*.) with no rations, no uniform and no accommodation, are inadequate and are below those enjoyed by the *hatisar* personnel. Some of the ammunition does not 'go off'. No rewards or promotions appear to be awarded for good work, such as the capture of poachers or recovery of horns. As the value of these horns is very high—as much as Rs. 3135 Indian currency (£235) was paid to a poacher for a horn obtained in the Reu Valley—and the temptation to a lowly-paid guard very great, a system of promotion and rewards would have a stimulating effect.

But a danger to the rhinoceros of Nepal greater than that from poachers has arisen in the development and settlement of the grasslands of the Rapti Valley. As there is now increased competition for

grasslands between human occupants and wild life, a decision will have to be made by the Government as to whether settlement of human population is going to occupy all the available land of the Rapti Valley, or whether water and soil conservation and wild life preservation will have their rightful place in development schemes. It is confidently to be hoped that as a matter of wise land-use the authorities will set apart the appropriate areas for these urgently necessary requirements.

The habits of the rhinoceros of Nepal have been affected by two main factors. Firstly, rhinoceros have been shot for sport as well as by poachers for a very long time, if not since time immemorial. Secondly, they have been pushed further and further back from their habitat and feeding grounds, particularly during the past four years, by the influx into the grasslands of both authorized and unauthorized settlers. Consequently they have become more and more hunted and persecuted, and like an outlawed political party have 'gone underground', taking refuge in the thick scrub forest of the riverain tracts. They have become very scared, and if encountered in their hiding places frequently charge before rushing away to another hiding place. They have become very much more nocturnal than rhinoceros in India, and are rarely if ever to be found grazing in the open during day time. Their dung often consists of individual droppings, or very small dung heaps instead of the large dung heaps found in Assam, and this is probably due to their more furtive existence. Though Jungle Mynas (*Aethiopsar fuscus*) settle on rhinoceros in Nepal, Cattle Egrets (*Bubulcus ibis*) are never found in their company, though they are always so found in Assam; and this also is probably due to the rhinoceros' nocturnal habits and furtive existence.

The fact that so many rhinoceros cows were seen with young calves (12 young calves out of 57 rhinoceros seen by my party) goes to show that the rhinoceros of Nepal have become accustomed to the new conditions in which they have to live and are actually thriving.

The average horn I saw in Nepal was very much smaller than in Assam, and I saw no old rhinoceros. Both sportsmen and poachers look for large horns; furthermore the older rhinoceros (often with large horns) are the more easily shot.

At the present moment the position of the rhinoceros in Nepal is very insecure, especially considering the impending influx of 25,000 more authorized settlers, and an unknown number of unauthorized ones, into the Rapti Valley. An irrigation scheme also is proposed which would lead off the water of the Khagri Khola and other streams

to the newly-settled area. If this is put into effect, it will drain to a dangerously low level the rhinoceros habitat in the region of Tikoli and southwards to the Rapti.

It is not too late even now to allocate certain areas in the catchments of the rivers and streams for strict protection as a necessary and urgent measure of water and soil conservation; to demarcate clearly the boundaries of Reserved Forests and to prevent indiscriminate cutting and burning within them; and to allocate sufficient areas for rhinoceros and other wild life to live in safety and security alongside human settlers.

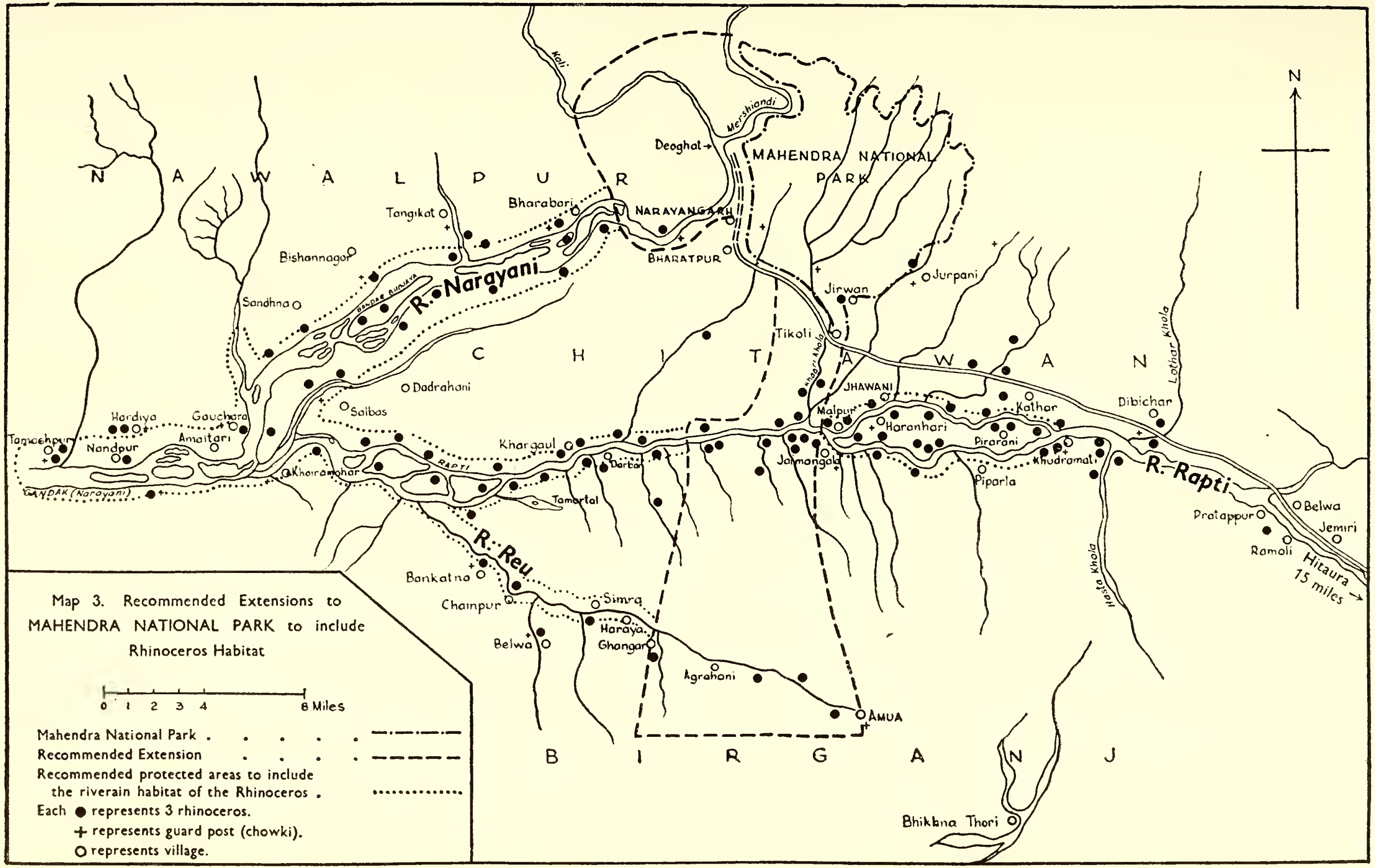
Owing to the various pressures and peculiar circumstances affecting the status of rhinoceros in Nepal it is recommended that the policy governing the administration of the national park and wild life preservation in general be a flexible one. While adhering as far as possible to the principles accepted by leading nature conservationists in the world, it is possible that certain departures from these principles might prove advantageous for the preservation of the rhinoceros. For instance, this species' partiality for a habitat near villages might indicate that a few carefully selected and strictly controlled 'forest villages' inside the national park could be allowed, in which rhinoceros guards would have assistance and protection in their operations against poachers. Also the fact that tigers prey on very young rhinoceros might render it advisable to control the numbers of tigers in the rhinoceros inhabited areas, should they become excessive. Any wild life management policy would naturally have to be based on ecological study.

VIII. Recommendations (see Map 3)

The following recommendations are made:

(1) That the present Mahendra National Park be enlarged and extended (*a*) southwards to include the migration routes and rhinoceros areas as far as the Reu valley, and (*b*) north-westwards to include the scenic area in the north-west. See Sections V and VI and Map 3. And that this national park be fully protected with buffer belts where possible.

(2) That the riverain tracts of the Narayani, Rapti, and Reu rivers which contain rhinoceros be designated as National Park Extension Areas or Protected Areas, with rights of local villagers for grazing, cutting firewood, and cutting thatch to continue as before, but to remain free of settlement and cultivation.


N
NAWALPUR
CHITAWAN
BIRGANJ
MAHENDRA NATIONAL PARK
R. Narayani
R. Rapti
R. Reu
Kali
Mershiandi
Deoghat
NARAYANGARH
BHARATPUR
Bharabari
Tangikat
Bishannagor
Sandhna
Dadrahani
Saibas
Hardiya
Nandpur
Gauchara
Amaltari
Tamaspur
Khoiranohar
GANDAK (Narayani)
Khargaul
Darta
Tamortal
Jirwan
Jurpani
Tikoli
JHAWANI
Malpur
Jaimangala
Haranhari
Pirarani
Kathar
Khudramati
Piparla
Dibichar
Lothar Khola
Hasta Khola
Pratappur
Belwa
Jemiri
Ramoli
Hitaura 15 miles
Bankatna
Chainpur
Simra
Haraya
Ghangar
Belwa
Agrahani
AMUA
Bhikhna Thori
0 1 2 3 4 8 Miles
Mahendra National Park
Recommended Extension
Recommended protected areas to include the riverain habitat of the Rhinoceros
Each ● represents 3 rhinoceros.
+ represents guard post (chowki).
O represents village.

Map 3. Recommended Extensions to MAHENDRA NATIONAL PARK to include Rhinoceros Habitat

(3) That a wild life sanctuary or national park be created in a suitable area in the Morang District of southeast Nepal in order to preserve the few remaining wild buffalo there; and that a few pairs of rhinoceros be re-introduced into that area so that there will be a second locality for the preservation of the rhinoceros in Nepal.

(4) That the Rhinoceros Protection Department be strengthened, chiefly by reorganization and by improvement of service conditions, as noted in Section VII. And that a suitably qualified officer be appointed, who could assume complete charge of wild life preservation in the rhinoceros area, including the national park.

(5) That a Nepal Board for Wild Life be constituted which would be the authority for all matters pertaining to wild life preservation in the country.

(6) That education and publicity be undertaken in order to develop consciousness among the people of the cultural and economic value of wild life and nature conservation, and to develop tourism as an important economic factor in support of wild life preservation.

IX. Acknowledgements

In conclusion, I must record my deepest appreciation of the help given to me in Nepal by officials and non-officials. First and foremost, to General Kiran Shumshere Jung Bahadur Rana who gave me his fullest moral support and advice as well as much information; to the Chief Forest Officer, Mr. Balarama Paul Baidya, who kindly made his departmental information available to me and allotted an officer to take me round the rhinoceros area; to Circle Officer Captain Tej Jung Thapa, an experienced sportsman and naturalist; to Major Lok Bikram, who helped me to obtain elephants in the Rapti Valley; to Mr. K. B. Malla, Chief of the Rapti Valley Multi-Purpose Project, who kindly allowed me camping facilities and transport to Dadrahani; to Mr. Boris Lissanevitch, of the Hotel Royal in Kathmandu, who very kindly made available to me some camping equipment as well as much information; to Colonel and Mrs. Proud of the British Embassy, Mr. Sen of the Indian Embassy, and Mr. N. Pal of the India Aid Mission, all of whom showed much interest in my mission.

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Basnayt and Lieutenant Gaj Raj Joshi, officers in charge of the Rhinoceros Protection Department, I owe my gratitude for making all the local arrangements, including camping, elephant trips, etc.

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Biology and Ecology of Oriental Termites (Isoptera)

No. 4.* The Dry-wood Termite, *Coptotermes heimi* (Wasm.), in India.

BY

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(*With* 3 *Plates*)

CONTENTS

I. INTRODUCTION

Coptotermes heimi (Wasmann) (synonym : *C. parvulus* Holmgren) (Fam. Rhinotermitidae, Subfam. Coptotermitinae) is one of the three species of termites which are most destructive to timber in houses and elsewhere in India, the other two species being *Heterotermes indicola* (Wasmann) and *Odontotermes feae* (Wasmann).

It is interesting to note that although *Coptotermes heimi* is a species occurring commonly throughout the Indian region, it is not (except in Lahore, West Pakistan) the common species to be found attacking the experimental pieces of timber buried in the ground (*vide* Beeson, 1934, p. 3). Beeson stated that the species occurring in the experimental wood-cubes treated with wood-preservatives and buried in the ground in Lahore was *C. heimi*, but in corresponding tests done elsewhere in India and

*Earlier numbers are as follows:

No. 1. *JBNHS* (1954), **52** (2 & 3): 459-462, 1 pl.
No. 2. *ibid.*, (1954), **52** (2 & 3): 463-467, 1 pl.
No. 3. *ibid.*, (1955), **53** (2) : 234-239, 2 pls.

Ceylon the species were different, thus: at Pusa (Bihar), *Microtermes obesi* Holmg. [=*M. anandi* Holmg.]; at Calcutta, *Odontotermes feae* (Wasm.); at Bangalore (S. India), *O. horni* (Wasm.); at Dehra Dun (U.P.), *O. bangalorensis* Holmg.; and in Ceylon, *O. horni* (Wasm.), *O.* (*Hypotermes*) *obscuriceps* (Wasm.), *O. redemanni* (Wasm.), and *Coptotermes ceylonicus* Wasm.

Information on the biology of *Coptotermes heimi* is limited and widely scattered. Some new information on its biology is presented here, and the existing knowledge summarised for easy reference.

In the course of a systematic revision of the Indian species of genus *Coptotermes* Wasmann, a large amount of material, consisting of over 63 lots and nearly 150 separate vials, was examined from all over India (including a few from the western Punjab, in West Pakistan). This material contained the original data of the collectors relating to dates and time of swarming, the names of the hosts attacked, and other valuable information on the biology of the species. The data are summarised below. Some of these specimens, e.g. from Calcutta, Kharagpur, and Allahabad, collected during 1907-1910, bore previous but wrong determination labels as *Coptotermes travians* (Haviland), and it is likely that they may have been referred to in the literature under that name. Besides this material, some data on nests became available during recent field surveys, and from other sources.

The data discussed here concern the following particulars: Geographical distribution; host-material; nature of damage; swarming; nests; duration of life; etc. The limited information available in the published literature on the species has also been discussed. Authors in whose papers information on biology and ecology is available are the following:

Annandale (1923): Swarming; nest construction, etc.

Assmuth (1913): Nature of damage to wood; nest-structure; swarming. (Accounts of *C. heimi* and *C. parvulus* were mixed up and not mentioned separately; most of the remarks refer to '*Coptotermes*'.)

Beeson (1934) : Nature of damage.

Beeson (1941) : Summary of biology.

Holmgren, K. & Holmgren, N. (1917): Swarming.

Holmgren, N. (1912): Swarming.

Margabandhu (1934): Summary of known information.

Rattan Lal & Menon (1953) : Literature on biology and systematics. [Mixed with *C. travians* (Haviland), with which they synonymise *C. heimi* (Wasm.)]

Roonwal (1954): Ecology.

Besides these, Assmuth (1915), Silvestri (1923), Dover (1931), and Dover & Mathur (1934) make casual mention of *C. heimi.*

The nomenclative position of the species is summarised below:

Coptotermes heimi (Wasmann, 1902)

(Synonym: *Coptotermes parvulus* Holmgren, 1913)

1902. *Arrhinotermes heimi* Wasmann, *Zool. Jb.* (*Syst.*), Jena, **17** (1), p. 104, Pl. 4, Fig. 1. (India: Wallon, Ahmadnagar Dist., Bombay State).

1911. *Coptotermes heimi*, N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **46** (6), p. 73.

1913. *Coptotermes parvulus* N. Holmgren, *J. Bombay nat. Hist. Soc.*, Bombay, **22** (1), p. 104; and *K. Sv. Vet. Akad. Handl.*, Stockholm, **50** (2), p. 73. (In both cases: Anand and Vadtal, Bombay State.)

1953. *Coptotermes travians* (Havil.), Rattanlal & Menon, *Catal. Indian Ins.*, No. 27, *Isoptera*, Delhi, p. 27. (Erroneously synonymise *C. heimi* (Wasmann) with *C. travians* Haviland.)

Bugnion (1910, *Ann. Soc. Ent. Fr.*, Paris, **79**, p. 137) also wrongly determined *C. heimi* specimens as *C. travians*.

Where no source is mentioned, the data given in the following account are original.

I am indebted to Shri M. Srinivasan, Curator, Industrial Section, Botanical Survey of India, Calcutta, for kindly checking the correct botanical names of the host-plants.

II. Geographical Distribution

Coptotermes heimi occurs all over India and parts of West Pakistan (Punjab). The present material studied by me is from the following localities:

India

Andhra Pradesh: Adoni.
Assam: Gauhati.
Bihar: Ankura (Saranda Div.); Pusa.
Bombay State: Bombay city and environs.
Madhya Pradesh: Khandwa; Sillari (near Nagpur); Balaghat.
Mysore State: Dharwar; Sidapur (Coorg); Bellahunisi, Kottur; Siriguppa.
Orissa: Barkuda Is. (Chilka Lake); Angul; Sambalpur; Balukhand (Puri Dist.).
Punjab: Hoshiarpur; Sri Hargobindapur (Gurdaspur Dist.); Jullander.
Rajasthan: Bariganga near Jodhpur.
Uttar Pradesh: Dehra Dun and vicinity (alt. *ca.* 610 m.); Kalsi (Dehra Dun Dist.); Chakrata (alt. *ca.* 2100 m.); Kanpur; Allahabad; Mirzapur; Rampur; Gopalnagar (Bijnor Dist.); Pathargarh (Najibabad Dist.); Lucknow; Biharigarh (Saharanpur Dist.); Haldwani.
West Bengal: Calcutta and environs; the 24-Parganas (the Sundarbans); Bankura; Kharagpur; Sam Sing.

West Pakistan

W. Punjab: Chichawatni; Lahore.

'*C. parvulus* Holmg.' has been recorded from India and West Pakistan as follows:

Anand and Vadtal in Bombay State. (type localities.) (Holmgren, 1913 *a*, *b*.)

Barkuda Is. (Chilka Lake, Orissa.) (Annandale, 1923; Silvestri, 1923.)

Karachi (Sind, W. Pakistan). (Assmuth, 1913.)

III. Host-material, etc.

Coptotermes heimi appears to be polyphagous and occurs in dead wood and under bark of numerous host-plants as well as in constructional timber in houses, railway coaches, bobbins, packing cases, old sleepers, and in insulated electric wire. It has also been recorded from 'mud tunnels' (apparently cemented excreta tunnels) on walls, and in one case '*ex* mound' (Angul, Orissa) but it is not clear whether the mound was built by the *Coptotermes* itself or by some other species—species of *Coptotermes* are not known to be mound-builders in India, though an Australian species, *C. lacteus* (Frogg.), does build mounds. In another case it was recorded '*ex* nest in a tree', and here again it is not clear whether it was a nest of the *Coptotermes* itself or of some other termite or even an ant.

1. List of Host-plants

About 35 different species, belonging to a wide assortment of families, have been recorded as hosts, as follows:

Acacia arabica Willd., Babul, Fam. Leguminosae. (From rotten log).

Acacia sp., Fam. Leguminosae. (From dead plant).

Albizzia sp., Fam. Leguminosae. (Under bark).

Avicennia sp. (*A. alba* Linn. or *A. officinalis* Linn.), Baen, Fam. Verbenaceae. (Nest found in dead log).

Bamboo, Fam. Gramineae, Tribe Bambuseae. (From dry splints).

Bauhinia vahlii W. & A., Fam. Leguminosae. (From dead log).

Boswellia serrata Roxb., Salai, Fam. Burseraceae.

Cactus sp., Fam. Cactaceae.

Carica papaya Linn., Papaya, papita, Fam. Caricaceae.

Casuarina equisetifolia Forst., Fam. Casuarinaceae. (Under bark).

Cedrela toona Roxb., Toon, Fam. Meliaceae. (From dead portion of green standing tree; and dead stump).

Euphorbia nivulia Ham., Thor, Fam. Euphorbiaceae.

Excaecaria agallocha Linn., Fam. Euphorbiaceae. (From pole).

Ficus benghalensis Linn., Banyan, Fam. Urticaceae (Moraceae according to some authors). (From dead stump. Nests also found in dead trunks).

Garuga pinnata Roxb., Fam. Burseraceae.

Heritiera fomes Buch.-Ham. (synonym: *H. minor* Roxb.), Sundri, Fam. Sterculiaceae. (From pole).

Jatropha curcas Linn., Fam. Euphorbiaceae.

Lagerstroemia parviflora Roxb., Fam. Lythraceae. (From half-dead tree).

Lannea coromandelica (Houtt.) Merr. [synonyms: *Lannea grandis* (Dennst.) Engl. and *Odina wodier* Roxb.], Fam. Anacardiaceae. (From pole in soil).

Mangifera indica Linn., Mango, Fam. Anacardiaceae. (From rotten stump; roots; and under bark).

Moringa pterygosperma Gaertn. [synonym: *M. oleifera* Lamk.], Fam. Moringaceae.

Morus alba Linn., White mulberry, Fam. Moraceae. (From fallen logs).

Palm leaves, Fam. Palmae.

Pinus longifolia Roxb., Chir Pine, Fam. Pinaceae. (Sometimes wrongly referred to as *P. roxburghii* Sarg.).

Prunus persica Bth. & Hook., Peach, Fam. Rosaceae.

Pterocymbium tinctorium Merr. [synonym: *Heritiera tinctoria* Blanco], Fam. Sterculiaceae.

Rhizophora conjugata Linn., Fam. Rhizophoraceae. (From rafters).

Salmalia malabarica Schott & Endl. [synonym : *Bombax malabaricum* DC.], Simal, Silk Cotton tree, Fam. Malvaceae.

Shorea robusta Gaertn. f., Sal, Fam. Dipterocarpaceae. (From pole; and under bark).

Saccharum officinarum Linn., Sugarcane, Fam. Gramineae. (From stump and crushed pieces).

Swietenia floribunda Griff., Fam. Meliaceae.

Tamarindus indica Linn., Imli, Fam. Leguminosae. (From stump; and packing case).

Tamarix gallica Linn., Fam. Tamaricaceae.

Tectona grandis Linn., Teak, Fam. Verbenaceae. (From dead portion of green standing tree; and log).

Xylocarpus gangeticus Parkin. [synonym: *Carapa moluccensis* var. *gangeticus* Prain], Fam. Meliaceae. (From pole).

2. Other Material

Besides the host-plants listed above, *C. heimi* has also been recorded as infesting the following materials:

Paper and books; wood-work in houses; wooden packing cases; wooden floor; wooden barrels; chemically treated wood blocks ('graveyard cubes'); pipe line and wood casing containing electrical wire; insulated electric wire; old wooden sleepers; wood-work of railway coaches; 'feeding on bobbin having cotton thread'; and below cow dung.

IV. Economic Importance and Nature of Damage

As stated above, *Coptotermes heimi* is economically one of the three most important termites which infest the wood-work of buildings in India. Apart from buildings, it attacks wood-work in railway coaches, wooden packing cases, stored timber, wooden sleepers, and papers and books. There are records of it having been taken from 'insulated electric wire' and 'pipe line and wood casing containing electric wire', this damage sometimes leading to the leakage of electric current.

The 'feeding pattern' is characteristic (Pl. 1, fig. 1). The termite eats away the softer parts of the wood along the fibres, leaving the outer surfaces of constructional timber intact. The harder parts of the wood, such as the heartwood, knots, etc., are generally not destroyed, but may be tunnelled through when necessary. Thus, longish, narrow oval cells are constructed whose long axis is along the similar axis of the wood-fibres. The thin partition walls are plastered with excrement. The cavities so formed are filled with a tough, mottled brown to bluish-black deposit (Pl. 1, fig. 2), the so-called 'fillings' of Assmuth (1913), 'formed in an irregular spongy or stringy network resembling superficially fungus combs' of certain termites (Beeson, 1941, p. 543). Assmuth (1913) believed that such plastering was done on all surfaces, including the surfaces of glass bottles, in order to facilitate walking. According to Annandale (1923), however, the plastering with excrement, which is done by the workers during nest-construction also, is for the strengthening of the thin partition walls.

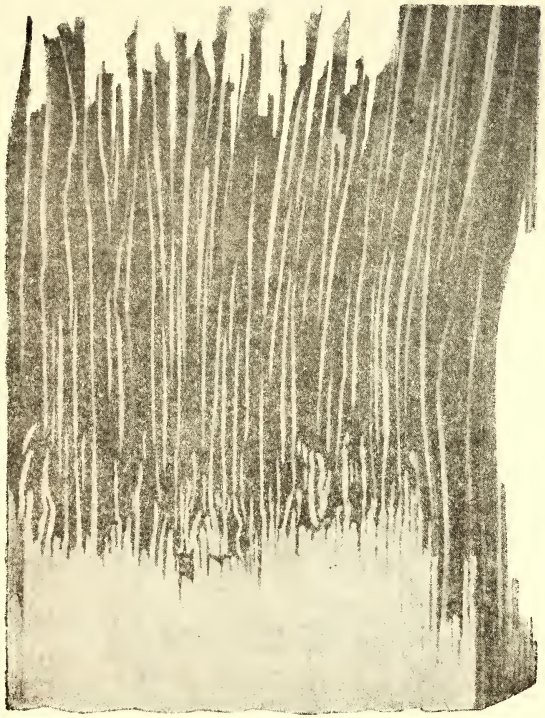
A similar feeding pattern occurs in *Heterotermes indicola* (Wasm.), another important dry-wood termite of India (Pl. 1, fig. 3).

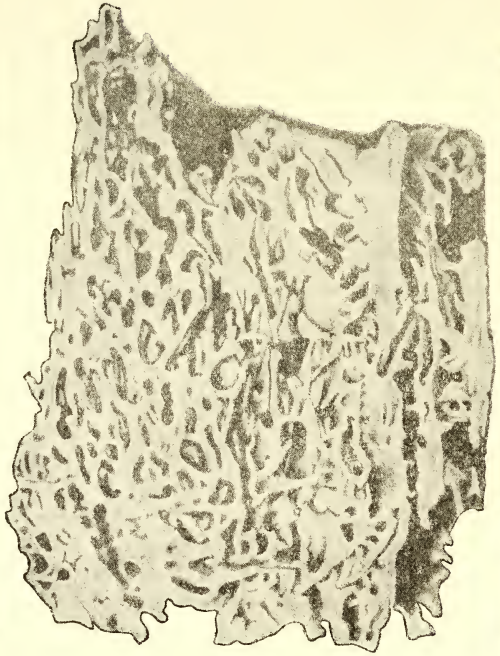
V. Swarming

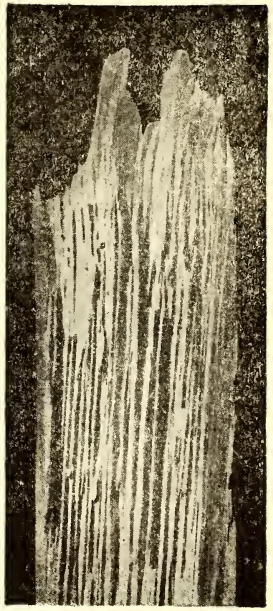
Swarming of *Coptotermes heimi* was observed in India in Uttar Pradesh (various parts), West Bengal (Calcutta), Orissa (Barkuda Is., Chilka Lake), and Bombay city.

1. Season of swarming

The following are the recorded dates, years, and locality of swarming, arranged chronologically under each month:







1 2 3

The pattern of damage to wood caused by *Coptotermes heimi* (Wasm.) and *Heterotermes indicola* (Wasm.).
Fig. 1.—A piece of softwood (chir pine) damaged by *Coptotermes heimi*. Enlarged.
Fig. 2.—The 'fillings' which fill the cavities in the wood damaged by *Coptotermes heimi*. Enlarged.
Fig. 3.—A piece of softwood (chir pine) damaged by *Heterotermes indicola* (Wasm.)

'*January to March*'

Beeson (1941, p. 544) stated: '*C. heimi* swarms at sunset during the dry season and especially in January to March.' This statement needs confirmation with regard to January.

February

2. ii. 1912. Coimbatore.

March

6. iii. 1910. Calcutta.
7. iii. 1908. Calcutta.
15. iii. 1911. Bombay. (Same material as in Holmgren, 1912, pp. 777-778.)
20. iii. 1910. Calcutta.

April

No record.

May

13. v. 1923. Barkuda Is. (Chilka Lake, Orissa).
25. v. 1907. Kharagpur (West Bengal).

June

8. vi. 1911. Pusa (Bihar). (Holmgren & Holmgren, 1917, pp. 144-145.)
11. vi. 1955. Dehra Dun (U.P.), alt. *ca.* 610 m.
12. vi. 1950. —do.—
15. vi. 1953. —do.—
16. vi. 1950. —do.—
19. vi. 1940. —do.—
21. vi. 1955. —do.—

July

1. vii. 1907. Allahabad (U.P.).
3. vii. 1941. Dehra Dun and Kanpur (U.P.).
5. vii. 1955. Dehra Dun (U.P.).
6. vii. 1952. Kalsi (Dehra Dun Dist., U.P.), alt. *ca.* 800 m.
15. vii. 1935. Dehra Dun (U.P.), alt. *ca.* 610 m.

August

6. viii. 1930. Dehra Dun (U.P.), (Only one imago collected.)

From these data it appears that swarming generally occurs from early March to early August. It seems to happen in the spring and early summer (March-May) in the warm and more humid parts of the country

(West Bengal, Orissa, Bombay), and during the monsoon (June to August) in the drier parts (Uttar Pradesh). There is no record of swarming in April. Beeson's (1941, p. 544) general statement of swarming in the winter, 'January to March', needs confirmation; Beeson does not mention the localities.

From his observations on the Barkuda Island (Chilka Lake, Orissa) during 1920-22, Annandale (1923, p. 234) stated as follows :

'Swarms earlier in the dry season [i.e. earlier than June 20]. Winged adults and a female which had just cast its wings were found in a nest on April 29th in 1922.'

He further wrote :

'The communites are comparatively small, only a few winged adults are produced at a time, and they probably issue forth singly or in small parties.'

2. Time of swarming

Swarming was observed at various times, e.g. in the evening, and at 7.30 p.m., 8 p.m., and 10 p.m. Other records merely stated : 'At dusk', 'in light trap,' or 'caught by lamplight'. It would thus appear that swarming occurs at and after dusk in the early part of the night.

3. Other particulars

C. heimi apparently breeds in dead wood of a number of species, below as well as above the ground, as the following records would indicate, and winged adults may thus swarm out of holes in the ground, from logs lying on the ground or from dead standing trees and stumps.

Dehra Dun (U.P.) :

'Adults coming out of a hole in a ground near a pole of *Lannea grandis* Engl.*; soldiers from the pole'.

'Swarming out of a small dead portion of a green standing tree, at about 7.30 p.m.'

'Swarming out of a dead stump of *Cedrela toona* Roxb. tree.'

'Swarming out of a dead portion of a green standing *Tectona grandis* Linn.'

Winged adults '*Ex* rotten mango stump'.

One observation, as follows, indicates that swarming may occur even during a light shower of rain :—Barkuda Is. (Chilka Lake, Orissa), 13. v. 1923 : 'At light during slight shower of rain'.

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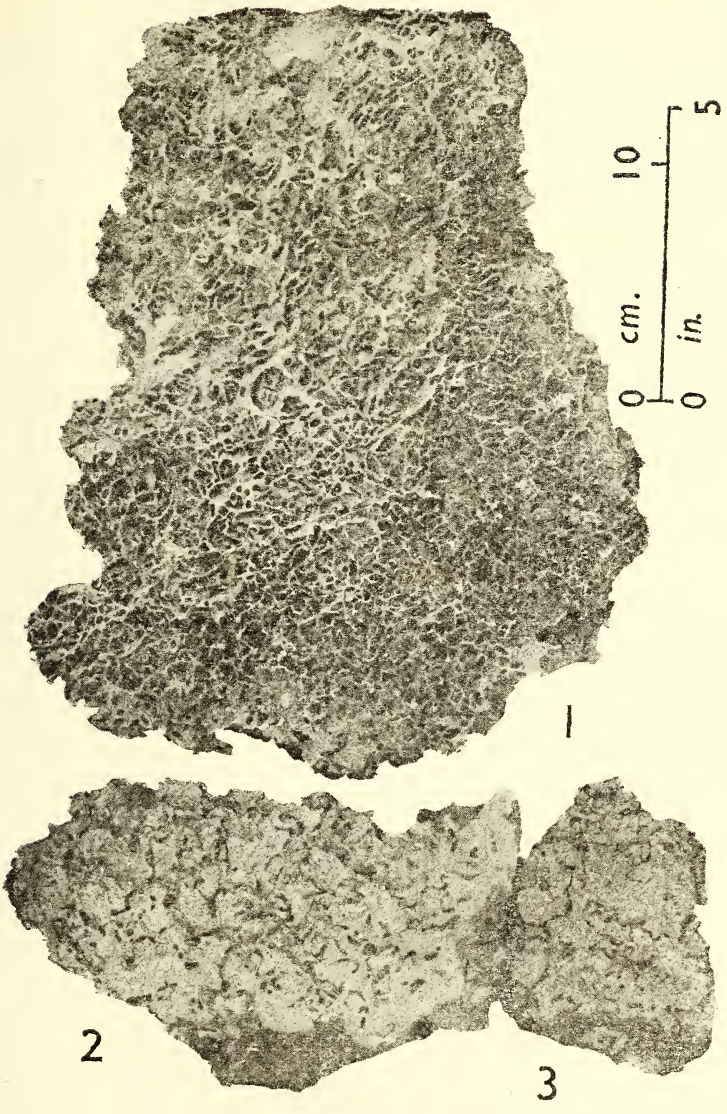
*The current name is *Lannea coromandelica* (Houtt.) Merr. [synonyms: *L. grandis* (Dennst.) Engl. and *Odina wodier* Roxb.]



Nest of the termite *Coptotermes heimi* (Wasmann), found between wooden boards in a railway carriage in north-western India.

Figs. 1, 2, 3. Portions of the nest.

Nest of the termite *Coptotermes heimi* (Wasmann), from the Sundarbans, 24-Parganas District, West Bengal, India (Narayanpur village, Namkhana Forest Range, Sundarbans Forest Division), found in a log of the 'baen' tree, *Avicennia* sp. (Family Verbenaceae), lying on the ground. *M. L. Roonwal* coll., 4th January 1954. (Coll. No. R3/4-1-54)

Figs. 1 and 2. Outer view of the nest which has been cut in two halves.

Figs. 3 and 4. Ditto. Inner view of the same two pieces of the nest.

VI. Nests and their Structures

(Plates 2 and 3)

Coptotermes heimi nests in dead logs of wood (Annandale, 1923, pp. 250-251; and Roonwal, present account), as well as in the soil (Beeson, 1941, p. 544). A nest has also been found between the wooden boards of a railway carriage in north-western India (Pl. 2). Either nests or swarming (*vide* above) of winged adults (which indicates breeding) have been recorded from logs or dead standing trees of the following species :

Avicennia sp.—Nest found (*vide infra*).

Cedrela toona Roxb.—Swarming from dead stump.

Ficus benghalensis Linn.—Nests in dead trunks (Annandale, 1923).

Lannea coromandelica (Houtt.) Merr. [synonyms : *L. grandis* (Dennst.) Engl. and *Odina wodier* Roxb.].—Probably nesting. (Swarming from hole in ground near pole of *Lannea*; soldiers taken from the pole).

Mangifera indica Linn.—Swarming from rotten mango stump.

Tectona grandis Linn.—Swarming from dead portion of green standing tree.

Annandale (1923, Pl. V, figs. 5 and 5*a*) reproduced photographs of small portions of a nest collected in the Barkuda Island (Chilka Lake, Orissa). I reproduce here photographs of two complete nests : (i) A nest found between the wooden boards of a railway carriage in north-western India (Pl. 2), (ii) A nest found in a dead log of 'baen' tree, *Avicennia* sp. (Fam. Verbenaceae) found on the ground in the Sundarbans, West Bengal (Pl. 3).

The nest usually consists of a somewhat flattened, porous structure of dark grey-brown colour, and composed of a network of strands, probably made partly of the harder wood-fibres left over during the process of eating away the wood and partly of the termite excrement cemented together by the insect and plastered over the wood fibres. There are irregular chambers of varying sizes, and the whole nest presents an appearance rather like the fungus combs of a mound-building termite such as *Odontotermes obesus* but with the chambers more flattened. The central portion of the nest is rather more compact than the superficial parts, where the chambers are larger. No royal chamber could be found.

The West Bengal nest was about 30 cm. in maximum length, 15 cm. in maximum width, and 12.5 cm. in maximum height. It was found in a log of 'baen' 60 cm. long and 30 cm. in diameter lying on the ground; the log itself showed no external indication of damage inside. The railway carriage nest was about 40 cm. in length and 15 c.m. in the large diameter.

For '*C. parvulus*' (which is a synonym of *C. heimi*, see above) Beeson, 1941, p. 544 wrote as follows : '*Coptotermes parvulus* makes a simple nest of small extent underground whence it tunnels into logs on the ground and ascends the trunks of trees in the bark in galleries covered in with earth.'

The only other observations on the nest of *C. heimi* are those of Annandale (1923, pp. 250-251) made on the Barkuda Island, Chilka Lake. The nests were found in the moist portions of logs and trunks of the banian, *Ficus benghalensis*. Several nests may occur in a single log and are confined to those parts of it that remain damp. During the hot weather the insects retire to the heart of the trunk, but in the rains they may be found immediately under the bark. The nest- structure has a superficial resemblance to the spongy excretory and woody material (the 'fillings' of Assmuth, 1913) with which the termite fills the cavities it creates inside the wood it feeds on, but can be distinguished from the latter by its more fragile and papery structure. According to Annandale : 'The chambers in this nest are eaten out from the wood by little bodies of workers, which crowd together for the purpose and are apparently so intent on their work that they can be dissipated only by violence. As they eat away the wood they secrete some substance that dyes it black to a depth of about a millimetre. Possibly this substance may guide another body working independently from the other side of the partition, by means of some flavour or of a peculiar consistency it imparts to the wood. The excrement must be spread on the walls in a liquid or semi-liquid condition after they are completed. The flattened pellets can be distinguished by the naked eye.'

Assmuth (1913) stated that the workers of *C. heimi* spread their excrement on any body including glass surfaces, over which they crawl, and that this layer may form an easy pathway for the workers. Annandale (1923), however, was of the opinion that the real function of this layer of excrement is to strengthen the walls of the cells of the nest etc., for 'the partitions between the cells are often so fragile, especially where the wood is rotten, that they would collapse unless strengthened'.

In a nest opened in April, Annandale found some of the cells, always at a considerable distance from those occupied by living individuals, filled with the dead and shrivelled bodies of workers and soldiers. No particular royal chamber could be distinguished. The occupied cells always contain large numbers of soldiers and workers, including immature individuals.

Annandale further noticed that the nests of *Microcerotermes annandalei* seem to be precisely like those of *Coptotermes heimi*, and he considered it possible that the former species merely occupies deserted nests of the latter.

VII. Some other biological Data

1. Duration of life

From observations in the Barkuda Island (Chilka Lake), Annandale (1923, p. 237) concluded that in *Coptotermes heimi* the individuals in a colony die early and probably do not live beyond a year. He wrote : '. . . the sexual individuals of those species in which the winged adults are small live for a shorter period than those in which they are large, and, indeed, probably survive for only one year. I base this conclusion on the fact that in *Capritermes obtusus*, *Coptotermes heimi* and *Eurytermes assmuthi* only very young wingless males and females were found in nests examined shortly after swarming time. In all these species it is probable that more than one pair of adults inhabits each nest.'

For workers and soldiers, he stated : 'That many die off in the latter part of the dry season I have no doubt . . . In a nest of *Coptotermes heimi* opened in April I found many dead and shrivelled corpses of workers and soldiers in chambers somewhat remote from those occupied by living individuals.'

2. Proportion of the various Castes

The only observations are those of Roonwal (1954, p. 465) who stated that in Sillari, Madhya Pradesh, the soldiers constituted about 33 per cent of a soldier-worker population in a dead tree of 'salai', *Boswellia serrata*.

3. Ecological Adjustment with other Species of Termites

Coptotermes heimi seems to live in peaceful ecological adjustment with several other species of termites. Thus, on the Barkuda Is. (Chilka Lake) Annandale (1923, p. 250) found that in a dead trunk of the banyan tree, *Ficus benghalensis*, no less than five species of termite were living : *Odontotermes feae*, *Odontotermes obesus*, *Microcerotermes annandalei*, *Microtermes anandi*, and *Coptotermes heimi*. Similarly, in the Sillari forest in the Nagpur-Wardha Forest Division in the Bombay State (formerly in Madhya Pradesh) Roonwal (1954) found that in a recently dead standing tree of the 'salai', *Boswellia serrata* Roxb. (Fam. Burseraceae), two species, namely *Coptotermes heimi* and *Odontotermes redemanni* (Wasm.), were living. *O. redemanni* fed on the surface of the sapwood not going deeper than about one centimetre from the surface both on the bole and the root stock, while *C. heimi* was confined to the core of bole which it had completely hollowed out and filled with a hard spongy whitish excretory material.

4. Secretion of Whitish Fluid by Soldiers

The soldiers of *C. heimi* share with other members of the genus *Coptotermes* the habit of ejecting a whitish milky fluid in the form of a droplet from the opening of the fontanelle on the dorsum of the head. The fluid, which on exposure to air quickly hardens to a gummy solid, is secreted by a large gland which extends from the head into the abdomen.

VIII. Summary

1. *Coptotermes heimi* (Wasmann) (Isoptera, Rhinotermitidae, Coptotermitinae) [synonym *C. parvulus* Holmgren] is one of the three termite species which are most destructive to timber in houses and elsewhere in India.

2. The available data on its biology and ecology are limited and widely scattered. In the present paper, while providing new biological data on swarming, nest-structure, host-material, etc., the existing data are summarised for ready use.

3. The nomenclative position of the species is briefly given, and *C. parvulus* Holmgren is regarded as a synonym of it. Some authors have, without justification, synonymised *C. heimi* (Wasm.) with *C. travians* (Haviland).

4. Geographical distribution. The species has been recorded from all over India and parts of W. Pakistan (W. Punjab). It does not occur in Ceylon.

5. Host-plants, etc. The species is polyphagous and feeds on dry constructional timber as well as on dead and semi-rotten wood, logs, and trunks of dead standing trees of a large number of host-plants. About 35 such species, belonging to a wide assortment of families, have been recorded. In addition, it has been recorded as damaging packing cases, wooden sleepers, papers, books, and woodwork in electrical installations, etc.

6. The economic importance of the species and the nature of damage it causes, i.e. its 'feeding pattern' in the wood, is discussed.

7. Swarming. Swarming occurs from March to August, at dusk or in the early part of the night. Statements of winter swarming (January and February) need confirmation.

8. Nests, etc. Nesting occurs in small colonies in logs of wood of several species (at least six such species have been recorded), in soil in the ground, and between the wooden boards of railway carriages. Several nests may occur in the same trunk. The nest made by the workers is a flat suboval structure, about 30 cm. in length and 15 cm. in the long diameter, composed of a network of narrow, flattened, suboval cells, constructed out of the wood left after eating, and with the walls plastered with termite excrement.

9. Some other biological data, such as the duration of life, the proportion of individuals of the various castes, ecological adjustments with other termite species, and the secretion by the soldiers of a whitish milky fluid from the dorsum of the head, are discussed.

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A Study of the Vegetation of Ajit Sagar Bundh, Rajasthan

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(*With a sketch map*)

Introduction

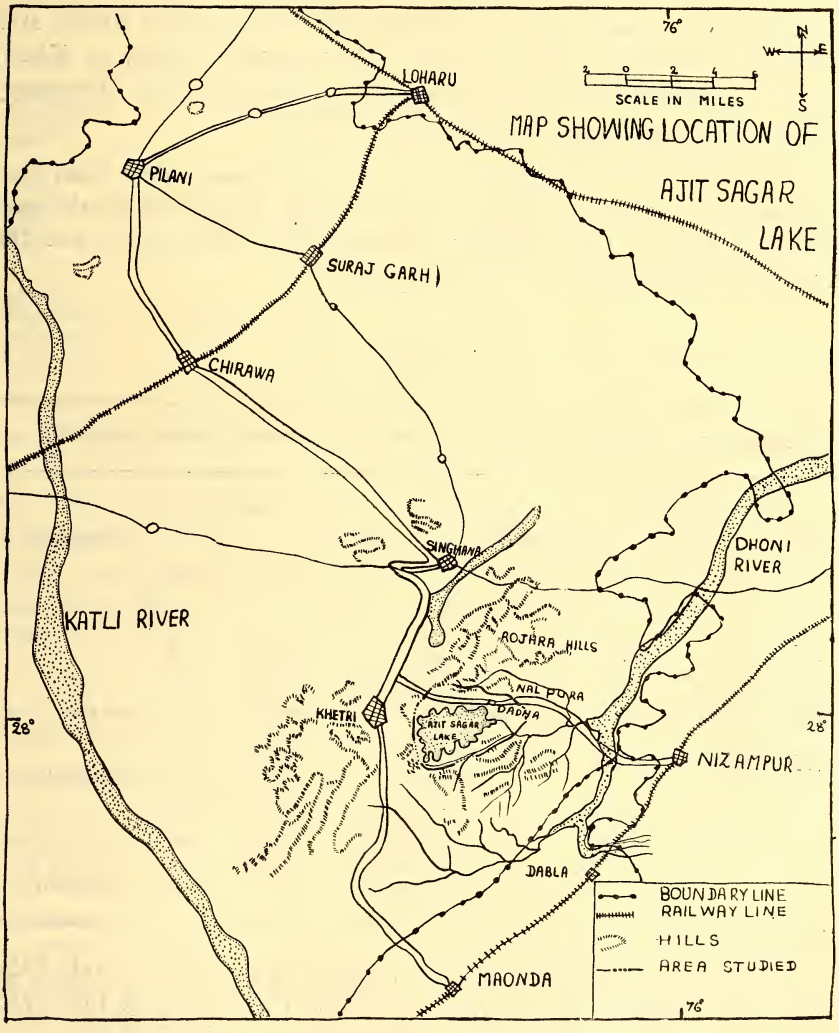
The present work deals with the vegetation of Ajit Sagar Bundh and the surrounding hills covering an area of about eighteen sq. miles. The work was undertaken because there is no information about the vegetation of the area. Another purpose of the study was to evaluate the suggestions of Drude, supported by Blatter and Hallberg (1918-1921) and Biswas and Rao (1953), that the line of demarcation between the Indo-malayan and Perso-arabian flora ranges from the Gulf of Cambay northwards along the Aravallis.

The study was commenced in December 1956 and was spread over eighteen months. The time at our disposal was very short. However, to make the study intensive, the area was visited at least twice a month which helped to give a preliminary knowledge of the phenology of each plant, the life cycle of herbaceous plants, and the relative abundance and distribution of such species in different parts of the year. Fresh specimens were brought to the laboratory for identification, which was confirmed by comparison with specimens in the Herbarium of The Forest Research Institute, Dehra Dun. The sheets are deposited in the Herbarium of Birla College, Pilani.

Topography and Physical Features

Ajit Sagar Bundh (27°60′N., 75°51′W.) is about 8 miles north-east of Khetri town (see map). The Bundh was founded by C. K. M. Walter in 1859 and was named after Ajit Singh, the ruler of the time. It is situated at an elevation of 1200 ft. above sea-level close to the villages Dhada, Fatehpura, and Tonda on the Khetri-Nizampur road. The unique position of the lake, fringed on all sides by hills (except the south-east where it is almost level ground), adds to its beauty and grandeur. The highest hill in the surroundings is Rojhra (2009 ft.).

One of the important physiographic factors on the hills is the gully erosion. Rain water flows down the slopes making small channels, as a result of which the rocky substratum has become exposed. The rains erode the surface of the hills and consequently the surface remains



rocky and bouldery with deposits of sand here and there. These hills, which are a part of the Aravalli system, represent an ancient crystalline complex and have contributed several metallic minerals, the most important among them being copper and iron.

There is a good orchard close by (½ mile) irrigated by water from the lake, which is conducted through a narrow channel paved with stones for more than one-third of its length. Due to improper levelling, there

are a number of puddles on either side of the narrow irrigation canal and a large marshy area of about 100 sq. yds.

Climatic Factors

No climatic data directly connected with the Ajit Sagar Bundh area could be procured. What we give below actually relates to Khetri and was obtained from the Revenue Record Office, and the Dispensary there. The data given cover the period 1954-1957.

Rainfall: The rainfall in the area fluctuates widely from year to year being as low as three-fourths or as high as one and a half times the mean figure. The following table gives the total annual, and the average monthly figures for the four years:

Table I

Total annual rainfall 1954-1957				Average monthly rainfall 1954-1957			
Year	Rainfall		Remarks	Month	Rainfall		Remarks
	inches	cm.			inches	cm.	
1954	18.20	46.28	Minimum	January	0.685	1.74	
				February	0.718	1.82	
1955	24.60	62.48		March	0.300	0.76	
1956	31.61	80.29	Maximum	April	0.000	0.00	No rain
				May	0.175	0.44	
1957	24.96	63.41		June	2.440	6.20	
				July	9.020	22.86	Maximum
				August	5.670	14.40	
				September	2.865	7.28	
				October	2.890	7.34	
				November	0.225	0.57	
				December	0.040	0.10	Minimum

The highest rainfall in a day was 3.25″ (8.25 cm.) on 21st July 1956. The highest rainfall in a month was 14.68″ (37.28 cm.) in July 1956. The average annual rainfall for the period was 24.84″ (63.09 cm.).

Temperature: The highest temperature recorded during the period 1954-1957 is 112°F. (44.4°C.) on 26th May 1954; the lowest 46.00°F. (7.78°C.) on January 1955. The range of daily temperature for the summer months was 12.0°F. (6.7°C.) and for winter 16.0°F. (8.9°C.). The following table gives the mean monthly maximum and minimum temperatures in F. and C.:

TABLE II

Mean monthly maximum and minimum temperature in °F. and °C.

Month	Mean maximum		Mean minimum		Remarks
	°F.	°C.	°F.	°C.	
January	69.9	21.0	54.9	12.7	
February	77.7	25.4	57.7	14.3	
March	87.9	31.0	70.1	21.2	Mean yearly temperature 81·0°F. (27.2°C.)
April	95.5	35.3	81.8	27.7	
May	104.7	40.4	91.7	33.2	
June	103.8	39.9	90.7	32.6	
July	94.7	34.8	83.5	28.6	Mean maximum temp. 87.4° F. (30.8°C.)
August	93.5	34.2	82.5	28.1	
September	90.2	32.3	81.7	27.6	
October	81.7	27.6	72.7	22.6	
November	76.5	30.3	65.5–	18.7	Mean minimum temp. 74.7°F. (23.7°C.)
December	73.1	28.4	55.9	13.3	

The water table in the surrounding areas seems to be only 30-40 feet deep. This is in contrast to other parts of Rajasthan where the water table is very much deeper. The water holding capacity of the rocky surrounding hills is very limited and the major portion of the rain water drains off into the lake where a depth of 25-30 feet is always present in the deeper spots.

Soil: A few spots in the Nizampur road have loose sandy soil but they do not form the rippled dunes characteristic of adjacent places. Table III gives a survey of the soil samples of the area. The soil is fairly rich in silt and humus in the sloping banks of the lake. The hillocks are gritty, and the soil is thin. Due to human agency the soil is very rich in the garden area. In the plain ground the soil is sandy but stable and fertile.

BIOTIC FACTORS

The biotic factors disturbing the vegetation here are the same as in other hilly parts of Rajasthan, namely the grazing and browsing by sheep, cattle, hares, and other mammals, and the felling of trees and bushes, and scraping up of ground vegetation by humans. The indirect effect of all this on the habitat is highly devastating.

VEGETATION

1. Vegetation along the road leading to the lake.

During the hot months the plants found along the roadside are mostly hardy perennial shrubs and trees indigenous to the area. These

TABLE III

Character of soil samples from different places in Ajit Sagar

Locality	Depth of the soil taken	Physical Nature		Chemical Nature					
		Colour	Texture	Chloride	Carbonate content	Nitrate content	Reductivity	pH	Remarks
1. Plains ..	5 cm.	Brown	Sandy	++	—	++	—	7.0	Neutral
	10 ,,	Brown	Sandy	+	—	++	—	7.0	Neutral
2. Bank of the lake ..	5 ,,	Grey	Smooth	++	—	+++	+	8.5	Alkaline
	10 ,,	Black	Smooth	+++	—	+++	+	7.5	Alkaline
3. Slopes of hills ..	5 ,,	Reddish	Gritty	+++	++	+++	—	7.0	Neutral
	10 ,,	Brown	Gritty	+++	+	++	—	8.5	Alkaline
4. Top of hills ..	5 ,,	Red	Gritty	++	—	++	—	7.5	Alkaline
	10 ,,	Red	Gritty	++	—	+	—	7.5	Alkaline
5. Garden area ..	5 ,,	Blackish	Clayish	++	+	++++	+	8.0	Alkaline
	10 ,,	Brownish	Clayish	+++	++	+++	+	7.5	Alkaline

include *Prosopis spicigera*, *Calotropis procera*, *Zizyphus* spp., *Grewia populifolia*, *Sida veronicaefolia*, and *S. grewioides*. Among introduced species, the following are found on either side of the road : *Prosopis juliflora*, *Albizzia lebbeck*, *Lawsonia* sp., *Punica granatum*, *Kigelia pinnata*, etc. During the rainy season there is a luxuriant growth of herbaceous plants, such as *Tribulus terrestris*, *Cleome viscosa*, *Vernonia cinerea*, *Cassia tora*, *Phyllanthus niruri*, *Tridax procumbens*, *Boerhavia diffusa*, *Trianthema pentandra*, *Indigofera* spp., *Tephrosia purpurea*, etc. The plants seen in the cold months are *Justicia* spp., *Cnicus wallichii*, *Argemone mexicana*, and *Indigofera* spp. *Pergularia daemia* and *Merua arenaria* are climbers found generally on *Acacia arabica*, *A. senegal*, and *Euphorbia nivulia*.

2. Vegetation in the plains.

The vegetation in open stabilized soil, soon after the rains, is abundant in grasses and other species of *Polycarpaea*, *Euphorbia*, *Leucas*, *Justicia*, *Indigofera*, *Tridax*, *Borreria*, *Digera*, *Mollugo*, *Boerhavia*, *Tribulus*, etc. Under the shade of shrubs and trees are found *Commelina benghalensis*, *Corchorus* spp., *Pupalia lappacea*, *Achyranthes aspera*, *Riccia* spp., and mosses. A few fungal species such as *Agaricus*, *Lycoperdon*, and *Ravenalia* were observed. *Ravenalia* was found to be in an epidemic form on *Albizzia*. Most of the above plants die away in winter and a few new plants such as *Solanum nigrum*, *Psamogeton biternatum*, *Argemone mexicana*, *Justicia* spp., *Cnicus wallichii*, *Launaea* spp., etc. come up. The ground is barren in summer except for a few plants such as *Phyllanthus niruri*, *Solanum xanthocarpum*, *Corchorus* spp., etc. The trees and shrubs that constitute the permanent vegetation are distinguished into the following associations :

(a) *Prosopis-Capparis* association.—This is the principal association of the area. The elements present are : *Prosopis spicigera* (d)[1], *Capparis decidua* (c), *Gymnosporia spinosa* (r), *Balanites aegyptiaca* (r), *Ephedra foliata* (r), *Acacia senegal* (r), *A. leucophloea* (r), *Mimosa hamata* (r), *Tecomella undulata* (r), *Zizyphus* spp. (c), and *Clerodendrum phlomidis* (r).

(b) *Acacia-Salvadora-Prosopis* association.—This is the second prominent association of the area and is constituted by *Acacia arabica* (d), *A. senegal* (c), *Prosopis spicigera* (c), *Salvadora oleoides* (f), *S. persica* (r), *Balanites aegyptiaca* (r), *Securinega leucopyrus* (r), *Lycium europeum* (r), *Zizyphus* spp. (c), *Gymnosporia spinosa* (r), *Coccinia cordifolia* (c), and *Saccharum munja* (r).

(c) *Acacia-Balanites-Capparis* association.—This is a little denser than the above two associations and occurs only at two spots. The

[1] d dominant, c common, f frequent, r rare,

constituents are : *Acacia senegal* (d), *Balanites aegyptiaca* (c), *Capparis decidua* (c), *Salvadora oleoides* (r), *Anogeisus pendula* (r), *Clerodendrum phlomidis* (r), *Zizyphus xylopyra* (c), *Saccharum munja* (r), *Gymnosporia spinosa* (r), *Coccinia cordifolia* (c), *Ephedra foliata* (r), and *Securinega leucopyrus* (r).

(d) *Capparis-Gymnosporia-Clerodendrum* association.—This association comprises *Capparis decidua* (c), *Gymnosporia spinosa* (d), *Zizyphus* spp. (r), *Clerodendrum phlomidis* (c), *Grewia tenax* (r), *Calotropis procera* (c), and *Boerhavia verticillata* (r).

Near temporary ponds tree species such as *Anogeisus pendula*, *Acacia arabica*, *Salvadora oleoides*, etc. were found to be very vigorous. On the slopes of these ponds an association of grasses such as spp. of *Cenchrus*, *Dactyloctenium*, *Cynodon* and species of *Cyperus*, *Phyllanthus*, *Polygonum*, *Glinus*, *Heliotropium*, *Amaranthus*, *Euphorbia*, etc. is found. When the ponds dry up *Polygonum plebejum* and *Glinus lotoides* are found in abundance. In loose sandy areas has been found an association of *Calligonum polygonoides*, *Saccharum munja*, etc.

3. Vegetation of the lake area.

(a) Inside the lake. A large number of algae, mostly filamentous, are collected in the lake soon after the rains and as the climate becomes hotter they decay and produce a very foul smell. The phanerogamic hydrophytes found in the lake include *Vallisneria spiralis*, *Hydrilla verticillata*, *Potamogeton indicus*, etc. As the water margin recedes, in the hotter months, these plants are forced to deeper zones while those on the margin die away and add to the silt after shedding seeds. This process may be regarded to be a very important factor in raising the substratum of the lake. By the onset of rains regeneration of the plants takes place.

(b) On the water margin. The vegetation on the bank of the lake close to the water margin shows a well-marked seasonal succession. As soon as the monsoon sets in the water margin shows a luxuriant growth of *Dentella repens*, *Coldenia procumbens*, *Glinus lotoides*, *G. oppositifolius*, *Cynodon dactylon*, *Eclipta prostrata*, *Alternanthera triandra*, *Phyla nodiflora*, and *Verbascum coromandalinum*. At places pure associations of *Dentella* and *Coldenia* in the form of thick carpets are also found. The aerial parts of the above mentioned plants assume a reed swamp stage, the underground parts spreading, anchoring the plants in the extremely mobile substratum, and contributing towards the stabilization of silt. By October all these plants except *Eclipta*, *Alternanthera*, and *Cynodon*, which flourish throughout the year, complete their life cycle and may perish or perennate by hardy root stocks. As the water level recedes in the hotter months the perennial ones encroach on the

deeper regions of the lake. *Coronopus didymus* and *Potentilla supina* found in abundance during the colder months perish by the onset of summer.

(c) On the slopes of the lake. On the sloping banks of the lake are found the following associations :

(i) *Prosopis-Securinega* association.—This is found on the gravelly slopes. The plants that constitute this association are : *Prosopis spicigera* (d), *Securinega leucopyrus* (c), *Grewia tenax* (f), *Zizyphus xylopyra* (r), *Cordia dichotoma* (r), *Gymnosporia spinosa* (r), *Calotropis procera* (r), *Dipteracanthus patulus* (r), etc. The ground vegetation is abundant in *Vernonia cinerea*, *Heliotropium supinum*, *Glinus lotoides*, *Celosia* spp., *Indigofera* spp., *Tephrosia purpurea*, and species of *Cyperus*, *Cynodon*, *Cenchrus*, etc. Most of the above plants except *Vernonia*, *Glinus*, and *Heliotropium* are found throughout the year. At one or two places, where silt has accumulated, a few trees of *Acacia arabica* were found to grow luxuriantly. During the rainy season when the lake is full these trees have more than one-third of their body under water.

(ii) *Saccharum-Grewia* association.—This association is found on the bundh side. The top of the levelled muddy bundh is almost dry throughout the year. The members constituting this association are : *Saccharum munja* (d), *Grewia tenax* (c), *Calotropis procera* (f), *Securinega leucopyrus* (r), *Rhus mysorensis* (r), *Pavonia zeylanica* (r), *Hibiscus micranthus* (r), *Sida grewoides* (c), *Capparis decidua* (r), etc.

4. Vegetation of the irrigation canal.

There is a permanent flow of water from the lake through the narrow and shallow canal. On the banks of the canal are found *Polygonum barbatum*, *Saccharum munja*, *Sida* spp., *Glinus lotoides*, *Cyperus* spp., *Ficus glomerata*, *Prosopis juliflora*, *Typha angustata*, *Bacopa monnieri*, etc.

5. Vegetation in marshy puddles.

The vegetation in puddles is almost a pure association of *Typha angustata*. On the banks of these marshes close to the water margin are found *Bacopa monnieri*, *Cyperus eleusinoides*, *C. arenarius*, *Fimbristylis diphylla*, *Panicum* spp., and *Zeuxine sulcata* in different seasons of the year. In puddles were observed *Hydrilla*, *Vallisneria*, *Potamogeton*, *Aponogeton*, and *Chara*.

6. Vegetation on the hills and hillocks.

During the dry months the herbage of the hills is almost inconspicuous and the rocky boulder-strewn slopes appear barren to a casual observer. On closer scrutiny, small trees, mostly or completely devoid of foliage, are seen to be scattered on the hill-sides. By the onset of

monsoon there is a grand flush of plant growth and innumerable number of plants formerly dry becomes recognizable while others not distinct before spring up. The small trees that dot the stony hills and were devoid of leaves become green and conspicuous. The most remarkable changes are seen in the annual and perennial herbaceous plants, the most dominating of them being *Cardiospermum halicacabum*, *Orygia decumbens*, species of *Indigofera*, *Tephrosia*, and *Justicia*. The whole hill-side becomes green. These herbaceous plants grow in the pockets and crevices of rocks where some soil has accumulated.

On the steep slopes, where run-off is excessive and soil erosion is at a maximum, the vegetation is very sparse and shows pure association of *Euphorbia nivulia*, *Opuntia dillenii*, and *Rhus mysorensis*. *Striga gesneroides* grows invariably on the roots of *Euphorbia nivulia*. On the gently sloping sides, where there are greater opportunities for soil accumulation, relatively thick growth occurs and the following associations have been distinguished :

(a) *Euphorbia-Grewia* association.—*Euphorbia nivulia* (d), *Grewia tenax* (c), *Cocculus laeba* (c), *Dipteracanthus patulus* (c), *Barleria prionitis* (r), *Securinega leucopyrus* (r), *Sida grewioides* (r), *Abrus precatorius* (c).

(b) *Acacia-Prosopis* association.—*Acacia senegal* (c), *A. arabica* (d), *Prosopis spicigera* (c), *Gymnosporia spinosa* (r), *Capparis decidua* (r), *Balanites aegyptiaca* (r), *Euphorbia nivulia* (r).

(c) *Acacia-Balanites* association.—*Acacia senegal* (d), *Balanites aegyptiaca* (c), *Capparis decidua* (c), *Grewia tenax* (r), *Securinega leucopyrus* (c), *Anogeisus pendula* (r), *Cocculus laeba* (r).

(d) *Rhus-Gymnosporia* association.—*Rhus mysorensis* (c), *Gymnosporia spinosa* (d), *Calotropis procera* (c), *Grewia tenax* (r), *Euphorbia nivulia* (r), *Barleria prionites* (r), *Dipteracanthus patulus* (c), *Orygia decumbens* (r).

LIST OF PLANTS

(The name given after the botanical name and author is the vernacular name. The number in parenthesis is the number of the hebarium sheet.)

Anonaceae

1. **Anona squamosa** Linn. Cultivated.

2. **Polyalthia longifolia** B. &. H. Ashok. Planted. Bark used in medicine.

Menispermaceae

3. **Cocculus pendulus** (Forst.) Diels.=*C. leaeba* DC. (2,3,229). Common.

4. **Tinospora cordifolia** Miers. Said to be flowering in the hot months but we have not seen the flowers. Root and stem used as an antidote for snake bite.

Papaveraceae

5. **Argemone mexicana** Linn. Satyanashi. (7). Common. Fls. Jan.-May. Sometimes found even in Sept. near temporary ponds.

Cruciferae

6. **Coronopus didymus** (Linn.) Sm.=*Senebiera pinnatifida* DC. In cold season.

7. **Capsella bursa-pastoris** Medick. A weed of cultivated places. Fls. Dec.-Feb.

The following plants are cultivated: 8. **Brassica oleracea** L. var. **botrytis**. 9. **B. caulorapa** Forsk. 10. **B. campestris** Linn. 11. **B. juncea** Hf. & T. 12. **B. rapa** Linn. 13. **B. oleracea** var. **capitata** L. 14. **Raphanus sativus** Linn. 15. **Iberis umbellata** Linn.

Capparidaceae

16. **Cleome viscosa** Linn. (135,136). Common in the plains after the rainy season. Fls. Jul.-Nov.

17. **C. brachycarpa** DC. (307). Similar except pubescence and in having six stamens. Very rare.

18. **Capparis decidua** (Forsk.) Pax. Fls. Oct-Nov. and March-April. Common in plains and hillocks. Near temporary ponds it forms pure associations.

19. **Merua arenaria** Hk. f. (330). A perennial woody climber with leathery leaves. Fls. greenish white. Dec.-Feb.

Violaceae

20. **Viola (stocksii** Boiss.?) (160). A small puberulous herb branched from root-stock. Dehiscence of the fruit, white seeds, apetalous flower, and scarious stipules are characteristic. Fls. Sept.-Nov. Very rare on hills.

21. **Viola (cinerea** Boiss.?) (164,224). Perennial herb of about 1 ft. Branching dichotomously. Flowers violet, polypetalous. Calyx hairy. Fls. Oct.-Nov.

Note: The above sheets could not be compared with any of the sheets in F.R.I. herbarium.

Polygalaceae

22. **Polygala erioptera** DC. (132,173). A common herb with margins of keel and wing yellow. Fls. Jan.-Mar.

Caryophyllaceae

23. **Spergula pentandra** Linn. (13). A common herb of winter in the plains, has fleshy leaves which are not grooved as in *S. arvensis*.

24. **Polycarpaea corymbosa** Lamk. (267,268). Common in open places. Fls. Sep.-Jan.

Portulacaceae

25. **Portulaca oleracea** Linn. (343). A fleshy annual with yellow flowers opening in the morning. Fls. Sept.-Dec.

26. **P. quadrifida** Linn. (342). Differs in the prostrate habit and long stipular hairs. Flowers bigger.

27. **P. grandiflora** Linn. Cultivated.

Tamaricaceae

28. **Tamarix dioica** Roxb. Farans. As plantations.

Malvaceae

29. **Sida grewioides** Guill. & Perr. Kharenti. (245). A perennial under shrub. Fls. Sept.-Jan.

Note: Blatter and Hallberg reported white flowers also from W. Rajasthan. The flowers observed by us were all yellow.

30. **S. veronicaefolia** Lamk. (93). A shade-loving low herb of the plains. Fls. Sept.-Jan.

31. **S. cordifolia** Linn. (92). A hairy undershrub. Fls. Aug.-Sept Rare.

32. **Abutilon bidentatum** A. Rich. (204). An erect downy shrub of about 4-5 feet. Leaves leathery. Pedicels shorter than the petiole. Ovary contains about 15 carpels. On slopes of hills. Fls. Oct.-Jan.

33. **A. fructicosum** Guill. & Perr. (31,32). Similar except in being woody and hairy, and having leathery leaves and lesser number of carpels (10 or less). Fls. Oct.-Dec. Common.

34. **Pavonia zeylanica** Cav. (14,203). A tall herb with pink flowers. Common after the rainy season.

35. **Hibiscus micranthus** Linn. (195,280,290,110,111). A small undershrub with rosy flowers. Common in stony and rocky places. Fls. Jul.-Dec.

36. **H. gibsonii** Stocks. (169,188). A trailing herb with palmately lobed leaves and long coiled epicalyx. Rare during monsoon.

37. **H. (lobatus** O. Ktze. = *H. solandra* L. ?). (92). An erect herb with pale hairy, serrate, cordate leaves. Corolla yellow. Fls. Aug.-Nov. Only one plant could be seen in the area surveyed.

38. **Malvastrum tricuspidatum** A. Grey. (109). A hairy undershrub. Fls. Sept.-Dec. Weed of cultivated and moist places.

39. **Abelmoschus esculentus** (Linn.)=*Hibiscus esculentus* Linn. Moench. Cultivated.

40. **Salmalia malabarica** (DC.) Schott. & Endl.=*Bombax malabaricum* DC. Plantations. Fls. Jan.-Mar.

Tiliaceae

41. **Grewia tenax** (Forsk.) Fiori.=*G. populifolia* Vahl. Common. Fls. Aug.-Nov.

42. **G. oppositifolia** Roxb. A small tree cultivated for fruits.

43. **Triumfetta cana** Bl. (50). A small undershrub. Fruit oval, spiny. Fls. Aug.-Dec. Very rare.

44. **T. bartramia** Linn.=*T. rhomboidea* Jacq. (193). An undershrub, leaves variable and bigger than in the above species. Frequent. Fls. Aug.-Nov.

45. **T. pentandra** A. Rich.=*T. neglecta* W. & A. (195). Differs from the above species in having rugose, oval, acute leaves. Frt. oval with armed hooks. Rare, in higher altitudes. Fls. Sept.-Nov.

46. **Corchorus depressus** (Linn.) Stocks.=*C. antichorus* Roeusch. (201) Perennial prostrate undershrub forming carpet on the gravelly and hard ground. Fls. and frt. Sept.-Jan.

47. **C. tridens** Linn. (210). An annual herb, capsule 1-2″ long, common in plains. Fls. and frt. Sept.-Dec.

48. **C. aestuans**. Linn.=*C. acutangulus*. (208,247). Capsules 1″ long, broader and winged, three-ridged. Fls. and frt. Aug.-Dec. In hard ground.

49. **C. trilocularis** Linn. (209). Stouter herb. Capsules 2-3″ long, cylindrical with short erect beaks. Fls. and frt. Aug.-Nov.

ZYGOPHYLLACEAE

50. **Tribulus terrestris** Linn. Gokhru. (28,122,123). A common plant of the plains during the rainy season. Frt. Dec.

51. **Fagonia cretica** Linn.=*F. arabica* Linn. (219,176). A spiny perennial herb. Flowers all round the year but more profusely in cold season.

GERANIACEAE

52. **Oxalis corniculata** Linn. (37,228). A yellow-flowered herb of shady moist places. Fls. and frt. Aug.-Feb.

53. **Averrhoa carambola** Linn. Kamrach. Cultivated.

RUTACEAE

The following plants are cultivated: 54. **Citrus aurantium** Linn. 55. **C. sinensis.** 56. **C. medica** var. **media.** 57. **C. medica** var. **acida** Roxb. 58. **C. medica** var. **limonum** Wall. 59. **C. medica** var. **limetta** DC. 60. **C. decumana** Linn. 61. **Feronia limonia** (Linn.) Swingle.=*F. elephantum* Correa. 62. **Aegle marmelos** Correa. Bel.

SIMAROUBACEAE

63. **Balanites aegyptiaca** Linn.=*B. roxburghii* Planch. (308). Fls. March-April. The greasy pulp of the fruit is used medicinally.

64. **Ailanthus excelsa** Roxb. Cultivated.

BURSERACEAE

65. **Commiphora mukul** (Hook. ex Stocks.) Engl. Gugul. Fls. Sept.-Dec. Common on the dry Maonda Hills. Gum is used medicinally.

MELIACEAE

As plantations: 66. **Melia azedarach** Linn. 67. **Azadirachta indica** Juss.

CELASTRACEAE

68. **Gymnosporia spinosa** (Forsk.) Fiori.=*G. montana* Benth. (27,240). Common. Fls. and frt. Oct.-Feb.

RHAMNACEAE

69. **Zizyphus nummularia** W. & A.=*Z. rotundifolia* Lamk. (121). A common bush. Fls. and ft. Aug.-Dec.

70. **Z. xylopyra** Willd. (269,270). Amedium-sized tree. Leaves and fruits bigger. Fls. and frt. Aug.-Dec.

71. **Z. mauritiana** Lamk.=*Z. jujuba* Lamk. non Mill. Cultivated.

VITACEAE

72. **Cayratia carnosa** Gagnep.=*Vitis trifolia* L. A twiner. Fls. and frt. Sept.-Oct.

SAPINDACEAE

73. **Cardiospermum halicacabum** Linn. Balloon vine. (27). Common herbaceous climber of the bushes. Fls. and frt. Sept.-Dec.

74. **Dodonaea viscosa** Linn. Common hedge plant.

ANACARDIACEAE

75. **Rhus mysorensis** Heyne. Dansar. (172,309). A spiny shrub. Fls. Aug.-Sep.

76. **Mangifera indica** Linn. Cultivated. Fls. April.

MORINGACEAE

77. **Moringa oleifera** Lamk.=*M. pterigosperma* Gaertn. Sainjna. Cultivated.

LEGUMINOSAE

78. **Crotalaria medicaginea** Lamk. (205,206). Undershrub. Fls. Oct.-Jan.

79. **C. burhia** Hamilt. (310). A diffuse erect herb with slender branches. Common in plains only. This plant was never seen to fruit. Fls. Sept.-Oct. Stray flowers are seen throughout the year.

80. **Cyamopsis tetragonoloba** (Linn.) Taub.=*C. psoralioides* DC. Guar. (116). Commonly cultivated, but as an escape at many places.

81. **Indigofera linifolia** Retz. (231,232). A small prostrate herb. Leaves lanceolate. Fls. and frt. Sept.-Feb.

Note: Leaves in our specimens were broader than those found at Pilani.

82. **I. cordifolia** Heyne. (118,141). Broader leaves with more pubescence. Common in crevices of rocks. Fls. and frt. July.-Nov. and Feb.-March.

83. **I. enneaphylla** Linn. (243,260). Diffusely branched prostrate herb. Leaves 5-9 foliate. Common in plain ground. Fls. and frt. Sept.-Feb.

84. **I. argentea** (non Linn.) Burm. (281). An undershrub with yellowish flowers. Leaves 5-7 foliate. Rare; fls. and frt. Sept.-Jan.

85. **I. tinctoria** Linn. (225,254). Bigger shrub. Leaves 11 foliate frequent all over the area. Fls. and frt. Sept.-Feb.

86. **Rhynchosia minima** DC. (175,256,273). A common climber with 3-4 seeded pods. Fls. and frt. Sept.-Feb.

87. **Tephrosia purpurea** Pers. (136,186). Has a good number of variations. Fls. Aug.-Feb.

88. **T. pumila** Pers.=*T. purpurea* var. *pumila* Pers. (191). Rare.

89. **T. petrosa** Blatt. & Hall.=*T. spinosa* Pers. (120,88). Fls. solitary, axillary, from Jul.-Dec.

90. **T. pauciflora** Grah.=*T. purpurea* var. *pauciflora* Grah. (185). Frequent.

91. **T. candida** DC. (150,279). Flowers white. Racemes 15 cm. long. Frequent on the hills. Pods 6-7 cms. long.

92. **T. multiflora** Blatt. & Hall.=*T. senticosa* Pers. (322). Rare.

93. **T. incana** Grah.=*T. villosa* Pers. var. *incana*. (49). Diffused undershrub. Common in rainy season.

94. **Abrus precatorius** Linn. Chimri. A rare climber on bushes.

95. **Sesbania sesban** (Linn.) Merr. var. **picta** Santapau=*S. aegyptiaca* var. *picta* Prain. (223). A common shrub of waste places. Leaves 25-30 cm. long. Corolla with black dots. Fls. and frt. Sept.-Dec.

96. **Alysicarpus vaginalis** DC. (161,283). A small herb with hairy leaves. Upper leaves lanceolate, lower roundish. Fls. red, frt. jointed and 8-chambered. Fls. July-Feb.

97. **Phaseolus trilobus** Ait. (71,283). Fls. Sept.

98. **Zornia diphylla** Pers. (189). Common. Fls. and frt. Aug.-March.

99. **Dalbergia sissoo** Roxb. Sisom. A roadside plantation. Some times self sown.

100. **Butea monosperma** (Lamk.) Taub. Palas. Very rare. We have not seen this plant in flowering state.

The following are cultivated: 101. **Pisum sativum** Linn. 102. **Trigonella foenum-graecum** Linn. Often runs wild. 103. **Cicer arietinum** Linn. 104. **Phaseolus mungo** var. **radiatus** Linn. 105. **P. aconitifolius** Jacq. Mott.

106. **Cassia occidentalis** Linn. (140). In barren places. Fls. Aug.-Jan.

107. **C. tora** Linn. (65). A small shrub. Fls. Aug.-Dec.

108. **C. pumila** Lamk. (187). Prostrate herb with flat pods. Fls. Jul.-Dec.

109. **Parkinsonia aculeata** Linn. Introduced, almost naturalized.

110. **Tamarindus indica** Linn. Cultivated.

111. **Delonix regia** Boj.=*Poinciana regia* Boj. In gardens.

112. **Prosopis spicigera** Linn. Common. Fls. May. Frt. stored and eaten.

113. **P. juliflora** DC. An Australian tree almost naturalized.

114. **Mimosa hamata** Willd. (26,311). A straggling shrub. Pod flat, 5 cms., recurved sutures, prickly; heads globose, axillary, pink turning white. Fls. and frt. Aug.-Feb. Common in plains.

115. **Acacia arabica** Willd. A common tall tree of the area. Pod medicinal.

116. **A. senegal** Willd. Khair. (159,264). A small tree of the area. Spines hooked in threes, abundant on the hills; pod much flattened, 2-3 chambered. Fls. Oct.-Dec.

117. **A. leucophloea** Willd. A small rare tree with terminal inflorescence and long spines. Fls. white, Aug.-Nov.

118. **Albizzia lebbeck** Benth. A roadside plantation, often infected by *Ravenalia sessilis* during Dec.-Jan.

Rosaceae

119. **Potentilla supina** Linn. (346). A prostrate herb of winter, near water margin of the lake. Leaflets 5, deeply lobed. Fls. solitary, axillary, minute, yellow, from Jan.-March. The only other report of the plant in Rajasthan is from Mt. Abu.

120. **Rosa indica** Linn., 121. **Prunus communis** Linn., and 122. **Quisqualis indica** L. are cultivated.

Combretaceae

123. **Anogeissus pendula** Edgw. Dhau. (57,177). A tall tree, branches pendulous. Common particularly near ponds and on the hills. Fls. Aug.-Jan.

124. **Terminalia arjuna** Bedd. Fls. April-May. Probably planted. Rare.

Myrtaceae

The following species are cultivated: 125. **Psidium guajava** Linn. 126. **Syzygium cumini** (Linn) Skeels.=*Eugenia jambolana* Lamk. 127. **Eucalyptus** sp.

Lythraceae

128. **Ammannia baccifera** Linn. (99). A small decumbent herb with red solitary axillary flowers. Fls. and frt. Oct.-Feb.

129. **Nesaea lanceolata** Koehn. (36). A small herb with minute flowers in Nov.-Dec. This is a new record for Rajasthan.

The following are cultivated: 130. **Punica granatum** Linn. 131. **Lagerstroemia indica** Linn. (15). 132. **Lawsonia inermis** Linn. (147).

Onagraceae

133. **Trapa bispinosa** Roxb. Singhara. Cultivated.

Caricaceae

134. **Carica papaya** Linn. Cultivated. May be dioecious or polygamous.

Cucurbitaceae

135. **Momordica dioica** Roxb. A climbing herb, dioecious. Fls. after rains.

136. **M. balsamina** Linn. (340). Common climber on bushes. Fls. Aug.-Jan.

137. **Cucumis callosus** (Rottl.) Cogn.=*C. trigonus* Roxb. Common in bushes.

138. **Citrullus colocynthis** Schrad. Tumba. (178). A common herb.

139. **Blastania fimbristipula** (Fenzl). Kotschy. & Perr.=*Ctenolepis cerassiformis* Naud. (207,220,278). A monoecious climber with stipuliform bracts. Fls. and frt. Jul.-Dec.

140. **Melothria maderaspatana** Cogn. (226). Common during rainy season.

141. **Coccinia cordifolia** (Linn.) Cogn.=*Coccinia indica* W. & A. A climber with tuberous roots and large white flowers. Fruit edible.

The following species are cultivated: 142. **Momordica charantia** Linn. 143. **Lagenaria vulgaris** Ser. 144. **Cucurbita moschata** Duch. 145. **C. maxima** Duchesne. 146. **Cucumis melo** Linn. 147. **C. sativus** Linn. 148. **Luffa cylindrica** (Linn). Roem.=L. *aegyptiaca* Mill. 149. **L. acutangula** var. **amara** Clarke. 150. **Citrullus vulgaris** Schrad. 151. **C. vulgaris** var. **fistulosus** Stocks.

Cactaceae

152. **Opuntia dillenii** Haw. (333). A common plant on gravel. Fls. Nov.-Dec.

Molluginеae

153. **Trianthema portulacastrum** Linn.=*T. monogyna* Linn. (171). Procumbent annual herb. Carpel single. Stamens 15. Fls. red, Aug.-Dec.

154. **T. decandra** Linn. (325). Carpels 2, fls. white.

155. **T. triquetra** Willd. ex Rottl.=*T. crystallina* Vahl. (313). Carpel 1, stamens 5, a rare plant in plains only. Fls. July-Oct.

156. **Mollugo cerviana** Ser. (259). On sandy soil. Fls. and frt. Oct.-Feb.

157. **M. nudicaulis** Lamk. (261). Common in open places.

158. **Glinus oppositifolia** (L.) DC.=*Mollugo oppositifolia* Linn. (170). A prostrate glabrous herb. Flowers greenish. Common.

159. **G. lotoides** Linn.=*Mollugo hirta* Thunb. (331). A stellate, woolly herb very common in winter and spring. Stamens 10.

160. **Orygia decumbens** Forsk.=*O. triantha* Vicary. (17,18). Fls. Sept.-Dec.

Umbelliferae

161. **Psamogeton biternatum** Edgw. (320). A small herb with much dissected leaves. Umbels of silvery pink flowers. Rare, fls. Feb.-March.

The following are cultivated: 162. **Foeniculum vulgare** Mill. 163. **Coriandrum sativum** Linn. 164. **Trachyspermum ammi** (Linn.) Sprague. =*Carum copticum* Benth. 165. **Cuminum cyminum** Linn. 166. **Daucus carota** Linn.

Rubiaceae

167. **Dentella repens** Forsk. (142,143). A small prostrate herb rooting at nodes. Flowers solitary, axillary, white. According to Hooker (F.B.I.) the flowers are $1 \times 12''$ only but in our collection they were $\frac{1}{2}''$ long. Fls. and frt. Sept.-Dec. This plant is a new record for Rajasthan.

168. **Oldenlandia corymbosa** Linn. (169) Common after rains.

169. **Borreria hispida** (L.) Schum.=*Spermacoce hispida* Linn. 214,286). An erect or prostrate annual herb. Fls. and frt. Sept.-Feb.

170. **B. stricta** (L.) Schum.=*Spermacoce stricta* Linn. (67). Fls. Aug. Nov.

COMPOSITAE

171. **Erigeron canadensis** Linn. (238). An annual herb with ribbed stem. Fls. all tubular, dirty white, Oct.-Jan. Common on hillocks.

172. **Vernonia cinerea** Less.=*V. patula* W. & A. (61,242). Very common herb with pinkish heads.

173. V. **conyzoides** Wight.=*V. candolleana* W. & A. (55). A bigger plant very variable for its leaf and colour of the flower. Fls. Aug.-Jan.

174. **Pulicaria crispa** Benth. (130). A small pubescent herb. Heads minute, leaves toothed. Fls. Dec.-April.

175. **P. wightiana** Clarke. (263). Profusely branched herb, fls. throughout the year.

176. **Eclipta prostrata** Linn.=*E. alba* (L.) Hassk. Common. Fls. July-Jan.

177. **Blainvillea acmella** (Linn. f.) Philipson.=*B. rhomboidea* Cass.= *B. latifolia* L. (66,155). A common herb on the banks of the lake Leaves very variable. Fls. during rainy season.

178. **Glossocardia bosvallea** DC.=*G. linearifolia* Cass. (179). A small prostrate annual herb with much dissected leaves. Fls. Sept.-Nov. Rare.

179. **Bidens biternata** (Lour.) Merr. & Sherff.=*B. pilosa* Linn.=*B. wallichi* DC. (70). An erect herb with much-lobed leaves. Fls. Aug.-Dec.

180. **Tridax procumbens** Linn. (4,58). Fls. throughout the year.

181. **Sonchus asper** Hill. (53). Fls. Nov.-Dec.

182. **Launaea nudicaulis** Hk. f. (219). A perennial undershrub. Fls. Sept.-Feb.

183. **Cnicus wallichii** DC. (73,334). A common spiny herb on the slopes of the hills. Head a cottony ball of 1-1½″ diam. Fls. Dec.-May.

PRIMULACEAE

184. **Anagallis arvensis** Linn. (29). A small herb with fleshy leaves. Fls. Jan.-Apr.

OLEACEAE

185. **Jasminum multiflorum** (Burm. f.) Andr.=*J. pubescens* Willd. Ornamental.

Sapotaceae

186. **Achras sapota** Linn. Chikku. Cultivated.

Salvadoraceae

187. **Salvadora persica** Linn. Fls. March-June. Rare.
188. **S. oleoides** Decne. Fls. Feb.-June.

Apocynaceae

189. **Lochnera pusilla** K. Schum.=*Vinca pusilla* Murr. (62,63,287). A small herb with white hypocrateriform corolla. Fls. Aug.-Sept. Very rare.

190. **L. rosea** Reichb.=*Vinca rosea* var. *alba* Linn. Ornamental, runs wild.

191. **Nerium indicum** Mill. In gardens. A few plants were observed near marshy locality. Appears to be self sown.

Other cultivated species include, 192. **Thevetia peruviana** (Pers.) K. Schum. 193. **Plumeria rubra** Linn. forma **acutifolia** (Poir.) Woodson. 194. **Carissa carandas** Linn. 195. **Ervatamia coronaria** Staf.

Asclepiadaceae

196. **Calotropis procera** R. Br. Common.

197. **Pergularia daemia** (Forsk.) Chiov.=*Daemia extensa* R. Br. (335). A perennial climber. Flowers yellowish green, tinged pink at base. Oct.-Feb.

198. **Leptadenia pyrotechnica** (Forsk.) Decne.=*L. spartium* Wight. Khimp. Common.

199. **Ceropegia bulbosa** Roxb. (183). Common. Fls. Sept.-Feb.

200. **Cryptostegia grandiflora** R. Br. Common.

Boraginaceae

201. **Cordia dichotoma** Forsk. f.=*C. myxa* Linn. (38,44). A small tree with white clustered flowers Aug.-Dec. On gravelly soil.

202. **C. rothii** Roem. Goyandi. (339). Planted. Fls. hot season. Frt. edible.

203. **Coldenia procumbens** Linn. (14,16). An annual grey, hairy herb, procumbent, close to water margin of the lake. Fls. from July-Sept.

Note: Nairne (1894) described it to be common weed of the cold season in western India. But in the area under consideration they are abundant in rainy season. In cold season they die away.

204. **Heliotropium subulatum** Hochst. (237). An erect annual hispid herb. Leaves sessile, lanceolate, 2″ long spike, branched. Fls. sessile, Oct.-Nov.

205. **H. paniculatum** R. Br. (129). An erect herb, leaves 1½″ long, linear. Fls. pedicellate. Spikes 2″ long terminal.

206. **H. strigosum** Willd. (128). A small procumbent, hispid herb. Leaves minute, ½″ long, linear. Fls. shortly pedicellate; nutlets 4, hairy.

207. **H. eichwaldii** Steud. (172). An erect herb, branching from base. Leaves oval thick. Spikes 2″ long, helicoid, terminal.

208. **H. supinum** Linn. (332). A villous herb, spreading, densely clothed with soft hairs. Flowers in short, axillary silky spikes; on the sloping banks of the lake. Fls. Jan.-Mar.

209. **Trichodesma indicum** R. Br. (59). Much-branched erect herb. Flowers pale blue. Leaves gland-dotted.

210. **T. amplexicaule** Roxb. (60). A smaller herb with brownish white flowers and longer lanceolate thicker leaves. Fls. Aug.-Oct.

Convolvulaceae

211. **Cuscuta reflexa** Roxb. (42). A common parasite of *Adhatoda*. Fls. Sept.-Jan.

212. **C. hyalina** Roth. (113,115). Parasatic on *Tephrosia*, *Trianthema*, *Tribulus*, *Amaranthus*, *Acalypha*, and *Commelina*. Common after the rains.

213. **Evolvulus alsinoides** Linn. (105,106). A diffused perennial herb, branches many, villous. Fls. blue. Corolla subrotate. Fls. Aug.-Dec.

214. **Convolvulus pluricaulis** Chois. var. **macra** Clarke (304). A diffused hairy herb, branches suberect, densely silky. Fls. solitary or in groups of threes, white with rosy tinge. Fls. twice a year.

215. **Ipomoea pilosa** Sweet. (152). A hairy climber ; flowers pink,

the lower surface of the leaf white and upper brown and silky. Fls. Sept.-Oct.

216. **I. nil** (Linn.) Roth. J.=*I. hederacea* auct. non. Jacq. (151). A twining herb sparsely hairy. Leaves deeply 3-lobed. Peduncle 1-flowered. Fls. blue tinted pink.

217. **I. pes-tigridis** Linn. (215). Twining pubescent herb. Frt. enclosed in densely hairy calyx. Leaves deeply five-lobed. Common after rainy season. Fls. white.

218. **I. rumicifolia** Chois. (217). Suberect herb, leaves hastate, petioles 2″ long, Corolla campanulate ½″ or some times more in diameter.

The cultivated members include, 219. **I. pes-caprae** (Linn.) Sweet.= *I. biloba* Forsk. 220. **I. batatas** Poir. 221. **Argyreia** sp.

Solanaceae

222. **Solanum xanthocarpum** S. & W. (26,140,227). Spiny shrub with purple corolla, stamens yellow.

223. **S. nigrum** Linn. Makoi. (323). A common weed. Fls. white, Dec.-Mar.

224. **Physalis minima** Linn. (157). Common in rainy season.

225. **Datura metel** Linn. var. **alba** Clarke. A common shrub.

226. **Lycium europaeum** Linn. (249,251). A thorny shrub, 8-10 ft. Fls. Oct.-Dec.

227. **Withania somnifera** Dunal. Aswagandh. A common undershrub. Fls. almost throughout the year.

The following species are cultivated: 228. **Lycopersicum esculentum** Mill. 229. **Nicotiana tabacum** L. 230. **Capsicum frutescens** L. 231. **Solanum melongena** L. 232. **Cestrum nocturnum** L. 233. **Petunia** sp.

Scrophulariaceae

234. **Anticharis linearis** Hochst. (264). A small herb, appears to be perennial, fls. purple, in Aug.-Oct. and Feb.-March.

235. **Verbascum coromandalinum** (Vahl.) Ktze.=*Celsia coromandalina* Vahl. (174,236). An annual shrub with yellow, spurred flowers. Common on the bank of the lake and moist places during the rainy season.

236. **Striga gesneroides** (Willd.) Vatke.=*S. orobanchoides* Benth. (74). A root parasite on *Euphorbia nivulia*. Common after the rains up to Dec.

237. **Kickxia ramosissima** (Wall.) Janchen.=*Linaria ramosissima* Wall. (137). A prostrate herb. Common in crevices of rocks. Fls. Nov.-Jan.

238. **Lindenbergia indica** (L.) Ktze.=*L. urticaefolia* Lehm. (89,90). In gravelly ground and old mud walls of the villages. Flowers during rainy season; very rare in cold months.

239. **L. machrostachya** Benth. (91). A small herb, branching from the rootstock. Leaves reddish and smaller than the previous species. Fls. Aug.

240. **Bacopa monnieri** (L.) Pennel.=*Herpestris monniera* Benth. (205, 206). Succulent herb near water-logged areas. Fls. Jul.-Dec. rarely Feb.-Mar.

Bignoniaceae

241. **Tecoma undulata** G. Don=*Tecomella undulata* Seem. Fls. March-Apr.

242. **Kigelia pinnata** DC. and 243. **Millingtonia hortensis** Linn. are cultivated.

Pedaliaceae

244. **Martinia annua** Linn.=*M. diandra* Glox. (146,148). A shrub known for its characteristic fruit. Leaves very large, more than a foot in length. Generally found on rubbish heaps. Fls. Aug.-Sept.

245. **Sesamum indicum** DC. (68,69). A common herb. Fls. and frt. Aug.-Oct. Cultivated and wild.

Acanthaceae

246. **Dipteracanthus patulus** (Jacq) Nees.=*Ruellia patula* Jacq. (11, 47). A small shrub on gravelly soil. Common. Fls. Aug.-Dec.

247. **D. prostratus** (Poir.) Nees=*Ruellia prostrata* Poir. var. *dejecta* Clarke. (144). An undershrub with longer internodes. Fls. Aug.-Dec.

248. **Andrographis echioides** Nees. (163). Fls. Jul-Nov.

249. **Barleria prionitis** Linn. (98,183). A spiny undershrub with long internodes and yellow flowers. Common in gravelly places, road sides, and hills. Fls. Sept.-Feb.

250. **B. acanthoides** Vahl. (336). Smaller herb with short internodes and broad oval leaves. Fls. Dec.-Jan.

251. **Lepidagathis hamiltoniana** Wall. (143). A spiny undershrub with spherical heads at lower nodes. Fls. Nov.-Jan.

252. **Justicia simplex** D. Don. (21). An erect herb with small linear leaves. Fls. Sept.-March.

253. **J. diffusa** Willd. (22,75,76). Common after the rainy season.

254. **Peristrophe bicalyculata** Nees. (43). A shrubby weed. Common after the rainy season. Fls. Oct.-Dec.

255. **Adhatoda vasica** Nees=*Justicia adhatoda* L. (6). Common in hills. Fls. Nov.-March. Generally attacked by *Cuscuta reflexa.*

Verbenaceae

256. **Phyla nodiflora** (Linn.) Greene.=*Lippia nodiflora* Mich. (18, 139). A diffusely branched prostrate herb, rooting at nodes. Heads globose. Abundant on the water margin. Fls. Oct.-Jan.

257. **Lantana indica** Roxb. (329). Fls. Jan.-Feb. Rare, on hills.

258. **Clerodendrum phlomidis** Linn. A rare plant. We could not find this plant in flowering.

Labiatae

259. **Ocimum basilicum** Linn. Marva. (337). Ornamental.

260. **O. sanctum** Linn. Cultivated and self-sown.

261. **O. americanum** Linn.=*O. canum* Sims. Bapchi. (104,124,125). An undershrub. Most common on the slopes of the hills, after the rainy season.

262. **Leucas urticaefolia** R. Br. (194,196). A small annual herb. Leaves 1″ broad, toothed. Fls. Sept.-Dec.

263. **L. cephalotes** Spreng. (199). Diffusely branched herb. Leaves longer 3″. Flower head bigger; on slopes of hills.

264. **L. ciliata** Benth. (200). A small hairy herb with woody base.

265. **L. aspera** Spreng. (197). Leaves linear, 2″ long. Bracts provided with bristles. Common in plains.

266. **Salvia aegyptiaca** Linn. (97,171). A small undershrub. Aug.-Jan.

NYCTAGINACEAE

267. **Boerhavia diffusa** Linn. (12,154). Fls. Aug.-March.

268. **B. repanda** Willd. (277,282). A glabrous herb. Rare.

269. **B. verticillata** Poir. (153). A decumbent sometimes climbing shrub, leaves broader than the above two species. Perianth white. Fls. Sept.-Jan.

The garden plants include: 270. **Mirabilis jalapa** Linn. 271. **Bougainvillea spectabilis** Willd.

AMARANTHACEAE

272. **Celosia argentea** Linn. (20,22). Spikes very variable.

273. **Digera muricata** (L.) Mart.=*D. arvensis* Forsk. (244). Rare.

274. **Amaranthus spinosus** Linn. Common in waste places and near ponds.

275. **A. gangeticus** Linn. An erect stout herb. Stem grooved. Bracts membranous exceeding perianth. Stamens three only.

276. **A. viridis** Linn. (235). A much-branched glabrous herb. Leaves notched at the apex. Bracts shorter than the perianth. A common weed. Leaves eaten.

277. **A. polygamus** Linn. var. **angustifolia.** (16). Common prostrate weed, leaves 2-lobed at the apex, rigid, stamens 3. Frt. ovoid. Fls. Nov.-March.

278. **Aerua javanica** (Burm. f.) Spreng.=*A. tomentosa* Forsk. (234). Common.

279. **Achyranthes aspera** Linn. (23). A common monsoon weed in bushes. Fls. after rainy season.

280. **Alternanthera triandra** Lamk.=*A. sessilis* (L.) R. Br. (52,56). Common on the water margin.

281. **Pupalia lappacea** Moq. (25). Common in bushes. Fls. Aug.-Jan.

CHENOPODIACEAE

282. **Chenopodium album** Linn. Bathua. (13). Common herb of winter.

283. **C. murale** Linn. (15). Common in cold season. Spikes shorter.

284. **Beta vulgaris** Linn. 285. **Spinacia oleracea** Linn. and 286. **Basella rubra** Linn. are cultivated.

Polygonaceae

287. **Calligonum polygonoides** Linn. Phog. A common leafless shrub of the plain ground. The bushes are covered with pinkish-white flowers in April.

288. **Polygonum plebejum** R. Br. var. **brevifolia** (10). A prostrate herb. Rootstock woody, branches grooved. Internodes very short concealed by leaves and stipules. Flowers sessile, Jan.-May.

289. **P. indicum** Heyne=*plebejum* var. *indica* (54). Branches spreading all round. Internodes shorter than the leaves, 2-3 flowers in the axils.

290. **P. effusum** Meissn.=*P. plebejum* var. *effusa* (9). A slender herb, internodes longer, fls. pedicellate, Dec.-Feb. Common near ponds.

291. **P. barbatum** Linn. (38,39). A stout annual herb. Stipules strigose, mouth with cilia exceeding the tube. Common in marshes and ditches.

292. **Antigonon leptopus** Hook. and 293. **Rumex hastatus** D. Don. are cultivated.

Aristolochiaceae

294. **Aristolochia bracteata** Retz. (134,202). A decumbent or very rarely climbing glabrous herb. Fls. solitary. Perianth tube cylindric with trumpet mouth, dark purple. Common in bushes. Fls. Aug.-Nov.

Euphorbiaceae

295. **Euphorbia parviflora** Linn.=*E. hypericifolia* L. var. *parviflora* Prain. (119,257). A decumbent herb, branching at base. Leaves glabrous on both sides. Fls. Aug.-Nov. and Feb.-Apr.

296. **E. hirta** Linn.=*E. pilulifera* L. (41,130). A common ascending herb clothed with yellowish hairs. Stem 4-angled, leaves dark green above, pale beneath. Flowers greater part of the year.

Note: Blatter, McCann, & Sabnis (1929) listed *E. hirta* and *E. pilulifera* as two separate species.

297. **E. thymifolia** Linn. (17). A small prostrate hispid herb with a copper-tinged stem. Leaves obtuse, near each other. Common in gravel.

298. **E. microphylla** Heyne. (343). Stems spreading from the root and dichotomously branched; pale and brittle. Leaves as long as broad stipules minute styles deeply bifid.

299. **E. clarkeana** Hk. f. (325). Leaves longer, stipules larger, seeds rugose pale brown. Common.

300. **E. nivulia** Buch.-Ham. A large shrub. Branches fleshy and cylindrical with pairs of sharp spines. Common. Fls. Feb.-March.

301. **Phyllanthus niruri** Linn. (218). An erect glabrous herb. Stems angular, leaves sub-sessile, flower axillary. Common weed of cultivated places.

302. **P. urinaria** Linn. (13,19). A weed herb. Branches very few at the top; leaves sessile, pale beneath. Rare.

303. **Emblica officinalis** Gaertn.=*Phyllanthus emblica* Linn. Cultivated.

304. **Securinega leucopyrus** Willd.=*Flueggea leucopyrus* Willd.= *Securinega obovata* (Willd.) Pax & Hoffm. (265). Common. Fls. Sept.-Nov.

305. **Acalypha ciliata** Forsk. (1,115). A stout herb. Branches few, leaves finely serrate, petiole longer than blade, bracts crowded. Fls. Aug.-Oct.

306. **Ricinus communis** Linn. Cultivated and wild.

Moraceae

307. **Ficus glomerata** Rox. Gular.

308. **Morus alba** Linn., 309. **Ficus benghalensis** Linn., 310. **F. religiosa** Linn., 311. **F. carica** Linn., and 312. **F. krishnae** C. are cultivated.

Hydrocharitaceae

313. **Vallisneria spiralis** Linn. (48,239). Common hydrophyte. Leaf size very variable. Fls. Nov.-Dec.

314. **Hydrilla verticillata** Presl. (33,34,101,102,108). A submerged water plant; leaf very variable in shape and size.

315. **Lagarosiphon roxburghii** Benth. (328). Submerged herb, stem filiform, upper branches floating. Leaves sessile, opposite. Common in lake.

ORCHIDACEAE

316. **Zeuxine sulcata** Lindl. (327,328). An erect fleshy terrestrial herb of marshy places, 6-8" high, leaves sessile, linear, acuminate, 2½" long, flowers white in dense raceme, Jan.-Feb.

SCITAMINAE

317. **Canna indica** Linn. (35), 318. **Zingiber officinale** Rosc., and 319. **Musa sapientum** Linn. (two varieties) are cultivated.

AMARYLLIDACEAE

320. **Crinum asiaticum** Linn., and 321. **Agave** spp. are cultivated.

DIOSCOREACEAE

322. **Dioscorea bulbifera** Linn. Cultivated.

LILIACEAE

323. **Asparagus racemosus** Willd. Satavar. (133). On hills. Fls. hot months.

324. **Asphodelus tenuifolius** Cav. Fls. Feb.-March.

325. **Allium cepa** Linn., 326. **A. sativum** Linn., and 327. **Aloe barbadensis** Mill.=*A. vera* Linn. are cultivated.

COMMELINACEAE

328. **Commelina benghalensis** Linn. (149,258). A glabrous herb. Fls. Sept.-Nov.

329. **C. obliqua** Buch.-Ham. (61,288).

330. **C. wightii** Raizada=*C. glabra* Clarke. (85,284). Narrow lanceolate leaves, fls. solitary, axillary, pale brown. Aug.-Sept.

331. **C. suffructicosa** Bl. (86). Very rare.

332. **C. salicifolia** Roxb. (285). Becomes dark brown on drying. Fls. Sept.-Dec.

333. **C. nudiflora** Linn. (180,230,274). Frequent.

334. **Cyanotis axillaris** Schult. (158). Leaves pink, fls. solitary axillary.

PALMAE

335. **Phoenix sylvestris** Roxb. Cultivated.

PANDANACEAE

336. **Pandanus tectorius** Soland. ex Parkinson=*P. odoratissimus* Roxb. Cultivated.

TYPHACEAE

337. **Typha angustata** Chaub. (127). A herb 5-6 feet, nearly half beneath water. Monoecious; catkins very large, upper bigger half male yellowish, lower half female brownish. Abundant in marshy places and irrigation canals.

ARACEAE

338. **Pistia stratiotes** Linn. A few plants floating in ponds and puddles, leaves broadly rounded retuse. In cold months they were found decaying; flowers could not be observed.

339. **Colocasia** sp. Cultivated.

NAIADACEAE

340. **Potamogeton indicus** Roxb. Common in lake and puddles.

341. **Aponogeton monostachyon** Linn. Rare.

CYPERACEAE

342. **Cyperus arenarius** Retz. (82). A small sub-erect herb of plains and moist places, branching from the rootstock. Fls. Dec.-Feb.

343. **C. niveus** Retz. (126). Many white spikes gathered in the form of a star on a one foot long peduncle. Common around lake.

344. **C. eleusinoides** Kunth. (84,289). 1½-2 ft. high stem arising from a perennial rootstock, 3-angled. Many axillary spikes arise at the top. Abundant in marshy places along with *Typha*. Fls. Aug.-Dec.

345. **C. rotundus** Linn.

346. **C. compressus** Linn. (331). A small herb in the form of tufts. In moist places. Fls. Dec.

347. **Fimbristylis diphylla** Vahl var. **annua** Clarke. (211,306). Herb 1 ft. high. Spikes ¼″, red, oval. Fls. Aug.-Oct.

348. **F. squarrosa** Vahl. (349). Annual. Leaves about half the length of the stem, ligule squarrose. Style 2-fid, base with many long hairs.

349. **Kylinga triceps** Roxb. (77). A sub-erect herb, 6″, many stems arising from a bulbous rootstock. Inflorescence 3-lobed, with 3 linear leaves.

Gramineae

350. **Bothriochloa pertusa** (Linn.) A. Camus = *Andropogon pertusus* Willd. var. *insculptus*. (338). An erect annual grass, nodes bearded, 3-4 purple spikes in a spathe silky. Awn of 4 glumes ½″ long.

351. **Cenchrus setigerus** Vahl = *C. biflorus* Roxb. (81). An erect grass 6″ long. Inner bristles of the flower short. Common in plains.

352. **C. barbatus** Schum. = *C. catharticus* Del. A tufted grass, leaf sheath inflated, inner bristles long and spinescent.

353. **C. prieurii** (Kunth.) Maire. = *Pennisetum prieurii* Kunth. (346). Spikes short, similar to *P. cenchroides* but leaves long with filiform tip.

354. **Setaria verticillata** Beauv. (72). An annual grass.

355. **Paspalum paspaloides** Camus. = *Panicum paspaloides* Pers. A tall grass, rachis flat. Spikelets biseriate, glabrous. Spikes longer than internodes.

356. **Bracharia ramosa** (L.) Stapf. = *Panicum ramosum* Linn. (75). Stem ascending from a creeping base. Rachis narrow, first glume shorter than the 3rd, five-nerved.

357. **B. reptans** (L.) Gard. & Hubbard = *Panicum prostratum* Lamk. (75). Similar, with shorter leaves, 1st glume only ¼ of the third glume. Stems branching at most of the nodes.

358. **Paspalidium punctatum** (Burm. f.) A. Camus = *Panicum punctatum* Burm. (321). Perennial erect grass. Inflorescence 6-12″ long, spikes 20, fls. ovoid, pale. Common in wet places.

359. **P. antidotale** Retz. Tall branching panicle large, spikelets short ovoid, clustered.

360. **Rhynchelytrum villosum** Chior. = *Tricholaena teneriffae* Parlat. (78). Leaves convolute rigid, spikes open, spikelets ¼″, purplish white, silky with spreading hairs.

361. **Digitaria sanguinalis** Scop. (339). Rare annual. First glume ciliate.

362. **Melanocenchrus royleana** Nees var. **plumosa** Raizada & Jain. (83). A tufted annual grass, spikelets 2-flowered. Fls. Dec.-Feb.

363. **Cynodon dactylon** Pers. (342). Common.

364. **Chloris inflata** Link. = *Chloris barbata* Sw. (319). A common perennial grass. Stem stout tufted leafy at the base. 10-15 sessile spikes 2½″ long.

365. **Dactyloctenium scindicum** Boiss. = *Eleusine aristata* Ehr. (241). A common grass of the plains, 6-10″ high, spikes 3-4 (½″). Fls. Aug.-Feb.

366. **D. aegypticum** Willd. = *Eleusine aegyptiaca* Desf. (345). Stem longer than the above species, nodes swollen, spikes 4-6, longer 1-1½″.

367. **Aristida mutabilis** T. & R. (80). Annual. Common spikelets ¼″, 1st and 2nd glumes shortly awned, 3rd has long awn.

368. **A. setacea** Retz. (317). Perennial. Spikelets ½″, 1st and 2nd glumes long awned.

369. **Eragrostis tremula** Hochst. (248). Panicle diffused, spikelets pinkish white. Common.

370. **E. tenella** R. & S. var. **plumosa** Stapf. Stem prostrate, spikes long. Spikelets 3-5 flowered. Common.

371. **Erianthus munja** Roxb. Jesweit = *Saccharum munja* Roxb. Common.

The following species are cultivated: 372. **Saccharum spontaneum** Linn. 373. **S. officinale** Linn. 374. **Bambusa** spp. 375. **Sorghum vulgare** Pers. 376. **Pennisetum typhoideum** Rich. 377. **Zea mays** Linn. 378. **Hordeum vulgare** Vill.

Ephedraceae

380. **Ephedra foliata** Boiss. var. **ciliata** (C. A. May) Stapf.

Pteridophytes

381. **Actinopteris dichotoma** Bedd. (213). On hills in crevices of rocks.

382. **Adiantum** sp.

Bryophytes

383. **Riccia robusta**

384. **R. crystallina**

General Conclusion

The vegetation of the hill presents a very striking life form consisting of spiny *Euphorbia nivulia* and other thorny plants such as *Balanites aegyptiaca*, *Acacia senegal*, *Gymnosporia spinosa*, *Zizyphus* spp., *Barleria* spp., etc. Therefore this may be called a thorny scrub.

The vegetation on steep slopes of the hills is very sparse, whereas on the gentler slopes it is rich. This marked difference in the nature of the vegetation of the hills emphasises the importance of edaphic (soil depth) and topographical factors. Based on the rainfall Biswas and Rao (1953) divided Rajputana into three zones: the desert zone, the arid zone, and the semi-arid zone. The Aravalli ranges with their comparatively dense vegetation, when compared with the rest of Rajasthan, fall in the semi-arid zone. Mt. Abu, the highest peak in the Aravallis, receives a higher rainfall (62.49″ =158.72 cms.) than the rest of Rajasthan and the vegetation is richer in both density and number of species than western Rajasthan (cf. Blatter & Hallberg, 1918-1921; Mahabale & Kharadi, 1946), Harsh Nath (Nair & Nathawat, 1957), and the hills at Ajit Sagar. Mt. Abu with its high altitude favours the growth of some of the Himalayan species of the families Rosaceae, Salicaceae, Berberidaceae, and Ranunculaceae. These elements and the species characteristic of peninsular India, found at Mt. Abu, such as species of *Diospyros*, *Sterculia*, *Holarrhena*, *Plumbago*, *Spondias*, etc. are not found in Harsh Nath and the area under consideration. However the vegetation in Harsh Nath is much denser than Ajit Sagar. The difference may be attributed to several factors, primarily the water-supplying capacity of the soil. Where a shallow soil cover lies over a porous and strong substratum drought is felt almost all round the year and if the rainfall is low a dry scrub develops as in Ajit Sagar hills which are dry almost eight months of the year so that only those species which can withstand drought can grow. Therefore the plants growing there develop characters designed to meet the environmental conditions and it may not be surprising, then, that a large number of plants growing there have similar characters that enable them to pass readily the adverse conditions. This may account for the predominance of thorny scrub on the hills. Where the soil is deeper and less rapidly depleted of soil moisture or the loss of water is compensated in the form of occasional rains the incidence of drought may be seasonal and a forest can develop as in Mt. Abu. These considerations lead to the conclusion that the distribution of vegetation in the different parts of Aravalli ranges is controlled by soil moisture, which, of course is affected by climate, soil, and topography. They can therefore be described as edaphoclimatic climax. The influence of biotic factors also cannot be overlooked. The plant coverage and their gregariousness are affected by grazing and cutting.

It has been considered at various quarters that the simpler vegetation not only of the Aravallis but the whole of Rajasthan is the deterioration product of a rich vegetation. There has been some speculations as to whether the degradation is due to increasing climatic adversities or operations in the past of the various factors resulting in the deterioration of richer communities. According to Wadia (1954) the whole of Asia is undergoing dessication. He states that Rajasthan was a fertile tract with rich vegetation about 2500 years ago. The main reason he considers for the desertification is the change in climate leading to a very low rainfall. Joshi (1956) considers that the luxuriant growth of vegetation during the rainy season supports the hypothesis of Wadia. The following observations will be of interest in this connection: (a) The richer communities of eastern Rajasthan gradually become thinner and thinner towards the west. (b) The simpler communities could be derived by the elimination of a few species characteristic of complex ones. (c) Simpler communities show occasional occurrence of species of complex ones. (d) The vegetation of the southern region of the Aravalli ranges is more complex than those in the north. These considerations bear testimony to prove that the simpler associations are the deterioration product of a climatic climax vegetation.

The families having five or more genera are Malvaceae (5), Asclepiadaceae (5), Solanaceae (5), Cucurbitaceae (6), Scrophulariaceae (6), Acanthaceae (7), Amaranthaceae (7), Compositae (11), Leguminosae (14), and Gramineae (15). The last three families are the most dominating as is also the case in Pilani, Chirawa, Harsh Nath, and western Rajasthan. The Cyperaceae which occupy the fourth place in W. Rajasthan are poorly represented as is also the case in E. Rajasthan. The families having five or more species are Asclepiadaceae (5), Polygonaceae (5), Labiatae (6), Solanaceae (6), Cucurbitaceae (7), Scrophulariaceae (7), Commelinaceae (7), Mollugineae (8), Convolvulaceae (8), Tiliaceae (9), Boraginaceae (9), Cyperaceae (8), Malvaceae (10), Acanthaceae (10), Amaranthaceae (10), Euphorbiaceae (10), Compositae (13), Gramineae (22), and Leguminosae (29). The families Leguminosae, Gramineae, Compositae, Euphorbiaceae, Amaranthaceae, and Malvaceae constitute about two-fifths of the flora.

The various genera are poorly represented. The largest genera having 5 or more species are *Indigofera* (5), *Heliotropium* (5), *Cyperus* (5), *Euphorbia* (6), *Commelina* (6), and *Tephrosia* (7). The relatively good representation of *Commelina* is remarkable.

In general 3 distinct elements, namely western (African-Persian), eastern (Malayan), and Indian can be distinguished in the flora of Ajit Sagar. Of the three elements western is represented by 83 and eastern by 33 species. The eastern is a little more than one third of the western. In western Rajasthan the eastern element is only one seventh

of the western. This shows the greater proportion of eastern element in Ajit Sagar. Blatter and Hallberg (1918-1921) and Biswas and Rao (1953) supported the suggestions of Drude that the line of demarcation between the Indo-malayan flora and the Perso-arabian flora ranges from the Gulf of Cambay northwards along the Aravallis. If it is true, one would expect a mingling of western and eastern elements in equal proportions. The dominance of western elements in Lohargal, Harsh Nath, and Ajit Sagar indicates that the line of demarcation should be sought more towards the east. However, more intensive studies of the various parts of the Aravallis are necessary before a final conclusion can be arrived at.

Summary

The various associations found around Ajit Sagar lake area are described. The vegetation on the hills is regarded to be a thorny scrub. The poor vegetation is attributed to the limited water supplying capacity of the soil, and the existing vegetation is considered to be the deterioration product of a climatic climax vegetation.

Of the 384 plants listed, 379 are angiosperms which include 126 cultivated and 253 indigenous plants. Leguminosae, Compositae, and Gramineae are the most dominating families. The largest genera include *Indigofera*, *Helliotropium*, *Cyperus*, *Euphorbia*, *Commelina*, and *Tephrosia*.

Three elements, western, eastern, and Indian, can be distinguished in the flora. The western element predominates over the eastern element. The eastern type is only a little more than one-third of the western.

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On the Parakeet *Psittacula intermedia* (Rothschild) [Aves : Psittacidae]

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Zoological Survey of India, Calcutta

Psittacula intermedia was described by Rothschild (1895) on a single trade skin shipped to him from Bombay. He accepted it as an Indian bird. Later, he obtained six more specimens from one Mr. Dunstall, a plumassier of London. Hartert (1924, p. 126) in his account of these specimens stated that these six skins were selected from a greater number of these birds.

Owing probably to the rarity and uncertain locality *Psittacula intermedia* did not receive the attention it deserves in Indian ornithology. Both Rothschild's and Hartert's papers had apparently been overlooked by subsequent workers on Indian ornithology, and the species found no place in any work of such eminent ornithologists as Blanford, Stuart Baker, Ticehurst, and Whistler. Nevertheless, we find it resuscitated, without locality, by Peters (1937, p. 246).

The problems created by this bird are many and somewhat intriguing. I have made an attempt here to determine its status, its affinities, and the possible place of its occurrence.

Rothschild (loc. cit.) pointed out that *Ps. intermedia* is somewhat intermediate between *Ps. schisticeps* (=*himalayana*[1]) and *Ps. cyanocephala*[2]. There appear then two possibilities as to its status:

(1) that it is a hybrid between *Ps. himalayana*/*Ps. finschi* and *Ps. cyanocephala*/*Ps. roseata*, produced by nature or by man; and

(2) that it is a genuine species wild at some unknown locality.

Regarding the possibility of its being hybrid, Rothschild (loc. cit.) has expressed the opinion that it is not a hybrid, and Hartert (loc. cit.) has stated: 'If it were a hybrid, so many specimens would not very

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[1] *Psittacula himalayana*, as hitherto understood, has recently been shown by Husain (1959) to be composed of two separate species, *Ps. himalayana* and *Ps. finschi*.

[2] *Psittacula cyanocephala* has subsequently been shown by Biswas (1951, pp. 1-6) to be composed of two species, *Ps. cyanocephala* and *Ps. roseata*.

likely have come at the same time, and one would expect them to vary, but they are all alike.' Indeed, I have independently come to the same conclusion after an examination of all these specimens. Besides, if they were man-made hybrids, they would necessarily have been cage birds. But the character of their toes does not indicate this. *Psittacula intermedia* may, therefore, be regarded as a genuine wild species.

It is necessary to record here a few words about the known specimens of *Ps. intermedia.* Including the type only seven specimens of the species are believed to exist, and they are all housed in the Rothschild Collections of the American Museum of Natural History, New York. None of the specimens is sexed but, from coloration, six of them appear to be exceedingly similar adult males, while the seventh (A.M.N.H. No. 621545) is an immature specimen, being green all over, and its sex cannot be guessed. Incidentally, it may be added that this specimen has as long a wing as that of the longest-winged male specimen, and it matches well with immature examples of *Ps. himalayana,* both in coloration and in size. I am thus led to consider it an immature specimen of *Ps. himalayana,* which brings down the total number of known specimens of *Ps. intermedia* from seven to six.

All the specimens are in more or less fresh plumage. In one (A.M.N.H. No. 621544) the central tail feathers still show the sheaths at their bases. The post-juvenile moult in another specimen (A.M.N.H. No. 621542) is almost finished. Its body feathers are all very fresh, its wings and tail are in moult, and its head has new red and blue feathers with some greenish towards their centres. A third specimen (No. 621543) is a trifle different from the other specimens in having very little yellow on the tips of its central rectrices, and more green than verdigris on the rump.

As has already been stated by Rothschild and by Hartert, *Ps. intermedia* is intermediate between *Ps. himalayana*/*Ps. finschi* and *Ps. cyanocephala*/*Ps. roseata.* A careful comparison of the five species shows that *Ps. intermedia* shares characters with the four other species as presented in Table 1. It would appear from the above that if coloration alone is considered *Ps. intermedia* is closer to *Ps. cyanocephala*/*Ps. roseata* than to *Ps. himalayana*/*Ps. finschi* (*contra* Rothschild). However, taking into consideration the size factor (Table 2) also, I am inclined to agree with Rothschild that *Ps. intermedia* is nearer *Ps. himalayana*/*Ps. finschi.* Furthermore, the conglomeration of characters among the five species, as presented in Table 1, suggests that they are genetically related.

TABLE 1.

SHARING OF CHARACTERS AMONGST THE MALES OF *Psittacula roseata*, *Ps. cyanocephala*, *Ps. intermedia*, *Ps. himalayana*, AND *Ps. finschi*.

	Ps. roseata	*Ps. cyanocephala*	*Ps. intermedia*	*Ps. himalayana*	*Ps. finschi*
Ps. roseata	A″, b, d	g, h, i	E, F	c, E, F	c
Ps. cyanocephala	g, h, i	A, e, f	B, C, D	B, D	B, D, e
Ps. intermedia	E, F	B, C, D	A′	B, D, E, F, G, H, I	B, D, G, H, I
Ps. himalayana	c, E, F	B, D	B, D, E, F, G, H, I	a	a, B, c, d, G, H, I
Ps. finschi	c	B, D, e	B, D, G, H, I	a, B, c, d, G, H, I	F/f

Explanation of symbols :

Crown : rich lilac (A), pale lilac (A″), intermediate (A′), slaty (a) ; verdigris collar : present (B), absent (b) ; rump : verdigris (C), green (c) ; under wing-coverts : verdigris (D), green (d) ; wing patch : darker red-brown (E), lighter red-brown (e) ; tips of central tail feathers : yellow (F), white (f), yellowish white (F/f) ; mandible : yellowish buff (G), blackish (g) ; wing size : large (H), small (h) ; bill size : large (I), small (i).

As to the place of occurrence of *Ps. intermedia*, nobody knows for certain where it occurs. Nor has any ornithologist ever seen this bird alive in nature. Rothschild thought that it occurs somewhere in the 'Western Provinces' of India, meaning western Himalayas, because

TABLE 2.—MEASUREMENTS IN MILLIMETRES OF *Psittacula roseata*, *Ps. cyanocephala*, *Ps. intermedia*, *Ps. himalayana*, AND *Ps. finschi*.

		Wing	Tail	Bill from cere
Ps. roseata				
Sikkim, northern Bengal, Assam, Burma (except Tenasserim)	30 ♂	135–150 (142.3)	152–198 (178.5)	16–20 (18.4)
	21 ♀	132–143 (138.0)	140–179 (157.7)	16–18.5 (18.0)
Ps. cyanocephala				
Himalayas from the Punjab to northern Bengal	15 ♂	143–150 (146.0)	195–253 (218.7)	18–19 (18.4)
	13 ♀	139.5–144 (143.2)	190–200 (196.3)	17–18 (17.6)
Ps. intermedia				
"India. Nat. Skim." TYPE	1 (♂)	157	—	20.5
"India." Other specimens	5 (♂)	148, 155, 155+156, 158	185, 202, 221	19, 20, 20, 21, 21
Ps. himalayana	23 ♂	162–174 (167.1)	172–270 (232.5)	21–23.5 (22.2)
Himalayas from Kashmir to Nepal.	10 ♀	155–166 (162.2)	175–231 (202.0)	20.5–22.5 (21.3)
Ps. finschi	16 ♂	148–156 (153.0)	244–270 (256.5)	22–23 (22.3)
Assam, upper Burma	5 ♀	143–149 (145.5)	225–251 (240.1)	21.5–23 (22.1)

Figures in parentheses represent average measurements.

along with the type 'came two skins of *P. schisticeps*' (=*himalayana*). Hartert believed that it 'evidently came from some part of the Himalayas, as it was accompanied by other Himalayan birds', and hinted at the possibility of its occurrence in the western Himalayas. On the label (Rothschild's Tring Museum label) of the type specimen, however, we read: 'India Nat. Skim.' This may be a slip meaning either 'native skin (a skin collected by a native) from India', or 'India, Native Sikim'—as present Sikkim used to be called by the British authorities in olden days to distinguish it from British Sikkim= Darjeeling district. In the latter case, it is impossible to know now whether the change in the locality of the type label was merely a

clerical error or written under instruction. It is possible that either Rothschild or Hartert, or both, had reasons to change their earlier opinion on the probable place of occurrence of the bird, but there does not appear to be any published account to corroborate this assumption. The labels of the other specimens simply bear 'India' as the locality.

Four species of *Psittacula*, namely *Ps. eupatria*, *Ps. krameri*, *Ps. cyanocephala*, and *Ps. himalayana*, occur in the western Himalayas (west of Kumaon), while as many as seven species, i.e. the four above-named species plus *Ps. roseata*, *Ps. finschi*, and *Ps. alexandri*, are found in the eastern Himalayas (Kumaon eastward). Competition among the species of *Psittacula* would, therefore, seem to be greater in the eastern Himalayas. However, the fact that the wing, tail, and bill are larger in *Ps. intermedia* than in *Ps. cyanocephala* and *Ps. roseata* may perhaps indicate that the former ranges to an altitude higher than the latter, and nearly as high as *Ps. himalayana*/*Ps. finschi*. Along the whole length of the Himalayas, in the altitudinal zone of approximately 1800-2400 metres, the only species of *Psittacula* known to occur are *Ps. himalayana* and *Ps. finschi*. Possibly, *Ps. intermedia* co-exists with either or both of them in this altitudinal belt where obviously competition among them is expected to be comparatively less than it is elsewhere. It is likely that the species has escaped the notice of ornithologists so far because of its probable localized distribution. Furthermore, great portions of the Himalayas, particularly the Assam Himalayas, remain yet to be faunistically explored.

Acknowledgements

I am indebted to the authorities of the American Museum of Natural History, the British Museum (Natural History), and the Bombay Natural History Society for giving me facilities to study their material. I am grateful to Professor Ernst Mayr, Professor J. L. Bhaduri, Dr. Sálim Ali, and Dr. K. K. Tiwari, who read an earlier draft of the manuscript of this paper, discussed the problems with me, and gave me the benefit of their mature advice on one point or the other; and to Dr. Dean Amadon who re-examined a specimen at my request and sent me his report.

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Some New Isopod Parasites on Fishes

BY

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(*With two plates*)

Introduction

In a preliminary investigation on the Isopod fauna of Bombay, the presence of three new species of parasitic Isopods was noted. A detailed description of their morphological features with suitable illustrations is given below.

1. **Argathona muræneae** sp. n.

Family: Corrallinidae.
Genus: *Argathona* Stebbing.
Host: *Muræna tessellata.*
Date: August 1956.
Collection: 9 females.

Description

Body ovate. Colour violet. Surface setose. Thoracic segments without any tubercles. Convex along the mid-dorsal line. Less than half as broad as long.

Cephalon and its appendages: (Pl. I, Fig. 1). The cephalon is more or less a triangular plate, though slightly broader than long. The base of the cephalon is comparatively straight while the lateral sides are broadly rounded and meet anteriorly in a very small rostral projection covering the base of the antennae. The surface of the cephalic segment is setose but not as thickly as the other body regions. Moderate eyes situated wide apart at the postero-lateral sides of the head.

Antennae (Pl. I, Figs. 2 and 3) are well developed. The first pair (Pl. I, Fig. 2) is extensible as far as the posterior margin of the first

thoracic segment. Its peduncle is well defined with three segments, and the flagellum with eleven to thirteen segments. Each segment of the flagellum carries a pencil of brush setae along the mid-anterior margin on the ventral aspect. The terminal segment, however, bears brush setae at its apex.

The second antenna (Pl. I, Fig. 3) is long and slender. It extends to the posterior margin of the third segment of the thorax. The peduncle and flagellum of the second antenna are well defined. First two joints of the peduncle are small, the third slightly longer but atrophied on the inner side, thus giving it a triangular appearance. The fourth and fifth articles are as long as the combined length of the first three articles and are more or less sub-equal to each other. The flagellum of the second antenna consists of thirty to thirty-four articles or segments. Each segment bears a thin pencil of setae on the ventral side. The terminal segment bears setae at the apex.

Mandibles (Pl. I, Fig. 4 *a* and 4 *b*) are strong, and their cutting edges thickly chitinised, retaining their brown colour even in permanent preparations. Left mandible (Fig. 4 *a*) is represented by a thin blade-like projection which is not serrate.

First maxilla (Pl. I, Fig. 5) has the outer joint strong, chitinised unguis, and a hook-like spine at the base.

Second maxilla (Pl. I, Fig. 6) is simple, short and lobe-like.

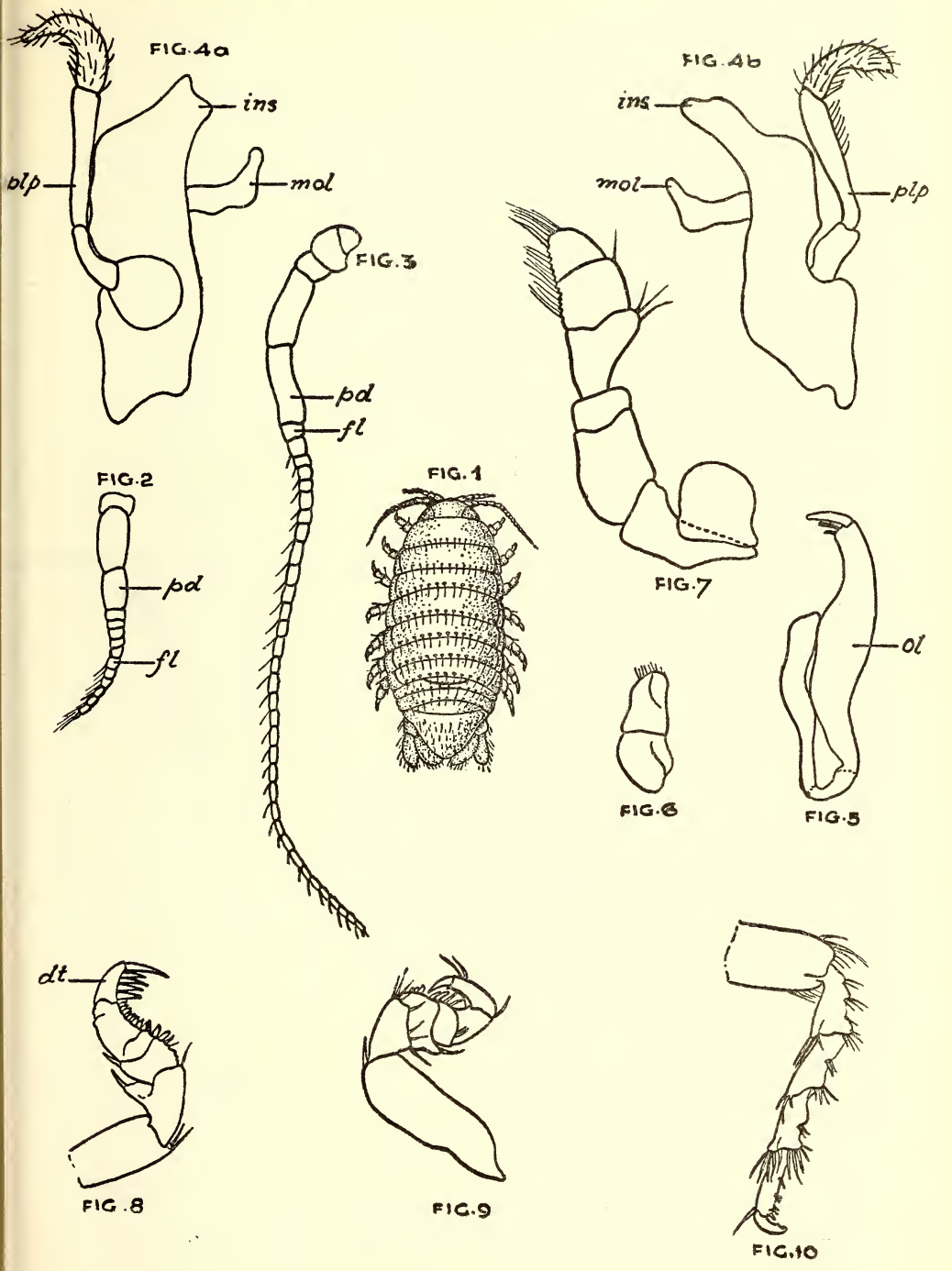
Maxillipeds (Pl. I, Fig. 7) with the last two joints setose along their inner margin towards the apex.

Thorax and its appendages: (Pl. I, Figs. 1, 8, 9, 10). Thorax is long and broad. Its surface is uniformly setose. The first thoracic segment is the longest of all. The second, third, and fourth segments are sub-equal and slightly shorter than the first. The fifth, sixth and seventh are shorter, the seventh being the shortest. The breadth of the thoracic segments goes on increasing up to the fourth thoracic segment which is broadest. Succeeding segments are slightly narrower.

Epimeral expansions of the thoracic segments are well defined, excepting those of the first one. The second and third segments have their epimera developed but not as much as in the succeeding segments.

First thoracic leg exhibits a dentate dactylus on the inner side, in addition to a strong terminal spine (Pl. IV, Fig. 8). The succeeding two legs are also dentate but on a smaller scale. Others are strong and thickly setose (Pl. IV, Fig. 9).

Abdomen and its appendages: (Pl. I, Fig. 1). Due to the bent nature of the body, the first abdominal segment is totally



Argathona muraeneae sp. n.

Fig. 1 : Adult female. Fig. 2 : First antenna, *fl*—flagellum, *pd*—peduncle. Fig. 3 : Second antenna, *fl*—flagellum, *pd*—peduncle. Fig. 4a 4b plp—plp : Left and right mandibles, *ins*—incisor, *mol*—molar. Fig. 5 : First maxilla, ol—outer lobe. Fig. 6 : Second maxilla. Fig. 7 : Right maxilliped. Fig. 8 : First thoracic leg. Fig. 9 : Second thoracic leg. Fig. 10 : Seventh thoracic leg.

FIG. 4

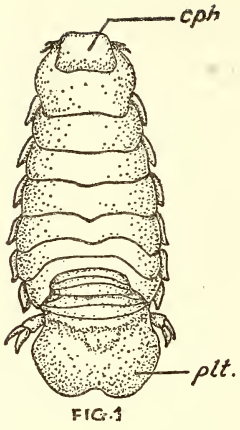


FIG. 1

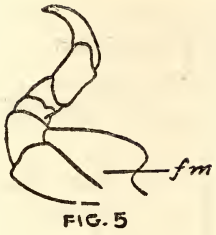


FIG. 5

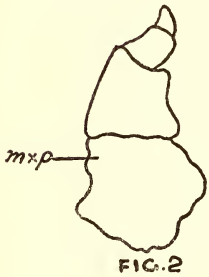


FIG. 2

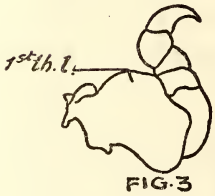


FIG. 3

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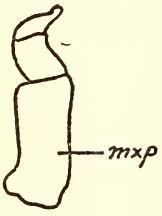

FIG. 10

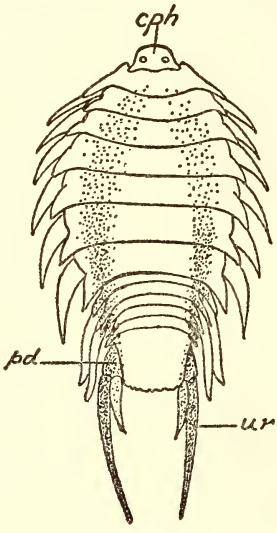

FIG. 6

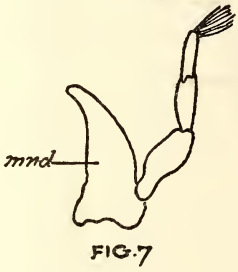

FIG. 7

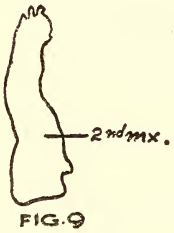

FIG. 9

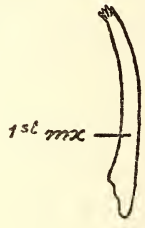

FIG. 8

SHIRGAONKAR

Cymothoa cinerea sp. n.

Fig. 1 : Adult female—*cph*—cephalon, *plt*—pleotelson. Fig. 2 : Maxilliped, *mxp*—maxilliped. Fig. 3 : First thoracic leg. Fig. 4 : Second thoracic leg. Fig. 5 : Seventh thoracic leg.

Nerocila pigmentata sp. n.

Fig. 6 : Adult female, *cph*—cephalon, *pd*—peduncle, *ur*—uropod. Fig. 7 : Right mandible, *mnd*—mandible. Fig. 8 : 1st *mx*—First maxilla. Fig. 9 : 2nd *mx*—Second maxilla. Fig. 10 : *mxp*—Maxilliped.

covered by the seventh segment of the thorax. Likewise, the second abdominal segment is also partially covered. The third is nearly as broad as the seventh thoracic segment. The fourth, which is equally broad, covers the fifth segment laterally. Excepting the first and the covered portion of the second, all the abdominal segments are setose.

Epimeral expansions of the abdominal segments are not defined but they can be recognised by their backward projections on the third and fourth segments.

The last abdominal (pleotelsonic) segment is bulged on each side of the mid-dorsal line in the anterior region. The telsonic region is triangular with rounded apex posteriorly. The telson is not thickly setose. The posterior margin of the telson and of the uropods is dentate with long and fine setae, sprouting out from the depression of the dentary.

Remarks

The gills and the buccal cavity of the fish *Muræna tessellata* was found infested with the aforesaid species of isopods. Their general appearance and body colour resembled the description of *Argathona normani* (Stebbing, 1905). However, they differed from it by their apparent parasitic habitat and the non-tuberculate nature of the thoracic segments and the telson. In view of this, this species is named here as *Argathona muræneae*.

2. **Nerocila pigmentata** sp. n.

Family: Cymothoidae.
Genus: *Nerocila* Leach.
Host: *Opithopterus turtoor* (dorsal side).
Date: May 1956.
Collection: Two ovigerous females.

Description

Body ovate and compact; broad (13 mm.) in the middle and broadly converging at the ends (length 21 mm.). Body colour beautiful yellow-grey. Presence of lateral dark violet bands running almost throughout the length of the body; becoming faint, sparse, and broad on the thoracic region, and deeply pigmented on the abdomen, peduncle of uropod, and its outer-ramus.

Cephalon (Pl. II, Fig. 6). Cephalon or head is broader than long and subquadrate. Its anterior margin is broadly rounded and

posterior trilobed. The median lobe is large and rounded and the side ones are small and angled. Eyes, situated in the postero-lateral angles of the head, are small. First pair of antennae does not reach the middle of the first thoracic segment and the second extends to the middle of the segment. Mandibles, maxillae and maxillipeds show the characteristic structure of the genus *Nerocila* (Richardson, 1905) (Pl. II, Figs. 8, 9, 10).

Thorax (Pl. II, Fig. 6). The length of the thorax is almost equal to its breadth at the 6th segment. First thoracic segment is 2½ times broader than long. Its anterior margin is trisinuate and posterior uniformly curved. The postero-lateral angles of this segment are very prominent and extend nearly to the posterior margin of the second segment. Epimera of the first segment are not visible. The second, third, and fourth segments are subequal in length but narrower than the first. The posterior margin of these segments is broadly rounded in a convex manner. The postero-lateral angles of the second segment are abruptly short as compared to those of the first, and gradually elongated in posterior segments. The epimeral expansions of the second segment are slender, acute, and extend almost to the posterior extremity of the third segment. Those of the third and fourth are also slender but slightly more elongated. The fifth segment of the thorax is broad and long. At the sides, it exhibits anteriorly a pair of sutures demarcating the anterior portion, from which the epimeral expansions arise. Its posterior portion extends laterally backwards, to form well-developed postero-lateral angles of the segment. The epimera of the fifth segment are well developed, with a broad base, sloping into a fine acute point, reaching the lateral sutures of the succeeding segment. The sixth and seventh segments are broad, the former being the broadest. They are also longer than the rest but are subequal. The posterior margin of the 6th segment is almost straight, and of the seventh concave. The lateral sutures of these segments are prominent. Their epimeral expansions are robust and long. Postero-lateral angles of these segments are very well developed.

The first five thoracic legs are prehensile and closely situated. The sixth is slightly posterior to the middle of the body and wide apart from the fifth. The seventh leg is also situated far off from the sixth. All the legs are similar to each other in structure but they increase in length abruptly in the posterior pairs, the seventh being the longest.

Abdomen (Pl. II, Fig. 6). The abdomen is slightly immersed in the thorax. Its five free segments are well defined. The lateral

angles of the first four segments are well developed and elongated. The epimera of the first two abdominal segments are slender, acute, elongated, reaching the distal end of the peduncle of the uropod. Epimera of the other segments are not visible. The pleotelson is more or less a rectangular plate, with its angles broadly rounded, the inner margin of which is almost straight as compared to the outer. The peduncle of uropod is distinct. The outer distal angle of the uropod is extended. Peduncle and outer ramus of the uropod are deeply coloured. Both the rami of the uropod are elongate, terete, slender, and acute. The outer ramus is double the length of the inner, and is darkly pigmented. The inner ramus has a slightly broader base.

Remarks

The significant features like long acute arrow-like epimeral expansions of the posterior segments of the thorax, broadly rounded telson, the presence of beautiful dark violet bands on the sides on the body and the long slender uropod region make this species strikingly different from the other known species of the genus *Nerocila* (Richardson, 1905; Barnard, 1940). Therefore, the species is named as *Nerocila pigmentata* owing to its dark pigmentation of the sides of the body and uropods.

3. **Cymothoa cinerea** sp. n.

Family: Cymothoidae.
Genus: *Cymothoa* Fabricius.
Host: *Stromateus cinereus* (in the buccal cavity).
Date: September 1956.
Collection: Two females.

Description

Body stout oblong 44 mm. long and 19 mm. broad at 4th thoracic segment. Colour brown-yellow. Thoracic segments punctate. Abdominal segments not smooth.

Cephalon and its appendages: (Pl. II, Figs. 1 and 2). *Cephalon* (Pl. II, Fig. 1 cph.) is large with its posterior margin straight. Laterally, the posterior angles are straightly curved into a rounded margin. The lateral margins of the cephalon are also straight but not parallel to each other: instead they slope anteriorly

to meet the anterior truncate margin. This gives the cephalon a trapezoidal appearance. The anterior half of the trapezoidal cephalic plate is slightly depressed in the middle. Small, more or less rounded eyes are placed a little behind the middle of the head or cephalon.

First antenna is smooth and robust with nine articles. The apical articles are slenderer than the basal. It reaches the projected latero-anterior angles of the first thoracic segment.

Second antenna is smooth but much more slender than the first. It consists of eight articles and almost touches the posterior lateral angles of the first thoracic segment when stretched.

Maxillipeds possess cilia-like projections on the inner border of basal segment (Pl. II, Fig. 2).

Thorax and its appendages: (Pl. II, Figs. 1, 2, 4, 5).

The first thoracic segment is the longest and the fifth the broadest. The antero-lateral angles of the first thoracic segment nearly extend up to the middle of the cephalon. The second, third, fourth, and fifth thoracic segments are equal in length, while the length of the succeeding two segments is less, the last being the shortest. The anterior margin of the first segment is emarginate and that of the succeeding segments is covered by the preceding segments. The posterior margin of all the thoracic segments is not straight but is projected mid-dorsally into a small curved protrusion. This curved projection is more prominent in the fourth and fifth segments.

The lateral epimeral plates of the thoracic segments are not attached to the entire length of the segment, but are attached only to the anterior half. In the posterior segments this attachment can be easily distinguished by the presence of a prominent transverse notch in the middle of the segment. The first three pairs of thoracic legs (Pl. II, Figs. 3, 4) have long strong dactyli nearly as long as those of the following pairs. The last four pairs have strongly developed carinae on the femora. The femur of the seventh pair is (Pl. II, Fig. 5) broad and long.

Abdomen and its appendages: (Pl. II, Fig. 1).

The abdomen is nearly $\frac{1}{2}$ the length of the body and is conspicuously immersed in the thorax. The fifth abdominal segment is broader than the preceding ones. Each of the abdominal segments has four to five small tubercles on the anterior half, arranged in an inconspicuous row. The remaining portion of the segment is smooth.

The pleo-telson (Pl. II, Fig. 1, *plt.*) is broader than long. The anterior margin has irregular tubercles on the top. Its anterior side has conspicuous depression on the mid-dorsal region. The postero-

lateral margins are broadly rounded. The posterior margin has a wide notch on the mid-dorsal line.

Remarks

The presence of such a large specimen in the buccal cavity of *Stromateus cinereus* is very interesting. Its study shows a close resemblance of shape and body form to that of the known parasite *Cymothoa stromatea*, parasitic on *Parastromateus niger* (Pillai, 1954). However, the present species differs from *C. stromatea* in possessing longer thorax, shorter and tuberculated abdomen, and slightly punctate sides of the body. Hence it is named after its host.

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An Ornithologist revisits West Nepal (March 21-25, 1959)

BY

ROBERT L. FLEMING

After an interval of seven years, we found ourselves again at Sanauli, the check-post north of Gorakhpur on the Nepal border. Nothing much had changed—motor lorries were all older. In 1949 we knew nothing of the bird life but collected there twice (1949, 1951). Armed only with binoculars, note-book, and some local ornithological experience, we now had a good chance to check again on birds along the road to Tansen and around Pokhara.

The bus apparently would be delayed for some time, so we ranged out from the station. There were several common birds about—House Crows, Common Mynas, Black Drongos on a dead tree. A Crimsonbreasted Barbet called from a mango grove. Out in cut-over grain fields were many Pied Mynas, more plentiful here than in any other place we have visited in Nepal. Indian Rollers sat on bounds between fields; this species became less frequent or not seen at all until we reached Pokhara where they were positively numerous. A frequent roadside bird was the pink-legged Indian Pipit with its speckled breast. From a large almost leafless tree came the metallic chirp of the Yellowthroated Sparrow. Two of these occupied a special branch which was apparently an 'apartment'. I had only found this sparrow twice before. A Grey Partridge called from a distant hedge. Jungle Crows here may have been either the Indian or Himalayan race. There was a species of dove, identity undetermined.

No sign of the departure of any bus, therefore we set out on foot to observe what we could before being overtaken. The road ran westward with large, white boundary posts at intervals on our left. A pair of Ashycrowned Finch-Larks crouched in the dust of the road. The male flew upward for five or six wing-beats, then plummeted down a short distance on folded wings only to rise again and repeat the performance to the accompaniment of a sweet little song. Large white egrets stood near a distant pond. We have collected *Egretta alba modesta* (Gray) but are still looking for the smaller bird, *E. intermedia*. Overhead wheeled a number of birds like martins—black above, white below with light gray, almost whitish throats. On a

bound of a field rested a White-eyed Buzzard which turned its head and blinked its eyes. When we tossed a clod in its direction, it flew low over the ground, then suddenly ascended into a low tree. An Indian Bush Chat sat on the top of a shrub on the far side of the field.

We looked back but could see no activity at the distant check-post. Soon we reached a stream near a camp. The Indian Pond Herons were here as well as a pair of Redwattled Lapwings. From a mango grove darted a Green Bee-eater showing a metallic sheen as it flattened its wings, wheeled and glided back to the same twig. Overhead a flight of Roseringed Parakeets flashed by, 'clacking' as they went. At the water's edge a White Wagtail, possibly *Motacilla alba dukhunensis* Sykes, restlessly searched for insects. A single sandpiper ran along the edge of the water [*Actitis hypoleuca* (L.) ?]. A Blackheaded Shrike flew with heavy flight from a small tree. This species is common from the terai to 8000 feet and beyond. Several days north of Kathmandu we found *Lanius schach tricolor* to be very common. In May, at 7500 feet they were breeding. Colonel Richard Proud, who went on through the Gosainkund Pass at 14,500 feet into Langtang Valley, saw only the black-headed bird on this side, and immediately on the other side only the grey-headed race *L. s. erythronotus* (Vigors). A group of Common Babblers moved among trees above a cactus hedge. This was the first glimpse of this common bird in Nepal. Many Redvented Bulbuls were here and in the foothills. The Kite of this area was much darker than those at Tansen and Pokhara.

Our bus finally caught up with us. From here to Butwal, about twenty miles, we spotted several more familiar birds. Neophrons circled through the air at Bhairahwa town. House Sparrows were in holes in brick buidings, while an Indian Hoopoe with its rose-tinted breast, dropped into a tree in front of a shop.

Again on the road we saw a group of Cattle Egrets feeding in company with buffaloes. Some say egrets pick ticks off animals' backs but careful examination of stomachs in Egypt have not confirmed this. They apparently take insects which are stirred up by grazing herds. A Wiretailed Swallow rested on a concrete bridge we crossed—a species we have not yet taken in Nepal. A brown vulture with white on its back sat upright on a nest-platform in a tall tree. A Bank Myna scurried between the legs of cattle, reminding me of the first one I tried to collect which did the same thing. Occasional Pied Bush Chats perched on shrubs in open meadows while the Common Kingfisher sped over patches of water beside the road. On

a larger stream we caught a glimpse of the Pied Kingfisher poised on hovering wings.

In the distance a forest of tall trees loomed up. A pair of Sarus Cranes as well as Lesser Adjutant Storks stood in one of the last clearings. What appeared to be a Yellowbreasted Babbler popped out of the dry grass next to the road. As we entered the forest we were hemmed in for the next few miles and saw nothing. Not that the area was empty for we crossed the very stream where we found Conover's Green Pigeon (sp. nova) and the Great Grey Woodpecker (*Mulleripicus*)—the only place we've ever seen it. We finally completed our twenty mile trip in a little over four hours and reached Butwal (900 feet), at the foot of the Siwalik Range, where we stayed over night.

Next morning Purple Sunbirds were calling from trees heavy with mistletoe. Here was the only Brownbacked Indian Robin we saw, in the same place we collected it ten years before. We struck out northward along the rocky trail which leads through a defile up the Tinau River bed. The Whistling Thrush now became common along the stream. Whitecapped Redstarts skimmed from rock to rock; soon they would be nesting on mountain streams at 12,000 feet. The *too-lee, too-lee* of the Tailor Bird now followed us much of our way. Here we heard the loud, metallic *cluk* of the Indian Grackle. This species is very common farther east where, at Hitaura and Amlekhganj below Kathmandu, young birds are sold in the bazaar for a rupee or two. A hunting party in the taller trees contained several willow warblers, the Chestnutbellied Nuthatch, and a small pied woodpecker, possibly *Dendrocopos canicapillus mitchelii* (Malherbe). Near a village was a small dove about the size of the little Red Turtle Dove. The Whitecheeked Bulbul as well as the little White-eye with its plaintive *teer* became frequent.

The road, a series of stone ledges, now wound through a forest with a ravine on our right choked with creepers and shrubs. I didn't see the Green Magpie, Redheaded Trogon, nor Red Junglefowl of other years, but the Brownbacked Pied Shrikes were in their place, flitting from limb to limb, and also the Greyheaded Flycatcher with its cheery notes. Bulbuls like each other's company for the Blackheaded Yellow, the Black (really grey with a black crest and coral beak), and the Browneared, which we call 'the musical bulbul', were all together. The little Bronzed Drongo hawked insects from a dead branch in the same tree where he had been before.

Rani Bas, 'the place where the Queen sat', was the spot on the way to Tansen which was 'bursting' with birds. The Green Pigeon there

may have been the thick-billed species. The first class songster of the ravine was the Indian Shama. And the first class mimic, in almost every tree was the Orangebellied Chloropsis. The Blackbreasted Sunbird was in the same sunny nook next to the village near some dark green Willow Warblers. A bit higher the forest was full of barbet calls. There was the Bluethroated, the two-note *whe—lp* of the Goldenthroated, and the piercing *pir-au* of the Himalayan Great Barbet. The second is only occasionally found while there are many of the other two. The sketchy little song of the Whitebrowed Fantail Flycatcher came from dense cover where it sat on lower branches swaying from side to side. On the ridge above the village Hodgson's Striated Swallows skimmed the treetops while a party of Whitecrested Laughing Thrushes filled the air with their hollow mockery. Then something rustled at our feet. After a moment out stole a Streaked Laughing Thrush which fluttered down the hill followed by a second one. The Mussoorie race is very much more common than its Nepal cousin (*setafer*). The soft *chir* of the Redbilled Babbler revealed a small party of these birds in dense undergrowth. Although it was mid-forenoon a Barred Owlet suddenly unleashed a ripple of notes. Greyheaded Flycatcher-Warblers worked energetically in the trees, singing as they went while their duller relatives, the Blackbrowed Flycatcher-Warblers, worked near the ground in a more deliberate manner.

We climbed a narrow defile, crossed a bridge, and passed a number of thatched Nepali houses neatly trimmed in two-toned cream and terra cotta. On the cut-over hillside Hodgson's Rustycheeked Scimitar Babblers sent forth a duo: *pick—puck, peak.* In this rather narrow valley we came across a considerable number of Verditer Flycatchers which seemed to be moving northward in a compact group for we hadn't seen them before nor did we see or hear them later. The Dark-grey Cuckoo-Shrike with its three descending notes, called at intervals. A flock of Scarlet Minivets flew across the valley and filled the air with their conversation. Just overhead a tiny Fire-breasted Flowerpecker rummaged about in a cluster of leaves. A pair of Crested Buntings sat on the edge of a field. For the first time we met the Magpie Robin, so very common in Pokhara, Tansen, and Kathmandu.

The road led steeply upward for a thousand feet to Marsain (4000 feet) beyond which we could see the white buildings of Tansen, seven miles distant. We had to drop down fifteen hundred feet to a stream and rice fields. In a secondary growth of jungle we came across a party of Yellowcheeked Tits, escorting leaf warblers,

Velvetfronted Nuthatches, and others. Here the Indian Sunbird gave a vivid view of his brilliant red and green breast and abdomen. A flock of Longtailed Minivets, with their mellow *tweet—tweet*, flew through the trees.

We reached the bottom of the steep descent and passed out into rice fields. Redbilled Blue Magpies sent their grating notes down from the slopes above. Then followed the *tidilly—aye—kok* of the Himalayan Tree Pie which flew above us with laboured wing-beats and drooping tails. The common Hawk-Cuckoo screamed *brain fever* in rising crescendo. A Whitebreasted Kingfisher sat at the edge of a stream, but we missed his brown-headed stork-billed cousin which we had collected here seven years before.

We still had three or four miles to go and a climb from 2500 to 4500 feet. We followed the survey route of the new motor road to run from Butwal to Pokhara. Sal forest and some pine covered the hills. We saw several uniformly grey-brown flowerpeckers and near them a party of Greenbacked Tits. A Crested Serpent Eagle screamed overhead, displaying bands of white on outstretched wings. A single Collared Bush Chat along the roadside appeared to be the darker Turkestan species. Just below Tansen the Haircrested Drongo, with its upturned tail feathers flew from one tree to another ahead of us. In and around Tansen we noted Barn Swallows, and Hodgson's Munias which buzzed off with a plaintive *tik*. A Black Vulture circled above the town in company with several Griffon Vultures. Along the path to Bussaldara where the Mission Hospital is being built, a Kestrel flew from a rock below the road and glided down to a similar vantage point. Its back seemed rather dark like that of the Himalayan race. Just then a magnificent golden-headed Bearded Vulture swiftly cut through the air, a common bird here but not farther east. Our host and hostess at the Mission Hospital were Dr. and Mrs. Carl Friedericks.

Next morning we were up early to visit old haunts in Srinagar forest behind Tansen. Much to my dismay, many of the trees had been lopped and much of the bird population had disappeared. A pair of Pine Martens (*Martes flavigula*) ranged over the hillside, also accounting for the scarcity of birds. However, I did add a dozen more species to my list. The Upland Pipit, everywhere common, called *teacher, teacher* from several directions. Numerous Tree Pipits flew from shady forest floors. Tree Sparrows had a nest in a hole of a hospital building; they had completely replaced House Sparrows. On the northern slope were both Greenfinches and Dark-grey Bush Chats. Then we heard a Spiny Babbler. It was in a small tree

across a ravine and was soon joined by another, remaining there several minutes before disappearing. The Little Blue-and-White Flycatcher sat in one of the larger trees; its white supercilium was quite distinct. Near the ridge were several Nepal Grey Tits. A Barred Owlet puffed itself out and sat silently in the early morning sunshine. Several Blackthroated Thrushes flew from wild pear trees bordering the old firing range. Nepal House Swifts careened over grassy slopes. In the last grove before we reached the hospital was a leaf warbler, greenish grey in colour with a large bill and pink lower mandible, probably *Phylloscopus magnirostris.*

Next afternoon, on the way back to Butwal, a forktail was near the stream below the road. As darkness overtook us the Jungle Owlet called, followed by the *haw-ek* of the Hawk Owl. We heard from three to five deliberate notes of a nightjar, possibly *Caprimulgus macrurus albonotus.* Along the Tinau River at Butwal came the high-pitched *chait, chait* of Franklin's Nightjar.

After a restful night we attempted to get to Bhairahwa to catch the plane to Kathmandu. It took us six hours to get twenty miles and we missed our connection. A shuttle plane took us as far as Pokhara where we had the good fortune of being stranded two days! The pilot invited us into the cockpit. It was like magic to look down on that rough, steep road we had covered three times by foot and to know you could sit back and get to Pokhara in minutes. We saw Tansen, the Kali Gandak gorges and river, and had glimpses of Annapurna up ahead.

Our impromptu stop in Pokhara, in a valley at 3000 feet and only fifteen miles south of the Annapurna Range, was most pleasant, made so by Dr. and Mrs. F. Okada of the American Museum, New York City. They introduced me to Captain Gibson, Gorkha tele-communication officer from Malaya, who accompanied me to the low ridges north of the parade ground. Some of the birds were the same as those near Tansen but there were additions. The Koels held noisy conversations throughout the valley; we hadn't heard them since we left the plains of India. Flocks of Greyheaded Mynas in large numbers reminded us of a similar distribution in central Nepal from 1000 to 3000 feet. We picked out a buzzard in a tree at the edge of rice fields. Sand Martins lined the telephone wire over open cultivation. Several Blue Rock Pigeons flew out of the Seti River gorge, while light coloured kites above us were probably *Milvus l. lineatus.* A Spiny Babbler, one of a party of two or three, called from the scrub jungle on the ridge above the rice fields and Captain Gibson watched one through the glasses. We had to turn back because of

an on-coming storm. As we did so, we heard still other Spiny Babblers at a spot a little to the west and exactly where I had collected one almost ten years before.

A brilliant dawn broke over a glorious array of snow-capped mountains next morning. The air had been washed and this was the day for pictures—but no camera! As we started out for the wooded ridge to the south of the town, bordering Phewa Tal, I could not keep my eyes off that Himalayan grandeur. En route we met numbers of old bird friends[1] but there were others which made the trip exciting. Some of the most common species around Pokhara were the Bengal Tree Pie which we hadn't seen since leaving India, the Spotted Dove, and Jungle Mynas which outnumber Common Mynas. On a wooded hillside we came upon a natural bath in a large rock, filled by the rain of the night. A pair of Eastern Redbreasted Flycatchers, a Greywinged Blackbird (the only one we saw), and tits were taking full advantage of this provision for their needs. The Large Himalayan Cuckoo-Shrike flew into a leafless tree at the top of the ridge; its loud *per-lee* indicated its presence before we could see it. The Blacknaped Woodpecker also frequented the same ridge. A Shikra swooped into a tree ahead of us and stayed several minutes, showing the vermiculated breast of an adult bird.

We looked down from the top of the ridge on to the lake below. Phewa Tal had lost about a fourth of its water but a new dam will restore it. A rest house now rose from the water's edge, recently put up for Their Majesties. We walked toward a cultivated field in the centre of which was a large, old mango tree. We were surprised to see a male Maroon Oriole in glistening plumage. There was a commotion to our left; four Haircrested Drongos pursued a fifth into a tree. In the next few minutes we counted six others. Beyond the field a Black Partridge sent out his *chuck—pān, biri, cigarette*! Back down in the fields we saw a pair of Whitenecked Storks in deliberate flight towards town. Along one of the streets a European Cuckoo sent his familiar call from the top of a bare tree. Then on one of the wide, shaded avenues I had a real surprise. There was a Redthroated Thrush which I had never seen before, hopping around on the ground in front of me. It looked and acted just like its black-throated cousin. After a few minutes it flew up into a tree.

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[1]Dr. O'Hanlon and we watched a pair of Barn Swallows feeding their four young in the rafters of a house at the Mission Hospital. First one fledgling, more hungry than the others, pushed forward and received food four or five times in succession. Then it slumped back into the nest for a rest while the next one monopolized the feeding for several minutes. The second gave place to the third, and so on.

That evening we went back to the place on the terraced hillside north of the parade ground where we had heard the second group of Spiny Babblers. Ten years before the hillside was covered with scrub jungle, but now there was nothing left except a small tree or two and a tangle of brush and ferns around a neglected spring—a place now quite easy to find. A Crimsonbreasted Barbet flew on outspread wings out of a neighbouring pipal tree, after flying ants. Meanwhile two or three Spiny Babblers were carrying on an animated conversation just ahead of us. One came out of the tangle near the ground toward me but soon darted back to shelter. Another one flew out the far side of this patch. One, however, mounted a small bush and put on a full concert: *There, chir, chir; we we*, then with rising notes, *right here, right here, right here* followed by a loud *tee-ter, tee-ter, teeter, tee-ter, tee-ter, tee-ter*, the second syllable two notes below the initial one. There followed several mimic calls like *pwink* of a bulbul and *chip, chip* of a Blackthroated Thrush. Again a loud series of *tee-ters*, a descending *pookil, pookil, pookil* augmented with a *chupu, chupu*, then fresh introductory gurgles, the *tee-ter* refrain concluding with more gurgles and trills. When disturbed it gave a low *chur-r-r-r*. By now it was almost dark.

The following day we had a long wait at the airport so we visited the Mission Leprosarium near by. We crossed the Seti River to get there. A pair of Neophrons had a nest in the gorge. They would fly on to the ground some distance away, then come wheeling back with something in their beaks. One after the other they would disappear into the wall crevice, come out about twenty seconds later, and be off again.

Several kestrels also flew about this spot, possibly the paler European bird. When we returned a couple of hours later we could only see one. It was perched on an overhanging branch eating a snake. It worked away for about ten minutes, then picked up the long tail and tried to swallow it whole. The tail stuck in its throat so the falcon placed the tail of the snake between its talons and pulled at it for several more minutes. Again the bird tried to swallow the lot with same result. A third try—no luck. Finally the kestrel gathered the morsel, flew to a rock, placed it behind a projection and glided away. The reptile may have been a keelback (*Natrix*). Back to the airport the plane finally came from Dang and we reached Kathmandu at dusk after a memorable visit again to Tansen and Pokhara.

BIRD LIST FOR TANSEN-POKHARA, 1959

Indian Pond Heron. *Ardeola grayii* (Sykes).
Cattle Egret. *Bubulcus ibis coromandus* (Boddaert).
Eastern Large Egret. *Egretta alba modesta* (Gray).
Intermediate Egret. *Egretta intermedia* (Wagler).
Whitenecked Stork. *Dissoura episcopus episcopus* (Boddaert).
Smaller Adjutant Stork. *Leptoptilos javanicus* (Horsfield).
Blackwinged Kite. *Elanus caeruleus vociferus* (Latham).
Pariah Kite. *Milvus migrans govinda* Sykes.
Large Indian Kite. *Milvus lineatus lineatus* (J. E. Gray).
Shikra. *Accipiter badius dussumieri* (Temminck).
Japanese Desert Buzzard. *Buteo buteo burmanicus* Hume.
White-eyed Buzzard. *Butastur teesa* (Franklin).
Black Vulture. *Sarcogyps calvus* (Scopoli).
Himalayan Griffon. *Gyps himalayensis* Hume.
Indian Whitebacked Vulture. *Pseudogyps bengalensis* (Gmelin).
Bearded Vulture. *Gypaetus barbatus L.*
Indian Crested Serpent Eagle. *Spilornis cheela cheela* (Latham).
European Kestrel. *Falco tinnunculus tinnunculus* L.
Himalayan Kestrel. *Falco tinnunculus interstinctus* Horsfield.
Black Partridge. *Francolinus francolinus asiae* Bonaparte.
Northern Grey Partridge. *Francolinus pondicerianus interpositus* Hartert.
ndian Sarus Crane. *Grus antigone antigone* (Linnaeus).
Redwattled Lapwing. *Lobivanellus indicus indicus* (Boddaert).
Common Sandpiper. *Actitis hypoleucos* L.
Thickbilled Green Pigeon. *Treron curvirostra nipalensis* (Hodgson)
Indian Blue Rock Pigeon. *Columba livia intermedia* Strickland.
Indian Spotted Dove. *Streptopelia chinensis suratensis* (Gmelin).
Indian Red Turtle-Dove. *Oenopopelia tranquebarica humilis* (Temminck).
Eastern Roseringed Parakeet. *Psittacula krameri borealis* (Neumann).
Common Hawk Cuckoo. *Cuculus varius* Vahl.
European Cuckoo. *Cuculus canorus* L.
Koel. *Eudynamys scolopacea scolopacea* (L.)
Jungle Owlet. *Glaucidium radiatum radiatum* (Tickell).
Western Himalayan Barred Owlet. *Glaucidium cuculoides cuculoides* (Vigors).
Indian Brown Hawk-Owl. *Ninox scutulata lugubris* (Tickell).
Long-tailed Nightjar. *Caprimulgus macrurus albonotus* Tickell.
Franklin's Nightjar. *Caprimulgus affinis monticolus* Franklin.
Pied Kingfisher. *Ceryle rudis leucomelanura* Reichenbach.
Common Kingfisher. *Alcedo atthis bengalensis* Gmelin.
Whitebreasted Kingfisher. *Halcyon smyrnensis smyrnensis* (L.)
Indian Roller. *Coracias benghalensis benghalensis* (L.)
Indian Hoopoe. *Upupa epops orientalis* Stuart Baker.
Green Bee-eater. *Merops orientalis orientalis* Latham.
Assam Great Barbet. *Megalaima virens magnifica* Baker.
Goldenthroated Barbet. *Megalaima franklinii franklinii* (Blyth).
Bluethroated Barbet. *Megalaima asiatica asiatica* (Latham).
Crimsonbreasted Barbet. *Megalaima haemacephala indica* (Latham).
Blacknaped Woodpecker. *Picus canus sanguiniceps/gyldenstolpei.*
North Indian Pigmy Woodpecker. *Dendrocopos moluccensis nanus* (Vigors).
Ashycrowned Finch-Lark. *Eremopterix grisea* (Scopoli).
Common Swallow. *Hirundo rustica rustica* L.

Hodgson's Striated Swallow. *Hirundo daurica nipalensis* Hodgson.
Indian Sand Martin. *Riparia paludicola chinensis* (Gray).
Indian Wiretailed Swallow. *Hirundo smithii filifera* Stephens.
Scarlet Minivet. *Pericrocotus flammeus speciosus* (Latham).
Western Longtailed Minivet. *Pericrocotus ethologus favillaceus* Bangs & Philips.
Brownbacked Pied Shrike. *Hemipus picatus capitalis* (McClelland).
Dark Grey Cuckoo-Shrike. *Coracina melachistos melachistos* (Hodgson).
Large Himalayan Cuckoo-Shrike. *Coracina novaehollandiae nipalensis* (Hodgson).
Black Drongo. *Dicrurus macrocercus albirictus* (Hodgson).
Bronzed Drongo. *Dicrurus aeneus aeneus* Vieillot.
Haircrested Drongo. *Dicrurus hottentotus hottentotus* (L.)
Maroon Oriole. *Oriolus trailii traillii* (Vigors).
? Himalayan Jungle Crow. *Corvus macrorhynchos intermedius* Adams.
? Indian Jungle Crow. *Corvus coronoides levaillanti* Lesson.
Indian House Crow. *Corvus splendens splendens* Vieillot.
Redbilled Blue Magpie. *Kitta erythrorhyncha occipitalis* (Blyth).
Bengal Tree Pie. *Crypsirina vagabunda vagabunda* Latham.
Himalayan Tree Pie. *Crypsirina formosae himalayensis* (Blyth).
Nepal Grey Tit. *Parus major nepalensis* Hodgson.
Greenbacked Tit. *Parus monticola lepcharum* Meinertzhagen.
Yellowcheeked Tit. *Parus xanthogenys xanthogenys* Vigors.
Chestnutbellied Nuthatch. *Sitta europaea almorae* Kinnear & Whistler.
Velvetfronted Nuthatch. *Sitta frontalis frontalis* Swainson.
Hodgson's Rustycheeked Scimitar Babbler. *Pomatorhinus erythrogenys ferrugilatus* Hodgson.
Redbilled Babbler. *Stachyris pyrrhops* Blyth.
Yellowbreasted Babbler. *Macronous gularis rubricapilla* (Tickell).
Spiny Babbler. *Turdoides nipalensis* (Hodgson).
The Common Babbler. *Argya caudata caudata* (Dumont).
Whitethroated Laughing Thrush. *Garrulax albogularis albogularis* (Gould).
Whitecrested Laughing Thrush. *Garrulax leucolophus leucolophus* (Hardwicke).
Nepal Streaked Laughing Thrush. *Garrulax lineatus lineatus* (Vigors).
Orangebellied Chloropsis. *Chloropsis hardwickii hardwickii* Jardine & Selby.
Blackheaded Yellow Bulbul. *Pycnonotus flaviventris flaviventris* (Tickell).
Whitecheeked Bulbul. *Pycnonotus leucogenys leucogenys* (Gray).
Bengal Redvented Bulbul. *Pycnonotus cafer bengalensis* Blyth.
Browneared Bulbul. *Microscelis flavalus flavalus* (Hodgson).
Magpie Robin. *Copsychus saularis saularis* (L.).
Indian Shama. *Copsychus malabaricus indicus* (Stuart Baker).
Whitecapped Redstart. *Phoenicurus leucocephalus* Vigors.
Plumbeous Redstart. *Phoenicurus fuliginosus fuliginosus* Vigors.
Greybacked Forktail. *Enicurus schistaceus* (Hodgson).
Indian Bush Chat. *Saxicola torquata indica* (Blyth).
Turkestan Bush Chat. *Saxicola torquata przewalskii* (Pleske).
Western Dark Bush Chat. *Saxicola ferrea* Gray.
Brownbacked Indian Robin. *Saxicoloides fulicata cambaiensis* (Latham).
Himalayan Whistling Thrush. *Myiophoneus caeruleus temminckii* Vigors.
Greywinged Blackbird. *Turdus boulboul* (Latham).
Blackthroated Thrush. *Turdus ruficollis atrogularis* Temminck.
Redthroated Thrush. *Turdus ruficollis* Pallas.
Blackbrowed Flycatcher-Warbler. *Seicercus burkii burkii* (Burton).
Greyheaded Flycatcher-Warbler. *Seicercus xanthoschistos xanthoschistos* (Gray).
Green Leaf Warbler. *Phylloscopus inornatus humei* (Brooks).

Himalayan Leaf Warbler. *Phylloscopus proregulus chloronotus* (Gray).
? Largebilled Leaf Warbler. *Phylloscopus magnirostris* Blyth.
Crowned Leaf Warbler. *Phylloscopus reguloides reguloides* (Blyth).
Burmese Tailor Bird. *Orthotomus sutorius patia* Hodgson.
Beavan's Wren-Warbler. *Prinia hodgsonii rufula* Godwin-Austen.
Eastern Redbreasted Flycatcher. *Ficedula parva albicilla* (Pallas).
Verditer Flycatcher. *Muscicapa thalassina thalassina* Swainson.
Greyheaded Flycatcher. *Culicicapa ceylonensis calochrysea* Oberholser.
Whitebrowed Fantail Flycatcher. *Rhipidura aureola aureola* Lesson.
Indian White Wagtail. *Motacilla alba dukhunensis* Sykes.
Northern Tree Pipit. *Anthus hodgsoni yunnanensis* (Uchida & Kuroda).
Indian Pipit. *Anthus richardi rufulus* Vieillot.
Upland Pipit. *Oreocorys sylvanus* (Blyth).
Blackheaded Shrike. *Lanius schach tricolor* (Hodgson).
Indian Grackle. *Gracula religiosa intermedia* Hay.
Greyheaded Myna. *Sturnus malabaricus malabaricus* (Gmelin).
Pied Myna. *Sturnus contra contra* L.
Common Myna. *Acridotheres tristis tristis* (L.).
Jungle Myna. *Acridotheres grandis fuscus* (Wagler).
Bank Myna. *Acridotheres ginginianus* (Latham).
Purple Sunbird. *Nectarinia asiatica asiatica* (Latham).
Black-breasted Sunbird. *Aethopyga saturata saturata* (Hodgson).
Indian Scarletbacked Sunbird. *Aethopyga siparaja seheriae* (Tickell).
Tickell's Flowerpecker. *Dicaeum erythrorhynchum erythrorhynchum* (Latham).
Firebreasted Flowerpecker. *Dicaeum ignipectus ignipectus* (Blyth).
Indian White-eye. *Zosterops palpebrosa palpebrosa* (Temminck).
House Sparrow. *Passer domesticus indicus* (Jardine & Selby).
Tree Sparrow. *Passer montanus malaccensis* Dubois.
Yellowthroated Sparrow. *Gymnorhis xanthocollis xanthocollis* (Burton).
Hodgson's Munia. *Lonchura striata acuticauda* (Hodgson).
Greenfinch. *Carduelis spinoides spinoides* Vigors.
Crested Bunting. *Melophus lathami* (Gray).

(The subspecific designations are based on material previously collected and identified. Nomenclature from *Birds from Nepal*, Rand and Fleming, 1957 and THE BIRDS OF BURMA, Smythies, 1953).

Albinism and Partial Albinism in Tigers

BY

E. P. GEE

(*With a plate*)

By kind permission of the Maharaja of Rewa, I was recently able to visit and photograph the famous white tigers which are in captivity in that former princely State. A white tiger, which had been captured as a cub in the jungles of Rewa, had been mated with a normal-coloured tigress which was its own offspring as the result of a previous litter by an ordinary tigress. This experiment of inbreeding had produced four white cubs which appeared to be identical in coloration with the father, and a striking contrast to the mother.

Before proceeding to give the details of this unique event, it would perhaps be advisable to explain that the terms 'albino' and 'white' are often rather loosely used in reference to light-coloured tigers in India. Varying degrees of 'whiteness' are to be found, from light-coloured specimens with dark brown stripes (sometimes known as 'red' tigers), and cream-coloured ones with dark brown or dark grey stripes, to the Rewa type which have ashy-grey stripes on an almost white background.

Incidentally, when examining tiger skins caution must always be exercised due to the fact that, after lapse of time and exposure to light, all normal-coloured tiger skins fade from their true colour to a cream background with dark brown stripes. Only freshly-cured skins, or those which have been carefully and correctly preserved, can be accepted as giving an accurate picture of what the live animal looked like.

Nearly all the lighter-coloured 'white' tigers which are often described as 'albinos' are only partial albino, for to be a true albino a specimen must have white hair (or feathers in the case of a bird) with no pigmentation, and pink eyes with no pigment in the iris.

As far as I can ascertain, there has only been one case of true albinism in tigers. This was in 1922 in the former state of Cooch Behar in north-east India, reported in a Miscellaneous Note in the *Journal of the Bombay Natural History Society* [**28** (4) : 1124] by Victor N. Narayan. He wrote: 'We sent our head Jemadar to

reconnoitre and he came face to face with 4 tigers, 2 of which he reported as being of a very light colour. Three days later we shot 4 tigers out of the same jungle . . . We thought we had bagged all the tigers, but on examination found that two were full-grown cubs, and two about three-quarters grown. The two full-grown cubs, were of the ordinary colour and markings of a tiger, 1 male and 1 female. Measurements about 6′-6″. The three-quarters grown cubs, were unique and to me seemed pure albinos. They had pink eyes and were evidently in very bad condition because before being shot at they only trotted along like big dogs, whilst the other two galloped hard. Another peculiarity was the long neck, quite unlike that of any other tiger or leopard I have ever seen; one was a male and one a female. As it was dark we could not beat any more but two days later got the mother, a fine beast in the prime of life and condition. Measurement 8′-9″. I forgot to mention the measurement of the freaks viz. 6′-0″. Such beasts have never been known of, or seen here, nor during the many shooting excursions my father (the late Maharaja Uripendra of Cooch Behar) made into Assam.'

Whereas there is some doubt as to whether black tigers or white leopards have ever existed, black leopards are commonly found in the wetter regions of south and north-east India and in other parts of south-east Asia. It would be expected that white tigers would be found only in the drier regions, but in fact they are found also in Assam which has a high rainfall with very thick forests, as well as in a large area of central India which is now in the re-organized States of Madhya Pradesh and Bihar. This area includes the Bilaspur and Mandla districts of the old Central Provinces, and old Rewa State, and parts of Bihar.

Cases of white tigers, which have not been true albinos and which appear to have been of varying degrees of creaminess and whiteness, are many. Richard Lydekker in THE ROYAL NATURAL HISTORY records that 'a white tiger, in which the fur was of a creamy tint, with the usual stripes faintly visible in certain parts, was exhibited at the old menagerie at Exeter Change about the year 1820'. A record of a white tiger from Poona was published in the *Proceedings of the Zoological Society of London* in 1891.

Messrs. Rowland Ward in their RECORDS OF BIG GAME record a number of white tigers shot in India, of which one was shot in Rewa State and presented by the Maharaja to King George V, and is now in the Natural History Museum in South Kensington, London. A male white tiger from the Lechuar Jungles of Bihar is exhibited in the

The white tiger in the courtyard of the palace. A large and fine beast.

The normal-coloured mother with her four white cubs, in a separate courtyard.

Photos : E. P. Gee

Indian Museum, Calcutta, of which the ground colour is cream, stripes light brown, and (glass) eyes normal-coloured.

The Bombay Natural History Society recorded no less than seventeen cases of white tigers shot in India between the years 1907 and 1933. One of these was shot in the Dhenkanal State, Orissa, in 1909 and was described as follows: 'The ground colour was pure white and the stripes were of a deep reddish black colour' [*JBNHS* **19** (3)]. Another was shot in the Bilaspur District of the then C.P. in 1910 and is described in the *Journal* [**24** (4)] as 'cream coloured throughout but paler on the head and the stripes were chocolate brown'. Another was shot in the district of Bhagalpur in Bihar, and was described [*JBNHS* **32** (3)] as: 'pure white with black stripes on her body and russet brown ones on the tail. The taxidermists to whom the trophy was sent report that during the year 1926 they received three white tiger skins including mine (mine was shot on December 6, 1926), but my skin is the only pure white one, the other two being cream coloured.' As recently as 1958 a white tiger was shot near Hazaribagh in Bihar, and the skin was on view at a Calcutta taxidermist's.

A number of white tigers have from time to time been reported from Assam. In March 1889 one was shot in upper Assam and is recorded by Lydekker. Lt.-Col. F. T. Pollok in his book WILD SPORTS OF BURMAH AND ASSAM published in 1879 wrote: 'Mr. Shadwell, Assistant Commissioner in the Cossyah and Jyntiah Hills, also had two skins quite white, but when turned about in a strong light just a faint mark or two could be seen to indicate that they belonged to a tiger at all . . .'. Boga-bagh Tea Estate in upper Assam is so called from the two white tigers found there at the beginning of this century, and one of them had 'a lemon-coloured patch on the back of the neck, otherwise it was white with faint stripes'. The two light-coloured tigers shot by W. G. Forbes of Hathikuli Tea Estate in 1929 were described at the time of curing by Messrs. Van Ingen as 'red tigers'.

Now back to the Rewa white tigers. There have been eight cases of a white tiger in this old State during the last 50 years, during which time diaries have been kept at the palace. These include a two-year-old male captured near Sohagpur in December 1915 and kept for some years in captivity. H. E. Scott of the Indian Police saw this animal five years later (December 1920) and described it in a Miscellaneous Note in the *Journal* [**27** (4)] as follows: '*Body colour:* pure white. No cream colour was visible. *Stripes:* indistinct or light black: while some of the stripes, particularly the face markings, are quite black, the majority are ash-coloured owing to white hairs being

mixed with the black. *Nose:* mottled grey-pink (instead of pure pink as in normal tigers). *Lips:* grey-black on hair line but quickly merge to pink (instead of being quite black and gradually merging to pink well inside the mouth as in normal tigers). *Eyes:* the colourings of the eyes are very indistinct. There is no well-defined division between the yellow of the comex and the blue of the iris. The eyes in some lights are practically colourless, merely showing the black pupil on a light yellow background. *Eyelids:* pinkish-black. *Ears:* practically normal in colour and markings. The ground black is however slightly ashy. *General description:* the tiger is of course underdeveloped owing to years of captivity, but in height he is probably slightly above normal and in a wild state would undoubtedly have been an exceptionally large animal.'

The former Maharaja of Rewa shot a white tigress in 1937. In 1946 a white tigress was shot by the Administrator and when skinned was said to have been found to have six unborn cubs—described as white, but I believe this was not substantiated. The present Maharaja shot a white tiger in 1947—the last one to be shot in this area. At this stage I must record my gratitude to Shri Arimardan Singh, Private Secretary to the Maharaja of Rewa, who not only personally conducted me to see the tigers but also gave me much valuable information about their history and so on.

The white tiger now in captivity in the old disused summer palace at Govindgarh, twelve miles from Rewa town, was captured on May 27, 1951 when it was believed to be about nine months of age. A tigress and four cubs came out in a beat. The mother and three cubs were shot, while the fourth cub which was white and bigger and stronger than the others was later captured in a cage with water placed in it (in a dry place at the dry time of the year). Since then no more reports of a white tiger have been received in the area which used to be Rewa State. On February 27, 1952, a normal-coloured tigress was captured in this area and was kept with the white tiger. Two male normal-coloured cubs were born on September 7, 1953, and of these one was given to Bombay and the other went to a Calcutta dealer.

The second litter of four normal-coloured cubs was born on April 10, 1955, consisting of two males and two females. A male and a female cub of this litter went to a Calcutta dealer, and one male cub was given to the Ahmedabad Zoo—where it still is. A female cub was kept at Rewa (now the mother of the litter of four white cubs). A third litter was born to the white tiger and the normal-coloured tigress on July 10, 1956. Of the four cubs one died on

the first day. Two female cubs were presented to the President and the Prime Minister of India, and went to the Zoological Park in New Delhi. A male cub along with its mother was given to the Ahmedabad Zoo. Ever since then the female cub of the second litter was kept with the white tiger, its father.

On October 30, 1958, the present litter of four white cubs was born, consisting of three females and one male. One cub was weak, but the mother looked after it very well and suckled it first in a corner before feeding the others, and soon this cub became as strong as the others. When I saw the family on April 13 the cubs were said to be fully weaned, and I saw them feeding on pieces of meat. I spent two busy hours in trying to photograph the family, both in colour and in black-and-white, and had little opportunity of closely observing or noting down the exact details of their coloration.

But generally speaking the tiger appeared to be an exceptionally large and powerful beast, with a fine coat and ruff, with ground colour of almost pure white or off-white. There seemed to be no trace of brown, lemon, or even cream colour. The stripes were ash-coloured. The eyes appeared to be icy-blue, and the pads of the paws pink. It behaved in a manner which one would have expected from a typical tiger—it crouched in the shade at the far end of its courtyard and glared at its human visitors as they stood on a safe balcony above. Then it rose, advanced with dignity, and then charged with a shattering roar across the sunlit courtyard. Then it strode back to the furthest shady corner. This demonstration was repeated several times—a spectacular and most impressive sight.

In an adjoining courtyard the normal-coloured tigress and her four white cubs were playing. The cubs appeared to be exact replicas of the father, and therefore need no description. All appeared to be in perfect health, and a striking contrast to their richly-coloured mother. All five animals behaved as would be expected of tame animals in a zoo.

The history of the breeding of these four white cubs poses some interesting problems of genetics. I am personally not competent to express an opinion on this point, but I have found that my Siamese cat when crossed with her own 'tabby-coloured' son (she had mated with a non-Siamese 'tabby-coloured' cat near by produced pure-looking Siamese kittens. Also there is the case of the famous white bull American bison named Big Medicine of the Moiese National Bison Range in the U.S.A.: when crossed back with its own normal-coloured mother, the latter produced a white offspring which was a pure albino with pink eyes and even white hooves.

According to some notes made by me some years ago from a scientific work by Professor J. B. S. Haldane, one of the world's leading geneticists, albino mated with albino produces albinos, while albino crossed with normal almost always produces 'normals' to look at. (I am using inverted commas to distinguish between the different types of normal offspring.) But such a 'normal' crossed with a similar 'normal' would produce $\frac{1}{4}$ albinos and $\frac{3}{4}$ "normals", and "normal" crossed with "normal" would also produce $\frac{1}{4}$ albino and $\frac{3}{4}$ "normals". (Other possibilities of crossing are: 'normal' with normal, "normal" with normal, "normal" with 'normal', and albino with "normal".)

In the case of the Rewa white cubs now under review, this has been the result of crossing an albino (if we use the term loosely: more correctly it is a partial albino) with 'normal'. It would be interesting to see if the same crossing repeated would again produce a complete litter of white cubs, for Professor Haldane in a letter to me recently has expressed the opinion that we are dealing with a 'recessive mutant' and that whiteness being presumed to be a recessive character one would expect equal numbers of white and normal-coloured ("normal") cubs from such a mating between the white tiger and its normal-coloured ('normal') daughter. He considers (provisionally) that the chance of getting a 'run' of four white cubs was 1/16, like getting four tails running on spinning a coin. More information on the family history of the Rewa white tiger and its various offspring is required before a complete study of the case can be made.

The white tigers of Rewa and adjacent districts appear to have usually been of great size in their wild state, and the present captive Rewa tiger certainly is a large beast. A number of sportsmen and naturalists have from time to time wondered if there existed a separate breed or variety of white tiger in the forests, and whether a wild white tiger would prefer a white mate to a normal-coloured one. Possibly this will never be decided now, owing to the decline in their numbers—no white tigers have been heard of in old Rewa State since 1951.

But now at the Govindgarh palace zoo history appears to have been made, and a distinct breed of white tigers has begun to be established. It should not be difficult now for the white tiger to be again crossed with his normal-coloured ('normal') daughter and more white cubs to be produced; and when the present four white cubs grow up, one hundred per cent white cubs should definitely result

from a crossing between the females and the male, or between the father (also grandfather) and the female cubs.

Caution would have to be exercised against overdoing this kind of inbreeding, although it does seem to take place in the wild state without too much deterioration of stock. The 'normal' and "normal" normal-coloured cubs of the family could also be used in a scientifically planned and properly managed breeding programme.

Such a white breed of tiger, if firmly established in India, would give this country a considerable amount of prestige in the zoological world, as well as provide a fillip for tourism and at a later date a possible economically valuable item of export to foreign countries.

[A few words of explanation may bring out the genetical significance of the case. The white male tiger captured in 1951 genetically carries the double recessive mutant for white (nn). The normal tigress with which it was first mated carried the double dominant for normal colour (NN). The offspring of a cross between nn ♂ × NN ♀ will always be normal-coloured but genetically heterozygous, i.e. will be Nn.

Theoretically a cross between the old white tiger (nn) and a heterozygous normal-coloured female (Nn) may give rise to 50% Nn, normal-coloured heterozygous, and 50% nn, white coloured homozygous. The latter carries factors nn only, and generally speaking any cross between the old white tiger (nn) or any white ♂ descendant and a ♀ white tigress (nn) will only produce white offspring. The white race of tiger may thus become permanently established; however the possibility of a reversion to normal colouring through mutation is not to be discounted.—EDS.]

A brief account of the Flora of Visnagar, N. Gujarat, and its environs

BY

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INTRODUCTION

The importance of flora work has often been stressed, and with the establishment of the Botanical Survey of India it has assumed national importance.

The FLORA OF BOMBAY PRESIDENCY was published by Cooke (1901-08) more than fifty years ago. E. Blatter and C. McCann (1926-34), Saxton and Sedgwick (1918-22) have done considerable work on the 'Bombay Grasses' and on the 'Flora of North Gujarat' respectively. Recently Father H. Santapau (1945) has contributed enormously by his detailed and painstaking work on 'Flora of Khandala', 'Flora of Gir and Dang Forest'. Phatak and Joshi (1955) have to their credit an account of the 'Flora of the University Campus', Baroda.

It was with an idea of advancing the knowledge of the vegetation of Gujarat and thereby helping to build the flora of India that the present work was undertaken.

TOPOGRAPHY

Visnagar is a Taluka in the Mehasana District of north Gujarat. It is 56 miles north of Ahmedabad on the Ahmedabad-Taranga Hill railway line. It is situated on 72° 42′ E. and 23° 42′ N. The general climatic conditions are similar to those of semi-desert areas. The average rainfall is 15″ to 30″; the temperature Max. 117°F. and Min. 48°F. The soil salinity, though present in excess in a few patches of the land, is much lower than that of the semi-desert areas. The general texture of the soil is sandy, though the percentage of clay present is much higher than in the sandy semi-desert areas. The Visnagar taluka is especially rich in sub-soil water. There is sufficient well irrigation, and hence in winter and summer the climate is comparatively more humid.

COLLECTIONS

As a first step the vegetation in the area within a radius of two miles surrounding the M.N. College, Visnagar, was studied. This served as a background for a more thorough exploration of Visnagar and other

talukas near about. Some plants are from Varetta and Balaram, the collections of which were made on botanical excursions, when the author was attached to M.N. College, Visnagar. In all 215 plants have been collected and described from about 62 families.

Ranunculaceae

1. **Clematis gouriana** Roxb. (Morvel).

Hab. An extensive climber with grooved stem. *Fl.* (Oct.-Dec.) Yellowish white. *Loc.* Wild near Hanuman temple.

Anonaceae

2. **Polyalthia longifolia** Bth. & Hk.f. (Asopalav).

Hab. A tall handsome tree. *Fl.* (Mar.-May) Yellowish green. *Loc.* College garden.

3. **Anona squamosa** L. (Sitaphal).

Hab. Shrubby plants to small trees. *Fl.* Noted in leaf only. *Loc.* Botanical Garden.

Menispermaceae

4. **Tinospora cordifolia** Miers (Galo).

Hab. An extensive climber with corky grooved bark and adventitious aerial roots. *Fl.* (Apr.-May) Yellowish green. *Loc.* On hedges. Common.

5. **Cocculus villosus** DC. (Vevadi).

Hab. A straggling scandent twiner with soft hairs covering the leaves. *Fl.* (Dec.-Jan.) Small, green. *Loc.* On hedges. Common.

Nymphaeaceae

6. **Nymphaea lotus** L. (Poyna).[1]

Hab. Rhizome stout, horizontal with floating leaves. *Fl.* White. *Loc.* Along railway lines. Vadnagar.

7. **Nelumbium speciosum** Willd. (Kamal, Padmakamal).

Hab. Large aquatic herb, with creeping stems. *Fl.* White or rosy. *Loc.* Vadnagar.

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[1] The real *N. lotus* L. is an Egyptian plant, not found wild in India. What this plant may be we are unable to tell without actual specimens at our disposal.—Eds,

PAPAVERACEAE

8. **Argemone mexicana** L. (Darudi).

Hab. A prickly herb with spreading branches. *Fl.* (Dec.-Feb.) Yellow. *Loc.* Common in waste places.

CAPPARIDACEAE

9. **Gynandropsis pentaphylla** DC. (Thanamani).

Hab. Annual, erect branched hairy herb. *Fl.* (Jul.-Sept.) White or pale pink. *Loc.* Growing wild in waste places.

10. **Capparis aphylla** Roth (Kerandu).

Hab. A straggling glabrous herb. *Fl.* (Nov.-Mar.) Reddish brown. *Loc.* Common, grows wild.

11. **Capparis sepiaria** L. (Kanther).

Hab. A much branched, woody climber. *Fl.* (Feb.-May) White. *Loc.* Common as a hedge.

12. **Cadaba indica** Lane. (Khordu).

Hab. A straggling, much branched shrub. *Fl.* (Nov.-Mar.) Greenish white. *Loc.* Along the border of fields.

PORTULACACEAE

13. **Portulaca oleracea** L. (Ghol).

Hab. An annual succulent, prostrate herb. *Fl.* (Sept.-Dec.) Yellow. *Loc.* Wild on ground in moist places.

14. **Portulaca grandiflora** Lam.

Hab. A small, hairy herb with fleshy leaves. *Fl.* (May-Jul.) Red. *Loc.* Botanical Garden.

MALVACEAE

15. **Sida veronicifolia** Lam. (Bhoybala).

Hab. A perennial, much branched prostrate herb. *Fl.* (Oct.-Nov.) Yellow. *Loc.* College grounds.

16. **Abutilon indicum** Sweet. (Kansaki).

Hab. A small shrub, hairy. *Fl.* All the year, yellow. *Loc.* Wild in Bot. Garden.

17. **Hibiscus rosa-sinensis** L. (Jasud).

Hab. A garden plant known for its conspicuous red flowers.

18. **Hibiscus schizopetalous** L. (Latkanjasud).

Hab. A garden plant with pendulous flowers; petals divided.

19. **Thespesia populnea** Soland. (Parasbhendi).

Hab. A small tree. *Fl.* (Oct.-Jan.) Yellow with purple base, and black centre. *Loc.* Bot. Garden.

Bombacaceae

20. **Adansonia digitata** L. (Choramlo).

Hab. Noted as a small tree. *Fl.* Not flowering. *Loc.* Bot. Garden.

21. **Bombax malabaricum** DC. (Ratoshimlo).

Hab. Noted as a small tree, not flowering. *Loc.* Bot. Garden.

Sterculiaceae

22. **Guazuma tomentosa** H.B. & K. (Badok).

Hab. A small tree. *Fl.* (Aug.-Sept.) Yellow, fragrant. *Loc.* Bot. Garden.

Tiliaceae

23. **Grewia asiatics** L. (Phalsa).

Hab. A small tree, young parts hairy. *Fl.* (Mar.-Apr.) Yellow. *Loc.* Bot. Garden.

24. **Corchorus trilocularis** L. (Kadavi chenchadi).

Hab. Annual hairy herb. *Fl.* (Sept.) Yellow. *Loc.* In fields, common.

Zygophyllaceae

25. **Tribulus terrestris** L. (Gokru).

Hab. Branching prostrate herb, usually silky. *Fl.* (Sept.-Dec.) On pseudoaxillary peduncles. *Loc.* College grounds.

Rutaceae

26. **Murraya koenigii** Spreng. (Mitolimdo).

Hab. Noted as a small tree not flowering. *Loc.* Bot. Garden.

27. **Citrus medica** var. **limonum**. (Pahadilimdo).

Hab. A small tree. *Fl.* (Aug.-Oct.) White. *Loc.* Bot. Garden.

28. **Feronia elephantum** Corr. (Kotu).

Hab. A big tree armed with spines. *Fl.* (Mar.-May) Dull red. *Loc.* Bot. Garden.

29. **Aegle marmelos** Corr. (Bel).

Hab. A small thorny tree. *Fl.* (Apr.-May) Greenish white. *Loc.* Along roadsides and Bot. Garden.

Simarubaceae

30. **Ailantus excelsa** Roxb. (Arduso).

Hab. Lofty trees with glandular hairy leaves. *Fl.* (Dec.-Mar.) Small, polygamous. *Loc.* Common. Near fields.

31. **Balanites roxburghii** Planch (Shnoria).

Hab. A small tree, branches ending in very strong sharp ascending spines. *Fl.* Green in small axillary cymes. *Loc.* Bot. Garden.

Meliaceae

32. **Melia azedarach** L. (Bakan limdo).

Hab. Medium-sized tree. *Fl.* (Apr.-May) Lilac. *Loc.* Common. Along roadsides.

33. **Azadirachta indica** A. Juss. (Limdo).

Hab. A large tree. *Fl.* (Mar.-May) White. *Loc.* Common. Everywhere.

Celastraceae

34. **Gymnosporia marginata** Roth

Hab. A shrub with stout zig-zag branches profusely armed with spines. *Fl.* (Aug.-Jan.) White with reddish tinge and in fascicles. *Loc.* Along railway lines.

Rhamnaceae

35. **Zizyphus jujuba** Lamk. (Bor).

Hab. A small thorny tree. *Fl.* (Sept.-Oct.) Greenish yellow. *Loc.* Common in Visnagar. Wild in Balaram.

36. **Zizyphus lotus** Lamk. (Khareki bor).

Hab. A small thorny tree. *Fl.* (Sept.-Oct.) Greenish-yellow. *Loc.* Vadnagar.

37. **Zizyphus rotundifolia** Lamk. (Chanibor).

Hab. A small much branched shrub, armed. *Fl.* (Sept.) Small, greenish. *Loc.* Balaram. Wild.

38. **Zizyphus oenoplia** Mill. (Burgi).

Hab. A small thorny shrub. *Fl.* (Sept.) Green. *Loc.* College road.

VITACEAE

39. **Vitis quadrangularis** Wall. (Had sankal).

Hab. Stem winged, climbing by tendrils. *Fl.* (July) Green. *Loc.* Bot. Garden.

40. **Vitis repanda** Wt. & Arn. (Gandovelo).

Hab. Stems hairy, woody. *Fl.* (Mar.-Apr.) Greenish. *Loc.* In fields.

41. **Vitis trifolia** L. (Ratakhat katumbo.)

Hab. Stem fleshy, hairy. *Fl.* (Aug.-Sept.) *Loc.* Fields, hedges. Common.

SAPINDACEAE

42. **Cardiospermum halicacabum** L. (Karoliyo).

Hab. Annual and perennial, slender delicate climber. *Fl.* (Sept.-Dec.) White. *Loc.* Common on hedges in Bot. Garden.

43. **Sapindus laurifolius** Vahl. (Arita).

Hab. A tree. *Fl.* (Oct.-Dec.) Dull white. *Loc.* Bot. Garden.

44. **Dodonaea viscosa.** L. (Jakmi).

Hab. A shrub. *Fl.* (Jan.-Feb.) Greenish yellow. *Loc.* As a hedge in College garden.

ANACARDIACEAE

45. **Mangifera indica** L. (Ambo).

Hab. A large tree. *Fl.* (Jan.-Feb.) Orange coloured, odorous. *Loc.* Field near railway station.

46. **Anacardium occidentale** L. (Kaju).

Hab. A small crooked tree. *Fl.* (Jan.-Mar.) White with red stripes. *Loc.* Varetta gardens.

47. **Semecarpus anacardium** L. (Bilama).

Hab. A small tree. *Fl.* (May.-Jul.) Greenish white. *Loc.* Varetta gardens.

MORINGACEAE

48. **Moringa pterigosperma** Gaertn. (Sargavo).

Hab. A small, soft-wood tree. *Fl.* (Sept.-Dec.) White. *Loc.* Bot. Garden.

PAPILIONACEAE

49. **Heylandia latebrosa** DC. (Godhadi).

Hab. A prostrate herb. *Fl.* (Aug.) Yellow. *Loc.* College grounds.

50. **Crotalaria juncea** L. (Shan).

Hab. Erect hairy shrub. *Fl.* (Aug.-Sept.) Bright yellow. *Loc.* Fields.

51. **Indigofera lineafolia** L. (Gali).

Hab. Scandent herb in sandy soil. *Fl.* (Aug.-Sept.) Pink. *Loc.* College grounds.

52. **Indigofera enneaphylla** L. (Bhuiguli).

Hab. Prostrate, trailing hairy herb. *Fl.* (Aug.-Jan.) Bright red. *Loc.* College grounds.

53. **Indigofera tenuifolia** L.

Hab. Same as above. *Fl.* (Aug.-Dec.). *Loc.* College grounds and in fields.

54. **Sesbania grandiflora** Poir. (Agathiyo).

Hab. Small soft-wood tree. *Fl.* (Aug.-Dec.) White, large. *Loc.* Bot. Garden.

55. **Sesbania aegyptica** Poir. (Shevari).

Hab. Small shrub. *Fl.* Throughout the year. *Loc.* Common, as a hedge.

56. **Abrus precatorius** L. (Chanoti).

Hab. A wiry perennial twiner. *Fl.* (Aug.-Sept.) White with pink tinge. *Loc.* Balaram.

57. **Butea frondosa** König. (Khakaro kesudo).

Hab. A small tree, young parts hairy. *Fl.* (Feb.-Mar.) Bright red. *Loc.* Bot. Garden.

58. **Zornia diphylla** L. (Galgivi).

Hab. Small diffuse herb. *Fl.* Small, yellow. *Loc.* Fields.

59. **Clitoria ternatea** L. (Garani).

Hab. A twining herb. *Fl.* (Jul.-Sept.) Blue and white. *Loc.* On hedges on College road.

60. **Canavalia ensiformis** DC. (Tarvardi).

Hab. Twiner. *Fl.* (Aug.-Sept.) Pink. *Loc.* On hedges in college compound.

61. **Alhagi maurorum** Fisch. (Jawasa).

Hab. Low shrub with green branches and strong hard thorns. *Fl.* (Aug.-Nov.) small, red. *Loc.* College playgrounds.

62. **Pongamia glabra** Vent. (Karanj).

Hab. A small tree. *Fl.* (Apr.-Jun.) White and purplish in dense racemes. *Loc.* Along roadsides. Common.

63. **Melilotus officinalis** Willd.

Hab. An annual herb. *Fl.* (Dec.-Apr.) Pale yellow. *Loc.* Common in waste places.

Caesalpinaceae

64. **Caesalpinia pulcherrima** Swartz. (Galtoro).

Hab. A small unarmed shrub. *Fl.* Throughout the year ; yellow and red. *Loc.* Bot. Garden.

65. **Poinciana regia** Bojer. (Gulmohor).

Hab. A big tree. *Fl.* (Apr.-Jun.) Red. *Loc.* Bot. Garden.

66. **Cassia fistula** L. (Garmalo).

Hab. A small tree. *Fl.* (Mar.-Jun.) Yellow. *Loc.* Bot. Garden.

67. **Cassia occidentalis** L. (Kasundaro).

Hab. Small annual shrub, fetid when rubbed. *Fl.* (Sept.-Nov.) Yellow. *Loc.* Common in waste places.

68. **Cassia tora** L. (Povadio).

Hab. A small herb. *Fl.* (Aug.-Oct.) Yellow. *Loc.* Common as a weed in waste places.

69. **Cassia auriculata** L. (Aval).

Hab. A much branched shrub. *Fl.* All the year round; light yellow. *Loc.* College compound.

70. **Cassia grandis** L.

Hab. A small tree. *Fl.* (Mar.-Sept.) Rose coloured. *Loc.* Bot. Garden.

71. **Tamarindus indica** L. (Amli).

Hab. A large tree. *Fl.* (May-Jul.) Yellow with pink strips. *Loc.* College road and a few trees inside the city.

72. **Bauhinia variegata** L. (Kanchan).

Hab. Medium-sized spreading tree. *Fl.* (Feb.-Jun.) Pink. *Loc.* Bot. Garden.

73. **Bauhinia racemosa** Lamk. (Asondaro).

Hab. Small crooked tree. *Fl.* (Mar.-June) White. *Loc.* Wild along road going to Balaram.

MIMOSACEAE

74. **Prosopis spicigera** L. (Khijdo).

Hab. Armed small tree infested with insect galls. *Fl.* (Dec.-Mar.) Yellow. *Loc.* Common. Along railway lines towards Mehsana.

75. **Acacia arabica** Willd. (Baval).

Hab. Small armed tree with fissured bark. *Fl.* (Jul.-Feb.) Yellow. *Loc.* Common. Grows wild.

76. **Acacia catechu** Willd. (Kher).

Hab. A small tree, leaves with glands. *Fl.* (Aug.-Sept.) Pale yellow. *Loc.* Common.

77. **Albizzia lebbek** Benth. (Kaliosaras).

Hab. Unarmed deciduous tree. *Fl.* (Mar.-May) White, fragrant. *Loc.* Bot. Garden.

78. **Pithecolobium dulce** Benth. (Vilayati ambli).

Hab. A small armed tree. *Fl.* (Dec.-Mar.) White. *Loc.* Varetta gardens. Few trees in Visnagar.

79. **Parkia biglandulosa** Wt. & Arn. (Chandufal).

Hab. An unarmed big tree. *Fl.* (Jan.-Mar.) White. *Loc.* Bot. Garden.

CRASSULACEAE

80. **Bryophyllum calycinum** Salisb. (Dhamari).

Hab. A succulent herb. *Fl.* (Jan.-Feb.) Reddish purple. *Loc.* Bot. Garden.

81. **Kalanchoe cylindrica** DC.

Hab. A succulent herb, leaves with small bulbils. *Fl.* Not flowering.

Combretaceae

82. **Terminalia catappa** L. (Deshi badam).

Hab. Small tree with whorled horizontal branches. *Fl.* (Aug.-Sept.) Greenish white. *Loc.* Bot. Garden.

83. **Terminalia belerica** Roxb. (Baheda).

Hab. A tree. *Fl.* (Mar.-May) Upper flowers male; lower female. *Loc.* Bot. Garden.

84. **Combretum coccineum** Wall.

Hab. A large climbing shrub with slender stems. *Fl.* (Feb.-Apr.) Bright crimson in brush-like spikes. *Loc.* Bot. Garden.

85. **Quisqualis indica** L. (Rangoon vel).

Hab. A scandent climbing shrub. *Fl.* (Mar.-Sept.) Different shades of red or white. *Loc.* Professors' quarters.

Myrtaceae

86. **Eugenia jambolana** Lamk. (Jambu).

Hab. A big tree with exfoliate bark. *Fl.* (Feb.-Apr.) White. *Loc.* Outskirts of Visnagar.

87. **Psidium guayava** L. (Jamfal).

Hab. A very small tree, bark white, peeling off. *Fl.* (Apr.-May) White. *Loc.* Common.

88. **Eucalyptus globulus** Labill.

Hab. A large straight growing tree, bark white, peeling off. *Fl.* (Nov.-Feb.) White. *Loc.* Varetta gardens.

Lythraceae

89. **Lawsonia alba** Lamk. (Mendhi).

Hab. Much branched shrub. *Fl.* Throughout the year. Fragrant, white. *Loc.* As a hedge on College road.

90. **Lagerstroemia indica** L. (Chinaimendhi).

Hab. A small shrub. *Fl.* (May-Jul.) Pink. *Loc.* Bot. Garden.

PUNICACEAE

91. **Punica granatum** L. (Dadam).

Hab. A small shrub. *Fl.* All the year. Reddish-crimson. *Loc.* Common.

ONAGRACEAE

92. **Trapa bispinosa** Roxb. (Singoda).

Hab. Aquatic floating herb with swollen petioles. *Fl.* (Jul.-Sept.) White. *Loc.* Very common in tanks ; is grown for its fruit.

CARICACEAE

93. **Carica papaya** L. (Papayu).

Hab. A tree of medium height. *Fl.* (Sept.-Nov.) Unisexual, yellow white. *Loc.* Bot. Garden and Sardarji's garden. Common.

CUCURBITACEAE

94. **Trichosanthes cucumerina** L. (Ranpadval).

Hab. Annual, monoecious climber. *Fl.* (Sept.-Dec.) White. *Loc.* On hedges and in rice fields.

95. **Momordica dioica** Roxb. (Kankoda).

Hab. Perennial, dioecious tuberous-rooted climber. *Fl.* (Sept.-Dec.) Yellow. *Loc.* On hedges in fields.

96. **Luffa acutangula** var. **amara** C. B. Clarke (Kadava turiya).

Hab. Annual, monoecious climber. *Fl.* (Aug.-Dec.) Yellow. *Loc.* Near Randala station.

97. **Cucumis trigonous** Roxb. (Kotembra).

Hab. A monoecious scabrid climber. *Fl.* (Aug.-Dec.) Yellow. *Loc.* Wild on hedges in gardens and fields.

98. **Coccinia indica** Wt. & Arn. (Ghiloda).

Hab. A perennial, dioecious tuberous-rooted climber. *Fl.* (Aug.-Jan.) White. *Loc.* Bot. Garden.

99. **Melothria maderaspatana** Cogn. (Charate).

Hab. An annual, monoecious climber with simple tendrils. *Fl.* (Aug.-Jan.) Light yellow. *Loc.* On hedges in Bot. Garden.

100. **Blastania garcinia** Cogn.

Hab. An annual, monoecious climber. *Fl.* (Sept.-Dec.) Yellow, small. *Loc.* Bot. Garden.

101. **Citrullus colocynthis** Schrader. (Mota indravarana).

Hab. A perennial, monoecious creeper on ground. *Fl.* (Aug.-Dec.) Yellow. *Loc.* In fields.

Rubiaceae

102. **Ixora parviflora** Vahl. (Nevari).

Hab. A small evergreen shrub. *Fl.* (Jan.-Apr.) Crimson. *Loc.* Bot. Garden.

103. **Spermacoce hispida** L. (Madhurijadi).

Hab. A small procumbent herb. *Fl.* (Sept.-Jan.) White. *Loc.* College playgrounds.

104. **Hamelia patens** Jacq.

Hab. A small shrub, stem reddish, square. *Fl.* (Jun.-Jan.) Orange red. *Loc.* Bot. Garden.

Compositae

105. **Vernonia cinerea** Less. (Sahadevi).

Hab. An annual herb, stem hairy. *Fl.* (Oct.-Jan.) Pinkish violet. *Loc.* Common; in waste places.

106. **Ageratum conyzoides** L. (Makadmari).

Hab. An annual hairy herb. *Fl.* (Nov.-Mar.) White or pale blue with bad odour. *Loc.* Bot. Garden.

107. **Sphaeranthus indicus** L. (Gorakh mundi).

Hab. A small much branched glandular hairy herb. *Fl.* (Nov.-Jan.) Reddish purple. *Loc.* As a weed in fields and waste places.

108. **Caesulia axillaris** Roxb. (Maka).

Hab. A succulent sub-erect herb. *Fl.* (Sept.-Jan.) Axillary heads pale blue. *Loc.* Common in waste places; near College hostel.

109. **Xanthium strumarium** L. (Gadriyu).

Hab. A small unarmed herb with short hairs. *Fl.* (Nov.-Feb.) Monoecious, unisexual heads. *Loc.* Common in moist places.

110. **Tridax procumbens** L. (Pardeshibhangro).

Hab. A small straggling procumbent perennial herb, hairy. *Fl.* All the year round. Yellow. *Loc.* Common as a weed.

111. **Echinops echinatus** Roxb. (Shuniyo).

Hab. A much branched rigid spiny herb with white cottony hairs. *Fl.* (Oct.-Jan.) In big white spiny balls. *Loc.* Near Rajput boarding, common near wet places.

112. **Eclipta alba** Hassk. (Bangro).

Hab. A rough annual erect or prostrate herb. *Fl.* All the year. Heads small, white. *Loc.* Common as a weed.

113. **Adenostemma viscosum** Forst.

Hab. An erect annual, viscidly pubescent. *Fl.* (Sept.-Mar.) Heads in dense panicles. *Loc.* Common as a weed.

114. **Launaea pinnatifida** Cass.

Hab. Perennial glabrous herbs. *Fl.* All the year. Heads fascicled, yellow. *Loc.* Common weed.

115. **Tricholepis glaberrima** DC.

Hab. Annual, branched glabrous erect stem. *Fl.* (Sept.-Feb.) Heads solitary, purple. *Loc.* Common weed.

Sapotaceae

116. **Bassia latifolia** Roxb. (Mahudo).

Hab. A large tree with rounded crown. *Fl.* (Mar.-Apr.) In dense fascicles. *Loc.* Outskirts of Visnagar.

117. **Mimusops elengi** L. (Borsali).

Hab. A small evergreen tree. *Fl.* (Dec.-Apr.) Light brown or white; fragrant. *Loc.* Dosabhai garden.

118. **Mimusops hexandra** Roxb. (Rayan).

Hab. Large evergreen tree. *Fl.* (Sept.-Nov.) White. *Loc.* Varetta gardens.

119. **Achras sapota** L. (Chiku).

Hab. A small evergreen tree with milky juice. *Fl.* (Apr.-Oct.; May-June) White. *Loc.* Bot. Garden.

Oleaceae

120. **Nyctanthes arbor-tristis** L. (Parijatak).

Hab. A small tree. *Fl.* (Sept.-Jan.) Yellow with white lobes. *Loc.* Bot. Garden.

121. **Jasminum grandiflorum** L. (Chameli).

Hab. A shrub, scandent. *Fl.* (Jan.-May) White, fragrant. *Loc.* Bot. Garden.

SALVADORACEAE

122. **Salvadora persica** L. (Piludi).

Hab. A tree with drooping branches. *Fl.* (Jan.-Mar.) Small, functionally unisexual. *Loc.* Common.

APOCYNACEAE

123. **Carissa carandas** L. (Karmada).

Hab. Large armed shrub with twin stout thorns. *Fl.* (Jan.-Apr.) White, odorous. *Loc.* Bot. Garden.

124. **Vinca rosea** L. (Sadaphuli).

Hab. A small shrub. *Fl.* All the year round, pink. *Loc.* Cultivated in gardens.

125. **Vinca rosea** var. **alba** L.

Hab. A small shrub. *Fl.* All the year ; white. *Loc.* Cultivated in gardens.

126. **Nerium odorum** Sol. (Kaner).

Hab. A shrub with milky juice and verticillate leaves. *Fl.* All the year; pink, red, white. *Loc.* Cultivated in gardens.

127. **Cerbera thevetia** L. (Pilikaner).

Hab. A small tree with milky juice. *Fl.* All the year; yellow. *Loc.* Near temples and women's hostel.

128. **Plumeria acutifolia** Poir. (Khadchampo).

Hab. A deciduous tree with milky juice. *Fl.* (Feb.-Oct.) White with golden centre. Fragrant. *Loc.* Bot. Garden.

129. **Plumeria rubra** L.

Hab. A smaller tree than above. *Fl.* (Feb.-Oct.) Petals red, centred with rich yellow; fragrant. *Loc.* Bot. Garden.

130. **Wrightia tinctoria** R. Br. (Mito indrajav).

Hab. A deciduous tree of moderate size, with milky juice. *Fl.* (Mar.-May) *Loc.* Bot. Garden.

131. **Tabernaemontana coronaria** R. Br. (Chandani).

Hab. A small shrub with milky juice. *Fl.* (Jul.-Sept.) Snow white. *Loc.* Bot. Garden.

ASCLEPIADACEAE

132. **Calotropis procera** R. Br. (Nanoratoankado).

Hab. A small shrub, young parts with cottony hairs. *Fl.* (Nov.-Feb.) Pink. *Loc.* Common; in waste places.

133. **Asclepias curasavica** L. (Kakatundi).

Hab. A small perennial herb with milky juice. *Fl.* (Aug.-Sept.; Jan.-Feb.) Crimson. *Loc.* Bot. Garden.

134. **Leptadenia reticulata** Wt. & Arn. (Nanidodi).

Hab. A twiner. *Fl.* (June-Aug.) Small greenish yellow. *Loc.* Common; on hedges and in Bot. Garden.

BORAGINACEAE

135. **Cordia sebestena** L.

Hab. A small evergreen shrub. *Fl.* (Sept.-Mar.) Scarlet or orange red with sooty calyx. *Loc.* Bot. Garden.

136. **Heliotropium supinum** L. (Ghedeo okhrad).

Hab. A prostrate softly hairy herb. *Fl.* (Dec.-Mar.) Small. *Loc.* College playgrounds and common near wet places.

137. **Cordia rothii** R. & S. (Nanagundha).

Hab. A small deciduous tree. *Fl.* (Mar.-Jun.) White, small. *Loc.* Bot. Garden.

CONVOLVULACEAE

138. **Cuscuta reflexa** Roxb. (Amarvel).

Hab. A parasitic twiner; pale greenish yellow. *Fl.* (Nov.-Feb.) White in clusters. *Loc.* Common in villages.

139. **Evolvulus alsinoides** L. (Shankavali).

Hab. A small prostrate wiry herb; hairy. *Fl.* (Aug.-Dec.) Light blue. *Loc.* Common; on sandy soil.

140. **Jacquemontia violacea** Choisy (Jakshini).

Hab. A perennial twiner with slender stems. *Fl.* (Dec.-Jan.) Bright blue. *Loc.* Dosabhai garden.

141. **Argyreia speciosa** Sweet. (Samudrashok).

Hab. A huge climber, stems stout, hairy, white. *Fl.* (Aug.-Sept.) Large rose purple; bracts large white. *Loc.* Dosabhai garden.

142. **Ipomoea aquatica** Forsk. (Jalgamini).

Hab. A floating aquatic plant with hollow stem, and rooting at nodes. *Fl.* (Oct.-Apr.) Pale purple. *Loc.* Common in tanks.

143. **Ipomoea batatas** Poir. (Shakkaria).

Hab. Creeping plant, rooting at nodes. *Fl.* Noted in vegetative condition only. *Loc.* Bot. Garden.

144. **Ipomoea quamoclit** L. (Kamlata).

Hab. An annual, slender twiner with pectinate leaves. *Fl.* (Sept.-Dec.) Scarlet. *Loc.* Bot. Garden and Professors' quarters.

Solanaceae

145. **Solanum xanthocarpum** S. &. W. (Bhoyringani).

Hab. A spiny prostrate perennial herb. *Fl.* (Oct.-Mar.) Yellow. *Loc.* Common; in waste places.

146. **Withania somnifera** Dunal (Ghodakun).

Hab. A small hairy undershrub. *Fl.* (Sept.-Nov.) Yellowish green. *Loc.* Common; in wet places.

147. **Physalis minima** L. (Popti).

Hab. A small herb with toothed or lobed leaves. *Fl.* (Aug.-Nov.) Yellow. *Loc.* Common; in wet places.

148. **Datura fastuosa** L. (Kalodhaturo).

Hab. A small shrub with purplish and white spotted branches. *Fl.* (Sept.-Jan.) White or tinged with purple. *Loc.* Common; near marshy places.

149. **Cestrum nocturnum** L. (Ratanirani).

Hab. A small scandent shrub. *Fl.* (July-Nov.) Yellowish green. *Loc.* Sardarji's garden.

Scrophulariaceae

150. **Herpestis monnieria** H.B.K. (Bam, Jalnevari).

Hab. A small succulent creeping aquatic herb, rooting at nodes. *Fl.* (Jan.-May) Pale blue. *Loc.* Near Talav.

151. **Striga orobanchioides** Benth. (Ratoagiyo).

Hab. A small erect herb parasitic on roots of Bajari; stem reddish purple. *Fl.* (Oct.-Nov.) Pink with white spot at the base of each lobe. *Loc.* In fields, along railway lines.

152. **Russelia juncea** Zucc. (Raseeli).

Hab. A much branched phylloclade with thick nodes; whorled pendulous branches. *Fl.* All the year. Red. *Loc.* College garden.

153. **Lindenbergia urticifolia** Link & Otto.

Hab. A small hairy glandular herb. *Fl.* (Aug.-Dec.) Yellow. *Loc.* Near wet places, and on wet old walls.

154. **Angelonia grandiflora** L.

Hab. A small perennial herbaceous plant, with glands secreting sticky fluid. *Fl.* (Sept.-Jan.) Of peculiar shape with characteristic smell. *Loc.* Bot. Garden.

BIGNONIACEAE

155. **Tecomella undulata** Seem. (Ragatrohido).

Hab. A small tree with drooping hairy branches. *Fl.* (Dec.-Apr.) Orange-yellow. *Loc.* Varetta gardens, and behind College garden.

156. **Millingtonia hortensis** L. (Akashneem).

Hab. A large straight evergreen tree with corky covering on stem. *Fl.* (Sept.-Dec.) White; sweet scented. *Loc.* Bot. Garden.

157. **Spathodea campanulata** Beauv.

Hab. Noted as a small tree. *Fl.* (Dec.-Feb.) Orange-scarlet. *Loc.* Bot. Garden.

158. **Kigelia pinnata** DC.

Hab. Noted as small trees in Bot. Garden; not flowering.

159. **Tecoma stans** L.

Hab. A large shrub. *Fl.* (Sept.-Dec.) Bright yellow. *Loc.* Common along hedges in Bot. Garden.

ACANTHACEAE

160. **Thunbergia grandiflora** Roxb.

Hab. A large, woody climber. *Fl.* (Feb.-Sept.) Bluish. *Loc.* Grows extensively, covering the green house in Bot. Garden.

161. **Barleria prionitis** L. (Pilokantasholiyo).

Hab. A small shrub, much branched, very prickly. *Fl.* (Oct.-Jan.) Yellow. *Loc.* Grows wild in Bot. Garden.

162. **Lepidagathis trinervis** Nees. (Harancharo).

Hab. A very small diffuse herb much branched. *Fl.* (Nov.-Mar.) Purple. *Loc.* Common.

163. **Asteracantha longifolia** Nees. (Echaro).

Hab. A herb with reddish brown stems with yellow straight spines in the axil of leaves. *Fl.* (June-Jan.) Purplish blue. *Loc.* Common by the side of tanks.

164. **Rueilia tuberosa** L.

Hab. A small herb with fasciculated tuberous roots. *Fl.* (Aug.-Oct.) Purplish blue. *Loc.* Common in Bot. Garden.

165. **Adhatoda vasica** Nees. (Ardusi).

Hab. A much branched shrub. *Fl.* (Aug.-Jan.) White with rose-coloured streaks in the throat. *Loc.* Common as a hedge plant.

Verbenaceae

166. **Lantana camara** L. var. **aculeata** Mold. (Indra danu).

Hab. A shrub, stems with many recurved prickles. *Fl.* All the year. Of various colours. *Loc.* Bot. Garden. Does not grow wild.

167. **Gmelina hystrix** Schutt.

Hab. A large spinous shrub. *Fl.* (Aug.-Dec.) Yellow in pendulous panicles. *Loc.* Bot. Garden.

168. **Vitex negundo** L. (Nagodi).

Hab. A small tree, stem square, white and hairy. *Fl.* All the year. Bluish purple. *Loc.* Bot. Garden.

169. **Clerodendron inerme** Gaertn. (Vanvai).

Hab. A shrub with climbing habit. *Fl.* (Aug.-Jan.) White. *Loc.* College garden; as a hedge.

170. **Clerodendron serratum** Spreng.

Hab. A small shrub with branches spreading at base. *Fl.* (Aug.-Jan.) Pink. *Loc.* College garden.

Labiatae

171. **Ocimum sanctum** L. (Tulsi).

Hab. An annual, much branched herb; hairy purplish. *Fl.* (Sept.-Dec.) Purplish. *Loc.* Common.

172. **Ocimum gratissimum** L. (Avachibavchi).

Hab. A small shrub. *Fl.* (Jul.-Dec.) Pale greenish yellow. *Loc.* Near tennis court.

173. **Ocimum basilicum** L. var. **thyrsiflora** Benth. (Sabjo).

Hab. A small herb, much branched, purple hairy. *Fl.* (Aug.-Nov.) Pink with long white hairs. *Loc.* College garden.

174. **Leucas aspera** Spreng. (Kubo).

Hab. An annual herb, stem square and hairy. *Fl.* (Oct.-Nov.) White. *Loc.* Common; in wet places.

Nyctaginaceae

175. **Boerhavia diffusa** L. (Punarnava).

Hab. A creeping herb, stem purplish. *Fl.* (Sept.-Dec.) Dark pink. *Loc.* Common; grows wild.

176. **Boerhavia repanda** Willd. (Satodo).

Hab. A small herb with long internodes. *Fl.* (Oct.-Dec.) Pink. *Loc.* In hedges in Bot. Garden; and along railway lines.

177. **Bougainvillea spectabilis** Willd. (Rativel).

Hab. An extensive climber. *Fl.* (Aug.-Jan.) Rosy-purple bracts. *Loc.* College and Dosabhai garden.

Amaranthaceae

178. **Celosia** sp.

Hab. A small, annual erect herb with grooved stem. *Fl.* (Sept.-Jan.) In small terminal spikes. White. *Loc.* Common on waste land.

179. **Digera arvensis** Forsk. (Kanejaro).

Hab. A small erect annual herb. *Fl.* (Sept.-Dec.) Perianth rose-coloured. *Loc.* Common; in fields.

180. **Amaranthus spinosus** L. (Kantalodambo).

Hab. A small annual erect herb with grooved stem, bearing axillary spines. *Fl.* (Aug.-Nov.) Green. *Loc.* A common weed.

181. **Achyranthes aspera** L. (Andhadi).

Hab. An annual erect herb with square stem. *Fl.* (Nov.-Jan.) Greenish white. *Loc.* Common in waste places.

182. **Pupalia lappacea** Moq. (Dhologipto).

Hab. A large hairy herb. *Fl.* (Aug.-Dec.) Perianth woolly. *Loc.* In hedges, common.

183. **Gomphrena globosa** L. (Batan).

Hab. A small annual herb, stem dichotomous, purplish. *Fl.* (Sept.-Apr.) Purplish red. *Loc.* In gardens, often growing as an escape.

Chenopodiaceae

184. **Basella rubra** L. (Pothi).

Hab. A perennial large twiner, stem red with thick leaves. *Fl.* (Oct.-Jan.) Red. *Loc.* Bot. Garden.

Polygonaceae

185. **Polygonum plebejum** R. Br. var. **indica** Hook.

Hab. A much branched prostrate herb. *Fl.* (Dec.-Mar.) Pink. *Loc.* College grounds.

186. **Polygonum glabrum** Willd. (Ragatrohido).

Hab. A tall shrub, slightly branched and reddish below. *Fl.* (Oct.-Mar.) Pink. *Loc.* On margins of tanks.

Aristolochiaceae

187. **Aristolochia bracteata** Retz.

Hab. A herb; almost spreading on the ground. *Fl.* (Aug.-Jan.) Dark purple. *Loc.* Near Kadarpur railway station.

Euphorbiaceae

188. **Euphorbia neriifolia** L. (Thor).

Hab. A large fleshy much-branched shrub. *Fl.* (Aug.-Apr.) Involucres forming shortly pedunculate solitary or twin cymes. *Loc.* As a hedge along fields and gardens.

189. **Euphorbia tirucalli** L. (Kharsadi thor).

Hab. A small, unarmed, much-branched tree. *Fl.* (Mar.-May) Involucre rose-coloured. *Loc.* As a hedge in Bot. Garden.

190. **Euphorbia splendens** Boj.

Hab. A small armed shrub. *Fl.* (Sept.-Mar.) Cyathia dichotomous. Involucre crimson or scarlet. *Loc.* Dosabhai and Bot. Gardens.

191. **Euphorbia heterophylla** L.

Hab. A small annual herb with floral leaves. *Fl.* (Sept-.Feb.) Green. *Loc.* P.W.D. garden.

192. **Phyllanthus niruri** L. (Bhoyamli).

Hab. A small annual herb. *Fl.* (Aug.-Nov.) Yellowish green, very small. *Loc.* Common as a weed.

193. **Putranjiva roxburghii** Wall. (Putravanti).

Hab. A small evergreen tree with drooping branches. *Fl.* (Mar.-May) Dioecious. *Loc.* Bot. Garden.

194. **Jatropha glandulifera** Roxb.

Hab. A small tree, glandular. *Fl.* (Jan.-May) Greenish yellow. *Loc.* Bot. Garden.

195. **Croton tiglium** L. (Napalo).

Hab. A large evergreen shrub. *Fl.* (Sept.-Dec.) Monoecious. *Loc.* Gardens.

196. **Ricinus communis** L. (Erandi).

Hab. A large annual or perennial shrub. *Fl.* (Dec.-Mar.) Monoecious. *Loc.* Bot. Garden and cultivated in fields.

Moraceae

197. **Ficus religiosa** L. (Pipalo).

Hab. A large tree. *Fl.* Receptacles in pairs; dark-purple when ripe. *Loc.* College garden and near temples.

198. **Ficus bengalensis** L. (Vad).

Hab. A very large tree, with aerial roots. *Fl.* Receptacles in pairs, red. *Loc.* College garden.

199. **Ficus carica** L. (Anjir).

Hab. A small tree. *Fl.* Receptacles solitary; basal bracts reddish purple when ripe. *Loc.* Bot. Garden.

200. **Morus alba** L. (Shetur).

Hab. A large deciduous shrub. *Fl.* (Feb.-Mar.) Monoecious. *Loc.* Bot. Garden.

Urticaceae

201. **Pilea microphylla** Lieb.

Hab. Small perennial herb. *Fl.* (Sept.-Oct.) Monoecious. *Loc.* Bot. Garden.

MONOCOTYLEDONS

Hydrocharitaceae

202. **Hydrilla verticillata** Presl. (Bam).

203. **Valisneria spiralis** L. (Prangavat).

Hab. Submerged plants; abundant in Talav.

Amaryllidaceae

204. **Crinum asiaticum** L. (Nagdaman).

Hab. A herb with tunicated bulb. *Fl.* (Aug.-Oct.) White. *Loc.* Dosabhai garden.

Agavaceae

205. **Agave americana** L. (Ketaki).

Hab. A large perennial herb. *Fl.* Any time of the year ; yellowish green. *Loc.* Bot, Garden.

Liliaceae

206. **Asparagus gonoclados** Baker. (Satavri).

Hab. A much branched armed small weak undershrub with nodular roots. *Fl.* (Dec.-Jan.) White. *Loc.* Bot. Garden.

207. **Dracaena goldieana** Bull.

Hab. An erect woody plant with crowded leaves. *Fl.* Not in flower. *Loc.* Bot. Garden.

208. **Gloriosa superba** L. (Vachnag).

Hab. A large annual herbaceous climber, with solid and white tuberous rootstock. *Fl.* (Aug.-Oct.) Orange and scarlet. *Loc.* Along railway lines in hedges. Wild.

209. **Asphodelus tenuifolius** Cav. (Dungro).

Hab. A small annual herb with fibrous roots. *Fl.* (Dec.-Mar.) White with red tinge. *Loc.* In wheat and bajri fields.

210. **Aloe vera** L. (Eliyo).

Hab. A small herb with fleshy leaves. *Fl.* (Aug.-Jan.) Orange-scarlet. *Loc.* Bot. Garden. Grows extensively.

Commelinaceae

211. **Commelina nudiflora** L. (Shishmuli).

Hab. A small diffuse glabrous herb rooting at nodes. *Fl.* (Sept.-Dec.) Dark purple. *Loc.* Grows wild after rains everywhere.

Palmaceae

212. **Phoenix sylvestris** Roxb. (Khajuri).

Hab. An unbranched plant, the stem covered with petioles of fallen leaves. *Fl.* (Jan.-Mar.) Dioecious. *Loc.* Bot. Garden.

Pandanaceae

213. **Pandanus furcatus** Roxb.

Hab. A small tree with aerial roots. *Fl.* Not flowering. *Loc.* Bot. Garden.

Potamogetonaceae

214. **Potamogeton indicus** Roxb. (Jalpupodi).

Hab. An aquatic herb. *Fl.* (Dec.) Spike; dense flowered. *Loc.* In tanks along railway line.

Coniferae

215. **Thuja orientalis** L. (Morpankhi).

Hab. A small compact evergreen plant. *Fl.* Monoecious, minute. *Loc.* Bot. Garden.

Acknowledgements

My sincere thanks are due to Principal C. D. Deshpande for encouragement and to Dr. H. V. Kashyap, Head of the Biology Dept., M.N. College, Visnagar, for help during the preparation of this work. I have also to thank Dr. H. D. Noronha, Head of the Biology Dept., Gujarat College, Ahmedabad, for allowing me to consult the collections of Saxton and Sedgwick at the Gujarat College.

Reviews

1. THE ROYAL BOTANIC GARDENS, KEW. By W. B. Turrill, D.SC., F.RS., London: Herbert Jenkins, 1959. 22×14 cm.; pp. 256, map, 26 half-tone illustrations. Price 25*s*.

This year the Royal Botanic Gardens, Kew, celebrate the second centenary from their foundation in the eighteenth century; this book is a fitting tribute to the work that has been done and is being done in the various branches of Horticulture and Botany. It is appropriate, too, that Dr. Turrill should write this story; in the words of Dr. G. Taylor, the present Director, who introduces the book to the public, 'the book is in good measure a jubilee commemoration of his (Dr. Turrill's) half-century's devotion to Kew. His is a splendid record of loyal service which has brought great credit to the institution.' When I first knew him, Dr. Turrill was the Curator of the Herbarium; and it was thanks to his great kindness that this reviewer and many others like him could appreciate the treasures housed in the various departments of the Royal Botanic Gardens.

To the professional gardener or botanist, Kew is a hallowed place, the mere name of which seems to inspire reverence and love; it certainly does this to me. Both the gardens and the herbarium and library, and the various laboratories now established in Kew, owe much to the inspiration and energy of such giants in the botanical world as the two Hookers (Sir William and Sir Joseph Dalton), to Bentham, to Col. Prain, and others, to speak only of those that have gone to their reward. Their example seems to be animating the present staff with their boundless energy and enthusiasm.

Dr. Turrill has delved into the archives of the Royal Botanic Gardens, and has as a result produced a book that reads like a story; in simple and non-technical language he tells of the development of a Royal Garden of but about 9 acres into the magnificent establishment of today with over 250 acres of ground. After many vicissitudes as a private Royal Garden, Kew developed into one of the world's leading botanical institutions from the appointment of Sir William Hooker in 1841, when Sir William became the first director officially appointed by government; from that moment practically every year has seen new additions to the Gardens, new facilities for research. The Herbarium, housed in three large galleries, numbers over 6,000,000 specimens; among them there is a most valuable number of type sheets; the Indian

collection is the best in the world, both in numbers and in type materials. As for the Gardens themselves, William Aiton, one of the first Curators, in 1789 listed 5500 species under cultivation in Kew; in the last few years, I heard from the then Director, Sir Edward Salisbury, that over 45,000 different species of plants were being cultivated in the gardens, in the open air or under glass in the various hot-houses.

Dr. Turrill describes in detail the gardens and the various houses. Among the latter the Palm House is probably the most striking structure in Kew; it happens to be also one of the oldest houses. It was completed in 1848; its length is 362 ft., its width 100 ft., its height 66 ft. The Palm House stood as originally built until the Second World War, when much of the glass was destroyed by enemy action; in spite of this most of the plants could be saved, and are now housed again in the rebuilt Palm House.

Another showy detail of Kew is the orchid house. 'The main orchid house at Kew is a new construction built in 1958. There are, connected with this, a number of orchid "pits" that is special smaller houses where orchids are raised from seed and by vegetative propagation and are kept till ready for public exhibition.' The collection of living orchids at Kew is an astonishingly large one, it is also a very showy one. One of the details mentioned by Dr. Turrill when speaking of orchids may be of interest to our readers: orchids are known to produce very large numbers of minute seeds; the record for Kew is a specimen of *Cynorchis chlorochilon*, one single fruit or capsule of which contained 3,770,000 seeds!

At the end of the book there is a large-scale map of the Gardens, with the help of which it is easy to locate any of the various details discussed in the book.

The subjects dealt with in the various chapters are the following: History from the beginning to 1958; scientific research at Kew; economic botany and the various museums; detailed description of the gardens, of the green houses, etc.; Kew in spring, summer, autumn, and winter. There is an interesting chapter on Wild Life at Kew, where many of the birds, insects, etc. seen at Kew are mentioned. The appendices and indexes are of particular help to scientific readers.

One of the great attractions of Kew is that every season of the year seems to bring out a beauty of its own. Bluebells cover the ground in early spring, soon to be followed by daffodils; a little later the sides of the Broad Walk are a riot of colour with the finest combination of massed tulips; by Easter time the Japanese cherry trees with their profuse flowering are a great attraction to visitors, with Rhododendrons

and Azaleas also at their best. All through summer roses, geraniums, and other colourful plants are the delight of countless visitors that flock to the Gardens. Kew is visited annually by over a million persons, and all seem to find there something to delight and interest them. Merely as a picnic spot there is no better place in the world!

It is but natural that such a large institution should be costly to run; it is also natural that the government and the country should expect some tangible return for the money spent. Kew has repaid the money spent many times over; perhaps this has not been done directly to the British treasury, it has certainly been done through the Commonwealth. It was through Kew that India and the East obtained their quinine plants from the high ranges of the Andes in South America; it was also through Kew that southeastern Asia received the *Para* rubber seedlings from which the rubber plantations of Ceylon, Malaya, and other eastern countries have been developed.

To the professional botanist the world over, Kew is known for its many botanical publications, among which *Index Kewensis* stands out signally; two large volumes and twelve supplements of this monumental work have so far been published; in this index all the seed-bearing plants of the world are listed; beginning with Linne's *Species Plantarum*, published in 1753, every plant that has been described or published in any scientific work to the present day is listed with the appropriate reference to the original publication. If the Royal Botanic Gardens, Kew, had done nothing but to sponsor the publication of this book and its supplements, Kew would still deserve a high place in the esteem and gratitude of all the botanists of the world. But it has done much more than that: some of the finest botanical gardens, at least in the British Commonwealth in general and in India in particular, owe their inspiration to Kew. India owes a special debt of gratitude to Kew, in that the FLORA OF BRITISH INDIA and the more important provincial floras have been compiled by the staff of the Kew Herbarium.

The printing of the book is an honour to the British printing trade; the many fine illustrations are well selected to give an idea of the history, activities, and beauty of Kew. The book is clearly a work of love. On this bicentenary occasion the reviewer, remembering the happy years spent in Kew, sends hearty wishes; may the Royal Botanic Gardens of Kew continue for many centuries to flourish and prosper. *Floreat Kew!*

H. SANTAPAU

2. BIRD WATCHING AS A HOBBY. By W. D. Campbell, M.B.O.U. 114 pp. (18.5×12 cm.). With photographic illustrations by H. A. Thomson. Stanley Paul, London, 1959. Price 10*s.* 6*d.* net.

This is an excellent little introduction to Bird Watching written interestingly and in simple language by an experienced devotee of the hobby. It is intended for the young and the novice, but its comprehensive coverage should make its appeal to the general reader with even a passing interest in his natural surroundings.

The chapter headings are descriptive of the contents: Bird watching as a Hobby; Structure; The Bird's Voice; Reproduction; The Food of Birds; Migration; Classification; Recognition and Identification; Man and Birds; From Bird Watcher to Ornithologist. The text is enlivened by good photographs and by illustrative anecdotes from the author's personal experiences of over a quarter century of bird watching.

The general reader will find the chapters on Migration and Man and Birds of particular interest. At the end of the latter are given some particulars concerning the Protection of Birds Act of 1954 which, even in its toned-down form as passed by the British Parliament, is in many respects exemplary. Suitably adapted to local needs and conditions, it could serve as a model for similar legislation in other countries, including our own. The chapter on Recognition and Identification gives useful hints on what, where, and how to observe and record, which, if persistently and intelligently followed, will without special effort transform the man who starts bird watching as a hobby into a competent scientific ornithologist as it has done the author of the book.

S. A.

3. POULTRY KEEPING IN INDIA. By P. M. N. Naidu. Pp. xviii+293 (24.5×18.5 cm.). 21 coloured plates, 192 black-and-white photographic and line illustrations. Published by the Indian Council of Agricultural Research, New Delhi, 1959. Price Rs. 19.80.

At the outset it may be pointed out that 'poultry' in the title is evidently used here in a restricted sense to cover only domestic fowls. Ducks, geese, turkeys, and guinea fowl which are normally also included in the term are not dealt with. They are perhaps intended to form the subject of a future volume.

India was the centre of domestication of the indigenous Red Junglefowl, believed to be the progenitor of all the existing domestic

breeds. Man's primary quest seems to have been for a good fighting bird, and though fowls were doubtless also used as food, domestication for this purpose was apparently only a secondary consideration. Little attention seems to have been paid in India through the ages to poultry keeping as an economic undertaking, or developing suitable breeds as a source of food supply for the community. Even today as an industry it is far less exploited or popular than its potentiality as a food resource would warrant in a country like ours, for ever striving to make the ends of food production and food consumption meet.

No ventures in poultry farming have so far been undertaken here on a scale comparable with the gigantic industry into which it has developed in western countries, especially the U.S.A. But in a small way poultry keeping has always flourished as a cottage industry or for domestic consumption in villages throughout the countryside. No traveller in India can be unfamiliar with the tough and stringy dak bungalow chicken and the diminutive pigeon-like eggs which are the produce of that bird. That seemingly no effort should have been made to improve the size of the egg and the quality of its layer is strange, but understandable in the absence of official encouragement for scientific experimentation and selection for better breeds. The few fanciers and well-meaning reformers who from time to time tried to introduce foreign strains of egg-layers or meat-producers to improve the indigenous stock had not long to wait before having their entire flocks wiped out by one or other of the numerous poultry diseases which are the bane of the poultry keeper, especially in the tropics, but against which the hardier local breeds have developed some measure of immunity.

It is only now, with the encouragement and facilities provided to poultry keepers by the Central and State Governments through prophylactic inoculations of the birds and competent scientific advice, that poultry farming is gaining in popularity and becoming a practicable proposition for the villager and man of modest means, and gradually transforming its erstwhile speculative character into a steady profit-earning industry.

Poultry keepers as well as all concerned over the food problem in India will welcome this timely publication of the Indian Council of Agricultural Research. From time to time the Council had put out a number of pamphlets on poultry keeping, but the need of a comprehensive book providing practical knowledge in a handy form was acutely felt. The author Shri P. M. N. Naidu has done his job admirably, and deserves to be complimented. That the book

provides just the sort of information poultry keepers needed will be evident from its list of contents. The chapters cover every aspect of the industry, from the history and economics of poultry keeping in India, and the choosing of breeds for different purposes, through the practical techniques of breeding, feeding, and care, to marketing. In the reviewer's opinion, the chapter on Diseases and their Control, in the light of past disappointments and failures, should prove of the greatest practical usefulness and go a long way to reassure the many poultry keepers who have suffered through the ravages of these epidemics and been compelled to abandon their enterprise and enthusiasm.

The book is well printed and attractively got up, and the illustrations are chosen with care, although the colour rendering in some of the plates is not all that can be desired. Considering the high cost of art paper and colour printing, the price is not unreasonable, though unfortunately still rather beyond the reach of the ordinary small man who might be induced to take up poultry farming not only to augment the family income, but also as a service to the community in producing more food. An official publication like this, to carry its message to the widest circle of would-be beneficiaries and produce practical results, needs to be heavily subsidized by government.

S. A.

4. A GUIDE TO FRESHWATER INVERTEBRATE ANIMALS. By Dr. T. T. Macan. Pp. x+118 (18.5×13 cm.). With 202 line drawings. Longmans, Green & Co., Ltd., London, 1959. Price 11*s.* 6*d.*

The scope and organisation of this book are well set in its introduction. It has been the intention of the author to provide such practicable keys as would enable young naturalists or beginners interested in freshwater animal life to identify their captures to the nearest group.

The author, in this work, has devoted 111 pages to four keys—a painstaking work for identifying freshwater invertebrates and then in the end contributes a short account, comprising only four pages, on parasites and epibionts. Of the four keys, the first helps to identify all the freshwater invertebrates up to phyla, and animals belonging to Protozoa, Sponges, Coelenterata, and minor phyla up to their groups. The remaining three keys deal with Mollusca, Worms, and Arthropoda

respectively. More than half of the book is devoted to the identification of freshwater insects.

Literature on animal taxonomy, generally speaking, is too often not readily comprehended by a general student of freshwater animal life. Sometimes also the unfortunate attitude that only an expert is capable of identifying animals correctly has discouraged many a promising beginner from attempting field work. But a book of this type can help any one to readily identify the more common freshwater invertebrates with reasonable accuracy up to a group if he is prepared to follow up the keys given here.

The book is, therefore, recommended for those who have developed interest in identifying freshwater invertebrates, and it will also form a useful addition to biological libraries.

DR. KEWALRAMANI

5. FISHERY SCIENCE, ITS METHODS AND APPLICATIONS. By George A. Rounsefell and W. Harry Everhart. Pp. xii+444 (15×23.5 cm.). With a frontispiece, one coloured plate, and 106 text-figures. John Wiley & Sons, Inc., New York. Price $ 7.50.

The unprecedented activities in the development of fisheries science in this country during the last ten years has opened up a new field for post-graduate training and research in fishery biology, management, and technology in many Indian Universities. However, as in most countries in the tropics, the science is still in its infancy not having progressed beyond the exploratory stage and hence it will be a long time before a comprehensive text-book on the subject specially pertaining to this region is available for the guidance of students and researchers. On the other hand, in the waters of the temperate regions fishery science offers a wealth of practical knowledge made possible mainly by the pioneering and inspiring works of John Murray, Michael Sars, W. Thompson, W. Herdman, J. Johnstone, C. G. Joh. Pettersen, J. Hjort, and many others and carried on through the last few decades in many parts of the world, notably the North Sea, the Baltic, the Sea of Azov, the Atlantic and Pacific coasts of North America, and the fresh waters of the Holarctic. Among the more recent books a long list may be cited as being both informative and instructive to the student and researchers, but there are practically none which have attempted a synthesis and common interpretation of the methodology and principles employed for both freshwater and marine fishery biology in such a way as to be equally applicable to

the research, conservation, and management of fishery resources regardless of where the fish occur. Although six years have elapsed since its publication we are pleased to make known to our readers the availability of such a book in FISHERY SCIENCE, ITS METHODS AND APPLICATIONS.

The book, which is divided into eleven sections, has 25 chapters, each having at its end a list of references which is heavily weighted to North American works. The opening chapter 'How do we produce knowledge?' is an appropriate one and worthy of reading by all biologists engaged in preparing research papers whether of an applied or fundamental nature. The remaining chapters deal with principles of fishery management in general, and as pertaining to streams and ponds; methods of estimating population size, abundance, and limiting factors; habitat improvements; varied types of gear and their uses; tagging; age and growth studies; fishery statistics, stream and lake surveys; fishery regulations, etc.; and conclude with one on fishery problems needing immediate and greater attention, such as abundance; genetics in relation to increased annual harvest; natural balance; role of nutrients; estuarine ecology; interspecific relations, and the like. This is followed by an appendix giving a list of scientific journals exclusively dealing with fishery science or in which the majority of the articles pertain to fishery research and once again there is a partiality to North American publications. The book concludes with a useful six-page glossary of scientific terms and a thirty-page author and subject index.

Fishery problems are varied both from place to place and from species to species and the ever increasing output of research material is also accompanied by constant refinements of existing methods and techniques. Naturally to expect one book to elucidate all would seem an impossibility. One basic requisite for anyone specializing in fishery biology and management is a good grasp of the principles of ecology as applicable to this field and a working knowledge of the problems, methodology, and applications of the allied subjects of limnology, oceanography, marine biology, and ichthyology. To rationalise, the user of this book is expected to have some training in these subjects. Although lagging, fishery science in tropical waters has its own specialities as regards some of the problems, methods, and its applications, and a chapter or two on this aspect would have greatly enhanced the usefulness of this book as an international reference work on the subject. Nevertheless many of the principles and methods treated by the authors are equally applicable to tropical situations, both freshwater and marine. The treatment of the various

topics dealt with is concise, but in some places only passing references are made to topics worthy of more detailed treatment which would necessitate looking into other references also. Indeed, this is a drawback. For instance in a text-book discussion meant to be an aid to students one would expect to find also a reference to Graham, M. (1929): Studies on Age-determination in Fish. Parts 1 & 2, *Fish. Invest. Min. Agri. Fish. Ser.*, II, Vol. 11, Nos. 2 & 3 for the subject on scales and age-determination (Chapter 18), or to Hynes, H. B. N. (1950): *J. Anim. Ecol.*, 19 (1): 36-58 for the section on 'Methods of stomach analysis' (p. 356), and so on. More recent researches on the dynamics of fish populations will necessitate some changes in chapters 6 and 7.

Prediction, judicious management, and conservation are the goal of fishery science and this book will give some idea of the immense amount of systematic and consistent work necessary to attain these ends. On the whole the book is well written, well illustrated, and the production is excellent. Many of the principles of value find a place in it thus making it a worthy text-book and source of reference. The omissions and suggestions are minor when compared to the many useful qualities of the book and at its present standard a life of many editions is assured. The book can be confidently recommended as an aid to post-graduate teaching as well as a guide to researchers through the pages of which a wide knowledge of the methods and applications of fishery science as specially pertaining to the piscine world can be gained.

E. G. Silas

6. DIVERSIONS OF A DIPLOMAT IN CEYLON. By Philip K. Crowe. Pp. x+318 (21.5×14.5 cm.). Line drawings by P. E. P. Deraniyagala, and a map. London, 1957. Macmillan & Co. Ltd. Price 30*s*. net.

As a keen shikari the author has travelled widely in Ceylon and picked up from many sources interesting items of natural (and sometimes unnatural) history. The identity of the devil bird, the blood-sucking vampire bat, and the singing fish of Batticaloa Harbour still appears to be uncertain and the author refers to a new species of red bear described from Ceylon in 1815. There is an extraordinary account of the discovery, in company with Major W. W. A. Phillips, of a red-wattled lapwing sitting on a clutch of Kentish Plover eggs . . . 'an hour later the Kentish plover mother was back on the job. Undoubtedly the lapwing was a paid egg-sitter!'

As in India, the Ceylon authorities no doubt have headaches with the matter of game preservation, but it is strange that they have not yet outlawed some of the commonest offences, e.g. shooting deer and junglefowl from cars and killing of stags in velvet. Perhaps it is prohibited, but if so the fact that a person of the standing of the author has indulged in these practices implies that little publicity has been given to the law which, as in many parts of India, is nobody's concern.

Unfortunately the author has been a little too free in the identification of birds and animals mentioned by him. Upon enquiry it was discovered that the apparent additions of the Pintailed Duck, the Green Pigeon, and the rabbit to the fauna of the Maldives could not be vouched for!

The book is, however, very readable and is just the kind which arouses interest and discussion among naturalists and shikaris.

H. A.

7. THE TIGER OF RAJASTHAN. By Colonel Kesri Singh. Pp. 197 (22×14 cm.). With twelve plates. London, 1959. Robert Hale Ltd. Price 18*s*.

In the foreword, the meaning of the word 'Kesri' is given as 'tiger'. 'Kesri' is really a mutilated form of the Sanskrit word Kesari meaning the 'maned one'. In the preface the author has expressed gratification on his good fortune of being able to select his favourite occupation as his profession. He claims to having been in constant touch with, and studied wild animals for over thirty-seven years. The book is the result of his experiences during this time. The reader therefore is naturally expectant to learn something new about the tiger, but is disappointed to find that the book is largely a chronicle of how innumerable tigers were slaughtered by the author himself or beaten out for slaughter by others. Interlarded are anecdotes, some curious, some interesting, some merely to point a moral or adorn a tale. The photographs on the whole are poor. Many of them are of doubtful authenticity, and some quite obviously posed.

Col. Kesri Singh has a great reputation in Rajasthan as a tiger slayer, and an even greater reputation for knowledge of tiger lore.

Perhaps it is this reputation that is responsible for the disappointment the reviewer feels on laying down the book!

B. Basu

8. COLLECTING, PRESERVING AND STUDYING INSECTS. By Harold Oldroyd, M.A., F.R.E.S. Pp. 327 (23.5×15.5 cm.). 15 monochrome plates and numerous line dawings. Hutchinson and Co. Ltd., London, 1958. 25*s*.

One basic prerequisite towards becoming a skilled insect collector is to learn the habits and life-history of your quarry. By understanding the reactions of various insects towards light, warmth, food, moisture, and shelter you can learn to anticipate their movements and know where to look for them.

This seemingly simple knowledge, which in some cases can become almost instinctive, leads some entomologists to capture rare or unusual insects, while other unobservant collectors at the same time and place are securing only the most commonplace species.

A fundamental wisdom and personal humane awareness permeates this practical and thoughtful book on identifying, collecting, and preserving insects. The author Harold Oldroyd sets forth a large amount of accumulated details. His strong sense of humour and individuality as well as a clear and fluid style set this book apart, and makes interesting reading to the neophyte amateur as well as informative matter to the professional entomologist.

The work describes many established as well as up-to-date aspects of entomology, such as practised methods of killing, preservation, mounting, photography, identification, classification, and methods of recording new facts and describing new species. Each phase is thoroughly discussed, with an ample supply of directions, explanations, lists, diagrams, and plates to make each point quite clear. Further aids are given at the back of the book with an appendix of useful chemical formulae and reagents; a glossary of entomological terms; a list of references; and some 'useful addresses' for materials, books, and new and second-hand cabinets in London.

The field of entomology offers many unexplored possibilities, for considerable work has yet to be done in the way of international classification, unification, study, and collection of insects in various parts of the world. Very little is known about Indian insects, for instance—with the possible exception of those injurious to specific crops or responsible for human diseases. Mr. Oldroyd mentions the fact in particular that the fauna of decaying rot-holes in trees has not yet been completely explored, especially in the tropics where some rare and beautiful insects have yet to be fully investigated. 'No opportunity of collecting them should be missed,' he succinctly points out.

In many ways this book offers a challenge. With detailed information packed into this book, and new fields for exploration pointed out, a person could be aided and inspired to promote further study and offer solid contributions to the present knowledge of entomology.

B. J. TUFTY

9. KERALATTILE PAKSHIKAL—(in Malayalam). By Induchúdan. Pp. xiii+638+indexes 2 unnumbered (21×14.5 cm.). 10 colour plates and 169 line drawings. Kerala Sáhitya Academy, Trichur. 1958. Price Rs. 8.50.

This is the book form of the series of articles contributed in the last few years to the illustrated Malayalam weekly, the *Matrubhumi*, by Induchúdan, the assumed name of the author, Sree K. K. Neelakantan, who is now Professor of English Literature in the Women's College at Trivandrum.

The book contains detailed descriptions of 115 or more of the commoner birds occurring in the State of Kerala. There are additional chapters for general topics, such as a historical sketch of Ornithology in India, hints to bird watchers, and a list of suggested reading which includes two books already published in Malayalam.

The descriptions are well written and largely supplemented by the author's own observations. They reveal his keenness for birds and competence as an observer. He writes intimately and sympathetically of his subjects which makes the book eminently readable.

The reported occurrence of the Common Hornbill, *Tockus birostris* (Scop.) in the Valluvanád and Palghat Taluks of the District of Malabar, where it is common, is interesting. The bird has not so far been found in Travancore or Cochin. But it may be pointed out that it is listed in the Malabar birds given as appendix iv of THE MANUAL OF THE MALABAR DISTRICT by W. Logan (1906). The author's discovery of Peafowl living in the wild state is also interesting, though he has not disclosed where, out of fear for their safety.

The format of the book is pleasing. The colour plates, from blocks borrowed from the Bombay Natural History Society, have reproduced well and the line drawings, in most cases, are good. But the printer's errors, from which Malayalam publications are seldom free, outnumber the 41 items already listed in the errata and are offending to the sensitive reader. At least the mistakes in spelling of the English and scientific names of birds in the first table of the opening chapter should have been avoided.

It would have been a great convenience to the reader, if the scientific names of birds were also included in the chapter headings, which now contain their Malayalam names only. Similarly, the scientific names of the different trees and plants associated with birds mentioned in the book are also desirable.

These are only minor matters in an otherwise excellent book and the author deserves to be congratulated not only for his painstaking studies, but also for doing a real service to all Malayalam readers by giving them a reliable handbook of their birds.

N. G. P.

Miscellaneous Notes

1. MUSK SHREWS FEEDING ON LEECHES

Commenting on B. K. Behura's note [*JBNHS* **55** (3): 552] on a musk shrew (*Suncus murinus*) attacking a keelback (*Natrix stollata*), the editors of this journal mentioned the widely varied dietary of the musk shrew, which includes besides cockroaches and other insects which are its normal food being an Insectivore, various other animals like scorpions, toads, bull-frogs, suckling guinea pigs, as well as vegetable matter like roots, grain ?, and bread, etc. Elsewhere, Deoras and Gokhale have recorded [*JBNHS* **55** (3): 459] baby rats and mice also in the dietary of the musk shrew.

Recently, I have observed rather an odd item in their dietary. While keeping for experimental purposes over a hundred live leeches (*Foraminobdella heptamerata*) in a wide-mouthed open earthenware vessel, I was noticing a conspicuous dwindling in their numbers every morning, but no dead ones could be seen in the container. Unfortunately, I was neither aware of the presence of two musk shrews in my house nor of their nocturnal pilferings of my leeches till one evening, when I noticed them at dusk getting up the vessel in my very presence, poking their snouts right into the water, snatching the leeches, and rushing off with them to the nearest retreat.

In about a week's time nearly eighty leeches were knocked off this way. Sometimes I noticed dead leeches floating, with cuts on their body, probably the shrew-bites. These dead and stinking ones seem to attract the shrews more, because, when the vessel was removed to concealment, the shrews could easily scent their way up.

It is rather unlikely in nature for leeches to come within reach of musk shrews, which normally inhabit human surroundings, but I wonder whether the shrews would resort to hunting after this strange food, if they happen to live in the vicinity of leech infested waters.

Department of Zoology,
Madras Christian College,
Tambaram, South India,
September 19, 1959.

P. J. SANJEEVA RAJ

2. PRESENT STATUS OF THE TWO-HORNED RHINOCEROS, *DIDERMOCERUS SUMATRENSIS* (FISCHER) IN THE SHWE-U-DAUNG RESERVE, BURMA

U Tun Yin of Rangoon has sent us a recent draft report on the Shwe-U-Daung Reserve by Mr. Oliver Milton who, together with Mr. R. D. Estes, is presently engaged on a survey of wild life in Burma. This report is of a preliminary nature and covers the period of one month (July-August) when the monsoon was at its worst making it difficult to find, follow, and identify rhino tracks. More than half the Reserve, i.e. over 60 sq. miles, was sampled including some 25 sq. miles in which grew abundantly two sources of food particularly favoured by rhinoceros, namely Kyansa (*Toddalia aculeata*) and Kyein (*Calamus* sp.), where the rhinoceros were expected to be found. From all the evidence obtained, both directly and by questioning the locals, it appears that there are now only two rhinos living in this area (some believe 3) confined to the upper reaches of the streams in the remotest parts of the Reserve.

Considerable depletion of wild life took place in the Reserve during and since the last war until about 1956, anti-government elements having made protective control by the Forest Department impossible. From local evidence it seems that since about 1940 at least 17 rhinos have been killed. This figure may represent only a part of the total destruction. What an attractive commercial proposition a dead rhino can be to the poacher is shown by the values attached to the various parts of its body, given as under:

Dried blood	5 kyats	=$1.05 U.S.	per half ounce
Fresh blood	500 kyats	=$105 ,,	per 1 viss (=3.65 lb.)
Bone	50 kyats	=$10.5 ,,	per viss
Skin	100 kyats	=$21 ,,	per viss

Horn varies from 500 kyats ($105) to 1000 kyats ($210) per inch.

The survey will be resumed in March/April 1960 after which a further report will be submitted by the investigators, with their comments and suggestions.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, EDITORS
BOMBAY 6,
September 27, 1959.

3. THE SHOU OR 'SIKKIM STAG'

In the *Journal* for December 1958 (**55**: 556) Mr. Gee appeals for information regarding the status of the 'Shou' (*Cervus affinis* Hodgs.) in Bhutan and Tibet. I have visited all the areas in which this animal is said to occur, and my experience of it may be of interest despite the fact that it is not up-to-date.

Western Tibet

I do not think the Shou has ever occurred in recent times in the vicinity of Mt. Kailas and the Manasarowar Lake. The fact that an antler was found in a monastery near the lake means nothing. All sorts of queer objects such as python skins, stuffed monkeys, crocodile heads, etc., are to be found in these monasteries—presents from pious pilgrims. Western Tibet is a barren, elevated country, totally devoid of forest, and suitable only to such animals as the yak, kiang, gazelle, and antelope which are specially adapted to the rigours of life on the great Plateau. The Shou could never exist under such conditions.

Chumbi Valley

When I was in Gyantse from 1923 to 1926 a few Shou inhabited the Chumbi Valley in the vicinity of a little plain called Lingmothang. In the winter of 1925 I saw three hinds in this area, but no stags. The Shou was also reported to occur at this time in the upper reaches of the Ha Valley in Bhutan, but even at this early date the animal was said to be on the verge of extinction, and in later years Raja Dorje, who owned the Ha Valley, told me he was convinced that all had been exterminated. In 1933 and 1949, in company with Major G. Sherriff I traversed Bhutan from west to east keeping for the most part to the temperate zone under the eaves of the Great Himalayan Range. Burhel were plentiful, also musk deer and barking deer, and in certain valleys takin, but I saw no Shou nor did I hear of any, though the country seemed eminently suited to their needs.

SE. Tibet

In 1936, 1938, and again in 1946-47, Major Sherriff and I made extensive journeys in SE. Tibet. We visited the provinces of Takpo, Kongbo, and Pome, and explored the great Tsangpo Gorge, and the valleys of the Po Yigrong and Po Tsangpo. In none of these areas did we see or hear of Shou, except in the district of Tsari. Tsari is holy ground wherein no life may be taken. Mt. Takpashiri, a place of pilgrimage, is as sacred in the eyes of the Tibetans as Mt. Kailas

in western Tibet. But Tsari unlike western Tibet is densely forested, and here the Shou at the time of our visits occurred in fair numbers. At the village of Chikchar the inhabitants informed us that it descended in winter to feed amongst their cattle. We were told, however, that even in this holy sanctuary the deer were often harried in late autumn by barbaric Dafla tribesmen who ascend the Subansiri to trade, and slay the animals with arrows tipped with deadly aconite. In proof of this we found Shou heads in the vicinity of Chikchar with horns still attached to the skull.

Lhasa

During the war, in 1942-43, I was stationed in Lhasa and in the summer of 1942 I sent my Kashmiri servant to a place called Reting, 60 miles north of the city, to collect plants. He was given a letter of introduction to the Reting Rimpoche, a lama of high rank who acted for a time as regent of Tibet after the death of the 13th Dalai Lama. My servant was well and hospitably received and allowed to wander wherever he wished. He returned to Lhasa in the autumn with a fine collection of plants, and confirmed the reports I had heard that the Reting district was a fertile and well-wooded area. He was most enthusiastic about the country, and said it closely resembled Kashmir and that it contained a large number of Shou which he called 'bara singh', which were strictly preserved by the Reting Rimpoche. In addition to the Shou, he said there were numbers of bear, leopard, and burhel. The fact that Shou occurred in the Reting area was also corroborated by Lhasa officials whom I consulted on the matter. It is certain, therefore, that the Shou enjoyed sanctuary in this Reting area until the end of the war. Unfortunately, after the war, the Reting Rimpoche got into serious trouble. He was arrested for a political crime, and imprisoned in a Potala dungeon where he is said to have died. Shortly after this China invaded Tibet. In view of the Chinese belief that the horns of deer in velvet possess aphrodisiac qualities, it is extremely doubtful if the Shou at Reting any longer enjoy the protection afforded them by the late Reting Rimpoche.

Information on this point could probably be obtained in Kalimpong.

BRITISH MUSEUM (NATURAL HISTORY),
CROMWELL ROAD,
LONDON, S.W.,
March 3, 1959.

F. LUDLOW

4. A TRUSTING CROW

Yesterday while I was sitting reading on the veranda of my house, a common crow (*Corvus splendens*) flew in and alighted quite close to me. This unusually deliberate act on its part made me curious. On examining, I was able to find that the crow had a small metal ring pressed around the lower half of its beak, quite close to its base, causing slight bleeding and preventing it from closing the beak. I approached the crow, which made not the least sign of fear, and holding it by hand removed the ring. Without any delay the crow flew out. I wonder whether there is any other record of this kind. A probable explanation is that, by long association with man, the crow has come to believe in his essential dignity; at least it is fascinating to think so.

MARINE BIOLOGICAL LAB.,
TRIVANDRUM-7, P. RABINDRA NATH
July 11, 1959.

5. SPINY BABBLERS IN KATHMANDU VALLEY

On our day off last week, my wife and I headed for the haunts of the Spiny Babbler [*Turdoides nipalensis* (Hodgson)]. We picked up Dr. Das in Kathmandu, drove past the King's palace, and seven miles northward to Buda Nilkantha Narain with its new white-washed walls trimmed with terra cotta. There we made a right angle turn toward the west and zigzagged for three miles up through a pine forest and scrub jungle to Tokha Sanatorium and the doctor's bungalow. From his lawn we looked down from our 5800 feet to the Kathmandu Valley below. The Sanglakhola on the right meandered through lush, green rice fields to meet the Vishnumati on our left and disappeared behind familiar landmarks of modern Kathmandu—Bhim Sen Tower, the Tundikhel, and Phurtli Sarak.

By mid-morning, monsoon clouds lay above and below us. Armed with binoculars and vasculum and accompanied by our little white Tibetan apso 'Jhapu', we paused at the end of the terrace to get direction. Yes, the 'Spinys' were calling both to the right and to the left, so we picked our way down through a grove of young pines (*Pinus longifolia*), past corn fields, to a hill-side of scrub *Symplocos*, *Rhododendron*, and laurel, shrubs of *Phyllanthus* and *Osbeckia*, over patches of grass brightened with yellow *Hypoxis* and beds of *Selaginella*.

Half way there we came upon an improvised shrine beside a

running brook. A *pujari* was chanting before a platform of large, multi-coloured dahlias, supported by rows of fruit. A group of villagers sat around him, many of whom grasped scrawny chickens.

A hundred yards beyond, a 'spiny' began to sing and was immediately answered by birds in two other directions. We came to a little rise and scanned the bushes and young trees across a ravine. Sure enough, there sat our bird near the top of a twelve-foot pine tree, facing us. He would tilt his head back, hold his tail fairly still and warble for several seconds. He would bend forward, flicking his head and tail slowly from side to side, then straighten up and sing again. There were really two parts to his song: the first was quiet and confidential, the second loud and clear. Initially he seemed to imitate a bulbul, a streaked laughing thrush, and a kestrel, his notes were so varied. But as he swung into the emphatic part of his refrain, the notes were more characteristically 'spiny'.

After the song had been in progress for about three minutes, a second bird flew into the lower branches of the same tree. Its attitude was like that of a Whitethroated Laughing Thrush [*Garrulax albogularis albogularis* (Gould)], with tail bent down and wings flopping open as the head and tail jerked from side to side. It soon 'branch-hopped' upward and sat close to the first bird which flared open its tail and shivered for an instant. The breast of the newcomer was of a distinctly darker shade. The second bird moved about continually, sidling out and back along the branch while the first bird kept his original place. Finally the second one seemed to persuade the first they had an engagement elsewhere, so one after another they 'branch-hopped' vertically downward to the lowest limb of the tree and flew with rapid wing beats to a bush farther into the ravine. We heard two or three calls before all was quiet.

On our way back up the hill we stood at the edge of a corn field and heard still other 'spinys' a quarter of a mile away. We saw brown crickets, tan dragonflies, and a black-and-white day moth with a red body among the foliage. Coral and gill mushrooms lined the path while silver lip (*Cheilanthes farinosa*) and lady ferns (*Athyrium pectinatum*) lined overhanging banks. Along a water course grew a single lily-of-the-valley (*Ophiogopon*) hedged about with Christmas ferns (*Polystichum squarrosum*). Rocks of quartz lay among loose earth glinting with mica.

As we came back past the shrine, four small children played among the debris. The flowers were splashed with blood while the hillside was strewn with fresh feathers, but the fruit was gone. A

kite (*Milvus l. lineatus*) slowly wheeled about the spot where the villagers had sacrificed to 'Ban-Kali', Goddess of the Forest, for rain and a good harvest.

A ray of sun broke through white clouds and lit up the rice fields. Another spiny called from the spur to the east. It was strange that no one had recorded this bird from the Valley for 114 years until we found it first at Nagarjung, then on Sheopuri, Negarkot, and Lele. It is the common babbler of the scrub jungle on the hills surrounding Kathmandu.

SHANTA BHAWAN,
PATAN, KATHMANDU,
NEPAL,
July 25, 1959.

R. L. FLEMING

6. COMMUNAL NEST-FEEDING IN BABBLERS

In a Miscellaneous Note on the parasitic habits of the Pied Crested Cuckoo in Volume **40**, p. 125, I remarked on a case of four members of a gang of Jungle Babblers feeding young in one and the same nest. I thought I had enlarged on this elsewhere but do not seem to have done so. At one particular moment I could see a babbler flying away from the nest having just fed the young, another was now on the rim parting with food, a third was waiting near by in a nim tree, the fourth arrived on the roof of the bungalow a short distance away. I waited till Nos. 3 and 4 had also fed the young. This was in Bareilly, but I have seen three of these babblers feeding the young in a nest as far away as Madras.

In the Pied Crested Cuckoo note I referred to Jungle Babblers feeding two young cuckoos moving about together and wondered whether the young cuckoos were out of the same or different nests—they looked the same age incidentally—of the same party of babblers. However, I think this is the place to point out that I never succeeded in finding two nests of the Jungle Babbler in use at the same time, that is, in an area in which I could say they belonged to the same gang. In fact I have a strong suspicion, supported by a certain amount but insufficient evidence for certainty, that the pairs in a gang nest consecutively and not concurrently. If I am right, this is not a negation of the synchronized nesting idea but merely an adaptation of it which might well be of considerable value in the case of these gregarious birds. I would also add that I have no reason at all to believe that two or more females ever lay their eggs in the same nests as Mr.

Malcolm Macdonald suggests. It should not be too difficult with the help of colour-ringing for someone with the necessary time and patience to elucidate these points.

HAYBARN,
THURSLEY,
SURREY, ENGLAND,
July 26, 1959.

R. S. P. BATES,
Lt.-Col., I.A. (Retd.)

[A. Skutch (1935, *Auk* **52** : 267) found in the Central American Bush Tit, *Psaltriparus melanotis*, where males outnumber females by 4-6 : 1, that unmated bachelor males help the mated pair to feed the young. At three nests 1, 1, and 3 extra males were sharing in this duty.

Out of the 12 young fledged from these three nests, all seemed to be males! But sex was not determined by dissection, so there is a possibility of error.

It would be of great interest to determine the sex ratio in babbler 'sisterhoods'.—EDS.]

7. TWO DEAD SWALLOWS IN A NEST

On 15th September 1959 we went to Changalra (Bhuj) for netting birds under the B.N.H.S. Migration Study Scheme, and in the shooting box there Dr. Sálim Ali found a nest of the Redrumped Swallow, *Hirundo daurica erythropygia* (Sykes), with one dead bird blocking the entrance tube of the nest. On further examination of the nest after the entrance was broken open we found one more dead swallow inside with the shells of its eggs. It appears that the birds had completed the nest, and one of them was incubating the eggs while the other one must have been busy putting the finishing touches to the structure. The only plausible explanation for this rather unusual mishap seems to be that one of the birds must have taken the last few pellets of mud late in the evening, and thereafter on entering the nest to roost it must have tried to complete the day's work. The result of this last-minute constructional alteration was that the entrance hole became too narrow and the birds thus unwittingly entrapped themselves. As some of the mud must have dried up and become hard set during the night, it must have become impossible for the poor swallows to get out of the narrow entrance the next day, and eventually they starved to death.

The two dead swallows were found in a completely dry state and hence it appeared that this little tragedy must have taken place at least a month ago. It is likely that the eggs were broken by the birds during their struggle to escape from the nest; or the other possible explanation for the broken eggs might be that the starving birds helped themselves to the contents?

This unusual incident also throws some light on the roosting habits of this swallow. It would seem, at least in some cases, that the male roosts in the nest while the female incubates the eggs.

BHUJ,
KUTCH, M. K. HIMMATSINHJI
September 20, 1959.

8. THE DIFFERENT CALLS OF THE GREY PARTRIDGE *FRANCOLINUS PONDICERIANUS* (GMELIN)

Generally people are under the impression that the call of the Grey Partridge, commonly heard in our countryside, is uttered by the male alone, but in actual fact in eight cases out of ten it is the combined calls of both the cock and the hen which one hears. I have kept partridges as pets, and thus have had the opportunity to study their different calls at close quarters. These I shall now try to describe.

There are mainly two types of calls which are uttered by the male. Generally they are preceded by low clucks or chuckles uttered several times at intervals of a few seconds, each successive cluck rising in intensity. This is followed by the high-pitched *kili ka ka ka kili ka ka ka* or *kila kila kila* repeated in quick succession. While fighting or challenging, rival males also utter a sharp *pila . . . pila . . . pila* at intervals of two to three seconds. The female sometimes utters low chuckles also, but these are not as sharp as those of the male. The usual call of the female is a very high-pitched monosyllabic *tee tee tee* repeated several times. She also says *kila kila kila* like the cock, but this call, though similar, is softer and more sharp in comparison. Normally, when the male calls the female joins him and combines her *tee tee* with his *kili kaka* or *kila kila*; and so when they call in unison it sounds like *kiliaak killak killaak* or *kateela kateela kateela.* In the former call, i.e. *kiliaak*, the first syllable of the male's call is uttered simultaneously with the *tee* of the female followed by the *likaka*, while in the latter, i.e. *kateela*, the *tee* of the female is uttered a fraction of a second after the *ki* of the

male, and hence this combined call sounds like *kateela kateela kateela.*

Apart from the above calls there is also a very sharp and high-pitched alarm call which sounds like *tirrr tirrr tirrr* repeated quickly when partridges are flushed by a bird of prey or any animal. When danger is suspected, *chirrr . . . chirrr . . . chirrr* is repeatedly uttered at intervals of between two to eight seconds. This short alarm call is usually continued to be sounded by the birds until they are satisfied that the danger, whether real or imaginary, has passed. When partridges have young chicks with them the above calls are uttered more often. As soon as the parents sound the alarm notes the young ones rush for cover, and they remain quite still until called out by the parent birds with a soft *kunva kunva kunva* which is answered by the shrill *ti ti ti . . . ti ti ti* of the chicks, audible at some distance. These calls of the parent birds are repeated, and the little ones also continue with their tiny calls until the whole family is re-united. Young males sometimes make their first attempt to call when they are between three to eight weeks old.

BHUJ,
KUTCH, M. K. HIMMATSINHJI
September 28, 1959.

9. THE OCCURRENCE OF THE WHITENECKED STORK [*CICONIA EPISCOPA* (BODDAERT)] IN THE KASHMIR VALLEY

Early in the morning of May 15 1959, when I was walking along the Dal Lake in Srinagar, a solitary Whitenecked Stork was observed opposite to Oberoi Palace Hotel (altitude about 5200 ft.).

The occurrence of the Whitenecked Stork in the Valleys is noteworthy since it marks an extension of its distributional as well as as altitudinal range. THE BOOK OF INDIAN BIRDS mentions that it occurs up to an altitude of 3000 ft. above sea-level. Osmaston (Notes on the Birds of Kashmir, 1927, *JBNHS* **32**) does not record it, neither do Bates & Lowther in their THE BREEDING BIRDS OF KASHMIR.

174, KASBA PETH,
POONA 2, V. C. AMBEDKAR
October 20, 1959.

[The Whitenecked Stork occurs in the Salt Range area of the Punjab and has once been recorded in Sind. As far as we are aware, the above is the first published record for Kashmir.—EDS.]

10. LARGE CLUTCH OF NAKTA EGGS

K. S. Shivbhadrasinhji informed me that he had found a nest of a Nakta duck (*Sarkidiornis melanotus*) containing a large quantity of eggs on 21st August 1959 at his farm at Hathab, Gohilwad District, about 18 miles from Bhavnagar.

So on 25th August 1959 he and I went to see the nest. The nest-hole was in a bifurcated trunk of a mango tree. There were two mango trees close to each other, one of which contained the hollow in which the eggs were laid. The trees were situated in open grassland with clusters of other mango trees here and there. A small pond of dirty rain water, the only suitable pool in the neighbourhood, was 300 yards from the nest-hole. The nest-hole was 70 inches from the ground, the diameter of the entrance was 9 inches and the hollow 45½ inches deep. The bottom of the nest-hole was slightly wider, had a separate narrow exit leading upwards to a broken stump, the width at the base being 6 inches. The nest-hole was mostly lined with soft down mixed with sand debris and contained 54 (fifty-four) eggs. We consider this to be an unusually large number, perhaps a record for one nest, the product of at least three or more females. A. Anderson found a nest with 40 eggs, and Livesey in Kotah, Rajasthan, found one with 47 (Baker, NIDIFICATION **4**: 490). The latter thought that it was the product of two or more females.

Taking into account other observations in the vicinity of the nest-hole within a week, we saw one male Nakta and four females, and one day the drake had with him five ducks. We made a search of the neighbouring trees for nests but could not find any and the one which contained the eggs appeared to us as the most suitable site for the Naktas. Therefore, a communal nesting appears to be the obvious answer when suitable nest-sites are wanting. Later, owing to human disturbance, we found the Naktas had deserted the nest and a few of the eggs were cracked and smelly.

DIL BAHAR,
BHAVNAGAR, R. S. DHARMAKUMARSINHJI
August 27, 1959.

[This, as far as we know, is the largest number of eggs recorded in a single Nakta nest.—EDS.]

11. ADDITIONS TO THE BIRDS OF KUTCH

During recent field work in the neighbourhood of Bhuj (15-30 September) in connection with the Society's project of ringing birds for migration study, the following species were recorded as new for Kutch:

1. **Locustella naevia straminea** Seebohm: The Eastern Grasshopper Warbler.

Winter migrant from northwestern central Asia to practically all India. Previously recorded from Gujarat and Saurashtra.

2. **Phragamaticola aedon** (Pallas): The Thickbilled Warbler.

Winter migrant from Siberia from Tomsk to Manchuria, and N. China. An unexpected find as hitherto known only as a visitor to NE., E., & S. India, presumably migrating from the eastern side.

Two specimens were taken in mist nets near Bhuj on 26 and 29 September. Since it has never before been recorded in NW. or W. India it needs to be ascertained whether these two examples were merely vagrants—in some way under pressure of the phenomenally heavy monsoon in Kutch, Saurashtra, and Gujarat this year—or whether the species has consistently evaded collection or observation in the past. It may be mentioned that but for the fact of their getting caught in the mist nets the birds would most certainly have been overlooked or mistaken for the Great Reed Warbler, *Acrocephalus stentoreus brunnescens* (Jerdon), to which it bears a close superficial resemblance.

3. **Ploceus benghalensis** (Linnaeus): The Blackthroated Weaver Bird.

A specimen taken in the nets, 16 September 1959 (preserved but unfortunately destroyed by a cat).

Not recorded from Saurashtra or Sind; nearest from the Baroda and Kaira districts of Gujarat. This was the only specimen (in female plumage) taken during a fortnight amongst 220 *philippinus*. It is possible that small numbers may be resident (?), or may visit Kutch under favourable conditions produced in years of heavy rainfall. Before the specimen was obtained I had observed (on September 7) two nests (this year's) presumably abandoned owing to flood. They were typical of this species both as to structure and site, but no birds were present to confirm their identity.

33 Pali Hill,
Bandra,
Bombay 20,
October 30, 1959.

SÁLIM ALI.

12. ADDITIONS TO THE BIRDS OF TAMBARAM, (CHINGLEPUT DISTRICT, S. INDIA)

Alice M. Barnes has recorded (*JBNHS* **40** : 467-476 and 744-747) eighty-four species of birds noticed in and around Tambaram during the years 1932-1939. During my stay here since 1945, I have noticed some more birds, the addition of which to the bird list of Tambaram may be of interest to bird watchers in this locality:

1. **Dicrurus caerulescens** (Linn.) The Whitebellied Drongo.

Often seen in the college estate either singly or in pairs from October to December. Habits very much like the Black Drongo's. Sometimes noticed in the company of other insectivorous birds like bee-eaters and shrikes. One was observed lying in wait and snatching away a mole cricket scratched out of a gutter side by a domestic hen.

2. **Anthus rufulus** Vieillot The Indian Pipit.

Observed only once late in the evening on 12-10-1957 feeding in the grasslands adjacent to the Selaiyur tank bed.

3. **Crocopus phoenicopterus** (Latham) The Common Green Pigeon.

One was seen in the garden one evening in March 1957.

4. **Sterna aurantia** Gray The River Tern.

Common from February to April when the surrounding tanks begin to dry up. Can be seen flying overhead in flocks of 2-12, but are known to alight only at the larger Agaram tank.

5. **Himantopus himantopus** (Linn.) The Blackwinged Stilt.

Common on all the local tanks from February to April, feeding in the shallow receding waters.

6. **Phalacrocorax niger** (Vieillot) The Little Cormorant.

Only one, probably an accidental visitor, was once captured in 1946 on the Kadaperi tank.

7. **Ardea cinerea** (Linn.) The Grey Heron.

Observed twice on the Selaiyur tank. Once in July 1957 and later on 24-3-1959. Usually single, right in the middle of the tank, rather late in the evenings.

8. **Egretta intermedia** (Wagler) The Smaller Egret.

Noticed only once on 4-2-1958 on the drying up tank at Amruthapuram near the Tambaram Sanatorium station.

9. **Nycticorax nycticorax** (Linn.) The Night Heron.

Never seen them alighting on the local tanks but groups of 2-6 can be seen flying overhead every day at dawn and at dusk from January to April.

DEPARTMENT OF ZOOLOGY,
MADRAS CHRISTIAN COLLEGE, P. J. SANJEEVA RAJ
TAMBARAM,
July 14, 1959.

[Since the above two more species have been added to the Tambaram list by Mr. Gift Siromoney of the above college as follows:

1. **Dumetia hyperythra** (Franklin) The Rufousbellied Babbler.
A small flock in the garden on 16-9-1959.

2. **Motacilla indica** Gmelin The Forest Wagtail.
A group of 5 on 25-9-1959 and a single on 27-9-1959.

He also gives the description of a bird which was evidently

Lanius cristatus Linn. The Brown Shrike.
Single on wires on 19-10-1959.—EDS.]

13. SOME BIRDS OF CHINGLEPUT DISTRICT, MADRAS

I send here a note on a few birds seen recently around here which are not very commonly observed:

1. Laggar Falcon: *Falco jugger.* Once seen by A. Krebs and myself near the hills south of this town (Chingleput) and again near the western foot of the same hills in early December. On this occasion it stooped very fast from a height and struck down a myna near the bank of a channel. It dragged its victim on to the bank below the bund on which I was standing, and plucking it proceeded to make a meal. Its large size and powerful build and the distinctive colouring easily visible at such a short distance were clear guides to its identity.[1] (Only 2 records—one Chingleput District and one Wynaad.)

[1]The records in brackets are from The Vernay Scientific Survey of the Eastern Ghats, Ornithological Section, by H. Whistler and N.B. Kinnear, and The Birds of Mysore, by Sálim Ali, published in previous volumes of *JBNHS.*

2. Small Indian Swallow-Plower or Pratincole *Glareola lactea.* A dozen of these small plovers drew my attention as they moved on the sandy bed of the Palar River SW. of Chingleput, and thinking they were Ring Plovers I was puzzled by the lack of rings. As more flew in bands of 30 or 40 their almost tern-like long wings, black-tipped tail, and general appearance showed them to be something quite different. The problem of their identity was solved the next day (25th Dec.) when I saw the fine coloured plate in Henry's BIRDS OF CEYLON.

On the sand the birds nestled low or stood, occasionally moving forward in little spurts. The general appearance of the bird is grey with the dark stripe from beak to eye very conspicuous, the chest sandy or buff in colour. At close quarters the white ring round the eye is very conspicuous. Even when at rest the dark tips of the long wings stand out, while in flight the dark primaries and dark-tipped tail contrasting with the white tail coverts prevent false identification.

I estimate that more than 100 were gathered when the light faded. A few days later none were to be seen.
('Godaveri Delta', Mysore, 'Mangalore'.)

3. The Tufted Duck: *Aythya fuligula.* A small party of 9 of these were seen by me on the P. V. Kalathur tank near here on 1-1-59. They were fortunately unusually close to the bund when we appeared. They then paddled off very smartly for the middle of this large tank. Their tubby form, large head (only some had crests), prominent eye, and the striking black and white of the drakes were immediately recognisable, though my last view of these ducks was on a pond in Edinburgh. They have apparently only once been recorded in Ceylon and I myself have not seen them before in these parts. ('North Coimbatore, Vizag, Godaveri, Kistna, Chingleput, Chittore, and Bellary', Mysore.)

4. Spottedbilled Pelican: *Pelecanus philippensis.* On 13-3-59, the watcher at Vedanthangal informed me that no pelicans had been seen this season. Half an hour later, at 5.30 p.m., one appeared and after circling round for a while settled in a tree well in the middle of the tank.

CHURCH OF SCOTLAND MISSION,
CHINGLEPUT,
S. INDIA,
March 14, 1959.

REV. E. O. SHAW, M.A.

14. BIRDS EATING POISONOUS FRUIT OF YELLOW OLEANDER (*THEVETIA NERIIFOLIA*)

Earlier, Krishnan has reported in the *Journal* (**50**: 943-944 and **52**: 207) the Koal (*Eudynamys scolopaceus*) and the Common Myna (*Acridotheres tristis*) eating the fleshy mesocarp of the fruit of the Yellow Oleander. Subsequently, Neelakantan (*JBNHS* **51**: 738) has noted the same habit in the Common Grey Hornbill (*Tockus birostris*) also.

About the end of August, ripe fruits were dropping to the ground from a single Yellow Oleander in front of my house and, for two days alone, I was noticing the Redvented Bulbuls (*Molpastes cafer*) and the Whitebrowed Bulbuls (*Pycnonotus luteolus*) frequenting the plant for the fruit. These birds are abundant in the surrounding 300-acre scrub jungle of the college estate. Only on a single occasion, did I see a Redvented Bulbul pecking at a fruit on the plant, otherwise, they seemed to prefer the ripe ones fallen on the ground underneath. Each bird would eat about half of the fleshy part of the fruit which it pecked at and tore off with its beak. Sometimes while in fear of intruders, it carried off the fruit to safety in a near-by hedge. I noticed several Common Mynas also approaching the ripe fruit but, strangely enough, none of them touched it.

I feel that the preference shown by birds for the ripe fruits is probably due to the lesser amount of latex they contain than the raw ones. Even then it is not every bird, but only an occasional individual that relishes the fruit. Unfortunately, we have no evidence of the effects of eating such poisonous fruit on the birds concerned, either good or bad.

DEPARTMENT OF ZOOLOGY,
MADRAS CHRISTIAN COLLEGE, P. J. SANJEEVA RAJ
TAMBARAM,
S. INDIA,
September 22, 1959.

15. *CALOTES* LIZARD OCCUPYING BIRD'S NEST

At Jodhpur there was a small nest of a bird (?) in a *Capparis aphylla* bush which was being searched for snakes and small mammals at midnight. The net was examined and found to be occupied

by a lizard, *Calotes versicolor*. It was carefully captured, identified, and marked with indelible ink. Next evening it was released near the bush. The nest was again examined late in the night and found to be occupied by the same lizard. During the day the nest, which appeared to be abandoned by the owner, was always found vacant. It was only a nightly resort of the *Calotes*, which was observed living there for about a week after which it disappeared.

Department of Zoology,
Maharaja's College, ISHWAR PRAKASH
Jaipur,
May 1, 1959.

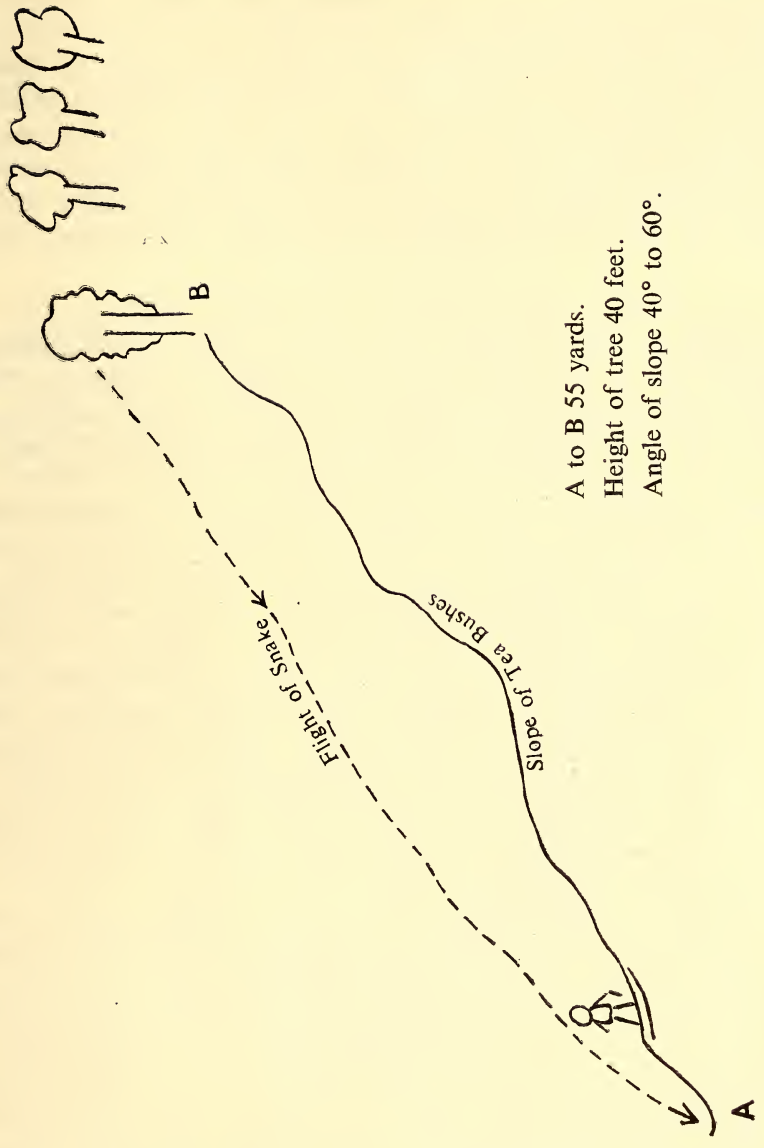
16. FLYING SNAKES

(*With a text-figure*)

I have to report an extraordinary occurrence which happened to me on 16th June 1959.

While walking along a path on my tea estate I saw a snake hurtling through the air towards me on a diagonal trajectory from right to left. When I first saw it, it was about 20 feet above ground level and appeared to have launched itself from a rosewood tree on the slope of 30° above me and some 50 yards away. It came with a furious swimming motion keeping itself perfectly horizontal, and as I drew back whipped past about five feet in front of me at chest level and landed below me between two tea bushes and some five yards away. It lay on a heap of weeds perfectly still, and I was able to observe that it was about 2½ feet long, thin, and coloured yellowy brown with red, black, and white markings on its back. After a few minutes I clambered down the bank to kill it but at the first blow with my stick, which landed towards its tail, it shot off into the bushes. I was unable to observe its head which was in the shadow and behind a branch.

I have never heard of a 'flying snake' or one that could launch itself such a distance and at such a height and anyhow why should it do it? On the other hand if it had been dropped by a bird of prey it would have fallen straight down and not been trajected across my line of vision?



This estate is in the South Wynaad and the average elevation is about 3000 feet.

CHEMBRA ESTATE,
CHEMBRA P.O.,
VIA MEPPADI,
MALABAR,
June 17, 1959.

K. H. VAUGHAN-ARBUCKLE

[Elaborating the note our correspondent sent us the above sketch drawn from measurements taken later.

The snake concerned could be the Golden Tree Snake *Chrysopelia ornata* which occurs in the W. Ghats south of Goa. In the *P.Z.S.* for 1906 (pp. 227-230) are described some experiments with this species. The ventral scales are narrow and the belly can be pulled in to show a concavity in cross section thus giving the snake leaping from a height the same buoyancy through space as of a split bamboo.—EDS.]

17. THE FOOD OF THE BULL FROG

During my stay in Poona, when I kept quite a lot of snakes in captivity, I used to catch frogs and toads regularly to keep the snakes alive. On one occasion I picked up a rather gigantic specimen of *Rana tigrina*, and though I had my doubts that my pet Dhaman (of 8 feet in length) would make the necessary exertion to swallow the huge frog, I put it in with the snake anyhow to see what would happen.

As I had thought, the snake did not even try to eat the frog, and the two animals seemed to get along pretty well, the frog sitting all day in the water bowl provided for the snake. After a week, realising that the snake had to eat something anyhow, I threw in a sparrow. Next day the sparrow was gone, and I thought that the dhaman had eaten it. After three or four days another sparrow, and then a third. All down the snakes throat, so I thought. But for the third sparrow I came back after an hour, and was surprised to find no 'bump' in the snake's belly where the sparrow should have been. I thought that rather funny, because a freshly eaten sparrow always showed a swelling in the stomach in the past.

This time I waited a whole week, and then brought a sparrow along to the large glass-fronted snakebox. And then I witnessed a nauseating sight. As soon as the sparrow fell into the box it made for the glass, thinking it would get through, and at that very instant the huge frog made a frantic dive for it, missed, dove again, missed again. I first thought that the frog was merely frightened by the sparrow and so was jumping around in fear. But in the fourth or fifth try the frog had the sparrow caught in between its jaws, and then using both its forelegs like hands it just shoved the bird into its mouth, pushing first left and then right, left and right, till the bird was entirely within the mouth and throat. Then with an awful effort it gave a mighty swallow, and down went the bird.

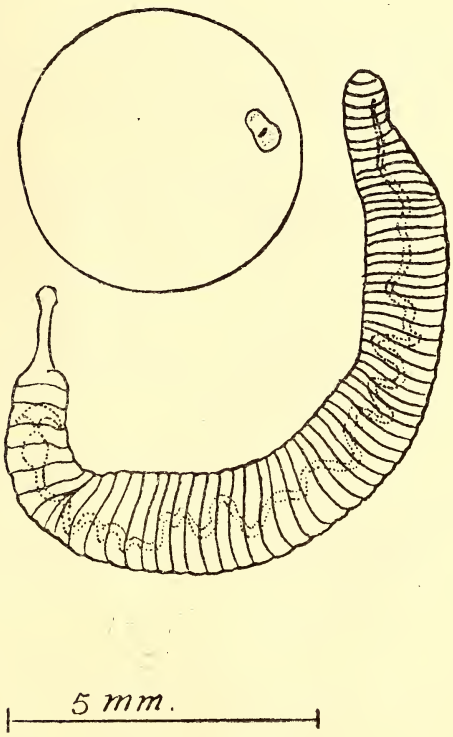
CATHOLIC CHURCH,
RAJ-ANANDPUR, BIHAR, RICHARD LANE SMITH, S.J.
July 27, 1959.

[Several notes have appeared in the *Journal* from time to time on the exceedingly varied nature of the bull frog's dietary. Reference is invited to p. 213 of Vol. **52** (1) where some of the foods previously recorded have been summarized.—EDS.]

18. A PRELIMINARY NOTE ON THE CULTURE AND DEVELOPMENT OF INDIAN EARTHWORMS

(*With a text-figure*)

The role of the earthworm is controversial. Some regard it as beneficial, whereas others consider it a pest and recommend measures for its elimination. Thus, about three years ago, the Smithsonian Institution recorded the invasion of the eastern United States by a 'Plague' *Pheretima lupeinsis* or the green earthworm.



Pheretima houlleti 24 hrs. after hatching, with capsule.

One reason for the controversy is perhaps the fact that there are many types of earthworms, some beneficial and some otherwise. Hence, the cultivation and breeding of a few selected types has been

undertaken abroad. In India, this aspect has barely received attention, though others are fairly well represented. Thus the monumental work of the late K. N. Bahl deals mainly with Systematics & Anatomy, while J. V. Bhat, N. V. Joshi, and others have concentrated on the intestinal microflora. Shrikhande & Pathak in Kanpur, and Nijhavan & Kanwar in Ludhiana have studied the physico-chemical properties of earthworm castings and the latter team has compared them to those of other insects. Such studies are of the greatest importance in India where nitrogen, in particular, is in short supply and its addition to the soil in the inorganic form is subject to losses by way of leaching, base exchange, and volatilization. The cultivation and breeding of a few select types of earthworms which may produce good manure is thus important to our agronomy.

Work along these lines has advanced so much in other countries that the following can be only a very sketchy review of the same.

Thus, according to the U.S. Dept. of Agr. Exp. Sta. Record **27**, No. 6 (2), it is estimated that earthworm castings deposited during an active growing season of 6 months of the year (in the valley of the White Nile in the Sudan) amount to 239,580 lb. (119.79 tons) per acre.

Wolney has found from direct experiments in culture boxes that the ratio of higher production in the presence of worms varied from 2.6 per cent in Oats to 63.9 per cent in Rye, 135.9 per cent in Potatoes, 140 per cent in Vetch, and 300 per cent in Field Pea to 733 per cent in the case of Rape.

Bafile (1950) has concentrated on the industrial production of humus by earthworms, and Grant (1955) has expanded upon the subject of earthworm breeding farms.

In our own country Joshi (1954) has made a beginning by noting the improvement in black cotton soils due to increased nitrification resulting from earthworm activity.

Experiments conducted so far (unpublished) by the junior author, with castings of *Pheretima houlleti* seem to indicate a fair amount of ammonification in culture flasks.

The procedure given below has been adapted, in part, from Barrett:

Earthworm Culture

Wooden boxes (11″×7″×8″) are filled with garden soil, cowdung, and straw in equal quantities (by volume) and topped up by an inch-thick layer of dried leaves. The upper surface of the leafy layer is then covered by gunny cloth. The boxes are supported on two bricks in a metal tray containing water to prevent attacks from insect

predators like red ants. A population of 250 mature earthworms can be supported by a box of this size. Accordingly they are collected and after preliminary screening, 250 healthy specimens are distributed per box. The boxes are to be watered at regular intervals, avoiding water-logging. (A two-inch layer of crocks and pebbles arranged in the bottom of the box prior to filling up provides good drainage).

The contents are examined at monthly intervals. If a few cocoons are detected then the examination is repeated every week in order to collect the full quota of cocoons. If on the other hand, many young ones are observed then the cocoons can be taken to have hatched during the interval. If allowed to remain, the cocoons will produce young worms in the course of time. If embryological studies are in view then the following method is recommended.

10-12 cocoons are distributed over layers of moist filter or blotting paper kept in the bottom of 8″ petri dishes. The sheets are moistened with a weak watery extract of soil from the earthworm box. The young worms can be maintained for a few days, at least, on a diet of moist filter paper only. This, incidentally, suggests a method for studying the food habits of worms by impregnating the filter-paper with various kinds of artificial media. The excreta can then be subjected to chromatographic analysis.

The following is a list of the earthworms cultured by the method described.[1]

1. *Pheretima posthuma.*
2. „ *houlleti* (Perrier, 1892).
3. *Pontoscolex corethurns.*
4. *Hoplochoetella khandalensis* (Stephenson, 1924).
5. *Perionynx* sp.

It may here be mentioned that *H. khandalensis* could not be maintained successfully for long periods. *P. posthuma* and *P. houlleti* were selected for further study in pure cultures. Their choice was due to their importance as types for undergraduate courses.

Observations

1. *P. posthuma* prefers more organic matter than *P. houlleti.*

2. *P. posthuma* produces cocoons after a period of four weeks from maturity, whereas *P. houlleti* requires three weeks.

3. The cocoons of *P. posthuma* are brown in colour, oval in outline, and with two projections at either end of the long axis. The

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[1]We are indebted to Dr. G. E. Gates, U.S.A., for the identification.

cocoon is deposited deep within the burrow. *P. houlleti*, on the other hand, produces cocoons which are white, round, and slightly larger than those of *P. posthuma*. They are distinct from the soil and can be easily separated.

4. The hatching period for *P. posthuma* is about 30-37 days under petri dishes, while *P. houlleti* requires 25-30 days depending on the temperature and humidity. If the temperature is lowered below 28° C. and 50% relative humidity, the cocoons take a longer time to hatch, about 45-50 days.

5. Both the worms are surface casters.

6. A newly hatched animal has same segments as the adult.

7. About 20% of the cocoons do not develop; probably they are unfertilized.

In brief, it is hoped that the technique presented here will enable workers to contribute towards elucidating the role of the earthworm in agronomy. The animal is also interesting from the zoological as well as the biochemical point of view. Regeneration, respiration, and the nitrogen content of the excreta are some other aspects of importance. Lastly, it will enable teachers to provide live specimens for dissection throughout the year.

Acknowledgements

The authors wish to thank Dr. D. V. Bal, Director, Institute of Science, and Prof. Mrs. E. Gonzalves, Prof. of Botany, Institute of Science, for the facilities provided and for their constant encouragement.

Biology Department,
Elphinstone College, Bombay, V. B. TEMBE

Botany Department,
Institute of Science, Bombay, P. J. DUBASH

August 8, 1959.

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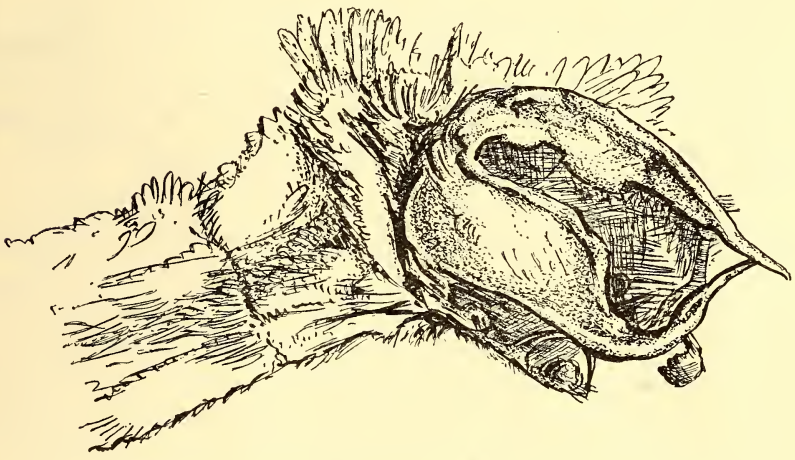
19. APPEARANCE OF *NACADUBA PACTOLUS CONTINENTALIS* FRÜH., (LEPIDOPTERA: LYCAENIDAE) AT LONAVLA, WESTERN GHATS

(*With a text-figure*)

In October and December 1956, and in November 1957 and 1958, I was fortunate in encountering this rare Line-blue butterfly on the outskirts of Lonavla, (2300 ft.) on the main line between Bombay and Poona.

I took one male only, on 12-12-1956, and a female on 14-10-1956. The next female was caught on 30-11-1957; seven on 5-10-1958, and one each on 15-10, 12-20, and 2-11-1958. There were also two females in November 1958 from which I tried to get eggs.



Clasps of *Nacaduba pactolus continentalis* Früh. (ventro-dorsal view)

All the specimens occurred in a small jungle, only about 200 by 50 yards in area, next to the Christian cemetery. I believe the vegetation here is in the climax stage; a remarkable fact in itself, for the place lies between the bazar and a region of bungalows. But the ground dips suddenly into a hollow, and so man has not cared to spoil it much. I know of no other place in the district where, at most seasons, butterflies are so thick on the ground.

I am unable to give a proper account of the plants; a complete list, eventually, may prove to be the only way of getting at the food-stuff of *pactolus*; at present I can only mention a few which I have learnt to recognize through their known connections with the Lycaenidae. The undergrowth includes a great deal of the leguminous

Mezoneurum cucullatum, the tenacious hooks of which are a great nuisance to the collector. There are also some grand full grown *Entada scandens* (Leg.). On young shoots of young plants of this species I have found larvae of the common *Nacaduba beroe gythion* Früh. Other under-plants are *Cylista scariosa* (Leg.), *Acacia* sp., and *Dioscorea* sp. Among the trees are *Pongamia glabra* (Leg.), growing only on the edge of the wood, apparently not more than six feet high, and without flowering—a botanist's problem. *Terminalia* sp. (Combret.), and *Eugenia jambolana* (Myrt.) conclude this inadequate summary of the plants.

On the identity of the butterfly I am on firm ground. I am much indebted to Mr. T. G. Howarth of the British Museum for checking the identity of the only male I caught. The clasps of the genitalia are distinctive, being in shape rather like the head and bill of a cormorant (see text-figure). It is worth emphasizing how easy it is to obtain a view such as this, sufficient to see the characteristics for identification, provided one remembers to squeeze out the genitalia while the specimen is fresh (see *JBNHS* **54** (1): 212-215 for full information about methods of examining genitalia). In the case under consideration I wanted to remove one clasp in order to see further in. But I found I must wait until I have had more practice.

When I saw Mr. Howarth I had only one female; his opinion was that this should be linked with the male. This helped me towards a confident decision on the fairly large catch of females in 1958, several of which are in excellent condition. But all, whether worn or not, show clearly the darkened veins on the disc of the upper forewing, a feature distinguishing females of *pactolus* from those of *Nacaduba hermus*. (See Wynter-Blyth, pp. 296 and 299; Woodhouse & Henry, pp. 87-88. Evans, 1931, does not mention this point.)

The following is a summary of all the data and records I have been able to get together. I am most grateful to those in charge of the major collections for so kindly easing my way both by letter and personally.

British Museum:

Type from Sikkim, Godwin Salvin Coll., 1908.
Burma: Ataran Valley, Maymyo, E. Pegu, Upper Burma, Nagas.
Assam: Khasis, Angralong.
S. India: Coorg, 9-4-1929, J. H. Yates.
'India': Coll. Hewitson.

Bombay Natural History Society:

Sikkim: Tista Valley, March, April, October, November 1949 and 1950.

Assam: Sibsagar, July 1952. All above in Souter Coll.
S. India: N. Kanara, Karwar, March and May 1920 and 1921, T. R. Bell.

Zoological Survey of India:

Sikkim: 19-10-1884, de Nicéville Coll.
„ undated „
Assam: Sibsagar, undated, Peal Coll.
Tenasserim: Dawnat, undated, de Nicéville Coll.
Bhutan: Buxa, undated, Mus. Coll.

Hope Department of Entomology, Oxford:

Standing under the name of *Nacaduba macropthalma* Fldr. are the following specimens:

1 ♂ Nilgiris 3000 ft. July 4th 1896 A.G. Cardew.
1 ♂ SE. Nilgiris 6000 ft. Coonoor, May 5th 1918 Coll. C. Donovan.
1 ♂ SE. Nilgiris 6000 ft. Coonoor, May 11th 1918 Coll. C. Donovan.
1 ♂ SE. Nilgiris 6000 ft. Coonoor, May 6th 1919, Coll. C. Donovan.
1 ♂ SE. Nilgiris 6000 ft. Coonoor, May 18th 1919, Coll. C. Donovan.
1 ♂ South India. Palni Hills, 6000 ft. Kodaikanal May 27th 1919. Coll. C. Donovan.
S. India: Coorg, Urti, 28-10-1926, female.
Coorg, Sampaje Ghat, 22-4-1929, male. Both Coll. Winkworth, and labelled *N. pactolus continenlalis.*

The only published records I have been able to find are:

A. *JBNHS* Vol. **35**, p. 105, where Yates tells of four males he took on one short stretch of road on the Sampaje Ghat in Coorg. He then thought his specimens were the first for S. India, until he saw the female in Col. Winkworth's collection. Evidently he did not know of Bell's, Cardew's, and Donovan's specimens.

B. *JBNHS* Vol. **50**, p. 287. F. M. Bailey took a single specimen at Kathmandu in Nepal on 4-10-1937. This is the most northerly record so far.

C. *JBNHS* Vol. **51**, p. 52. Sir Keith Cantlie mentions that it is not rare in the Cherra State, Khasi Hills, Assam, where it occurs from March, and in the autumn.

D. Wynter-Blyth, p. 296, mentions that there are records from the Nilgiris.

There ought to be more data obtainable from private collections, and these, with further research into the literature, would be of great use in filling out the scanty information given above.

The butterfly does seem to be rare, but the available data point to its being even more rarely noticed. Yates was of the opinion that the vast jungles of Coorg had not been thoroughly 'combed'. This I think applies too to the diminishing jungles farther north on the same ghats. An insect which is apparently not continuous-brooded can easily escape notice. Also, as with most Lycaenids, it cannot be identified until caught; and, as everyone who has tried it knows, there is usually at least one butterfly, in the course of a day's catching in thick and thorny jungle, about the identity of which one can only philosophize. One's difficulties are increased with *pactolus*, because where it does occur, it seems to keep to a very restricted area. It certainly seems to do this at Lonavla. Yates's information (see A. above) points this way. Earlier in the same article (*JBNHS* **34**: 1054) he notes that the Coorg specimens are subsp. *continentalis*, and not *ceylonicus* as might have been expected. If the species is as sedentary as it seems, it may even be that further geographical races remain to be sorted out.

The fact that I caught only one male may simply be due to some limitation in myself. At the same time, this may point to the males covering a wider area than the females, which would be normal, but in a rare species would reduce one's chances of getting them. Probably, in my case, they were sitting on leaves high up while I was catching their females down below. Or they may have been at water or damp patches; there is a good spot for this just outside the wood. Woodhouse and Henry (loc. cit.) say that the males have this convenient habit.

At Lonavla the females were flying around in a small patch of filtered sunlight at the bottom of a dell; they could be taken without great difficulty when once they settled for a moment, never for long, on leaves low down. When I missed one, it shot up to the higher levels, probably to an *Entada* creeper; after which no others were seen for a quarter-hour of precious time. Such corporate wariness could well be developed by insects living in close colonies. I only saw them between 11 and 1 in the forenoon, the usual egg-laying time for the season, if *N. beroe* is a guide.

As a matter of fact, the first female I saw in 1958 was probably looking for a place to lay. I caught it, saw it was a four-line *Nacaduba*, and realised that if it was *pactolus* I had lost a chance of discovering its unknown foodplant; which needless to say did not occur

again. I did what I could, marking the spot with a scrap of blue cloth—which is still there. The likeliest plants were: a bushy growth of *Mezoneurum* about four feet high under which the specimen had been fluttering; a poor shoot of *Entada*, trying to grow under the *Mezoneurum* bush; and a scandent *Acacia* not far away. I failed to find any eggs or larvae. I brought two live females home to Poona, and tried without success to get them to lay on a potted *Entada* seedling. At least they lived three days. I hope this will not be the end of the story.

It would be good to hear the experiences of others in this difficult matter of persuading captive butterflies to lay. There must be means of overcoming their well-known reluctance in India. It is specially important to perfect the technique for Lycaenidae, because the gaps in our knowledge of the early stages of this family in India are very large. Wynter-Blyth (pp. 496-499) gives an excellent table, comprising the whole of our present knowledge of Lycaenid foodplants, that is of only 87 out of the 438 species of the Indian region. And many of this large remainder are nothing like as rare as *Nacaduba pactolus*.

This note may fittingly conclude with a spur to our efforts. The great T. R. D. Bell knew at least something about the early stages of this butterfly, though the knowledge probably died with him. His specimens in the Bombay Natural History Society's collection have their pupa case below on the pin. They are dated 1920-21; it was two years before this that he had included notes on some of the *Nacadubae* in his series on Indian butterflies in this journal. He only mentions *N. pactolus* in passing, under the synonym *macrophthalma*, and implies that the early stages are unknown. I am indebted to Mr. Wynter-Blyth for pointing this out; he believes that Bell reared most of the butterflies he presented to the Society's collection. We cannot presume to blame Bell, who published so much, and is still our fullest authority on the habits and growth of Indian butterflies, for not having managed to publish records of the pupa, and probably of the other stages of *pactolus*. It is even possible that the information exists in MS. somewhere. Are any of his note-books still available? Meanwhile, in our fumbling way, those of us who have contracted butterfly fever, and proud of it, must go on trying.

ACKNOWLEDGEMENTS

My grateful thanks are due to the authorities of the British Museum, especially to Mr. T. G. Howarth; to Dr. Varley, and members of the staff at the Hope Department of Entomology, Oxford; to Dr. Kapur of the Zoological Survey of India, to the Hon Secretary and other officers of the Bombay Natural History Society, in particular

Dr. E. J. Silas; and to the staff at the Prince of Wales Museum, Bombay.

St. John's Mission House,
Panch Howd,
Poona 2,
June 22, 1959.

A. E. BEAN

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20. A NEW VARIETY OF THE BUTTERFLY *RAPALA NISSA RANTA* SWINHOE

Rapala nissa ranta var. **bifida.** var. nov.

Two males taken at Sadon, N. Burma in June 1926, in the Tytler collection in the British Museum (Natural History).

In colour and markings these are typical *nissa* of the form that lacks the orange patch on the upper side of the forewing and would, according to the nomenclature used in the Museum arrangement described in paragraph 2 below, be called *nissa ranta* f. *ranta.* I dissected them because at that time my knowledge was confined to the mistaken statement in Evans's IDENTIFICATION OF INDIAN BUTTERFLIES that all *nissa* in Burma had orange patches and were *nissoides.* The cleft between the conjoined clasps of the Sadon specimens extends to half way down the clasps; in other words the total length of the clasps is double the depth of the cleft. In all forms of *nissa* hitherto known the length of the clasps is three and a half times the depth of the cleft. The difference is very noticeable to the eye. Corbet in *Proc. Roy. Entom. Soc.* (B) **8** (6), June 1939 figures clasps of some species and relies on the fixity and constancy of differences of depth of cleft between the species. The cleft of *nissa* is shallower than that of other species except *buxaria*—now called *rectivitta,* for which see below—but is not actually so shallow as is shown in the figure in Corbet, who selects the form *nissoides* as his example.

I hesitate to treat these two specimens as a new species on this evidence alone, so describe them merely as a variety. If more be found they may prove then to be a distinct species.

2. The subspecific name *ranta* is used according to the present arrangement of *nissa* by Corbet in the British Museum. The name

rectivitta Moore was applied by Evans to the Common Flash of Sikkim and Assam, but Corbet has reverted to the view of Swinhoe in LEPIDOPTERA INDICA that *rectivitta* is the older name for the Shot Flash which de Nicéville called *buxaria*. The type of *rectivitta* is not now discoverable in the Museum though Swinhoe wrote that he saw it there. But in the Museum drawer is a specimen of the Shot Flash from the Swinhoe collection with a label '*rectivitta* compared with the type' in the handwriting of Swinhoe.

In the British Museum collection the species *R. rectivitta* Moore 1879 (=*buxaria* de Nicéville, 1888) is separated from *R. nissa* Kollar 1848 by *R. rosacea* de Nicéville 1888 (easily distinguished by its vinous red underside). *R. nissa* is divided into two subspecies:

(1) *R. nissa nissa* Kollar. Confined to NW. Himalayas,

(2) *R. nissa ranta* Swinhoe, 1897. Sikkim, Assam, Burma.

The various varieties of ssp. *ranta* are recognisable as follows: If there be no orange path on the forewing upperside, the name is *nissa ranta* form *ranta*; if there be an orange patch the name is *nissa ranta* form *maculata*. (*Maculata* is a name taken from Seitz 1910 applicable to any *nissa* of any ssp. with an orange patch). In Burma those with a very large orange patch, all being from Hsipaw and Yenwentang, Shan States, are labelled *nissa ranta* form *nissoides* Swinhoe 1910. Those with an orange patch, sometimes very faint, of moderate or small size, are *nissa ranta* form *maculata*. Those from Burma without an orange patch are labelled *nissa ranta* form *ranta*. The existence of any form in Burma except *nissoides* was unknown to Evans in 1932. Most were got by Tytler, and I have found more from Loimwe and Kalaw in his material. Dissections exhibit the depth of cleft normal for *nissa*; only the two from Sadon show a deep cleft.

(3) The use of the term *ranta* should be explained. Swinhoe in LEPIDOPTERA INDICA 1897 thought *nissa* with or without an orange patch extended from the NW. Himalayas to Burma. He got three specimens from the Jaintia Hills (Assam) without orange, differing somewhat in colour and strength of markings, and named them *Rapala ranta*. In Corbet's arrangement *nissa nissa* is confined to the NW. Himalayas and *ranta* is taken as the subspecies occurring from Sikkim to Burma embracing those without and those with an orange patch, these being further distinguished by the form names *ranta* and *maculata* respectively.

5, UPPER WIMPOLE ST.,
LONDON W. 1,
August 26, 1959.

KEITH CANTLIE

21. INFESTATION OF BANYAN TREE BY CATERPILLARS OF THE MOTH *HYPSA FICUS* FABR.

In the first week of April 1959, I noticed that a large *Ficus bengalensis* ('Bargat') tree was covered with caterpillars eating the young leaves. It would seem that the caterpillars emerged from their eggs about March 28th. It was noted that the shoots started sprouting, growing light green leaves on this tree and others near by, about March 12th. At that time weather conditions were hot and close: rain followed on the 30th March, 0.48 inches, and on the 31st March, 0.42 inches. Frass was falling all around the spread of the tree, some 120 feet in diameter.

Large caterpillars started moving off the tree about April 13th. At this time a type of dipterous fly was found hovering over the caterpillars most of the day. The largest, sluggish caterpillars were unable to stop this fly from making a temporary stop at one side of the body, but the younger caterpillars, at the approach of a fly, were able to wag the top half of their bodies violently which kept the flies off and they promptly moved on elsewhere.

Eventually all but the mid-rib of the leaves which were able to grow to some size before the caterpillars became large fell off in 4 or 5 days' time after the leaf had been eaten. Except for one or two Magpie-Robins (*Copsychus saularis*) which seemed to take a few caterpillars early morning, birds were not interested. At this time Mynas [*Aethiopsar* ?] were around in great numbers, migrating uphill.

The larger caterpillars started pupating about mid-April, most down around the roots of the banyan. Many entered the verandah and outer rooms of a near-by cottage. The chrysalids were to be found in rough nests made by the caterpillars of paper, cotton, blanket, gunny-sack 'wool'. Other chrysalids were found uncovered and plain in tins and boxes.

The caterpillars were about 45 mm. long at the final moult. They had hair over the body which was marked by a yellow central band and with two black bands along the two sides. The chrysalis was nearly 20 mm. long and of a dark brown colour. Moths emerged about April 24th. The moth was about 20 mm. long from head to tail, with a wing-spread of from 50 to 60 mm. The upper-forewings are coloured brown/grey with thick light-coloured veins. The wing-cells and head/body are coloured yellow with white patches containing black dots. The underforewings are light brown with a yellow

and white patch nearer the body. The hind-wings were of a light grey colour having a yellow patch near the body.

The moth has been identified by the Bombay Natural History Society as above.

The pupa of the dipterous fly was about 7 mm. long while from head to tail the length of the fly is near 6 mm. with a wing-spread of about 12 mm. The specimen sent for examination was identified as a wasp of the genus *Brachymeria* but, as it was damaged, the species could not be determined. This parasite has apparently not been recorded from *Hypsa ficus* before.

The tree stands at some 2000 feet elevation, at the foot of the first Himalayan range, some 3 miles east of Kathgodam, NE. Rly., Naini Tal District, Kumaon, U.P. It was not until about 9th May that the tree started to sprout young fresh shoots which developed slowly, giving only about 25% of the usual shade it gave at this time of the year, mid-May.

Since writing the above, I noticed that another large tree, some half-mile away in the orchards, also had its young leaves eaten by the same type of caterpillar. Villagers mentioned that some other trees about half a mile further from the village were also attacked.

Most banyan trees in the forest near by were not attacked, as also one near the cottage—a seven year old banyan—and another larger and older tree with a spread of about 150 feet. This is the first time in about 25 years that I have found caterpillars feeding entirely off such banyan trees.

During the last four years there had been much extraction of timber, sal, haldu, jaman, etc., with the burning of charcoal in this area by the Forest Department. It could be that some new crops recently introduced, not usually grown hereabouts in the past, such as Sunn hemp or Arhar dal, attracted this pest. Perhaps egg-laying moths may have come down from the flora of the hillside above, the top ridge of which is about 2000 ft. higher. The main crops grown by the farmers within a three mile radius are wheat and rice.

THE ALLEN ORCHARD ESTATES,
BHOWALI P.O., P. R. SHERRED
KUMAON, U.P.,
July 20, 1959.

22. IDENTITY OF THE LADYBEETLE, *EPILACHNA IMPLICATA* MULSANT, FROM INDIA (COCCINELLIDAE: COLEOPTERA)

(*With two figures*)

The ladybeetle, *Epilachna implicata* Mulsant, was first described in 1850 from India by Mulsant who regarded it as allied to *Epilachna vigintioctopunctata* (Fabr.) and superficially resembling a variety of the latter. He, however, pointed out the differences in respect of the disposition and sizes of the black elytral spots by which the two species could be distinguished from each other. In view of the almost infinite variation of spots in *E. vigintioctopunctata*, Crotch (1874) considered *E. implicata* to be a mere variety of the latter. This nomenclatorial status of *implicata* has ever since remained unchanged in literature, as may be seen in the works of Mader (1927) and Korschefsky (1931). Although Dieke (1947) gave a monographic account of *Epilachna* (*sens. lat.*) in Asia, Europe, and Australia, he made no reference to *implicata* either as an independent species or as a variety of *E. vigintioctopunctata* of which he gave an extensive account from India and elsewhere under the name *Epilachna sparsa* (Herbst).

Mulsant (loc. cit.) described *E. implicata* from the material in the collections of Germar and Schaum, Hope, Reiche, and Westermann. As was generally the practice in those days, he did not designate any single specimen as the 'type' or the 'holotype'. Consequently all the examples of *E. implicata* in the above-mentioned collections are syntypes. The one in Prof. Hope's collection at the Oxford University Museum was lately obtained on loan through the kindness of Prof. G. C. Varley. It tallies in the main with Mulsant's description and has, on detailed examination (including that of its genitalia), proved to be quite distinct from *E. vigintioctopunctata* or any of its known varieties. I have since designated this example as the 'lectotype' and give below a brief redescription of the species. The lectotype bears the locality label 'Mysore' and is a female.

Through the courtesy of Dr. M. Puttarudhriah, Government Entomologist, Department of Agriculture, Mysore State, I was also able to obtain some material of *Epilachna* spp. from Bangalore and found in it a series of nine examples of *E. implicata* collected from the cucurbit *Coccinia indica*. The material of *E. vigintioctopunctata* was on the other hand collected from solanaceous plants like the brinjal and potato. As both the males and females were represented in the above-mentioned series of *E. implicata*, a study was also made of the

male genitalia with a view to give further distinguishing characters of the species.

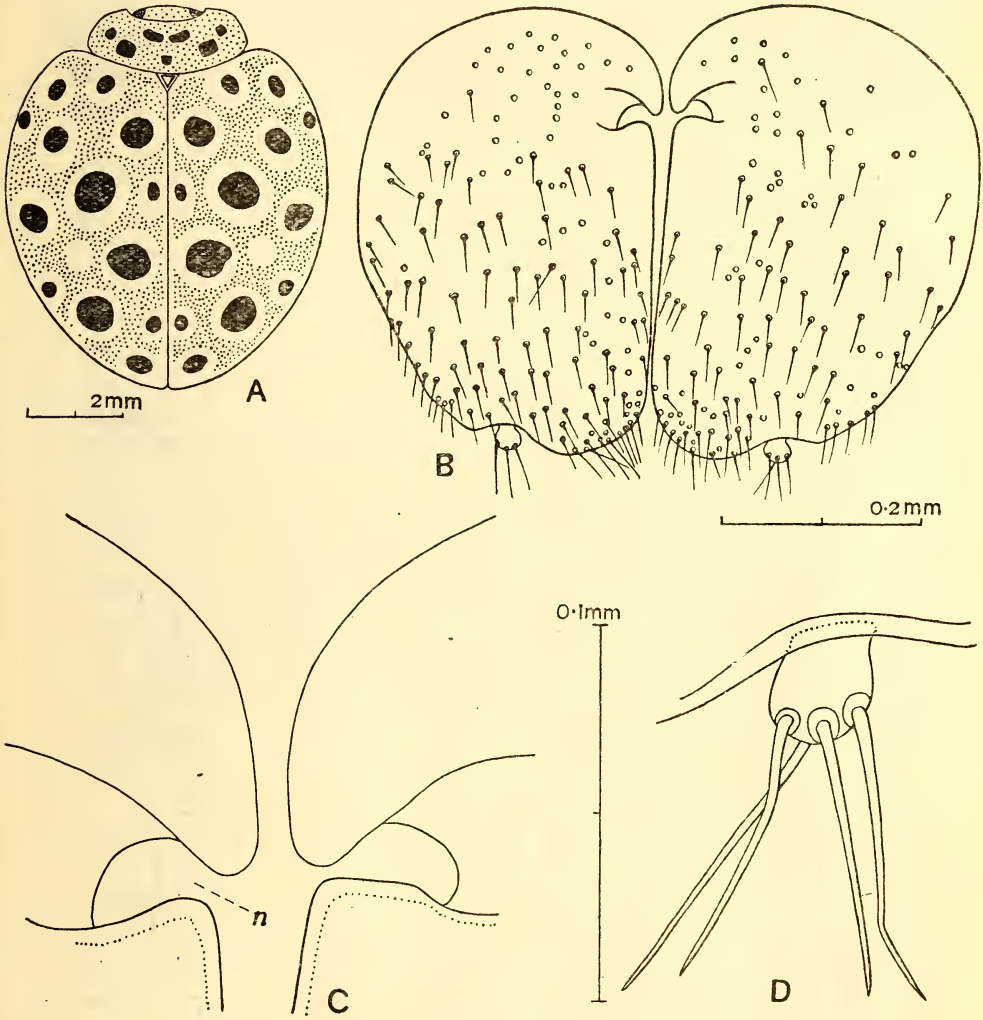

Figure 1. *Epilachna implicata* Muls. (♀, Lectotype).

A. Outline of body and pattern of markings. *B*. Female genital plates (ix sternite). *C*. Inner notches of the genital plates, much enlarged. *D*. Stylus of the genital plate, much enlarged.

0.1 mm. scale for figures C & D.

On account of the harmful association of *E. implicata* with *Coccinia indica*, the fruits of which are used as a vegetable, this ladybeetle is likely to feature in literature on economic entomology. It seems desirable, therefore, that its systematic position be clarified and its possible confusion with *E. vigintioctopunctata* avoided.

Epilachna implicata Mulsant

1850. *Epilachna implicata* Mulsant, *Ann. Soc. Agric. Lyon* **3**, pp. 837-838.

Body similar in general appearance to *E. vigintioctopunctata* but slightly larger, more convex and rounded; generally testaceous with the black spots on the pronotum and elytra of the lectotype as shown

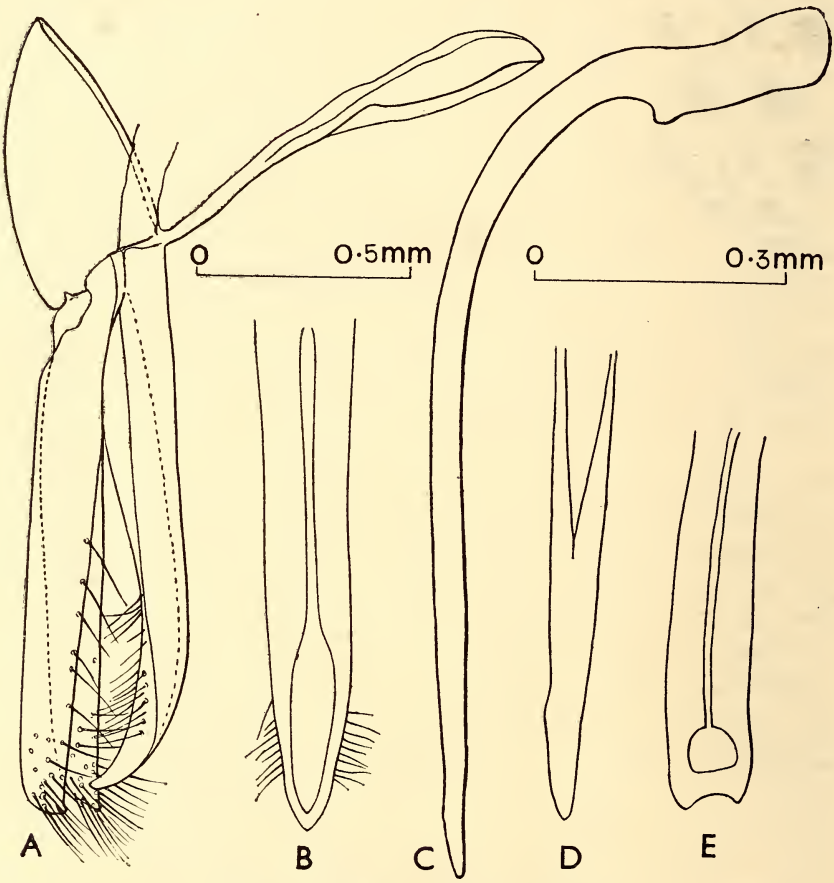

Figure 2. *Epilachna implicata* Muls.

A. Lateral view of external male genitalia except sipho. *B*. Outline of median lobe as seen from below. *C*. Sipho, lateral view; *D*. Apex of the same much enlarged; *E*. Apex of sipho seen from below, much enlarged. 0.5 mm. scale for figures A—C; 0.3 mm. scale for figures D & E.

in Figure 1, A; each elytral black spot invariably surrounded by a light yellow ring. In certain other examples instead of the seven pronotal spots as seen in the lectotype, only five (as a result of the coalescence of the central three spots into one) or six (as a result of

fading away of the posterior central spot) are present. Likewise instead of the thirteen black spots on an elytron, as in the lectotype, certain examples may have fourteen black spots, but in such cases the relative size and position of the spots remain almost unchanged. Underside with a pair of small, piceous spots on the metasternum and median three abdominal sternites. The lateral margins of pronotum are rounded anteriorly but gradually become subparallel in the posterior half. In *E. vigintioctopunctata,* on the other hand, the lateral margins are uniformly rounded. Another character by which the two species may be easily distinguished is that the apical angle of the elytron is rounded in *E. implicata* and distinct in *E. vigintioctopunctata.* It may, however, be mentioned that there are also other Indian species, e.g. *Epilachna dodecastigma* (Wied.) and *Epilachna septema* Dieke, in which the apical angle of the elytron is rounded. Caution must therefore, be exercised in distinguishing *E. implicata* on this character alone. The external genitalia offer the most reliable characters in identification of the species.

♀ *genitalia* (Lectotype): The female genital plates (Fig. 1, B) rounded proximally, slightly narrowed but rounded distally; length 0.44 mm., maximum width 0.31 mm.; the notch on the inner margin fairly deep, subrounded, with a narrow, slanting opening; an enlarged view of the same (Fig. 1, C) shows both the upper and lower lips of the opening (*n*). In the case of *E. vigintioctopunctata,* on the other hand, the notch in the genital plate is wide and the upper lip absent. The pear-shaped stylus (Fig. 1, D) at the distal end of the genital plate bears three or four long setae.

♂ *genitalia:* Sipho (Fig. 2, C) gently curved near the base, from then on straight and gradually narrowed distally to a point if seen in profile (Fig. 2, D). In this respect it is very similar to that of *E. vigintioctopunctata,* but can be easily distinguished from the latter when seen from below on account of its flattened surface and widely emarginate apex (Fig. 2, E). In *E. vigintioctopunctata* the apex of sipho is narrowed and pointed all round. Parameres and basal piece are nearly similar to those of the latter but the median lobe is quite distinctive; when seen in profile (Fig. 2, A). the underside of median lobe is straight in the basal two-thirds of its length and gently curved up to a pointed apex in the apical one-third; the upper side is with a narrow vertical blade-like ridge which starts at the base of the parameres and is gradually narrowed distally to end at the middle of the length of the median lobe; the distal half of the latter bears two rows of long hairs. Seen from below (Fig. 2, B) the median lobe looks like a closed and gradually narrowing tube with the seam along the

middle in the basal two-thirds of its length and an elongate-oval orifice in the distal one-third. In *E. vigintioctopunctata*, on the other hand, the median lobe, when seen in profile, is slightly emarginate at a little distance below the middle and then curved upwards into a hook at the apex; the blade-like ridge is also broader; seen from below the orifice of the median lobe is smaller and more or less diamond shaped.

The two species are thus easily distinguished from each other by several reliable characters and should be regarded as distinct.

ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA, A. P. KAPUR, PH.D., D.I.C.
September 28, 1959.

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23. APHIDS OF CALCUTTA AND SUBURBS (WEST BENGAL)

INTRODUCTION

The first records of aphids from West Bengal were by Cotes (1896). Later van der Goot (1916, 1917) added some more species. It was not till 1955, however, that these insects received attention in this part of India and Banerjee and Basu recorded 13 species. In the same year in a review of the Entomological section of the Department of Agriculture, Government of West Bengal, a list of 26 species of aphids including the previous 13 was published.

Of the species so far known from West Bengal, 15 are found in Calcutta and suburbs including 2 new records, one of which has very recently been published by Ray Chaudhuri and Ghosh (1958). A list of such species with a preliminary key for some of them, is given below.

LIST OF SPECIES

Aphis L.

1. **A. craccivora** Koch—320 apterae, 5 alatae.

Locality & Host plant family: Cossipore Club, Calcutta, on 18-10-52, 25-10-52, 27-1-53, from Cucurbitaceae; Dalhousie Square,

Calcutta, on 10-10-52, 24-10-52, 25-1-53, from Labiatae, Urticaceae, & Scitaminaceae; Curzon Park, Calcutta, on 30-1-53, from Nyctaginaceae; Bishop's Garden, Calcutta, on 3-11-53 from Leguminosae.

2. **A. gosspii** Glov.—10 apterae, 12 alatae.

Locality & Host plant family: Cossipore Club, Calcutta, on 26-10-52, 1-11-52, & 2-11-52 from Euphorbiaceae and Leguminosae; Curzon Park, Calcutta, on 30-11-52 & 4-12-53, from Amarantaceae and Malvaceae; Dalhousie Square, Calcutta, on 22-10-53, from Araliaceae.

3. **A. nerii** Boyer.—35 apterae, 9 alatae.

Locality & Host plant family: Science College Garden, Calcutta, on 6-11-57, from Asclepiadaceae.

Liphaphis Mordvilko

4. **L. erysimi** (Kalt.).—38 apterae, 17 alatae.

Locality & Host plant family: Dalhousie Square, Calcutta, on 1-10-52, from Araliaceae; Eden Garden, Calcutta, on 11-11-57, from Cruciferae.

Longiunguis van der Goot

5. **L. sacchari** (van der Goot).—37 apterae, 20 alatae.

Locality & Host plant family: Dum Dum, Calcutta suburbs, on 6-1-58, from Graminaceae.

Rhophalosiphum Koch

6. **R. maidis** (Fitch.)—4 apterae.

Locality & Host plant family: Agri-Horticultural Society, Calcutta, on 22-9-53, from Graminaceae.

7. **R. nymphaeae** L.—56 alatae.

Locality & Host plant family: Cossipore Club, Calcutta, on 20-12-52, from Caesalpinioideae.

8. **R. rufiabdominalis** (Sasaki).—7 alatae.

Locality & Host plant family: Behala, Calcutta suburbs, on 4-12-52, from Chenopodiaceae.

Schizaphis Börner

[1]9. **S. graminum** (Rond.).—1 alata.

Locality & Host plant family: Eden Garden, Calcutta, on 28-10-53, from Solanaceae.

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[1] This species is recorded for the first time in West Bengal.

Toxoptera Koch

10. **T. aurantii** (Boyer).—20 apterae, 5 alatae.

Locality & Host plant family: Agri-Horticultural Society, Calcutta, on 10-2-52, from Moraceae.

Macrosiphonellia Del Guercio.

11. **M. sanborni** L.—10 apterae.

Locality & Host plant family: Eden Garden, Calcutta, on 26-10-55, from Compositae.

Myzus Pass.

12. **M. persicae** (Sulz.).—25 apterae, 3 alatae.

Locality & Host plant family: Agri-Horticultural Society, Calcutta, on 4-2-53 & 10-2-53 from Acanthaceae & Malvaceae.

Pentalonia Coq.

13. **P. nigronervosa** Coq.—13 apterae.

Locality & Host plant family: Hoogly, Calcutta suburbs, on 10-1-54, from Leguminosae.

Myzocallis Pass.

14. **M. kahawaluokalani** Kirk.—2 apterae, 8 alatae.

Locality & Host plant family: Curzon Park, Calcutta, on 16-10-52, from Lythraceae.

Tetraneura Hartig

15. **T. hirsuta** (Baker).—2 alatae.

Lacality & Host plant family: Behala, Calcutta suburbs, on 3-12-51 & 4-1-52, from Cruciferae and Solanaceae.

Aphis L.

Key to the Apterous Viviparous Females

1 (2) Processus terminalis $4\frac{3}{4}$-5, 2/5 times as long as base of same segment, equal to, or $1\frac{1}{2}$ times as long as, IIIrd antennal segment. Hairs on first tarsal joints 3, 3, 3. Cauda with 7-9 hairs.

A. nerii Boyer

2 (2) Processus terminalis 2-$2\frac{1}{2}$ times as long as base of the same segment, $\frac{3}{4}$ of, or at most equal to, IIIrd antennal segment. Hairs on first tarsal joints 3, 3, 2. Caudal hairs 1-6.

3 (4) Body pear shaped. Dorsum of the abdomen with honeycomb pattern. Hairs on abdominal tergites with acuminate or furcated apices.

A. craccivora Koch

4 (3) Body elongated. Dorsum of the abdomen without such pattern. Hairs on the abdominal tergites with acute or acuminate apices but never with furcated ones.

A. gossypii Glov.

Key to Alate Viviparous Females

1 (2) Processus terminalis 4-5,1/5 times as long as the base of the same segment. IIIrd antennal segment usually with 8-12 rhinaria not placed in a row and IVth antennal segment without or with at most 3 rhinaria. Hairs on first tarsal joints 3, 3, 3. Cauda usually with 9 hairs.

A. nerii Boyer

2 (1) Processus terminalis twice or at most up to thrice as long as base of same segment. IIIrd antennal segment usually with 4-7 rhinaria always in a row and IVth antennal segment never with any rhinarium.

3 (4) Abdomen broadly oval. Basal diameter of siphunculi nearly or at most twice as thick as the middle of the hind tibiae; the middle of siphunculi at most $1\frac{1}{2}$ times as thick as the middle of hind tibiae. Middle of hind tibiae never more than $1\frac{1}{2}$ times as basal diameter of IIIrd antennal segment. Apices of femora and tibiae black. Siphunculi black.

A. craccivora Koch

4 (3) Abdomen elongated oval. Basal diameter of siphunculi never less than $2\frac{1}{2}$ or may be up to $2\frac{3}{4}$ times as thick as the middle of hind tibiae; middle of siphunculi never less than $1\frac{1}{2}$ times and may be almost twice as thick as middle of hind tibiae. Middle of hind tibiae always more than $1\frac{1}{2}$ times and may be up to almost twice as thick as the basal diameter of IIIrd antennal segment. Apices of femora and tibiae pale brown; Siphunculi yellowish brown.

A. gossypii Glov.

Rophalosiphum Koch

Key to Alate Viviparous Females

1 (2) Antennae 5-jointed. IIIrd antennal segment. 1, 2/5-1, 3/5 times as long as IVth antennal segment. Longest hair on segment III, 1½ to twice as long as the basal diameter of the segment. Processus terminalis 5, 1/5-6, 3/5 times as long as the base of the same segment. Siphunculus slightly swollen at its middle, and which may extend up to distal 2/3 portion, imbricated from base to apex.

R. rufiabdominalis (Sasaki)

2 (1) Antennae 6-jointed. IIIrd antennal segment 2, 3/5-3, 1/10 times as long as IVth antennal segment. Longest hair on segment III, ½ the basal diameter of the same segment. Processus terminalis 3, 3/5-3, 4/5 times as long as the base of the same segment. Siphunculi bagpipe like, imbricated only at its ½-2/3 portion.

R. nymphaeae L.

Acknowledgement

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Zoology Laboratory,
St. Xavier's College,
Calcutta,
November 27, 1958.

A. K. GHOSH
D. N. RAY CHAUDHURI

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24. INSECT PESTS OF MAIZE IN RAJASTHAN

The region, south-east of the Aravalis, is the chief maize growing area of Rajasthan. About 60 per cent of the total area under the crop falls in this region, which is one of the most important maize producing tracts of India. The cultivation of this crop has of late years become of so much national importance as well as domestic interest that the farmers are anxious to obtain maximum yields.

The crop is sown in June-July and harvested in September-October. It has been observed that, out of the many adversities that maize cultivation has to face, the damage caused by insect pests is by far the worst. To the misfortune of the farmers, practically no information exists on the insect pests of this crop in Rajasthan. An intensive survey was, therefore, undertaken to investigate the insects injurious to maize and elucidate points in their biology which would help in suggesting and developing control measures against them.

It has been found that maize crop is attacked by many kinds of insects. No part of the plant escapes injury. Although no specific determinations have been made of the losses occasioned by insect pests, it is quite evident that at a very conservative estimate 10 to 15 per cent of the produce is lost annually in this region on account of the insects alone. Furthermore, insect attack weakens the plant, which may later succumb to unfavourable weather conditions, encroachment of weeds, or other causes.

A list of the insects noticed to cause economic loss to maize crop is arranged under the different parts of the plants damaged, together with short notes on their biology and nature of damage for the more important ones. The pests recorded in this paper were collected and identified, and as far as possible reared in the entomological laboratory of the College. Wherever necessary, specimens were sent to different entomological institutes for identification. In preparing this report the works published by Sen-Gupta and Behura from Orissa (1), Srivastava from Uttar Pradesh (2), and Trehan and Pingle from Bombay (3) have been of great help.

Insects attacking Roots

1. White ants, *Odontotermes* sp. and *Microtermes* sp. (Termitidae).

Major pests under unirrigated conditions. Infestation may begin soon after germination and also occurs at any stage of growth of the crop.

Leaf Feeders

A. *Chewing*

1. Kharif grasshopper, *Hieroglyphus banian* Fb. (Acrididae).

A major pest, usually active during the months of July to October. Adults and nymphs feed on the leaves and there is only one generation in a year.

2. Surface grasshopper, *Chrotogonus trachypterus* (Bl.) (Acrididae).

A minor pest; injurious to the young crop during June and July.

3. Hairy caterpillar, *Amsacta moorei* Butl. (Arctidae).

A major pest. The caterpillars defoliate the plants. There is only one generation during June-July, the pupa of the second brood hibernates in the soil. Sometimes the infestation is very serious during the early growth of the crop. The caterpillars feed voraciously on the seedlings and the damage increases as the caterpillar grows, so much so that in certain years all the seedlings in a field are often wiped out, thus necessitating resowing of the crop which may be too late.

4. Army worm, *Cirphis unipuncta* H. (Noctuidae).

A major pest; attacks the crop at all its stages of development. As soon as the crop germinates the larvae are attracted to and feed on the leaves mostly at night, while during the day they remain hidden in the clods underground. In severe cases of attack they completely defoliate the seedlings as is done by the hairy caterpillars. When the crop is somewhat advanced in its growth and the internodes have been formed, the worms attack the growing shoot and remain hiding singly or more frequently in groups of 2 or 3 in the whorl. When the injured leaves unfold they present a ragged and unsightly appearance. Such damage results in stunted growth of the crop and reduced grain production. There are 2 to 3 generations from June to October and then it hibernates as pupa in the soil.

5. Lucerne caterpillar, *Laphygma exigua* (Hb.) (Noctuidae).

A minor pest; feeds on the leaves during July and August along with the hairy caterpillar and the army worm.

B. *Sucking*

1. Aphids, *Aphis maidis* Fitch. (Aphididae).

A minor pest. Infestation usually occurs from August to September.

2. Stem bug, *Pundaluoya simplicia* Dt. (Fulgoridae).

A minor pest found on the tender shoots. Nymphs and adults are active during September and October.

Stem Borers

1. Maize borer, *Chilo zonellus* (Swin.) (Pyralidae).

A major pest. The newly hatched larvae, after feeding for sometime on the tender leaves, bore into the stem and produce dead heart in the young crop. When the plants are sufficiently grown they tunnel into the stem causing reddening of the stems and yellowing of the leaves. The pest is active from June to November. There are about four generations in a year and the caterpillar hibernates in stubble. Early planted crop is severely damaged in summer.

2. Pink borer, *Sesamia inferens* (Wlk.) (Noctuidae).

A major pest; occurs along with the maize borer, but its first generation appears after the first generation of the maize borer is over. This pest is active from July to March and there are 6 generations in a year. The tunneling by one borer in a stalk does not always cause appreciable damage, but when two or more are present within the same stalk, as frequently happens, it becomes reduced to a mere shell and is filled with fragments of the frass or castings of the borers. It has been noticed that maize plants suffering from severe borer injury ripen much earlier than the healthy ones.

Attacking Tassels and Cobs

1. Army worm, *Cirphis unipuncta* Haw. (*vide* leaf feeders).

A serious pest of cobs. When tassels appear the worms immediately attack them, but this feeding rarely results in serious injury. As soon as the silks and ears appear the larvae leave all other parts of the plant and turn their attention to them. They feed upon the silks as long as these are fresh, and such feeding is within the protection of the shunk. The young larvae crawl to the tip of the shunk, push their way in between the silk strands and start feeding. After the silk has dried out the larvae feed upon the developing kernels till they are soft.

2. Maize borer, *Chilo zonellus* (Swin.) (*vide* stem borers).

Frequently found in the cobs. At the early stage of the development of borers they enter the ear directly at the tip, base or side. Ordinarily the ear is entered at its tip by small borers which feed first upon the tender portion of the husk, and then work their way down into the cob and grain.

Pink borer, *Sesamia inferens* (Wlk.) (*vide* stem borers).

Not serious on cobs. The caterpillars usually enter the ears indirectly through the short stem, or shank, by which the developing cob is attached to the stalk. In such a case the stem is frequently so weakened by the injury that it breaks off before the ear has completed its development. The damage inside the cobs is similar to that produced by the maize borer.

The author is indebted to Dr. A. Rathore, Principal, for providing necessary facilities and encouragement for this work.

RAJASTHAN COLLEGE OF AGRICULTURE,
UDAIPUR, B. K. SRIVASTAVA
July 27, 1959.

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25. THE MELTING POINT OF THE WAX OF INDIAN BEES

In a recent report of the Apicultural Laboratory (Bombay Village Industries Board), Poona, there was a reference to the melting point of wax of the combs of *Apis dorsata*, the large Rock Bee, being lower than that of the other two honey-producing Indian species *A. indica* and *A. florea.*

The combs of *A. dorsata* are built on cliffs etc. thus liable to greater exposure to the sun and consequent heating up, and a *lower* melting point seemed an inconsistency which would be of distinct disadvantage to the species. We therefore wrote to the Hony. Research Director of the institution, Dr. G. B. Deodikar, for confirmation. He replies as follows:

'As regards melting point of *dorsata* wax, we also anticipated *a priori* that the melting point should be higher than in other bees building combs in shaded enclosures. Contrary to our expectation it has been repeatedly confirmed from samples collected in various parts of India that the melting point of *dorsata* wax is about 4° F. lower than *indica* wax. As the comb becomes older and impregnated with fat, soluble ingredients from nectars and pollens, or with propalis as also deposition of insoluble sediments and debris, the melting point does rise by a few degrees, but this is so in all the three species of

bees. This is rather difficult to understand. Though *dorsata* builds in shade, the nest is exposed to much higher temperature than that of *indica*. A partial explanation may be the fact that the bees cover the wax comb completely and they have a method of airconditioning by means of remarkably synchronised fanning of wings. Anyway lower melting point of *dorsata* wax is quite contrary to what might be normally expected.'

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, EDITORS
BOMBAY 6,
October 29, 1959.

26. IDENTITY OF A TIBETO-HIMALAYAN *RANUNCULUS*

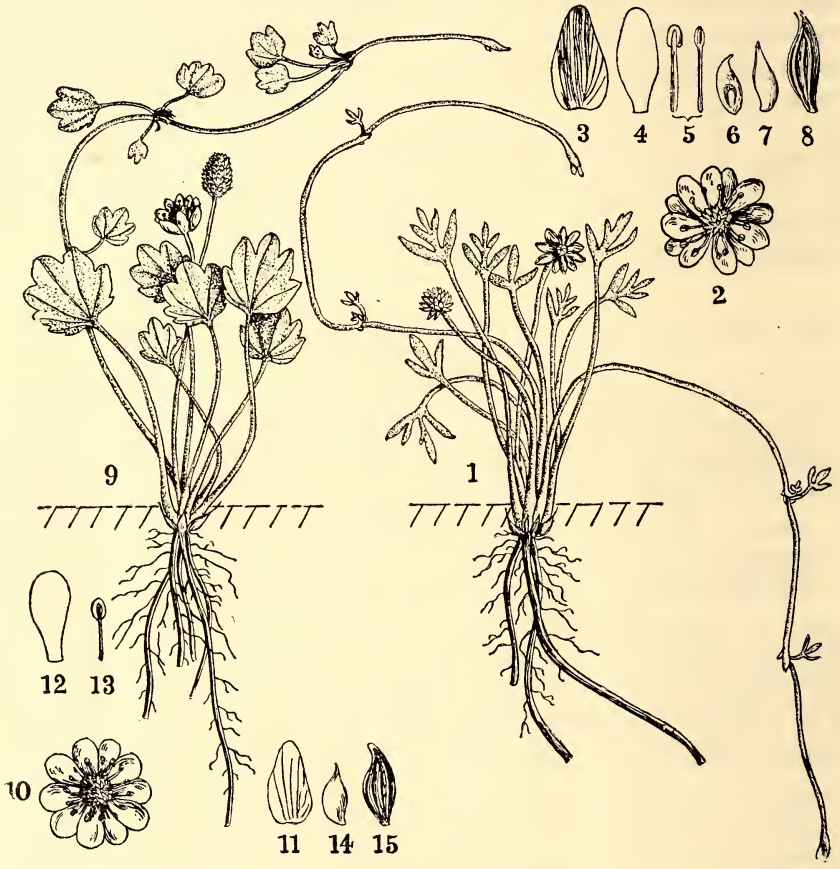
(*With text-figures*)

Among the Tibeto-Himalayan species of Ranunculaceae, a somewhat unusual member is the commonly known *Ranunculus cymbalariae*. The plant is dwarfish and lacks a proper stem. It produces a number of long, articulated runners which help in vegetative propagation. Its seeds have a very thin papery surface.

In 1900, Greene created the genus *Halerpestes* to accommodate some of these peculiar plants, but for a long time his genus was not recognised. Hutchinson in his review of the genera of Ranunculaceae, considered the generic name *Halerpestes*, but left it as a synonym of *Ranunculus*. Two years later, Dunn described a species called *Ranunculus palifolius* which was considered to be closely allied to the hitherto known *Ranunculus cymbalariae*. Unfortunately, however, the species *Ranunculus cymbalariae* itself, as understood by Hooker f. & Thomson, is a mixture of two species neither of which belongs to true *Ranunculus cymbalariae* Pursh [=*Halerpestes cymbalaria* (Pursh) Greene] as originally described by Pursh.

The first author who recognised *Halerpestes* as distinct from *Ranunculus* appears to be Komarov and he was followed a few years later by Handel-Mazzetti. The genus is characterised, among other things, by the absence of any proper stem and the achenes having thin texture and striated surface. A few years ago, the present author, while working in the Kew Herbarium, came across an unnamed specimen of *Ranunculus* collected from Kashmir (Koelz no. 2318). This specimen agreed with the specimen described earlier by Dunn as *Ranunculus palifolius*. On further scrutiny, it was found that Dunn's species agreed so well with *Ranunculus cymbalariae*, that it is

impossible to maintain Dunn's plant as a distinct species. Thus, while the identity of the Koelz specimen (no. 2318) became clear, both its nomenclature and the nomenclature of the plant hitherto known as



1. *Halerpestes tricuspis* (Maxim) Hand.-Mazz. General view ; 2 Flower; 3 Sepal ; 4. Petal ; 5 Stamens; 6 Carpel with ovule ; 7 Carpel, side view ; 8. Achene. 9. *Halerpestes sarmentosa* (Adams) Komarov. General view; 10 Flower; 11 Sepal; 12. Petal ; 13. Stamen ; 14 Carpel ; 15. Achene.

Ranunculus cymbalariae got more and more involved. It is, therefore, proposed to clarify the position. The Tibeto-Himalayan plant as understood by Hooker f. & Thomson, dissolves into two species and their nomenclature and distribution are as follows:

1. **Halerpestes tricuspis** (Maxim) Hand.-Mazz. in Acta Hort. Goteburg. **13**: 135 (1940).

   Ranunculus tricuspis Maxim. Fl. Tang. **12** (1889); Enum. Pl. Mongol. 14, 16, tab. 4, fig. 17-27 (1889).

   Ranunculus palifolius Dunn in Kew Bull. 1925: 280.

Ranunculus cymbalariae Hook. f. & Thoms. var. alpinus Fl. Ind. **1**: 32 (1855).

Ranunculus cymbalariae Hook. f. & Thoms. *non* Pursh in Hook. f. Fl. Br. India **1**: 17 (1872) *pro parte*.

Distribution.—NW. Himalayas, *J. L. Stewart* s.n. (Herb. Cal.); Kashmir, Nulre (Mulra ?) valley 3300 m. *T. Thomson* s.n. (Kew); Baltistan, Dras valley, 3300 m. *J. F. Duthie* 11740 (Cal. et Kew); British Lahul, beyond Baralacha Pass 5000 m. *S. R. Kashyap* 44 (Kew); Ladak, *I. Thomson* s.n. (Kew); Ladakh 5000 m. *Thomson* 2010; Ladak, *J. L. Stewart* s.n. (Kew); Rupsu, Hanle river 4600 m. *W. Koelz* 2318 (Kew); Tibet, Khambajong, *Younghusband* 20, 51, 278 (Cal.); Tibet, without name of collector 246 (Cal.); Giri, *Younghusband* s.n. (Cal.); Tisum 5100 m. *Strachey & Winterbottom* 23 (Cal.); Chumbi & Phari, *Dungboo* s.n. (3 sheets in Cal.); Sikkim, Lhonak 5000 m. *Smith & Cave* 1910 (Cal.); Tongloo, *J. A. Soulie* 903; 936 (Kew).

2. **Halerpestes sarmentosa** (Adams) Komarov in Kom. et Klob-Alis, Key Pl. far East U.S.S.R. **1**: 550 (1931).

Ranunculus sarmentosus Adams in Mem. Soc. Nat. Mosc. **9**: 244 (1834).

Ranunculus cymbalariae Hook. f. & Thoms. var. *major* Fl. Ind. **1**: 32 (1855).

Ranunculus salsuginosus Pall. Resise **3**: 213, 265 (1776) non Georgi.

Halerpestes salsuginosa (Pall.) Greene in Pittonia **4**: 208 (1900).

Ranunculus subsimilis Printz in Contr. fl. As. int. **3**: 239 (1921).

Distribution.—Afghanistan (?), *Griffith* 1401 (Cal.); Afghanistan, *Aitchison* 354 (Cal.); Lahul near Kardong, *Jaeschke* s.n. (Cal.); Baltistan, Skardo, *C. B. Clarke* 30026 C (Cal.); Tibet frontier, Gyangtse, *H. J. Walton* 24 (Cal. et Kew); Topidhunga 5000 m., *Strachey & Winterbottom* 22 (Cal.); Western Nepal, Kali Valley 3500 m. *J. F. Duthie* 6321; Sikkim, Lajhep, 4000 m. *W. W. Smith* 3294 (Cal.); Nakuchu, Lhonak 5500 m. *Smith & Cave* 1900 (Cal.).

Besides the distribution shown above, both the species have been recorded from north Szechuan, Siberia, Persia, North America, Mexico, mountains of South America. *Halerpestes sarmentosa* (Adams) Komarov is distinguished by its more robust appearance, longer and more numerous achenes (80 to 130) collected in oblong capitulum, and more or less orbicular crenately incised leaves. *H. tricuspis* (Maxim.) Hand.-Mazz., on the other hand, is more slender, has broader achenes

numbering 40 to 50 in each roundish capitulum, and has elliptic and deeply cleft leaves.

In *Acta Hort. Goteburg* **13**: 136 (1940), Handel-Mazzetti has placed *Ranunculus palifolius* Dunn as a synonym of *Halerpestes linifolius* (Bert.) Hand.-Mazz. The present author is of the view that Dunn's plant should be more correctly placed under *Halerpestes tricuspis* (Maxim) Hand.-Mazz., and this has been done in this paper.

INDIAN BOTANIC GARDEN,
SIBPUR,
CALCUTTA,
September 26, 1959.

D. CHATTERJEE

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Komarov, V. L. (1931) : Key Pl. far East Reg. U.S.S.R. **1** : 550.
Handel-Mazzetti, H. (1939): Acta Hort. Goteburg, **13** : 135.

27. *CEDRELA TOONA* ROXB. IN RAJASTHAN. A CORRECTION

N. C. Nair and G. R. Nathawat in the *Journal* (**54**: 288) mentioned *Cedrela toona* Roxb. as occurring at Harsh Nath in the Aravalli Hills. Shri K. S. Sankhala, the Div. Forest Officer, Jaipur, has called the Editors' attention to this point, and adds: 'The observation of the authors appears to be incorrect, as there is no *Cedrela toona* Roxb. on the hill. It appears that the authors have . . . identified *Lannea grandis* Engl. of the Anacardiaceae as *Cedrela toona* Roxb. *Lannea grandis* trees are often met with in the other hills of Sikar forests and occurrence of the tree in Harsh Nath is nothing new. Since the record of *Cedrela toona* Roxb. at Harsh Nath may create subsequent complications, particularly for the ecological studies, and may influence future forest management and plantation programmes, I consider it extremely necessary that a correction should be published.'

Cedrela toona Roxb. is found in moister forests than those of Rajasthan; for this reason the Editors will be hopefully awaiting confirmation of its existence in Harsh Nath; if this can be confirmed, it will form an interesting record.

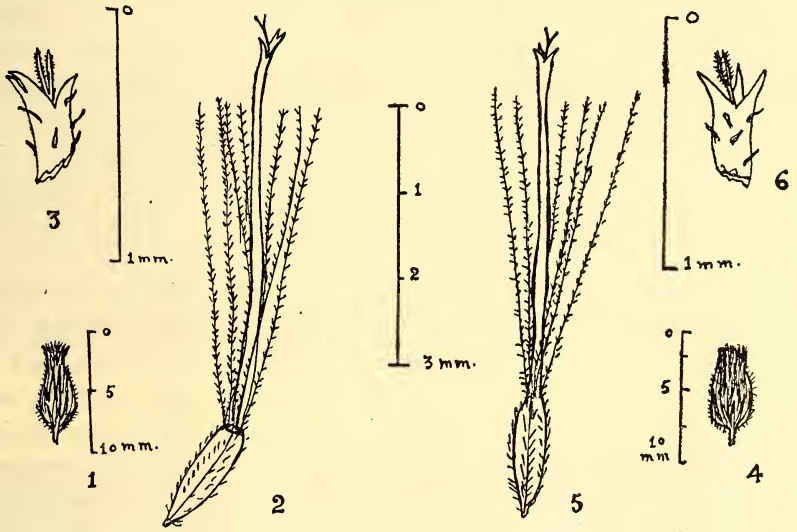
BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
June 16, 1959.

EDITORS

28. A NEW PLANT RECORD FOR INDIA—*ERIGERON FLORIBUNDUS* (H.B.K.) SCH. BIP.

(*With text-figures and a plate*)

During the course of a detailed systematic study of the Compositae of Dharwar, the authors came across a plant that was fairly similar to *Conyza ambigua* L. Later, it was referred to the Kew authorities who identified it as *Erigeron floribundus* (H.B.K.) Sch. Bip. This is,



Figs. 1-3. *E. floribundus* (H.B.K.) Sch. Bip. 1. Jug-shaped capitulum. 2. A single outer floret. 3. Apical portion of the above showing the bilabiate corolla and stigma.

Figs. 4-6. *E. bonariensis* L. 4. Cup shaped capitulum. 5. A single outer floret. 6. Apical portion of the same showing the corolla with subequal lobes and stigma.

as far as we are aware, the first record of the occurrence of the plant in India. A detailed description as from actual examination of fresh specimens collected from Dharwar is given below:

Stout annual herb up to 1.4 m. high, generally branched from the base. Stem angular, longitudinally furrowed, often with purplish blotches, hairy to puberulous, becoming woody when old. Leaves pale green, alternate, sessile, simple, oblanceolate, pubescent on both surfaces, more so on the upper. Margin entire or distantly serrate or pinnatifid. Lower leaves up to 17 cm. by 3.5 cm., and gradually becoming smaller towards the apex. Heads many, about 0.7 cm. by 0.3-0.4 cm., in terminal and axillary panicles, the whole forming a pyramidal compound inflorescence. The lateral branches of the inflorescence do not overtop the apex of the main axis. Peduncles of

heads 0.6-1.2 cm. long, filiform, pubescent. Involucre cylindrical; bracts in 2-3 series, 20-30 in number, green, pubescent, sometimes purple at the apices, linear, acute, the innermost the largest, chestnut brown on the inside when reflexed (on the old dry heads). Disc naked, pitted, about 0.2 cm. in diameter. Outer florets about 0.5-0.6 cm. long, pistillate, in many series, filiform. Corolla rayed or bilabiate, upper lip generally bifid, the lower entire or obsolete. Style exserted or included, bifurcated; style-arms filiform. Inner florets disciform, 0.5-0.6 cm. long, numerous, bisexual. Corolla tubular; tube slightly dilated at the apex, 5-toothed, lobes acute, hairy outside, yellow. Stamens 5; anthers appendiculate; anther-bases entire. Style exserted, bifurcated; style-arms almost compressed or plano-convex, the tips lanceolate and hairy outside. Pappus hairs in a single series, spreading, many, pale straw coloured or brownish white. Achenes of ray- and disc-florets similar, about 0.1-0.13 cm. long, angular, laterally compressed, sparsely covered with appressed short hairs.

E. floribundus (H.B.K.) Sch. Bip. is closely allied to *E. bonariensis* L. (Syn. *Conyza ambigua* L.). It has been reported that *E. floribundus* was passing frequently under the name *E. bonariensis* L. Burtt (1948), (On *E. bonariensis* L. Kew Bull., pp. 369-373), has clearly shown the differences between these closely resembling species. *E. floribundus* and *E. bonariensis* are said to be of South American origin, the latter chiefly occurring in temperate Mediterranean countries, though it has spread out to the tropical countries, while the former is reported to have a preference for the tropical climate. Both occur as weeds. In India, *E. bonariensis* is well known as *Conyza ambigua* L.

The chief differences between these two species as given by Burtt (1948) are as follows:

E. bonariensis L.	*E. floribundus* (H. B. K.) Sch. Bip.
Herb up to 4 ft., branched, the lateral branches often overtopping or at least equalling the main axis (cf. *E. acris* L.); inv. bracts whitish inside; capitula when pressed commonly 1 cm. or more in diameter; pappus white or pinkish.	Herb up to 6 ft., branched, the lateral branches NOT overtopping the main axis and the whole forming a pyramidal compound infl. (cf. *E. canadensis* L.); inv. bracts showing chestnut brown on the inside when reflexed on the old capitula; capitula when pressed commonly less than 1 cm. in diameter; pappus straw coloured.
Further differences:	Further differences:
Corolla of outer flowers 3-4 toothed; teeth equal or subequal.	Corolla of outer flowers rayed bilabiate or rarely the lobes subequal.

Photo A. *Erigeron floribundus* (H.B.K.) Sch. Bip.
The compound pyramidal inflorescence in which the lateral branches are *not* overtopping the apex.

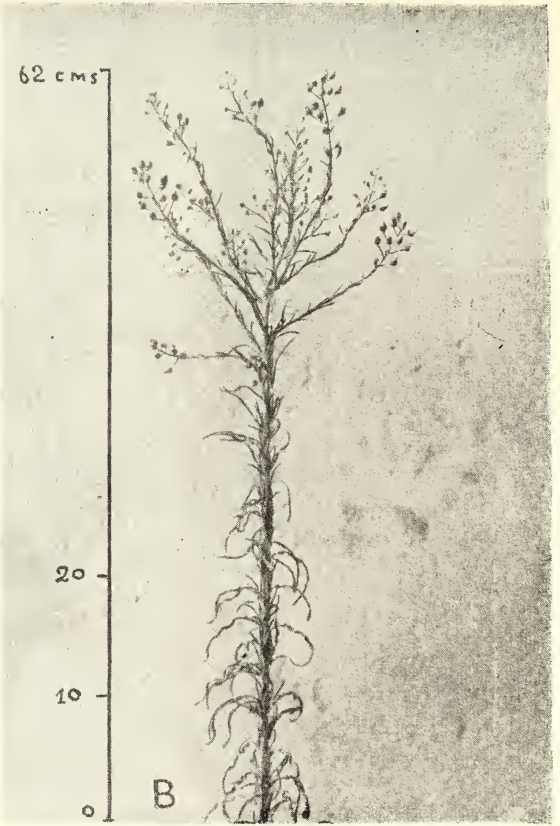


Photo B. *Erigeron bonariensis* L.
Part of the plant with compound inflorescence in which the lateral branches overtop the apex.

The authors are thankful to Prof. L. K. Gunjikar, Head of the Botany Department, Karnatak Science College, Dharwar, for laboratory facilities and to Rev. Fr. H. Santapau, St. Xavier's College, Bombay, for help in preparing this manuscript.

Department of Botany,
Karnatak Science College,
Dharwar,
New Mysore State,
July 15, 1959.

H. R. LADWA
R. M. PATIL

29. RECORD OF *CRYPTOSTEGIA MADAGASCARIENSIS* BOJ. FROM BARODA

Cryptostegia madagascariensis Boj. is a woody, shrubby climber, grown in tropical gardens for its showy flowers, which are either purple-pink or white tinged with purple or pink. Although it is an ornamental garden plant, it is sometimes found established in a wild state as an escape.

This plant was first reported from some places near Bombay and Poona by Santapau and Irani (*JBNHS* **55**: 594-595, 1958) with a remark that 'it is a new record for Bombay and possibly for the whole of India'. In the same note they have given a detailed description of the plant along with a key to identify the two species of the genus *Cryptostegia*. The plants were collected in cultivated and wild state.

During the course of our local excursions, we came across several plants of *Cryptostegia*, which looked slightly different from *C. grandiflora*. These plants, on detailed examination of the flowers, turned out to be *C. madagascariensis* Boj. This is not only the first record for Baroda but for the whole of Gujarat.

At present the plants have been collected from a few localities in and around gardens, but we propose to study the range of distribution of these plants in the various areas of Baroda and environs.

Department of Botany,
M.S. University of Baroda,
Baroda,
July 24, 1959.

A. R. CHAVAN
S. D. SABNIS

30. NOTES ON THE FLOWERING OF *CARVIA CALLOSA* BREMEK. (=*STROBILANTHES CALLOSUS* NEES)

Rev. Father H. Santapau (1955) in his paper on Excursion of the Indian Botanical Society to Pavagadh Hill near Baroda, on January 7th, noted this plant as 'only occasional in the lower half of the slopes; abundant in almost pure stands on the upper half in leaf only'. In the subsequent year a few plants flowered. Mr. B. B. Joshi (1956) collected this plant in flower (*Joshi*, 23-9-1956, 326 P.). In the succeeding year (1957) we observed the general flowering on the slopes of the hill (up to about 523 metres) in the months of September-November (*Oza*, 1-9-57, 103 and 6-11-57, 262). This shrub with bright purple flowers having the bracts green with a pink tinge, and pleasing scent, reached the height of about 60-120 cm., presence of minute hairs on the margins of leaves, stems squarish with continuous furrows; the plant species being fairly abundant on the upper half of the slopes of the hill. By the month of May in 1958, dried plants were noted on the same slopes of the hill. Observations during the months of September-November in the same year helped us to note only a few small plants in flower. The flowering was then random.

The year 1956 witnessed the partial flowering only and hence it could not be called general. As the general flowering occurred in 1957, the authors expect the next general flowering to take place some time about 1963. Further observations on the next general flowering of this plant will be reported to the *Journal* immediately it occurs either before or after 1963.

Department of Botany,
M.S. University of Baroda,
Baroda,
February 28, 1959.

V. G. PHATAK, D.Sc.
G. M. OZA, M.Sc.

[The general flowering of *Carvia callosa* Bremek. reported in this note as having taken place in 1957 on Pavagadh Hill is of interest in one respect. When in the past there has been a general flowering of *Carvia* on any of the hills near Bombay, it has coincided with a similar general flowering practically all over Bombay and southwards to the limit of the distribution of the plant. Further it seems to have coincided also with a general flowering of *Phlebophyllum kunthianum* Nees (=*Strobilanthes kunthianus* T. Anders.) in the south of India. In 1957 there was no general flowering of *Carvia callosa* in Bombay, except for Pavagadh Hill near Baroda; a few plants were noted in flower in Mahableshwar, Khandala, etc. On the

Carvia callosa Brem.

A. Last year's spikes, B. This year's new leaves

other hand, to judge from the remains noted on the Kodaikanal Hills in May of this year, there seems to have been a general flowering of *Phlebophyllum* on the Palnis and Nilgiris.—EDS.]

31. THE FLOWERING OF *STROBILANTHES*

(*With a plate*)

Most of the plants listed in our floras under the name of *Strobilanthes* seem to belong to what Bremekamp has termed 'plietesials', that is to say they flower once after several years of vegetative growth and then die off. My experience of many years confirms that this is the normal behaviour of such plants.

Recently in Khandala (*c.* 2000 ft.) on the Western Ghats, I was surprised to see that some *Strobilanthes* plants appeared not to conform to the general habit of 'plietesials'. The top of the hill known as Echo Point, near Bhoma Hill, the higest point of Khandala, is practically covered with dense thickets of the *Karvi* plant, *Carvia callosa* Brem. (=*Strobilanthes callosus* Nees); the rains had been on for several days, and most of the *Karvi* shrubs were in leaf. Whilst walking to the top of the hill along paths through the *Karvi* thickets, I noticed exactly nine plants which showed remains of the flowering or fruiting spikes of last year together with fresh leaves of this year, both on one and the same branch. Some of these abnormal plants were collected and pressed and are now kept in Blatter Herbarium under the reference number *Santapau* 23140-23143. Together with these I noticed also four or five plants that had flowered last year and were obviously dead. This is the first time that I have noticed the survival of *Karvi* plants after their flowering. The number of survivors may have been much higher, but I did not stray from the paths to investigate further. (See plate.)

It is clear, then, that the *Karvi* plant may flower and survive to a second flowering, though this seems to be most unusual. The general rule is for the plant to flower once in several years, 7-12, and then die off before the next monsoon; at the beginning of June of the year following the flowering of the plant, the seeds that have remained on the dead parent plant are scattered by an elastic mechanism in the capsule or fruit and germinate at once on the arrival of the first steady showers.

ST. XAVIER'S COLLEGE,
BOMBAY 1, H. SANTAPAU, S.J.
June 10, 1959.

32. THE LEAVES OF *ALSEODAPHNE SEMECARPIFOLIA* NEES.—A CORRECTION

In a note published in the *Journal* (**56**: 160, 1959) mention is made of the properties of some leaves and tubers, which by mistake were said to be those of *Alseodaphne semecarpifolia* Nees. The leaves are indeed those of this plant; but the tubers are of *Dioscorea*, probably *D. bulbifera* Linn. This latter plant produces a large underground tuber and in addition brings out a number of small 'bulbils' or tubers in the axils of most of the leaves; it is these bulbils or tubers of *Dioscorea* that are used in the treatment of eczema. *Alseodaphne* does not produce any tubers, at least normally.

St. Xavier's College,
Bombay 1, H. SANTAPAU, S.J.
August 3, 1959.

Gleanings

Crop damage by Blackfaced Weaver Bird (Quelea quelea) in Tanganyika

'It has been calculated that one bird eats the equivalent of two ounces of mature wheat a day, so that a roost of 492,000 was eating 300×200 lb. bags of wheat a day, or 27 tons.'

[Extract from *Bull. Brit. Orn. Cl.* (1959) **79**, p. 38.]

Perennial Wheat

'After 35 years experimentation U.S. Department of Agriculture plant breeders appear to be on the verge of developing a commercially valuable perennial wheat. A hybrid of wheat and certain tall grasses, the perennial yields grain for several years, resists insects and disease and provides year-round cover for the soil.

The quest for perennial wheat was started by W. J. Sando, now retired, who in 1923 crossed wheat with wheat grass and other species of the genus *Agropyron.* Among those who followed up his work was C. A. Suneson, a Department of Agriculture agronomist working in the California Agricultural Experimental Station at Davis, Calif. He has evolved an especially promising perennial by backcrossing Sando's hybrids to spring wheat and intercrossing the progeny.

Suneson's plants live about four years and bear grain that is especially rich in protein. They withstand drought and are highly resistant to smut, rust, mildew, and other wheat diseases. Furthermore, they are not attacked by the Hessian fly and other insects that ravage wheat. There is, however, one drawback. While the yield of grain in the first year matches that of local wheats, it drops off by 40 per cent or more in the second year. But Suneson now believes that he can keep the yield high throughout the lives of the plants if he can work out ways to fertilize them every year and to control weeds.'

[From *Scientific American*, Vol. 200, No. 1, pp. 62-63, January 1959.]

Fishing with Air Curtain

'An ingenious method for herding herring into the fisherman's net has been developed by the Bureau of Commercial Fisheries, Fish and Wild Life Service.

In the method, the fish are blocked off from escape into other waters by use of a "bubble barrier" or underwater air curtain. The bubble barrier is created by pumping compressed air through long lines of plastic pipe laid down on the ocean floor. Air escaping from the tiny holes in the piping forms a wall of bubbles which serves as an effective barrier to a school of fishes.

Government experts say that tests have shown the air curtain to be successful in guiding the movement of herring. The plastic pipe can be swept across the bottom of the open ocean or a deep channel, driving the fish into water shallow enough for seine fishing.'

[From *Science Digest*, Vol. 45, No. 5, p. 12, May 1959.]

Termites

'The termite is a fascinating creature to study but is also a very frightening menace. In America where only fifty-five species are known, the active damage caused by termites was reckoned in 1934 as forty million dollars a year. Over four hundred species have been identified in the continent of Africa, some of which live and work underground, tunnelling into the centre of their prey, be it beams or door frames or stalks of plants, and eating away the inside unnoticed, until the outer walls collapse. The termites are invading the earth. From Australia to India, Malaya and Ceylon, from California to San Francisco, from North to South America, one or another species of the four hundred main families of termites has made its home. Climate is no deterrent to them, for they adapt themselves to withstand cold as well as heat and have been found high in the Himalayas. In a right proportion they are beneficial to agriculture and to life. It is the terrific pace of their increase that has caused them to become enemies instead of friends.'

[Richard St. Barbe Barbe Baker (1954): SAHARA CHALLENGE. (London. Lutterworth Press.)]

Mixed Forests

'For successful forestry it is well to study the natural forest. . . , The virgin forest often contains a preponderance of so-called secondary timbers, for which there is little economic use. On the face of it the obvious solution is to concentrate on promoting the regenerating growth of a few of the most valuable timbers, and to transform the mixed, uneven-aged virgin forest—this apparently struggling mass—into uniform plantations of a single valuable species. This was done in the mahogany forests. . . . That experiment failed. . . .

'In the Kingdom of Wood there is a complicated society of living things in which each is a dependent member. No single species can thrive by itself, nor may it be used in plantations where it is isolated from its natural nurses and helpful neighbours. Observation shows that the trees that man regards as useless to cultivate can each make their own especial contribution to the good of the community. The slogan "Back to Nature", as applied to silviculture, holds a deep significance, for once the rhythm of the forest is broken, growth will lag and degeneration will set in. The harmonious functioning of all parts of the forest is the best guarantee of its health and well-being. It should be remembered, however, that in the virgin forest growth only keeps pace with decay, and until man harvests the matured trees, they are unproductive of timber.'

[Richard St. Barbe Baker 1942): AFRICA DRUMS.]

Notes and News

Bird Migration Study

In the April (1959) issue reference was made to the Society's plans for Bird Migration study in Kutch. A pilot project was put through between 15 and 30 September mainly to test the potentialities and train personnel for the field work proper in spring 1960, in which financial participation by W.H.O. is expected. The phenomenally heavy and long-drawn monsoon this year, with the resulting inundations and road breaches, rendered it impossible to reach the venue originally selected, namely Kuar Bet in the Great Rann. Therefore a more accessible area in the neighbourhood of Bhuj had to be chosen which would provide reasonably adequate opportunities. The project was financed out of the grant received by the Society from the Rockefeller Foundation earlier. Thanks to a special donation from W.H.O., we were enabled to invite to India Dr. Alfred Schifferli, Director of the Swiss Migration Research Centre, Sempach, for a few weeks to impart the necessary training to our personnel in the use of Japanese mist nets and other relevant migration study techniques. The trainees included three members of the Society's staff and several amateur ornithologists who, it is expected, will participate in the field work next March.

During the fortnight's operation 2060 birds of 56 forms were netted, including some 300 recaptures. 27 species of these 56 were migrant. Owing to the abnormal weather conditions migration appeared to be greatly retarded. Many species though overdue had not arrived, while those present were also in small numbers. The birds were banded with aluminium rings of 3 sizes—A, B, C—bearing, in addition to a serial number, the legend INFORM BOMBAY NAT. HIST. SOCIETY. Readers are requested to publicize this information as widely as possible by every means at their command. The success of the scheme depends upon ensuring that no recovery of a ring goes unreported to the Society.

The birds were identified, registered, measured, and weighed. Prior to release, all except 33 were also examined for ectoparasites by technicians of the Virus Research Centre, Poona, who accompanied the field party. Ticks were found on only 6 birds, two of which belonged to migratory species. The netting operations produced 3 new birds for Kutch—species not recorded before. (See Misc. Note 11, p. 635.)

The spring migration field work is provisionally scheduled for 8-31 March 1960. Persons willing to participate (and prepared to put up with a certain amount of physical discomfort) should contact Dr. Sálim Ali.

* * * *

The Marine Biological Association of India

The Marine Biological Association of India was founded at Mandapam Camp, to promote interest in marine biological and cognate sciences. The Association was formally inaugurated by the Hon'ble Mrs. Lourdammal Simon, Minister for Fisheries and Local Administration, Madras State, on January 3rd, 1959. The following office bearers were elected: Dr. S. Jones (President), Prof. R. V. Seshaiya (Vice-President), Dr. R. Raghu Prasad and Dr. C. P. Gnanamuthu (Secretaries), Dr. R. P. Varma (Asst. Secretary), Shri. K. V. Rao (Treasurer), Dr. P. N. Ganapati (Editor), Dr. R. Subramanyan (Joint Editor), and Dr. S. V. Job (Managing Editor). The official organ of the Association, the 'Journal of the Marine Biological Association of India', is expected to be issued half-yearly. Membership is open to all interested. All correspondence may be addressed to the Secretary, Marine Biological Association of India, Marine Fisheries P.O., Mandapam Camp, South India.

* * * *

The All-India Congress of Zoology

The First All-India Congress of Zoology, sponsored and organized by the Zoological Society of India, was held at Jabalpur, October 24-27th, under the presidentship of Dr. M. L. Roonwal.

Nearly 120 papers were received on many branches of zoology, in addition to contributions to the three Symposia on 'Reorientation of teaching of Zoology in India', 'Marine Zoology and fisheries in the Indian Ocean', and 'Recent evolutionary studies in India.'

Proceedings of the Congress, including these papers in full, are being printed. Abstracts, which were issued in advance, and other information may be obtained from the General Secretary, Dr. B. S. Chauhan, c/o. Zoological Survey of India, 34 Chittaranjan Avenue, Calcutta 12.

It is proposed to hold similar Congresses every three years.

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR ENDING 31ST DECEMBER 1958

President

SHRI SRI PRAKASA, *Governor of Bombay*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S.
Rev. Fr. H. Santapau, S.J.
Dr. Sálim Ali

Executive Committee

Prof. S. P. Agharkar, M.A., PH.D., F.L.S., F.N.I.
Dr. D. V. Bal, M.SC., PH.D.
Mr. R. E. Hawkins
Dr. C. V. Kulkarni, M.SC., PH.D.
Mr. D. N. Marshall
Mr. D. J. Panday
Mr. D. E. Reuben, I.C.S. (Retd.)
Mr. J. A. Singh, I.F.S.
Mr. Humayun Abdulali (*Hon. Secretary*)
Mr. M. J. Dickins (*Hon. Treasurer*)

Advisory Committee

Mr. H. G. Acharya, F.R.E.S. ...	... *Ahmedabad*
Mr. G. V. Bedekar, I.C.S. ...	... *Aurangabad*
Sir Chintaman Deshmukh, KT., C.I.E., I.C.S.	... *New Delhi*
Rev. Fr. Dr. J. B. Freeman, M.A., L.T., PH.D., D.D.	*Mysore*
Mr. E. P. Gee, M.A., C.M.Z.S. ...	... *Assam*
Col. R. C. Morris, F.R.G.S., F.Z.S. ...	... *Attikan*
Lt.-Col. E. G. Phythian-Adams, O.B.E., F.Z.S., I.A. (Retd.)	... *Nilgiris*
Dr. Baini Prasad, D.SC., F.N.I. ...	... *Dehra Dun*
Lt.-Gen. Sir H. Williams, C.B., C.B.E., M.I.C.E., M.I.E.	... *Roorkee*
Dr. M. L. Roonwal, M.SC., PH.D., F.N.I., F.Z.S.I.	... *Calcutta*

List of members of the Executive and Advisory Committee elected for the year 1959:

President

SHRI SRI PRAKASA, *Governor of Bombay*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S.
Rev. Fr. H. Santapau, S.J.
Dr. Sálim Ali

Executive Committee

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Mr. D. N. Marshall
Mr. D. J. Panday
Mr. D. E. Reuben, I.C.S. (Retd.)
Mrs. Barbara J. Tufty
Mr. Humayun Abdulali (*Hon. Secretary*)
Mr. Surendr Lall (*Hon. Secretary*)

Advisory Committee

Mr. H. G. Acharya, F.R.E.S.	*Ahmedabad*
Mr. F. C. Badhwar, O.B.E.	*Calcutta*
Mr. G. V. Bedekar, I.C.S.	*Aurangabad*
Sir Chintaman Deshmukh, KT., C.I.E., I.C.S. (Retd.)	*New Delhi*
Rev. Fr. Dr. J. B. Freeman, M.A., L.T., PH.D., D.D.	*Mysore*
Mr. E. P. Gee, M.A., C.M.Z.S.	*Shillong*
Dr. Baini Prasad, D.SC., F.N.I.	*Dehra Dun*
Dr. M. L. Roonwal, M.SC., PH.D., F.N.I., F.Z.S.I. ...	*Calcutta*
Mr. P. D. Stracey, I.F.S.	*Dehra Dun*
Lt.-Gen. Sir H. Williams, C.B., C.B.E., M.I.C.E., M.I.E.	*Roorkee*

HONORARY SECRETARY'S REPORT FOR THE YEAR 1958

THE SOCIETY'S JOURNAL

Parts 1, 2, and 3 of Volume 55 were published during the year. It was decided to complete this and future volumes with the third number so that each volume will now coincide with the calendar year. The last volume contained 39 articles and 85 miscellaneous notes.

The routine work of the Society included the identification of specimens and the answering of many enquiries, several of which have led to miscellaneous notes.

General

With the formal sanction of the Government grant, referred to in the last report, the Society's offices have been moved to 91, Walkeshwar Road, where it is hoped that members will be able to take better advantage of the library and, in due course, of the reference collections also.

Mrs. Barbara Tufty, a member of the Society, has very kindly undertaken the cataloguing and arrangement of the large number of books and magazines in our library, but her efforts are being hampered by our inability to obtain all the steel bookcases which have been ordered.

The reference collections will also be brought over with the completion of the agreement with the Prince of Wales Museum and, after these are under the same roof as the library, members and others will have better opportunities to study them.

The negotiations with the Ministry of Scientific Research and Cultural Affairs regarding the building funds have not progressed any further.

With the funds made available by the Sir Dorabji Tata Trust grant, six students have been given varying awards for field work.

Owing to technical difficulties Dr. J. H. Crook of Cambridge University, who is working on the breeding biology of the baya around Poona, has not been accepted by the University of Bombay as a teacher for the M.Sc. course in Zoology (Field Ornithology), and at the moment this work is being supervised by Dr. Sálim Ali. The only student on our rolls is, however, working in conjunction with Dr. Crook and is one of the beneficiaries under the Sir Dorabji Tata Trust grant.

Through the courtesy of the Canadian High Commissioner in Delhi, we were able to show three excellent films entitled 'Hunting with a Camera', 'Your Forest Heritage', and 'Life on the Western Marshes' on 11th July at the B.E.S.T. Conference Hall.

A number of antlers, horns, and skeletons of many different mammals, which had been lying in the Society's godown for many years, were distributed to some 14 colleges and institutions in India for display in their Zoology Departments.

Publications

The second edition of THE BOOK OF INDIAN ANIMALS is now in the press but, as most of the coloured plates are being replaced, it will

be at least another year before it is ready. THE SYNOPSIS OF INDIAN BIRDS by Dr. S. Dillon Ripley is making progress and should be ready by the end of next year.

Nature Education

The Nature Education Scheme financed by the Government of Bombay is now in its 11th year. Though limited by the funds available, the usual activities were continued. Some 3400 children were taken over the Natural History Section of the Prince of Wales Museum (44 visits), the Taraporevala Aquarium (9 visits), and the Municipal Gardens (4 visits). Nine field trips to different places, e.g. Kanheri Caves, Powai Lake, etc., were arranged for the Nature Study clubs.

In addition to the talks accompanying these excursions, 65 talks on different natural history subjects were delivered at the Museum and 40 conversational meetings held in the schools.

A series of eight lectures on 'Plant Life' with demonstrations was thrice arranged for teachers. They were also given the benefit of a course in geology by Dr. R. N. Sukheshwala of St. Xavier's College. This included two field trips into Salsette Island.

A meeting of children to celebrate Wild Life Week was called on 7th October when films were shown and Dr. Sálim Ali and Fr. H. Santapau addressed them.

Revenue Accounts

In the latter part of 1957 the entrance fee of Rs. 25 for membership of the Society was reduced to Rs. 5 with the object of attracting more members. It is perhaps still a little too early to say, but this move does not appear to have been particularly successful and the increase in membership during 1958, although slightly larger than in the past, has not been significant. Efforts to attract more members, however, continue and it is becoming increasingly apparent that the reduction in entrance fees will have to be supplemented by other measures before a larger growth in membership can be achieved.

As at the end of 1958 the register showed a total membership of 1255 but this is misleading in that approximately 274 members have either not paid their subscription or cannot now be traced. Although efforts are continuing to ascertain their whereabouts, it seems likely that most of them will have to be struck off the membership rolls in the near future.

During the year under review the income of the Society was Rs. 47,374 as against Rs. 50,992 in the previous year. This drop of

Rs. 3618 was due almost entirely to the Society not having received the usual annual grant of Rs. 8000 from the Government of India and attempts are still being made to secure these funds from the Government both in respect of 1958 and for the future.

The operations of the Society during 1957 had, as you already know, shown a deficit of Rs. 9542 and, though attempts were made to prevent a recurrence, the delay in receipt of the Government of India grant to the Society has led to the showing of a further deficit of Rs. 11,448 as at the end of the year under review. A promised recovery of Rs. 3210 from the Prince of Wales Museum (half the salary of the Acting Curator who has now been taken over by the Museum) has not been taken into account as the amount had not been received before the close of the year. Had it been possible to effect this recovery in time, the deficit for the year would have been reduced to to Rs. 8238.

Expenses during the year amounted to Rs. 58,822, a drop of Rs. 1711 as compared to the previous year. This is very satisfactory if it is borne in mind that the increased responsibilities of the Society necessitated a small increase in the staff, resulting in an increase of Rs. 2559 in expenditure on staff, despite which an overall saving has been achieved.

As for the future, it is still hoped that there will be no curtailment of the Government of India grant, but the seriousness of recurring deficits cannot be ignored. This matter is already engaging the attention of the Executive Committee and ways and means are being explored of cutting expenses without impairing the work being done by the Society, or in any way reducing the facilities it affords to its members.

Staff

The Committee wishes to record its appreciation of the willing co-operation of the entire staff in the activities of the Society.

Acknowledgements

The Committee's thanks are due to Mr. J. L. Bernard who continues to look after the Society's interests in United Kingdom.

APPENDIX TO THE HONORARY SECRETARY'S REPORT COVERING THE PERIOD JANUARY TO AUGUST 1959

This report for January to August 1959 is in several ways supplementary to that for 1958.

The agreement with the Prince of Wales Museum has been signed and the Reference Collection, consisting of some 21,000 mammal skins, 20,000 birds, 3,500 fish, 4,000 reptiles, 1,000 amphibians, 80,000 insects and a large number of miscellaneous items, has been brought over to the Society's premises where it is now available to members and other research students. The Society retains two representatives on the Board of Trustees of the Museum and it is hoped that the apparent separation will not lead to any dissociation from the management and maintenance of the Natural History Section of the Museum which is accepted as the best in India, if not in Asia.

It has not yet been possible to appoint the additional staff necessary for the proper maintenance, working, and development of the collections. The salary of a Senior Research Assistant is to be paid out of the annual grant from the Government of Bombay and the scale provided under the Government notification is insufficient to enable us to secure a suitable person. We are trying to persuade Government to increase the grade.

In the meantime, we have had the opportunity of sending members of the staff into the field with foreign and other expeditions. P. W. Soman, Junior Research Assistant, spent several months in Nepal with Mr. Klavs Becker-Larsen of Denmark while two members of the junior staff were attached to an American Museum expedition to Madhya Pradesh where they have had excellent instructions and practice in the preparation of bird and mammal skins. Later P. B. Shekar was attached to the Virus Research Centre's trip to Kashmir for the collection of some birds in the course of their investigations and he has brought in 73 birds for our collection.

The Virus Research Centre at Poona is investigating the Kayasanur Forest Disease which occurs in restricted areas in Mysore, some parts of Russia, and of which traces have been found in Kathiawar. From this distribution it is suspected that the disease, which is sporadic, is carried by migratory birds and large numbers of many species will have to be captured for the examination of their blood.

Dr. Sálim Ali attended a WHO Conference at Geneva and negotiations are in progress to secure their financial co-operation for a relatively large project for the capture and ringing of birds on migration in the Rann of Kutch. Some preliminary investigations

have been made and a trial project is going into operation next week. If this shows promise, a much larger effort will be made next spring.

From the funds made available by the Rockefeller Foundation, the Society has offered financial assistance for specific pieces of field work in natural history to be completed during the current year. Unfortunately, as has been our experience in the past, most of the applicants have a very poor idea of what they propose to do and very few have made any definite proposals. The majority of the applications are yet to be considered but some of those already sanctioned and completed may be of interest. Mr. E. P. Gee whose photographs are familiar to you was commissioned by the Survival Service of the International Union for Conservation of Nature and Natural Resources to inquire into the present status of the Great Indian Rhinoceros in Nepal. The Society contributed Rs. 250 towards his expenses and I hope that you will be able to read Mr. Gee's report in the December number of our *Journal*.

We helped Dr. Sálim Ali with his travelling expenses on a trip to Uttar Pradesh in search of Finn's Baya. This species was discovered and named by Hume in 1869 and then rediscovered by Finn in 1901 in the Calcutta Bazar. Though it occasionally turned up in the bird markets both at Calcutta and in Bombay, it had never been found again in a wild state and the Indian Board for Wild Life placed it among the rarer of our birds, completely prohibiting its export, dead or alive. Dr. Sálim Ali saw large numbers in the Kumaon terai and also obtained photographs and movie films some of which we hope to be able to show you in the near future.

The pioneer bird banding project in Kutch to which I referred earlier is also being assisted to the extent of Rs. 5000.

Dr. Gardiner Bump of the U.S. Fish and Wildlife Service is in India on a two-year visit to study the ecology and habits of some Indian game birds which it is proposed to introduce into the United States. Attempts are being made to collaborate with him and have the food of these species studied. The results would be of considerable importance and interest in India itself. Dr. Bump showed to our members a most remarkable film on 'The Bobwhite Quail' at the U.S.I.S. Auditorium, on 19th March. This was followed by a talk on Game Preservation.

I am sorry to have to announce the death of Lt.-Col. E. G. Phythian-Adams who was a member since 27-10-1909 and has been actively associated with our Advisory Committee since January 1930.

Mr. M. J. Dickins, our Honorary Treasurer since 1950, has

retired from India and the office taken over by Mr. Surendr Lall. We would like to record our deep gratitude to Mr. Dickins for the help which he has rendered to the Society not only as Honorary Treasurer, but also as a constant adviser and consultant while the Society's offices were at Messrs Phipson & Co. Ltd. Mr. Dickins has presented to the Society a large meeting table as also photographs of the earlier Directors of Phipson & Co. who were also closely associated with the administration of the Society since its inception.

The negotiations with the Ministry of Scientific Research and Cultural Affairs for a building grant are progressing very slowly, but it is hoped that in due course it will be possible to put up a new building in the Museum premises and increase the extent of the educational and research work which we can sponsor or handle.

The wall charts for the identification of poisonous snakes in English, Marathi and Gujarati are ready and prospectuses will go out to members shortly.

Since the last Annual General Meeting 102 members have joined, 47 in 1958 and 55 during the current year.

New Members

The following 102 members have joined since the last Annual General Meeting:

From 19 June to 31 December 1958

Mr. H. B. Fossey, London; Mr. Gerald Malcolm Durrell, Hampshire; The Peermade Game Association, Peermade; Mr. C. S. Machia, Mudis; Mr. R. C. Patil, Mugar; Mr. Pratapsinh R. Morarji, Bombay; Mr. B. R. Dave, Bombay; Mar Ivanios College, Trivandrum; Mr. Abdul Rahman M. Yusuf, Bombay; Mr. S. S. Podar, New Delhi; Mr. Oden Meeker, New Delhi; Messrs Sarabhai Chemicals, Baroda; Mr. K. Sivaloganathan, Kandy; Central Botanical Laboratory, Allahabad; Mr. Kamal Singh, Dumraon; Officers' Mess, Bengal Engineer Centre, Roorkee; Mr. Edwin T. Goodridge, New Jersey; Gorakhpur University, Gorakhpur; Mr. J. S. Lall, New Delhi; Central National Herbarium, Howrah; Mrs. Harold Tufty, Bombay; Director of Indian Aid Mission in Nepal, Kathmandu; Union Club, Raipur; Mr. Syed Shamsuzzoha, Comilla; Government College, Sirohi; Mr. A. C. Thimiah, Virajpet; Shan & Kayah States, Taunggyi; Dayanand College, Sholapur; Institute of Pre-University Course, Gadag; Fr. Joe Rodrigues, Poona; Conservator of Forests, Junagadh; Lady Shri Ram College for Women, New Delhi; Dr. Gardiner Bump, New Delhi; Mr. Sanit Tongsanga, Calcutta; Mr. Yakubali Mohamedali, Bombay; Mr. K. Becker-Larsen, New Delhi; Mr. Yashwant H. Talcherkar, Sironj; Miss Ellen Drake, New Delhi.

FROM 1 JANUARY TO 31 AUGUST 1959

Mr. T. N. Mehrisi, Sendhwa; Mr. David Livingstone, Palayamkottai; Col. S. S. Bhatnagar, Bombay; Mr. A. F. Burdett, Dehra Dun; Mr. H. F. Bartsch, Jamshedpur; Mr. H. A. R. Eadie, Digboi; PMC. Officers Mess, C/o 56 APO; Mr. S. I. Hassan, Mombasa; Mr. Bijay Narain Sinha, Latehar; Mr. J. E. Matthews, Marangi; Mr. Sergei Postupalsky, Michigan; Dr. G. K. D. Roy, Arunachal; Messrs. Davidoss & Co., Bangalore; Miss E. L. Campbell, Balaghat; Mr. P. S. M. Molyneux, Coonoor; Mr. D. M. Holmes, Bombay; Mr. Georges Gogel, Bombay; St. Thomas Inter College, Shahganj; Mr. Urendra T. Mehta, Bombay; Mr. Walter Mink, Bombay; Government Degree College, Mandsaur; Bombay Veterinary College, Bombay; Mr. Dix Campbell, Mass.; Maharaj Kumar Fatehsinh of Kutch, Bhuj; Mr. N. K. C. Parish, Town Khalispur; St. Xavier's College, Ahmedabad; Indian Botanical Gardens, Howrah; Chief Wild Life Warden, Lucknow; Mr. K. S. Sadananda, Barsikatte; Mr. Kalyan Kumar Gupta, Shillong; Major Kumar S. N. Rai Deb, Calcutta; Mr. Mohamed Aminuddin Khan, Munnar; Mr. Jan Roger van Oosten, Washington; Mr. R. G. Brown, North Lakhimpur; Karachi University Library, Karachi; Mrs. William H. Mathers, Long Island; Fisheries Research Officer, Udaipur; Mahatma Gandhi Memorial College, Udipi; Mr. Wayne H. Bohl, New Delhi; University College of Ghana, Accra, Ghana; University of Jammu & Kashmir, Srinagar; Mr. Jagdish Narain, Moradabad; Yuvraj Digvijaysinh, Wankaner; Divisional Forest Officer, Tirap; Mr. Nar Singh Sidhu, Tamkote; Divisional Forest Officer, Tezu; Jamal Mohamed College, Tiruchirapalli; Mr. A. N. C. Lothian, New Delhi; Mr. P. K. Basu, Dalsingpara; Mrs. Martha Howe Gogel, Bombay; Dr. Chas E. Klontz, Vellore; Duke University, Carolina; College of Science & C. B. Patel's Arts Institute, Nadiad; Dr. Bankay S. Lall, Sabour; Wild Life Preservation Society of Northern India, Dehra Dun; Mr. R. A. S. Melluish, Madras; Mr. L. A. Woodfall, Bombay; Holkar College, Indore; Dr. Edward W. Taylor, Kansas; Rajasthan College of Agriculture, Udaipur; Mr. J. MacLellan, Calcutta; Mr. S. M. Zubair, Bombay; Delaware Museum of Natural History, Delaware; Mr. A. A. Salunkey Patil, Damoh.

THE BOMBAY NATURAL HISTORY SOCIETY

BALANCE SHEET AS AT 31 DECEMBER 1958

FUNDS AND LIABILITIES	Rs nP	Rs nP
Trust Fund or Corpus:		
Life Membership Fund		
Balance as per last Balance Sheet ...	97,190.28	
Add: Amount received during the year ...	150.000	
		97,340.28
Other Earmarked Funds:		
Expedition Fund	1,800.00	
Field Work Fund		
Balance as per last Balance Sheet 529.72		
Add: Transferred from Income and Expenditure Account 2,380.25		
	2,909.97	
Wild Life Fund	715.25	
Mammal Survey Fund	3,265.73	
Building Fund	30,000.00	
Reserve for Snake Wall Charts ...	3,000.00	
Unspent Grant of Government of Bombay		
Transferred from Income and Expenditure Account	33,515.43	
		7,206.38
Liabilities:		
For Expenses	18,970.12	
,, Advances (Subscriptions and Entrance Fees)	936.14	
,, Sundry Credit Balances ...	4,674.54	
		4,580.80
Income and Expenditure Account		
Balance as per last Balance Sheet	38,098.49	
Less: Deficit as per Income and Expenditure Account	11,447.80	
		26,650.69
Carried forward ...		2,23,778.15

ASSETS	Rs nP	Rs nP
Immovable Properties		nil
Investments:		
Rs. 14,000 4% Bombay Port Trust Bonds	10,780.00	
,, 15,000 4% Bombay Improvement Trust Bonds ...	11,400.00	
,, 36,000 3% Funding Loan 1966-68	35,812.62	
,, 25,000 3% Conversion Loan 1946	25,000.00	
,, 2,000 3% First Development Loan 1970-75 ...	1,948.75	
,, 92,000	84,941.37	
(Market value Rs. 82,098.50)		
£ 460 3½% Defence Bonds	6,133.34	
	91,074.71	
Less: Provision for Depreciation ...	3,750.00	87,324.71
Furniture and Fixtures:		
Balance as per last Balance Sheet ...	2,030.11	
Less: Sold during the year	338.40	
	1,691.71	
Less: Depreciation during the year ...	250.22	1,441.49
Loans: (Secured)		
	Good *Doubtful*	
Loan Scholarships	nil nil	
Other Loans (to staff) ...	,, ,,	
Advances:		
To Trustees	nil	nil
,, Employees	,,	
,, Contractors	1,956·84	
,, Lawyers	nil	
,, Nature Education Scheme	2,004.11	
,, Others	246.29	
		4,207.24
Income Outstanding:		
Rent	nil	
Interest (Accrued)	1,741.89	
		1,741.89
Other Income:		
Supplies and Services	9,082.60	
Government of Bombay (Grant) ...	4,000.	13,082.60
Carried forward ...		1,07,797.93

BALANCE SHEET AS AT 31 DECEMBER 1958—(*continued*)

FUNDS AND LIABILITIES		Rs nP	ASSETS	Rs nP	Rs nP
Brought forward ...		2,23,778.15	Brought forward ...		1,07,797.93
			Stock of Books on hand: (At cost or under)		
			As certified by the Honorary Secretary ...		53,411.16
			Cash and Bank Balances:		
			(*a*) *In Current Account with :*		
			National and Grindlays Bank Ltd., Bombay	12,677.88	
			National and Grindlays Bank Ltd., London (£ 715 11-9)	9,541.18	
			Call Deposit with the Comptoir National d'Escompte de Paris, Bombay	40,000.00	
			(The above accounts are in the name of the Society)		
			(*b*) With the Trustees	Nil	
			(*c*) With the Cashier (Shri A. L. Hegde).	350.00	62,569.06
Total ...		2,23,778.15	Total ...		2,23,778.15

The above Balance Sheet to the best of my belief contains a true account of the Funds and Liabilities and of the Properties and Assets of the Trust.

For Bombay Natural History Society
(Sd.) SÁLIM ALI,
Trustee.

As per our report of even date.
(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants

THE BOMBAY NATURAL HISTORY SOCIETY

Dr. *INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31 DECEMBER 1958* *Cr.*

EXPENDITURE	Rs nP	Rs nP
To Expenses in respect of Properties:		
Rates, Taxes, Cesses, Repairs, and Maintenance	nil	
Salaries	,,	
Insurance	,,	
Depreciation (by way of provision or adjustments)	,,	
Other expenses	,,	
		nil
Expenses from the Special Grant of Government of Bombay:		
Rent	7,000.00	
Purchase of Furniture	3,231.80	
Salaries	1,111.15	
Miscellaneous	141.62	
		11,484.57
Establishment Expenses:		
Salaries (including Dearness Allowance)	30,737.20	
Society's contribution to Staff Provident Fund	1,254.94	
Rent	1,600.00	
Postage	1,281.81	
Printing and Stationery	1,272.29	
Advertisement	56.80	
Editor's Travelling Expenses	900.00	
		37,103.04
Remuneration to Trustees:		nil
Remuneration (In the case of a Math).		nil
Legal Expenses		nil
Audit Fees		500.00
Contribution and Fees		nil
Amounts written off:		
Bad Debts	nil	
Loan Scholarships	,,	
Irrecoverable Rents	,,	
Other items	,,	
		nil
Carried forward ...		49,087.61

INCOME	Rs nP	Rs nP
By *Rent:* Accrued	nil	
Realised	,,	
		nil
Interest (Realised and Accrued)		
On Securities	4,441.67	
On Bank Account	1,003.79	
		5,445.46
Dividends		nil
Donations in cash or kind		,,
Grants:		
Government of Bombay	4,000.00	
Government of Bombay Special Grant.	45,000.00	
Sir Dorabji Tata Trust Grant for Field work	3,000.00	
		52,000.00
Income from other sources:		
Subscriptions	21,637.75	
Entrance Fees	15.00	
		22,052.75
Publications:		
Journal Sales	7,025.28	
Books etc., Profits:		
Book of Indian Birds	3,169.22	
Book of Indian Animals	7.65	
Some Beautiful Indian Climbers and Shrubs	1,008.32	
Some Beautiful Indian Trees	756.1	
Butterflies of the Indian Region	782.9	
Circumventing the Mahseer and other Sporting Fish	318.86	
Game Birds Vol. III	42.32	
Indian Molluscs	161.66	
Calendars	2,030.91	
Other Publications	92.32	
Taxidermy, etc.	58.55	
		15,454.26
Carried forward ...		94,952.47

Dr. **INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31 DECEMBER 1958—(*continued*)** *Cr.*

EXPENDITURE	Rs nP	Rs nP	INCOME	Rs nP	Rs nP
Brought forward ...		49,087.61	Brought forward ...		94,952.47
To Miscellaneous Expenses:			By *Refund of Insurance Premium in respect of the year* 1957		421.87
Field Work Expenses	619.75		*Deficit carried to Balance Sheet* ...		11,447.80
General Charges	2,305.69				
Fire Insurance	138.63				
Sales Tax and Central Sales Tax ...	637.35				
		3,701.42			
Depreciation :					
On Investments	nil				
,, Furniture	250.22				
		250.22			
Amounts Transferred to Reserve or Specific Funds:					
Unspent Grant of Government of Bombay	33,515.43				
Unspent Grant for Field Work transferred to Field Work Fund	2,380.25				
		35,895.68			
Expenditure on Objects of the Trust :					
(*a*) Religious	nil				
(*b*) Educational—Journal Expenses ...	16,716.04				
Library	1,171.17				
(*c*) Medical relief	nil				
(*d*) Relief of Poverty	,,				
(*e*) Other Charitable Objects	,,				
		17,887.21			
Total ...		1,06,822.14	Total ...		1,06,822.14

BOMBAY, *30th March, 1958*

As per our report of even date
(Sd.) A. F. FERGUSON & Co.,
Chartered Accountants.

For Bombay Natural History Society
(Sd.) SÁLIM ALI,
Trustee.

THE BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the year ended 31 December 1958

Receipts	Rs nP	Payments		Rs nP
To Bank balance as at 1 January 1958 brought forward	1,221.83	By Repayment of Advance from Bombay Natural History Society		1,000.00
Grant from Government of Bombay for 1957-58 ...	6,100.00	Salaries of Nature Education Organiser		5,915.00
Sales of Line drawings, etc, ...	50.12	Postage		221.03
Sales of Booklet No. I	655.05	Printing and General Charges		288.35
Sales of Booklet No. II	658.29	Cost of Booklet No. III		2,800.00
Sales of Booklet No. III	631.80	Cost of Booklet No. IV		9.25
Advance Receipt for Booklet No. IV	1.19	Balance carried forward:—		
Bombay Natural History Society Advance ...	2,004.11	Cash with the Cashier	50.00	
		Bank Balanee on 31 December 1958 ...	1,038.75	1,088.75
Total ...	11,322.39	Total ...		11,322.39

Bombay. 30th March, 1958

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants.

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD IN THE B.E.S. & T. CONFERENCE HALL, BEST HOUSE, ORMISTON ROAD, BOMBAY 5 ON MONDAY 31ST AUGUST 1959 AT 5.45 P.M. WITH REV. FR. H. SANTAPAU, S.J., IN THE CHAIR

1. The Honorary Secretary's Report for the year ended 31st December 1959 which was circulated among members prior to the meeting was taken as read and adopted.

2. The Balance Sheet and Statement of Accounts presented by the Honorary Treasurer were approved.

3. The Honorary Secretary then read a Supplementary Report on the activities of the Society from January to August 1959.

4. After completion of the formal business the following films were exhibited and greatly appreciated:

(1) WHERE THE TIGER PROWLS.

(2) JOURNEY IN SPRING.

5. The meeting terminated with a vote of thanks to Mr. Saul Blickman of New York for the gift of the tiger film and to the British Information Services for the loan of the film JOURNEY IN SPRING.

PRINTED AND PUBLISHED BY V. M. PHILIP AT THE DIOCESAN PRESS
18 CHURCH ROAD, VEPERY, MADRAS—18-2-1960. C2916
EDITORS: SÁLIM ALI, AND H. SANTAPAU
91 WALKESHWAR ROAD, BOMBAY 6

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. With many coloured and black and white plates. 2nd (revised) edition. (*In preparation*)

Birds

Game Birds of India, by E. C. Stuart Baker. Vol. III. Pheasants, 1st Edition. **Rs. 20**
(*Price to Members Rs.* 15)

The Book of Indian Birds, by Sálim Ali. With 64 coloured and many black and white plates, 6th edition, revised and enlarged. (*In preparation*) **Rs. 20**

Fishes

Circumventing the Mahseer and Other Sporting Fish in India and Burma, by A. St. J. Macdonald. With coloured and black and white plates. **Rs. 15**
(*Price to Members Rs.* 12)

Snakes

Identification of Poisonous Snakes. Wall chart in English, Gujarati, and Marathi. Rs. 10
(*Price to Members Rs.* 8)

Miscellaneous

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 2nd edition. Revised by W. T. Stearn. **Rs. 20**
(*Price to Members Rs.* 16)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. **Rs. 22**
(*Price to Members Rs.* 17.50)

Butterflies of the Indian Region, by M. A. Wynter-Blyth. With 27 coloured and 45 monochrome plates. **Rs. 28**
(*Price to Members Rs.* 22.50)

Indian Molluscs, by James Hornell. With 2 coloured and many monochrome plates, and text figures. **Rs. 6**
(*Price to Members Rs.* 4.50)

Glimpses of Nature Series Booklets :

OUR BIRDS, 1 (with 8 coloured plates) in English, Gujarati, Hindi, Kannada, and Marathi. **62 nP**

OUR BIRDS, 2 (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **62 nP**

OUR BEAUTIFUL TREES, 3 (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **62 nP**

OUR MONSOON PLANTS, 4 (with 8 coloured plates) in English. **80 nP**

Back numbers of the Society's Journal. Rates on application.

Obtainable from :

The Honorary Secretary,
Bombay Natural History Society,
91 Walkeshwar Road, Bombay 6.

Agents in England :

Messrs. Wheldon & Wesley Ltd.,
Lytton Lodge, Codicote, Nr. Hitchin,
Herts., England.

The Society will gratefully accept back numbers of the Journal, particularly numbers prior to Vol. 45, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 5 and a life membership fee of Rs. 500.

Ordinary Members pay an entrance fee of Rs. 5 and an annual subscription of Rs. 30.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

MEMBERS RESIDING OUTSIDE INDIA

The terms are the same for members living outside India. Such members should pay their subscriptions by means of orders on their Bankers to pay the amount of the subscription, plus postage—in all Rs. 32.50—to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £2-10-0 should be paid annually to the Society's London bankers—The National Overseas & Grindlay's Bank Ltd., 26 Bishopsgate Street, London, E.C. 2.

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