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VOLUME 102 (3): DECEMBER 2005

CONTENTS

NEW DESCRIPTIONS

REVIEWS

MISCELLANEOUS NOTES

Cover Photograph: Leopard Dorid *Jorunna funebris*
By Deepak Apte

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WE THANK

Experts who have given editorial inputs for this volume

B.F. Chhapgar
D.B. Bastawade
D.K. Lahiri Choudhury
Gayatri Ugra
Isaac Kehimkar
Naresh Chaturvedi
Otto Pfister
Rahul Kaul
Varad Giri

Editorial

Highest Importance: Lowest Priority

"Environment sustainability is not an option but an imperative. Clean air, pure water, conservation of forests and wild life and generation of greenery are the essentials for a healthy environment. Prevention of degradation of land, controlling floods and droughts, preventing desertification, conservation of fragile eco-system, prevention of deforestation, conserving bio-diversity and mitigating water and air pollution all present challenges for planners and policy makers."

Nice words, isn't it? This is quoted from a government document "Mid-term Appraisal: Tenth Five Year Plan – Part II, Chapter 14, pp: 429-443. Let us see if this rhetoric matches with the deed. I quote from another government document given to me in one of the meetings of the 11th Five Year Plan:

Plan	Year	Allocations in Crores	% of the National Plan
6th	1980-85	692.50	0.07
7th	1985-90	1,859.00	1.03
8th	1992-97	4,910.00*	1.13
9th	1997-02	7,336.00**	0.84
10th	2002-07	14,344.00***	0.94

* Swaminathan Committee appointed by the Planning Commission, Government of India, recommended allocation of Rs. 9,950 crores for the 8th Plan.

** Mukherjeee Committee of the Planning Commission recommended allocation of Rs. 26,752 crores for the 9th Plan for ensuring covering of 33% area in 20 years.

*** The National Forestry Action Plan aimed at having 33% of land area under forest/tree cover in 20 years. To achieve this, the Ministry of Environment and Forests, in 1999, requested allocation of Rs. 27,256 crores for 10th Plan.

The MoEF got 0.94% of the National Plan of the Government of India in the 10th Five Year Plan for protecting the environment and almost 20% in the land of the country that is officially under forest cover (the state governments have their own budgets). Let us see what the forests provide to us. Intangible benefits of forests and biodiversity run in billions, perhaps hundreds of billions of rupees – though I do not have statistics for this. To give you some examples of the intangible benefits of forest and wild areas: most rivers originate from the forests; forest cover regulates stream flow and rain water; forests and grasslands help in ground water recharge and soil conservation; vegetation cover does CO^2 fixation and provides us with clean air; forests, grasslands, mangroves and wetlands provide a plethora of medicines and genes for crops. The tangible benefits of the forests are: 70% of all rural and 20% of urban fuel energy comes from forests, 40% of the green fodder (grazing, lopping and cutting) comes from forests, 80% of all rural medicine and a large volume of non-timber products come from forests. All of these activities support livelihood in the rural sector. Millions of people visit national parks and sanctuaries ever year. The state governments earn crores of rupees from forests through harvest of timber, Forest Corporations, and auctions of Minor Forest Products. The Forestry sector employs millions of people in rural India.

Environmental sustainability is certainly not an option which can be delayed for future generations. Future generations and civilizations *are* sustained by environmental sustainability. Can we sustain and protect the environment when the Planning Commission (and the Government) gives it a low priority?

In this age of globalization, WTO, Millenium Development Goal, agriculture subsidies, Davos and Doha, will someone in India calculate the benefits, both tangible and intangible that our forests and wildlife provide to us? With an economist for a Prime Minister, and Secretary of Environment and Forests, this is perhaps the only language they would understand.

Discussions on the 11th Five Year Plan are ongoing with each ministry putting up their demands of funds. Let us take the mandarins of the Planning Commission to a national park before they decide fund allocation for the MoEF.

Perhaps, clean air, pure water, unpolluted streams, song of the Malabar Whistling Thrush, and innocent alarm calls of a skittish Cheetal doe would change their heart.

Perhaps, taking them to the forest in central India, where the Chambal river originates, would change their outlook to nature.

Perhaps, a morning walk on a lonely nature trail in the thick jungles of Arunachal Pradesh would change their mind.

Perhaps, in the 11th Five Year Plan the MoEF will get 5% of the National Plan, which the MoEF rightly deserves.

Perhaps, the statement quoted at the starting of this editorial would not remain just an empty rhetoric.

Perhaps...!

Asad R. Rahmani

OBSERVATIONS ON THE NATURAL HISTORY AND BEHAVIOUR OF THE PRIMITIVELY EUSOCIAL WASP *ROPALIDIA CYATHIFORMIS* (FAB.) (HYMENOPTERA: VESPIDAE)[1]

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This paper reports on natural history and behaviour of the primitively eusocial wasp *Ropalidia cyathiformis*, which builds small, open, paper carton nests and exhibits an aseasonal nesting cycle. The number of adult wasps on a nest ranges from one to about a hundred, and nests last from a few days to sixteen months or more. Most colonies have a single queen, who is morphologically similar to her workers but has better developed ovaries. Female wasps exhibit several dominance behaviours which are positively correlated with rates of snatching food and building material from incoming foragers, and also of feeding larvae and building the nest. This suggests that behaviourally dominant individuals specialize in performing intra-nidal tasks including brood care. Queens are the most behaviourally dominant individuals of their colonies and appear to inhibit worker reproduction and regulate non-reproductive activities of workers using dominance behaviours. Our observations suggest that *R. cyathiformis* is a typical example of a primitively eusocial species, in striking contrast to the congeneric *R. marginata* which exhibits some features reminiscent of more advanced eusociality. Queens of *R. marginata* are behaviourally docile and appear to use a non-behavioural (probably pheromonal) method of regulating worker reproduction. Non-reproductive activities of workers in *R. marginata* are regulated in a decentralised, self-organised manner without the involvement of the queen. A comparative study of *R. cyathiformis* and *R. marginata* will be valuable in understanding the evolutionary transition from primitive to advanced eusociality in general.

Key words: primitively eusocial wasps, social evolution, *Ropalidia cyathiformis*, *Ropalidia marginata*, nesting cycle, dominance behaviour

INTRODUCTION

Eusocial insects are characterised by overlap of generations, co-operative brood care and reproductive differentiation into fertile reproductive and sterile worker castes. Eusociality is seen in ants, bees, wasps, termites, aphids, thrips, ambrosia beetles, marine shrimps, a possible example among spiders and a lone vertebrate example – the Naked Mole Rat. Eusocial species may be classified as primitively or highly eusocial. Primitively eusocial species lack morphological caste differentiation and retain many behavioural features of their solitary ancestors. Highly eusocial species exhibit morphological differentiation between workers and reproductives, and have acquired many behavioural features not present in their solitary ancestors and inconsistent with solitary life (Michener 1969; Wilson 1971; Hölldobler and Wilson 1990; Bourke and Franks 1995; Crozier and Pamilo 1996; Gadagkar 2001). The emergence of a sterile, altruistic worker caste is one of the most challenging problems of the evolution of eusociality. Primitively eusocial species are appropriate model systems to investigate the early stages of evolution because reproductives and workers are usually not irreversibly committed to their respective roles and because individuals in many species have retained the ability to found nests and rear brood in the solitary mode.

Among social Hymenoptera, primitively eusocial species are found among bees and wasps. The old world tropical genus *Ropalidia* is thought to be of particular interest in understanding the evolution of eusociality because it includes both primitively as well as highly eusocial species. *Ropalidia marginata* and *Ropalidia cyathiformis* are the two most abundant primitively eusocial wasps in peninsular India. Of these, *R. marginata* has been studied extensively to yield a number of interesting insights into the evolution of eusociality (Gadagkar 2001). By comparison, *R. cyathiformis* remains poorly studied but promises to contribute to our understanding of the evolution of eusociality in new and interesting ways (Gadagkar 2001).

R. cyathiformis was first described by Fabricius (1804) as *Eumenes cyathiformis*. It was also described as *Icaria ceylonica* by Cameron (1898), as *Icaria cayaynensis* by Ashmead (1905a,b), as *Icaria bilineata* by Cameron (1905) and as *Icaria cyathiformis* by Schulz (1912). Vecht (1941, 1962) first used the combination *Ropalidia cyathiformis*. *R. cyathiformis* wasps are small in size, the females are 6.5 - 7.0 mm long and the males about 5.5 mm. Sexes are easily

distinguishable. *R. cyathiformis* has been reported from Uttar Pradesh, Arunachal Pradesh, Bihar, Assam, Madhya Pradesh, Maharashtra and Karnataka in India and also from Nepal, Sri Lanka, Malaysia and Sulawesi and Sumba in Indonesia (Das and Gupta 1989).

We have initiated a long-term study of this species to develop an additional model system for investigating the evolution of altruism and eusociality. Here we describe some aspects of the natural history and behaviour of *R. cyathiformis* in Bangalore (13° 00' N and 77° 32' E), India.

METHODS

Nesting cycle

Selected buildings and other favourite nesting sites on the campus of Indian Institute of Science (IISc), Bangalore were surveyed once in about two weeks for the presence of nests of *R. cyathiformis*. When a nest was first encountered, the number of eggs, larvae, pupae, parasitized cells, empty cells, combs, pedicels, adult females and adult males present were recorded. This was done before 0700hrs or after 1900hrs when adult wasps are expected to be in the nest. On subsequent visits we noted only whether it was active or abandoned. A nest with brood and adults was considered active and one devoid of both was considered to have been abandoned.

Adults of old world primitively eusocial wasps remove the larval meconium (faecal matter) by chewing a small hole at the bottom of the cells. This is done immediately after the larva spins a silk cap on its cell, in preparation for pupation. After removing the meconium, the adult wasps seal the hole with salivary secretion. Thus, transparent windows can be seen at the bottom of those cells in which larvae have pupated at least once. Since the cells are reused, empty cells as well as egg and larva bearing cells may have transparent windows. Hence the presence of any one or more transparent windows at the bottom of empty cells, egg cells or larval cells indicates a post-emergence nest. Based on this criterion, every nest was classified either as a pre-emergence or post-emergence. When a pre-emergence nest had only eggs and young larvae, it was designated as having been initiated in that month. The numbers of nests seen to have been initiated or abandoned in different months of the year were compiled from such data. The survey was done for most months during four consecutive years (Table 1). For those months in which survey was done in more than one year, the numbers of nests initiated and abandoned in that month was averaged over all the years during which survey was done. During this study we located and recorded data on 33 pre-emergence nests and 53 post-emergence nests.

Behaviour

We observed 10 post-emergence nests (Table 2) from April 2002 to January 2004. All adults on each nest were uniquely marked with spots of quick drying, non-toxic enamel paints. Five minute observation sessions were made, during which every performance by each individual was recorded for the following behaviours: dominance behaviour, bring food, snatch food, lose food, feed larva, bring building material, snatch building material, lose building material and build. Observation sessions were evenly distributed from 0630 hrs to 1830 hrs. Five sessions of 5 minute observations were randomly performed each hour during four to six hours per day. Each nest was thus studied for 16-20 hours over a period of four to six days.

Table 1: Monthly census records. √ denotes nest census was taken in that month for that year while — denotes no census was taken in that month for that year

Month	1999	2000	2001	2002	No. of events of census
January	√	√	√	√	4
February	√	√	√	—	3
March	√	√	√	—	3
April	√	√	√	√	4
May	√	√	—	√	3
June	√	√	√	√	4
July	√	—	√	—	3
August	—	—	√	√	2
September	—	√	—	√	2
October	—	√	√	√	3
November	√	√	√	√	4
December	√	—	√	√	3

Table 2: Number of females, males, eggs, larvae, pupae, empty cells and parasitized cells present in the 10 nests used for the behavioural observations

Nest	Females	Males	Eggs	Larvae	Pupae	Empty cells	Parasitized Cells
C76	14	0	17	20	5	0	0
C79	33	0	37	35	16	1	0
C80	26	0	14	26	6	0	0
C81	14	0	22	16	7	1	2
C85	15	0	19	17	12	1	0
C90	21	0	14	29	9	0	1
C93	17	0	14	25	4	0	0
C96	21	1	25	19	13	0	1
C97	26	12	18	23	9	0	2
C98	18	2	11	31	8	0	0

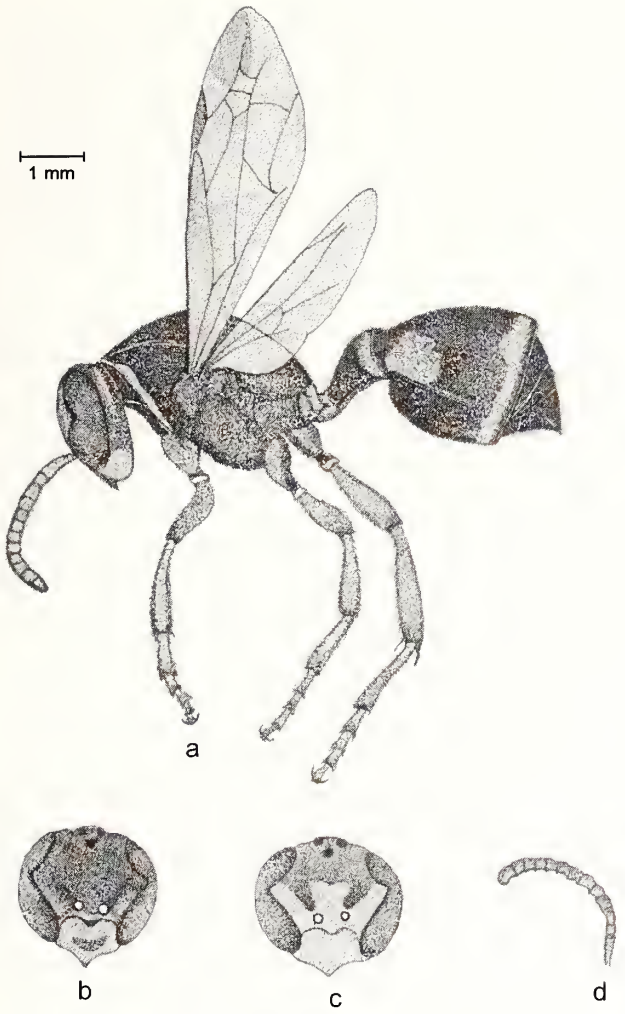

Fig. 1: Camera lucida drawings of (a) female *R. cyathiformis* in profile, frontal view of (b) head of female, and (c) head of male and (d) side view of male antenna showing curved apical segment and tyloids. (By Thresiamma Varghese)

Body size

All adult wasps were collected at the end of the study, and stored at -20° C for measurement and later dissection. For each wasp, the following were measured: interocellar distance, right ocello-ocular distance, left ocello-ocular distance, head width, head length, clypeus width, clypeus length, width of first segment of right antenna, length of first segment of right antenna, width of first segment of left antenna, length of first segment of left antenna, inter-antennal distance, width of mesoscutum, length of mesoscutum, alitrunk length, length of right wing, length of left wing, length of 1st marginal cell of right wing, length of 1st marginal cell of left wing, number of hammuli on right wing, number of hammuli on left wing, width of 1st gastral segment, length of 1st gastral segment, height of 1st gastral segment, width of 2nd gastral segment, length of 2nd gastral segment and height of 2nd gastral segment. These 27 body measurements were subjected to principle components analysis using a correlation matrix, separately for each colony as well as for data pooled from all the 10 colonies. The results were used either as an index of body size (defined as the magnitude of the first principle component) or to plot the relative positions of different wasps in a two dimensional principle components space.

Ovarian development

Female wasps were dissected to evaluate the state of ovarian development. The following measurements were made: width of the largest oocyte, length of the largest oocyte, average width calculated over all proximal oocytes, average length calculated over all proximal oocytes, total number of oocytes, number of oocytes with yolk and number of mature oocytes. The ovarian measurements were subjected to principal components analysis and the results were utilized as for body size.

Dry weight and fat content

After taking all measurements the wasps were oven-dried at 72 °C for 36 hours and weighed. Fat content was then estimated using the method of Folch *et al.* (1957).

RESULTS

Females have a crescent shaped brown mark on the clypeus, which males' lack. The apical segment of the antenna is more curved in males. Only males have tyloids on the third and the subsequent segments of the antennae. The first of these differences is easily seen, without disturbing wasps sitting on the nest, making field identification easy (Fig. 1).

Nesting habits

Like most primitively eusocial polistines, *R. cyathiformis* builds simple, stelocyatarus (suspended by a pedicel) and gymnodomous (un-enveloped) nests. Each nest has a single pedicel only, and generally a single comb. Of the 86 nests observed 82 had a single comb, three had two combs and one had three combs. Each comb was suspended by a single pedicel, situated either approximately at the centre (60 combs) or at the periphery (31 combs). Stone pillars and walls (40 nests), cement walls (11), croton bushes (10), wooden door and window frames (9), iron beams (7), asbestos sheets (3), underside of leaves (3), glass panes (2) and brick wall (1) were used as nesting sites in decreasing order of preference. Nests were invariably built in relatively open spaces and were never seen in crevices or in closed places with only a narrow entrance. Active nests were seen throughout the year (Fig. 2a). Nests were also abandoned at all times of the year, but

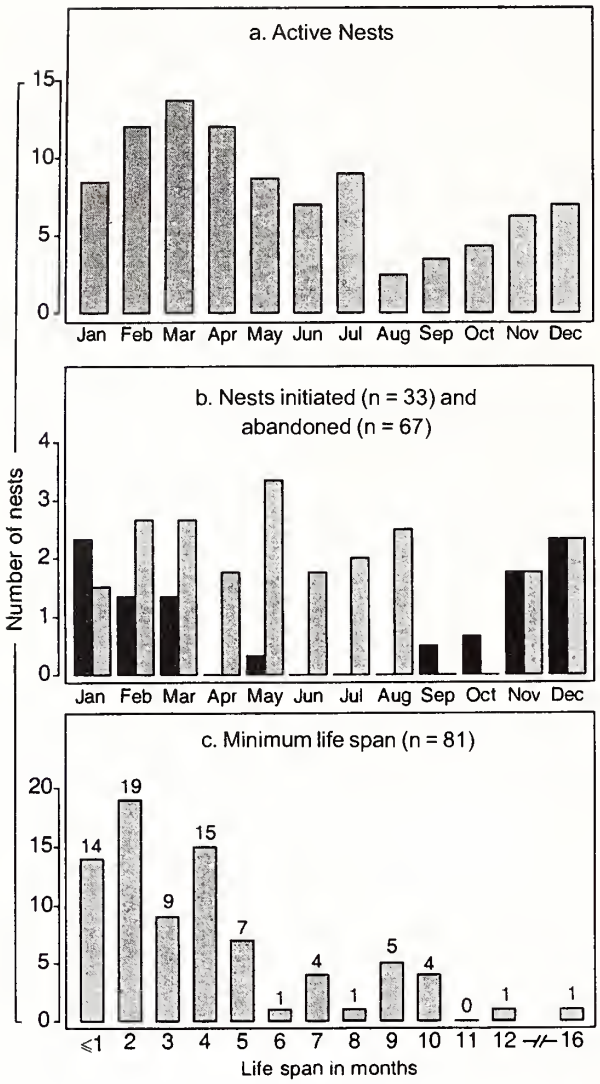

Fig. 2: Frequency distribution of (a) active nests, (b) nests initiated (black bars) and abandoned (grey bars), (c) minimum life span of nests. Sample sizes of nests studied are shown in parentheses in (b) and (c) and also above the bars in (c)

nest initiation occurred usually between October and March (Fig. 2b). For most nests we either recorded the initiation or the abandoning, but not both. This is because either the nests were already initiated at the beginning of our study or our study was terminated before the nest was abandoned. Hence we can only assess the minimum life span of the nest which ranged from one month or less to 16 months, with six out of 81 nests lasting for 10 months or more. The median of the minimum life span was three months and mode was two months.

The total number of adult wasps on a nest ranged from 1 to 93 (Fig. 3a) and the number of females ranged from 1 to 72 (Fig. 3b). 22 out of 33 newly initiated nests had a single founder while the remaining 11 had two founders each. Males were never seen on pre-emergence nests. Out of 53 post-emergence nests, 11 had from 1 to 21 males (Fig. 3c). Information on nest size in terms of cells and brood is summarised for 75 nests in Fig. 3d-g. Although ants and an unidentified ichneumonid wasp occasionally prey upon/ parasitize *R. cyathiformis* nests, the hornet *Vespa tropica* is undoubtedly its major predator (not counting humans), keeping its population in check.

Body size

Intracolony variation in the seven most variable parts of the body and in the index of body size is depicted for a representative colony in Fig. 4a. Intracolony variation in body size is rather small and continuous. By no measure of body size is the queen the largest individual. Multivariate statistical analysis confirms that intracolony variation in body size is relatively continuous and that the queen is intermediate; there are individuals with lower as well as higher values than the queen along principal component 1 as well as principal component 2 (Fig. 5a). The intermediate position of the queen relative to workers is even more clear when data from all the 10 colonies are pooled. The 10 queens are scattered among the 136 workers along the two principal component axes (Fig. 5b). In colony C97 there were 12 males in addition to 18 females. In two others (C96 and C98) there were males but only one and two respectively. Intracolony variation in body size for males, workers and queen for the colony C97 is depicted in Fig. 6 as the relative positions of different wasps in principal components space. Males and females form two distinct clusters with all females (with one exception) having higher values of principal component 1 than males. Males and females have similar variation in values of principal component 2. Since wing length has the maximum weightage in principal component 1, this means that males are smaller than females when measured by wing length although they may be comparable to females in some other measures of body size.

Ovarian condition

In sharp contrast to body size, ovarian condition varies discontinuously within colonies. Intracolony variation in ovarian condition for seven measurements of the ovaries, as well as by a composite index of ovarian condition for the same representative colony is depicted in Fig. 4b. When measured by length and width of the largest oocyte, average length and width of proximal oocytes or total number of oocytes, three kinds of individuals can be recognized - the queen with a very high value, about half the workers with low and the remainder with zero values. Mature oocytes and oocytes with yolk were generally seen only in the queen. When the data are subjected to principle components analysis

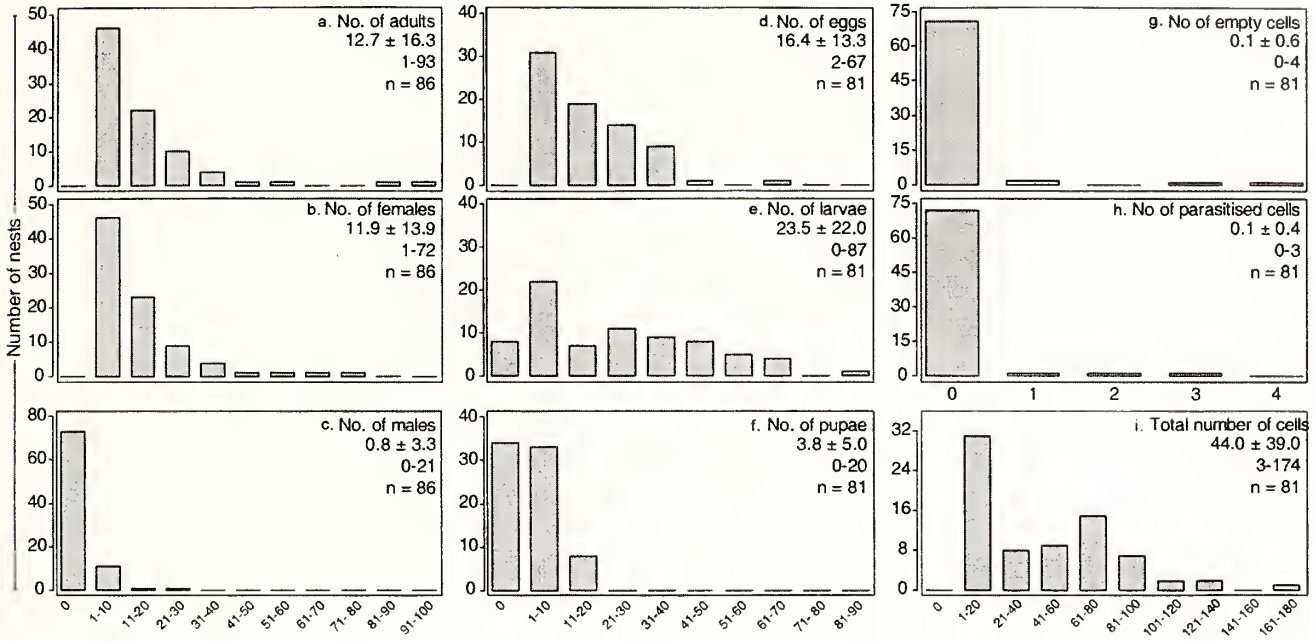

Fig. 3: Size distribution of nests. The measure of nest size, mean ± S.D., range and sample size are indicated in each panel

and the relative positions of individual wasps are plotted in the first and second principal components space, the discontinuous variation is even better emphasized. The workers form one cluster and the queen alone lies far away (Fig. 7a). Even when data are pooled across all colonies the queens (with one exception) form a distinct cluster at one end while workers (with two exceptions) form a tight cluster at the other end (Fig. 7b). The one exceptional queen that lies in the cluster of workers was labelled as the queen because she was the only individual observed to lay eggs in her colony. However, upon dissection she was found to have no mature oocytes. The workers with higher values of ovarian index had proximal oocytes similar to or smaller than that of the queen, but they had higher numbers of oocytes. We suspect that the queen in this colony had approached the end of her tenure.

Dominance behaviour

As in other primitively eusocial wasps, adults of *R. cyathiformis* exhibit several kinds of aggressive or agonistic behaviours towards each other on the basis of which one member of the interacting pair can be unambiguously designated as 'dominant' and the other as 'subordinate'. Six distinct dominance behaviours were observed; peck, nibble, chase, attack, hold in mouth and sit on another wasp. The sum of the frequencies of these behaviours was designated as the frequency of dominance behaviour. The relative abundance of the six behaviours is shown in Table 3. When the frequencies of dominance-subordinate behaviours were used to compute a dominance index and construct a dominance hierarchy, the queen was always at the top of the hierarchy except in colony C97 in which we suspected the queen to be approaching the end of her tenure (see section on ovarian condition). These data are not given here because similar results have been published before (Kardile and Gadagkar 2002, 2003). The frequency of dominance behaviour shown by the wasps had a significantly positive correlation with the frequency with which they snatched food, fed larvae, snatched building material and built the nest, as well as with their state of ovarian development and fat content. The frequency of dominance behaviour was not significantly correlated with body size and dry weight (Table 4).

DISCUSSION

The main motivation for studies on *R. cyathiformis* from our laboratory comes from the desire to identify a species of

Table 3: Types of dominance behaviour and their relative abundance, measured as percentage of total dominance behaviour

Types of dominance behaviour	Relative abundance (mean ± S. D.)
Peck	42.9 ± 22.7
Nibble	30.8 ± 11.7
Chase	2.3 ± 2.3
Attack	10.4 ± 8.5
Hold in mouth	10.6 ± 9.7
Sit on another wasp	3.0 ± 3.4

Data pooled from the 10 colonies used to study dominance behaviour

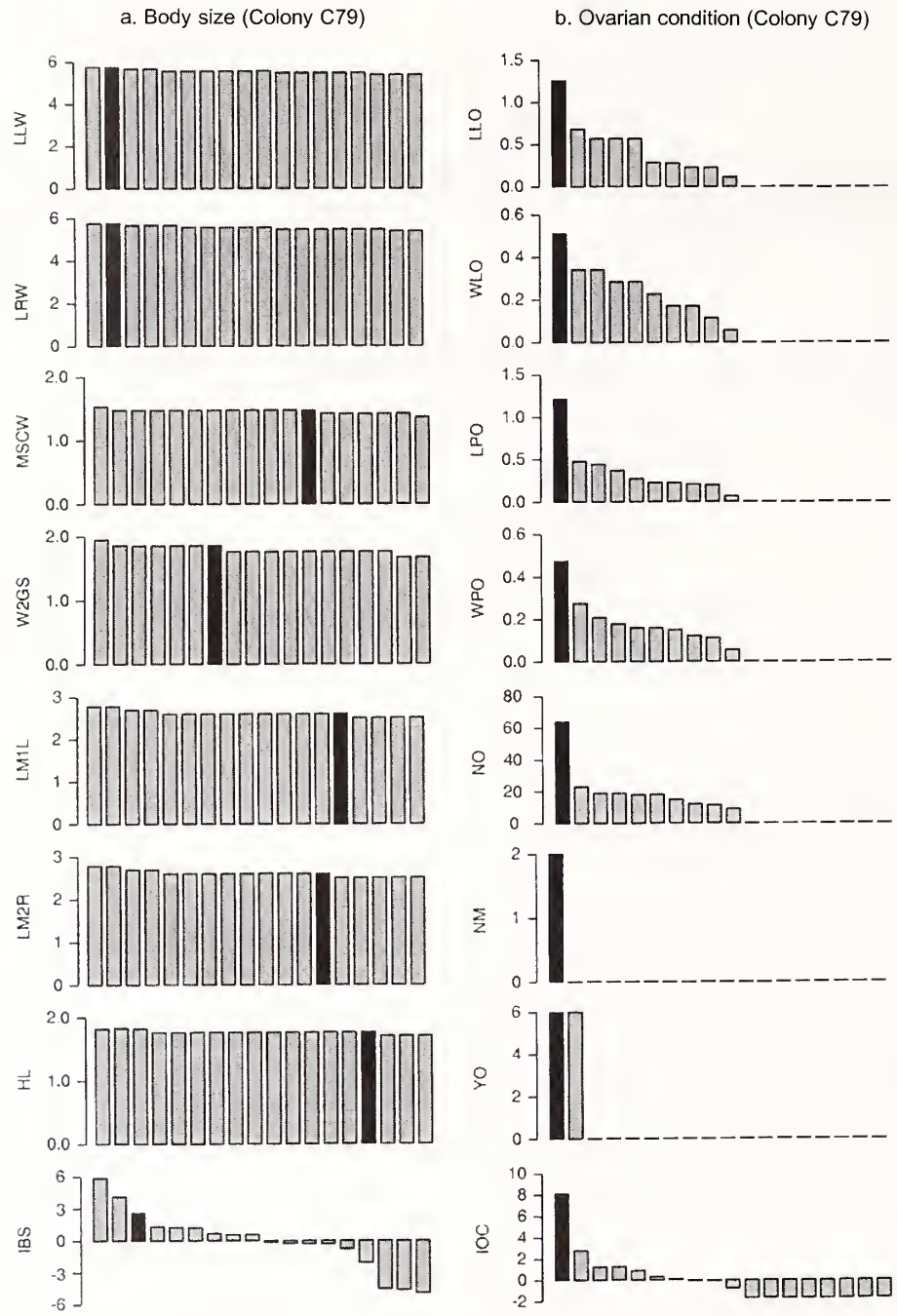

Fig. 4: (a) Body size and (b) Ovarian condition of wasps in a representative colony C79. The seven most variable measures of body size are on the left panel and all the seven measurements of ovarian development are on the right panel. Grey bars represent workers while black bars represent queens. Left panel: LLW, length of left wing; LRW, length of right wing; MSCW, width of mescoscutum; W2GS, width of second gastral segment; LM1L, length of 1st marginal cell of left wing; LH1R, length of 1st marginal cell of right wing; HL, head length; IBS, composite index of body size. Right panel: LLO, length of the largest oocyte; WLO, width of the largest oocyte; LPO, average length of proximal oocytes; WPO, average width of proximal oocytes;.NO, total number of oocytes; NM, number of mature oocytes; YO, number of oocytes with yolk; IOC, composite index of ovarian development.

primitively eusocial polistine wasp that would be suitable for comparison with *R. marginata*. The latter is also classified as a primitively eusocial wasp because of the absence of morphological differentiation between queens and workers. *R. marginata* is one of the most extensively studied social wasps, whose natural history, ethology, nesting biology and social biology have been documented in considerable detail during the past 25 years. This species has served as an

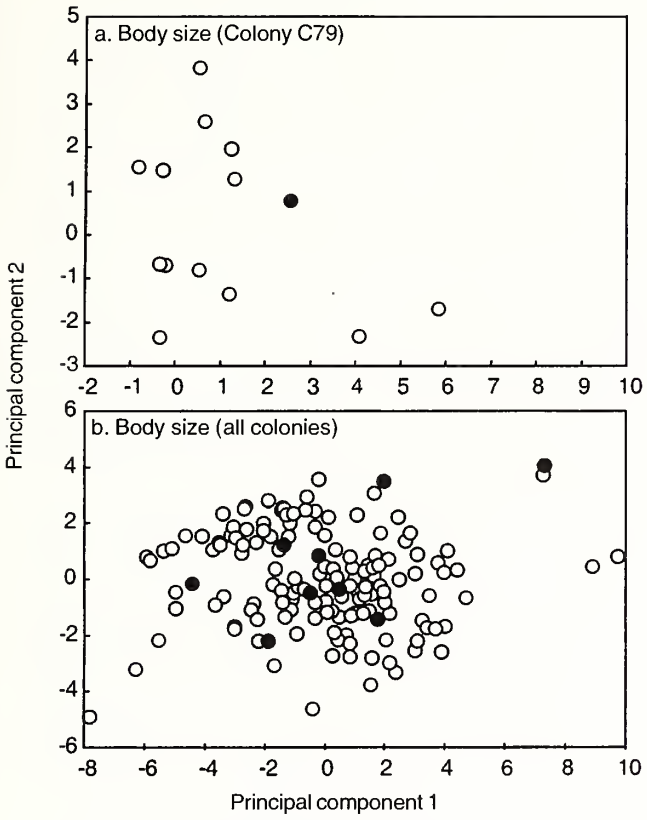

Fig. 5: Intra- and inter-colony variation in body size (a) colony C79 and (b) all colonies. Closed circles = queens, open circles = workers

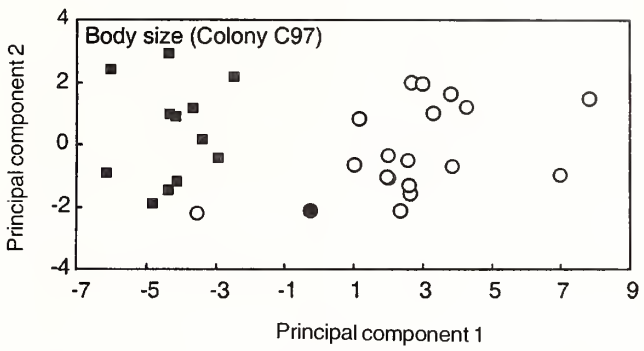

Fig. 6: Intra-colony and inter-sex variation in body size. Closed circle = queen, open circles = workers, closed squares = males

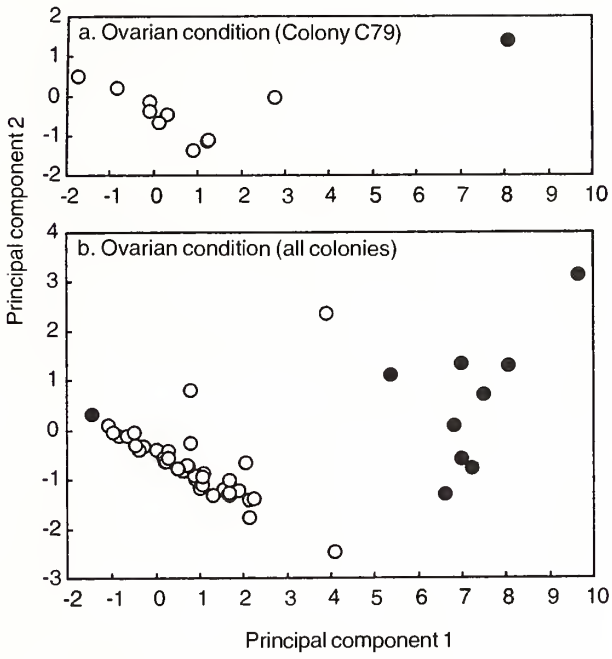

Fig. 7: Intra- and inter-colony variation in ovarian condition (a) colony C79 and (b) all colonies. Closed circles = queens, open circles = workers

excellent model system for understanding the evolution of eusociality and the apparent paradox of altruism (Gadagkar 2001). These investigations have, however, yielded a major surprise. In primitively eusocial species queens are known to be the most behaviourally dominant, active and interactive individuals who are always at the top of the dominance hierarchies of their colonies and use dominance behaviour to suppress worker reproduction as well to coerce workers to undertake non-reproductive activities such as foraging for food and building material. Because of these roles, queens in primitively eusocial species have sometimes been labelled as central pacemakers of their colonies (West-Eberhard 1969, 1977; Wilson 1971; Breed and Gamboa 1977; Brothers and Michener 1974; Buckle 1982; Dew 1983; Reeve and Gamboa 1983, 1987; Fletcher and Ross 1985; Gamboa *et al.* 1990; Gadagkar 1991; Reeve 1991; Röseler 1991).

By contrast, queens of *R. marginata* are classified as meek sitters who are never at the top of dominance hierarchies

Table 4: Kendall's coefficient of rank correlation (tau) between dominance behaviour and other variables

Variable	Tau	N
Bring food	-0.12	205
Snatch food	0.25*	205
Lose food	0.01	205
Feed larvae	0.17*	205
Bring building material	0.03	205
Snatch building material	0.15*	205
Lose building material	0.02	205
Extend walls of cells + build new cells	0.19*	205
Body size index	0.04	146
Ovarian index	0.20*	146
Dry weight (mg)	0.15	136
Fat (mg)	0.23*	136

To test significance of tau, α was set at 0.05. After Bonferroni correction (12 tests), $p < 0.004$ was considered significant and is indicated with an asterisk. Because data on all variables were not available for all wasps, sample sizes (N) varied between different correlations

(Gadagkar 2001). Nevertheless they are completely successful in maintaining reproductive monopoly and there is suggestive evidence that they may do so by using pheromones to regulate worker reproduction (Sumana *et al.* in preparation). Queens of *R. marginata*, by virtue of their physical inactivity and lack of behavioural dominance are also not involved in regulating non-reproductive activities of their workers. This appears to be achieved by the workers in a decentralised, self-organised manner (Premnath *et al.* 1995). *R. marginata* also exhibits a well-developed, remarkably honeybee-like age polyethism that is not usually expected in primitively eusocial species (Naug and Gadagkar 1998). *R. marginata* may perhaps be described as a relatively more socially advanced species among the primitively eusocial species (Gadagkar 2001).

Such unusual features of *R. marginata* merit comparative investigations with another closely related species which is more typically primitively eusocial. There is already some evidence that *R. cyathiformis* may be the appropriate species for enhancing our understanding of the unusual properties and evolutionary position of *R. marginata* (Gadagkar 2001; Kardile and Gadagkar 2002, 2003). We have, therefore, commenced detailed investigations on the biology of *R. cyathiformis* similar to previous studies with *R. marginata*. Here we report our observations on the natural history and behaviour of *R. cyathiformis*.

There are several features of *R. cyathiformis* that are very similar to *R. marginata*. Both exhibit an aseasonal nesting cycle and lack morphological caste differentiation. Most nests are monogynous (have a single egg-layer). As in *R. marginata* most of the dominant individuals stay on the nest, snatch food and building material from incoming foragers and specialise in performing intranidal activities, including brood care. An important difference is that the adult wasps, as well as the nests, are much smaller in *R. cyathiformis*. Another difference is that *R. cyathiformis* colonies can be polygynous (although all ten studied here were monogynous), which is never so in *R. marginata* (Gadagkar and Joshi 1982; Gadagkar 2001). We already know that queens of *R. cyathiformis* are indeed the most dominant, active and interactive individuals and behave as if they regulate worker reproduction and activities by using dominance behaviour (Kardile and Gadagkar 2002). Unlike in *R. marginata*, regulation of foraging appears to be a centralised process with a major role for the queen (Kardile and Gadagkar 2003).

The observations reported here combined with the previous studies make *R. cyathiformis* an ideal model system to compare with *R. marginata*. A comparative study of *R. cyathiformis* and *R. marginata* is expected to help understand the evolutionary transition from physical to chemical control of reproduction, centralised to decentralised regulation of worker activity and from the primitive to the highly eusocial state in general.

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CAPTIVE-REARING OF *SPHAEROTHECA BREVICEPS* FROM EARLY EMBRYONIC STAGES TO OVER THREE-YEAR-OLD ADULT[1]

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Sphaerotheca breviceps is a burrowing frog of Family Ranidae, widespread in peninsular India. 40 eggs of this species were collected from the wild, and reared successfully under laboratory conditions using five different set-ups, depending upon their developmental or seasonal needs. Rapid development, juvenile cannibalism, seasonal behaviour of aestivation, and possibility of breeding under laboratory conditions are the highlights of rearing this species. The development including metamorphosis was completed in 35 days. The adult males showed vocal sacs and nuptial pads, and gave mating calls during three successive breeding seasons. The adult survivors showed an average life span of three years, one of which survived for 1289 days. Their rapid development and overall health during the course of the study indicate that the species can successfully adapt to variations in temperature and humidity in the laboratory.

Key words: *Sphaerotheca breviceps*, frog, laboratory rearing, development, juvenile cannibalism, aestivation, mating calls, life span

INTRODUCTION

The Indian Burrowing Frog *Sphaerotheca breviceps* (Schneider 1799) is distributed in India, Sri Lanka and Myanmar (Boulenger 1890, 1920). We have identified three locations on the Pune-Alandi and Alandi-Chakan Road that have a dense population of frogs (Fig. 1a). During the monsoon season of 1997, we came across an unusual spawn similar to that of *Microhyla ornata*. Intrigued, we collected forty eggs from this spawn that had about three hundred eggs, and reared them under laboratory conditions. During the course of the study, S.K. Dutta identified the species as *Sphaerotheca breviceps* from the two eventually grown adults. Hitherto known information on the habits of this species is little; more information on its ecology and behaviour was, therefore, felt necessary (Daniel 1975, 2002). In this paper, we report our observations of 1289 days on rapid development, voracious feeding, good acclimatization to laboratory conditions, cannibalism on metamorphs and distinctive mating calls of the Indian Burrowing Frog.

STUDY AREA

We have been visiting three ponds along the Pune – Chakon road to observe their rich amphibian fauna. Three sites were identified and marked as Location 1, Location 2 and Location 3. Location 2 and 3 are adjacent to each other on Alandi – Chakan road, 27 km from Pune and 6 km from Alandi. Location 1 is situated at 18° 38' 22" N and 73° 52' 45" E on Pune – Alandi road, 16.6 km from Pune and 4.4 km from Alandi (Fig. 1a). It comprised of eleven temporary rainwater puddles and one big seasonal pond (Fig. 1b). The pond contains water for about nine months of the year (July-March) under conditions of average rainfall in monsoon. The amphibian species found at these sites are *Hoplobatrachus tigerinus*, *Microhyla ornata* and *Bufo melanostictus*. *M. ornata* is the dominant species found in Location 1. The spawn of *S. breviceps* eggs was noticed only once at Location 1 in puddle number 6 (Fig. 1a & b).

MATERIAL AND METHODS

Rearing of developmental stages: During the early period of embryonic and tadpole stages, the eggs were kept in a plastic tub containing dechlorinated water. The tadpoles showed well-developed hind limbs at 23 days, corresponding to Gosner stage (CGS) 38 (Gosner 1960). About 5 ml of spinach extract was added every day and about 2 ml of plankton concentrate was added every alternate day to the water as feed. Planktons were collected from the wild every fortnight and maintained in the laboratory until fresh replenishments were obtained. The spinach debris or excreta was removed every day with a wide-mouth pasteur pipette, and the water in the tub was replenished every alternate day. The tadpoles developed forelimbs at 31 days (CGS 42). They were then transferred to a plastic bucket containing tap water, dechlorinated by storing for at least two days, and coarse sand. In the bucket, coarse sand was arranged on one side in a slope with height 2 cm above the water level. The tadpoles were kept under this set up till they metamorphosed into froglets around the 35th day (CGS 46).

Rearing of newly metamorphosed froglets: When metamorphosis was complete, the young froglets were transferred to an aquarium with steps of thermocol as shown

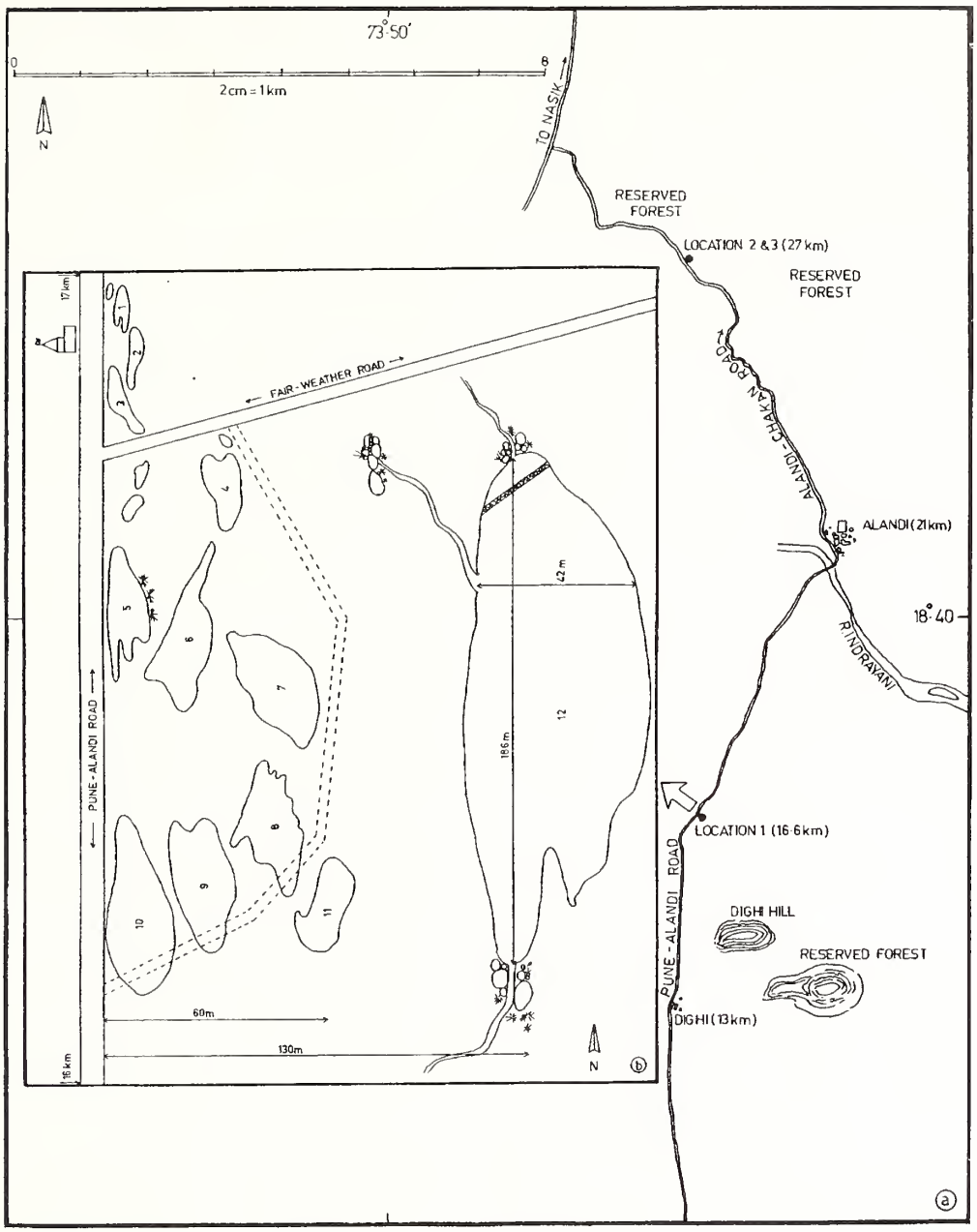

Fig. 1: (a) Location map of dense population sites of frogs on Pune-Alandi Road and Alandi-Chakan Road; (b) Schematic site map of the puddles and pond on Pune-Alandi Road where spawn of *Sphaerotheca breviceps* was found

in Fig. 2a. The thermocol steps were covered with filter papers that were changed once a week or when found soiled. A few pebbles were kept on the steps. Water was added up to the lowermost thermocol step and was changed every alternate day by tube siphoning. Trials were made to feed the froglets black ants, de-winged or vestigial winged *Drosophila* flies, termites, red cotton bugs, besides successfully feeding them commonly available tubificid worms of genus *Limnodrilus*. Black ants and termites were collected from nature. *Drosophila* flies and red cotton bug (*Dysdercus koenigii*) nymphs were from cultures maintained in the laboratory.

Rearing of young and mature adults: The aestivation set up was prepared based on initial observations at the onset of the first winter and summer respectively, during rearing of the froglets. Two aluminium trays were kept on either ends of an aquarium. One tray was filled with non-sticky garden soil while the other was half-filled with water. A thermocol sheet covered with a sheet of filter paper, which was changed routinely, was placed between the two trays (Fig. 2b). A petri plate containing weighed quantity of tubificid worms was kept on the covered sheet of thermocol every evening. The soil in the tray was kept moist by sprinkling water over it as

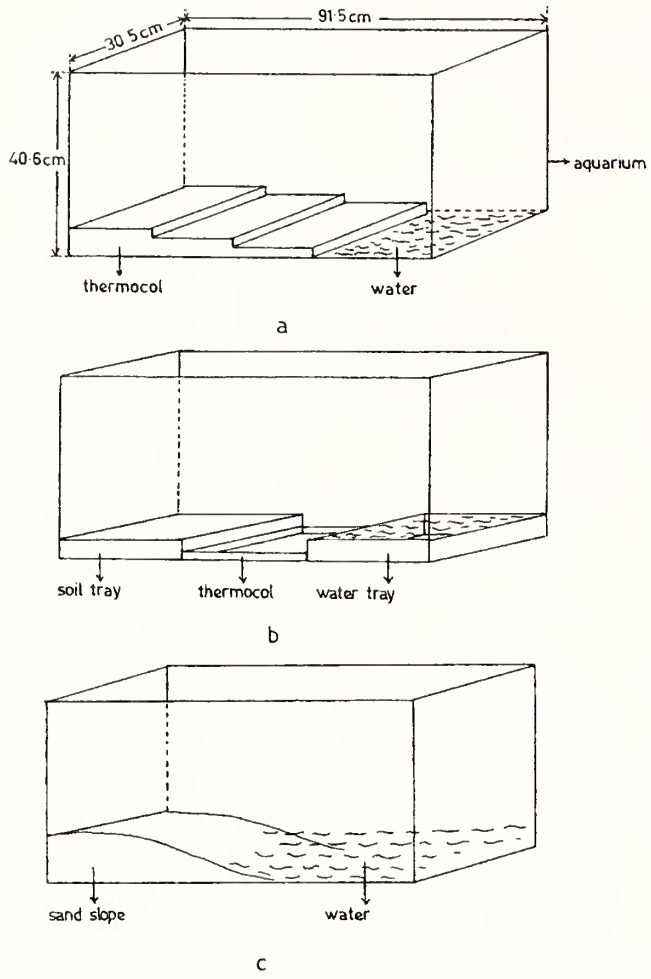

Fig. 2: Different laboratory habitats used for rearing *S. breviceps*; (a) Habitat used for newly metamorphosed froglets; (b) Habitat used for young and adults for aestivation; (c) Habitat used during monsoon for adults

and when required. The soil from the tray was changed every 3 months. The water tray was removed, cleaned and refilled every day with dechlorinated tap water maintained in the laboratory. During each monsoon period, between July and October, all the frogs were transferred into another aquarium set up. This contained a 15 cm high slope of sand, starting on one side and terminating in the middle of the aquarium. The other half of the aquarium was filled with 10 cm water with few small stones close to the sand bed (Fig. 2c).

Laboratory temperature and humidity: The eggs, tadpoles and adults were maintained in the laboratory under normal uncontrolled conditions of temperature and humidity. The temperature in the laboratory between March and June was 25 °C to 40 °C, between July and October was 20 °C to 35 °C and between November and February was 10 °C to 30 °C. The relative humidity in the laboratory during summer was 40% to 60%, during monsoon 60% to 90% and during winter 50% to 70%.

RESULTS AND DISCUSSION

Spawn and eggs: During a routine survey, on July 27, 1997, a spawn of *S. breviceps* was collected from puddle no. 6 (Fig. 1b) at Location 1. It was a round spread of jelly holding eggs. Eggs were reddish mustard in colour. The spawn was of moderate size consisting of about 300 eggs. The appearance of the spawn and eggs was different from the spawns and eggs of other frogs and toads in that area. So, we carefully separated a small piece of the spawn at 1030 hrs. The eggs were well formed and in the dorsal lip stage (CGS 10). The eggs were counted in the laboratory and found to be 40 in number. We observed the eggs under a binocular zoom microscope, and found them to be in the early neurula stage, at approximately 9 hrs of age (CGS 13).

Developmental span and feeding habits: The present report of developmental span from eggs to metamorphosed froglets in *S. breviceps* is 35 days, which is shorter by 10 days in comparison with an earlier report (Mohanty-Hejmadi *et al.* 1979). *S. breviceps* tadpoles and adults accepted all kinds of food supplied. They readily and greedily swallowed tubificid worms throughout their life span under laboratory conditions. There is a drastic shift in the feeding habit of *S. breviceps* from herbivorous tadpoles to wormivorous froglets and frogs, when reared under laboratory conditions. These observations conform to inferred natural food habits recorded as herbivore in tadpoles (Sekar 1992) and insectivorous in frogs of this species (Mohanty-Hejmadi and Acharya 1982). The overall growth rate of the species appeared to be considerably rapid and they remained healthy during their life span under laboratory conditions. These observations led us to believe that the species could serve as a good amphibian laboratory model.

Juvenile cannibalism: All forty individuals of *S. breviceps* observed during this study were reared together. Soon after completion of their metamorphosis we were trying to feed young froglets with various kinds of food as mentioned earlier, when we observed four froglets being swallowed by their fellow frogs during this early phase after metamorphosis. We not only observed the process of swallowing, but also noticed the bulging bellies of the cannibalistic individuals. We increased the tubificid quota substantially, which they relished, to avoid such instances. No more act of cannibalism was observed throughout the remaining course of rearing after this change. The intraspecific predation among amphibians is well known. Juvenile cannibalism is reported earlier in *R. pipiens* and *R. temporaria* as reviewed by Polis and Myers (1985). This is the first report on juvenile cannibalism in *S. breviceps.*

Aestivation: During the course of the study, the young adults underwent aestivation during which they were seen

hiding below the filter paper or burrowing under the thermocol sheet. It was fascinating to see most of them hiding under the filter paper cover. We, therefore, prepared a special set up for burrowing activity (Fig. 2b). The young adults showed enhanced feeding prior to aestivation as was evident from the average amount of food consumed (about 10 gm/frog/day); from November, the extent of feeding reduced drastically (about 2.5 gm/frog/day). As the room temperature at night dropped below 20 °C, the frogs buried themselves in the moist soil kept in one of the trays. They used their forelimbs as shovels to remove the soil sideways while burying into the soil. The dug out soil was cleared quickly with the help of hind limbs. It is inappropriate to say that the structure of hind limbs enables this frog to burrow as reported previously (Boulenger 1890). Some of them used to emerge out of these hideouts during late evenings for meagre feeding (less than 2 gm/frog/day) before burrowing into the soil again. The feeding almost ceased during December and January. The frogs looked thinner and pale after aestivation. During summer, the frogs showed burrowing behaviour only during daytime. They continued feeding (less than 3 gm/frog/day) until the onset of the rainy season in June. The surviving individuals showed similar behavioural patterns in subsequent years too. As adults grew, the average amount of food consumed increased during subsequent years (about 15 gm/frog/day), but the extent of meagre feeding during aestivation remained unchanged (about 3 gm/frog/day). We observed such behaviour for seven complete cycles. This behaviour in young adults indicates that seasonal cyclical changes are built intrinsically.

Mating calls: This was another important feature of *S. breviceps* observed in one-year old adults, around the onset of monsoon. It was striking that the eleven individuals in the laboratory were responding to the natural seasonal changes outside. This indicates built-in physiological rhythms related to breeding, which may not necessarily depend upon environmental cues. At the beginning of breeding season in 1998, the surviving frogs showed development of vocal sacs. The call notes were short syllables "*auan*" expressed in quick succession. Each call group was composed of a series of syllables. The frequency and pitch of the calls gradually increased towards the end of each call group. As previously described, the call notes were neither the short syllables "*Rut-Rut-Rut*" (Rao 1915) nor the soft "*awang*" (Daniel 1975, 2002), but each call group is composed of a large number of calls (Kanmadi *et al.* 1994) that can be heard from a distance of about 15 m. On observing this, we developed a special set up in the hope of possible breeding (Fig. 2c). The entire lab was filled with loud, but not shrill mating calls during late evenings, prompting us to rush to the laboratory every morning for two weeks; we expected to see some eggs, but this never happened, because all the adults reared were males. This prompted us to carefully check vocal sacs and nuptial pads on forelimbs of all the individuals. Since all of them had vocal sacs as well as nuptial pads, egg laying was no more a possibility. The mating calls were heard from the surviving adults during two more breeding seasons that followed.

Life span: The objective of these studies was to learn the total life span of this species. In terms of surviving numbers, it is obvious that the individuals were more protected under laboratory conditions than in their natural surroundings. In terms of other natural factors, including possible variety in feeding, they may have been deprived of several unknown factors. The healthy condition of the surviving adults, throughout the course of this study, indicates that the observed life span in their natural habitat may not be substantially different. Our observations indicate that majority of the adult individuals survived an average life of three years. The last individual survived for 1289 days. This may serve as an indicator of average life span of this species in the nature too. This is first report on the longevity of *S. breviceps* under laboratory conditions or otherwise.

Life profile under laboratory conditions: Our initial strategy of fixing froglets at 5 mm snout-vent length increment retrospectively appears to be an unwanted intervention. This could have prevented the 'all-male-situation' of surviving adults. Success of rearing this species during the initial year prompted us to search for more spawn(s). In spite of our best efforts, we could not locate one more spawn at the localities identified by us (Fig. 1a & b) between 1998 and 2003. The species may have become extinct from the study localities. The present study opens up a possibility of rehabilitation of this species by rearing them under laboratory conditions.

The overall trend of life of this frog under laboratory conditions highlights other important features of this species. The foremost being that they remain healthy in captivity if their basic needs are provided in time. Although voracious, their feeding behaviour is flexible and it is surprising that they adjusted well to feeding on tubificid worms. Barring juvenile cannibalism, they co-existed well in captivity sharing their resources. Rapid development, juvenile cannibalism, cyclical behaviour of aestivation and strong possibility of breeding under laboratory conditions were the highlights of rearing this species. The entire chronological sequence of events of rearing *S. breviceps* individuals is tabulated in Table 1 to help subsequent work on amphibian studies, to keep track of this long-lasting exercise and also to keep a record of available specimens for study.

Table 1: Chronological events of rearing the Indian Burrowing Frog *Sphaerotheca breviceps* from developmental stages to over three-year-old adult

Duration	Highlights of the Event	Number of survivors
July 29, 1997	Observed a floating spread of spawn with reddish mustard coloured eggs; the spawn was medium-sized containing about 300 eggs out of which 40 eggs were collected at dorsal-lip stage (CGS 10) and brought to the laboratory at neurulation stage (CGS 13).	40
Up to August 28, 1997	Two tadpoles died (CGS 42) during this 30 day period: one died on 27th August (SVL = 33 mm) and another died on 28th August (SVL = 35 mm).	38
August 30-September 5, 1997	Metamorphosis completed (CGS 46) in 35 ±3 days	38
September 1-2, 1997	Three froglets were fixed in Bouin's fixative (SVL = 15 mm) and preserved in 70% ethanol.	35
September 1-13, 1997	Four froglets were swallowed by their fellows.	31
September 14, 1997 to June 30, 1998	Twenty froglets/young adults (measuring 15-45 mm SVL during the course) were fixed in Bouin's fixative and preserved in 70% ethanol or formalin fixative after a 5 mm increase in their SVL; of these two specimens were handed over for species identification. During the onset of the first cycle of aestivation, froglets scratched and dug into thermocol sheets or hid themselves under filter paper. No significant change in behaviour was noted during the consequent cycles.	11
July 1 to September 25, 1998	An aquarium, with a slope of coarse sand at one end and water at the other end was prepared and the frogs were transferred into this aquarium. Mating behaviour in the form of loud mating calls was noted.	11
August 13, 1998	Soil tray - thermocol sheet - water tray set-up was prepared for the forthcoming aestivation cycle.	11
September 26 to December 23, 1998	Three frogs died naturally, two of which were fixed in formalin and one was discarded.	8
November 1998 to June 1999	Second cycle of aestivation was observed; One adult died (preserved).	7
July to October 1999	Second breeding season when behaviour of mating calls was noted.	7
November 1999 to June 2000	Third cycle of aestivation was observed Five adults died (preserved).	2
July to October 2000	Third breeding season when mating calls were heard. One adult died (preserved).	1
November 2000 to February 2001	Fourth cycle of aestivation.	1
March 9, 2001	Last adult died (preserved).	0

CGS = corresponding Gosner Stage; SVL = snout-vent length

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SPECIES COMPOSITION, SEX-RATIOS AND MOVEMENT PATTERNS IN DANAINE BUTTERFLY MIGRATIONS IN SOUTHERN INDIA[1]

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Longitudinal migration of danaine butterflies takes place across the plains of southern India to the Western Ghats during October-November, and towards the plains, about April-May. I report here on the butterfly migration through Chinnar Wildlife Sanctuary, Kerala, in October 2001. *Tirumala septentrionis* (Butler) was predominant, constituting 78.5% of the migrating butterflies. *Euploea sylvester* (Fabricius) was twice as numerous as *E. core* (Cramer), the two species making up the remaining 21.5%. The migrants were freshly emerged adults and sex-ratios were equal, except in the slightly male-biased *E. sylvester*. The number of butterflies in this swarm was conservatively estimated at over 175,000 over three days. Reproductive status of migrating danaines and the apparent resident population of *E. core* at Chinnar Wildlife Sanctuary are discussed. I suggest that the migratory tendencies evolved to avoid the torrential southwest monsoon in their larval habitats in evergreen and semi-evergreen forest of the Western Ghats. This hypothesis is consistent with the absence of diapause in early stages of these species, and with the fact that the butterflies breed alternately in the plains and in the Western Ghats.

Key words: *Tirumala, Euploea*, Danainae, butterfly migration, sex ratio, seasonal movements

INTRODUCTION

Annual butterfly migrations in southern India have been documented since the turn of the 19th century (Williams 1927, 1930, 1938) but their nature is still poorly understood. Unlike the small-scale or occasional butterfly migrations that take place in central India and northern Western Ghats (Bharos 2000; Chaturvedi 1993; Chaturvedi and Satheesan 1979; Reuben 1961, 1962; Williams 1938), the southern Indian migrations are both regular and on a very large scale, involving hundreds of thousands of individuals (Fisher 1945; French 1943; Larsen 1978; Williams 1927, 1938). The patterns of the short-distance north-south migrations in the Anamalai-Palni and Nilgiri mountains are relatively well-documented and have been monitored over decades (Evershed 1910; Williams 1938; Briscoe 1952; Larsen 1978, 1987). However, literature pertaining to the long-distance east-west migrations that take place through the plains of southern India is scarce. During this migration butterflies traverse a distance of 300-500 km, from the plains near the eastern coast to the Nilgiri and Anamalai-Palni mountains, near the western coast of southern India. This migration takes place mainly during October or November and towards the plains about April-May (Williams 1930, 1938; Karthikeyan *et al.* unpublished observations. The east-west migrating swarms are composed mainly of *Tirumala septentrionis*, *Euploea sylvester* and *E. core* of Danainae (Nymphalidae), as opposed to the north-south migrations exclusive to the hills, which are composed of *Catopsilia pomona* (Fabricius), *C. pyranthe* (Linnaeus), *Appias albina* (Boisduval), *Papilio demoleus* Linnaeus and smaller proportions of *Tirumala limniace* (Cramer), *Danaus genutia* (Cramer), *Hypolimnas bolina* (Linnaeus), *Cynthia cardui* (Linnaeus), and *Lampides boeticus* (Linnaeus) belonging to families Papilionidae, Pieridae, Nymphaliade and Lycaenidae (Evershed 1910; Larsen 1978; early works reviewed by Williams 1938).

Estimates of the size of swarms of migrating butterflies based on quantitative data are scarce, although a few subjective estimates are available. Relative proportions of species (Palot 2000) and sex-ratios (Larsen 1986) in largely danaine aggregations have been reported, but not from migrating swarms in southern India. The sex-ratios of migrating butterflies are also of crucial importance, since they would strongly influence sexual displays and mating behaviour at their ultimate destinations. In this paper, I provide quantitative estimates of the size of the swarm, relative proportions of species and the sex-ratios of butterflies in the migration that passed through Chinnar Wildlife Sanctuary, Kerala, in October 2001. Also reported are observations on the breeding and larval parasitization in the local *E. core* population during the migration period. I further suggest a pattern of movements and breeding of migratory danaines of southern India.

METHODOLOGY

Chinnar Wildlife Sanctuary (10° 15'-10° 22' N, 77° 05'-77° 15' E; total area 90.42 sq. km) is situated between Amaravathi Wildlife Sanctuary in Tamil Nadu and Eravikulam National Park in Kerala. It is near Munnar, on the eastern side

of the Western Ghats, in Kerala, at an altitude of 500 m to 2400 m. The mean annual rainfall is 1000 mm, due mainly to the northeast monsoon, from late October to December. The Sanctuary contains dry deciduous and scrub forests. The vegetation is dominated by stunted trees and thorny shrubs, including various species of *Acacia*, *Ziziphus*, *Santalum album*, *Anogeissus latifolia*, and along riverbeds, *Terminalia arjuna* and *Pongamia glabra*. This is similar to the original vegetation of the plains of southern India east of the Western Ghats (Puri *et al.* 1983).

I observed migrating butterflies at Chinnar Wildlife Sanctuary and Eravikulam National Park from October 18-20, 2001, and sampled individuals from the swarm between 0900 hrs and 1430 hrs on October 20. I do not know exactly for how many more days the migration lasted. On October 20, the weather was warm and sunny, but there had been occasional rains the previous week, with clouded evenings. Observations were made from a spot approximately in the middle of the stream of butterflies. The migrating band was at least several hundred metres wide, but for a most conservative estimate I restrict my calculations to 50 m. The general direction, flight behaviour and total number of individuals were quantitatively estimated, without collecting the butterflies. For this purpose, I chose a 10 m wide imaginary belt at the centre of the stream of butterflies, and counted the number of butterflies passing through this belt over a 5-minute duration. Eight such observations were taken between 0930 hrs and 1405 hrs (Table 1). Since the two species of *Euploea* could not be distinguished apart in flight, they have been combined in this count. *T. limniace* did not form a significant proportion of these butterflies, and it was missing completely from the quantitative sampling.

A random sample of 250 migrating butterflies was taken with a butterfly net to confirm species identities and determine sexes of the butterflies caught, after which they were released on the spot.

RESULTS

The butterflies were flying from east to west, with a slight northeast to southwest tilt, over the plains through Amaravathi and Chinnar sanctuaries towards Eravikulam National Park. *Tirumala septentrionis*, *E. sylvester* and *E. core* comprised most of the migrating swarm, with *T. limniace* making up a very small fraction. A few other species, notably *P. demoleus*, *C. pomona* and *Danaus chrysippus* (Linnaeus), were also seen flying along with the swarm, but due to their small numbers, inconsistent direction and manner of flight, it could not be concluded that they were migrating. *Tirumala septentrionis* far outnumbered all other species, in the migrating swarm, making up about 78.5% of all butterflies (Tables 1 and 2). *Euploea sylvester* was twice as numerous as *E. core*, the two species making up the remaining 21.5% of the swarm. All butterflies were flying between 1 and 4 m above the ground. The flight speed and style were usual for the danaines - leisurely but persistent with continuous wing-beats — and during the day they never halted to feed or rest. There was no perceptible wind when the observations were made. More than 95% butterflies captured for close examination were freshly emerged adults, without any wing wear or tear.

Table 1 shows number of butterflies that passed through a 10 m belt in five minutes. Based on these data, of the total number of migrating butterflies was estimated. The migration was in progress for a minimum of three days for at least five hours daily (0900-1400 hrs). Assuming a minimum width of 50 m for the main stream of the migrating swarm, size was calculated as follows:

Butterflies flying in 1 hour in a belt of 10 m (195 in 5 minutes x 12) = 2,340.

Butterflies flying in 5 hours a day in a belt of 50 m (2,340 x 5 x 5) = 58,500.

Size of the swarm (58,500 x 3 days) = 175,500.

Thus, the most conservative estimate of the size of this migrating swarm was over 175,000 butterflies; *T. septentrionis* constituting almost 137,000 of the total number and *Euploea* spp., the remainder. The number of butterflies involved in this exodus would appear to be small as compared to "millions" of butterflies reported by Larsen (1978) in the Nilgiris. However, it should be noted that Larsen reported the breadth of Nilgiris migrating swarms to be almost 6 km, whereas I have assumed a modest breadth of 50 m for the migration I witnessed. The estimates would rise exponentially if these assumptions are changed and further quantitative observations are made with a more intensive effort.

Table 1: Number of butterflies passing through a 10 m belt in 5-minute duration

Time	0930-0935 hrs	1045-1050 hrs	1140-1145 hrs	1148-1153 hrs	1209-1214 hrs	1239-1244 hrs	1317-1322 hrs	1400-1405 hrs	Average (±SD)
T. septentrionis	175	208	202	80	152	158	102	145	153 (±44.61)
Euploea spp.	42	49	37	50	49	35	36	37	42 (±6.51)
Total	217	257	239	130	201	193	138	182	195 (±41.63)

Table 2 gives sex-ratios calculated from 250 individuals of three migrating species as well as an estimate of relative proportions of two species of *Euploea*, the sample of *Euploea* being random. The sex-ratio in *T. septentrionis* and *E. core* was approximately 1:1, while that in *E. sylvester* was slightly biased towards males.

On the breeding of *E. core* at Chinnar Wildlife Sanctuary: *E. core* from the plains may have both migratory and non-migratory populations, as has been reported for many butterflies with migratory tendencies elsewhere (Williams 1930). In support of this, I report the following observations pertaining to the occurrence and breeding of *E. core* at Chinnar and Bangalore.

Isolated by about 200 m from the main stream of migrating butterflies was a puddling assemblage of about 50 individuals of *E.* core and *Appias libythea* (Fabricius) at the Chinnar forest check-post. These butterflies remained at that spot throughout the day, and showed no indication of joining the migration. Therefore, they were most probably from local breeding populations of these species, rather than the migrating swarm. Of the 25 caterpillars and pupae of *E. core* collected from a *Nerium* plant close by, only two yielded adult butterflies. The rest were destroyed in early stages by parasitoid dipterans except one, which was destroyed by a parasitoid wasp. Fresh eggs were observed on this plant, indicating that breeding was ongoing in the *E. core* population at Chinnar Wildlife Sanctuary. Butterflies from these eggs would have metamorphosed in about 40 days after the migration had passed through, and therefore would probably not have left their place of emergence.

In Bangalore city, which is on the migratory route, mid-way between east and west coasts, *E. core* is active throughout the year (unpublished data). It is not known what proportion of the local population, if any, joins the migrating swarm. However, this area maintains a local, continuously breeding population of *E. core*, feeding mainly on *Ficus* spp. Thus, both migratory and non-migratory individuals are expected to comprise the *E. core* population.

Table 2: Sex-ratios of migrating butterlies

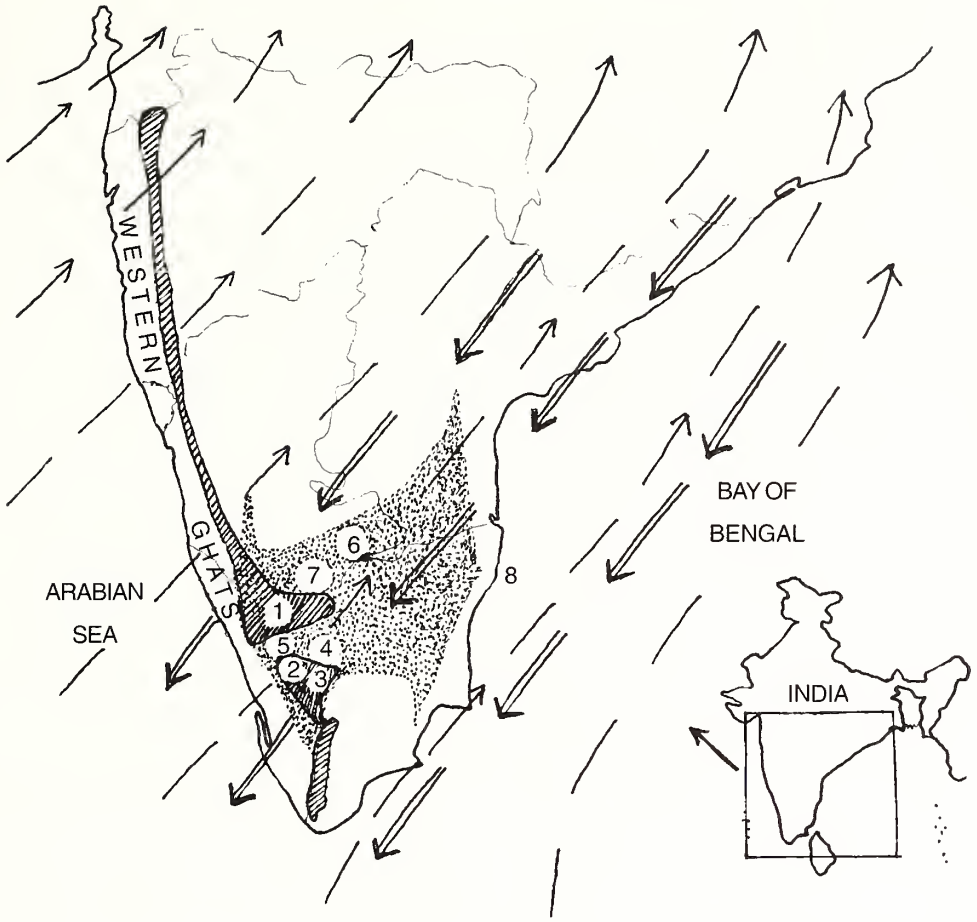
Species	Male	Female	Total	%Males
T. septentrionis	78	80	158	49.5
T. limniace	03	00	03	100
E. sylvester	37	26	63	58.75
E. core	14	12	26	54
Total	132	118	250	

DISCUSSION

The danaine butterfly migration in southern India is interesting for a) its longitudinal extent, and b) the pattern of migrational movements which is influenced by the Indian monsoon. Most of the known seasonal migrations of butterflies in the world are either latitudinal or altitudinal (Johnson 1969; Williams 1958). Both are somewhat similar, in that they are adaptations mainly to escape adverse seasonal temperatures and host plant availability at very high altitudes or latitudes. The southern Indian migration does involve an altitudinal component, but the butterflies do not just descend the hills and settle in the eastern foothills on the plains in the rain shadow, but travel across the plains to disperse close to the eastern coast, travelling a minimum of 300 km. However, the exact area of dispersal is still unknown, and therefore the longest distance travelled, by migrating butterflies is still unknown. Importantly the longitudinal component overwhelms the altitudinal component, and therefore this migration is better viewed as longitudinal.

Southwood (1962) observed that globally most migratory lepidopterans belong to semi-arid areas where habitats are temporary. These migrants are mainly from cold altitudes, extreme latitudes or warm semi-desert areas; for example *Cynthia cardui* (Linnaeus) and *Pieris* spp. in northern Africa and Europe (Johnson 1969; Williams 1958). In Costa Rica, *Danaus plexippus* (Linnaeus) and others apparently migrate from dry forests to evergreen forests of the hills (Scoble 1995). The southern Indian danaine migration superficially seems to fit the pattern that their preferred habitat is dry forests of the plains, from which they migrate to moist and cool evergreen forests of the hills, presumably to escape hot summers. However, in the unique geography of the Western Ghats and the eastern plains, where a combination of torrential southwest monsoon and milder northeast monsoon brings about markedly different seasons on either side of the Western Ghats (see below), an interesting new pattern emerges; i.e., southern Indian danaine butterflies escape from the wettest season in an evergreen forest and migrate to drier habitats. This is exactly opposite to the pattern observed in most migratory insects.

On the pattern of migration and breeding in southern Indian danaine butterflies: Unlike the relatively well-documented, predominantly pierid migrations in southern India (Evershed 1910; Larsen 1978), observations on the exclusively danaine migration have been random and sporadic, because its importance and magnitude was probably not realized. There was no conceptual framework in which observations could be fitted to construct a coherent picture of movements of the danaine butterflies involved in this



→ : southwest monsoon

⇨ : northeast monsoon

▒ : movement of butterflies

1 : Nilgiri Mountains

2 : Anamalai Mountains

3 : Palni Hills

4 : Chinnar Wildlife Sanctuary

5 : Palghat Gap

6 : Bangalore

7 : Mysore

8 : Chennai

Fig. 1: Movement pattern* of migratory danaine butterflies in southern India

*a) Predicted movement pattern is extrapolated from opportunistic observations

b) The Western Ghats are not accurately reproduced, but illustrated only for reference

migration. I attempt to offer such a framework here, based on my observations over the past five years and partly from the data presented here. This needs validation by further observations, especially since 110 years of studies on the migration of *Danaus plexippus* in North America have taken a tortuous path (Brower 1995). I hope that this beginning can generate interest and stimulate further observations and research.

I propose that topography of the Western Ghats in relation to southern Indian plains and its effect on the monsoonal pattern are the decisive factors in shaping the pattern of this migration (Fig. 1). I briefly review these two factors.

Topography of the Western Ghats and southern India: The Western Ghats is a mountain chain parallel to the western coast, about 1600 km long. It can be conveniently divided into three natural zoogeographic zones: a) northern (southern Gujarat up to Kali river in northern Karnataka), b) central (south of Kali river to Palghat Gap) and c) southern (Palghat Gap southward). The migrations of *E. core* reported by Aitken (1898) take place from around Kali river northward.

The danaine migrations under present consideration

occur in the Nilgiri and Anamalai-Palni mountains, lying north and south of the Palghat Gap, respectively. The Palghat Gap is a gap of lowland, about 40 km wide, in the otherwise continuous mountains of the Western Ghats. It forms a major natural barrier between the high hills of the Nilgiris and Anamalais, isolating endemic butterflies of the two mountain ranges.

The Nilgiri and Anamalai mountains rise to an altitude of over 2,500 m, with a spectrum of habitats, from scrub and deciduous forests to mid-elevation evergreen forests and montane *shola* forests and grasslands. The highest peak in southern India: Anaimudi (2,695 m), lies in the Anamalai mountains, and the danaine migration passes at 2,400 m through the surrounding plateau. The Karian and Varagaliar sholas in the Anamalais, on the eastern slope at 600-700 m are known breeding habitats of migrant danaines. They harbour dense tropical evergreen forest, now remaining as tiny habitat islands representing once extensive evergreen forests in the presently vast ocean of secondary deciduous forests, and tea, coffee and teak plantations.

The plains east of southern Western Ghats lie mainly at an altitude less than 200 m. The high mountains of the southern Western Ghats, where southwest monsoon is the main monsoon, cast a rain shadow over the plains.

Monsoonal pattern and seasonality in southern India: The southern part of the Indian peninsula receives two monsoons, the torrential southwest and milder northeast monsoon. The southwest monsoon begins on the Western Ghats with heavy downpours from June to early October. The Nilgiri and Anamalai mountains receive more than 4,000 mm of precipitation mainly in June and July. During this period humidity is maximum and sunshine is virtually absent for two months; therefore adult butterfly activity is suspended. The high ranges more or less drain the clouds. As a result, although the plains receive the southwest monsoon, their main monsoon is the northeast monsoon. This is active from late October to December or early January. In contrast to the Western Ghats, the plains receive very little precipitation, varying from 400 mm to over 1,000 mm. October to January is the ideal breeding season for most butterflies in the plains, the rest of the year being very hot and dry. The northeast monsoon is effective also on the eastern slopes of the Western Ghats, bringing rains mainly in November and December. There is a marked gap in October after the southwest monsoon recedes and the northeast monsoon opens in the hills. Overall butterfly activity peaks in the hills from October to January or early February. Sporadic but heavy pre-monsoon showers break in the hills toward the end of April and continue through May. There is a brief period of butterfly activity in April and May before the onset of the southwest monsoon.

The southwest monsoon has earlier been implicated as the prime force driving butterfly migrations. Aitken (1898) suggested that *E. core* fly north to the northern Western Ghats to escape the heavy rain with which the southwest monsoon opens in the southern and central hills. However, this would only affect butterflies in areas close to the northern ranges, which do not participate in the migration discussed here. The long stretches of mountains immediately north and south of the Nilgiris, Anamalais and Palni Hills, where the present migration occurs, are equally wet and unfavourable during the southwest monsoon. Williams (1938) in connection with the butterfly migrations from the Palni Hills, alluded to October-November being a shift between southwest and northeast monsoons in southern India. However, neither author developed the theory further to cover exact movement patterns and breeding cycles of the butterflies involved in this migration, as has been done here.

Movement and breeding patterns of the danaine butterflies: *Tirumala septentrionis*, *E. core* and *E. sylvester* are widespread in Asia, and have been reported to be migratory in various parts of their range (Ackery and Vane-Wright 1984; Wang and Emmel 1990). In southern Western Ghats and the plains lying to the east the butterflies have two migratory flights every year: towards the Nilgiris, Anamalais and Palni Hills in October-November, and towards the plains in April-May. Therefore, they spend roughly half the year on the plains and half in the hills, but during most years they take flight by late April or May and mid-October, thus spending more of their time in the hills. This pattern could result from either of two possibilities: a) the preferred habitats of these danaine butterflies are scrub and dry deciduous forests of the plains, and the butterflies take refuge in the cooler, forested hills for part of the year, or b) these species belong to evergreen and semi-evergreen forests of the hills, and are forced to migrate to the plains to avoid the southwest monsoon. The former would resemble the movement pattern of *Danaus plexippus* and others in Costa Rica (Scoble 1995), while the latter would mean a unique pattern of migrational movements in southern India. I favour the latter possibility. The crucial point is that November-December is the wet season for southern plains and therefore October to January is the ideal breeding season there for most butterflies. In spite of this, the danaines emigrate from this region without exploiting the optional breeding season of the plains, and take refuge in the hills. On the other hand, the months the butterflies spend away from the hills are the exact period when the southwest monsoon is at its peak, adversely affecting adult activity, breeding and larval growth. Combining these observations, evergreen and semi-evergreen forests of the Western Ghats could be interpreted as preferred habitats of

the danaines. This migratory tendency has apparently evolved to escape the heavy southwest monsoon. Possible adaptation to escape this monsoon could have been to undergo a long diapause. However, diapause in early stages is apparently absent, and because of the monsoonal climate in the hills is unhealthy for adults, the option of migration was necessary. Since the hills of the Western Ghats immediately south and north of the Nilgiris, Anamalais and Palni Hills are equally inhospitable, the butterflies fly to the eastern plains, rather than north, as *E. core* does in northern Western Ghats (Aitken 1898).

On arrival in the hills in late October-November, the butterflies spend a few weeks in dense congregations (pers. obs) that are reminiscent of the overwintering congregations of danaines elsewhere in Asia (Wang and Emmel 1990). They cling in dense clusters of several thousand individuals to higher branches at about 15 to 20 m of medium-sized trees inside the forest. Mortality seems to be very high in these congregations, and the forest floor is strewn with scores of body-less wings of butterflies. This could be due to avian predation as in overwintering colonies of *D. plexippus* (Brower and Calvert 1985), or to other reasons. Butterflies from these congregations, however, do not usually visit wet soil patches for puddling or feed regularly from flowers, although they occasionally fly around the congregations. They disperse by December-end or early January, with the males soon engaging in feeding at the edges of forests on damaged plant parts of *Crotalaria* spp. (Fabaceae), the sap of which contains pyrrolizidine alkaloids.

The movement and breeding patterns of these butterflies after they disperse are unknown. However, at least a portion of butterflies breed in the hills by April, before leaving for the plains. I have reared caterpillars of *T. septentrionis* on *Tylophora* sp. in Karian shola, Anamalais, adults from which emerged by May, before the migration towards plains. We do not know whether all adult butterflies breed and perish in the hills and only their offspring undertake the migration towards the plains. Observations on adult butterflies migrating towards the plains will elucidate this. However, it is apparent that the butterflies breed both in the plains and the hills before the respective migrations; and it is predominantly freshly emerged and unmated individuals that participate in the migrations. Thus, seasonal sexual diapause and overwintering behaviour as seen in other migratory danaines (Brower 1995; Wang and Emmel 1990) seem to be replaced in southern India by alternate but continuous breeding in two ecologically very different and spatially distant habitats. Observations on the post-migration behaviour of the danaines in the plains are lacking.

The almost equal sex-ratio of the migrating butterflies reported in here is also significant. Assuming that all freshly emerged butterflies migrate, without sex related bias in migratory tendency, it may be concluded that sex ratio at eclosion in these danaines is 1:1. The fact that freshly emerged males fly along with freshly emerged females further supports the idea that *T. septentrionis* and *Euploea* spp. have pre-reproductive migratory flights. Similar pre-reproductive migration also occurs in *Danaus plexippus* (Brower 1985). The information on sex ratio and physical and reproductive status of butterflies taking a migratory flight towards the plains in April-May is crucial to further understanding.

The unique longitudinal extent and the yearly breeding cycles in different habitats in two distant areas in the hills and in the plains make this butterfly migration in southern India a very interesting study. Some crucial questions remain unanswered. For example, we do not know the exact location(s) of the beginning of the exodus from the plains, and whether it is a single swarm of butterflies starting from the plains which later splits to reach the Nilgiri and Anamalai mountains, or if there are many arms to this migration. It is puzzling that if the butterflies migrate to the plains merely to escape the heavy southwest monsoon, they should travel as far as close to the eastern coast of India, rather than stopping at the eastern foothills. Also unknown is whether *T. septentrionis* and *E. sylvester* have permanent resident, breeding populations, apart from migratory ones, in the plains as suggested here for *E. core*. Most importantly, the exact patterns of breeding phenology, voltinism, relative breeding success and occurrence of danaines in the plains and the hills remain obscure. Large-scale captures and examination of butterflies prior to, during, and following migration would elucidate the reproductive status of the migrating species. I hope that a directional effort may advance our understanding of the causes and working of this migration in the light of the new framework proposed, which may help to formulate and test specific hypotheses about migrational movements and breeding in these danaines.

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NESTING ECOLOGY AND BREEDING SUCCESS OF CHEER PHEASANT *CATREUS WALLICHII* IN GARHWAL HIMALAYA, INDIA[1]

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Nesting ecology and breeding success of the Cheer Pheasant *Catreus wallichii* was studied in Garhwal Himalaya, Uttaranchal from 2000 to 2002. Five active nests were located in May-June and one in September on the south, southwest and northwest aspects, in shallow depressions; hollow pits or below stones, lined with dry pine needles and leaves. The vegetation around the nest was less than the dry litter. Clutch size ranged from 6-12. Hatching success was 71 per cent, but breeding success was less than half the clutch size.

Key words: Cheer pheasant, nesting ecology, breeding success, chick survival

INTRODUCTION

Cheer pheasant *Catreus wallichii* (Hardwicke), is a threatened species (Fuller and Garson, 2000), found in the Himalaya from northwest Pakistan to west-central Nepal between the Indus and Kali-Gandaki rivers (Ali and Ripley 1980; Garson *et al.* 1992). Information on the breeding biology of this pheasant is scarce and mainly derived from accounts of Hume and Marshal (1995) on wild birds, Chandola-Saklani *et al.* (1990) and Singh and Singh (1995) on captive birds.

In this paper the nesting ecology, clutch size, breeding success and associated behaviour of Cheer is described on the basis of six active nests located from year 2000 to 2002 in Garhwal Himalaya, India.

STUDY AREA AND METHODOLOGY

Cheer Pheasant (called 'Chair or Phaklas/Phakras' in Garhwal Himalaya, Uttaranchal) inhabit steep slopes covered by Chir-pine and pine-mixed forests (*Pinus roxburghii, Phyllanthus embellicus, Quercus leucotricophora, Rhododenron arboreum, Myrica nagi, Lyonia ovalifolia*) between 1000-2150 m altitudes. During summer months (May-June) their habitats become relatively inaccessible due to accumulation of dry slippery pine needles, grass and leaves. We were, however, successful in locating six active nests at different sites in districts Pauri and Chamoli, Uttaranchal (29° 22' N to 31° 07' N and 78° 07' E to 80° 10' E) during a survey conducted on status and distribution of Cheer in the year 2000-2001 and 2002 (Bisht *et al.* 2002). Information on altitude, aspect, position on ground, distance to escape site (nearest ridge and hiding cover), dimension of nests and vegetational cover was collected for each located nest site. Quadrats measuring 10 x 10 m were laid at each nest site where canopy cover, shrub cover and grass cover was assessed through an arbitrary index of 1-25, 25-50, 50-75 and 75-100% (De Vos and Mosby 1981). Grass height and litter depth around the nests were also recorded.

Each nest was visited at intervals of 2-3 days, and records were maintained on the number and colour of eggs laid, shape and size of nest, hatching success (total number of eggs laid by total number of chicks hatched), chick survival (total number of chicks hatched by total number of chicks survived up to 8 weeks), breeding success (total number of eggs laid by total number of chicks that survived to adulthood), population survival (total number of adults that survived till the next breeding season) and associated behaviours.

RESULTS

Nest site characteristics: Detailed information is presented in Table 1. The nests were found between altitudes of 1450-1700 m. Of the six nests: two were on the north-west facing slope, two on the southwest slope, one on the southern slope and one on the western slope. The nests were found under the shelter of rocks, in a hollow or pit on the ground. Average distances of nests from the nearest escape sites, namely ridge/cliff and hiding cover were 29.0 ±14.4 m and 11.5 ±1.5 m respectively. Diameter and depth of the nests were 24.2 ±1.6 cm and 9.3 ±0.8 cm respectively. All nests were made up of dry pine needles, grass and leaves in a shallow depression. The median scores for vegetation cover around the nests were as follows: canopy – 25.0% (inter-quartile range – 18.8), shrub – 12.5% (inter-quartile range – 5.0) and grass cover – 10.0% (inter-quartile range – 0.0). The grass height and litter depth were 17.7 ±5.5 cm and 10.6 ±2.2 cm respectively.

The nesting sites were characterised by low grass height and grass cover (except in nest no. V – Table 1). The litter depth was significant during May-June, subsequently depleting during September. The five nests located in May-June were found near the ridge/cliff (10-25 m), however, the nest found in September was far from the ridge (100 m). The grass cover and grass height are positively and significantly correlated to distance of nest from ridge/cliff ($r=0.989$, $P>0.01$ and $r=0.960$, $P<0.01$) respectively.

Clutch size and breeding success: A mean clutch size of 8.5 ±1.0 eggs was recorded. The eggs were of the size of those of a domestic fowl, and coloured brownish buff-white with reddish brown specks around each end. Eggs from two nests were probably picked up either by villagers or predators. From the remaining four nests, 79% (inter-quartile range – 11.4) eggs were hatched. The chicks were generally dark chestnut in colour.

The hatching success recorded was 70.8% (inter-quartile range – 64.1) with chick survival and breeding success of 53.6% (inter-quartile range – 51.8) and 37.5% (inter-quartile range – 39.6) respectively. The percentage population survival for the four families recorded before the commencement of the next breeding season was 53.6% (inter-quartile range – 14.1).

DISCUSSION

The breeding of Cheer Pheasant in Garhwal Himalaya starts with pairing and territory formation by the end of February. The first courtship display was observed on March 17. During this period the breeding pairs remain in isolation within their home range and are sometimes accompanied by an unpaired sub-adult male from the previous year. The male performs mate guarding while the female feeds. Egg laying generally starts by the first week of May and incubation continues till June. Hatching was observed from mid to end June (16th, 23rd and 26th) after an incubation period of 25-27 days. Sub-adults become apparent by the first week of September and sexual dimorphism is complete by mid-October to November (Hume and Marshall 1995; Ali

Table 1: Nesting ecology and breeding success of Cheer Pheasant

	Breeding events	Number of nests						Mean ± SE or Median value
		I	II	III	IV	V	VI	
1.	Location of nest							
	(a) Altitude (m)	1700	1680	1600	1500	1450	1575	
	(b) Aspect	NW	NW	S	SW	SW	W	
	(c) On ground	Below stones	In a hollow	In a pit	Below stones	Amidst grass	In a hollow	
2.	Distance of nest from escapting site							
	(a) ridge (m)	10.0	12.0	25.0	10.0	100.0	17.0	29.0 ±14.4
	(b) nearest hiding cover (m)	5.0	14.0	15.0	12.5	10.0	12.5	11.5 ±1.5
3.	Size of nest (cm)							
	(a) Diameter	20.3	24.4	21.1	25.9	22.1	31.2	24.2 ±1.6
	(b) Depth	7.6	11.2	7.6	11.9	7.9	9.4	9.3 ±0.8
4.	Vegetation cover around nest							
	(a) Canopy cover (%)	50.0	25.0	25.0	50.0	25.0	25.0	25.0 (18.8)
	(b) Shrub cover (%)	25.0	10.0	15.0	15.0	10.0	10.0	12.5 (5.0)
	(c) Grass cover (%)	10.0	10.0	10.0	5.0	90.0	10.0	10.0 (0.0)
	(d) Grass height (cm)	15.2	12.7	11.4	6.4	44.5	16.0	17.7 ±5.5
	(e) Litter depth (cm)	10.2	12.7	15.2	16.5	2.5	6.4	10.6 ±2.2
5.	Clutch size	8	6*	8	10*	6	12	8.3 ±1.0
6.	Hatching success (%)	75.00	0.0	87.50	0.0	66.67	83.33	70.8 (64.1)
7.	Chick survival (%)	66.70	0.0	57.15	0.0	75.00	50.00	53.6 (51.8)
8.	Breeding success (%)	50.00	0.0	50.00	0.0	33.33	41.67	37.5 (39.6)
9.	Population survival (%)	40.00	□	50.00	□	75.00	57.14	53.6 (14.1)

* Eggs were either removed by villagers or predators; □ not recorded; values in the parentheses are inter-quartile ranges

and Ripley 1980). However, locating an active nest at 1500 m altitude in district Chamoli in September 2001, which later produced chicks with breeding success of 33.3%, may indicate an extended breeding season.

The principal source of nesting mortality in Galliform species is predation (Jimenez and Conover 2001). The nest site (with its complexities) is important for nest survival; as it should camouflage the nest from predators. The nests recorded by us had a stone/rock-wall or litter (mostly pine leaves) filled hollow/pit as background, which provided a good camouflage to the incubating hen. The canopy, shrub and grass cover (except in nest no. V) were low while the litter cover and depth were significant. The dulling of the red orbital patch during the breeding season in the females may also be advantageous during incubation. It was observed that the facial patch of the incubating female (while actually on the nest) is concealed by the supercilia and the infra orbital parts, revealing only the eyes, making it almost invisible. However, this red orbital patch becomes noticeable when it leaves the nest for feeding. Though the pre-monsoon in May-June influence invertebrate abundance (necessary for chick survival), it does not affect the litter cover/depth, which aids in making the nest less conspicuous, The monsoon showers usually wash the litter away and promote vegetational growth during July and August.

Five of the six nests were located quite near ridges and cliff, a possible area for escape from predators for though the Cheer runs fast it seldom takes to wing if the ground is open (Hume and Marshall 1879). The presence of hiding cover (5-15 m) near the nest was also advantageous in case the female wanted to seek shelter. The cause of nesting failure of the two nests was predation. Though both nests were located in habitats similar to successful ones, nesting success seemed to have no significant association with habitat features. This may be credited to high predation or anthropogenic pressures as the nests were exposed due to fire.

Larger nests (diameter) appear to have larger clutch sizes ($r=0.875$, $N=5$, $P<0.05$) [Nest II was excluded as the eggs were exposed to predation (human/potential predators) due to forest fire before a complete clutch was laid.] The clutch size of 6-12 found in the present study is comparatively lower than 9-14 eggs reported earlier (Hume and Marshall 1995). In captivity, an average clutch size of 10.8 eggs/brood, hatching success (average 56%) and chick survival (average 57%) has been recorded (Chandola-Saklani *et al.* 1990).

Chick survival can be related to factors like invertebrate abundance (Hill 1985) and predation pressure. Adult survival is another major factor influencing propagation and dispersal, and is probably affected by excessive hunting during the winter months (Bisht *et al.* 2002).

Cheer can adapt relatively well to high levels of human disturbance (Lelliott 1987). Fires, which may be necessary for maintenance of open grassland and scrub communities, are lit during the egg laying and incubating period. This may disrupt breeding and cause re-nesting (as was witnessed during this study), and along with hunting may be a severe threat to the survival of Cheer in Garhwal. Habitat degradation, therefore, may not be the only cause of depletion of this threatened monotypic species.

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BIRDS RECORDED DURING SEVEN EXPEDITIONS TO LADAKH FROM 1997 TO 2003[1]

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The consolidated results of seven ornithological expeditions to Ladakh, Indian Trans-Himalayas during summers of 1998, 1999, 2001, 2002, 2003 and autumns of 1997, 2000 are documented with information on habitat, abundance, distribution and status. Interesting sightings and observations are presented in greater detail together with records from previous studies of the area. A total of 122 bird species were recorded including four new records for the area. The adverse impact of tourism, overgrazing and other factors on the fragile ecosystem of this remote area are discussed and recommendations made for protection of the habitat for pregnable, endemic bird species.

Key words: Ladakh, ornithological expeditions, new records, avifauna

INTRODUCTION

Summer and Autumn surveys of raptors were conducted in collaboration with the Indian Army from 1997 to 2003. The main objective of the surveys was to collect distribution and breeding data on raptors and list all other bird species in Ladakh. Although Ladakh is remote and logistically one of the most difficult areas to work in, it has attracted many ornithologists after 1976 when travel restrictions were relaxed. Subsequently, most studies have focused on the 'vulnerable' Black-necked Crane *Grus nigricollis*. Sálim Ali guided a joint Bombay Natural History Society (BNHS) and World Wide Fund for Nature (WWF) expedition to Ladakh in 1976 in search of the crane, which led to a four-year study (Hussain 1976). The project aimed at rediscovering its breeding grounds, through short-term missions to Ladakh, and monitoring its breeding success. In 1986, a follow up expedition was organized by the BNHS to observe the status of the Black-necked Crane (Ali *et al.* 1986). Otto Pfister studied the Black-necked Crane from 1994 to 1997 (Pfister 1998 and 2001) in addition to general mammal/bird surveys. Migration studies, conducted by Southampton University between 1977-82, were mainly concentrated in the Suru valley and Shey-Tikse marshes (William and Delany 1985, 1986). WWF initiated a project in 1999 for the "Conservation of High Altitude Wetlands of Ladakh" (Chatterjee *et al.* 2002).

Our yearly surveys over seven years during summer were conducted during July 1999, June/July 2001 and August 2002 (HS and RKN) and May/June 1998 (RKN) and June/July 2003 (RKN and others); during autumn in September 1997 (RKN and others) and August 2000 (RKN and HS). The duration of the surveys was three to four weeks except in 2002, which lasted two weeks. During these expeditions a total of 122 bird species were recorded, of which four had not been reported earlier for the Ladakh region: Little Grebe *Tachybaptus ruficollis*, Little Cormorant *Phalacrocorax niger*, Large Pied Wagtail *Motacilla maderaspatensis* and Rufous-necked Snowfinch *Pyrgilauda ruficollis*. Little Grebe, Large Pied Wagtail, Small Blue Kingfisher *Alcedo atthis* and House Crow *Corvus splendens* were recorded at considerably higher elevations than previously reported in the Indian subcontinent. The breeding of Upland Buzzard *Buteo hemilasius* was confirmed – first for the Indian subcontinent (Naoroji and Forsman 2001).

Geographical description of the area

Ladakh is a cold desert situated in the westernmost Trans-Himalayan region of India representing the westernmost extremity of the Tibetan Plateau. Ladakh has close ecological and cultural affinities with Tibet and was included in the "Outer Plateau" area of Tibet by Charles Vaurie (1972) who studied the birds of Tibet. Ladakh is extremely arid, rugged and mountainous receiving less rainfall than eastern Tibet. The 100,000 sq. km area of Ladakh is bordered by the Karakoram range in the north and by the main Himalayan range in the south, the Ladakh and Zanskar ranges running between and parallel to these main mountain ranges. From its source on the Tibetan Plateau, the Indus river flows northwest between the Zanskar and Ladakh ranges, turning southward 300 km downstream into northern Pakistan. Almost all the settlements (including army and ITBP) are concentrated along the main river valleys (Nubra – Shyok, Indus, Suru, and Zanskar), each of which contains small areas of low lying, open, level ground. Eastern Ladakh has several lakes and forms the western extremity of Changthang, the northwestern adjunct of the Tibetan plateau.

Fig. 1: Map of Ladakh - Areas Surveyed

In Ladakh the altitudes range from 2700 m to 7000 m. The landscape which includes barren mountains, steep valleys, sand dunes, grasslands, upland bogs, marshes, rivers, and sweet and brackish lakes make it a land of contrasts and extremes. The temperatures are extreme with maximum and minimum temperatures ranging from 35°C in summer to minus 45°C in winter. Precipitation is less than 100 mm per year. The human population is sparse, mainly concentrated within the habitable Indus and other river valleys. The flora consists of selective elements from Afghanistan, Siberia, Tibet and the Himalayan region together with a considerable proportion of endemic species. Vegetation consists primarily of sparse grass, herbaceous plants and low thorny scrub. The combination of constant high winds, low temperatures and high altitude has a depressing effect on the vegetation.

Objectives: The objectives of the expeditions were:

a) survey all areas for raptors (status and habitat requirements) and prepare checklists of all birds observed.

b) search for nests of resident raptors and observe their breeding biology and ecology, and identify threats if any.

c) raise awareness levels of our main collaborators – the army and the forest department and suggest conservation measures.

METHODS AND STUDY AREA

Raptors and other birds were primarily recorded by employing the 'line transect' method from the vehicle or while hiking. Breeding studies and intensive surveys were conducted near nesting sites of raptors, where we camped for reasonably long periods. Birds observed were logged, photographed if possible and maximum numbers were noted to assess relative abundance. Mammals (mainly Tibetan Wild Ass *Equus kiang*) encountered were also logged.

Accessible areas along the Indus, west up to Alchi, but mainly from Leh eastwards to Shey, Tikse, Chumatang, and Loma, Rumbak, the Nubra and Tankse valleys, and especially

Rupchu and Changthang territories in the east were regularly surveyed on each visit.

Conservation significance of Ladakh

Despite the harsh environmental and climatic conditions, the avifauna of Ladakh is diverse, displaying Palaearctic, Mediterranean and Chinese influences. Each trip has stimulated us with sightings of unexpected migrants and little known high altitude species. Uniquely located on the border between the Palaearctic and Indo-Malayan zoogeographic zones, Ladakh is strongly influenced by typical species from both regions. The characteristic Tibetan species extend their ranges well into eastern Ladakh. In addition, dry and sunny summer months attract many summer visitors and breeders. These diverse climatic and geographic influences make Ladakh a melting pot of bird movements, resulting in more than 300 species recorded in the area so far (Pfister 2001).

The 'vulnerable' Black-necked Crane breeds in Ladakh. Thirteen pairs have been breeding regularly in the area, including one pair each in Tso Moriri and Tso Kar (Chatterjee *et al.* 2002). Tso Moriri is not only an important staging point for migratory birds, but also the main breeding ground of the declining Bar-headed Goose *Anser indicus* in the Indian subcontinent. The fresh water Startsapuk Tso and the saline Tso Kar have a large population of Brahminy Shelduck *Tadorna ferruginea*. Tso Moriri and Tso Kar have small breeding populations of Great Crested Grebe *Podiceps cristatus*. The Common Tern *Sterna hirundo* breeds in small numbers in the marshes around the lakes. At Tso Moriri, Common Merganser *Mergus merganser* also breeds in small numbers (Chatterjee *et al.* 2002). The Brown-headed Gull *Larus brunnicephalus* and Lesser Sand Plover *Charadrius mongolus* breed in good numbers at Tso Kar, whereas Common Redshank *Tringa totanus* breeds in small numbers in the area.

Several large mammals including those categorised by IUCN as vulnerable, critical, or endangered are found in Ladakh such as Snow Leopard *Uncia uncia*, Tibetan Wild Ass or Kiang *Equus kiang*, Siberian Ibex *Capra sibirica*, Great Tibetan Sheep Ovis *ammon*, Urial or Shapu *Ovis vignei*, Bharal or Blue Sheep *Pseudois nayaur*, Tibetan Antelope or Chiru *Pantholops hodgsonii*, Tibetan Gazelle *Procapra picticaudata*, Wild Yak *Bos grunniens*, Eurasian Lynx *Lynx lynx*, Tibetan Wolf *Canis lupus*, Indian Wild Dog *Cuon alpinus*, Red Fox *Vulpus vulpus*, and Brown Bear *Ursus arctos*.

RESULTS

During the seven surveys, a total of 122 bird species were recorded, including twelve species of birds of prey; ten diurnal and two nocturnal. Four new species were recorded from the area: Little Grebe, Little Cormorant, Large Pied Wagtail and Rufous-necked Snowfinch. The observations of Little Grebe, Large Pied Wagtail, Small Blue Kingfisher and House Crow in Ladakh increased altitudinal ranges of those species' to considerably higher elevations than previously reported. In addition, breeding of Upland Buzzard in Ladakh was documented — first record for the Indian subcontinent. One nest was found in 1998, and two nests containing near fully-fledged young were observed in 1999 (Naoroji and Forsman 2001).

Threats to the habitat and wildlife

The Ladakhis are innately life respecting people and sensitive to their environment. Traditionally they have used the natural resources of the region wisely without causing any adverse impact on the environment. However, recent changes in land use patterns, influx of tourists, settlement of Tibetan refugees at Hanle and increase in livestock, especially in Changthang, has had increasingly adverse effects on the fragile environment and consequently the wildlife even in the more remote areas (see Recommendations). For example, the Tibetan Gazelle *Procapra picticaudata* was abundant on the plateau to the southeast of Tso Moriri lake, on the hills east of Hanle, and in the Indus valley from Demchok, the frontier village of Ladakh, as far down as Nyima (Nyoma) (Sterndale 1884). In seven visits we only once sighted three Tibetan Gazelles at Hanle. The endangered Black-necked Crane, which has so far managed to survive, is increasingly becoming vulnerable to changes in land use patterns, and increase in predation of eggs and chicks by proliferating numbers of feral dogs and to a lesser extent increase of egg predation by Ravens (Pfister 1998).

The pastures are increasingly being overgrazed and consequently degraded due to considerable increase in livestock because of increased government supported commercialized production of the valuable Pashmina wool. The Changthang area of Ladakh holds about 14,000 domesticated livestock, represented mainly by sheep, goat, yak and ponies. The growing domestic livestock population has overgrazed the pastureland, causing wind erosion and desertification. Heavy pressure on available pastures have resulted in the herdsmen, known as Changpas (who earlier co-existed peacefully with wild herbivores), becoming hostile especially to the Kiang which are now being driven away from all pastureland and marshes along river valleys. The herdsmen argue that the Kiang and Tibetan Gazelle directly compete with their domestic livestock.

Domestic livestock (including ponies and yak) are furthermore herded into marshes and shallow ponds (not their natural habitat) where the vegetation is comparatively lush

and intact. At Chushul, Hanle and Lal Pahari livestock grazing in knee-deep water disturb breeding Black-necked Crane and waterfowl. The Changpas deliberately do not harm the breeding birds, but their frequent movement near nesting sites sometimes forces incubating birds to leave the clutch, allowing aerial and terrestrial predators access to their nests (Pfister 1998).

Herders are openly hostile towards the Kiang, which are driven off on horseback. Their dogs are also trained to warn them of approaching Kiang. Most grazing pastures are now fenced, effectively preventing the Kiang from feeding. Furthermore, the Changpas have ceased practising rotational grazing and are only partially nomadic, having permanent summer camps in prime pastureland (when the Black-necked Crane, Waterfowl and ungulates breed), thereby creating additional pressure on the wildlife and the land. In the near future, confrontation between the Kiang and the Changpas in Changthang could be a major conservation issue.

Throughout Ladakh shepherds are visibly hostile towards the Golden Eagle *Aquila chrysaetos*. Accessible nests are destroyed, as the species is perceived as a threat to their lambs. In fact, Buddhist values are discarded and accessible nests usually destroyed or nesting disturbed so that the adults desert the nest. Its habit of only occasionally lifting few weeks old lambs of domestic sheep and goat does not endear the species to the local population. The pressure on Golden Eagles is primarily during the summer breeding season, which coincides with the lambing period.

The large population of dogs belonging to the Changpas and adopted by soldiers at army and ITBP outposts are the biggest threat to the Black-necked Crane, ground breeding birds in general and small mammals. Dog numbers have multiplied by as many as 50 at most outposts as they are fed to provide vigilance. Egg destruction and chick mortality caused by dogs represent the biggest threat to the Black-necked Crane population in Ladakh, and are responsible for up to 50 per cent destruction of broods within a productive cycle during certain years (Pfister 1998).

The Jammu and Kashmir government and the Indian Army have improved accessibility to Ladakh, particularly the Changthang and Rupshu areas. Motorable tracks have been laid even in extremely remote areas for strategic reasons. However, road construction accompanied by blasting has not only created disturbance to wildlife but also initiated new development activities in remote areas. During our visit to Hanle in 2002, we found recently erected electricity poles cutting through the marsh. This poses a direct threat of electrocution or wings being sheared off to flying Black-necked Cranes, especially at night. The poles could have been routed along the periphery of the marsh.

Encouraging Tibetan refugees to settle at Hanle is directly creating new threats to the Changthang Wilderness area. The Tibetan refugee settlement is rapidly growing into a township with cement residential buildings, schools, dormitories and a handicraft centre, thanks to generous foreign aid. The small primitive Ladakhi settlement is, however, unchanged. The Hanle river has been diverted to newly created agriculture fields, not only reducing the area available for wildlife, but also shrinking the marsh. Unsuccessful fenced-in plantations of stunted Willow *Salix* and Poplar *Populus* are irrigated through channels diverted from the marsh. Lack of water may drastically shrink or dry up the marsh in the near future. Relatively large-scale agriculture along the marsh has also led to fencing of fields. This recent practice has reduced and fragmented primary habitat.

Ladakh has been experiencing an increasing influx of tourists since 1974. The easy availability of 'inner line' permits from the district administration in Leh has made the popular lake areas of Tso Moriri, western Pangong Tso and Tso Kar accessible since 1993. Tourism in the region is expected to rise. Surveys conducted by the World Wide Fund Nature-India (WWF) indicate that there has been an alarming increase in the number of visitors to the Changthang region (Chatterjee *et al.* 2002).

Tourists are accommodated in eco-friendly tents, as permanent infrastructure is thankfully lacking. Although tents are usually pitched in defined areas, waste management is unfortunately totally neglected and most tourist sites are littered with various non-degradable items. Additionally, at some remote army and Indo-Tibetan Border Police (ITBP) outposts degradable and non-degradable garbage is a common sight. The impact of tourism has been maximum near the major wetlands of Tso Moriri and Tso Kar.

Pastures and wetlands are the feeding and breeding areas of the Upland Buzzard, Black-necked Crane and Bar-headed Goose (*Anser indicus)*; camping in these areas, driving off track and washing of vehicles are disturbing the breeding marsh dependent birds (Chatterjee *et al.* 2002). The dramatic increases in trekkers' pack animals — donkeys, mules and horses have further degraded the pastures particularly around the wetlands accessible to tourists.

Recommendations

There is an immediate need to develop a strategy and action plan for the conservation and management of Ladakh's natural heritage, especially the high altitude wetlands and lakes throughout Changthang and Rupshu, namely Tso Moriri, Tso Kar and Nuro Sumdo. Prompt steps need to be initiated by involving all the stakeholders – local communities, tour operators, development agencies and defence forces.

Pangong Tso is comparatively pristine as it is more isolated and tourism is restricted to the southeastern part of the lake. Any development around the wetlands must be supervised and executed in an eco-compatible manner. Unregulated tourism can impair the wetland's fragile eco-system in the future. With the present unregulated flow of tourists and lack of any drainage system, pollution levels of Tso Moriri and Tso Kar will increase in the near future (Mishra and Humbert-Droz 1998).

As the peak tourist season coincides with the breeding season of birds (when they are most vulnerable), there is all the more urgency to increase visitor's awareness about the delicate situation. Awareness literature should be given to all tourists on arrival. There is need to control reckless driving particularly around Tso Kar as it is damaging the vegetation and causing siltation of the lake. Leftovers in the form of plastic bottles and bags, tin cans, glass bottles, battery cells and other non-biodegradeable waste after each tourist visit at Tso Kar and Tso Moriri must be removed. Travel agencies' guides and drivers accompanying tourists should be made responsible to carry back their garbage to be disposed off in a non-polluting eco-friendly manner — not to be buried/burnt or left at the camping site. Guards should be stationed at all important sites to verify whether only designated camping sites are occupied, monitor activities of tourists and control littering and fine offenders.

All breeding and staging sites at designated wetlands need to be protected. As army and para military forces have a regular presence they should be updated about the ecological sensitivity of this area. They can play a major role in the conservation of the biodiversity of Ladakh. For example, ITBP camped at Korzok (Tso Moriri) can help in protecting the breeding Bar-headed Goose by safeguarding their breeding grounds. According to a WWF-India report they have helped in clearing the lake from time to time by removing garbage and waste dumped by the tourists around Tso Moriri (Chatterjee *et al.* 2002).

Recently erected electrical and telephone poles cutting through the Hanle marsh are a very serious threat to the flying Black-necked Crane. The poles need to be re-routed along the periphery of the marsh.

Religious leaders of Ladakh should be involved in conservation activities as they can help in motivating the local population. A good beginning was recently made by involving the head Lama of the Tso Moriri monastery in the conservation of the lake area (Chatterjee *et al.* 2002).

Certain areas such as the wetlands and marshes in Changthang should be kept inviolate, at least seasonally, during the breeding season. Staff of the Wildlife Department needs to be motivated and trained in wildlife management techniques. The wetlands should be monitored by the Forest Department and NGOs to curb disturbance and ensure breeding success of water-birds, especially key species such as the Black-necked Crane and Bar-headed Goose. The Changpas should be sensitized to their environment and even encouraged to pick up trash by offering monetary incentives. Some NGO could try this activity.

Feral dogs have to be culled at least around the marshes where their numbers are a direct menace to breeding Black-necked Crane and other marsh-dependent birds. Even sterilization can be attempted in view of the religious sentiments of the people. Defence personnel should be discouraged to keep dogs in large numbers.

The refugees settled at Hanle should be settled elsewhere. They have already encroached on the marsh within the Changthang Conservation Area and are rapidly expanding their economic activities.

The people of Ladakh are innately life respecting. They should not be prevented from using their traditional grazing grounds. It is not that wildlife cannot co-exist or breed where people are present. But they have to be taken into confidence (a long term on going exercise) and educated about their environment. They have also to be motivated to follow some basic rules. They should not allow domestic animals to wander in bogs unattended at least during the breeding season of the birds, and need to keep their dogs in check.

It must, however, be remembered that unless inhabitants of protected areas see some logical benefit especially in the long term, it would be difficult to convey the message of conservation and garner support. The management should not appear to be seen as solely concerned about the conservation of wildlife and habitat, which might not appeal to the local people, but also be concerned for their welfare. To accomplish this NGOs could have a role in bringing together scientists, management, administration, Army and ITBP and the local people. Only then can biological diversity be preserved by creating new protected areas and extension of existing ones in this region where low productivity and wildlife at low densities necessitate larger areas for protection of viable populations.

Systematic List of Birds

122 species recorded during June, July, August, and September are listed below. The account includes information on abundance, status, location, distribution and breeding. Previous notable records are briefly compared with our findings.

Abbreviations used

(Br.) – proof of breeding found. This refers to nests found with eggs or chicks or adults carrying nesting material

or food; with nidifugous species young seen or receiving parental care by adults.

* new record, species not previously reported from Ladakh.

? status uncertain

1. **Little Grebe** ***Tachybaptus ruficollis****

Vagrant. Three observed in summer plumage at Trishul Tso (*c.* 3500 m) near Leh on July 1; 1999. One individual again recorded on July 3, 1999. This represents the first record of the species for Ladakh. Moreover, the sighting represents an altitudinal record, considerably exceeding the highest altitude previously recorded for the species in the Subcontinent (Sangha *et al.* 2003).

2. **Great Crested Grebe** ***Podiceps cristatus***

Summer visitor. Br. Recorded nesting on ponds and lakes in Changthang. On July 25, 1999 at least nine breeding pairs observed at Startsapuk Tso (seven nests and four chicks). On August 30, 1999 one pair was observed followed by four grown up chicks at Tso Moriri near Korzok village. The chicks were independently diving for food. Pfister (2001) recorded breeding at Yoye Tso (4700 m) in June 1995 and September 1997.

3. **Little Cormorant** ***Phalacrocorax niger****

Vagrant. An adult observed repeatedly diving for fish in the murky water of the swollen Indus river on August 18, 2002 at Mahe, far to the north of its hitherto known distribution range in the Indian subcontinent (Sangha and Naoroji 2005). There is one more record of the species for Ladakh. Rouf Zargar, Wildlife Warden of Ladakh reported sighting of a bird from Shey fish-ponds in summer, 2001 (Otto Pfister pers. comm.).

4. **Bar-headed Goose** ***Anser indicus***

Summer visitor. Br. This near-threatened species is common on the fresh and brackish water lakes of Changthang and the upper Indus river up to Chumathang, increasingly uncommon in the west up to Leh. Absent further west. Colonies of breeding pairs were observed at Pangong Tso (one pair with three young birds on July 18, 1999) and Chushul (six breeding pairs including one with fledged chicks on July 19, 1999). Seven fledged young with adults were observed along the upper Indus near Mahe on July 25, 1999 and three pairs with chicks between Mahe and Nyoma on July 3, 2001. At Tso Moriri, the main breeding stronghold of the species in the Subcontinent, the birds are wary due to disturbance caused by spread of cultivation right up to the lake edge.

5. **Brahminy Duck** ***Tadorna ferruginea***

Summer visitor. Br. Apart from the regular sightings throughout the study area, a pair with two fledged young near Mirak on July 18, a pair with two chicks at Chushul on July 19, a pair with seven chicks at Hanle on July 23 and fifty five at Tso Kar, including four breeding pairs with chicks on July 25, were recorded in 1999. A pair and eight young were recorded at Hanle on June 30, 2001.

6. **Gadwall** ***Anas strepera***

Summer visitor, mainly passage migrant. Three were observed at Chushul on July 19, 1999 and eight at Hundar on August 20, 2000.

7. **Mallard** ***Anas platyrhynchos***

Summer visitor, mainly passage migrant. A drake on July 21, 2000 at Panamik and eight at Hanle on July 1, 2001.

8. **Northern Pintail** ***Anas acuta***

Summer visitor, mainly passage migrant. Four were seen on July 2, 1999 and three on September 1, 2000 at Trishul Tso.

9. **Garganey** ***Anas querquedula***

Summer visitor, mainly passage migrant. Eight on Pallu marsh (at the northern base of Khardung La) on August 18, fifteen at Lal Pahari on August 25, and sixteen at Hanle on August 26, 2000. Four on the Indus near Loma on August 18, 2002.

10. **Common Teal** ***Anas crecca***

Passage migrant. Ten recorded on August 15, 2002 at Hanle.

11. **Tufted Pochard** ***Aythya fuligula***

Summer visitor, mainly passage migrant. One at Trishul Tso on July 5, 1999.

12. **Common Merganser** ***Mergus merganser***

Resident, augmented by summer visitors. However, the summer visitors descend to lower altitudes in winter. The remnant resident population is confined to ice-free patches along the Indus. Mallon (1987) saw small parties (1-4) along the Indus and Zanskar rivers. Five on the Indus near Kidmang on August 25, 2000, twenty four on the Hanle river between Loma and Lal Pahari on August 25, 2000. Nineteen at Hanle on August 28, 2000 and sixteen on the Indus near Mahe on August 31, 2000 (HS and RKN).

13. **Black-shouldered Kite** ***Elanus caeruleus***

Rare Vagrant. The species also recorded by Pfister (2004). Both RKN and Pfister (2004) observed the species during

(August-September). Observed by RKN in the Chushul marshes in early September 1997. The species has once been observed at high altitude in Sikkim (Ganguli-Lachungpa 1990), well beyond its normal habitat and altitudinal range.

14. **Black Kite** ***Milvus migrans lineatus***

Summer visitor/Passage migrant. Br. A pair observed during May/June 1998 near Leh Bazaar breaking off twigs from a Poplar and disappearing from view (RKN). One sighting from Army Headquarters 3 Infantry Division, Leh on July 15, 1999. There is at least one record of a pair breeding in 2001 in Leh (Otto Pfister, pers comm.). This race has been observed during spring passage (Williams and Delany 1986).

15. **Bearded Vulture** ***Gypaetus barbatus***

Resident. Widespread throughout the study area. One nest with a single young observed near Chang La on July 17, 1999 at *c.* 5000 m. Another nest with a fledged young was located near Hanle in a steep valley on August 14, 2002 at *c.* 4500 m. It was lined with grass, rags, sheep and yak wool, goat hair, pieces of plastic and strips of cloth (some plucked from prayer flags). It also contained animal remains like bones, skin, skulls and intact legs and feet of domestic and wild ungulates. An adult was observed feeding red meat to the young and carrying large bones in the bill to the nest. Breeding season extends from November/December to July, occasionally up to mid August.

16. **Himalayan Griffon** ***Gyps himalayensis***

Resident, infrequent. Widespread throughout the study area in small numbers – usually two/three, sometimes up to five/eight.

17. **Upland buzzard** ***Buteo hemilasius***

Resident. Restricted only to Changthang and Rupshu in eastern Ladakh. Dependent on marshes and wetlands for food when breeding. All nests located were on rocky outcrops adjacent to marshes. An active nest was found on June 22, 1998 near Ponguk village, Hanle (Naoroji and Forsman 2001). Two nests containing near fully-fledged young were observed at Hanle on July 23, 1999. One active nest with almost fledged young was found at Puga on July 25, 1999. The species was seen at Chushul, between Chushul and Hanle, Lal Pahari, Hanle, Puga, Tso Kar and with highest incidence and sightings between Dungti and Demchok at regular intervals (three adult pairs, two single adults and two recently fledged young on August 11, 2002) along the Indus where habitat comprised a mix of marsh/fluvial flats and steep rocky outcrops.

18. **Golden Eagle** ***Aquila chrysaetos***

Resident. Widespread throughout the study area, but under pressure during the breeding season. Accessible nests are usually destroyed by shepherds who perceive the species as a threat to their lambs. Two active nests on cliffs with two downy young and almost fledged young were found at Ney in May 1998 and end June 1999 respectively, and between Hanle and Chumur at Lenak La on July 2, 2001. Breeding season in Ladakh extends from late February to early August. Nestling period is usually 65-70 days. Prey observed included young of Shapu *Ovis vignei* and Bharal *Pseudois nayaur*, Himalayan marmot *Marmota himalayana* and very occasionally lambs of domestic sheep.

19. **Common Kestrel** ***Falco tinnunculus***

Common summer visitor. Br. Widespread throughout Ladakh. Opportunistically breeds both on trees in the vicinity of human habitation and rock faces usually away from human habitation. A pair observed breeding in a disused Black-billed Magpie *Pica pica* nest on a Poplar in the Shambala Hotel compound in Leh during July 1999. In the absence of suitable trees, observed breeding on rock faces and cliffs in Nubra, Changthang and western Ladakh.

20. **Merlin** ***Falco columbarius***

Passage migrant and winter visitor. Although Mallon (1987) considered it a migrant and winter visitor in very small numbers, Williams and Delany (1986) found it overwintering in small numbers. Our two sightings indicate that it is also likely to summer. One female was recorded in Nubra valley at Hundar on August 21, 2000 and a male between Demchok and Dungti at Chakhukma Tso on August 13, 2002.

21. **Eurasian Hobby** ***Falco subbuteo***

Common summer visitor. Br. One near Ney on July 1, 1999, one near Tangtse on July 17, 1999, and one near Karu on July 4, 2001. Additionally, regularly sighted at Shey marsh, where as many as three were observed on June 24, 2001 hawking dragonflies. Regularly observed throughout the Hanle valley on all visits. Throughout Ladakh, more frequently observed in open river valleys and marshes. Pfister (2001) also regularly sighted this summer visitor at Shey marsh and below Rizong from 1994 to 1997. Osmaston (1927b) found a nest at Kargil on a Poplar tree, in the nest of a carrion crow *Corvus corone* from which he had previously removed eggs. May occasionally nest on cliffs.

22. **Saker** ***Falco cherrug***

Mainly Passage migrant, also winter visitor. Uncommon. Sightings during summer indicate the possibility of the

species occasionally breeding. In September 1997 one individual observed between Chushul and Tsaga village, one between Loma and Hanle, another en route to Korzok. One recorded in the valley between Hanle and Lenak La on July 28, 2000. Near south Dungti; one on June 28, 2001, two in August, 2002 and one in June, 2003. One observed in June 2003 at Hanle (RKN and Pankaj Sharma). Mallon (1987) considered it as passage migrant and winter visitor in very small numbers.

23. **Himalayan Snowcock** ***Tetraogallus himalayensis***

Resident. Found at high elevations in western and central Ladakh though not common.

24. **Chukor** ***Alectoris chukar***

Resident. Common. Widespread over most of Ladakh. Loose parties of up to 20 are not uncommon around village fields. A pair with six chicks was observed in a barley field near Ney on July 6, 1999. Another pair with eight chicks was observed near Karu on August 9, 2002.

25. **Tibetan Partridge** ***Perdix hodgsoniae***

Resident. Regularly sighted between Hanle and Lenak La in the Changthang. We observed one pair with nine chicks on August 28, 2000 along the Hanle/Chumur road. Osmaston (1927b) found it "not uncommon in Rupshu especially from Polokonka down the Puga valley".

26. **Black-necked Crane** ***Grus nigricollis***

Summer visitor. Br. Regular on the wetlands of Changthang, which are under various threats. While studying their breeding ecology in 1997 Pfister (2001) recorded 38 birds of which 24 were breeding (12 nests, 24 eggs incubated, 13 eggs hatched, and nine chicks fledged).

27. **Common Moorhen** ***Gallinula chloropus***

Passage migrant. One individual recorded at Trishul Tso on July 6, 1999, one at Diskit on August 28, 2000 and three at Shey marsh including a juvenile on August 23, 2000.

28. **Common Coot** ***Fulica atra***

Passage migrant and summer visitor. Six observed at Trishul Tso on September 1, 2000. Two recorded at Shey marsh on June 24 and another two at Trishul Tso on July 5, 2001.

29. **Pacific Golden Plover** ***Pluvialis fulva***

Passage migrant. Six observed feeding along the grassy shore of Tso Moriri near Korzok village on August 30, 2000. The birds were in 50%-70% breeding plumage. Pfister (2001) also recorded it during autumn passage.

30. **Lesser Sand Plover** ***Charadrius mongolus***

Summer visitor. Br. Common on fresh and brackish marshes of Changthang. Twenty recorded on July 18, 1999 near Mikar (Pangong Tso) including two pairs with chicks. Four birds in breeding plumage were observed at Pashmina Goat Farm at Khurl on July 21, 1999. Another three birds in breeding plumage were recorded at Hanle on July 22, 1999. Four individuals telescoped at Chakhukma Tso between Demchok and Dungti and a pair with two chicks between Dungti and Loma along the Indus on August 13, 2002.

31. **Common Snipe** ***Gallingo gallinago***

Passage migrant. Five flushed from the grassy patch on the edge of Tso Moriri, Korzok village on August 30, 2000.

32. **Eurasian Curlew** ***Numenius arquata***

Passage migrant. Two observed at Hanle on July 24, 1999 and two more at Tso Kar on July 25, 1999.

33. **Common Redshank** ***Tringa totanus***

Summer visitor. Br. Widespread and breeds in very small numbers. Two breeding pairs were observed at Chushul on July 19, 1999. The behaviour of the adults left no doubt about the presence of chicks. On June 28, 2001 two chicks were observed with adults who tried to guide us away along the Hanle river near Loma. Breeding reported from Tso Kar lake and Puga Valley (Osmaston 1927b), but these sites at present are quite disturbed.

34. **Common Greenshank** ***Tringa nebularia***

Passage migrant. Three at Chushul on July 21 and one at Tso Kar on July 25 in 1999. Five near Diskit on August 21, 2000. Three along the Indus near Dungti on August 11, 2002.

35. **Green Sandpiper** ***Tringa ochropus***

Passage migrant, though a few individuals recorded throughout winter and summer months. One at Hanle on July 23, 1999, four at Diskit and one on the lake near Panamik on August 21, 2000. One at Hanle on August 26, 2000 and two at Tso Moriri on August 30, 2000.

36. **Wood Sandpiper** ***Tringa glareola***

Passage migrant. One observed at Lal Pahari on July 24, 1999.

37. **Common Sandpiper** ***Actitis hypoleucos***

Passage migrant. One recorded at Mikar (Pangong Tso) on July 18, another at Pashmina Goat Farm, Khurl on July 21 in 1999, two at Diskit on August 21 and another on 30 August at Tso Moriri in 2000.

38. **Little Stint** ***Calidris minuta***

Passage migrant. Seven birds in breeding plumage observed on a small wetland near Hunder on August 20, two at Hanle on August 26 and three at Tso Moriri on August 30, 2000.

39. **Temminck's Stint** ***Calidris temminckii***

Passage migrant. One at Demchok on August 13 and another at Loma on August 18 in 2002. Williams and Delany (1985) found it to be the commonest wader on autumn migration.

40. **Curlew Sandpiper** ***Calidris ferruginea***

Passage migrant. Rare to occasional. One recorded at Pangong Tso in full breeding plumage on August 18, 1999. Also recorded from other areas of Ladakh by other observers (Otto Pfister, pers comm.).

41. **Black-winged Stilt** ***Himantopus himantopus***

Passage migrant. Three at Tangtse on July 17, 1999, twenty two at North Pullu, a small lake at the base of Khardung La on August 19, 2000, two at Sumur on August 21, 2000, four at Hanle on August 26, 2000 and two along the Indus near Dungti on August 10, 2002.

42. **Pallas's Gull** ***Larus ichthyaetus***

Passage migrant. Two sightings on the Indus; one at Loma on August 25, 2000 and five near Demchok on August 13, 2002.

43. **Brown-headed Gull** ***Larus brunnicephalus***

Summer visitor. Br. Regular on the lakes in Changthang where it breeds. Commonly seen in the wetlands and along the Indus. More than forty at Pangong Tso on July 18 and sixty three at Tso Kar on July 25, 1999.

44. **Black-headed Gull** ***Larus ridibundus***

Passage migrant/summer visitor. One record of over sixty individuals on July 25, 1999 at Tso Kar. Sighted occasionally by Pfister (2001) during September and October 1997.

45. **Common Tern** ***Sterna hirundo***

Summer visitor. Br. Regularly seen on the lakes and the Indus river in groups of not more than three to four.

46. **White-winged Black Tern** ***Chlidonias leucopterus***

Passage migrant. One adult in partial breeding plumage and one juvenile observed hunting at Trishul Tso on September 9, 2000. Pfister (2001) recorded one at Startsapuk Tso/Tso Kar on June 23, 1995.

47. **Tibetan Sandgrouse** ***Syrrhaptes tibetanus***

Resident. Thirteen observed on July 22, 1999 but only two on June 28, 2000 at Pongo village, Hanle. On both occasions the birds were confiding and we observed them from merely four metres. Pfister (2001) recorded the species around Tso Kar, Chushul, Hanle and Lam Tso/Chumur. A pair of downy newly hatched chicks observed by Osmaston (1927b) near Tso Moriri on June 18. Five Tibetan Sandgrouse believed to be breeding were seen at Taglang La at *c.* 4500 m (Robson 1993).

48. **Blue Rock Pigeon** ***Columba livia***

Resident. Common and widespread including Leh.

49. **Hill Pigeon** ***Columba rupestris***

Resident. Common and widespread. Frequently in the company of the Blue Rock Pigeon.

50. **Snow Pigeon** ***Columba leuconota***

Resident. Two birds observed near Ney on July 8, 1999.

51. **Oriental Turtle Dove** ***Streptopelia orientalis***

Summer visitor. Br. Frequently encountered near cultivated areas and in tree-covered valley basins of Ladakh, including Nubra.

52. **Eurasian Collared Dove** ***Streptopelia decaocto***

Vagrant. This plains species was observed in cultivation area Nimu on July 3, 1999. Not recorded for Ladakh by Ali and Ripley (1981) and Grimmett *et al.* (1998). Kazmierczak and van Perlo (2000) mention only one passage record. Pfister (2004) found it to be a late spring occasional passage migrant with a few individuals over-summering in western Ladakh.

53. **Common Cuckoo** ***Cuculus canorus***

Passage migrant. One near Leh on August 18 and another near Kiari on August 31, 2000. Both sightings near cultivated areas/plantations. Recorded by Pfister (2001) at Hanle and in the Nubra valley.

54. **Eurasian Eagle-Owl** ***Bubo bubo***

Resident. Widespread and not uncommon. A pair with nestlings at Lal Pahari on July 21, 1999. One adult with two nestlings observed at Puga on July 25, 1999. A solitary adult on a rock cliff near Hundar on August 20, 2000 was the first record for Nubra valley. One roosting on the rocks near Hanle monastery on July 1, 2001. Another seen flying near Dungti on August 11, 2002 and two near Lal Pahari on August 16, 2002.

55. **Little Owl** ***Athene noctua***

Resident. Locally not uncommon. All sightings between Hanle and Lenak La at three different locations on the Hanle/ Chumur road. Pfister (2001) recorded it along the northern and eastern rocky slopes of Tso Kar plains, in the upper Indus valley and near Chang La at 5000 m.

56. **Alpine Swift** ***Tachymarptis melba***

Summer visitor?/passage migrant. Two at Loma on August 10 and two at Dungti on August 13, 2002.

57. **Common Swift** ***Apus apus***

Summer visitor. Br.? Three on July 4 and 12, 1999 near Ney, a single at Panamik on August 21, 2000.

58. **Small Blue Kingfisher** ***Alcedo atthis***

Summer visitor. One individual regularly seen at Chushul (4450 m) from July 18-20, 1999, exceeding the highest altitude of 4240 m previously recorded for this species in the Indian subcontinent (Pfister 2001) The species has been recorded from three other sites - Nubra valley, vicinity of Indus near Shey and Hanle (Pfister 2001).

59. **Common Hoopoe** ***Upupa epops***

Summer visitor and passage migrant. Br. Widespread breeder throughout the study area including Leh. Up to ten observed at foraging sites.

60. **Long-billed Calandra-Lark** ***Melanocorypha maxima***

Summer visitor. Br. Two birds; one calling with cocked tail near the Hanle observatory on June 28, 2001. Pfister (2001) found active nests in June at Hanle and flocks of up to 30 individuals at Chumur in mid-August, 1997. One record from the Markha valley, 4 km south-west of Spituk on August 2, 2002 constitutes the most westerly record to date (Robson 2003).

61. **Hume's Short-toed Lark** ***Calandrella acutirostris***

Summer visitor. Br. Widespread and very common. An active nest observed at Saspol on July 6; three nests near Tangtse; and another containing three chicks near Mikir on July 18 in 1999. Nesting observed in early September 2000, possibly extending the known breeding period (Sangha 2001).

62. **Horned Lark** ***Eremophila alpestris***

Resident and summer visitor. Found in both small parties and large flocks. Two nests located on open ground with hardly any vegetation near Hanle on June 30, 2001. The outer rim of one of the nests was lined with tiny pebbles and contained two nestlings. Another nest was lined with sheep/ goat wool and contained two eggs café-au-lait in colour peppered with small dark spots.

63. **Pale Martin** ***Riparia diluta***

Summer visitor. Br.? One recorded at Demchok on August 12, 2002.

64. **Eurasian Crag Martin** ***Hirundo rupestris***

Summer visitor. Br. Three chicks in a nest on a rock face observed being fed by adults near Rumbak on July 6, 2001.

65. **Common Swallow** ***Hirundo rustica***

Summer visitor?/passage migrant. A single between Sumur and Panamik on August 21, 2000. Flocks of over 300 birds 'built up' during cloudy weather in late August 1981 (Williams and Delany 1986).

66. **Northern House-Martin** ***Delichon urbica***

Summer visitor. Br. Occasional sightings mostly along the Indus, maximum being four at Kiari on August 31, 2000.

67. **White Wagtail** ***Motacilla alba***

Summer visitor. Br. A common summer visitor and passage migrant in the study area. In autumn large movements of the species have been noted (Williams and Delany 1986). Also recorded in winter (Mallon 1987). Early spring passage consists mainly of race *M.a. personata*, a rare breeder in Ladakh (Williams and Delany 1986).

68. **Large Pied Wagtail** ***Motacilla maderaspatensis****

Vagrant. Two birds observed along the Indus near Likir (*c.* 3000 m) on July 7, 1999. A new record for Ladakh, extending the species' known distribution range further north and considerably increasing its known altitudinal range of 2200 m (Sangha and Naoroji in press). There is an additional record by Anne Brooks from Rumbak on July 20, 2000 (Otto Pfister, pers.comm.).

69. **Citrine Wagtail** ***Motacilla citreola***

Summer visitor. Br. We observed more than ten nests in thorny bushes not more than 0.61-0.92 m above the ground near Ney on August 8, 1999. Adults are very vocal when feeding nestlings. One adult seen carrying food on August 18, 1999 at Mirak (Pangong Tso). Early spring passage consists mainly of *M.c. citreola*, a non-local race (Williams and Delany 1986).

70. **Yellow Wagtail** ***Motacilla flava***

Summer visitor. Br? The least common among the

wagtails in the study area. Breeds in Ladakh (Pfister 2001). The races *M.f. beema* and *M.f. thunbergi* appear during spring passage (Williams and Delany 1986).

71. **Grey Wagtail** ***Motacilla cinerea***

Summer visitor. Br. Occasionally seen in the marshes, swamps or rivers and lake-side mudflats.

72. **Eurasian Tree Pipit** ***Anthus trivialis***

Passage migrant. Three birds near Mahe September 2, 2000. Occasional sightings by Pfister (2001) during September 1997.

73. **Water Pipit** ***Anthus spinoletta***

Passage migrant. One bird along the Indus near Loma on June 28, 2001. Pfister recorded one at the northern spring of Tso Kar in September 1994, one in the Tangtse valley in June 1996 and more than five in the Shey marsh in March 2000 (Otto Pfister, pers. comm.). Also recorded by Williams and Delany (1986) during autumn.

74. **Grey-backed Shrike** ***Lanius tephronotus***

Summer visitor. Br. One near Tso Moriri on August 29, 2000. Another in a plantation near Pongo village in Hanle valley on August 15, 2002.

75. **White-throated Dipper** ***Cinclus cinclus***

Resident. Single adults observed; one perched on a rock overlooking the stream near Sumdo on August 31, 2000, another at Charding Nullah near the Hot Springs, Demchok on August 12, 2002. Adult observed feeding two just fledged chicks, incessantly begging for food at a stream opposite Mahe bridge check point on August 10 and 18, 2002.

76. **Brown Dipper** ***Cinclus pallasii***

Resident. Commoner than the previous species. Unlike the White-throated not recorded east of Mahe.

77. **Robin Accentor** ***Prunella rubeculoides***

Resident. Very frequently seen affecting scrubs and bushes along river valley bottoms and villages, often preferring wet areas throughout Ladakh.

78. **Brown Accentor** ***Prunella fulvescens***

Resident. Widespread, affecting trees and bushes in remote mountain valleys, but less common than the previous species.

79. **Blue Rock-Thrush** ***Monticola solitarius***

Summer visitor. Br. Widespread throughout Ladakh. A juvenile observed close to Hundar on August 20, 2000 and near the observatory at Hanle on August 15, 2002.

80. **Blue Whistling-Thrush** ***Myiophonus caeruleus***

Summer visitor. Br. A single at Rumbak on July 8, 2001. Otto Pfister (pers. comm.) found a nest in the Hundar gorge in 1997.

81. **Eurasian Blackbird** ***Turdus merula***

Passage migrant. One dead bird was found at the base of Lenak La on Hanle/ Chumur road. One female seen on 1 and 2 October, 1997 below Hanle monastery during autumn migration (Pfister 2001).

82. **Himalayan Rubythroat** ***Luscinia pectoralis***

Summer visitor. Br. A pair observed feeding two chicks at Chushul on 19 and 20 July 1999. The nest was in a *caragana* bush about one metre above the ground. Two sightings in 2000 – one on August 29 at Tso Moriri and another on August 31 near Sumdo. At Demchok one observed in bushes along the Indus on August 12, 2002.

83. **Bluethroat** ***Luscinia svecica***

Summer visitor. Br. One at Tso Moriri near Korzok on August 30, 2000. Singles at Rumbak on July 8, 2001 and Demchok on August 12, 2002.

84. **Black Redstart** ***Phoenicurus ochruros***

Summer visitor. Br. Widespread, common. Two chicks were observed being fed by adults on July 1, 1999. The nest was in a crevice of a stone boundary wall at Nimu.

85. **Guldenstadt's Redstart** ***Phoenicurus erythrogaster***

Resident. Widespread and common throughout the study area. Abundant in winter when the summer population is swollen by winter visitors (Mallon 1987).

86. **White-capped Redstart** ***Chaimarrornis leucocephalus***

Summer visitor. Br? One to three birds regularly seen at Ney (June 30-July 8), one at the base of Chang La, another at Chagar Tso (between Tangtse and Pangong Tso), two-three at Chushul (July19-21) in 1999. One to two birds regularly seen around Rumbak in early July, 2001. Not recorded at Hanle, Chumur, and Demchok. Our sightings at Chushul are far east of its known summer distribution range.

87. **Grandala** ***Grandala coelicolor***

Summer visitor. Recorded from two sites. Two to three were regular at Ney from 3-12 July, 1999. A female observed picking insects by flying close to the contours of rocky slopes

close to the Indo-Tibetan Border Police camp at Hanle on August 14, 2002.

88. **Common Stonechat** ***Saxicola torquata***

Passage migrant. An early autumn migrant observed while driving from Chushul to Loma on July 21, 1999. One observed in September 1997 near Diskit in the Nubra valley (Pfister 2001).

89. **Pied Wheatear** ***Oenanthe pleschanka***

Summer visitor. Br. A pair observed feeding chicks near Nimu on July 3, 1999. The nest was located in a culvert under the road in the gap between boulders used for support. This record confirms that the species breeds in Ladakh.

90. **Desert Wheatear** ***Oenanthe deserti***

Summer visitor. Br. Widespread and very common throughout the study area.

91. **Blyth's Reed-Warbler** ***Acrocephalus dumetorum***

Passage migrant. One individual was recorded at Korzok on August 30, 2000. Otto Pfister (pers. comm.) reported it from Nubra valley in September.

92. **Common Chiffchaff** ***Phylloscopus collybita***

Summer visitor. Two at Hanle on July 24, 1999 and two at Trishul Tso on September 3, 2000.

93. **Moutain Chiffchaff** ***Phylloscopus sindianus***

Summer visitor. Br. Widespread and commoner than the previous species. Smaller numbers seen in Changthang than Nubra and areas west of Leh. At least 4-5 active nests found with adults feeding nestlings near Ney on July 8, 1999.

94. **Olivaceous Leaf-Warbler** ***Phylloscopus griseolus***

Summer visitor. Br. Rather common and observed breeding at Ney from 3-12 July, 1999. Also recorded occasionally at Leh (including Trishul Tso) and Nubra. In Changthang, it was not uncommon in trees and thickets. At Sumdo, a family of three to four juveniles and adults were observed on August 31, 2000. At the army outpost at Demchok, daily counts of 4-8 birds seen on 11 and 12 August 2002 represent an eastern extension of its range in Ladakh.

95. **Common Lesser Whitethroat** ***Sylvia curruca***

Summer visitor. Many sightings from different areas including Leh. One at Ney on July 5 and two at Likir on July 6, 1999; three at Diskit on August 20 and six at Sumur on August 21, 2000. One at Karu on June 24 and two at Chumathang on June 27, 2001. Otto Pfister (pers. comm.) found an active nest in a small buckthorn bush near the Indus at Shey in June 1995.

96. **Tickell's Warbler** ***Phylloscopus affinis***

Summer visitor. Br. Not uncommon throughout our surveys in suitable areas with shrubbery, bushes and trees.

97. **Spotted Flycatcher** ***Muscicapa striata***

Passage migrant. All sightings during autumn. One observed on a Willow at Leh on September 2, 2000. Adults observed in early September in the Nubra valley (Otto Pfister, pers. comm.).

98. **Great Tit** ***Parus major***

Resident. Widespread and not uncommon in the Indus valley plantations and other patches of trees. Not recorded in Changthang.

99. **Wallcreeper** ***Tichodroma muraria***

Summer visitor. Br. A pair seen near Kiari on August 25; five including three trailing juveniles between Gaik and Kiari on August 31 along the Indus river in 2000. A pair were again seen near Kiari on August 18, 2002. Recorded from Rumbak in June 1996; Hundar gorge in Nubra valley and Sumdo near Puga in September 1997 (Otto Pfister, pers. comm.). Osmaston (1927a) observed breeding birds in June and July in the Gya Valley, also near Tankse and Khardong.

100. **Fire-fronted Serin** ***Serinus pusillus***

Resident. Widespread and locally common in the study area except Changthang. However, recorded once at Chumur in Changthang in the compound of the Indo-Tibetan Border Police in early August, 1997 (Otto Pfister, pers. comm.). Found in small flocks of up to 10 birds.

101. **Twite** ***Carduelis flavirostris***

Resident. Widespread and common in sandy and rocky areas. Immense flocks (well over 150 birds) seen while driving from Dungti to Tyagarmale on the afternoon of July 28, 2001.

102. **Hodgson's Mountain-Finch** ***Leucosticte nemoricola***

? Occasionally seen throughout the study area. Resident according to Pfister (2001) but Mallon (1987) recorded it only during the winter of 1983-1984, but was unclear whether the species was previously overlooked in other winters or normally leaves the area.

103. **Black-headed Mountain-Finch** ***Leucosticte brandti***

Resident. All sightings east of Leh usually in small numbers on desolate open stony ground, high altitude cliffs,

crags and barren mountaintops. Otto Pfister (pers. comm.) recorded it on all visits in the upper Rumbak valley. More than 25 sighted near Nyoma on June 26, 2001. Literally hundreds seen between Dungti and Tyagarmale on July 28, 2001.

104. **Mongolian Finch** ***Bucanetes mongolicus***

Resident. Occasionally seen throughout the study area. Williams and Delany (1986) found it quite common during spring. Pfister (2001) observed fledged young being fed by the adults during August.

105. **Common Rosefinch** ***Carpodacus erythrinus***

Summer visitor. Br. Common throughout the area in plantations, orchards, and thickets except Changthang. Two birds seen by us at Hanle on July 1, 2001 represent an eastern extension of its range in Ladakh. The recent Willow plantations probably account for the species' range extension.

106. **Streaked Great Rosefinch** ***Carpodacus rubicilloides***

Resident. Sighted only in Changthang. Not uncommon on rocky slopes, scree and plateaux. Occasionally found around army camps/settlements.

107. **Common Great Rosefinch** ***Carpodacus rubicilla***

Resident. Not uncommon. However, rather localized and in smaller numbers than the previous species. Two active and one abandoned nest were found in unoccupied army barracks at Loma in August 2002 (Sangha and Naoroji 2004).

108. **House Sparrow** ***Passer domesticus***

Resident. Quite common around human settlements and plantations in small groups and large flocks. One active nest (adults feeding nestlings) was located in the hollow of a Willow at Diskit on August 20, 2000. At Leh in early September, the ripe wheat crop attracts huge flocks.

109. **Tibetan Snowfinch** ***Montifringilla adamsi***

Resident. Widespread and common in the study area. Near Zingral (*c.* 4800 m) at least nine nests observed on the rocky slopes along the road in 1999. One located near Ney, below the road in the gap between boulders used to build a culvert. It is common around settlements, army and ITBP camps in Changthang.

110. **Rufous-necked Snowfinch** ***Pyrgilauda ruficollis****

Vagrant. Two birds observed on June 23, 2001 at More plains. This represents the first record of the species for Ladakh.

111. **Plain-backed Snowfinch** ***Pyrgilauda blanfordi***

Summer visitor. Br. Locally uncommon in dry sandy areas with stunted vegetation. More than ten birds observed feeding at the northern base of Lenak La on August 16, 2002. Pfister (2001) observed breeding in Pika *Ochotona* burrows and recorded three fledged young in early July 1996. At least five (including a pair feeding young in a nest) were seen near Taglang La on 30 June and 1 July (Robson 1993).

112. **Brahminy Starling** ***Sturnus pagodarum***

? Three observed in Willow plantations of the forest department at Nyoma on June 27, 2001. Pfister (2001) recorded it in early October 1997 at Hanle. The species has been recorded by others as vagrant on various occasions (Otto Pfister, pers. comm.). Williams and Delany (1986) reported it as 'very occasional' during November.

113. **Rosy Starling** ***Sturnus roseus***

Passage migrant. A flock of more than 200 restless juveniles observed between Sumur and Panamik on August 21, 2000. They were feeding on small black berries growing on extensive stands of buckthorn. Eleven were picking insects from a wheat field at Hanle on August 28, 2000. Juveniles observed in Tso Kar by late August and a good number (including a flock of more than 15) in the Nubra valley mostly around Diskit and between Sumur and Panamik (Otto Pfister, pers. comm.)

114. **Eurasian Golden Oriole** ***Oriolus oriolus***

Summer visitor. Br. A pair on July 15, 1999 and another single on September 1, 2000 in Leh. One record also from Changthang (Pfister 2001).

115. **Black Drongo** ***Dicrurus macrocercus***

Vagrant. Encountered only once near Nimu in crop fields on July 1, 1999. Also recorded from Mahe in July. An exhausted individual in the western Hanle plains in October 1997 (Pfister 2001).

116. **Black-billed Magpie** ***Pica pica***

Resident. Widespread and common throughout area surveyed. In western Changthang seen along the Indus up to Chumathang; vagrant further east. Five birds were sighted at Tangtse on July 18, 1999. In eastern Changthang, observed by RKN between 1998 and 1999 once between Mahe and Nyoma and once at Hanle. Observed once at Chushul on 9 June, 1996 (Otto Pfister, pers. comm.)

117. **Hume's Groundpecker** ***Pseudopodoces humilis***

Summer visitor. Br. Occasional in Changthang. However, relatively common and confiding at Hanle, Hanle/Chumur road,

and Chumur. On July 22, 1999 near Pongo, Hanle, five fledged young observed near a stream following adults and begging for food. Five fledged young being fed by adults observed on August 28, 2000 along a verdant valley on Chumur road. Another adult observed taking a dip in the stream and preening. Approaching Chumur on July 1, 2001, two adults were observed digging for larvae on humid grassy bank of a stream.

118. **Red-billed Chough** ***Pyrrhocorax pyrrhocorax***

Resident. Widespread and common throughout the study area. At least four nests located on July 23, 1999 in crevices/holes of the rocky foundations of the Hanle *gompa* (monastery). Osmaston (1927a) found 40 nests located in holes in a sandy cliff near Leh. A flock of more than 150 birds flying to their roost was sighted at Hanle on July 23, 1999.

119. **Yellow-billed Chough** ***Pyrrhocorax graculus***

Resident. Widespread and common throughout the study area but fewer than the previous species.

120. **House Crow** ***Corvus splendens***

Vagrant. Sighted on few occasions in Ladakh during summer of 2001. The observation at Hanle (4240 m) on June 29, 2001 represents the highest altitudinal record for this lowland species (Sangha and Naoroji 2003).

121. **Jungle Crow** ***Corvus macrorhynchos***

? One at Leh on August 24, 2000. Resident mainly in western Ladakh according to Pfister (pers. comm.).

122. **Common Raven** ***Corvus corax***

Resident. Widespread and common throughout the study area — in the mountains, high passes, remote valleys, around villages/towns including Leh. Up to eight at Chumathang on August 25, 2000. Two perched quietly in falling snow at Tanglang La (*c.* 5250 m) on June 23, 2001. Three followed us from the base of Lenak La (*c.* 5000 m) to the top of the pass expecting leftover food on August 18, 2002.

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BREEDING BEHAVIOUR OF THE BLACK-NECKED STORK *EPHIPPIORHYNCHUS ASIATICUS* IN DUDHWA NATIONAL PARK, INDIA[1]

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The breeding behaviour of the Black-necked Stork (BNS) (*Ephippiorhynchus asiaticus*) was studied from mid-September 1996 to mid-January 1997 in Dudhwa National Park (DNP). Observations were made for 749 hours on a single pair of breeding BNS. Both the sexes were engaged in gathering a variety of nest material. Nest material was collected throughout the breeding season, till the juveniles left the nest; dried grasses were collected most (69%) for nest insulation. The parental investment of male and female BNS was not equal. The pair spent almost 15% of its time incubating/resting and this varied significantly in various chick stages. Time spent on this activity was more during the early part of the day. Male and female spent almost equal time feeding their juveniles throughout the breeding season, whereas the frequency of feeding trips between the sexes varied significantly. As the chicks grew, there were changes in the type and amount of food delivered to the chicks. The breeding pair was very aggressive towards conspecifics, mainly to safeguard its nest and the nearby feeding grounds. Unusual competitions were recorded between adult male and female BNS for food on the nest; when one of the parents tried to feed the young, the partner tried to pilfer it. The parents brought water generally during mid-day, than in the morning or evening. Since nothing was known about the breeding behaviour of BNS, this work has revealed much, especially about the parental care and development of young.

Key words: Black-necked Stork, *Ephippiorhynchus asiaticus*, nest site selection, nest materials, breeding, parental investment

INTRODUCTION

The Black-necked Stork (*Ephippiorhynchus asiaticus*) was once widespread throughout south-east Asia and Australia; it has more recently declined in, or been extirpated from most of its world range (Kahn 1987). It has declined steadily in the Indian subcontinent (Rahmani 1989; Maheswaran *et al.* 2004). The Black-necked Storks of tropical Asia and Australia are uncommon throughout most of their range. This species currently ranges from India, Sri Lanka to Australia. In many places, however, populations have reached critically low levels (Dorfman *et al.* 2001). It is a solitary breeder and probably mates with the same partner during successive seasons. Pairs are frequently seen together even outside the breeding season (Kahl 1971). It is a very late breeder in India, starting in September in northern India that coincides with the end of the monsoon and in late November to early December elsewhere (Baker 1938). Except Kahl's (1971) brief study on the breeding biology of this species near Bharatpur, Rajasthan in 1966-67, no major study was undertaken before our study in Dudhwa National Park.

Information on activity pattern (Maheswaran 1998), effects of wading bird abundance on the foraging behaviour (Maheswaran and Rahmani 2001), and foraging behaviour and feeding success (Maheswaran and Rahmani 2002) of the Black-necked Stork are known. However, breeding behaviour, especially parental care of juveniles, is not known. Sundar's (2003) paper on the post-fledgling breeding success and productivity of the Black-necked Stork in an unprotected area of Uttar Pradesh is noteworthy. In 1996-97, out of three pairs, one pair of BNS was observed breeding within the Park. Here we document the breeding behaviour of this pair of adult Black-necked Storks and the type of food offered to the juveniles by the parent birds.

METHODS

Study area: Dudhwa National Park (DNP) is situated on the Indo-Nepal border in the Nighasan *tehsil* of Lakhimpur-Kheri district in Uttar Pradesh, within the *Terai*-bhabar biogeographic subdivision of the upper Gangetic Plain (Rodgers and Panwar 1988). The Park (*c.* 614 sq. km) lies between 28° 18' - 28° 42' N and 80° 28' - 80° 57' E. The Himalayan foothills are about 30 km north of the Park, and the rivers Suheli and Mohana form the natural boundaries of the Park. If the monsoon water level were to decrease, prey would become concentrated in the wetlands. The Forest Department therefore pumps water into the wetlands to maintain the water level primarily for the endangered Swamp Deer (*Recervus duvauceli*), which also benefits the BNS. As

pumped in water is available even during peak summer it maintains the territory and food supply of the BNS. The decreasing water level would have forced most birds to abandon the wetlands. Eight to ten hours supply of water for 10-15 days compensates water loss due to evaporation, facilitating birds such as BNS, egrets and herons. We located a solitary nest of the Black-necked Stork on September 20, 1996 in Kheima-Gauri area of Bankatti Range in Dudhwa National Park, Uttar Pradesh, India. The nest was on a Kheima or Haldu (*Adina cordifolia*) tree at a height of *c.* 20 m. No other tree was present within a radius of 25 m. Tall and short grasses, including *Saccharum munja*, *Imperata cylindrica* and *Desmostachys bipinnata*, surrounded the nesting tree.

Behavioural observations: Since no permission was given to build a hide close to the nest tree, all the observations were made from a hide on the nearest tall tree (23 m) 17 m above the ground. The distance between the hide and the nest tree was 80 m. Observations were made through a spotting scope and disturbance due to the observer was minimal, except when entering the hide. Once we entered the hide, the adult birds remained undisturbed. The nest being almost level with the hide, we could see the type of food the parents offered to the juveniles and sometimes even the exact number of whole fish. Most of the nests of the Black-necked Storks in India were located at 6-25 m above the ground, in trees such as Kadamb (*Acanthocephalus kadamba*), Peepul (*Ficus religiosa*), and Simul (*Bombax malabarica*) (Kahl 1973). The nest which we studied intensively (from September 20, 1996 to January 13, 1997; 116 days) was 120 m from the nearest human habitation (forest post on Indian side) and 140 m from agricultural fields in Nepal, and the breeding pair was habituated to human presence. Observations were made daily from 0600 to 1800 hrs. Observations were not made at night. Data were collected only from mid-September 1996 and the actual egg laying dates were not known, as the adult birds were already on the nest when we reached the site; probably they occupied the old (Hancock *et al.* 1992) nest built by them in the previous year. The nest was *c.* 1.5 m in width, placed on top of a tall tree at a point from which three barren stumps emerged. Eggs and chicks were not measured.

The behaviour of nesting BNS were broadly classified into 13 categories (Kahl 1973). Activities of both the male (having dark brown iris) and the female (having dark yellow iris) were recorded simultaneously when both were on the nest together. Focal animal sampling was used to record the activities, but two different sets of data sheets were used to record activities separately whenever both birds were on the nest. Whenever an adult stork brought any nest materials (mainly for lining or insulation), the type and quantity were recorded, and we termed such trips as the 'Nest Material Trip'. We term 'Wet Grass' as dried grasses soaked in water or drenched in dew brought to the nest by adult storks. Adult storks mostly collected 'Dry Grass' during mid-day. In addition, the time of each nest material trip, weather conditions and the time taken to insert the nest material were also recorded. When the parent storks poured water ('Watering Trip') on the chicks, the amount (less when water-drops dripped and more when water was poured from the bill) and number of drools were also recorded. In case of 'Feeding Trips', the amount (based on the number of full fish and their approximate length compared with bill length of stork) and type (anything other than fish) of food was observed.

Time duration for each activity was recorded with a stop-watch and the percentage of time spent on each activity was calculated with respect to chick stages (Chick Stage 1 (CS1) = 0-10 days old, CS2 = 11-20 days old; CS3 = 21-30 days old, CS4 = 31-40 days old, CS5 = 41-50 days old, CS6 = >51 days old) and the time of day. For our convenience and data analysis, we divided the number of days juveniles were present on the nest into six different chick stages, each spanning ten days; we presume that this does not have any ecological significance. All the percent values were arc-sine transformed, and only on such data were statistical tests performed. The Kruskal-Wallis test was used to determine the time an adult BNS spent on each activity in different months and at different chick stages, and Mann-Whitney U test was used to determine how each activity differed between sexes in different months and chick stages. Statistical packages STATA 5.0 (StataCorp 1997) and SPSS 6.1 (Norusis 1994) were used for data analysis.

RESULTS

Incubation and resting: Adult storks on the nest were observed for 85 days, covering 354 hrs for male and 395 hrs for the female. Both male and female BNS incubated, but the female spent more than 50% of its time for incubation, especially in September 1996 (Table 1). Clutch size was unknown, but three chicks were present in the nest. The first chick probably hatched on October 17, 1996. This was confirmed when parent birds started bringing fish many times during a day from October 19. One chick 10-15 day old died due to unknown reasons; it was later cannibalised (passive) by the adult male. Only 25% of the adults' time was spent incubating the eggs.

Standing and brooding in different chick stages: The pair spent 15% of its time resting and brooding the young and this varied significantly in different chick stages (χ^2=65.055, d.f. 5, P<0.01; Table 2). From September till mid-October adult storks spent almost 50% of their time away

from the nest. Twenty-five percent of the time was spent guarding the nest, by standing at the rim of the nest. The male BNS spent 13.6% of his time in resting; the resting time varied significantly in different chick stages (χ^2=41.309, d.f. 5, P<0.01). Time spent resting was more during the early part of the day, this could be to keep the juveniles warm, when the temperature is as low as 6 °C in December.

The female BNS spent about 17% of her time brooding and resting, which varied significantly in various chick stages (χ^2=25.269, d.f. 5, P<0.01; Table 2). Time spent on this activity was most during 1400-1800 hrs (Table 3). The female spent more time for resting than the male (Z=2.054, P<0.04) during the different chick-stages.

Nesting materials: Both male and female storks left the nest frequently to collect nest materials, but at least one of the parent remained on the nest until all the juveniles became independent. Often parents returned with only nest materials (Table 4), on a few occasions (n=5), however, food and water was brought with the nest material. Both sexes were observed engaged in nest material gathering and placement of collected materials independently, however, on two occasions they were seen arranging the nest material together.

The storks spent 10.4% of their time to bring nest materials, which included dry twigs, grasses, green leaves/ plants, cloth and polythene scrap. Rarely did they bring any greenery, and if so only the green veins of *Telliacora acuminata* (which normally do not have much leaves), besides small branches of other unidentified green plants. The Black-necked Storks mostly used dry grasses (Table 4) composed within a radius of 100-300 m for nest insulation. The frequency of nest material trips varied greatly during different times of the day (Table 5).

Feeding the chicks: As the chicks (n=2) grew, they adopted begging posture; the begging calls were clearly audible at a distance of 80 m. The hungry juveniles raised begging calls immediately after the parents arrived at the nest. When the chicks grew bigger they consumed more food, this

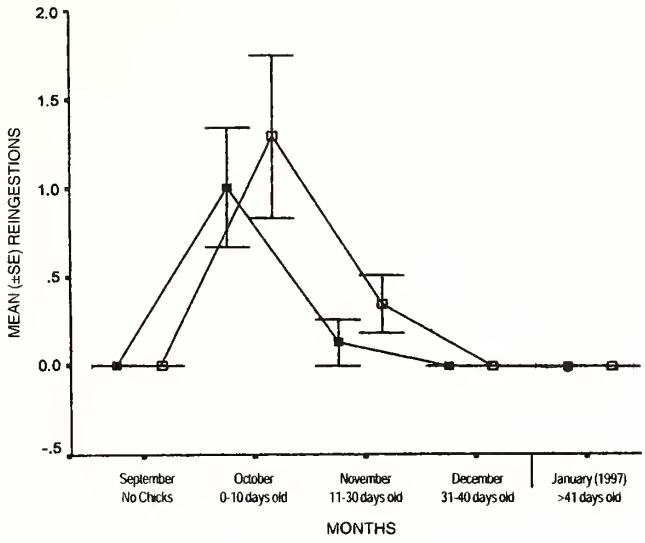

Fig. 1: Number of reingestion trips made by male (empty square) and female (solid square) Black-necked Stork in different months

Table 1: Percent time spent on various activities by the male and female Black-necked Storks during the breeding season (1996-1997) in Dudhwa National Park.

Activity	September*		October		November		December		January		Overall	
	M	F	M	F	M	F	M	F	M	F	M	F
Bill clatter	0	0	0.20	0.52	0.02	0.37	0.04	0.26	0.30	1.07	0.14	0.02
Chick maintenance	0	0	9.82	2.17	0	0	0	0	0	0	6.60	0
Defecation	0	0	0.90	0	2.61	0.55	0.02	0.84	0	0	1.20	0.21
Feeding the chicks	0	0	5.40	6.93	5.38	2.83	2.57	9.17	13.6	9.97	4.39	4.60
Away from nest	51.7	0	20.9	0	26.4	4.90	40.3	3.17	41.3	0	26.6	25.3
Nest arrangement	0	0	5.21	2.78	2.33	1.84	0.28	1.33	0.26	0.21	3.61	7.15
Bringing nest material	0	0	17.8	7.31	2.67	5.64	2.54	6.25	0.75	0.47	12.0	8.71
Preening	0	0	6.74	10.6	18.5	11.8	11.6	7.27	8.86	34.8	9.39	13.7
Re-ingestion	0	0	1.51	1.74	0.03	0.51	0	0	0	0	1.02	0.34
Standing/brooding	28.1	48.8	17.0	32.6	25.8	34.9	13.4	42.4	28.5	20.7	17.24	16.7
Incubating/resting	19.8	50.6	13.7	33.8	6.76	31.4	25.8	27.9	6.28	15.0	13.6	17.1
Wing stretching	0	0	0	0	5.85	3.24	3.26	1.41	0.10	0.48	2.53	3.02
Watering	0.26	0.62	0.66	1.43	1.74	1.21	0	0	0	0	0.81	2.98
Yawning	0	0	0	0	1.78	0.76	0.08	0	0	17.2	0.68	0.04

* - September till mid October was the incubation period.
Zeros represent no time spent on that particular activity by storks. (Male = 354 h; Female 395 h of observations)

was also evident from the reduced number of re-ingestions made by adult storks recorded during the breeding season (Fig. 1) and chick stages (χ^2= 17.20, d.f. 5, P<0.04). The parents regurgitated the food they brought onto the nest floor whether or not the chicks were begging for food. The juveniles preferred to consume bigger fish, followed by smaller ones. Fish were swallowed whole without being mutilated in about 2-6 seconds, depending upon the size of the fish.

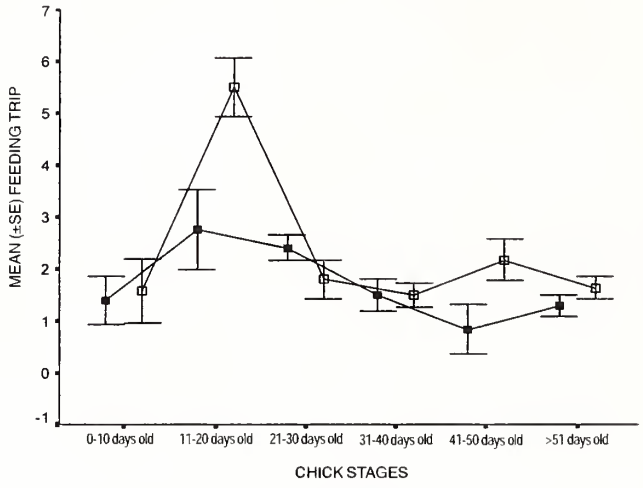

Fig. 2: Number of feeding trips made by male (empty square) and female (solid square) Black-necked Stork in different chick stages

Combined together, the pair spent 4% of its time feeding the chicks. However, the male spent 5% of its time and this differed significantly in different chick stages (χ^2=21.612, d.f. 5, P<0.01). The male fed the chicks more during the early part (0600-1000 hrs) of the day and the second peak was from 1400-1800 hrs (Table 3). The frequency of parents feeding the juveniles in different chick stages is given in Fig. 2. The female stork spent 4.6% of her time feeding the chicks, and this did not differ significantly among different chick stages. She fed the chicks most during 1000-1400 hrs (Table 3). The male fed the juveniles more and a greater number of times than the female, this was evident from the percentage time away (presumed to be foraging) from the nest, which was more for the male than female (Z= -2.012, P<0.04).

Watering: The pair under study spent about 2% of its time watering the chicks. This activity varied significantly in different chick stages (χ^2=19.095, d.f. 5, P<0.01). The frequency of watering trips by the male, in different chick stages, is given in Fig. 3. Even though the number of drools made by both the sexes was almost equal, the male poured more water over the eggs and chicks. The male stork made more watering trips during 1000-1400 hrs (Table 3), especially during September and October. The storks maintained the nest temperature at an optimum level and whenever there was an increase in the mean temperature they poured water over the

Table 2: Activities of male and female Black-necked Stork during different chick stages recorded during the breeding season in Dudhwa National park

Activities	Chick stages											
	CS1*		CS2		CS3		CS4		CS5		CS6#	
	M	F	M	F	M	F	M	F	M	F	M	F
Bill clattering	0.30	0.42	2.71	0.60	0.04	0.36	0.03	0.32	0.04	0.46	0.07	0.75
Defecation	0	0	0.06	0	5.52	0.62	0.05	0.65	0	0.47	0.02	0.86
Feeding the chicks	6.3	6.20	5.29	5.63	9.20	1.30	1.95	0.80	1.84	0.49	3.96	9.06
Away from nest	18.2	0	42.2	9.95	55.7	0	17.3	0	46.1	0	40.4	2.88
Nest arrangement	8.2	2.47	0.48	1.56	1.8	3.89	3.42	1.46	2.3	1.43	0.06	0.90
Bringing Nest material	17.8	6.15	4.85	3.56	0.23	1.97	0.93	9.90	0	9.67	0.18	18.4
Preening	6.14	7.87	10.7	19.8	1.40	11.7	8.49	11.8	31.8	3.53	11.7	6.42
Re-ingestion	2.11	1.39	1.08	1.63	0	0	0	0	0	0	0	0
Standing/guarding	14.3	27.9	16.7	38.2	11.3	53.1	44.6	40.3	11.5	29.2	13.7	35.7
Resting	9.79	29.0	15.7	16.3	1.84	24.2	12.9	32.6	6.43	46.8	26.4	23.3
Wing stretching	0	0	0.04	0.88	5.5	1.25	10.1	1.29	0	7.96	3.38	1.13
Watering	0.81	0.98	0.03	1.86	3.68	1.55	0	0	0	0	0	0
Yawning	0	0	0.05	0	3.7	0	0.10	0.87	0	0	0.08	0.64

CS1= 0-10 days old, CS2= 11-20 days old, CS3= 21-30 days old, CS4= 31-40 days old, CS5= 41-50 days old, CS6= >51 days old.

* = begins on October 20, 1996 (post-incubation period); # = Till January 13, 1997

eggs or chicks.

The female BNS spent 3% of her time watering, and this differed for different chick stages (χ^2=14.624, d.f. 5, P<0.01). The female stork made more watering trips during 1000-1400 hrs (Table 3). Time spent by the male and female BNS for watering did not differ significantly (Z=1.700, P>0.08) throughout the breeding season.

The male was seen to drool more water than the female. The Mann-Whitney U test result shows that frequency of drools did not differ significantly (Z=0.941, P>0.34), but as mentioned above, the quantity of water in each drool varied between the sexes. However, this could not be quantified for any statistical tests. On cloudy days (especially in November and December) there were no watering trips.

DISCUSSION

As a monogamous species, both sexes of Black-necked Storks should have spent almost equal amount of time (Trivers 1972) to care for their juveniles. The female spent more time for incubation and nest guarding than the male, whereas the male fed the juveniles more and made more feeding trips than the female. However, the total time spent for feeding the juveniles remained equal for both the sexes. According to Hancock and Kushlan (1984), the level of investment may be influenced by factors such as parent-offspring relatedness, age, number of chicks, condition of parent and offspring, and season.

Table 3: Percentage time spent on different activities by male (n=354 h) and the female (n=395 h) Black-necked Stork according to time of day recorded during breeding season in Dudhwa National Park

Activities	Time of day (hrs)					
	0600-1000		1000-1400		1400-1800	
	M	F	M	F	M	F
Bill clattering	0.02	0.02	0.04	0.03	0.009	0.004
Defecation	0.06	0.00	0.02	0.006	0.04	0.07
Feeding the chicks	0.97	0.48	0.25	1.60	0.36	1.15
Away from nest	55.1	68.5	34.5	52.3	64.6	44.6
Nest arrangement	0.75	0.80	1.58	0.07	0.10	0.73
Bringing nest material	2.35	1.08	0.63	1.23	0.67	1.51
Preening	4.67	4.03	3.72	4.27	3.55	4.97
Re-ingestion	0.28	0.13	0.03	0.07	0.05	0.15
Standing/guarding	20.1	14.4	48.2	26.6	22.5	31.6
Incubating/resting	15.5	9.93	10.2	13.4	7.05	14.3
Wing stretching	0.009	0.009	0.08	0.10	0.08	0.47
Watering	0.009	0.13	0.04	0.21	0.00	0.05
Yawning	0.03	0.03	0.46	0.003	0.95	0.02

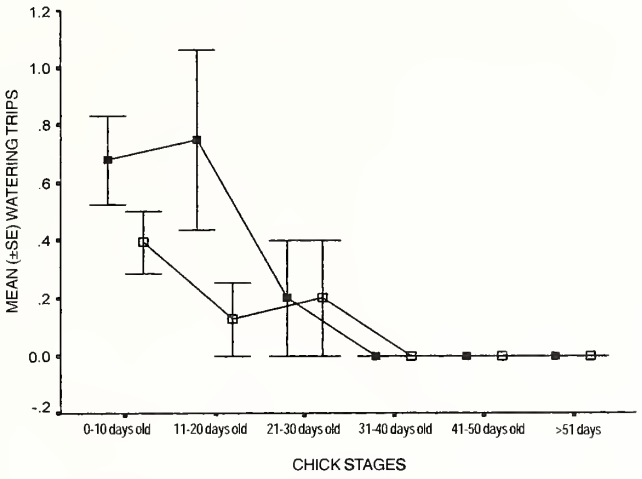

Fig. 3: Number of watering trips made by male (empty square) and female (solid square) Black-necked Stork during different chick stages

Birds may select a tree for nesting by looking at the tree structure and its proximity to feeding sites and human disturbances, so that no predator can easily access the nest. It appears that availability of food is the prime factor among breeding BNS in Dudhwa while selecting the nest site. Uninterrupted food supply from the nearby wetlands during the breeding season helps the BNS protect the nest/juveniles from predators as it can stay at the nest for longer periods. Once this is assured, the storks select the trees for the nest (Maheswaran 1998). Black-necked Storks (especially the study pair) in Dudhwa built their nest on a tall *Adina cordifolia* tree, situated amidst tall grassland habitat where no other nests of big birds were present. Large Ciconiiformes are not likely to nest in dense or low vegetation (Burger 1978).

Nest material, especially the lining, was brought separately by male and female Black-necked Storks throughout the incubation and brooding periods in DNP; similar behaviour has been reported among Maguari Storks

Table 4: Frequency of trips for nest materials made by male and female Black-necked Stork during the breeding season

Month	Nest materials			Sex	
	Wet grass**	Dry grass	Others*	M	F
October 1996	3	17	10	20	10
November 1996	4	65	22	27	64
December 1996	7	21	1	3	26
January 1997#	-	4	1	2	3

** = Dry grass soaked in dew/water
* = Dried twigs, polythene papers
# = Parents stopped collecting nest materials on January 6, 1997. Juveniles left the nest for the first time on January 10, 1997.

in Venezuela (Thomas 1986). Both the storks were rarely seen arranging the nest materials together. On the contrary, in Little Blue Herons (*Florida caerulea*) the nesting materials were gathered exclusively by the male and were given to the female who arranged the sticks in the nest (Werschkul 1982). Every year with permission of the Forest Department, local villagers cut grass for thatching after which the uncut grasses were burnt. We observed that these activities did not affect the breeding storks adversely, except for forcing adult birds to skulk in the nest for a while until all the people had left the area.

Green veins of *Telliacora acuminata* (which are not very leafy) were used mainly to secure loose sticks. In the early stages of nest building we could not see what material the adult birds brought in for nest insulation. Throughout the breeding season, the ambient temperature remained below 15°C, especially in the morning till 1100 hrs. BNS therefore used readily available dried cut grasses as nest insulation, to maintain the internal temperature. Studies on the insulation properties of Wood Stork (*Mycteria americana*) nests indicate that clean nests could maintain the surface temperature of eggs/nest only 1.5-2.5°C above the ambient temperature during evening hours (Rodgers *et al.* 1988). Three experimental nests of Wood Stork in the United States with greenery exhibited higher insulation properties, especially in the intact and dried greenery nests (Rodgers *et al.* 1988), irrespective of the time of the day. This was contradictory to BNS in Dudhwa, which mostly used dry grasses. But often we had seen storks collecting dried, but water-soaked grasses from nearby during the sunny part of the day. This behaviour was observed on October 1, 1996; we presume that the female stork might have laid the eggs either on that day or within the next two days.

According to Rodgers hypothesis, a nest with fresh greenery had higher insulation value especially during the early morning hours. This may be due to the initial higher water content of the fresh greenery and resultant greater heat transfer through evaporation. The energy cost in procuring greenery was more than that of collecting dried grasses for BNS. Furthermore, the dried and cut grasses were available abundantly and close to the nest. Nest insulation depends on the materials used in nest construction, which depends on availability (Whittow and Berger 1977; Skowron and Kern 1980; Rodgers *et al.* 1988). Since BNS is a big (*c.* 6 kg) bird and cannot lift off suddenly with a huge load of greenery, to reach the nest situated on top of a 20 m high tree, it probably preferred dried grasses that have less weight. Similar preference for dry over fresh vegetation has also been reported among Great Tit (*Parus major*) (Mertens 1977). The availability and preference in terms of nest materials' usefulness determined the selection of nest insulation materials among BNS in Dudhwa National Park.

Table 5: Number of nest material trips made by parent Black-necked Storks

Month	Time of day (hrs)					
	0600-0800	0800-1000	1000-1200	1200-1400	1400-1600	1600-1800
October 1996	1	14	6	0	3	0
November 1996	14	40	4	0	5	25
December 1996	0	17	2	0	0	17
January 1997	0	2	1	0	0	4

Watering and nest material trips may have been combined with food trips to reduce the energy loss when storks go for such trips separately. By combining such trips, BNS also stayed with the juveniles longer, to give them protection. Trees are scarce and isolated in the grasslands of DNP, and thus the visibility was good for adult BNS. This probably helped the birds to detect and avoid predators. On two occasions, the BNS pair was seen chasing away the intruder (intraspecies) with great determination, even leaving the nest with eggs alone for a few minutes. Black-necked Storks are more aggressive towards intraspecifics during the breeding season, mainly (1) To protect the nest for the future, as BNS tend to use the nest year after year. If another stork identifies the nest, it may come and occupy the same in the next season. (2) As BNS prefers to build nests close to a good food source, it is possible that by identifying the nest of BNS, other birds with similar food preferences can exploit the food sources.

Approximately two days after the chicks had hatched, we saw the male BNS feeding on fish taken from the nest floor. One of the parents must have deposited these fish during the night. It appeared that, immediately after egg hatching, the adults start bringing food to the juveniles in spite of them being very young and not able to consume all the food.

Both male and female storks spend almost equal amount of time in feeding their young ones throughout the breeding season, but the amount varies. It was observed among Intermediate Egrets (*Mesophoyx intermedia*) that the number of feeding visits to the nest and the amount of food boluses regurgitated were in direct proportion to the number of chicks being fed (McKilligan 1990). The quantity and size of food brought by parent storks depended greatly on the age of their nestlings, as Kahl (1964) has reported in Wood Storks. Even though there was not much difference between the time spent by the male and female BNS for feeding the chicks, the frequency of feeding bouts varied significantly. This was

further evident from the change in the feeding bouts during the different chick stages. This difference might largely be due to the feeding success of the foraging BNS (Maheswaran and Rahmani 2002) in Dudhwa National Park. Among BNS, males were more successful in procuring food than the females. During the breeding season, the male BNS explored more wetlands situated in far off places than the female, and this was confirmed when the male was observed going very far from the nest and returning very late, sometimes 6-7 hours later. But, we did not observe the adult storks' foraging behaviour during breeding season. The female may have re-ingested less food during mid-day. This was due to the increase in consumption of food by the growing juveniles. The female fed the chicks with less food than the male; the regurgitated food was completely or mostly consumed by the juveniles. In the early stages, when chicks were not able to eat all the fish, the parents re-ingested it and offered it later in the form of a bolus. However, more studies on different nests either simultaneously or during different years are needed within Dudhwa.

Availability of food (Kahl 1964; Clark 1979) and ability of the parents to provide adequate food to their chicks (Coulter and Bryan 1995) affect the reproductive success of ciconiiform birds. In Dudhwa, immediately after monsoon (when water starts drying) all the ponds were full of fish, which supported all fish-eating birds including BNS (Maheswaran and Rahmani 2001). Some long-legged wading birds had the greatest reproductive success or began breeding in large numbers during years with faster drying rates than in years with slower drying rates (Kushlan *et al.* 1975). The male fled the nest and often stayed away from the nest longer to get enough food for himself, besides collecting food for juveniles. His tendency to feed the juveniles more than the female must have compelled the bird to stay away (foraging) from the nest for longer periods on a few occasions. The optimum level of parental investment can be determined by the reproductive value of the brood (Houston and Davies 1985; Moller 1986) and the survival chances of the parent and the young at the given level of parental effort (Chase 1980; Houston and Davies 1985; Sargent and Gross 1985; Winkler 1987). As a large wading bird, BNS requires considerable quantity of food, especially during the breeding season, for successful breeding. Low food intake is particularly critical for fish-eating birds because of their load of symbiotic gastric nematodes, which attack the host when food consumption is reduced (Kushlan 1974).

We found that the parental investment of the male and female BNS was not equal. According to Aguilera (1990), among White Spoonbills *Platalea leucorodia*, males generally were absent from the colony at night (presumably foraging), while females attended to the nests. Yet there may be differences in the optimal level of investment for each partner (Trivers 1972). Sometimes there appeared to be competition for food between the male and female on the nest, but the reason for which was not clear. During the chick-rearing period, the competition for food grew at the nest, and even hungry juveniles did not get enough food.

The main reason for juveniles not getting enough food even when the parents were present on the nest could be the adult's unwillingness to offer food, fearing that the other partner would pilfer it. Only on a few occasions (n=12) did juveniles get food when both parent birds were present at the nest. When the chicks became older and started consuming more food, responsibility of parents to find food increased and this led to the competition between them. The ravenous juveniles had to stay on the nest for hours together without food. Further study is needed to determine if this observed tendency of storks could be one of the reasons for the declining population throughout their distributional ranges, apart from habitat alteration. Reductions in potential habitats leave storks with less food, resulting in severe competition among the adults, sometimes forcing them to avoid breeding. In three years we could see only one pair (out of three) breeding within Dudhwa National Park, that too only in 1996. Why the other two pairs did not breed within the Park can only be clarified by carrying out detailed long-term studies.

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NEW DESCRIPTIONS

A NEW SPECIES OF *PTERIS* L. (PTERIDACEAE: PTERIDOPHYTA) FROM WESTERN GHATS OF SOUTH INDIA[1]

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A new species of the genus *Pteris* from the Western Ghats ranges of Karnataka and Tamil Nadu is described and illustrated.

Key words: *Pteris manickami*, *Pteris* L., Pteridaceae, Western Ghats, South India

INTRODUCTION

Pteris Linn. is a pantropical, warm temperate genus with about 280 species (Copeland 1947). Holttum (1954) included 250 species in this genus, while Tryon and Tryon (1982) accredited only 200. In India, about 50 species are known (Dixit 1984). Manickam and Irudayaraj (1992) have recorded about 15 species in the Western Ghats, South India. The new species *Pteris manickami* distinctly varies from all the other 50 Indian species and particularly the allied species *Pteris confusa* T.G. Walker (RHT 32560, 32632, 32698).

Pteris manickami is exceptional in having the basal-most pair of pinnules or lobes reduced in all the pinnae.

Pteris manickami sp. nov.
(Fig. 1)

Description: Rhizomate erecto, stipitibus 20-65 cm longis, stramineis; laminis obscure viridis, late ovatis, 56 cm longis. Pinnae usque ad 20-25 pares, subsessiles, oppositae. Pinnae pinnatifidae, ad 2/3, Pinnae maximae 12 x 4 cm, oblongae cum 12 to 20 paribus loborum, lobae basalis, par deminuta, costa et nervatum hirsutae sparsim infra pinnam, margo cum pilis, dispersis. Venis liberis 9-15. Sporae tetrahedro - globosis, *c.* 46 µm in diametro. Sporae abortivisque intermixtis.

Rhizome erect, stipe 20-65 cm long, stramineous. Lamina green, ovate, 56 cm long. Pinnae 20-25 pairs, subsessile, opposite. Pinnae pinnatifid, lobed 2/3 to the costa. Pinna 12 x 4 cm maximum size, oblong with 12 to 20 pairs of lobes. Basal-most pair of lobes reduced. Costa and margin of the lobes sparsely hairy. Veins free, 9-15 pairs. Spores tetrahedro - globose, *c.* 46 µm in diameter. Spores aborted and intermixed.

Holotype: Devigar - Nagarigar path, Karnataka state, 900-1,200 m, 27.xii.1992, Manickam, XCH 2942.

Paratype: Maramalai hills, Tamil Nadu state, 700-1,100 m, 10.i.1998 Rajkumar, XCH 3715.

Etymology: The specific epithet honours Rev. Dr. V.S. Manickam, S.J., a pioneer in South Indian ferns, who was instrumental in establishing the St. Xavier's College Herbarium (XCH), one of the largest herbaria in India for ferns, with about 40,000 specimens.

Fig. 1: Bipinnate frond of *Pteris manickami* Rajkumar sp. nov. showing reduced basal-most pair of pinnules in all the pinnae

ACKNOWLEDGEMENTS

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PARASITIC WASPS OF THE GENUS *EUPLECTRUS* WESTWOOD (HYMENOPTERA: EULOPHIDAE) FROM INDIA[1]

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Four new species of the genus *Euplectrus* Westwood namely *E. pantnagarensis*, *E. dubeyi*, *E. viggianii* and *E. longiscapus* are described and illustrated. A key to some Indian species has also been framed.

Key words: Hymenoptera, Eulophidae, *Euplectrus longiscapus* sp. nov., *E. pantnagarensis* sp. nov., *Euplectrus dubeyi* sp. nov., *E. viggianii* sp. nov.

Genus *Euplectrus* Westwood

Euplectrus Westwood 1832, *Phil. Mag. 3*: 128. Type species: (*Euplectrus maculiventris* Westwood) = *Pteromalus bicolor* Swederus; by monotypy.

Diplectron Dahlbom 1857, 292. Synonymy by Gahan & Fagan 1923. Type species: *Pteromalus bicolor* Swederus, by designation of Gahan and Fagan 1923.

Pachyscapha Howard 1897: 159. Synonymy by Peck 1951. Type species: *Pachyscapha insularis* Howard; by monotypy.

Rekabia Cameron 1904: 65. Synonymy by Kerrich 1974. Type species: *Rekabia testaceipes* Cameron, by monotypy.

Heteroscapus Brethes 1918: 9. Synonymy by De Santis 1981. Type species: *Heteroscapus ronnai* Brethes, by monotypy.

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Diagnosis: Genus *Euplectrus* was proposed by Westwood (1832) with the type species *E. maculiventris*. The genus can be easily distinguished from other allied genera by the following combination of characters: scutellum without longitudinal grooves, which has mostly rather fine sculpture or is almost smooth; pronotum, rather short, dorsally with a fine transverse carina; hind tibia with at least one spur distinctly longer than basitarsus, thorax mostly with outstanding long bristles, funicle always segmented in female (Boucek 1988).

Discussion: The genus *Euplectrus* belongs to tribe Euplectrini, subfamily Eulophinae. It stands close to the genera *Euplectromorpha* Girault but differs from it in the above-mentioned diagnostic characters. The structure of propodeum in *Euplectromorpha* with two strong submedian carinae behind a distinct basal cup or, if latter is extended, with H-shaped carinae further separate the two genera. All recent workers have considered the genera *Diplectron* Dahlbom, *Pachyscapha* Howard, *Reckabia* Cameron and *Heteroscapus* Brethes to be synonyms of *Euplectrus* Westwood. Kerrich (1974) synonymized the genus *Rekabia* Cameron with *Euplectrus* Westwood. The distinguishing characters of the genus as proposed by Nikol'skaya (1952); Peck *et al.* (1964) and additional generic characters of pronotum, female genitalia and subgenital plate as proposed by Khan and Shafee (1980) apply well to the present species.

Recently, Wijesekara and Schauff (1994) revised the genera and species of the tribe Euplectrini (Eulophidae) and described eight *Euplectrus* species as new, namely *E. atrafacies*, *E. colliosilvus*, *E. geethae*, *E. itoralis*, *E. mellocoxus*, *E. nibilis*, *E. peechansis* and *E. xanthovulatus*. They transferred five species previously placed in this genus to other euplectrine genera as follows: *E. flavescens* Crawford = *Aroplectrus flavescens* (Crawford) comb. nov.; *E. phillippinensis* Ashmead = *Platyplectrus phillippinensis* (Ashmead) comb nov.; *E. rugosus* Crawford = *P. rugosus* (Crawford) comb. nov.; and *E. japonicus* Ashmead = *P. japonicus* (Ashmead) comb. nov. They also removed *E. ornatus* from *Euplectrini* and placed as *Cirrospilus ornatus* (Mukherjee) comb nov. (in Eulophinae).

Biology: Primary gregarious ectoparasitoids of caterpillars.

Distribution: Occurs in all biogeographical regions. Boucek (1988) estimated the number of species to be about 100. Most species are probably in the tropics. There are 12 species each in Australia and North America while 16 species are recorded from India.

Abbreviations used: FS1, FS2, FS3 and FS4 funicular segments 1-4; OOL- oculo-ocellar length, distance between lateral ocellus and eye margin; POL- postero-ocellar length, distance between lateral ocelli; MV- marginal vein; PMV- postmarginal vein; SMV- submarginal vein; SV- stigmal vein.

KEY TO SOME INDIAN SPECIES OF THE GENUS *EUPLECTRUS* WESTWOOD

1. All legs, including their coxae uniformly coloured yellow or white 2
— Legs with differential colour black, brown, reddish brown, light brown or a combination of these 10
2. Pedicel armed with bristles 3
— Pedicel without any bristle 7
3. Pedicel with 5 long bristles, entire face dark brown, antennae light brown, scape about 7 times longer than wide, pedicel dark brown, club 2-segmented ..... *E. pantnagarensis* sp. nov.
— Pedicel not more than 2 stout bristles, entire face black; scape less than 7 times longer than wide 4
4. Pedicel with 2 stout bristles 15
— Pedicel with only 1 bristle. 5
5. Vertex shallowly and closely punctate face very finely and obscurely punctate; POL more than 3 times as great OOL; prominence between antennal toruli distinctly more than one-third the width of frons between eyes; antennal scape pale white, rest of the antennal segments hyaline light brown; only one very narrow anellus present; scape 3 times as long as wide, funicle segments subequal about 2 times as long as broad; club unsegmented, distinctly shorter than preceding 2 funicle segments combined, mesoscutum strongly, rugulosely punctate anteriorly, the punctures not very well defined and virtually coalescent; scutellum and axillae minutely and shallow punctate; gaster mostly white except for a discontinuous centrally interrupted pale brown band apically, laterally and at the extreme base brown ..... *E. maternus* Bhatnagar
— Vertex and face smooth, without punctuation; POL and OOL almost equal in length; prominence between antennal toruli slightly less than one-third the width of frons between eyes; scape uniformly white, pedicel, anelli and first 2 funicle segments yellow, rest of the flagellum infuscated; only two anelli present; scape 5 times as long as wide; FS1 longest, almost 1.5 times as long as wide, funicle segments 2-4 sub-equal in size; distinctly longer than wide; club 2 segmented longer than preceding 2 funicle segments together; thorax smooth without punctation; gaster dark brown except a white patch on middle of dorsum ..... *E. longiscapus* sp. nov.
6. Scutellum uniformly punctate; or punctate in the middle. ... 7
— Scutellum not likewise smooth 8
7. Gaster yellow above, with only the sides and a more or less complete transverse band before the end brown, antennae slightly brown at tip; ocelli very large; the lateral ocelli close to the eye margins than to the front ocellus, pubescence, whitish, funicle segments not sub-equal in length; scutellum uniformly finely longitudinally striate; propodeum smooth; petiole slightly broader than long ..... *E. leucostomus* Rohwer
— Gaster black with a large yellow spot, without any transverse band; antennae uniformly yellowish white without infuscation at tip; ocelli small, widely separated from the eye margins; the OOL two-third as long as the POL; pubescence brown; funicle segments sub-equal in length; scutellum finely reticulate medially, reticulate lineate laterally; propodeum shining median furrow distinct, complete, petiole granular, longer than wide ..... *E. euplexiane* Rohwer
8. Pedicel slightly longer than broad; gaster yellow with a transverse strip before the end, line on the sides of the second segment and the petiole brown; vertex almost smooth, cilia very scattered; antennae with scape rather short, not reaching to the median ocellus; funicle thicker, funicular segments subequal in length ..... *E. parvulus* Ferriere
— Pedicel 2 times or about 2 times as long as wide and other character different 9
9. Gaster black with a rounded yellow spot; antennae brown, scape and pedicel yellow; vertex smooth; ocelli rather large, the lateral ocelli at about the same distance from the median ocellus as from the eye margins; scape narrow and elongate, but not reaching to the level of median ocellus; mesoscutum finely reticulate, without median carina, scutellum smooth; MV a little longer than the SMV; the longest hind tibial spur not quite as long as the first 2 tarsal joints together, petiole smooth, elongate, almost 3 times as long as broad ..... *E. petiolatus* Ferriere
— Gaster yellow above, slightly more orange-yellow at tip, only 2 lines on the sides at base and the petiole black; antennae orange-yellow, brown towards tip, scape light yellow; pronotum very short; mesoscutum with irregular transverse striate; scutellum finely reticulate. ..... *E. coimbatorensis* Ferriere
10. Pedicel distinctly longer than FS1 11
— Pedicel not likewise as long as or shorter than FS1 12
11. Gaster reddish brown in the middle; ocelli dark reddish brown; POL almost equal in length to OOL; malar space very long, almost 2 times the eye width; antennae dark brown except scape, pedicel and the anellus reddish brown, an anellus present; scape about 4 times as long as wide; funicle segments subequal in size; club unsegmented, equal to ½ of the preceding 2 funicle segments; mesoscutum and scutellum shallowly and closely punctate; the longer hind tibial spur distinctly longer than the

length of basal 2 tarsal join together ..... *E. spodoptera* Bhatnagar

— Gaster dark brown with metallic bluish reflections on the dorsum; ocelli white; length of POL almost 2 times as much as OOL; malar space longer than eye width; antennae yellow with slight infuscation except scape uniformly white; three anelli present; scape slightly more than 5 times as long as wide; funicle segments gradually increasing in width distad; FS1 as long as FS2, FS3 shortest, a trifle longer than wide FS4 quadrate; club three segmented; almost as long as preceding two funicle segments together; mesonotum and scutellum without punctations; longest hind tibial spur shorter than the basal two joints together ..... *E. viggianii* sp.nov.

12. Pedicel shorter than FS1 13

— Pedicel as long as FS1 14

13. Scape white, segment of funicle unequal; hind coxae completely black ..... *E. bussyi* Crawford

— Scape brown, segments of funicle subequal; hind coxae black basally and reddish brown apically; body black except below antennae light brown and gaster with a light brown patch in the middle; vertex and face very finely and closely punctate, in low power appears to be met with fine grains; antennae brown except scape yellowish white; 2 anelli present. ..... *E. mathuri* Bhatnagar

14. Mesoscutum coarsely reticulate medio-posteriorly, finely and lineately shagreened anterio-laterally, without a median line or furrow; head without punctures; scutellum faintly longitudinally striate; funicle segments gradually increasing in length, the FS4 somewhat shorter than FS3, club entire ..... *E. utethesiae* Mani and Kurian

— Midlobe of mesoscutum reticulately rugose, at rear medially with 1 or 2 longitudinal rugae, which extend forward about one-third the length of mesoscutum; scutellum basally indistinctly reticulate ..... *E. nyctemerae* Crawford

15. Light brown with white scape, and pedicel; gaster light yellow except tip, sides and petiole black; petiole rather long, 2 times as long as broad or little less, longer spur of hind tibia reaching 0.66 the length of first two tarsal segments together. ..... *E. ceylonensis* Howard

— Yellowish brown antennae except scape white with infuscation, gaster dark except with a broad yellow patch on mid dorsum before apex petiole short as long as wide, longer spur of hind tibia equal to the length of first two tarsal segments together. ..... *E. dubeyi* sp. nov.

Euplectrus pantnagarensis sp. nov.

(Figs 1-11)

Female: Dark brown; head lustrous dark brown, eyes reddish brown; antennae light brown; thorax dark brown with purplish reflections; wings hyaline; legs yellow; gaster dark brown.

Head (Fig. 1): Smooth except upper part of the frons very finely reticulate; wider than long in facial view (0.58: 0.43), frontovertex less than 3 times wider than long (0.36: 0.19), ocelli arranged in obtuse angled triangle; POL: OOL 0.10: 0.11; antennal toruli just at the lower level of eyes, distance between antennal toruli situated (0.08) more than 1/4th the width of frons; malar sulcus absent; length of malar space (0.19) much more than the eye width (0.11); maxillary palp and labial palp two and one segmented respectively. *Antennae* (Fig. 4): Scape cylindrical, apex of scape reaching up to the median ocellus, about 7 times longer than wide (0.25: 0.035), pedicel dark brown, short, more than 2 times longer than wide (0.09: 0.035), 2 anelli present; funicle 4 segmented, subequal in size except the FS1 short (0.13: 0.55), numerous sensilla and hairs present.

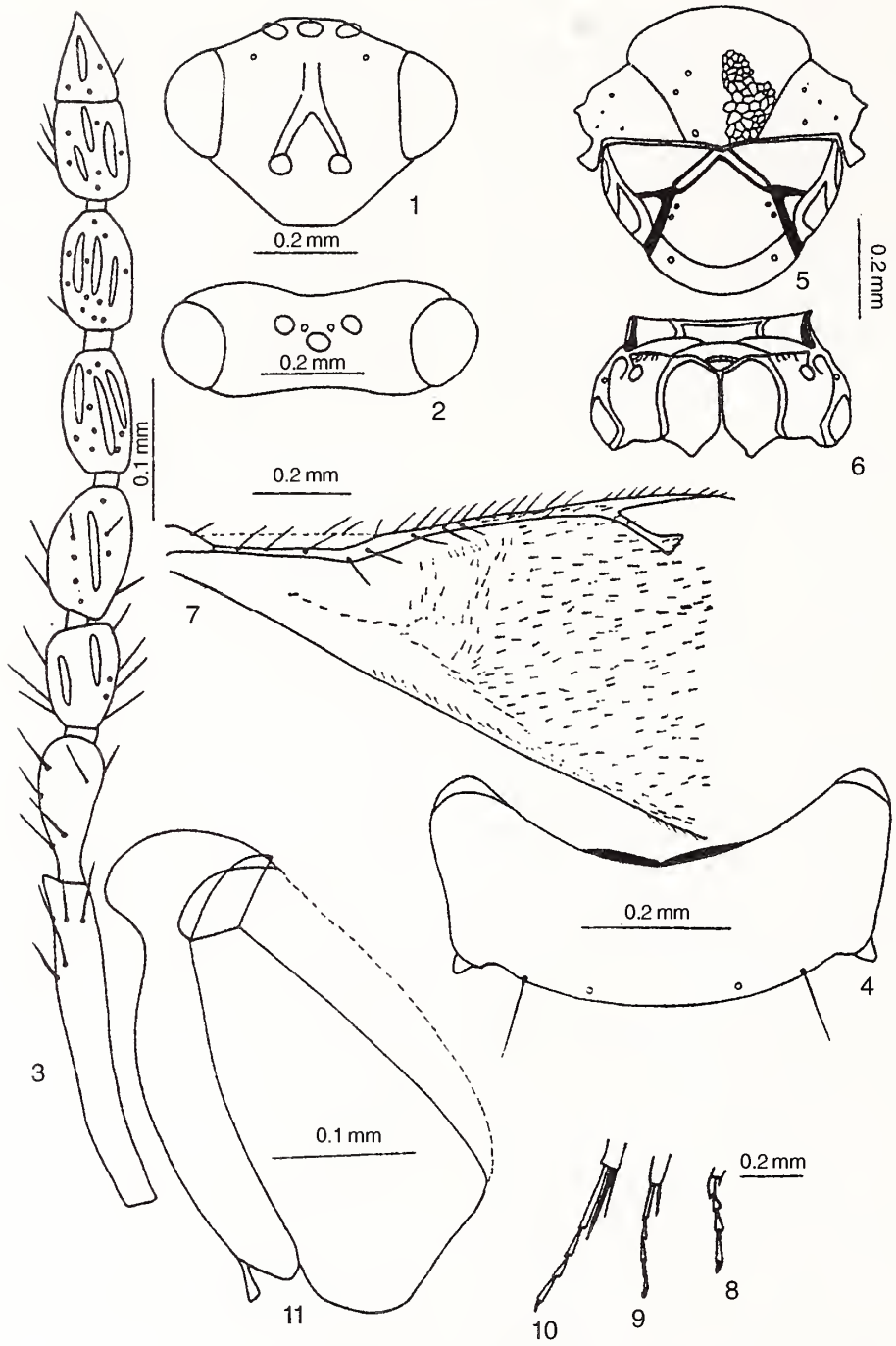
Thorax (Fig. 5): Pronotum reticulate and deeply notched at the anterior margin, posterior margin convex with 2 pairs of long setae (Fig. 6), mesoscutum more than 2 times wider than long (0.59: 0.28) with 6 pairs of setae, midlobe coarsely and strongly reticulate, scutellum smooth; axillae triangular and weakly reticulate, scutellum slightly wider than long (0.31: 0.16) with blunt apex, metanotum, band like, propodeum expanded on sides, median and submedian carinae and plicae prominent, sides of the propodeum with 3 long setae. *Forewings* (Fig. 7): more than 2 times longer than wide, SMV long (0.34) with 5 long setae, MV much longer (0.51); PMV longer than SV (0.21: 0.15), costal cell narrow, speculum broad and closed below, basal triangle hyaline, disc uniformly setose, marginal fringes moderate. *Hind wings*: more than 4 times longer than wide, tapering at the apex, marginal fringes long. *Legs* (Figs 8-10): hind legs with 2 tibial spurs; first tibial spur longer than basitarsus, remaining legs normal.

Gaster: Petiole slightly longer than wide; first valvifer triangular (Fig. 11) semicircular, second valvifer uniform in width, curved; third valvulae rudimentary, outer plate of ovipositor much enlarged, narrow at the base, much broadened at the apex, apex dark brown with a long setae, dorsal marginal ridge present throughout the length.

Male: Not known

Material Examined: **Holotype**: ♀. INDIA: Uttaranchal, Nainital, Pantnagar, CRC, host unknown, sweep net collection on Pigeon Pea. 2.xii.1990. Hym: Eulo. Nr. 1001 (S.N. Sushil). **Paratypes**: 4 ♀♀, data same as holotype. Hym: Eulo. Nr. 3029b (S.N. Sushil). Holotype and Paratypes have been deposited in the Entomological Museum, G.B.P.U. A & T, Pantnagar, India.

Etymology: The species name is derived from the type locality.

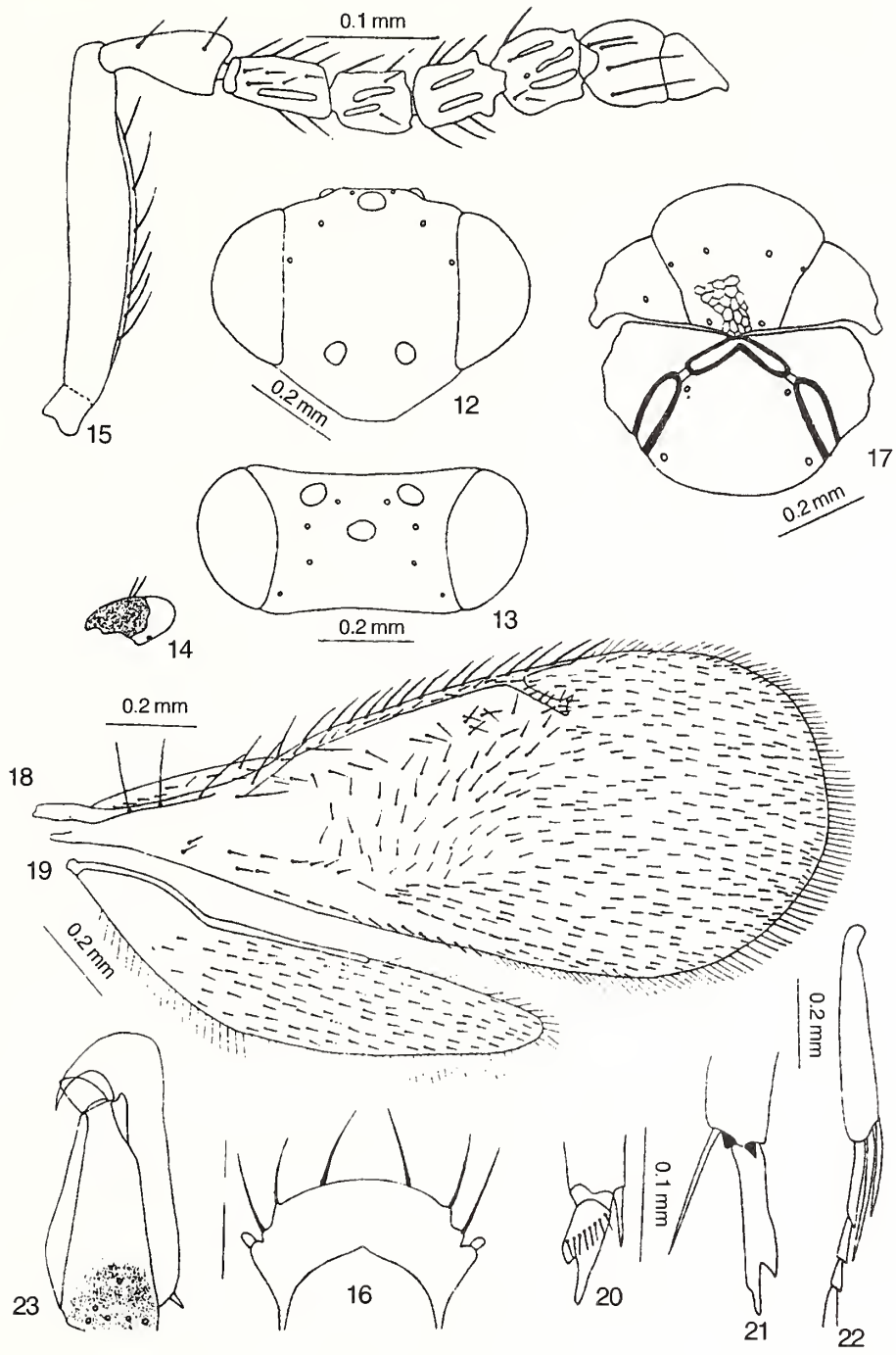


Figs 1-11: *Euplectrus pantnagarensis* sp. nov.
1. Head in frontal view, 2. Head in dorsal view, 3. Antenna, 4. Pronotum, 5. Thorax in dorsal view, 6. Propodeum, 7. Part of fore wing, 8. Part of fore leg, 9. Part of mid leg, 10. Part of hind leg, 11. Female genitalia

Euplectrus dubeyi sp. nov.
(Figs 12-23)

Female: Body length about 2.12 mm; general body colour black with metallic reflections; head black with slight metallic reflections except clypeal region and scape white with infuscation; thorax dark with metallic green reflections; wings hyaline; legs uniformly honey yellow; gaster dark except a broad yellow patch on mid dorsum.

Head (Fig. 12): Smooth except upper part of the frons weakly reticulate; frontovertex more than 2.4 times as wide as long (0.69:0.29); head in dorsal view more than 1.3 times as wide as long (0.67:0.50); ocelli arranged in obtuse angled triangle; POL:OOL 0.15:0.07; width of frons more than 3.5 times



Figs 12-23: *Euplectrus dubeyi* sp. nov.
12. Head in frontal view, 13. Head in dorsal view, 14. Mandible, 15. Antenna, 16. Pronotum ,
17. Thorax in dorsal view, 18. Forewing, 19. Hind wing, 20. Part of fore leg, 21. Part of mid leg, 22. Part of hind leg, 23. Female genitalia

the distance between antennal toruli; antennae inserted just at the lower level of eyes; scape not reaching up to the level of median ocellus; maxillary palp and labial palp two and one segmented respectively. Malar sulcus absent, length of malar space times the eye width; mandible bidentate *Antenna* (Fig. 15): 8 segmented excluding broad anellus; scape slightly dilated with long setae, more than 5 times as long as wide (0.28: 0.05); pedicel with 2 strong and 2 small setae, slightly 2 times as long as wide (0.09: 0.045), slightly longer than FS1; funicle 4 segmented, FS1 less than 2 times as long as wide (0.07: 0.04), longer than each succeeding segment, FS2 and FS4 sub-equal in size (0.06: 0.05), slightly longer than wide, club 2 segmented, less than 2 times as long as wide (0.11: 0.065), slightly shorter than preceding two funicle segments together.

Thorax (Fig. 17): Pronotum with anterior margin deeply concave in middle and reticulate (Fig. 16), anterolateral arms long and narrow, posterior margin much convex bearing 3 pairs of long setae; mesoscutum wider than long (0.59: 0.34), midlobe weakly reticulate anteriorly and strongly posteriorly, and with 4 pairs of setae; scutellum distinctly wider than long (0.40: 0.31), with 2 pairs of setae and round at apex; axillae smooth; propodeum less than 3 times as wide as long (0.62: 0.22), with prominent median carina and plicae, spiracles separated by a space more than one half the length of a spiracle. *Forewings* (Fig. 18): more than 2 times as long as wide (1.69: 0.72) with round apex; costal cell long, broad with 9 setae in row; SMV with 5 long setae, 4 upward and 1 downward, slightly shorter (0.48) than MV (0.53); MV with 13 setae; SV more than (0.14) 1/3rd the length of MV and slightly longer than PMV (0.12); basal cell bare; speculum narrow and closed below; cubital vein almost straight; subcubital line of hairs starting from the base of cubital vein; marginal fringe short, spaced by a distance less than 1/2 of their length. *Hind wings* (Fig. 19): 5 times as long as wide; marginal fringes spaced by a distance equal to 1/2 of their length. *Fore legs* (Fig. 20): basitarsus with an oblique row of 8 setae; tibial spur much shorter. *Middle legs* (Fig. 21): apical rim of tibiae with 2 pegs tibial spur long. *Hind legs* (Fig. 22): characterized by the presence of two long tibial spur, longest tibial spur (0.32) equal to the length of basal 2 tarsal segments together, shortest tibial spur (0.22) sub-equal in length to the first basal segment.

Gaster: Petiole short as long as broad; ovipositor slightly concealed arising from apical one third of gaster; first valvifers triangular (Fig. 23) with basal margin concave; second valvifers on uniform width, almost 8 times as long as wide (0.39: 0.05); third valvulae rudimentary (0.02) (Fig. 23), articulated with the second valvifers; outer plates of ovipositor narrow at the base, widened at apex, median longitudinal ridge well extended to the apex of outer plates of ovipositor.

Male: Not Known.

Material Examined: **Holotype**: ♀. INDIA: Uttar Pradesh, Rampur, host unknown, sweepnet collection, mango trees; 26.x.1990. Hym: Eulo. Nr. 1002 (R.S.J. Singh). **Paratypes**: 3 ♀♀, data same as holotype. Hym: Eulo. Nr. 1002 (R.S.J. Singh). Holotype and Paratypes have been deposited in the Entomological Museum, G.B.P.U. A & T, Pantnagar, India.

Etymology: The species is named in honour of Dr. O.P. Dubey, ADG (PP) ICAR, Govt. of India, New Delhi for his contribution to promoting Insect taxonomy in India.

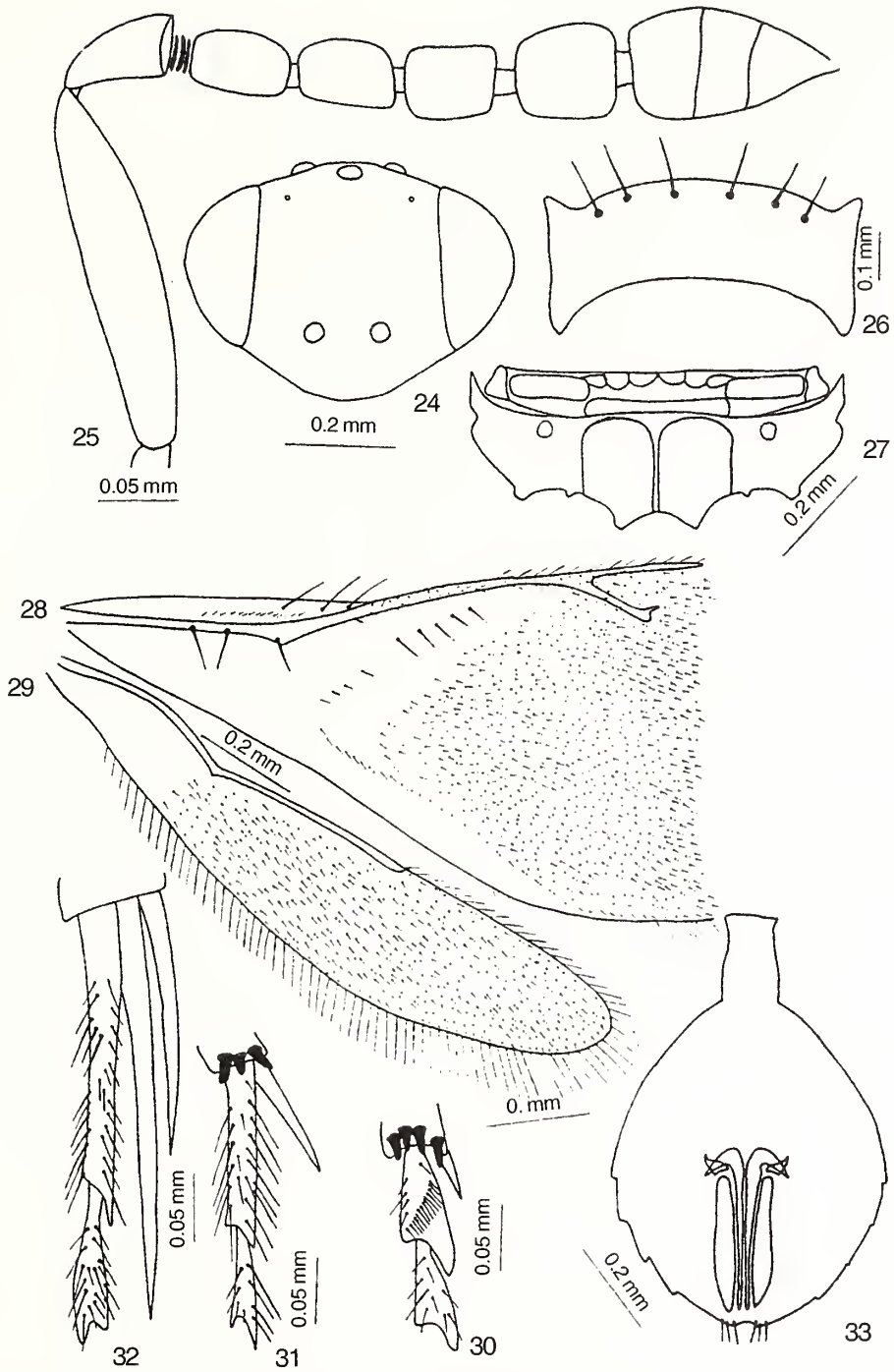
Euplectrus viggianii sp. nov.

(Figs 24-33)

Head (Fig. 24): Dark brown with metallic bluish reflections, wider than long (0.61:0.44); finely reticulate with punctures on frontovertex width less than 2 times the total head width (0.34:0.61); ocelli white arranged in obtuse angled triangle; POL:OOL 0.12:0.07; antennal toruli slightly above the lower level of eyes; apex of scape not reaching up to the median ocellus; prominence between antennal toruli less than 1/4th the width of frons between eyes (0.09:0.34); malar sulcus absent, length of malar space longer than the eye width (0.15:0.13); maxillary palp and labial palp two and one segmented respectively. *Antennae* (Fig. 25): yellow with slight infuscation, except scape uniformly whitish, nine segmented excluding 3 anelli; scape cylindrical, slightly more than 5 times as long as wide (0.22:0.05); pedicel less than 2 times as long as wide (0.09:0.05), distinctly longer than FS1, funicle 4 segmented, segments gradually increasing in width distad, FS1 (0.07:0.045) as long as FS2 (0.07:0.055), FS3 shortest, a trifle longer than wide (0.065:0.06), FS4 quadrate (0.07:0.07), club 3 segmented, slightly more than 2 times as long as wide (0.0165:0.08), almost as long as preceding two funicle segments together.

Thorax: Dark brown with metallic bluish reflections and pronotum (Fig. 26) with anterior margin deeply concave in the middle, anterolateral arms moderate, posterior margin convex bearing 3 pairs of long setae, posterolateral grooves deep, side projections raised, developed; mesoscutum with 3 pairs of long bristles wider than long scutellum smooth longer than wide and 3 pairs of bristles; axillae weakly reticulate propodeum with a median carina. *Forewings* (Fig. 28): Hyaline almost 2.5 times as long as wide (1.8:0.7); costal cell broad and long with 3 long and 15 small setae; SMV (0.61) with 4 strong setae, longer than MV (0.36), SV (0.18) 1/2 the length of MV and distinctly shorter than PMV (0.27); marginal fringe short, spaced by a distance equal to 1/3rd of their length. *Hind wing*: (Fig. 29) hyaline, less than 5 times as long as wide (1.3:0.28), blunt at apex; marginal fringe spaced by a distance equal to 1/2 of their length. *Fore legs* (Fig. 30): uniformly yellowish with slight infuscation, tibial spur shot, apical rim of tibiae with four stout pegs, basitarsus with an oblique row of small setae on dorsal surface. *Middle legs* (Fig. 31): Uniformly yellowish, femora with a long, strong setae at apical end; tibial spur shorter than basitarsus; apical rim of tibiae with 3 stout pegs. *Hind legs* (Fig. 32): Uniformly yellow except coxae with slight infuscation, tibiae with two strong tibial spurs; longest tibial spur shorter than the length of basal two tarsal joints together.

Gaster (Fig. 33): Dark brown with metallic bluish reflections on the dorsum; petiolate, petiole, almost 1.5 times as long as wide; ovipositor concealed, arising from apical one third of gastral venter, first valvifers triangular with basal and apical angles at different level, basal margin concave, second valvifers of uniform width and continuous with the third



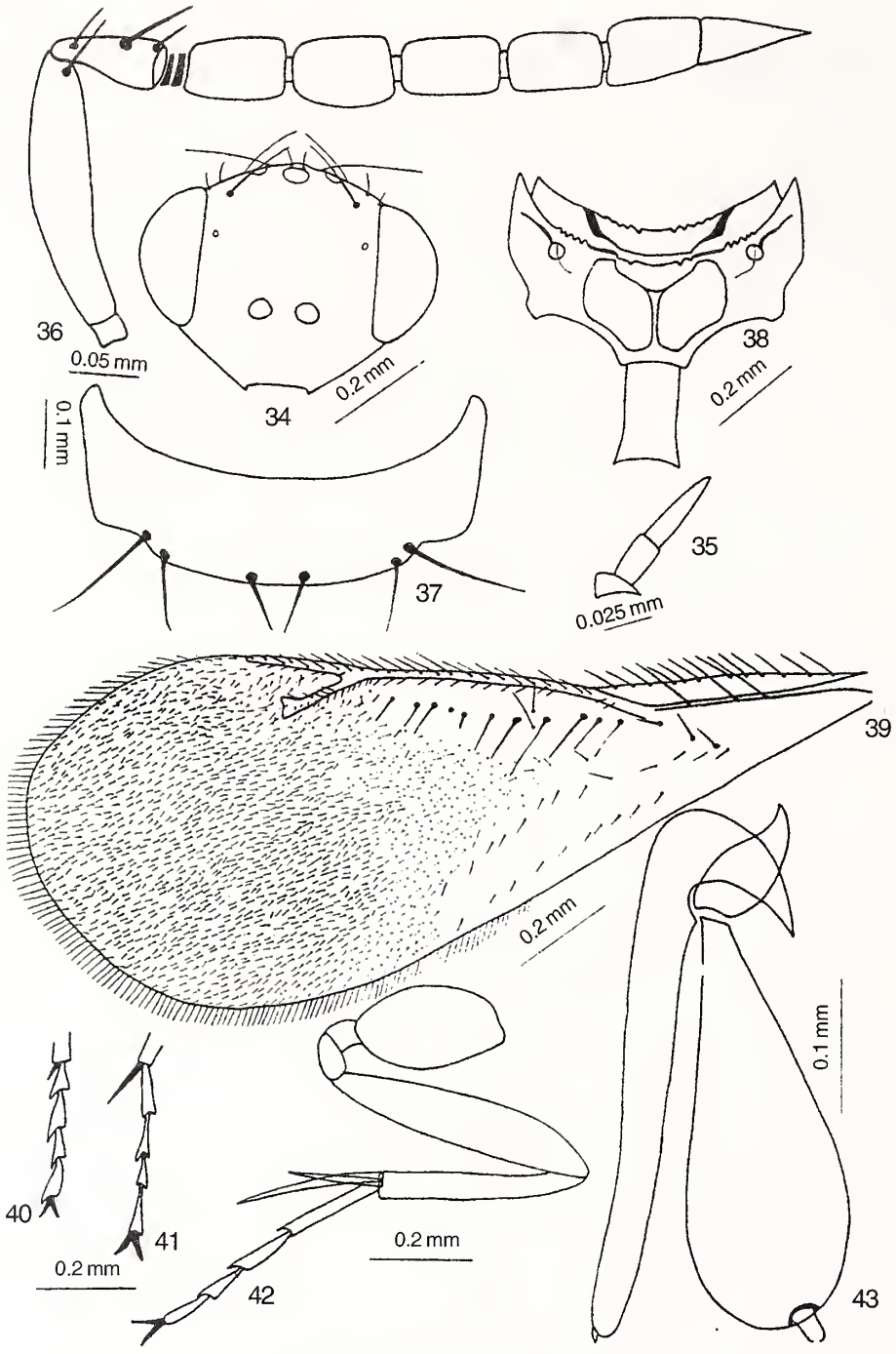
Figs 24-33 : *Euplectrus viggianii* sp. nov.
24. Head in frontal aspect, 25. Antenna, 26. Pronotum, 27. Propodeum, 28. Forewing, 29. Hind wing, 30. Fore leg, 31. Middle leg, 32. Hind leg, 33. Gaster

valvulae, outer ovipositor narrow at base, widened at apex; subgenital plate of uniform width, anterior margin straight posterior margin with a wide notch in the middle.

Length: 1.81 mm.

Male: Not Known.

Material Examined: **Holotype**: ♀. INDIA: Uttar Pradesh, Pilibhit. *Merasmia trapezalis* (Guen.) (Lepidoptera: Pyraustidae) on *Zea mays*. 1.viii.1989. Hym: Eulo. Nr. 4001 (M.A. Khan). **Paratypes**: 10 ♀ ♀, data same as holotype. Hym: Eulo. Nr. 4002 (M.A. Khan). Holotype and Paratypes have been deposited in the Entomological Museum, G.B.P.U. A & T, Pantnagar, India.



Figs 34-43: *Euplectrus longiscapus* sp. nov.
34. Head in frontal aspect, 35. Maxillary palp, 36. Antenna, 37. Pronotum, 38. Propodeum, 39. Fore wing, 40. Part of fore leg, 41. Part of mid leg, 42. Hind leg, 43. Ovipositor

Etymology: The species is named in honour of Professor G. Viggiani, University of Naples, Portici, Italy, for his outstanding contribution to the Family Eulophidae.

Euplectrus longiscapus sp.nov.
(Figs 34-43)

Head (Fig. 34): Dark brown with metallic reflections, sparsely setose; finely reticulate, wider than long in facial view (0.55:0.43); frontovertex less than 3 times as wide as long (0.63:0.22), vertex with 6 very long setae; ocelli pale, arranged in obtuse angled triangle, POL: OOL 0.14: 0.09; eyes dark brown and smooth; antennae inserted well above lower level of eyes; prominence between antennal toruli slightly more than 1/4th the width of frons between eyes (0.08: 0.33); apex of the scape not reaching up to the median ocellus; malar sulcus absent; length of malar space longer than eye width (0.18:0.11);

mandibles bidentate maxillary palp (Fig. 35) and labial palp two and one segmented respectively. *Antennae* (Fig. 36): Scape white, pedicel, anelli segments and first two funicle segments yellow and rest of the flagellum infuscated; uniformly setose; pedicel with a very long setae; 8-segmented excluding 2 anelli; scape cylindrical, 5 times as long wide (0.2:0.05); pedicel 2 times as long as wide (0.08:0.04), as long as FS1; funicle 4-segmented; FS1 longest and less than 1.5 times as long as wide (0.08: 0.05), FSs 2-4 subequal in size (0.07:0.055); club 2 segmented, less than 3 times as long as wide (0.15:0.055), longer than preceding two funicle segments together.

Thorax: Dark with metallic reflections and reticulate sculpture; pronotum (Fig. 37) with anterior margin concave in the middle, anterolateral arms moderately long, not much narrow, posterior margin convex bearing 6 long setae; notauli well developed; mesoscutum wider than long; scutellum longer than wide; side lobe, mesoscutum and scutellum with 2, 4 and 4 long strong setae respectively; axillae bare; propodeum (Fig. 38) with a median carina. Forewings (Fig. 39): hyaline, less than 3 times as long as wide (1.68:0.68); costal cell broad, setose, setae arranged in an apical row, 12 in number; basal vein with 3 setae; basal cell bare; speculum short, closed below; cubital vein sinuate; 10 admarginal hairs present; SMV (0.57) longer than MV (0.5); PMV (0.19) longer than SV (0.17); marginal fringe short, spaced by a distance equal to 1/3rd of their length. *Hind wings*: Hyaline, more than 5 times as long as wide with apex blunt; sparsely setose; marginal fringe short, spaced by a distance equal to 1/2 their length. *Legs* (Figs 40-42): yellow, apex of each femora with a long setae; mid tibial spur as long as basitarsus (Fig. 41); hind legs with two stout tibial spurs (Fig. 42), longest tibial spur shorter than the length of basal two tarsal segments together.

Gaster: (Fig. 43) Dark brown except a white broad patch on middle of dorsum; densely setose, petiolate, petiole less than 2 times as long as wide; ovipositor concealed, arising from apical 1/3rd of gaster; first valvifers (Fig. 43) triangular with basal and apical angles at different levels, basal margin concave; second valvifers (Fig. 43) of uniform width; third valvulae (Fig. 43) rudimentary, articulated with second valvifers; outerplates of ovipositor (Fig. 43) narrow at base, widened at apex, subgenital plate of uniform width, anterior margin straight, posterior margin with a wide notch in the middle.

Length: 1.75 mm.

Male: Not known.

Material Examined: **Holotype**: ♀. INDIA: Uttaranchal, Nainital, Pantnagar ex. *Lamprosema indicata* (Fabr.) (Lepidoptera: Pyraustidae) on *Phaseolus aureus* (Green Gram) 6.iii.1994. Hym: Eulo. Nr. 1003 (M.A. Khan). **Paratype**: ♀, data same as holotype. Hym: Eulo. Nr. 1003 (M.A. Khan). Holotype and Paratypes have been deposited in the Entomological Museum, G.B.P.U. A. & T., Pantnagar, India.

Etymology: The species name is from the long nature of the scape.

ACKNOWLEDGEMENTS

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*Original not seen

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DESCRIPTION OF A NEW SPECIES OF THE GENUS *DOLICHOGENIDEA* VIERECK (HYMENOPTERA: BRACONIDAE) FROM INDIA[1]

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A new species of the genus *Dolichogenidea* Viereck, namely *D. masoni* sp. nov. is described and illustrated.

Key words: Hymenoptera, Braconidae, Microgastrinae, *Dolichogenidea*, new species, India

INTRODUCTION

The genus *Dolichogenidea* Viereck (1911) was synonymized with *Apanteles* Foerster by Muesebeck (1920). Later, Nixon (1965) treated the species described in *Dolichogenidea* as *ultor* species group of *Apanteles*. However, the genus *Dolichogenidea* was revalidated by Mason (1981). *Dolichogenidea* is closely related to the genus *Apanteles*, but it is easily distinguished in having margin of vanal lobe convex, rarely flattened and uniformly hairy; punctures of scutum distinct and well separated and T_1 parallel sided or slightly broader apically.

Nixon (1967) provided a key to the Indo-Australian species of the *ultor* group of *Apanteles*, and included 9 species from India. Recently, Sumodan and Narendran (1990) and, Sathe and Bhoje (2000) added 4 species to *Dolichogenidea*. In the present work, a new species, namely *D. masoni* sp. nov. is described from India.

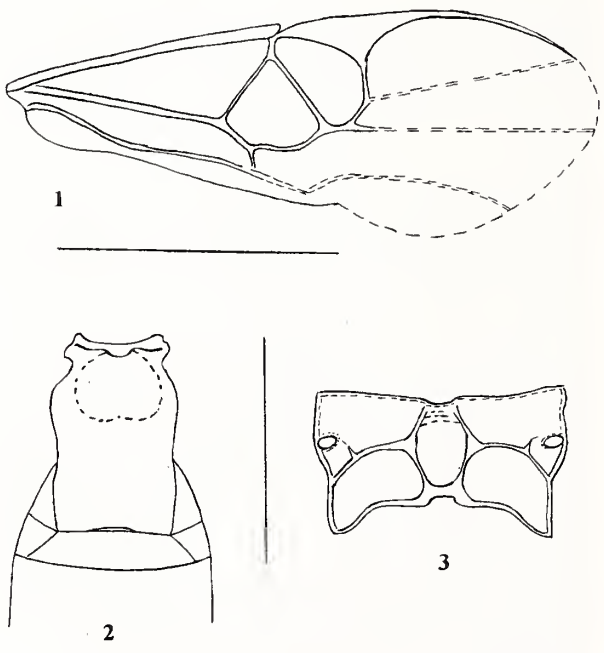
Dolichogenidea masoni sp. nov.
(Figs 1-3)

Female: 3.0 mm long.

Head: Transverse, 1.8x wider than long in dorsal view, with moderately dense white pilosity including eyes; vertex indistinctly punctate with hairs; OOL: POL: AOL: ØOD = 5: 5: 2: 2; frons concave smooth and shiny medially, punctate elsewhere; face indistinctly punctate, 1.2x wider than long with an indistinct median dorsal node; clypeus indistinctly punctate; antennae slightly longer than the body.

Mesosoma: 1.6x longer than wide with moderately dense, white pilosity except mesopleuron medio-posteriorly and metapleuron; scutum 1.4x wider than long, coarsely punctate with hairs, punctures become dense and more distinct at imaginary course of notauli; scutellum smooth and shiny except for few indistinct setigerous punctures associated with hairs; sides of pronotum smooth and shiny with a crenulate groove dividing into postero-dorsal and postero-medial arms; mesopleuron coarsely punctate anteriorly, smooth and shiny medio-posteriorly, metapleuron smooth and shiny; propodeum (Fig. 3) with U shaped areola, somewhat smooth and shiny anteriorly while very finely rugulose posteriorly; hind coxae large, smooth and shiny, almost reaching up to T_3; hind tibia 1.25x longer than hind femur; hind basitarsus 1.2x longer than outer tibial spur.

Wings: Fore wing (Fig. 1) with sparse pilosity in basal half, densely and evenly pilose in apical half; stigma 2.75x longer than wide, 0.9x longer than 1-R1; vein r about as long as maximum height of pterostigma and 1.6x longer than 2-SR,



Figs 1-3: *Dolichogenidea masoni* sp. nov. ♀
1. Fore wing; 2. T_1 and T_2; 3. Propodeum
Scale Line: Fig. 1 = 1.0 mm, 2 & 3 = 0.5 mm

angle between them distinct; discal cell slightly wider than long; vanal lobe of hind wing with long hairs basally, short and even hairs apically.

Metasoma: T_1 (Fig. 2) approximately 1.5x longer than wide, almost equally broad anteriorly as posteriorly, but slightly bulging sub-basally and slightly narrower medially, longitudinally rugulose-punctate over 0.6 of apical tergite; T_2 (Fig. 2) finely sculptured, 4.2x wider than long with slightly convex posterior margin; hypopygium large, medially folded; ovipositor sheaths 1.2x longer than hind tibia, uniformly hairy all along the length; ovipositor thick and stout and slightly curved downwards.

Colour: Black except for the following: mandible, antennae reddish brown; maxillary palpi, labial palpi and tibial spurs pale yellow; scape beyond apical rim, hind leg beyond coxae, basal part of basitarsus, mid leg beyond coxae, and fore leg are yellowish; apical hind tibia, apical segment of hind basitarsus, stigma brown and wings hyaline.

Male: Same as female except for following: Length 2.1 mm; antenna longer.

Holotype: ♀, INDIA: Uttar Pradesh, Aligarh; 15.x.2001 ex. *Parotis* sp. on *Tabernaemontana divaricata*, Coll. Kavita Pandey, deposited in the collections of ZDAMU (Catalogue No. HB. 1030). **Paratypes**: 10 ♀♀ and 10 ♂♂, data same as holotype.

Host: Reared from *Parotis* sp. (Lepidoptera: Pyralidae) on *Tabernaemontana divaricata*.

Cocoons: White and heaped together in masses.

Distribution: INDIA: Uttar Pradesh.

Etymology: The species is named after Dr. William R. Mason for his valuable contribution to our knowledge of microgastrine wasps.

Remarks: *Dolichogenidea masoni* sp. nov. closely resembles the Indian species *D. mohandasi* (Sumodan & Narendran), but differs in having (i) vertex indistinctly punctate (vertex finely rugulose in *mohandasi),* (ii) head 1.8x wider than long (head 1.5x wider than long in *mohandasi)*, (iii) ovipositor slightly curved downwards (ovipositor uniformly curved in *mohandasi*), (iv) scutellum with few indistinct punctures (scutellum completely smooth and shining in *mohandasi*).

Abbreviations used: OOL- ocello-ocular line; POL- post-ocellar line; AOL- anterior-ocellar line; ØOD- diameter of an ocellus; ZDAMU- Zoology Department, Aligarh Muslim University.

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■ ■ ■

THREE NEW SPECIES OF *LASIACANTHA* FROM SOUTHERN INDIA WITH A KEY TO THEIR IDENTIFICATION (HETEROPTERA: TINGIDAE)[1]

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Three new macropterous species of *Lasiacantha* on three different species of Acanthaceae have been described as the third, fourth and fifth species of this genus of Tingidae from the Indian region. A key for identification of the four exclusively south Indian species has been given. Relative expansion of the cephalic end of the median carina of the pronotum as a hood, the architecture of the paranotal expansions of the pronotum and the pattern of areolations of the hemelytra are the major diagnostic features of each species. Dense sharp spinocity characterize all species of *Lasiacantha*.

Key words: Insecta, Heteroptera, Tingidae, *Lasiacantha justiciaii* sp. nov., *L. peristrophii* sp. nov., *L. ruellii* sp. nov.

INTRODUCTION

Out of the twenty one species of *Lasiacantha* catalogued by Drake and Ruhoff (1965) in their monograph on the Lace Bugs of the world, only two species – *L. cuneata* and *L. altimitrata* were reported to have been described from India. Of these, only *Lasiacantha cuneata* (Distant) (*Jannaeus cuneatus* Distant 1909) was known to have been described from south India its host plant was not recorded. *Lasiacantha altimitrata* (Takeya) was reported from China and India; on Labiatae. In the present survey, three more species have been discovered from southern India and described. A key to the identification of all the four known south Indian species has been given.

The genus *Lasiacantha* is characterized by the largeness of its size (3.89 to 3.9 mm); presence of five prominent porrect cephalic tuberculate spines (two loral, a median frontal and two post genal); elytra beset with sharply pointed pedicellate spines; pronotum tricarinate, the median carina expanding cephalad as hood; paranotal expansion and bucculae broadly expanded; hemelytra terminally constricted and differentially pigmented.

1. ***Lasiacantha justiciaii*** sp. nov.
(Fig. 1)

Large, testaceous, narrow transverse band traversing middle of subcostal area and another median oblique band on apical sector of elytra; length 3.6 mm, width across pronotum 1.32 mm.

Head, testaceous, armed with five elongately porrect, stramineous, tuberculate spines; antennae moderately elongate, testaceous, densely packed with long, pedicellate, sharply pointed spines, proportionate length of the antennomeres 1:1.2:5.2:1; apical flagellar segment fuscus; eyes ochraceous; antenniferous tubercles moderately robust, almost passing scape; rostrum stramineous, apically testaceous, reaching middle of mesosternum; sternal lamina non-areolate; bucculae broadly elongate, biseriate, closely occluding basirostrum.

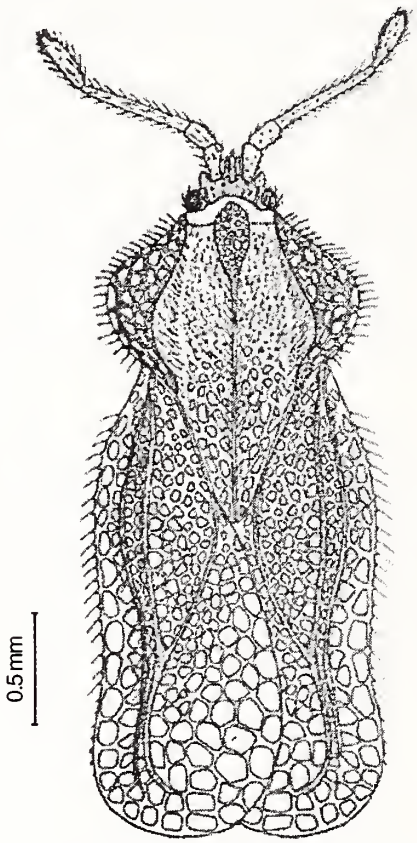

Fig. 1: *Lasiacantha justiciaii* sp. nov.

Pronotum, moderately convex, anteriorly punctate, proscutellum broadly areolate, proscutum tricarinate, median carina biseriate, interrupted midway by abrupt development of median anterior, vertically elevated hump like prominent

hood, anteriorly terminating subapically and posteriorly terminating at posterior tip of proscutellum; lateral earinae elongate, uniseriate, deviating posteriorly to terminate at base of proscutellum; paranotum, broad, four serially areolated, confluent with the lateral margin of the proscutum and strongly reflexed to lie juxtaposed to almost half the lateral area of proscutum on either side; densely spinous marginally, anterolateral areas of pronotum and subapical areas of carinae darkly pigmented.

Hemelytra, extending far behind abdomen, subapically constricted; sub-costal area biseriate, having broad areolae, confluent with post-cubital area; a darkly pigmented band running across middle; radial area moderately broad, triseriate, apically confluent with sutural area; discoidal area broad, multiseriate across middle; sutural area broad, multiseriate, areolae broad, apically infuscated; margins of elytra, media, cubitus and all veins beset with long pedicellate, less sharp spines, rest of the areas of elytra with long non-pedicellate recurved wavy spines; clavus proximally triseriate, distally biseriate, media, darkly pigmented midway; hypocostal lamina uniseriate.

Femur fuscus, fringed with long, pedicellate, porrect spines; tibia, stramineous, beset with long, pedicellate, sharp spines.

Holotype: Male (macropterous); locality: Malumichampatty in Coimbatore, Tamil Nadu; host plant: *Justicia simplex* (Acanthaceae), 12.xi.1979; **Allotype**: Female; **Paratype**: sixteen specimens; data same as holotype. Collector M.H.S. Yacoob. Deposited in Livingstone's Collection, Reg. No. 18T, Division of Entomology, Bharathiar University, Coimbatore.

Etymology: Named after the host plant.

Lasiacantha justiciaii sp. nov. resembles *L. peristrophii* sp. nov. in the architecture of their hemelytra and spinocity; but differs from it by its shorter III & IV antennal segments and the extent of development of antenniferous tubercles, almost passing scape. Presence of biseriate bacculae, biseriate subcostal area and triseriate radial area are yet other delineating features. It can be readily differentiated from *L. ruellii* sp. nov. by the presence of simple (nonbifid) nature of the post-genal pair of cephalic tubercles. It differs from *L. cuneatus* (Distant) by the presence of more compressed pronotal median anterior hood, longer III & IV antennomeres and more prominently incrassate femora.

2. *Lasiacantha peristrophii* sp. nov.

(Fig. 2)

Moderately large, stramineous, clothed with non-pedicellate spines, length 3.00 mm and width across pronotum 1.14 mm.

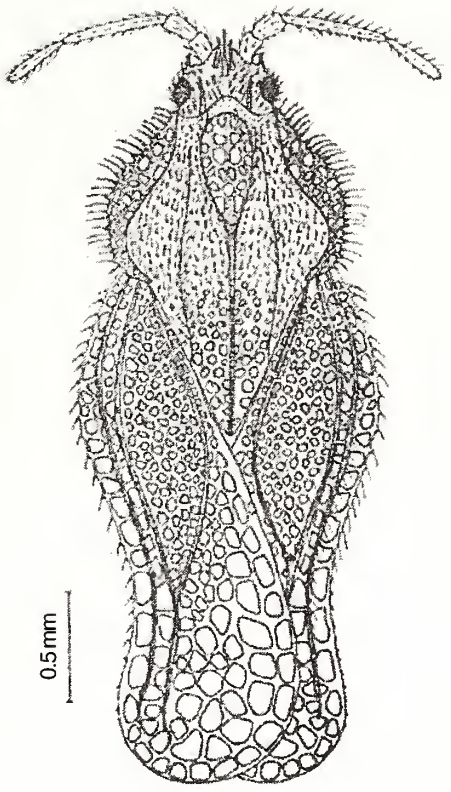

Fig. 2: *Lasiacantha peristrophii* sp. nov.

Head, fuscus, armed with usual five tuberculate spines, median frontal tubercle longest, porrect and post-genal pair forked apically; antennae moderately elongate, stout, testaceous, densely beset with long pedicellate spines, scape and pedicel short, subequal, first flagellar segment 1½ times longer than terminal segment; proportionate length of antennomeres 1 : 1.2 : 3.4 : 2.3; eyes ferruginous; antenniferous tubercles not passing middle of scape; rostrum not passing middle of mesosternum, stramineous, apically testaceous, fringed with hairs, rostral lamina lining rostral furrow broad, non-areolate; bucculae tetra-seriate, broadly elongate, occluding basirostrum.

Pronotum convex, proscutum punctate, tricarinate, median carina disrupted midway by the anterior, vertically elevated prominent hump-like hood and posteriorly merging with the broadly areolate scutellum; paranotal expansion three areolae deep, vertically deflected.

Hemelytra, passing abdomen, subapically constricted; subcostal area biseriate, cells rectangular, confluent with post-cubital area; a dark pigmented band traversing middle of subcostal area; radial area broad, tetraseriate, confluent with sutural area; discoidal area equally broad, six areolae deep across middle; sutural area broad, a few cells at its apical region infuscated; hypocostal lamina uniseriate; clavus proximally triseriate and distally biseriate; median vein darkly pigmented at middle; femur feebly testaceous, fringed with

long pedicellate blunt spines; leg, segments beyond femur stramineous; tibia proximally brownish.

Holotype: Female (macropterous); locality: Andipatti, Madurai District, Tamil Nadu; host plant: *Peristropha bicalyculata* (Acanthaceae) on 4.v.1981; **Allotype**: male; **Paratype**: nine specimens. Collector: M.H.S. Yacoob, data same as the holotype; deposited in Livingstone's Collection, Reg. No. 19 T, Division of Entomology, Bharathiar University, Coimbatore.

Etymology: Named after the host plant.

Lasiacantha peristrophii sp. nov. differs from *L. justiciaii* sp. nov. in the presence of tetraseriate broadly elongate bucculae; paranotum three areolae deep; biseriate subcostal area and tetraseriate radial area and by the presence of apically forked post-genal pair of cephalic tuberculate spines. It further differs from *L. ruelii* sp. nov. by the relative length of antennomeres and by the tetraseriate radial area.

3. ***Lasiacantha ruellii*** sp. nov.

(Fig. 3)

Moderately large; stramineous; a darkly pigmented band across subcostal area and subapical area of elytra; 3.9 mm long and 1.2 mm broad across pronotum.

Head, stramineous; pubescent, armed with five moderately long, stramineous, porrect cephalic tubercles, median frontal tubercles longest, postgenal pair of tubercles bifid apically; antennae moderately elongate, stramineous, I and II antennomeres short, stout and subequal, first flagellar segment slender, elongate, beset with long pedicellate blunt spines, terminal segment fringed with much elongated pedicellate hairs; proportionate length of antennomeres 1: 0.9: 4.1: 1.8; eyes reddish brown; antenniferous tubercles testaceous, short, not passing middle of scape, beset with long pedicellate spines; rostrum stramineous, apically testaceous, reaching anterior margin of mesosternum; sternal furrow shallow, sternal lamina non-areolate, broad; bucculae broadly elongate, triseriate, pubescent, occluding basirostrum.

Pronotum, pubescent, coarsely punctate, proscutum convex with dense vestiture of long slender hairs; tricarinate, median carina abruptly disrupted at middle by anterior segment developing as broadly areolated hood, occluding middle of head up to anterior margin of eyes, pronotal hood 5-6 rows of areolae deep on either side; lateral carinae narrow, uniseriate, sinuous, posteriorly terminating at origin of scutellum; paranotum broadly expanded, almost vertically reflexed, 5-6 areolae deep at middle, sharply spinous marginally, paranotal margin and median carina testaceous, scutellum broadly and coarsely areolate.

Hemelytra, reaching far beyond the abdomen, subapically constricted; subcostal area triseriate, proximally

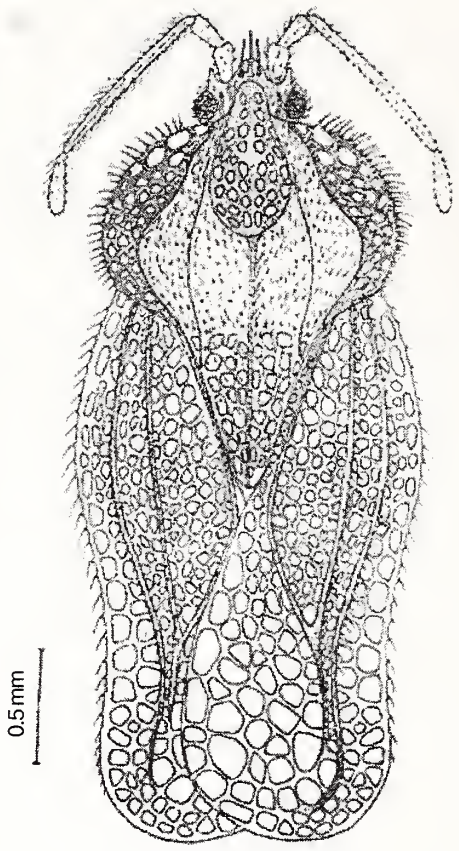

Fig. 3: *Lasiacantha ruellii* sp. nov.

and distally biseriate, confluent with post-cubital area; radial area triseriate, confluent with sutural area; discoidal area six areolae deep across middle; hypocostal lamina uniseriate; clavus proximally triseriate, distally uniseriate; sutural area broadly areolate, 5-6 areolae deep; outer margin of hemelytra, media and cubitus with dense vestiture of long pedicellate, sharply pointed spines; subcostal, radial and discoidal areas pubescent; sutural area sparsely beset with non-pedicellate spines.

Legs, testaceous, femur incrassate, both femur and tibia fringed with long pedicellate, sharply pointed spines.

Holotype: Female (Macropterous); locality: Semponvilai, in Kanyakumari District, Tamil Nadu; host plant: *Ruellia prostata* (Acanthaceae). 9.v.1981; **Allotype**: male; **Paratype**: Fourteen specimens; data same as the holotype. Collector: M.H.S. Yacoob. Deposited in Livingstone's collection, Reg. No. 20 T, at the Division of Entomology, Bharathiar University, Coimbatore.

Etymology: Named after the host plant.

Lasiacantha ruellii differs from *L. justiciaii* sp. nov. in the presence of bifid post-genal pair of cephalic tubercles and antenniferous tubercles not passing middle of scape. It can be readily distinguished from *L. peristrophii* sp. nov. by its triseriate bucculae and triseriate radial area.

KEY TO GENUS *LASIACANTHA*

1. Post-genal tuberculate spines apically biramus; antenniferrous tubercles not passing middle of scape; paranotal expansions fusing with pronotum, after reflecting vertically upward 2
— Post-genal cephalic tubercles simple; antenniferous tubercles passing middle of scape; paranotal expansions fusing with pronotum, without vertically reflecting upward 3
2. Bucculae triseriate; pronotal lateral carinae uniseriate; paranotal expansion six areolae deep; subcostal and radial areas triseriate; discoidal area six areolae deep ..... *Lasiacantha ruellii* sp. nov.
— Bucculae tetraseriate; paranotal expansion three areolae deep; radial area four seriate and discoidal area six seriate; tibiae proximally bearing two brown spots ..... *Lasiacantha peristrophii* sp. nov.
3. Bucculae broadly areolate and biseriate; pronotal median carina biseriate; lateral carinae uniseriate; paranotum 5-6 areolae deep; subcostal area biseriate; radial area triseriate and discoidal area five seriate ..... *Lasiacantha justiciaii* sp. nov.
— Paranotum more than six areolae deep; subcostal and radial areas equal and biseriate to triseriate; median carina 4-5 areolae deep ..... *Lasiacantha cuneata* (Distant)

ACKNOWLEDGEMENTS

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REVIEWS

1. CHANGING FAUNAL ECOLOGY IN THE THAR DESERT, edited by B.K. Tyagi and Qaiser H. Baqri. Scientific Publishers (India), Jodhpur, 2005. xii + 367 pp. (Size: 16.2 x 24.6 cm). Rs. 1850/-. Hardback.

This is a scholarly book with chapters written by experts and edited by two eminent zoologists of the Zoological Survey of India. The book is produced in commemoration of the distinguished zoologist Prof. Ishwar Prakash, father of rodentology in India (study of rodents), whose scientific bibliography runs into 21 pages! The first scientific publication of Prof. Prakash was in *JBNHS* in 1953, where he describes cannibalism in hedgehog. Since then, he has been associated with the Bombay Natural History Society. I know Prof. Prakash since 1981, when I first met him in Jodhpur during my survey of the Thar desert. For the next 20 years, till he passed away in 2002, whenever I used to pass through Jodhpur, I would meet him, to learn from his vast field experience of the desert.

The Thar is one of the smallest deserts in the world, but has very rich biological and cultural diversity. It is undergoing tremendous ecological, social, environmental and demographic changes, due to increase in human and cattle populations, military activities and tourism, and development of the Indira Gandhi Nahar Project (IGNP). This book discusses the changes in the faunal ecology of the Thar desert. The chapters are diverse and cover topics such as soil bioresources, reproduction in desert rodents, diversity, abundance and dominance of avian species, and the impact of changing ecology on termite fauna. Each chapter is written in a scholarly manner by experts, with abstract, introduction, methodology, results, discussion and references. After reading this book, I can say that each contributor was influenced by Prof. Prakash, sometime in his/her career. Such was the diversity of Prof. Prakash's interests and understanding in the field of desert ecology. This book is perhaps the best contribution to his memory. The editors and contributors need to be congratulated for bringing together such a vast storehouse of knowledge in 367 pages.

However, the book is not without the usual blemishes. At Rs. 1850/-, it is beyond the purse of most researchers and scholars. Secondly, the binding is shabby; the pages came loose even while I was reading it for review. While I cannot comment on the topics that I do not know properly, the chapter on birds written by C. Sivaperuman, Sumit Dookia, P.L. Kankane and Qaiser H. Baqri has many mistakes. They have listed 271 species, including 23 bird species seen for the first time in the Thar desert (Chapter 11). While some species are likely to occur due to the ecological changes brought by the IGNP (e.g. Marbled Teal *Marmaronetta angustirostris*, Osprey *Pandion haliaetus*, Dalmatian Pelican *Pelecanus crispus*), others need photographic or specimen evidence before these records could be accepted (e.g. Buff-breasted Sandpiper *Tryngites subruficollis* and European Calandra-Lark *Melanocorypha calandra*). The Buffbreasted Sandpiper has been reported as vagrant in India (Grimmett *et al.* 1999). Ali and Ripley (1987, p. 174) mention that a solitary specimen was collected in Ceylon (Sri Lanka) and another sight-recorded in the same country. Rasmussen and Anderton (2005) have mentioned a vagrant record from Goa without giving details. Its purported sighting in Ganganagar district on March 30, 2001 by the authors of this chapter needs further corroboration before it is accepted. Similarly, the European Calandra Lark is not even listed in the Indian avifauna (Ali and Ripley 1987, Grimmett *et al.* 1999). Rasmussen and Anderton (2005) have listed it only in Afghanistan. Sivaperuman et *al.*'s casual listing of this species in this book puts a question mark on their ability to recognise birds properly. Other questionable records are their 'sighting of 22 individuals of White-headed Babbler *Turdoides affinis* in a grassland near Suratgarh in Ganganagar district, and 12 birds in Kola forest farm in Hanumangarh district'. This babbler is found only in southern India, not seen north of Andhra Pradesh (Ali and Ripley 1987), how could they have see this non-migratory species in northern Rajasthan? They have probably misidentified the species. Ten species are listed as 'range extension', but most of them have already been recorded earlier. Ferruginous Pochard *Aythya nyroca* is a migratory species and can be seen in any good wetland in northwest India. I had seen eight Ferruginous Ducks or White-eyed Pochards on three wetlands in Gajner, Guda Vishnonian and Kolayat during 1993-94 surveys (Rahmani 1997). Similarly, White-tailed Lapwing *Vanellus leucurus* is another common species of marshes and damp fields in northern India. It was reported at Gajner, Badopal and a seepage wetland (RD507) of the IGNP (Rahmani 1997). The remaining eight species listed by Sivaperumun *et al.* are also common and have been reported earlier (see Rahmani 1997 for the full checklist), so they cannot be called as 'range extensions'.

Sivaperumun *et al.* have also listed Himalyan Griffon *Gyps himalayensis* from Jalore district. Looking at the questionable identity of other species, they could have misidentified the Eurasian Griffon *Gyps fulvus* as Himalayan Griffon as both look similar, except for some differences in

plumage. There are not many confirmed sight or specimen records of the Himalayan Griffon in Rajasthan, while the Eurasian Griffon is very common in winter.

In Plate 2 of this chapter, one map is missing. Another major problem with this chapter is the estimated number of different bird species and their relative dominance (Table 1, pp. 206-213). Coot, a purely wetland bird, with a sighting of total 13,186 individuals is the dominant species with the rank of 18.20. Imagine, a purely wetland bird being reported as the most dominant species of a desert! Didn't they see millions and millions of Greater Short-toed Larks *Calandrella brachydactyla longipennis*, hundreds of thousands of Eastern Calandra-Lark *Melanocorypha bimaculata*, and thousands of Ring Dove *Streptopelia decaocta*? Even Rose-ringed Parakeet *Psittacula krameri*, a relatively new entrant in the Thar desert (Rahmani 1997), has a higher dominance rank than larks? Unless all the habitat types of the Thar desert are surveyed equally, it does not make sense to give dominance ranks or list the total numbers seen. We will see more wetlands birds if we visit more wetland habitats. Moreover, analysis and data presentation should make some ecological sense. Merely giving long tables, clumping species just on the basis of the numbers sighted, and giving them some sort of dominance rank is not good science.

■ ASAD R. RAHMANI

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2. RAPTORS OF THE WORLD: A FIELD GUIDE, by James Ferguson-Lees and David Christie, Illustrated by Kim Franklin, David Mead, Philip Burton and Alan Harris. Christopher Helm, London. 2005. 320 pp. (Size: 15.6 x 23.4 cm). Price £19.99. Paperback.

This is a lavishly illustrated field guide for experts and birdwatchers, particularly raptor enthusiasts, who travel all over the world for raptor watching. Among birds, raptors are some of the most difficult groups to identify, especially members of *Aquila*, *Buteo* and *Circus*. They have confusing sex and age-related plumages, and also local variations. Even some common species of raptors such as the Black Kite *Milvus migrans* are not easy to identify in their juvenile plumage.

Many birds such as cormorants, storks and egrets prey on other animals, but the term 'birds of prey' is generally applied to kites, vultures, hawks, falcons and eagles. These days, they are more often called 'raptors', or more precisely 'diurnal raptors' to separate them from nocturnal owls, which also prey on other animals. About 338 species of diurnal raptors are now identified in the world, and all are covered in this book. As raptors have age, gender and subspecies/race related plumage differences about 2,180 individual birds are illustrated in 118 plates, of which 1,200 are in flight.

This is an excellent, but complicated book. To keep the book at a size suitable for use in the field much of the information is abbreviated or codified. Even the authors advise the readers to refer back to abbreviations, as it would take some time to get familiar with the codes. While reviewing this book, I had to constantly refer back to the codes and abbreviations explained in the introductory section, especially on pages 76-77. The most confusing part was when a species is compared with similar looking species or with the plumage of totally unrelated species, sometimes not occurring in the same region or the country. Even after repeated attempts, I could not understand the codes. Perhaps we have to use this book in the field to understand cross-referencing. Another intriguing point was that while total length, wingspan and tail length are given in centimetres, their respective average is given in inches.

Some information in this book is new, e.g. the size of male in proportion to the female. In many raptors, the female is much larger than the male so this information is quite useful. The first three plates describe the key to genera of mainly larger, medium-sized and smaller raptors. To know the size of different genera, instead of a scale, as given in most books, sizes of two most common raptors are given for comparison: Swainson's Hawk *Buteo swainsoni* of the New World and Black Kite of the Old World. Another bit of information not seen in other books, at least in coded form, is the population size of a species. For example, 1 means the population is between 1-10 birds, 2 means 11-100, 3 means 101-1,000... and 7 means the population is more than 1,000,000. A quick glance at Indian raptors reveals that the Black-shouldered Kite *Elanus caeruleus*, the Northern Sparrowhawk *Accipiter nisus* and the Shikra *Accipiter badius* have populations of more than 1,000,000. All have extremely wide distribution in Asia, Europe

and Africa. However, three-quarter raptors worldwide are not above the population order 5, i.e. their estimated population ranges from 10,001 to 100,000 birds. This is quite worrying as some of them have a wide range of distribution and should be occurring in much larger numbers.

This book is a much smaller and handier version of the authors' earlier book RAPTORS OF THE WORLD, published by A & C Black in the 'Helm Identification Guides' in 2001. Since then, 25 raptor species have been added, mostly subspecies or races elevated to species level, but one species, Cryptic Forest Falcon *Micrastur mintoni* is new to science. Among the species added to the Indian subcontinent, we have the Black-eared Kite *Milvus lineatus*, Slender-billed Vulture *Gyps tenuirostris*, Eastern Marsh Harrier *Circus spilonotus*, Indian Spotted Eagle *Aquila hastata*, Indian Tawny Eagle *Aquila vindhiana*, Dimorphic Hawk Eagle *Spizaetus limnaeetus*, and Andaman Hawk Eagle *Spizaetus andamanensis*.

The book is full of interesting details about raptors, such as how to measure their length and wingspan, sex and age differences in sizes and shapes, wing positions in gliding and soaring, migration, their main routes of migration and watching points, moult patterns, polymorphism etc. I recommend this book, not only to those interested in raptors, but to all birdwatchers, who can afford this pricey book.

■ ASAD R. RAHMANI

3. BIODIVERSITY OF MANGROVE ECOSYSTEMS, by K. Kathiresan and S.Z. Qasim. Hindustan Publishing Corporation (India), New Delhi, 2005. xii + 251 pp. (Size: 18.4 x 24.3 cm). Price Rs. 875/-. Hardback.

It would be cliché to say that mangroves are one of the most diverse and endangered ecosystems in the world. This book is written by two of the most prominent marine biologists of India. Prof. K. Kathiresan is associated with the Centre for Advanced Study in Marine Biology of Annamalai University and spent almost all his research career studying mangroves. Prof. S. Zahoor Qasim is an authority on Indian Ocean. He has written nine books and several hundred scientific papers.

As the blurb of this book says, this book describes the energy flow and ecological role of mangroves, their uses, the causes of their destruction and degradation, and the conservation strategies adopted in different countries. Unfortunately, the book is full of mistakes, mainly in the tables that appear to be compiled from many sources. The authors should have shown the chapters to subject experts, before including them in their book.

More than 400 bird species are listed from the mangroves of India (Table 28, pp. 138-146). A quick glance of the list shows that most of them are not mangrove species and it is wrong to say, "Some of the resident species are highly dependent on mangroves for their survival". Except for the Mangrove Whistler *Pachycephala grisola* and Masked Finfoot *Heliopais personata*, the remaining species are found in many other habitats, and mangroves happen to be one of those. Therefore, mangroves cannot be considered as the habitat for many species in this list. For example, Houbara *Chlamydotis undulata* is found on the sand dunes on Gujarat coast, but by no stretch of imagination can this arid zone bird be considered as a mangrove bird! Similarly, Swamp Francolin *Francolinus gularis* is not found in the mangrove, as it prefers tall wet grasslands of the Gangetic and Brahmaputra plains. There could be some old records of its existence from the grasslands of the river flood plains where they meet the mangroves of Sundarbans, but this does not make it a mangrove species. Similarly, there is no record, as far as I know, of Striated Babbler *Turdoides earlei* from the west coast of India. This bird is found in the river systems of north India and Indus in Pakistan. Who has seen it in the mangroves of the west coast? The bird list is so full of mistakes that I can go on and on.

As the first author is an authority on mangrove and botany, there are not many technical mistakes in these sections, but the tables are full of mistakes. Presumably, the authors have relied on other workers to compile these tables, so errors in spelling and obsolete taxonomical nomenclature have crept in. While the relative paucity of faunal diversity on the west coast of India compared to that on the east coast may be partially attributed to the greater extent of mangroves on the east coast (and thus more attention having been paid to them), it appears that the fewer number of animals on the west coast may be because the authors included those forms which have been specifically mentioned by other authors as 'inhabitants of mangroves'. Thus, in Table 21 (pp. 75-77), species numbered 2, 4, 5, 11, 14, 16, 26, 30, 32, 36, 38, 47, 51, 57, 60, 64, 66, 68, 70, 72, 78, 79, 83, 88, 91, 93, 97, 98, 99, 100, 102, 104, 108, 109, 110, 112, 114, 115, 117, 125, and 126 occur on the west coast of India. Incidentally, the title of this table is "Species of Crabs found in the Mangroves along the East and West Coasts....". Strictly speaking, crabs fall under Brachyura, however, the table includes *Petrolisthes* (porcelain crabs), *Diogenes* (hermit crabs), *Tachyphleus* and *Garcinoscoprius* (both horseshoe crabs), which fall under Anomura and Xiphosura. One of the major blunders is that authors have placed *Argulus* in Brachyura (crabs) instead of

Branchiura, where it belongs.

There are many other errors. For example, on p. 26 Veraval is mentioned in Mumbai instead of Gujarat. The book is also full of spelling mistakes, mainly in scientific names. Some are mentioned below (page number given in brackets): *carinicanda* instead of *carinicauda* (p. 71); *concinnus* instead of *carcinnus* (p. 72); Bernad instead of Bernard (p. 96); *Carcinocarpius* instead of *Carcinoscopius* (p 77); *Edwarsia* instead of *Edwardsia* (p. 103); *Covernalunia* instead of *Cavernulania* (p. 103); *Lumbriconeries* instead of *Lumbriconereis* (p. 111); *dibranchis* instead of *dibranchia* (p. 111); *decorate* instead of *decorata* (p. 117; and *annandeli* instead of *annandelei* (p. 118).

It is recommended that the next edition of this book should be shown to subject experts to avoid such mistakes.

■ ASAD R. RAHMANI
(With inputs from Dr. B.F. Chhapgar)

4. BIRDS OF SOUTH ASIA: THE RIPLEY GUIDE, VOL. 1: FIELD GUIDE, VOL. 2: ATTRIBUTES AND STATUS, by Pamela C. Rasmussen and John C. Anderton. 2005. Smithsonian Institution and Lynx Edicions, Washington D.C. and Barcelona. Vol. 1 378 pp., Vol. 2 683 pp. (Size: 15.7 x 22.6 cm). Price 55 Euros (includes both volumes). Hardback.

For me a good book is a gift from God. This book can be considered as one such gift. The more I read it, the more I like it. This was one of the most awaited bird books in South Asia, not only because of its anticipated high quality, but also because of the numerous taxonomic changes that we all knew Pamela was working on. While there could be doubts and debates about the splits, no one can doubt the quality of illustrations, design of the book, good description, with the latest information, good quality maps and the general feel of the book.

This book is in two volumes. Volume I is a Field Guide, while Volume II deals with Attributes and Status. I have written this review after using the book, especially Volume I, in the field and vouch that it is the best field guide for the birds of South Asia. Among the four field guides available to Indian birdwatchers (PICTORIAL GUIDE by Ali & Ripley, A FIELD GUIDE TO THE BIRDS OF THE INDIAN SUBCONTINENT by Krys Kazmierczak, BIRDS OF THE INDIAN SUBCONTINENT by Grimmett *et al.*, and this book), I would say Pamela and Anderton's book is the best.

The BIRDS OF SOUTH ASIA is unique in many ways among all the other available field guides. It contains 3,400 illustrations in 180 plates, 1450 colour maps, 1000 sonograms of vocalization – the first time in a bird book of South Asia, specimen measurements, alternative names, complete data on identification, status and distribution, and habits for each species, comprehensive index, list of endemic and near endemic species, brief ornithological histories of hypothetical species, new information and many taxonomic changes. The book also includes for the first time Afghanistan and Chagos Archipelago, traditionally excluded from South Asia (India, Sri Lanka, Pakistan, Nepal, Bangladesh, Bhutan and Maldives); the authors justify "These countries form a natural biogeographic region largely bounded by mountains and ocean. Several West Himalayan species reach the western limit of their ranges in the mountains of north-eastern Afghanistan, while the Chagos form a natural part of the chain of atolls of the Maldives Ridge."

Pamela C. Rasmussen (PCR) is the author of the text, while John C. Anderton is the chief illustrator. John has worked as illustrator for many books and journals, but this is his first comprehensive ornithological publication. Some well-known experts on Asian birds, like Per Alström, Nigel Collar, Bruce Beehler, Willian C. Clarke, Pratap Singh, Craig Robson, Philip D. Round, Deepal Warakagoda, have also contributed content for the book. PCR has exhaustively examined the status of species, particularly those included by Meinertzhagen, a notoriously dubious character, and the prolific E.C. Stuart Baker, who had a tendency to drift from the truth. In the taxonomy, 1441 species are listed, 1289 without any reasonable doubt, 58 are vagrants, 85 species are considered 'Hypothetical', requiring further data to be definitely included in the avifauna of the region (Appendix I). These are presented in a darker shade of text type. Twenty-four species have been rejected for which reasons are given (Appendix II). Taxonomic changes have been effected in 198 species from Ali & Ripley's HANDBOOK and 128 from Inskipp *et al.*, conspecific and composite species have been indicated (Appendix III). Species likely to occur in the region have been described, but not illustrated.

Although I am also very cautious while accepting sight records, especially from notoriously unreliable e-groups, I think not including published sight records of common species, by reputed ornithologists, is a handicap of this book. The use of mainly museum specimen data, some more than hundred years old, has distorted the picture of present distribution of many species. Habitat destruction and fragmentation and development of man-made water bodies, in case of wetland species, have altered the distribution of

many species. There are now many bird watchers and good bird field guides, so we regularly get new sight records and range extensions. Lastly, the days of collecting bird specimens are over – it is illegal and undesirable to kill birds for records. Therefore, for new sight records one has to depend on pictures, field notings and the honesty of the observer. Looking at Meinertzhagen's fraud, some museum records could also be as wrong as the sight records!

One of the major criticisms for this book has been the inclusion of a large number of splits or taxonomic changes - a total of 198 species. Conventionally, a taxonomic split or a new species is first described in a peer-reviewed journal before it is included in popular field guides. This was done in some cases, e.g. Slender-billed *Gyps tenuirostris* and Long-billed *G. indicus* vultures, *Seicercus* sp. warblers; but for most taxonomic changes listed in this book, detailed papers have not been published yet. I think including new taxonomic changes is another strength of this book. At least, birdwatchers will start looking more critically at the species that PCR has suggested to be considered as new taxonomic splits. Till full papers are published, can we not consider these splits as 'proposed'? PCR has shown that 71 splits are from extralimital species, 141 splits are within the region, 9 are new or overlooked species, 13 are reallocation of race(s) and 2 are deletions as they are not considered as valid species. Fifteen species are splits from extralimital as well as within the region. In total, PCR has added 128 species-level differences; of these 83 are additional species for the region (including splits and overlooked species), the rest are extralimital splits or reallocation of races.

Mercifully, PCR has followed the classification of Peters and Ali & Ripley (later used in the BNHS ENVIS Newsletter No. 6, by R. Manakadan and A. Pittie). For old timers like me, changes brought by Grimmett *et al.* both in the order and English names were quite painful and I always found it a little difficult to find a particular species in Grimmett *et al.* despite having used the book in the field for almost seven years. PCR has restored my confidence that I have not forgotten Indian birds!

The strength of any bird field guide is its illustration and morphological description through which species are identified; description is minimal in Volume I due to space constraints. Unlike Grimmett *et al.*, the plates are not cluttered, so finding a species is quick. Although John C. Anderton is the principal artist, he has illustrated only 70 of 180 plates; the plates are of variable quality. John Schmitt has illustrated 31 plates (including three which he shared). Schmitt is a master of raptor illustrations, as can be seen in the book. The raptors in flight are excellent, with the minutest details. I particularly like his illustrations of harriers in flight. Other noteworthy illustrators for the book are T. Schultz (thrushes), H. Burns (parakeets, sandgrouse), McQueen (owls, small passerines) and B. Zetterström (larks).

A major drawback for such books is the distribution maps, especially when they are drawn mainly based on museum specimens and authentic published records. For a region like South Asia, with rather limited number of serious ornithologists and birdwatchers, such maps show more the distribution of collectors/ornithologists than the actual distribution of birds!

While the breeding distribution of Bronze-winged Jacana is illustrated with green (year round resident), the Pheasant-tailed Jacana is shown as breeding migrant (yellow); (Plate 50, p. 110). The Bronze-winged Jacana is frequently recorded in south India. My experience is that both these species show great movement, especially in summer, in search of suitable water bodies, so why has this not been shown in the case of Bronze-winged Jacana?

The other qualities of this book are the size, morphological and habitat tips given along the distribution maps. For example, Purple Swamphen is larger in the north than in the south (Plate 49); the Gold-fronted Leafbird in the north has a blue throat, while in the Western Ghats and south India it has a black throat (Plate 108); and the Tibetan Lark is found in alpine bogs, steppe. However, for difficult and confusing species such as warblers (*Phylloscopus*, *Hippolais*, *Acrocephalus*, *Seicercus*), the FIELD GUIDE is not very useful, and one has to refer to the bulky Vol. II for details of plumage and song. Volume II weighs 1.5 kg and will not be easy to carry in the field.

Volume II intriguingly called "Attributes and Status" deals with more detailed text. The Preface is written by Bruce Beehler, another famous student of Dr. S. Dillon Ripley. This book was originally planned by Ripley but due to his long debilitating illness, which kept him bed-ridden, he could not fully supervise the work. The book was released 4 years after his death. As a tribute to this doyen of Asian ornithology, the subtitle for the book is "The Ripley Guide". The Introduction covers 23 pages and deals with scope or coverage of the book, Geography and avifauna, Moult and plumage, Measurements, Illustrations, Identification, Vocalizations, Taxonomy, Maps, Records, History of ornithology in South Asia, and Conservation. Families or groups are identified by blue strip (in both volumes).

For each species, the English, scientific and alternative names are given, followed by the HANDBOOK number. Then comes the identity (ID) description – the chief distinguishing characters are given in bold. For example, White-throated Brown Hornbill *Ptilolaemus austeni* ID is "A mid-sized ***brown*** hornbill with a low ***casque on pale yellowish bill***. Male has

white cheek and throat...." Another example, the ID of White-bellied Woodpecker *Dryocopus javensis* is "***Very large black woodpecker*** with ***whitish-buff flanks and upper belly*** and frilly ***red crest*** ...'. I find the bold tips in the description very useful for quick identification. ID is followed by 'Size', and then distribution, termed 'Occurs'. Unfortunately, the 'Habits' section is not in detail, perhaps to keep the number of pages down. To know the habits and behaviour of birds of South Asia, I find that there is still no substitute for the HANDBOOK by Ali and Ripley. The 'Voice' section is more detailed than 'Habits' for most species. This section is also one of the main attractions of this book. For people who can understand sonograms, this book is an asset. PCR should be congratulated for giving attention to call/songs of birds, because for many species this is the easiest way to recognize them (e.g. warblers). 'Taxonomy' description is included only for the new taxa or splits. It is reasonably detailed, but not as detailed as one expects in a research paper.

The second and third covers have thumbnail images of birds, which act as the plate key. This is extremely helpful to quickly find a particular group/species. Small identification differences such as 'Pale *Sterna* terns', 'Dark terns and skimmer', 'Larger pied woodpeckers' and "Green and brown woodpeckers' are given in these images, which further help in the field.

All in all, this is a fine and useful book and a landmark publication on Asian birds. The production quality is high – nothing less can be expected from Lynx Edicions, the publisher of another remarkable book, HANDBOOK OF THE BIRDS OF THE WORLD. The price is a little stiff for many bird watchers in India, but it is worth the investment. If you do not have this book, ask your nearest book shop to get it for you.

■ ASAD R. RAHMANI

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MISCELLANEOUS NOTES

1. OCCURRENCE OF THE RUSTYSPOTTED CAT *PRIONAILURUS RUBIGINOSUS* (GEOFFROY) IN SRIHARIKOTA, NELLORE DISTRICT, ANDHRA PRADESH, INDIA

The status and distributional range of the Rustyspotted Cat *Prionailurus rubiginosus* remains a mystery. Earlier, its range was considered to be confined to south-western India. However, since the 1970s, reports were also obtained from Jammu and Kashmir, Rajasthan, Madhya Pradesh, Orissa, Maharashtra and Gujarat (Jackson 1998; Mukherjee 1998). In Andhra Pradesh, the Rustyspotted Cat has been recently recorded in the Godavari and Telengana regions. Very little is known of the ecology and habitat of the species, reported to range from grassland, scrub and forest, rocky outcrops, areas around human habitation and even in house attics (Jackson 1998; Mukherjee 1998).

In this communication, we report a sighting of the Rustyspotted Cat in Sriharikota, Nellore district, Andhra Pradesh. Sriharikota is an island (181 sq. km), bounded on the west by Pulicat Lake and on the east by the Bay of Bengal. Openings of the Pulicat Lake into the Bay of Bengal skirt the northern and southern boundaries of the Island. The vegetation of the Island comprises of a mixture of tropical dry evergreen forest, scrub jungle, abandoned village forest, grasslands with scattered trees, mangrove-salt marsh patches, and plantations of eucalyptus, casuarina and cashew. The Island is a restricted area under the control of the Indian Space Research Organisation (ISRO). ISRO has a Conservation and Landscape Division for the conservation and management of the biodiversity of the Island.

The BNHS has an on-going 3-year ISRO funded project on the faunal diversity of the Island, and the Rustyspotted Cat has been recorded during some of the field visits during the first year of the project. The first record was of a road kill on October 12, 2002 near the Penubakkam Labour Colony – the skin and skull has been preserved. Two weeks later, we sighted another individual during night census in a mixed forest of eucalyptus and natural forest. This was followed by two sightings of a male (probably the same individual) during the day in scrub-natural forest habitat on the 23rd and 24th of the same month. The fourth sighting was of a three-quarter grown individual during a night census on November 24, 2002 in a casuarina plantation on the coast.

According to the tribal Yanadis, the Rustyspotted Cat, locally known as *Mottabala Pilli*, is common on the Island. It is said to be much more common than the Jungle Cat *Felis chaus* (Jangan Pilli). Yanadis say that the Rustyspotted Cat keeps to the forest, and unlike the Jungle Cat, does not venture into villages to prey on domestic fowl.

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MUKHERJEE, S. (1998): Cats: Some large, many small, 5-13. ENVIS Newsletter (Wildlife & Protected Areas): Vol. 1, No. 2. Wildlife Institute of India, Dehradun.

2. OCCURRENCE OF THE RUSTYSPOTTED CAT *PRIONAILURUS RUBIGINOSUS* (GEOFFROY) IN NUGU WILDLIFE SANCTUARY, KARNATAKA

As part of our study on lesser-known mammals in Karnataka, we surveyed the Nugu Wildlife Sanctuary (3032 ha) for small and nocturnal mammals. The Sanctuary lies between 11° 52' 47" - 11° 59' 00" N and 76° 26' 10"-76° 28' 37" E. The altitude varies between 742 and 959 m above msl and the mean annual rainfall is about 1000 mm. The major vegetation type in the Sanctuary is scrub forest. The survey was carried out during nights by flashing light from a jeep moving at the speed of 10 km/hr. On April 16, 2003 at 1950 hrs, we spotted a Rustyspotted Cat (*Prionailurus rubiginosus*). The animal was in a Fig (*Ficus bengalensis*) tree at a height of about 5 m, and the tree height was about 16 m. The animal was sitting on a branch with thick foliage. Because of the disturbance caused by our presence, the animal moved to an open area and became completely visible to us. We watched the animal for about 20 minutes. The white ventral portions were dotted with black spots. The dorsal grey hair with a reddish tinge had rusty spots, and the tail was without any spots or markings. Without any hesitation, we identified the animal as Rustyspotted Cat and later confirmed it by referring to Prater (1998) and Gurung and Singh (1996). The animal was in a tree at the border between the Sanctuary and cultivated croplands. The closest

village was at about half a kilometer.

The distribution of Rustyspotted Cat in India is based only on a few reports about its occurrence: Chakraborty (1978) in Jammu and Kashmir, Pathak (1990) in Gujarat, Chavan *et al.* (1991) in Gujarat, Tehsin (1994) in Rajasthan, Digveerendrasinh (1995) in Madhya Pradesh, Acharjyo *et al.* (1997) in Orissa, Dubey (1999) in Maharashtra, and Rao *et al.* (1999) in Andhra Pradesh. Although the species is reported to be widespread, from southern India to some parts of Kashmir (Prater 1998), the only published report from southern India was from Andhra Pradesh (Rao *et al.* 1999). However, Mukherjee (1998) mentions its occurrence in Mundanthurai plateau on the basis of personal communications from field researchers. Mudappa (pers. comm.) reported its occurrence in Indira Gandhi Wildlife Sanctuary. Our report confirms its occurrence in the state of Karnataka.

All published papers on Rustyspotted Cat are only occurrence reports, and no detailed studies are available on this species. However, each of such reports contributes in understanding its distribution, locality and habitat type. Hence, the present sighting is important, since it marks the 'southern most sighting location' of its distribution in India. The scrub forests of Nugu Wildlife Sanctuary and its edges continuing with croplands had only few tall trees of more than 5 m in height. Since the Rustyspotted Cat is an arboreal species, inhabiting scrub forests, grasslands, and ruins near villages (Gurung and Singh 1996; Prater 1998), special attention must be paid to the maintenance of large trees dispersed throughout such regions where it occurs, as such trees are essential to provide a viable habitat for this species.

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3. DISAPPEARANCE OF ELEPHANTS IN UTTARA KANNADA

We carried out a survey of mammals in Uttara Kannada, Karnataka, between February and April, 2002. During a walk of 198 km in several regions, in addition to direct sightings, the locals, officials of the Public Works Department and Karnataka Forest Department were interviewed to gather information on the occurrence of different animal species in each region. We found that an elephant herd had disappeared from Gersoppa region. Locals and officials stated that during 1992, two elephants were found dead in the backwaters of the Gersoppa Dam. In 1995, three more elephants were found dead in the water. Only one old adult male was left that used to range in the forests between Mastimane and Votehalla on Joga-Gersoppa road. During our survey, we had also found dung and signs of fresh movement of the elephant. But this elephant was also reported dead by the end of 2002. The details on the death of this elephant were not available and not revealed by anyone. However, there are no elephants in the region anymore.

Nair and Gadgil (1978) had reported a herd of elephants from the Gersoppa region that used to range north of River Sharavati, especially in the forests at Badal, Jankadkal, Medini, Herebail, Mahime and Gersoppa. A few herds of elephants were also reported south of Sharavati river at Meginavalley, Kollur Ghat and Nagavalli. Towards the north, a few herds were reported from Dandeli forest area. Nair and Gadgil (1978) also reported two elephants that were shot dead on the banks of Sharavati.

The disappearance of the elephant herd from Gersoppa region has created a more than one hundred kilometre gap between the existing populations at Meginavalley (in the south) to Dandeli (in the north). This is one more example of the local disappearance of a species. It is such processes that result in population fragmentation, and isolation between populations. Another notable result of such local extinctions is also the reduced overall area of occupancy of a species.

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4. MANDARIN DUCKS *AIX GALERICULATA* (LINNAEUS) ON THE SAT TAL LAKES NEAR NAINITAL, UTTARANCHAL

The Mandarin Duck *Aix galericulata* is an East Asian species whose native breeding range is restricted to the eastern part of Russia, northern China and Japan. Its main wintering areas are in the lowlands of eastern China and southern Japan. There is also an introduced feral population in the United Kingdom (Madge and Burn 1988).

In the Indian subcontinent, the Mandarin Duck is a very rare winter vagrant (Grimmett *et al.* 1998). It has only been recorded once in Nepal and once in Bangladesh (Gardiner 1991; Grimmett *et al.* 1998). There are only two records of Mandarin Duck from India, both from the northeast and more than 50 years old. One Mandarin Duck was observed in Assam (Baker 1902), and one in Manipur (Grimson 1934). All observations of Mandarin Ducks from the Indian subcontinent, except the one from Nepal, were at low altitudes.

On February 13, 1999 we were bird watching around Nainital (1940 m above msl), Uttaranchal, northern India. We were counting birds on the lakes of Sat Tal, situated in a hilly wooded area at an elevation of 1300-1450 m above msl (Kazmierczak and Singh 1998). On the lake near the Christian Ashram, we observed three Mandarin Ducks (1 male, 2 females). The birds were very shy and flew away each time we approached within 100 metres, so we used a telescope to observe them. The male was in colourful breeding plumage, which is unmistakable and cannot be confused with any other duck species (see Madge and Burn 1988; Svensson *et al.* 1999). The three observed Mandarin Ducks were the only duck or waterbird species recorded in the area on that day.

This is the third known record for India, and the first in the last 50 years. Except for the observation from Nepal it is also the highest record (1400 m above msl) from the region. According to the available data on the species distribution (Madge and Burn 1988), the observation from the Sat Tal lakes is the westernmost record for Mandarin Ducks from its native Asiatic population.

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5. RECORD OF THE AMUR FALCON *FALCO AMURENSIS* RADDE ON SRIHARIKOTA ISLAND, NELLORE DISTRICT, ANDHRA PRADESH

We sighted the Amur Falcon *Falco amurensis* on two occasions on Sriharikota island, Nellore district, Andhra Pradesh. The first sighting was of an adult male in an open scrub habitat at 1630 hrs on November 23, 2002. We saw probably the same bird in the same place, the next morning. It was perched on an electric wire and allowed close approach (*c.* 25 m). The second sighting was of a flock of 5 falcons in the morning, on May 23, 2003. The birds were actively hunting dragonflies along casuarina plantations on the seashore adjoining the Bay of Bengal.

Ali and Ripley (1987) mention that the Amur Falcon is a rare migratory falcon, which breeds casually in north Cachar (Assam); its main breeding grounds are in China (Ferguson-Lees and Christie 2001). In Peninsular India, they are autumn and spring passage migrants (observed or collected between September and April), migrating along a NE to SW route to East Africa (Ali and Ripley 1987; Ferguson-Lees and Christie 2001). Records of the Amur Falcon in Andhra Pradesh are very rare, being known from only two old records, one from Nellore and the other from Rajamundry (Ali and Ripley 1987; Grimmett *et al.* 1998; Kazmierczak 2000). Thus, our sighting of the species, twice in Sriharikota, which is outside the normal migratory route of the species in India and with a gap of 5 months between sightings, is interesting.

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6. SIGHTING OF ORANGE-GORGETED FLYCATCHER *FICEDULA STROPHIATA* (HODGSON) AT BANDHAVGARH (M.P.): A FIRST RECORD FOR PENINSULAR INDIA

In the first week of January 2002, while on a trip to Bandhavgarh National Park (Madhya Pradesh), a rather strange looking flycatcher drew my attention as it flitted about in the garden of Tiger Trails Resort. The Resort is located in Bijaria village, which is a few kilometres from the National Park boundary. At first, I mistook this flycatcher for the Red-throated Flycatcher (*Ficedula parva*).

A closer look revealed that this flycatcher did have much more than the plain red throat, though it did exhibit the white outer tail feathers similar to the outer tail feathers of the Red-throated Flycatcher (*Ficedula parva*).

The most interesting and striking feature this bird exhibited was the white band across the forehead, which extended up to the eyes, a black chin and an orange 'gorget', which could be clearly seen through the binoculars. The bird was not shy and one could watch it from a distance of less than four metres. I had never seen a flycatcher of this description earlier, which forced me to refer to the available literature to ascertain its identification. Referring to the BIRDS OF INDIAN SUBCONTINENT (Grimmett *et al.* 1998), led me to the conclusion that this new flycatcher in the area was a male Orange-gorgeted Flycatcher (*Ficedula strophiata*).

Mahinder Singh, a colleague, who was stationed at the Resort as a naturalist, later informed me that he had first noticed this bird around mid December 2001; and after that, the bird was seen everyday. The bird was seen around the

same area from day one and also had a couple of favoured perches. A horizontal branch of a small mango tree, about a metre from the ground was the first favoured perch; the second being a hammock placed for tourists just outside the dining area. I asked Mahinder Singh to keep a close watch on the bird every day and record the sightings, as I had to leave for Kanha in a couple of days. I returned to Bandhavgarh on March 9, 2002. The bird was still seen around the same area using the same old favoured perches, the only difference was that it had become bolder and allowed us to watch it from a distance of less than 3 m. A friend of mine even photographed the bird from close quarters. The bird eventually left Bandhavgarh around mid March 2002 and was not seen after that.

According to Ripley (1982) and Grimmett *et al.* (1998), the Orange-gorgeted Flycatcher (*Ficedula strophiata*), is an altitudinal migrant that breeds in the Himalaya from Himachal Pradesh to Arunachal Pradesh and NE India and winters in the foothills up to *c.* 2400 m. Till date, there is no record of the bird being sighted from anywhere in the Peninsula. The sighting of this bird at Bandhavgarh in central India and its prolonged stay, for almost three months, is the first record of this species for peninsular India.

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7. OCCURRENCE OF GREY-HEADED CANARY FLYCATCHER *CULICICAPA CEYLONENSIS* (SWAINSON) IN JAMNAGAR DISTRICT, GUJARAT, INDIA

While surveying parts of Jamnagar district in Gujarat for some rare and endangered plant and animal species, we sighted a Grey-headed Canary Flycatcher (*Culicicapa ceylonensis*). The bird was calling from a small patch of *Acacia nilotica* forest on the leeward side of the main bund of Ranjitsagar Dam in Jamnagar. We saw the bird busy feeding along with five Oriental White-eye (*Zosterops palpebrosus*) and a Common Lesser Whitethroat (*Sylvia curruca*).

The Grey-headed Canary Flycatcher is said to be a common resident, which migrates; it spends winter in southern India and summer in the north (Kazmierczak and Singh 1998). It is said to stay in the Himalaya (up to *c.* 3000 m) and NE hill states, and Bangladesh, winter in the Eastern and Western Ghats in India and Sri Lanka, and almost the entire Subcontinent (Ali and Ripley 1995; Ali 1996). In addition, Ali (1996) mentioned that the bird is practically found in the entire Indian Union, Bangladesh and Pakistan (except the arid north-west portions), resident and local migrant with the species extending its range eastwards to China and south to Malaysia. According to Grimmett *et al.* (1999), this species is a resident, which breeds in the Himalaya, hills of India, Bangladesh and Sri Lanka and winters in the Himalayan foothill and plains of Pakistan, and E and NE India.

Earlier, this species had been sighted in Mandvi Taluka in Kachchh (Himmatsinhji 1958), an arid part of India. Our sighting is the first record of this species in the arid part of Jamnagar district in Gujarat (Photographic evidence provided - Eds). The bird was alone and was sighted in a very small patch of *Acacia nilotica* thorn forest next to an orchard and agriculture lands. It is said to be found in deciduous or evergreen forest, sholas, secondary and mixed bamboo forest (Ali and Ripley 1995; Ali 1996) and in forest and wooded areas (Grimmett *et al.* 1999).

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8. LARGE PIED WAGTAIL *MOTACILLA MADERASPATENSIS* GMELIN IN LADAKH

On the morning of July 7, 1999, two adult Large Pied Wagtails *Motacilla maderaspatensis* were observed on the bank of the Indus river near Likeer on the Srinagar-Leh highway. The birds were easily identified, as the species is familiar to the observers. This is a new sighting for Ladakh, extending the species distribution further north. There are no previously documented records of the species from Ladakh to the best of our knowledge. Ali and Ripley (1998), Grimmett *et al.* (1998) and Kazmierczak and van Perlo (2000) do not mention this area in the species distribution for the Indian subcontinent.

The altitudinal range of the species for the Indian subcontinent is "up to *c.* 900 m (Sikkim) and locally 1500 m (Garhwal, Kulu) or 1700 m (Nepal – Diesselhorst); in the hills of southern India up to 2200 m" (Ali and Ripley 1998). The site where the birds were observed is at an altitude *c.* 3000 m, which considerably exceeds the known range of 2200 m.

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9. GANGES SOFTSHELL TURTLE *ASPIDERETES GANGETICUS* (CUVIER) ATTACKING A MALE PEAFOWL *PAVO CRISTATUS*

The Ganges Softshell Turtle *Aspideretes gangeticus* is present in many water bodies of southern Rajasthan (Sharma 2000, 2002); Madar dam near Udaipur City is one of them. Due to repeated drought, water in dams and ponds in the area is declining fast; even big water bodies like Madar dam are becoming unsafe for the Turtle.

On May 18, 2001, I was checking the availability of water and safety aspects of *A. gangeticus* at Madar dam. While scanning the drying bed of the dam in the morning, I saw a male Indian Peafowl *Pavo cristatus* drinking at the periphery of a burrow pit, present in the bed of the dam. Since this was not a strange or new event I ignored it and started looking at another site of the dam. After a lapse of few seconds, an unusual wing flapping action of the Peafowl drew my attention. I observed the bird through my binoculars and found that a large *A. gangeticus* had caught hold of the Peafowl's neck and was trying to pull the bird into the water. The Peafowl was trying its best to get out of the turtle's grip. After a short struggle, the bird became motionless. I did not disturb the turtle and left the site. The next morning, I reached the dam and minutely checked the dead bird. A big portion of the neck of the bird was missing.

The Ganges Softshell Turtle is an omnivorous species and its diet comprises a wide range of aquatic vegetation and animal food like fish, molluscs, frogs and crustaceans. It is also a very prominent scavenger (Tikader and Sharma 1985). Adults feed on other softshells, turtles and waterfowl too (Daniel 2002). The present observation indicates that this giant turtle can kill big sized terrestrial birds like *Pavo cristatus* and can predate on them if the opportunity is available.

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10. OCCURRENCE OF DEEP-SEA SHARKS OFF THE PONDICHERRY COAST

On January 17, 2000, members of our dive group landed on the beach at Solainagar, a suburban village of Pondicherry where we noticed a pile of dead shark carcasses dumped on the sand. Investigating this discarded catch, we at once realised that these were not ordinary sharks. These had the characteristics of deep-sea sharks, usually seen only in photographs taken from submersibles.

The sharks, about 200 in number and ranging from 3 to 140 cm, had a dull brown to blackish colour; some had bizarre fins, while others had long snouts. Some had thorn-like spines running along the body; others had odd spines sticking out. Their bodies were soft and flaccid and many had their internal organs sticking out. The eyes were noticeably big and bulging.

On quizzing the fishermen, they revealed that on the previous night they had dropped a long line in waters about 1,000 m deep some 30 km off the coast and had hauled up this catch. These bizarre sharks held no commercial value for them, and hence they were discarded.

From this discarded lot, three sharks were taken to the Sri Aurobindo International Centre of Education (SAICE) campus for display to students. Here they were photographed and measured. The biggest of them (130 cm; estimated length) had to be later thrown back onto the beach, as it was too big to be accommodated in a museum jar, while the two smaller ones were preserved in formalin.

A search was conducted on the Internet and we had responses from various scientists and specialists who expressed interest in this catch. A 'tele-identification' of the specimens was done.

The biggest fish was a Long-nosed Chimaera, a member of the genus *Neoharrita*. Of the three species of this genus recorded so far, one occurs in the southern Caribbean, the second off the West African coast and third has been recently described from the Gulf of Aden and eastern Somalia. Our specimen of the Chimaera, as examined by specialists via photographs, differ from the described species, and are probably a new species or a range extension of the Somalian species.

The second fish (64 cm; total length) is Bramble Shark *Echinorhinus bruccus*, which has a worldwide distribution, normally occurring at water depths of 400-900 m, sometimes shallower.

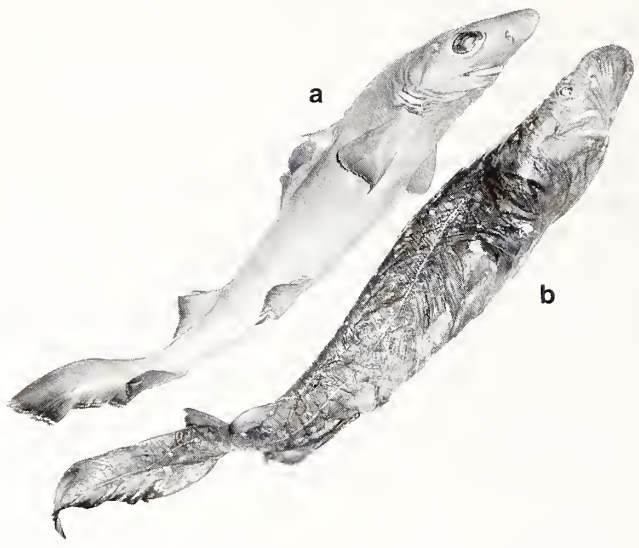

Fig. 1: Deep-sea sharks caught off Pondichery coast:
a. Gulper Shark *Centrophorus granulosus*
b. Bramble Shark *Echinorhinus bruccus*

The third fish (44 cm; total length) is tentatively identified as a Gulper Shark of the genus *Centrophorus*, probably *Centrophorus granulosus*, found in all the oceans but not recorded previously from India.

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We thank Philip Hastings, Associate Professor and Curator of Marine Vertebrates, Scripps Institute of Oceanography for identifying the specimens, albeit via the web and e-mail. And of course all this messy affair of dead, stinking sharks littering the campus would not have been possible without the understanding support of the faculty and staff of SAICE, to whom we are grateful.

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11. EXTENSION OF RANGE OF *PUNTIUS ARULIUS ARULIUS* (JERDON) IN VARIOUS STREAMS IN THUNGABADRA RIVER BASIN

Puntius arulius (Jerdon) was described from Cauvery river at Srirangapatanam (Jerdon 1849). Day (1875-78) recorded the species from Nilgiri and Wynaad hills. Shaji (1998) and Manimekalan (2000) recorded the species from various streams in Kabini and Vythiripuzha rivers (tributaries of Cauvery river). The distribution of the species was from Tamil Nadu in rivers of Cauvery drainage (Jayaram 1999). It is a rare barb having very restricted distribution and known only from Cauvery river basin. Recently, Gopi (2000) reported the occurrence of the species from Wynaad, Kottayam, Thenmalai, Kulathupuzha, and Jayaram (1999) reported it from Periyar Lake, Kerala. Occurrence of *Puntius arulius arulius* from various streams inside Kudremukh National Park, upstream of Thunga and Badra rivers (Kutch hole – 13° 12' 0.97" N, 75° 13' 48.1" E; Vimalanathi - 13° 19' 49.7" N, 75° 06' 15.7" E; Korkanhalla 13° 20' 22.3" N, 75° 10' 19.4" E and - Kummulikheri 13° 21' 31.1" N, 75° 11' 26.5" E), shows its range -extension to the other major east flowing rivers in Karnataka (Table 1).

Description: D iii 8; A iii 5; P i 14; V i 8

Body laterally compressed, dorsal and ventral equally arched, its depth 3.2 to 3.5 times in standard length. Head small, its length 3.5 to 3.7 times in standard length. Mouth subterminal with one pair of thin maxillary barbels. Dorsal fin inserted midway between tip of snout and base of caudal fin, its last unbranched ray non-osseous and weak. Scales moderate, lateral line complete with 21 to 24 scales, predorsal scales 8. A prominent, fairly deep pectoral pit is present. Further morphometric measurements are given in Table 1.

Colour: In life, black olivaceous-green, blending to silvery on belly with a reddish lustre; scales over lateral line with numerous tiny green spots; operculum with an iridescent green dot; three black bands on body, the transverse bars are at the level of dorsal fin origin, and the others at the level of anal fin and caudal peduncle. Pelvic and caudal fins reddish, with bright red tips.

Remarks: The occurrence of *Puntius arulius arulius* in Banatheerthem, Kil Manimuthar and Kanamparai river in Tamiraparani river basin by Johnsingh and Vickram (1987) is due to misidentification of this species with *Puntius arulius tambraparniei*. A detailed study has been carried out on the macro-, meso- and microhabitat requirements in the Gadana river basin (Sankaranarayanan 1999), the Manimuthar river basin (Johnson 1999) and the Tamiraparani river (Arunachalam 2000), and the existence of the subspecies has already been established (Jayaram 1999; Arunachalam. *et al.* 2000). Variation in phenotypic plasticity of *Puntius arulius tambraparniei*

Table 1: Morphometric measurements of *Puntius arulius arulius* in various streams of Thungabadra river basin

Proportion	Kutch hole (n=4)		Vimalanathi (n=4)		Korkanhalla (n=4)		Kummulikheri (n=1)
	Range	Mean	Range	Mean	Range	Mean	
Total length (mm)	75.3 - 109.55	88.79	63.5 - 85.19	74.94	67 - 77.15	72.5	82.75
Head length / Standard length	24.76 - 25.90	25.34	23.67 - 27.07	25.32	21.57 - 26.84	24.62	24.81
Body depth / Standard length	32.51 - 36.25	34.27	31.00 - 36.90	33.76	34.77 - 39.84	36.71	34.44
Predorsal length / Standard length	46.94 - 49.53	48.3	4.01 - 49.96	48.00	48.15 - 50.28	48.96	50.20
Post dorsal length / Standard length	54.43 - 55.83	55.2	53.63 - 57.77	55.39	53.44 - 57.92	55.28	55.00
Pectoral fin / Standard length	20.73 - 24.20	21.82	20.92 - 22.95	21.85	21.30 - 21.68	21.55	22.15
Pelvic fin / Standard length	21.67 - 24.61	23.23	21.53 - 24.19	23.12	22.62 - 23.86	23.44	22.40
Caudal fin / Standard length	28.12 - 29.31	28.64	25.25 - 29.82	27.88	22.72 - 28.0	25.94	28.23
Prepelvic length / Standard length	47.14 - 51.32	49.03	46.48 - 51.32	48.96	48.64 - 52.1	49.93	48.87
Eye diameter / Head length	7.81 - 9.25	8.54	8.07 - 9.01	8.38	7.8 - 9.94	9.06	7.50
Interorbit width / Head length	5.34 - 6.4	5.72	5.0 - 5.89	5.45	5.62 - 6.86	6.15	6.16
Snout length / Head length	13.01 - 14.96	14.32	12.84 - 15.69	13.75	13.46 - 15.76	14.49	12.44
Pectoral length / Head length	81.51 - 97.76	86.23	78.24 - 96.97	86.78	77.87 - 88.92	82.92	89.28
Pelvic fin / Head length	85.19 - 99.39	91.74	79.54 - 96.24	88.33	84.28 - 97.86	90.46	90.27
Height of caudal peduncle / Length of caudal peduncle	50.17 - 57.53	53.09	50.12 - 56.44	52.47	50.62 - 56.63	54.29	60.39
Pectoral to Pelvic fin / Pelvic to Anal fin	98.58 - 102.54	100.67	99.18 - 103.76	101.28	92.25 - 99.71	96.77	101.76

from streams, check dams, canals and wetlands in Tamiraparani river basin has already been documented (Shanthi 2002). In our ongoing project we also collected several specimens of *Puntius* sp. from Thenmalai, Kulathupuzha and Kottayam, which is closely related to *Puntius arulius arulius*, but it varies widely from *P. arulius* in several morphometric characters. Hence, the occurrence of this species (Gopi 2000) from this area needs further confirmation.

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12. NEW RECORDS AND RANGE EXTENSION OF FRESHWATER FISHES TO THE NILGIRI BIOSPHERE RESERVE, SOUTH INDIA

The Nilgiri Biosphere Reserve (NBR) is spread over the tri-junction of three states in southern India – Tamil Nadu, Kerala and Karnataka, and hence is under the joint jurisdiction of the forest departments of the three states. It is located at 10° 45'-12° 15' N and 76°-77° 15' E and has an area of 5,520 sq. km (Daniels 1993). It encompasses a complex of protected areas and reserve forests, including Nagarahole and Bandipur (Karnataka), Wynaad, the slope of Nilambur, Silent Valley and Siruvani Hills (Kerala), and Mudumalai, Nilgiris and Mukurthi (Tamil Nadu). Of these, Bandipur, Nagarahole, Silent Valley and Mukurthi are national parks, and Mudumalai and Wynaad are wildlife sanctuaries. Bandipur is a Tiger Reserve and also the single largest protected area (874.0 sq. km) within the NBR (Anon. 1981). The annual rainfall in the area ranges from 500 to 7000 mm (Mohanan and Balakrishnan 1991) and elevation varies from 80 m (Nilambur plains) to over 2,600 m

above msl (Nilgiri plateau) (Gadgil *et al.* 1986). The NBR forms one of the critical catchment areas in Peninsular India, as many major tributaries of the Cauvery, Chaliyar and Bharathapuzha river systems have their sources and catchment area within the reserve boundary. In addition, there are both westward flowing rivers, which include the Chaliyar, Kadalundi and Bharathapuzha and their tributaries and eastward flowing rivers of the Cauvery river system such as Noiyal, Bhavani, Kundah, Coonor, Pykara, Kabini and Gundal and their tributaries. All of these river systems provide excellent habitats for fishes.

1. *Barilius canarensis* was reported from Karnataka and Kerala parts of the Western Ghats (Jerdon 1849; Day 1878, 1889; Hora 1942). But in the present study, not a single specimen could be collected from Kerala and Karnataka part of NBR. However, it was collected at Kovaicourtalam, upstream of Noiyal river of Bhavani river basin. This is a new record to Bhavani river.

2. The distribution of *Neolissochilus wynaadensis* was known from Wynaad and Vythiri regions of Kerala (Day 1873, 1878, 1889; Jayaram *et al.* 1982; Daniels 1993; Easa and Basha 1995). During the present study, this species was collected from Nilpuzha, Vythiri and Kallar. Record of this species in Kallar of Bhavani river is a new record to Tamil Nadu part of the Western Ghats. Earlier workers (Mukerji 1931; Easa and Basha 1995) on Bhavani have not reported this species.

3. The distribution of *Garra hughi* Silas (1954) is so far known from the Cardamom and Palani hills (Talwar and Jhingran 1991; Jayaram 1999); this is the first record of this species in NBR.

4. *Clarias dussumieri* was recorded from Chaliyar river basin (Karimpuzha, Arikayampuzha and Panapuzha) and Kabini basin (Nulpuzha). Easa and Basha (1995) reported this species from Karimpuzha stream. But in the present study, this species was not recorded from Karimpuzha stream.

5. *Osteobrama neilli* was reported from Bhavani river at base of Nilgiri hills (Day 1873; Hora and Misra 1940; Daniels 1993). In the present study, this species was recorded from Nugu of Kabini river basin but not from earlier reported places. It also extended its range to Kabini river basin.

6. *Crossocheilus latius latius* has been reported up to Maharashtra (Hamilton 1822; Bleeker 1860; Day 1877, 1889; Hora and Misra 1938; David 1963; Menon 1974; Singh and Yazdani 1991; Jayaram 1999). Later, Easa and Basha (1995) reported this species from Kerala part of the NBR, but they did not mention the exact location. The present study showed the extended distribution to Belimeenthurai of Moyar river.

7. Many workers reported the distribution of the *Batasio travancoria* from and outside the NBR. Hora and Law (1941) described this species from Perunteraruvi, a tributary of Pamba river at Edakadathy. Later, many workers reported it from different places. Silas (1951) reported from Anamalai Hills, Jayaram *et al.* (1976) from Cardamom and Agastya hills of the Western Ghats, Raghunathan (1989) from Coorg district, Karnataka and Easa and Basha (1995) from Chalikal of Chaliyar river basin. The present study extends its distribution to Nulpuzha of Kabini river basin.

8. Pethiyagoda and Kottelat (1994) described *Travancoria elongata* from Chalakudy river near Vettilappara. After Pethiyagoda and Kottelat (1994), this species has not been reported from anywhere. The present record extends its range to Kovaicourtalam upstream of the Noiyal river of Bhavani basin.

9. Easa and Basha (1995) recorded *Channa striatus* from Karimpuzha, Nulpuzha, Kabini river, and Ajithkumar *et al.* (1999) reported it from Chalakudy river. In the present study, this species was colleted from the same location and Ombatta swamp of Mudumalai Wildlife Sanctuary. The present record extends its range to Bhavani river basin.

10. The distribution of *Silurus wynaadensis* was known, so far, from Wynaad hills (Day 1873, 1877, 1889; Hora 1937). It has not been reported subsequently from Wynaad hills. The present study extends its range to Thavalam and Kallar of Bhavani river.

11. Fish fauna of the Silent Valley was studied by Rema Devi and Indra (1986); Easa and Basha (1995) reported ten species from Silent Valley National Park. In the present study, ten species were collected from the same area. *Danio aequipinnatus* was collected from three locations (Madrimaramthodu, Eramalathodu and Pathrakadavu), which is a new addition to Silent National Valley Park.

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13. NOTES ON THE LIFE HISTORY OF *LACCOPTERA* (*SINDIA*) *SULCATA* (OLIVIER) (COLEOPTERA: CHRYSOMELIDAE: CASSIDINAE)

In the Fauna of British India, Maulik (1919) had included 3 species under the genus *Sindia*: namely *S. clathrata* (Fabricius), *S. foveolata* (Boheman) and *S. sedecimmaculata* (Boheman). Spaeth later added one more species, namely *S. jawalagiriana* Spaeth (Borowiec 1999). Borowiec (1994) expressed the opinion that *Sindia* Weise should be treated as a subgenus of *Laccoptera* Boheman. According to this recent revision, only two species are retained under the subgenus *Sindia* – *S. clathrata* (= *sulcata*) and *S. sedecimmaculata* (Borowiec 1999). The name *Sindia clathrata* (Fabricius) has been synonymised under *S. sulcata* (Olivier) (Hincks 1952; Borowiec 1996, 1999). Thus, the valid name today is *Laccoptera* (*Sindia*) *sulcata* (Olivier).

The species has been recorded from various parts of India, such as Nasik (Maharashtra), Kolkata (West Bengal) and 'Malabar' (Maulik 1919); Vissanpeta and Madras (Tamil Nadu), Pondicherry (Borowiec 1990); Pudukkotai (Tamil Nadu) (Borowiec and Takizawa 1991); Jabalpur (Madhya Pradesh) (Borowiec 1996). Some other records are given in the latest Catalogue of the World Cassidinae (Borowiec 1999). Apparently, this insect is widely distributed, though there are only a couple of records from Maharashtra.

For *Laccoptera*, scanty records are available on the life history of only 4 species, although there are more than 60

species under this genus (Borowiec 1999). The species whose life history stages are briefly known include: *L. quatuordecimnotata* Boheman and *L. quadrimaculata* Thunberg (now = *Laccoptera nepalensis* Boheman), both from India (Takizawa, 1980). Some aspects of the life history of an African species *L. excavata* Boheman have been reported by Muir and Sharp (1904).

Major Hingston (1928) presented an interesting natural history account of the larvae of *Laccoptera sulcata*, which contained some detailed information about how the larva constructs the faecal shield on its back. Maulik (1948) later obtained part of Hingston's material from the British Museum of Natural History and published his additional observations. In this paper, we are giving details about the larvae not mentioned earlier. Besides, we describe the ootheca, pupa and eclosion process for the first time.

Four adults (including one mating pair), two freshly hatched larvae and one ootheca were collected on June 24 and 26, 1999, from a Convolvulaceae plant, *Rivea hypocrateriformes*, at Anand Gram Society's Leprosy Rehabilitation Centre, Dudulgaon, Alandi (about 20 km North of Pune City). Subsequently (July-August, 1999), a population was also located near NDA, Pune; we could follow the development of the larvae in the field at this place.

The adults, larvae and oothecae were hand-picked and brought to the laboratory in small plastic bottles, along with leaves of the host plant, and then transferred to large 1l Pet jars. The jars were covered with muslin cloth and kept at 25°C in a B.O.D. incubator. The jars were regularly cleaned and the insects were provided with fresh leaves of the host plant. Observations were carried out with a KYOWA stereozoom microscope, which is calibrated for measurement using stage micrometer. Line drawings to the scale were prepared using an ocular grid. Colour photographs were exposed on Kodacolor Gold (negative) using either Honeywell Pentax or Vivitar V3000 SLR camera. We reared the beetles and larvae under laboratory conditions and studied all the life history stages.

The imago is brightly coloured, with distinct elytral costae and a characteristic pattern of black patches on red background (Fig. 1). Important taxonomic features of this species have already been published (Maulik 1919). The insect can be easily spotted against the background of green leaves in the field because of bright colouration. It cuts large holes in the leaves of *Rivea*. When disturbed, the beetle just moves on to another leaf or falls down, but does not attempt to fly.

Copulation was found to be of usual cassidine pattern. The mated female laid the first ootheca after 5 days. A total of 6 oothecae were laid by the female in two days, on both sides of the leaf, in the early hours of the morning. Each ootheca was circular (diameter 3.8-4.5 mm) and generally had 6-8 eggs arranged in three tiers (generally with 3 eggs in the basal tier). A thin transparent membrane covered each egg. A layer of faecal matter covered each ootheca so that it looked like a black blotch on the leaf (Fig. 2). The arrangement of the eggs within the ootheca is shown in Fig. 7.

The first instar larvae, which hatched out on the fifth or sixth day, were faint yellow brown, with very small black spots scattered throughout the body. The lateral processes were without spinules, except for the base of the first two processes. After 2-3 hours the first instar larvae started depositing faecal matter on each of the supra anal process, forming a more or less 'Y' shaped structure. The first larvae moulted after 3 days.

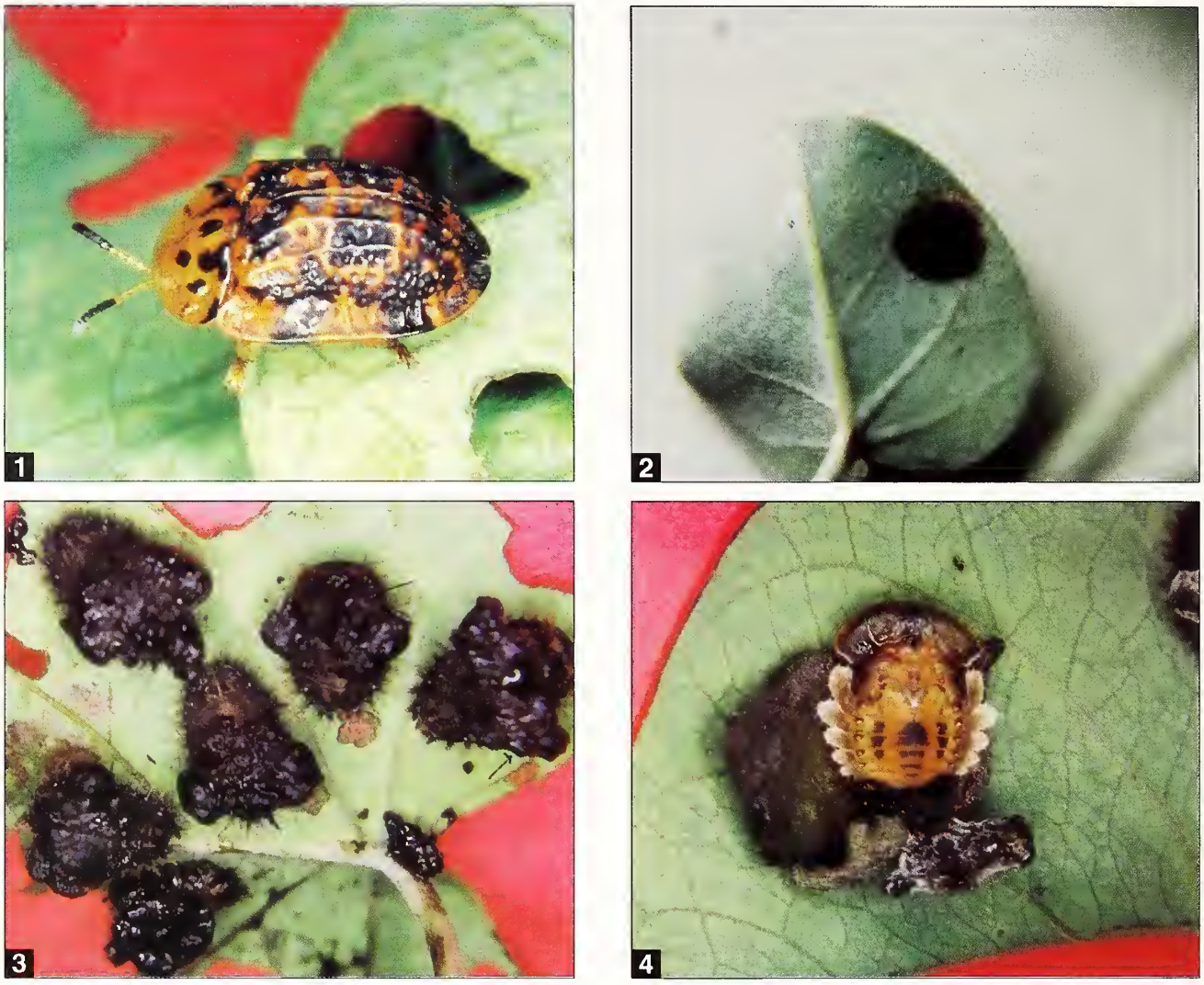
The second instar larvae showed well-developed spinules on the lateral processes. The supra anal processes carried a shield of dark faecal matter and the previous larval skin as an inverted triangular structure. The larvae moulted after 3 or 4 days.

The third instar larvae moulted after about 3 days. Up to the fourth instar, the larvae showed two distinct brown patches on the prothorax while the rest of the body was pale yellow brown. The fifth instar larvae showed usual growth pattern in the first 2-3 days of the instar, but there was acceleration in growth during the last 3 days of the instar. At the end of this accelerated growth phase, the larvae increased in length by more than 1.5, reaching to more than 10 mm. Generally, the last two instar larvae are a darker brown (almost black) compared to the preceding stages.

The first two larval instars fed only on the epidermis and mesophyll of the leaf and did not bore through the entire thickness of the leaf. The fourth and fifth instars, however, cut complete holes and skeletonized the leaves.

Larva (late 5th instar):

The larva has an oblong body, which is broad at the anterior end and somewhat narrow at the posterior end. Overall, it is brownish black dorsally and yellow brown ventrally. Lateral margin has 16 pairs of processes carrying spinules of variable length. Bases of all processes are deep brown or black. The 1st and 2nd lateral processes are fused at the base. Processes 1-4, 6th, 8-10 are long, almost of the same length, while 5th, 7th and 11-14 are smaller than the others. The last 2 processes are the longest. There are 2 small black spinules between the 2nd and 3rd processes. Prothorax is large, rectangular, almost twice as broad as long, with a distinct brownish black patch separated by a faint yellowish brown line medially. There is a light yellow brown patch in the centre of the dark patch on either side. Laterally, at the base of the 4th projection, is a circular, broad and tubular spiracle. The area



Figs 1-4: 1. *Laccoptera* (*Sindia*) *sulcata*, Imago, 2. Ootheca on leaf. Note black covering of faecal matter, 3. Larvae carrying a triangular shield (arrow) composed of faecal matter and previous larval skins, 4. Pupa. (Note the colour pattern. The faecal shield that normally covers dorsal surface is purposely displaced)

surrounding the base of the spiracle is light yellow brown. Mesothorax and metathorax are almost of the same length and possess deep brownish black lateral margins. Prothorax is longer than the two thoracic segments.

There are nine abdominal segments. Viewed from the dorsal side, each abdominal segment shows two transverse rows of small tubercles separated by a depression. Laterally placed, at the base of the lateral processes of first seven abdominal segments, are broad, circular spiracles. The base of each spiracle is surrounded by a broad, black patch, which narrows as it extends medially. The 9th abdominal segment is very small with brown supra anal processes. The basal region of each supra anal process has very small, fine spinules / setae (Fig. 5)

The larva carries large amount of black faecal matter, mixed with larval exuviae, in the form of an inverted, triangular shield that covers nearly the whole body of the larva (Fig. 3). The faecal matter is deposited with the help of highly manoeuvrable, telescopic anal tube, which can extend almost up to the head region dorsally. In this stage, the larva appears as a dark black blotch or dropping of a bird and is often mistaken as such. In some cases one can notice a healthy growth of fungus on this faecal shield, both in laboratory reared and wild population of larvae.

Head is large, somewhat oval, deep brown in colour, with 5 ocelli on either side. Proximal margin of clypeus is black and distal margin is yellow brown. Labrum is somewhat rectangular, black, with a median, transverse, yellow patch. Mandibles are yellow with heavily chitinised, dark brown denticles (Fig. 9). There are three pairs of stout, black thoracic legs; each leg has a single hook like claw (Fig. 11). Ventrally, the body is finely tuberculate.

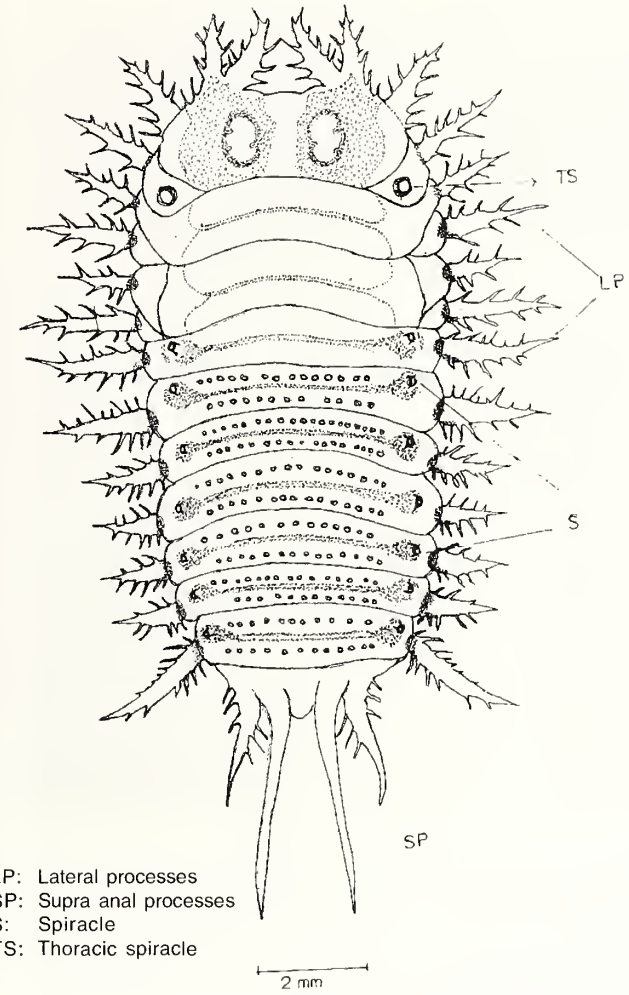


Fig. 5: Prepupal larva (dorsal view, without faecal shield). Note typical cassidine features

The fifth instar larva becomes sluggish and stops feeding about a day before pupation, which takes place after 6-8 days. Before pupation, the larvae are firmly attached to the leaf surface (generally upper surface) by means of some adhesive material secreted by the first two abdominal segments.

Pupa

The pupa is more or less rectangular, dorsally copper brown when alive and yellow brown when preserved, with a distinct black pattern. Prothorax is almost twice as broad as long, with an anterior median notch. The prothoracic margin has a row of spinules of variable length. The first six pairs of spinules are almost of the same length, the 6th and 7th pair is the longest, broad and branched. All spinules are partially red brown. There is a median black band more than 3/4th of the length of prothorax. A prominent inverted 'T' shaped yellow patch marks this band. Lateral and posterior margins of prothorax show prominent black patches (Fig. 4). Mesothorax

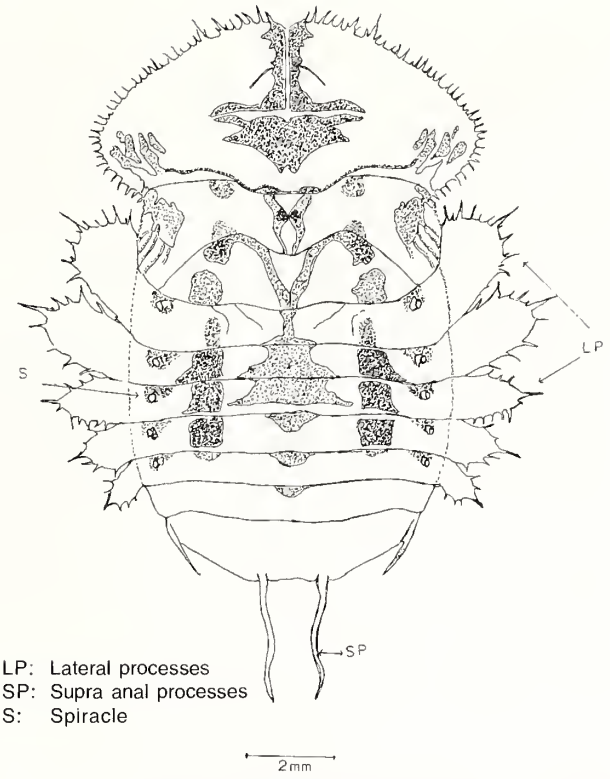


Fig. 6: Pupa (dorsal view, without faecal shield) showing specific colour pattern and other details

and metathorax possess 'V' shaped black marking medially. Lateral margins possess very small black tubercles that appear like black patches. These patches are bilaterally symmetrical.

There are eight visible abdominal segments with a black median band on first six segments. The segments 1-5 bear leaf like lateral projections. Each lateral projection has spinules of variable length. The first projection is long and broad apically and is directed anteriorly, the second is anterolateral and each of the 3rd to 5th is directed laterally. All lateral processes become successively shorter. The terminal spinule of each lateral process is strongly chitinised, red coloured and long in all the processes. At the base of the lateral processes of the first five abdominal segments, there are dorsolaterally placed, broad, tubular spiracles. The size of the spiracles becomes smaller posteriorly. A black patch surrounds the anterior basal margin of the spiracles. In

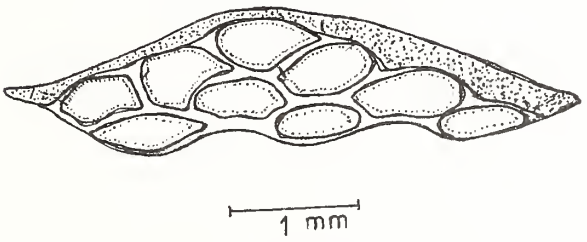
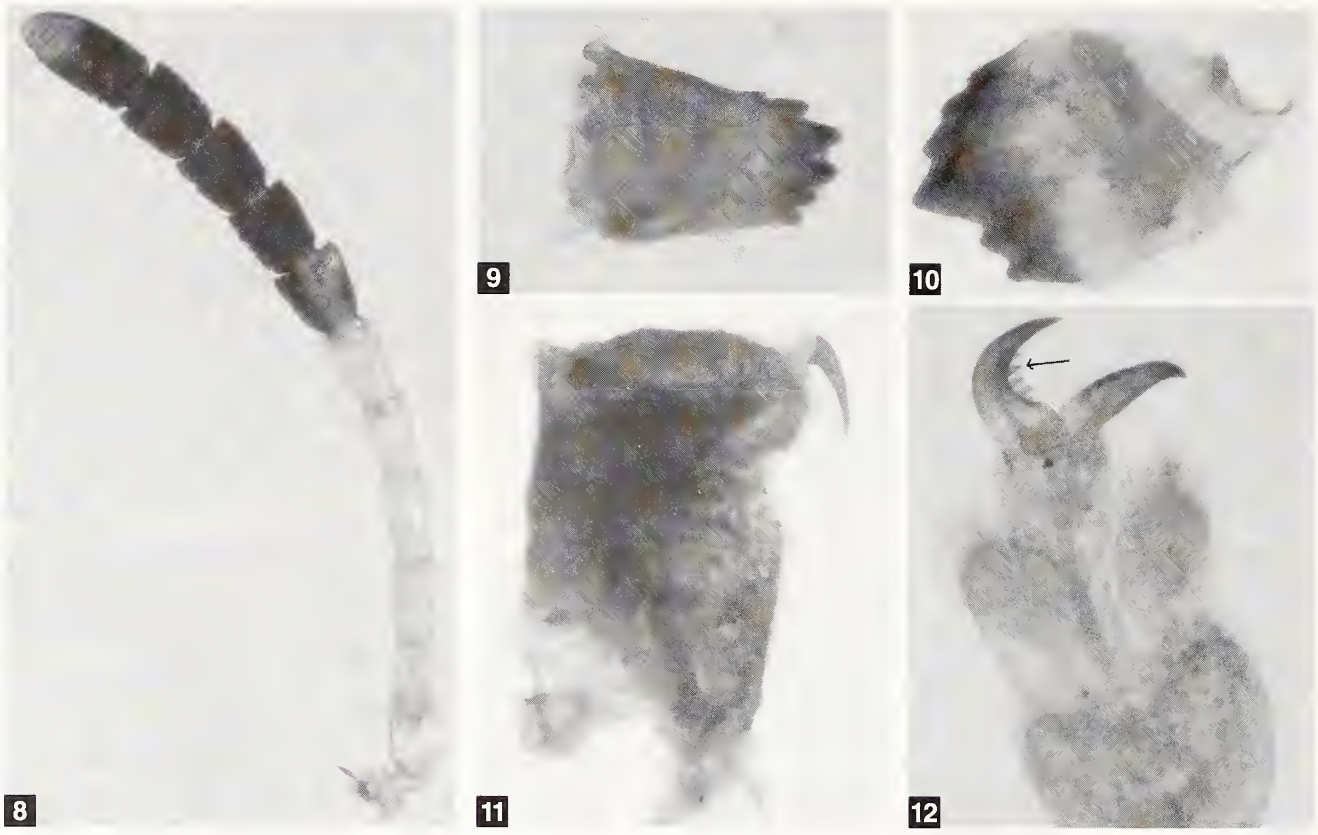


Fig. 7: Cross-section of ootheca to show arrangement of the eggs



Figs 8-12: 8. Adult antenna showing 6 smooth basal joints and 5 dark and hairy apical joints, 9. Larval mandible showing 6 visible, strongly chitinised, denticles (arrow), 10. Adult mandible showing 6 visible, strongly chitinised, denticles (arrow). 11. Apical region of the larval leg showing a single chitinised claw (arrow), 12. Apical region of imaginal leg showing a paired claw with pecten on inner face (arrow)

Table 1: Morphometry of the various stages of *Laccoptera sulcata*

Stages in life cycle	Size in mm		Duration in Days
	Length	Breadth	
Eggs	1.5-1.8	0.7-0.9	5
1st instar	1.6-1.8	0.7-0.8	3
2nd instar	2.1-2.3	1.1	3-4
3rd instar	2.7-3.2	1.7-1.9	3
4th instar	4.0-5.5	2.1-3.4	2-3
5th instar	6.0-10.4	4.0-5.3	5-6
Pupa	11.0-11.4	6.5-6.8	6-7
Adult	11.8-12.5	7.7-8.3	

Length of the larvae is measured from the head to the base of the supra-anal processes while breadth is the maximum breadth, excluding lateral processes in larva and in pupa; it is the breadth of the prothorax.

Sizes mentioned are minimum and maximum of 10 different specimens of a given stage. Exact measurements of freshly moulted larva are not available.

All measurements are of formalin fixed material, except for adults, which were measured when alive.

between the spiracles and the median dorsal black band, there is another longitudinal black band on first four abdominal segments, but it is more prominent on segments 2-4. The 7th abdominal segment gives out a long spiny projection, directed inward and posteriorly. Apical processes are thin, chitinised (except at the tips) and long (length about 3.2 mm), carrying faecal matter and previous larval skins or exuviae (Fig. 6, faecal matter and exuviae removed for clarity)

Imago:

The imago eclodes after about 6 days; the eclosion process is completed within 3 minutes. The fresh imago is lemon yellow and it turns yellow brown later. There are no black spots on elytra at the time of eclosion. The prothoracic black spots are, however, well developed. The elytral spots develop after 2-3 hours. The ventral side of the abdomen becomes deep black after about 3 hours. The adult attains the typical orange red colour after 13-14 days. The other imaginal characters, such as antenna with 5 black apical segments (Fig. 8), chitinised and denticulate mandibles (Fig. 10) and pectinate claws (Fig. 12) can be observed under the microscope.

segment, and the precision with which the faecal shield is made is astonishing. Pupa retains this faecal shield until eclosion. Eggs and larval / pupal protection by faeces and exuviae has been mentioned earlier (Rane *et al.* 2001) and discussed in detail by others (Hilker 1994; Olmstead 1994); and appears to be a common character among many cassidine beetles. Apparently both Hingston (1928) and Maulik (1948) did not mention faecal covering on the ootheca in this beetle and although the comments were made on the process of larval emergence, there was no record as to how many eggs are there per ootheca. Further, neither of them provided diagrams or structural details of the pupa and the period required for eclosion. The photographic record of the life history of this beetle, presented in this paper, will help naturalists and others to identify this colourful beetle.

The change in colouration of the imagines after a gap of about 10-14 days is similar to that reported in *Conchyloctenia nigrovittata* (Boheman) (Rane *et al.* 2001) and *Aspidimorpha miliaris* (Fabricius) (unpubl. data). Apparently many other related beetles, for example *Cassida murraea* L., undergo such colour change and this phenomenon is related in some cases with acquisition of chemicals like beta-carotene. Jolivet (1994) has recently reviewed these interesting aspects of colour change in adult cassidine beetles.

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Note: Three important papers have been published since the original submission and subsequent revision of this paper on *Laccoptera (Sindia) sulcata*. The first is an important paper that reviewed the status of the genus *Laccoptera* in the Oriental region (Swietojanska 2001); second is a detailed paper on morphology of the first / last larva (including details of setae) and bionomics of *Laccoptera foveolata* (Boheman) (Ranade *et al.* 2004) and third, a comprehensive paper on the biology of an African species, *Laccoptera cicatricosa* (Boheman) by Heron (2004).

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14. BATESIAN MIMIC BUTTERFLIES TAKEN IN BY THEIR MODELS AND THE MIMETIC STATUS OF *ARGYREUS HYPERBIUS* L. (NYMPHALIDAE)

Two types of inter-butterfly mimicry are known: Batesian mimicry, where palatable butterflies mimic unpalatable species in order to escape predation; Müllerian mimicry, where unpalatable species, often unrelated, develop very similar wing patterns and behaviour in order to reduce the cost of advertising their unpalatability to naive predators.

The phenomenon of Batesian mimicry involves three participants: a model, a mimic and an audience who is intended to be deceived by the mimic. The audience is believed to consist of insectivorous birds, lizards and perhaps some amphibians. In many cases, mimicry is restricted to the females, while males of the mimic look and behave very differently from the models.

It sometimes happens that there are unintended victims of deception. Peile (1937) mentioned two such instances. He stated "I have on several occasions seen a male *Hypolimnas misippus* L. (Danaid Eggfly) chasing a *Danaus chrysippus* L. (Plain Tiger)...." And "The female (of *Argyreus hyperbius* Johannsen, the Indian Fritillary) somewhat resembles *Danaus* (now *Salatura*) *genutia* Cramer (Common Tiger), and I have taken it in company with that species at flowers. The male (of *A. hyperbius*) is a fast flier, whereas the female, I observed, got up in a leisurely way and sailed, Danaid-like, over the bushes, and I have netted female. *A. hyperbius*, mistaking it for a *D. genutia*."

In the morning, on October 8, 2001, I witnessed an interesting interaction. A worn male *A. hyperbius* had established a beat on our front lawn which, after the rainy season, was covered with a rank profusion of grasses and low growing plants, interspersed with stands of Cosmea I to 3 m high. At 1015 hrs, what appeared to be a female *A. hyperbius* came by from the east and was immediately pounced upon by the male *A. hyperbius*, who forced her to the ground six or eight times in a typical preliminary act of courtship. The female arose each time and made a few yards progress before being forced down again. I thought nothing of the matter until the pair came nearer and I felt that the flight of the female was too perfectly like a *D. chrysippus* for a female *A. hyperbius* to maintain under the circumstances.

The female settled briefly on a Cosmea plant, enabling me to see that it was, in fact, a *D. chrysippus*, not an *A. hyperbius*. Meanwhile, the *A. hyperbius* male settled on a low growing shrub behind the Cosmea stand. When the *D. chrysippus* took wing a little over a minute after settling, it made off fast and low behind the Cosmea, out of the line of vision of the male *A. hyperbius*. The latter, perhaps having realised his mistake, made no move to harass the *D. chrysippus* further.

During the next hour, the male *A. hyperbius* also checked some passing individuals of *Neptis sappho* Pallas (Pallas' Sailer), *Papilio polytes* L. (Common Mormon) and a fresh male *A. hyperbius* who did not challenge the worn *A. hyperbius* for the beat and moved on without stopping.

Evans (1932a) and Wynter-Blyth (1957) treat female *A. hyperbius* as a Batesian mimic of *D. chrysippus*, while Peile (1937) found female *A. hyperbius* in the company of *S. genutia* and even mistook female *A. hyperbius* for *S. genutia*. Larsen (1987) stated that *A. hyperbius* females are very respectable mimics of *S. genutia*. The worn *A. hyperbius* male mentioned above mistook a *D. chrysippus* for his mate. Although it is difficult for an experienced human eye to confuse *D. chrysippus* and *S. genutia* on the wing, from the above references, it appears that *A. hyperbius* females can evidently pass themselves off as either of these species.

Perusal of the literature revealed that the putative Batesian relationship between *S. genutia* and *D. chrysippus* on the one hand and female *A. hyperbius* on the other (Evans 1932a; Wynter-Blyth 1957) had not been empirically proven, in that although the unpalatability of *S. genutia* and *D. chrysippus* are well known (Emmel 1976; Watson and Whalley 1983; Larsen 1987), the monotypic genus *Argyreus* Scopoli was not definitely known to be palatable. There is a brief account of attacks on *A. hyperbius* males (but not females) by Red-whiskered Bulbuls (*Pycnonotus jocosus*) at Longwood Shola near Kotagiri in the Nilgiris (Larsen 1987).

In order to confirm the palatability of *A. hyperbius*, I offered three female and eight male *A. hyperbius* to wild, free ranging, foraging parties of generalised insectivorous birds (mainly *Garrulax albogularis* and *Garrulax leucolophus*). The freshly collected, dead butterflies were presented with the wings closed, so that the mimetic pattern on the *recto* surface of the female's wings was not visible, thus precluding possible preconditioned visual aversion to the female butterflies on the part of the birds. The butterflies were offered sporadically over a period of three years as part of a larger experiment involving other butterfly species. Nine of the *A. hyperbius* specimens were eaten, of which eight were entirely eaten, including all three females. The birds showed no aversion to the butterflies and no distress behaviour was noted while the butterflies were being tasted and manipulated prior to being swallowed or immediately after they were swallowed.

A. hyperbius is known from Abyssinia and along the

Himalaya to Mount Abu, the Nilgiris, Palnis, High Wavys and Sri Lanka north to Japan and Korea and south to eastern Australia. Both the models also occur throughout this range except in Abyssinia and Papua New Guinea, where *S. genutia* does not occur (Shirozu 1960; Lewis 1974; Larsen 1987, 1988). However, the very similar *Salatura philens* Cramer occurs in Papua New Guinea. In Japan, the status of the mimetic relationship is unclear, since both the models are migrants while *A. hyperbius* is a common resident, with up to five annual generations (Kudrna 1974).

Of the eight subspecies of *A. hyperbius* known (Shirozu 1960; Samson 1976), seven are sexually dimorphic with mimetic females, while females of the race *castetsi* Oberthür, from the Western Ghats south of Palghat and the Palni Hills are apparently non-mimetic. *A. hyperbius* is common in suitable localities in the Palni Hills (Evans 1910; pers. obs.) all the year round, so its abstinence from mimicry does not seem to have greatly affected its capacity to survive or thrive.

In terms of altitude, *A. hyperbius* is found from nearly 3000 m in Papua New Guinea (Samson 1976) to 400 m on the plains of northern India (Larsen 1988), but it is commonest between 1200 m and 2200 m in India (*nilgi*) and from 2000 m to 3000 m in Papua New Guinea (Samson 1976). In India, both models are common at low elevation, rarely ascending over 2000 m. The zone in the Himalaya, where all three species are common, is between 1200 m and 1600 m.

The flying time of all three species coincides in all the areas for which information is available, i.e. Baluchistan (Evans 1932b), Chitral (Leslie and Evans 1903), Shimla (de Rhé Philipe 1931), Mussoorie (Mackinnon and de Nicéville 1897-98), Nepal (Bailey 1951) Kumaon (pers. obs.), the Palni Hills (Evans 1910) and the Naga Hills (Tytler 1911-12).

In view of the above facts, namely that *A. hyperbius* and the danaines are sympatric; are on the wing at the same time; are found in each other's company; in the case of *A. hyperbius*, females have a wing pattern similar to the danaines and often affect a flight and other behaviour patterns very similar to the danaines; and that the danaines are known to be unpalatable while *A. hyperbius* is palatable to birds, at least in some parts of its range, e.g. The Kumaon Himalaya and the Nilgiri Hills, it is possible to state with reasonable certainty that *A. hyperbius* females are Batesian mimics of *D. chrysippus* and *S. genutia* in India and possible of some additional, similar looking models in other parts of its range, e.g. Papua New Guinea.

Therefore, the observation of the interaction between the male *A. hyperbius* and the *D. chrysippus* described above is a case of a Batesian mimic taken in by its model.

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15. *COSMOSTIGMA RACEMOSA* WIGHT, A NEW HOST PLANT RECORD OF THE DARK BLUE TIGER BUTTERFLY *TIRUMALA SEPTENTRIONIS* (BUTLER) (LEPIDOPTERA: NYMPHALIDAE: DANAINAE) FROM KERALA

Faunistic exploration and larval rearings of Lepidoptera during October 2002 at the Government College Campus, Madappally, Vatakara, Kozhikode district, Kerala resulted in a new larval host plant record of the Dark Blue Tiger butterfly, *Tirumala septentrionis* (Butler) (Lepidoptera: Nymphalidae: Danainae).

During the study, I collected some butterfly larvae from a small climbing shrub with thin, heart shaped leaves. Upon rearing to maturity, the butterfly was identified as the Dark Blue Tiger *Tirumala septentrionis* (Butler) (Lepidoptera: Nymphalidae: Danainae).

The new food plant was *Cosmostigma racemosa* Wight (Asclepiadaceae). The Dark Blue Tiger has been reported to feed on *Wattakaka volubilis* (Asclepiadaceae), *Vallaris glabra*, *Vallaris solanacea* and *Vallaris heynei* (all Apocynaceae) (Wynter-Blyth 1957; Gunathilagaraj *et al.* 1998; Kunte 2000). Recently, a closely related tiger butterfly, the Blue Tiger, *Tirumala limniace* (Cramer) was reported utilizing *Cosmostigma racemosa* as larval food plant (Nair 2002).

The occurrence and successful rearing of the Dark Blue Tiger *Tirumala septentrionis* (Butler) on *Cosmostigma racemosa* (Asclepiadaceae) confirms it as a new larval host plant.

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16. *PARSONSIA SPIRALIS*: NEW LARVAL HOST PLANT OF ENDEMIC BUTTERFLY MALABAR TREE NYMPH, *IDEA MALABARICA* MOORE (DANAINAE, NYMPHALIDAE)

Malabar Tree Nymph *Idea malabarica* Moore is a butterfly endemic to semi-evergreen and evergreen forests of the Western Ghats of south-western India. In the larval stages, it is considered a monophagous species on *Aganosma cymosa* (Kunte 2000; Wynter-Blyth 1957). In this note, I report a previously unknown host plant for this species.

Malabar Tree Nymph is a common sight at Arippa Ammayambalam pacha in Kulathupuzha Reserve Forests and Shendurney Wildlife Sanctuary (*c.* 8°-8° 5' - 8° 55' N 77° 15' E) near Thiruvananthapuram, Kerala. The vegetation is a mosaic of degraded evergreen and semi-evergreen forests and *Myristica* swamps. On July 16, 1996, during my visit to this area, I observed a female ovipositing on *Parsonsia spiralis* (Apocynaceae). *Parsonsia* is a creeper-straggler found in mangrove, riverine moist deciduous and evergreen forests and *Myristica* swamps. I collected the eggs and successfully reared butterflies from them. Since then, I have repeatedly collected caterpillars from this plant and reared them successfully. It seems, therefore, that *Parsonsia spiralis* is a stable larval host of this butterfly in this area. It is, however, not known whether *Aganosma* is also used here.

Malabar Tree Nymph co-occurs with *Parsonsia* in other forests in southern Western Ghats. It is possible that it uses this plant in these patches as well, but that usage of this host plant has gone unnoticed. Given that this is an endemic and endangered butterfly, it will be important to delineate geographic boundaries or overlap between usage of its two known host plants as this may provide us with an insight into its evolution. It will also be interesting to explore the possibility that it uses other Apocynaceae species in other smaller habitat pockets.

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17. A NEW FOOD PLANT OF THE GREAT EGGFLY (LEPIDOPTERA: NYMPHALIDAE)

While working on the "Ecology of Ants of the Sanjay Gandhi National Park", during September 2000, the larva of a butterfly was found on the herb *Triumfetta pentandra*, Family: Tiliaceae. The larva was collected and reared in captivity to confirm the species. It was given leaves of *T. pentandra* on which it fed voraciously. The larva was velvety brownish-black, with spines on the body, and the head bearing two black horns. The pupa was thick, stout and dark brown (Bell 1910). The butterfly emerged after 12 days from the date of pupation and was identified as the Great Eggfly *Hypolimnas bolina*.

The female *H. bolina* mimics the Common Indian Crow *Euploea core*. Earlier records state that the food plants of *Hypolimnas bolina* are *Fleurya interrupta, Sida rhombifolia, Elatostemma cuneatum* (Family: Urticaceae), *Portulaca oleracea* (Family: Portulacaceae), *Laportea interrupta* (Family: Urticaceae) (Bell 1910).

The occurrence and the successful rearing of *Hypolimnas bolina* on *Triumfetta pentandra* confirms it as its new larval food plant.

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18. *UVARIA NARUM* WALL., (ANNONACEAE), A NEW HOST PLANT RECORD OF THE TAILED JAY BUTTERFLY, *GRAPHIUM AGAMEMNON* (LINNAEUS) (LEPIDOPTERA: PAPILIONIDAE) FROM KERALA

Lepidopteran fauna explorations and larval rearing at the Government College Campus Madappally, Vatakara, Kerala resulted in a new host plant record for the Tailed Jay butterfly, *Graphium agamemnon* (Linnaeus) (Lepidoptera: Papilionidae).

During November 2002, I collected some papilionid larvae from a climbing shrub. Upon rearing to maturity, the butterfly was identified as Tailed Jay, *Graphium agamemnon* (L.). The new larval food plant *Uvaria narum* Wall. (Annonaceae) is a woody climbing shrub common in this area.

The reported food plants of Tailed Jay are *Polyalthia longifolia*, *Annona discolor*, *A. muricata*, *A. squamosa*, *A. reticulata*, *Saccopetalum tomentosum*, *S. gaultheria* (Annonaceae), *Miliusa tomentosum*, *Cinnamomum zeylanicum* (Lauraceae) and *Michelia champaka*, *M. doltsopa* (Magnoliaceae) (Wynter-Blyth 1957; Sevastopulo 1973; Gunathilagaraj *et al.* 1998; Kunte 2000). Chaturvedi (1999) reported *Artabotrys hexapetalus* and *Polyalthia cerasoides* (Annonaceae) as host plants of Tailed Jay Butterfly.

The occurrence and successful rearing of Tailed Jay *Graphium agamemnon* (Linnaeus) on *Uvaria narum* Wall.

(Annonaceae) confirms it as the new larval food plant.

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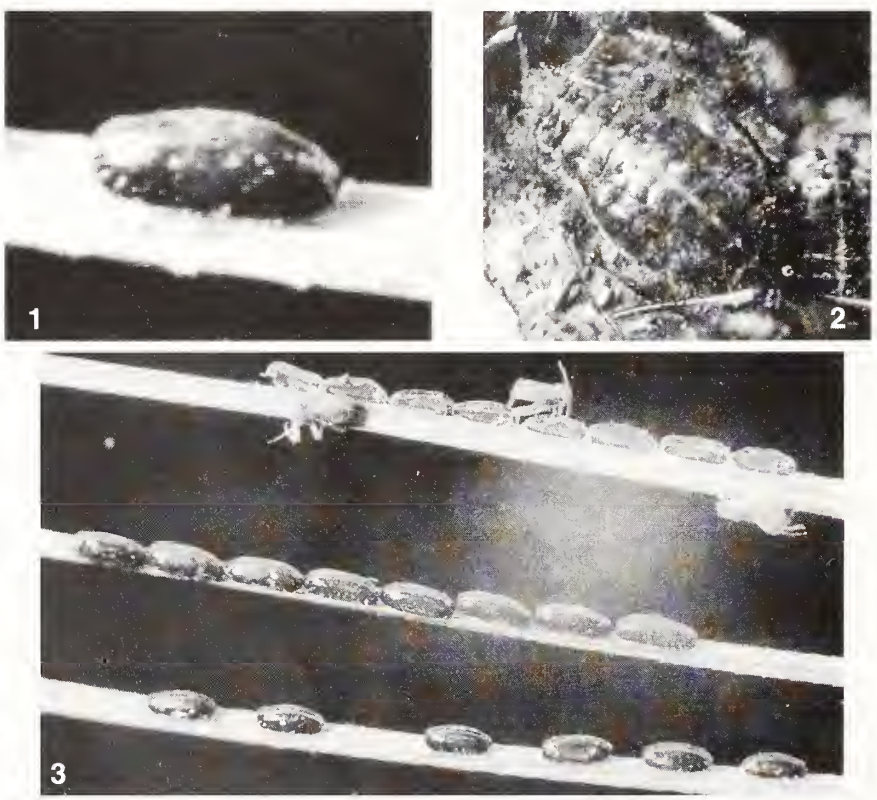
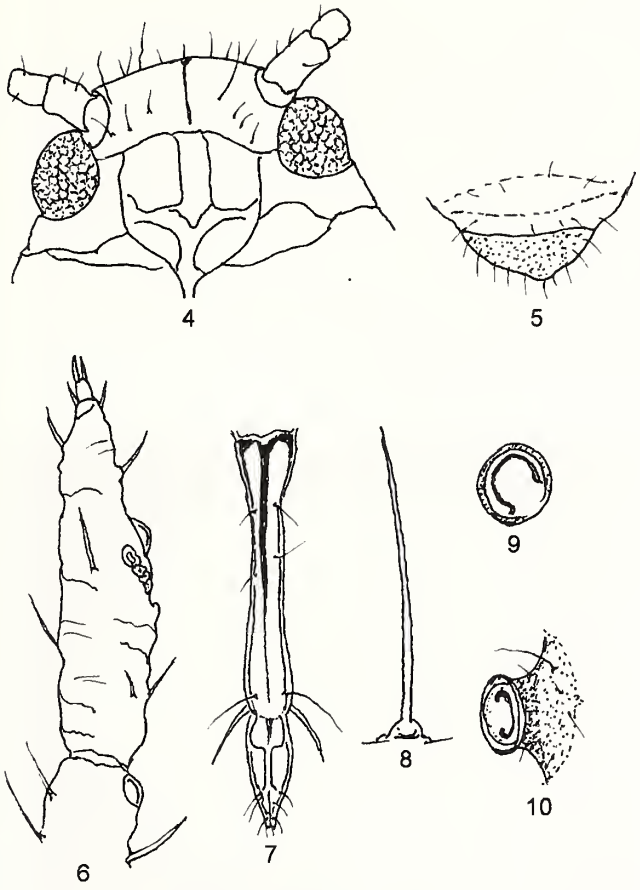
19. DESCRIPTION OF HITHERTO UNKNOWN EGG AND 1ST INSTAR NYMPH OF *CINARA MACULIPES* HILLE RIS LAMBERS (APHIDOIDEA: LACHNIDAE) FROM SHIMLA, HIMACHAL PRADESH

Pine is infested by about 170 species of aphids, including more than 100 species of *Cinara* (Blackman and Eastop 1994). *Cinara maculipes* Hille Ris Lambers principally feeds on *Pinus wallichiana*, Himalayan Blue Pine, abundant in the northwest Himalayan region of India. However, Ghosh (1982) studied one apterous viviparous female collected from



Figs 1-3: 1. Egg of *Cinara maculipes*; 2. Apterous viviparous female; 3. Newly hatched 1st instar nymph and eggs on pine needles



Figs 4-10: 4. Head; 5. Cauda;
6. Antennal segment IV and part of III; 7. URS (IV+V);
8. Hair on head; 9. Dorsal view of siphunculus;
10. Lateral view of siphunculus

Pinus patula, Mexican Weeping Pine – an exotic to India.

Detailed descriptions of apterous and alate viviparous female, alate male and 2nd instar apterous nymph are available in literature (Hille Ris Lambers 1966; David *et al.* 1969; Ghosh 1982). *Cinara maculipes* is distributed in Himachal Pradesh, Jammu and Kashmir, and in Pakistan (Ghosh 1986). So far, eggs and 1st instar nymphs were unknown from this region.

During January 2002, several thick colonies of *Cinara maculipes* (Fig. 2) were noticed feeding among needles and young shoots of Himalayan Blue Pine (local name: Kail) in and around Conifer Campus of Himalayan Forest Research Institute (HFRI), Shimla. In this communication, hitherto unknown eggs and the 1st instar nymphs (Fig. 3) are described.

Material Examined: 65 eggs from pine needles, ten 1st instar nymphs, nine apterous viviparous females and two alate viviparous females (in permanent microscopic slides: whole mount), host: *Pinus wallichiana*, locality: Conifer Campus, HFRI, Shimla, Coll.: S. Chakrabarti, 8.i.2002.

Egg: Elliptical, shiny black, and tough. Longitudinal narrow furrow along the mid dorsal surface of the egg. Length 1.6 ±0.14 mm, width 0.65 ±0.095 mm. Eggs laid on the pine needle, serially glued on the upper surface at an average of 6.73 ±1.09 eggs per needle. Maximum eggs laid per needle are 9 and minimum 5. Egg surface is often covered with minute white waxy particles (Fig. 1).

First instar apterous nymph: Oval, pale yellowish, legs slightly brown, rostrum darker. Body 1.64 ±0.13 mm long, width 0.68 ±0.09 mm at widest area of abdomen. Eyes multifaceted. Length of head (Fig. 4) across eyes 0.6 mm, bears 26 dorsal hairs, short hair 0.029 ±0.01 mm, long hair (Fig. 8) 0.06 ±0.018 mm. Antennae 4 segmented, yellowish, 0.74 mm long, 0.45 x body. Antennal hairs on segment III slender, hyaline, acuminate, 0.12x basal diameter of segment III. One prominent rhinaria apically on antennal segment III. Processus terminalis (Fig. 6) 0.17 mm long, spindle shaped, bears 2 apical and 8 other hairs, having one prominent rhinaria and 6 semicircular conjugant plates. Number of hairs on segments I, II, and III; 5, 4 and 30 respectively. Rostrum 1.35 ±0.09 mm long, slender, acuminate, reaches caudal tip, ultimate rostral segment (URS) distinctly divided into segments IV and V. URS darker, 0.23 ±0.06 mm long, bears 8 hairs each, on segment IV and V (Fig. 7). Legs stout, profusely hairy, length of leg I, II, and III, are 1.53 mm, 1.48 mm, and 1.86 mm respectively. Tarsal claws 0.059 ±0.02 mm long, paired, dark brown, sickle shaped. Length of hind $tarsus_2$ 0.284 mm. Dorsal hairs on tibia larger than lateral and ventral hairs, except for hind tibia where most hairs long. Length of long hairs 0.099 to 0.132 mm and short hairs 0.029 to 0.049 mm. Abdominal tergites faint but distinguishable, hairy, pigmented spots or muskelplatten semicircular to irregularly square, 0.028 ±0.06 mm, present laterally. Siphunculus circular with a chitinized rim inside (Fig. 9), slightly elevated on small sparsely hairy, pigmented cone (Fig. 10), diameter 0.053 ±0.09 mm. Cauda small, dusky, crescent shaped (Fig. 5), length 0.083 mm, width 0.2 mm, bears 0.071 ±0.016 mm long 8-10 hairs.

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20. A NEW RECORD OF THE CORAL *PAVONA VENOSA* (EHRENBERG, 1834) (SCLERACTINIA, AGARICIIDAE) FROM ANAIPAR ISLAND, GULF OF MANNAR BIOSPHERE RESERVE

A total of 208 species under 15 families and 60 genera of Scleractinian corals are reported from India (Venkataraman *et al.* 2003). According to a recent revision, among the four major zones of coral reefs of India, Andaman and Nicobar Islands are the most diverse in coral species (177 forms). Lakshadweep Archipelago ranks second (91 forms) and Gulf of Mannar Biosphere Reserve (GoMBR) ranks third (82 forms) in coral species diversity. The pioneer workers on the Gulf of Mannar (Thurston 1890; Brook 1893; Bernard 1897, 1905; Pillai 1967a, b, c) reported the richness of coral species diversity in this region and described the area as one of the hotspots for marine diversity. Although studies have been conducted on the coral reefs of GoMBR, information about the species diversity is still incomplete. The present report deals with the new record of *Pavona venosa* (Ehrenberg 1834) (Scleractinia: Agariciidae) from Anaipar Island, Gulf of Mannar Biosphere Reserve.

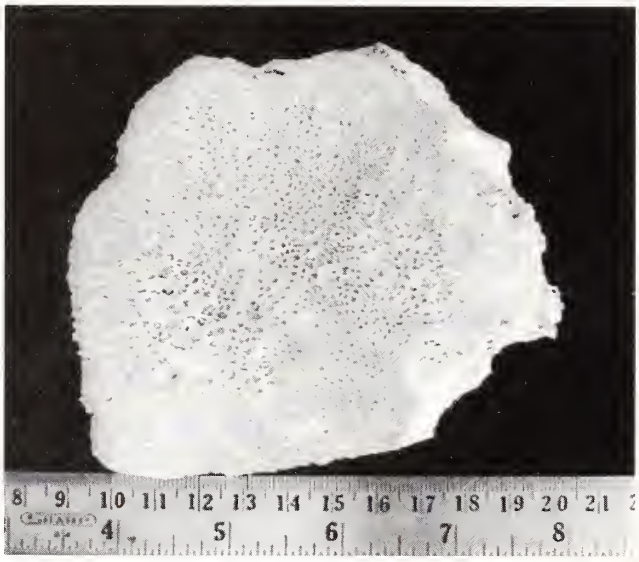

Fig. 1: *Pavona venosa* (Ehrenberg, 1834)

Description

Phylum: Cnidaria
Class: Anthozoa
Subclass: Zoantharia de Blainville, 1830
Order: Scleractinia Bourne, 1905
Family: Agariciidae Gray, 1847
Genus: *Pavona*

The Family Agariciidae includes six extant hermatypic genera – *Agaricia*, *Coeloseris*, *Gardineroseris*, *Leptoseris*, *Pachyseris* and *Pavona* – of which five genera, except *Agaricia*, are reported from India. Most of the genera are colonial. Colonies are massive, laminar or foliaceous. Corallites are immersed with poorly defined walls formed by thickening of the septo-costae. Septa seldom fuse and are continuous between adjacent corallite centres. Species of Family Agariciidae are most similar to those of Family Siderastreidae (Veron 2000).

Fig. 2: Corallites of *Pavona venosa*

The colonies of the genus *Pavona* are massive, laminar or foliaceous, the latter usually being bifacial. The corallites have poorly defined walls. They are small shallow depressions, usually with a central columella, sometimes separated by ridges. The corallites are interconnected by exert septo-costae. *Pavona* closely resembles *Leptoseris,* which has similar corallites but has fine septo-costae. Foliaceous colonies are unifacial in *Leptoseris*, but the distinction between genera may sometimes be unclear. Nine species representing the genus *Pavona* have been recorded in India (Venkataraman *et al.* 2003).

Pavona venosa (Ehrenberg, 1834) (Figs 1, 2)

Pavona (*Polyastra*) *venosa* (Ehrenberg), Wells 1936. *Ann. Mag. nat. Hist. Ser.* 10: 550, pl. 9, figs. 4, 5.

Pavona (*Polyastra*) *venosa* (Ehrenberg), Umbgrove 1939. *Zool. Meded. Rijksmus. nat. Hist. Leiden* 22: 48, pl. 15, figs. 1-5.

Pavona (*Polyastra*) *obtusata* (Quelch); Nemenzo 1955. *Nat. Appl. Sci. Bull.* 15(1): 16, pl. 9, fig. 4.

Pavona (*Polyastra*) *obtusata* (Quelch); Reddiah 1977. *Rec. zool. Surv. India* 72: 322.

Pavona venosa (Ehrenberg); Veron and Pichon 1979. *Australian Inst. of Mar. Sci., Australia.* Vol. 4: 30-33.

Material: During the status survey on GoMBR (May 21, 2003), two colonies were observed while snorkeling in the intertidal reef flat from the Anaipar Island, GoMBR (9° 9' 04" N; 78° 41' 38" E) by K.P. Raghuram, Marine Biological Station, ZSI, Chennai (Reg. No. ZSI/MBS-C/0001 dt. July 12, 2003).

Distribution: In India, it has been recorded only from the Andaman and Nicobar Islands (Reddiah 1977). Worldwide it is distributed throughout the Red Sea, Indonesia, Marshall Islands and the Great Barrier Reef, Australia.

Characters: Colonies are massive. Corallites are arranged in shallow sinuous valleys (Fig. 2). The valleys are 2.5-3.5 mm wide and 0.8-1.3 mm thick. Columella may be present, but is not well distinguished, or absent; the corallites are 1.54 to 2.43 mm in diameter. Calices range from 1.26-1.43 mm in diameter. There are three orders of septa; the septa are granulated and the primary septa are joined at the base; the corallites are interconnected by exert septo-costae (Fig. 2), coenosteum absent. The average (n=2) length, width, height and circumference of the colonies are 1.25 m, 1.01 m, 0.23 m, 3.11 m respectively. The colonies are yellowish brown in colour.

Habitat: Found on intertidal reef flat.

Remarks: The coral is uncommon. Silt gets deposited in the upper portion of the colonies due to sedimentation along the intertidal region. While describing the coral reefs of the Andaman and Nicobar Islands, Reddiah (1977) included the present species as *P.* (*Polyastra*) *obtusta* and stated that it is not found in the Andaman Islands, but is common in Nicobar Islands. However, Reddiah (1977) did not mention the exact location of the collection of the species.

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21. A NEW RECORD OF *TURBINARIA PATULA* (DANA, 1846) (SCLERACTINIA, DENDROPHYLLIIDAE) IN TUTICORIN, GULF OF MANNAR BIOSPHERE RESERVE

Family Dendrophylliidae is solitary or colonial, mostly azooxanthellate except the genera *Turbinaria*, *Duncanopsammia* and *Heteropsammia* which are hermatypic (reef building; *Balanophyllia*, *Endopsammia*, *Tubastrea*, *Dendrophyllia* and *Enallopsammia* are ahermatypic (non-reef building). In *Turbinaria*, most of the species are foliose forms (leaf-like or vertical/horizontal plates). The present genus is recorded in all the four major coral reefs in India (Venkataraman *et al.* 2003). Worldwide, eleven species of the genus *Turbinaria* have been recorded till date (Veron 2000). In India, only three species of *Turbinaria* (*T. peltata*, *T. reniformis* and *T. mesenterina*) are reported, so far, from the four major reefs. The present note reports an additional species to the above genus.

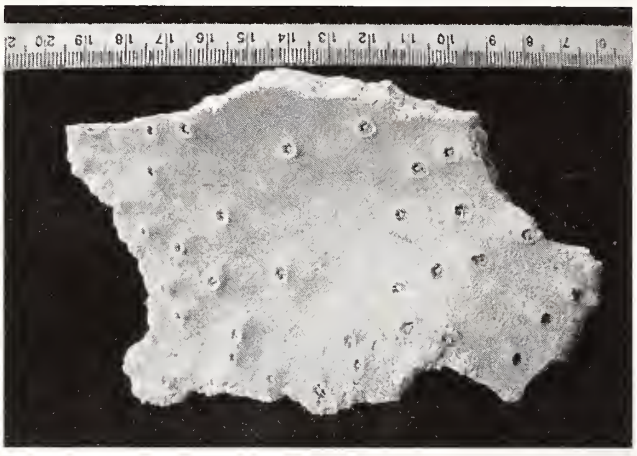

Fig. 1: *Turbinaria patula* colony

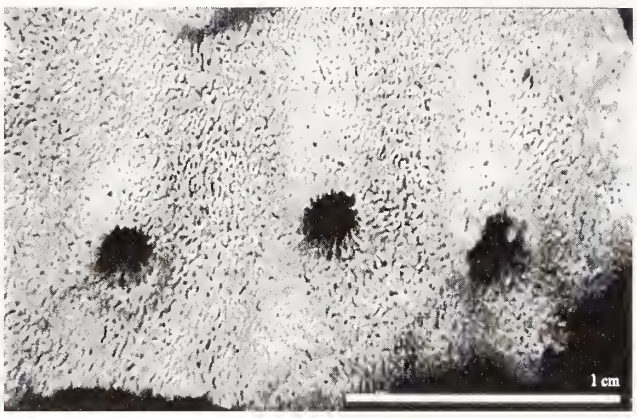

Fig. 2: Corallites of *Turbinaria patula*

Description

Phylum: Cnidaria
Class: Anthozoa
Subclass: Zoantharia De Blainville, 1830
Order: Scleractinia Bourne, 1905
Family: Dendrophylliidae Gray, 1847
Genus: *Turbinaria* Oken, 1815

Turbinaria patula (Dana, 1846) (Figs 1-2)

1846. *Gemmipora patula* Dana, U.S. Exploring Exped. 1838-1842. 7, 1-740.

1886. *Turbinaria patula* (Dana); Quelch, Rep. Sci. Results Voyage *H.M.S. Challenger Zool.* 16(3), 1-203, pls. 1-12.

1980. *Turbinaria patula* (Dana); Veron and Pichon, Scleractinia of Eastern Australia, Part III, 379-380, pls. 663-669.

2000. *Turbinaria patula* (Dana); Veron, Corals of the World, 2, 389, pls. 1-4.

Representatives of Family Dendrophylliidae are solitary or colonial, mostly ahermatypic. Corallite walls are porous, usually composed of coenosteum. Septa are fused in a distinctive pattern called *Pourtales Plan* (Inner margins of higher order septa curve to adjacent septa and fuse) (Veron and Pichon 1980; Venkataraman *et al.* 2003).

The colonies of genus *Turbinaria* are hermatypic, large explanate, crateriform, contorted or foliaceous. Corallites are united nearly to the summits by an extensive coenosteum and have porous synapticulothecate walls. Pourtales plan is apparent only in early stages. The columella is well developed (Veron 2000; Venkataraman *et al.* 2003).

Material collected: During the status survey on GoMBR (December 8, 2001), a colony of *T. patula* was collected in the shore near Tuticorin, Gulf of Mannar Biosphere Reserve, by K.P. Raghuram, Marine Biological Station, ZSI, Chennai.

Characters: Colonies are foliose and unifacial, corallites are not closely packed in the centre of the colony (Fig. 1). Corallites are tubular and inclined towards the margin (Fig. 2). Corallites are 3.7-4.0 mm in diameter and the distance between neighbouring corallite measures 7.8 ±4.1 mm (n = 14). Septal cycles are obvious and dentate. Columellae are well developed and broad. Coenosteum is porous.

Distribution: This is a new record to India. Worldwide it is distributed throughout Indonesia, Marshall Islands and the Great Barrier Reef, Australia.

Remarks: *Turbinaria patula* is similar to *T. peltata*. In the Gulf of Mannar, *Turbinaria* colonies are mostly found in turbid environment. *T. peltata* (Esper 1794) and *T. mesenterina* (Lamarck 1816) have been recorded by Pillai (1983).

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VERON, J.E.N. & M. PICHON (1980): Scleractinia of Eastern Australia. Aus. Inst. of Mar. Sci. Vol. 4, 421 pp.

22. PARASITIC INFESTATION OF THE CLAM, *MARCIA OPIMA* (GMELIN)

Reproductive studies on the clam *Marcia opima* from two geographically separated areas were conducted at the Tuticorin Research Centre of Central Marine Fisheries Research Institute. The clams were collected from Tuticorin Bay, Tamil Nadu (8° 45' N and 78° 12' E) and from Ashtamudi Lake, Quilon (9° 28' N and 76° 28' E). Sampling was done from December, 1998 to January, 2000. To identify the sex and maturity stages of the collected clams, gonad smears were observed under a microscope.

During the course of the study, infestation of the gonad by the larvae of trematode parasite *Bucephalus* sp. was observed in the clams collected from Tuticorin Bay. Infestation was noticed during December 1998, January 1999 and May 1999. The lengths of the infested clams ranged from 31.6 mm to 34.6 mm. The percentage of infection ranged from 5 % to 10% of the total sampled population.

There was no trematode infestation in the clams collected from Ashtamudi lake. However, a single incidence of fungal infection was observed in a clam 51 mm long in March, 1999. In May 1999, 10% of the sampled clams, with length ranging from 34.8 mm to 40.7 mm, were found to be infested by the pea-crab, *Pinnotheres* sp.

Bucephalid infestation in *Meretrix casta* was reported by Durve (1964). Silas and Alagarswami (1967) and Harkantra (1976) reported *Pinnotheres* infestation in *Meretrix casta*. Thangavelu and Sanjeevaraj (1985) reported occasional occurrence of larval forms of the trematode parasite *Bucephalus haemanus* in *M. casta*. Hesselman *et al.* (1989) observed trematode infestation in *Mercenaria* sp. Parasitic infestation of the clam *M. opima* has not been reported earlier, and this is the first report.

In the present study, it was observed that the presence of parasites caused gonad destruction. Hence, the sex of the infested clams could not be made out. The meat of the clams was found to be thin, transparent and watery. The same manifestations were observed by earlier workers also.

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23. ADDITIONS TO THE GRASS FLORA OF TAMIL NADU

While working on the flora of Mukurthi National Park (11° 10'-11° 22' N, 76° 26'-76° 34' E) and the Tropical Gene Pool Garden, Nadugani (11° 15'-11° 39' N, 76° 15'-76° 30' E) Nilgiris, Western Ghats, Tamil Nadu, we came across four rare, endemic and interesting grasses. On critical examination, they were identified as *Arthraxon lancifolius* (Trin.) Hochst., *Bothriochloa parameswaranii* Sreekumar *et al.*, *Eragrostis zeylanica* Nees & Mey. and *Isachne gracilis* C.E. Hubb. The voucher specimens are deposited in the Herbarium of Kongunadu Arts & Science College, Coimbatore for reference.

Arthraxon lancifolius (Trin.) Hochst, in Flora 39: 188.1856; Fischer in Gamble, Fl. Pres. Madr. 1729. 1934 (Repr. ed. 3: 1193. 1957); Bor, Grass. Bur. Cey. Ind. Pak. 100. 1960; Jain in J. Ind. Bot. Soc. 51: 176. 1972: van Welzen in Blumea 27: 288. 1981; Manilal & Sivaraj. Fl. Calic. 334. 1982; Sreekumar & Nair. Kerala Grass. 38.1991. *Andropogon lancifolius* Trin. in Mem, Acad. Sci. Petersb. Ser. 6(2). 271. 1832. *Arthraxon microphyllus* (Trin) Hochst. in Flora 39: 188. 1850; Hook. f, Fl. Brit. Ind. 7: 147. 1896. *Andropogon microphyllus* Trin. *l.c* 275. (Fig. 1)

So far, this grass is reported only from the states of Andhra Pradesh, Gujarat, Karnataka, Kerala and Maharashtra. The available literature pertaining to the grass flora of Tamil Nadu has not included this species. Hence, the present

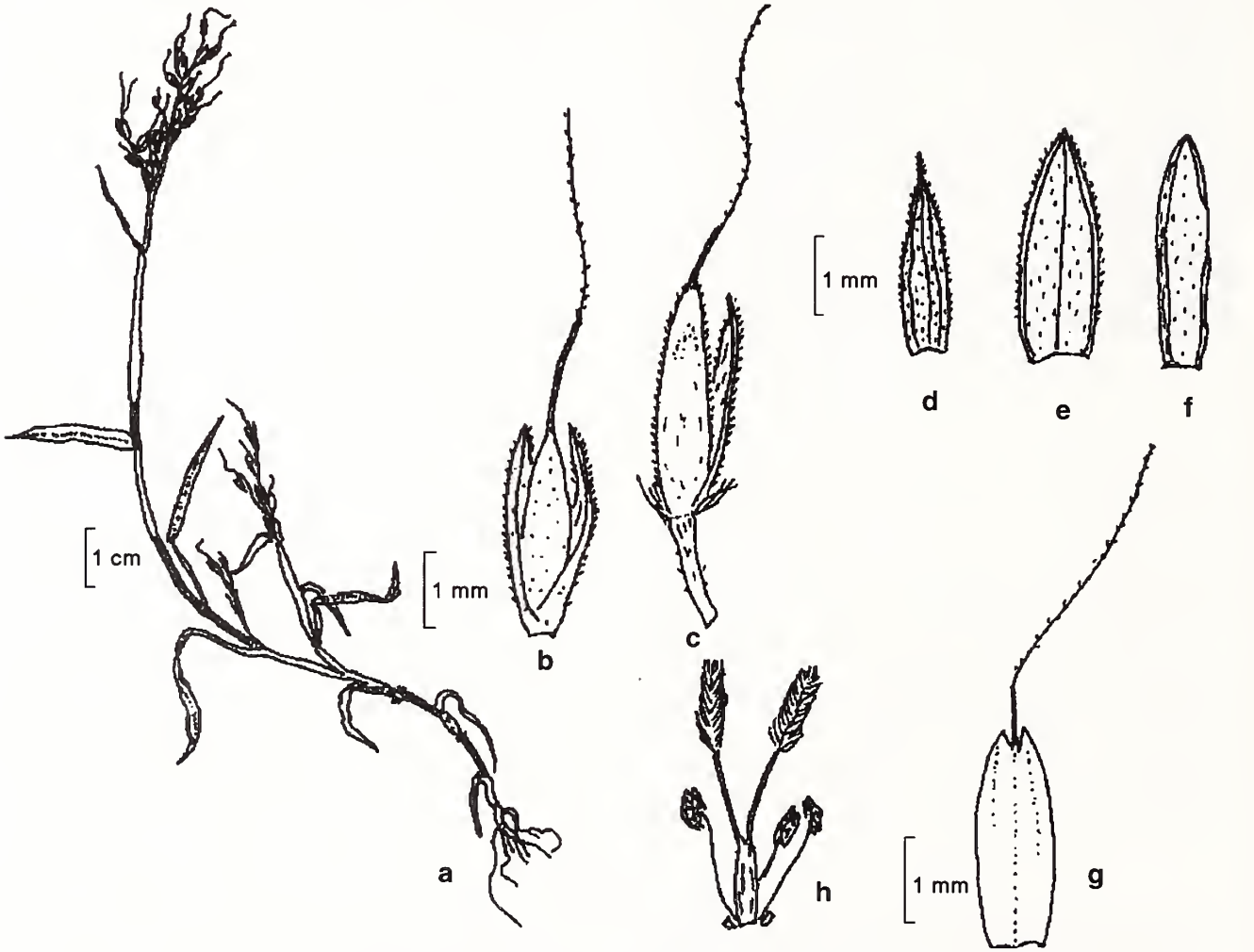

Fig. 1: *Arthraxon lancifolius* (Trin.) Hochst., a. Habit; b. Sessile Spikelet; c. Pedicelled Spikelet; d. Lower Glume; e. Upper Glume; f. First Lemma; g. Second Lemma; h. Stamen and Pistil

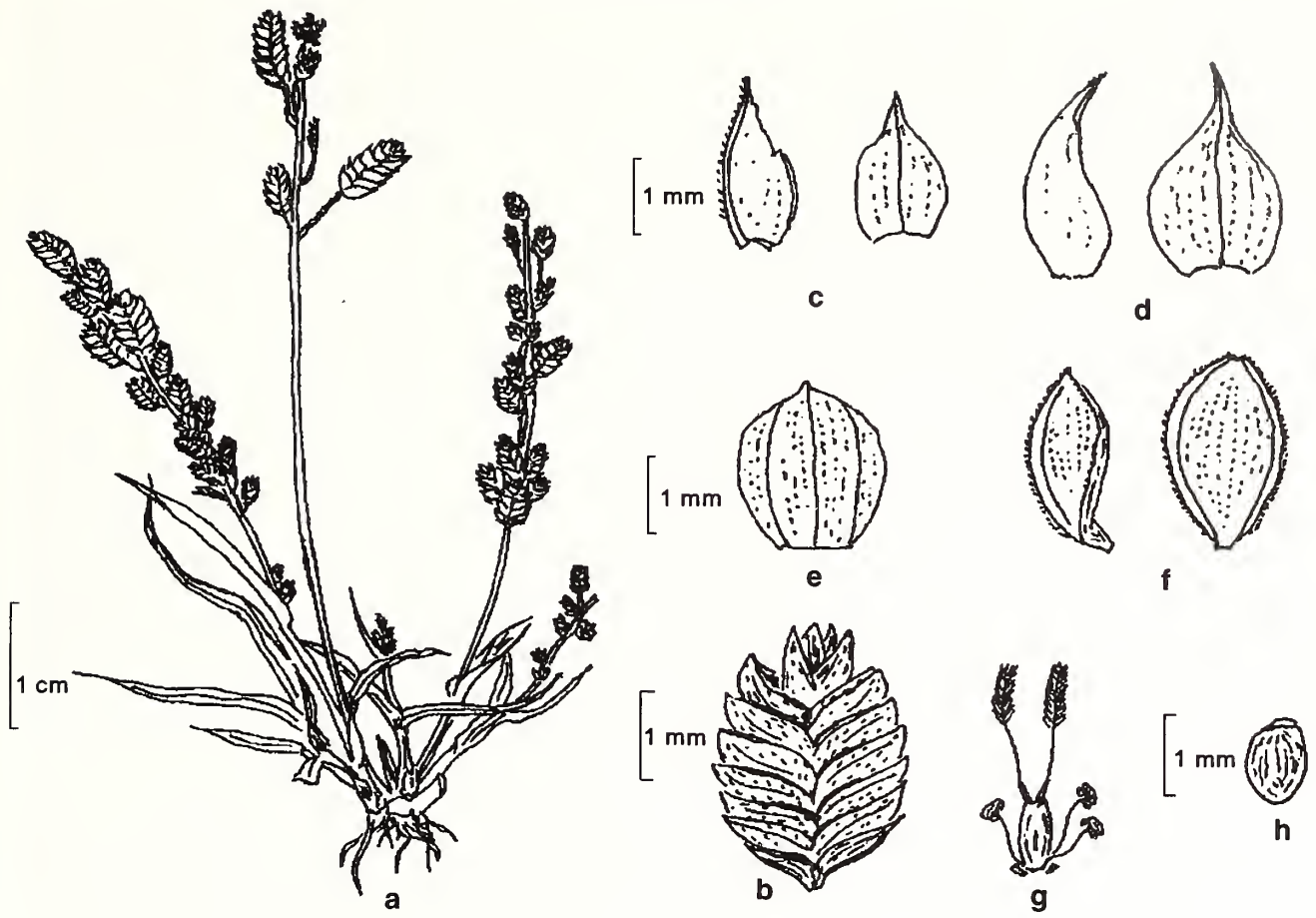

Fig. 2: *Eragrostis zeylanica* Nees & Mey., a. Habit; b. Spikelet; c. Lower Glume; d. Upper Glume; e. Lemma; f. Palea; g. Stamen and Pistil; h. Grain

gathering from Mukurthi National Park indicates its presence in Tamil Nadu, and it was observed that it is restricted to the hilltops above 2300 m above msl. The present report will form an addition to the existing grass flora of Tamil Nadu.

Annual. Culms up to 20 cm high, glabrous, nodes hairy. Sheaths keeled, glabrous or hairy. Blades 1.5-3 x 0.2 cm; margins laxly hairy, all over; upper and lower surface glabrous. Joints 2 mm long. Sessile spikelets 3 x 0.5 cm; callus hairy. Lower glume 3 x 0.5 mm, apex acuminate, 3-nerved; upper glume 3 x 0.5 mm, 3-nerved; lower lemma 2.5 x 0.2 mm, nerveless; upper lemma 2.5 x 0.4 mm, 1-nerved, awn 4 mm long; palea absent. Anthers 2, 0.5 x 0.2 mm. Styles 0.3 mm long, stigmas 0.7 mm. Pedicellated spikelets sterile, up to 4 mm long. Lower glume 3 x 0.4 mm, 3-nerved; upper glume 2 x 0.5 mm, 3-nerved; lower lemma 1.5 x 0.3 mm; upper lemma 1.5 x 0.2 mm, anthers 2, without pollen, up to 0.5 mm.

Distribution: Throughout India.

Ecology: Rare along the fringes of shola forests above 2300 m in hills.

Specimen examined: Tamil Nadu, Nilgiris, Mukurthi National Park, ± 2300 m. November 16, 2000; in flowering, V.S. Ramachandran & C.P. Anil Varghese 2650.

Bothriochloa parameswaranii P.V. Sreekumar, C.P. Malathi & V.J. Nair in J. Bombay Nat. Hist. Soc. 85(1): 163-165. 1988; Sreekumar & Nair, Kerala Grass. 52. 1991.

A neo-endemic species was described by Sreekumar *et al.* (*l.c.*) from Eravikulam National Park, Idukki district, Kerala in 1988. Subsequent to type, this species was collected from Mukurthi National Park, Nilgiris, Tamil Nadu and is an addition to the grass flora of Tamil Nadu.

Perennial. Culms 10-20 cm high, erect, glabrous. Leaves lanceolate, 2-10 x 0.2-0.3 cm, base rounded, midrib prominent; ligules ovate, acute, 1 mm. Racemes digitate, purplish, joints 4 mm long, linear, ciliate. Sessile spikelets oblong, 6 mm long, callus bearded. Lower glume oblong, 7 x 1.25 mm long, acute, chartaceous, 7-nerved, keels pectinate towards apex, margins hyaline; upper glume ovate - lanceolate, acuminate, 7 x 1.25 mm, chartaceous, 3-nerved, margin hyaline, villose at the upper half. First lemma ovate-oblong, 5.5 x 1 mm, acute, delicate, hyaline. Palea absent. Second lemma stipitate, 4 mm long; awn 10 mm long, column 6 mm long, chestnut-brown.

Stamens 3, anthers 1-1.25 mm long, ovary oblong, 0.5-0.75 mm, styles *c.* 1 mm long. Stigmas 1 mm, feathery. Pedicellated spikelets oblong-lanceolate, 7 mm long, Rachis 3 mm long.

Distribution: Kerala and Tamil Nadu (Endemic to Western Ghats).

Ecology: Common in Grasslands, above 2300 m in hills.

Specimens examined: Tamil Nadu, Nilgiris, Mukurthi National Park, ± 2300 m. November 16, 2000; in flowering, V.S. Ramachandran & C.P. Anil Varghese 2611.

Eragrostis zeylanica Nees & Mey. in Nov. Act. Nat. Cur. 19. Suppl. 1: 204. 1843; Bor, Grass. Bur. Cey. Ind. Pak. 515. 1960; Nair & Ramach. in Bull. Bot. Surv. Ind. 22: 193. 1980 (1982); Sreekumar & Nair, Kerala Grass. 394.1991. *E. elongata* sensu Stapf in Hook.f , Fl. Brit. Ind. 7: 319. 1896, non Jacq. 1813. (Fig. 2)

Earlier known only from Eastern India, Andaman and Nicobar Islands, Myanmar, Sri Lanka, Nair & Ramach. (*l.c.*) have reported its occurrence for the first time from southern India. The present collection from Tropical Gene Pool Garden, Nadugani, Nilgiris, Tamil Nadu records its presence in Tamil Nadu and also forms a new addition to the flora of Tamil Nadu.

Annuals. Culms up to 8 cm high, erect, nodes glabrous. Leaves lanceolate, 2.5 x 0.5-0.2 cm, rounded at base, glabrous, ligules fimbriate. Panicles oblong or ovate-oblong, 3.5 cm long, congested. Spikelets oblong-lanceolate, 2-3 mm. wide, acute, 8-10 flowered. Lower glume ovate-lanceolate, 1.5-2 x 1-1.5 mm; palea elliptic 1-1.5 x 0.5-1 mm long. Anthers 3, 0.25 mm long. Grain ovate.

Distribution: Eastern and southern India.

Ecology: Rare, along the forest margins of evergreen forests.

Specimens examined: Tamil Nadu, Nilgiris, Tropical Gene Pool Garden, Nadugani, ± 1000 m. November 16, 2000; in flower and fruit, V.S. Ramachandran & K.R. Devi 10426.

Isachne gracilis C.E. Hubb. in Kew Bull. 1927: 77. 1927; Fischer in Gamble, Fl. Pres. Madr. 179. 1934 (Repr. Ed. 3: 1244. 1957); Bor, Grass. Bur. Cey. Ind. Pak. 581. 1960; Vajravelu & P. Daniel in Jain & Sastry, Mat. Cat. Threat. Pl. India, 43. 1983; Ved Prakash & Jain in Fasc. Fl. Ind. 14: 25. 1984; 1: 227. 1984; Ahmedullah & Nayar, Endemic Pl. India. 1: 67: 1986; Sreekumar & Nair, Kerala. Grass, 422. 1991.

This is one of the neo-endemic grasses of Western Ghats and its type locality is in Karnataka. However, Ved Prakash and Jain (1984) have reported its occurrence from Maharashtra and Madhya Pradesh, showing its disjunct distribution in India. Sreekumar and Nair (*l.c.*) have recorded it from Kerala for the first time from Silent Valley. This rare and endemic species was also collected from Tropical Gene Pool Garden, Nadugani, Nilgiris, Tamil Nadu; extending its distribution to southern Western Ghats, and forming an addition to the grass flora of Tamil Nadu.

A small elegant grass 5-25 cm high; stems soft, geniculate below, with slender fibrous roots. Leaves oblong-elliptic or elliptic-lanceolate 1-3 x 0.2-1.5 cm; acute, sparsely villous. Ligules membranous to obscure. Panicles lax, 1-10 cm long. Spikelets globose, 0.5-1 mm long. Lower glume oblong, 0.5 x 0.25 mm, chartaceous, faintly 5- 7-nerved, softly hairy, 7-9-nerved, sparsely hairy. First lemma ovate-oblong. 0.5-1 x 0.5 mm, chartaceous; palea oblong, 0.5-1 x 0.5 mm, delicate; second lemma obovate, 0.5 x 0.5 mm, coriaceous, softly hairy, palea obovate or orbicular 0.5 x 0.5 mm, coriaceous, softly hairy. Anthers 0.25-0.5 mm long.

Distribution: Karnataka, Kerala, Madhya Pradesh, Maharashtra and Tamil Nadu.

Ecology: Occasional, on moist rocks and prefers dense shade.

Specimens examined: Tamil Nadu, Nilgiris, Tropical Gene Pool Garden, Nadugani, ± 1000 m, November 16, 2000; in flower and fruit, V.S. Ramachandran & KR. Devi 10413.

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24. NEW GENERIC RECORDS OF GRASSES FOR MAHARASHTRA

1500 specimens of about 300 species of grasses and bamboos have been collected during our extensive field survey over the past three years. Some of the specimens collected from Gondiya district of Maharashtra were of *Diectomis fastigiata*; specimens collected from Ajara of Kolhapur district were identified as *Lepturus radicans*. As both *Diectomis* and *Lepturus* form new generic records for the state, a detailed description along with illustration and field notes are presented in this paper. The specimens have been deposited in the herbarium of Shivaji University, Kolhapur.

Monotypic genus *Diectomis* Kunth is widely distributed in China, Myanmar, tropical America, Africa and India.

Diectomis fastigiata (Sw.) Kunth in Humb. Et Bonpl., nov. gen. et Sp. 1, 193 (1816) t. 64; Bor, Grass. Bur. Ceyl. Ind. Pak. 135. 1960; Moulik, Grass. Bam. Ind. 1:275. 1997. *Andropogon fastigiata* Swartz, Prodr. Veg. Ind. Occ. 26, 1788; Hook. F., Fl. Brit. India 7: 167, 1896 (Fig. 1).

Annual. Culms terete, erect or geniculate at base, 20-80 cm high; nodes glabrous. Leaf: Sheaths terete, 1.5-5 cm long, glabrous; ligule membranous, 3.5-4 mm long; blades linear, 2.5-20 x 0.1-0.2 cm long, glabrous, setaceous. Raceme single, enclosed by spathe, 2-3.5 cm long, joints turbinate, slightly compressed, 2.6-3 mm long, ciliate on both margins with white hairs. Callus short, bearded. Sessile spikelets coriaceous, linear-lanceolate, 3.3-4 x 0.4-0.5 mm. Lower glume coriaceous, linear-lanceolate, 3.8-4 x 0.4-0.5 mm, 6-nerved, deeply grooved on the back, 2-keeled, ciliate in the groove in upper half, apex 2-toothed. Upper glume coriaceous, boat shaped, 3.3-3.5 x 0.8-0.9 mm, 3-nerved, 1-keeled; keels ciliate, running into a capillary, 10-12 mm long awn, apex 2-toothed. Lower lemma membranous, ovate-lanceolate, 2.8-3 x 0.4-0.5 mm, strongly 2-keeled, 2-nerved, deeply grooved on the back, margins ciliate, apex obtuse, epaleate. Upper lemma membranous, boat shaped 2.6-2.7 x 0.6-0.7 mm 1-nerved, apex 2-fid, awned from the sinus; awn 20-25 mm long, scaberulous. Palea hyaline, oblong-elliptic, 2-2.2 x 0.4-0.5 mm, nerveless, obtuse, stamens 3; anthers 0.8-1.0 x 0.2-0.3 mm, ovary linear, 0.4-0.5 x 0.2-0.3 mm. Lodicules 2, cuneate, 0.4-0.5 mm. Caryopsis elliptic-obovate, 1.7-1.8 x 0.4-0.5 mm. Pedicle of pedicelled spikelet turbinate, slightly compressed, 2.3-2.5 mm, densely ciliate on the margins. Pedicelled spikelet ovate-lanceolate, 6.8-7 mm long. Lower glume membranous, ovate-lanceolate, 6.8-7 x 1.5-1.7 mm, 15-nerved, central nerve distinct, 2-keeled; keels obscurely winged, scabrid, 2-toothed at apex, median awn 5 mm long. Upper glume membranous, ovate-lanceolate, 3.2-3.4 x 0.4-0.5 mm, 5-nerved, 1-keeled, slightly 2-toothed at apex, awned; awn 3 mm long, ciliate on margins. Lemma membranous, ovate-lanceolate, 1.8-2 x 0.3-0.4 mm, nerveless, margins ciliate, acute, epaleate.

Growing in sandy soil and on rocky slopes.

Fl. & Fr.: September-November.

Note: *Diectomis fastigiata* has been reported from Uttar Pradesh, Madhya Pradesh, Bihar, Orissa and West Bengal. It grows in sandy soils and on rocky slopes in Gondiya district in Eastern Maharashtra. It is a very good fodder grass in young stages before the awns begin to form (Bor 1960). It turns red as it dries. It is very distinct in its 15-nerved lower glume of pedicelled spikelet.

Exsiccata: Borkanhar (Gondiya District) Potdar 1477, Mandodevi (Gondiya District) Potdar 1482.

Genus *Lepturus* R. Br. with about 8 species is distributed in coastal east Africa, Madagascar to Australia and Polynesia. So far, *Lepturus radicans* is the only species reported for India from Karnataka, which was recently collected from Maharashtra.

Lepturus radicans (Steud.) A. Camus in Ann. Soc. Linn. Lyon, 1922, n.s., 69, 87 (1923); Bor, Grass. Bur. Ceyl. Ind. Pak. 585. 1960; Moulik, Grass. Bamb. Ind. 2: 463. 1997 (Fig. 2).

Perennial, stoloniferous. Culms prostrate, 10-30 cm high, rooting at nodes, nodes glabrous. Leaf; sheath terete, 1-4 cm long, glabrous, ligule membranous 0.5-0.8 mm long; blades linear, 3-12 x 0.2- 0.6 cm long, glabrous, base with bulbous based hairs. Spike single, 2-6 cm long. Joints not breaking easily, 3 mm long, joints hollow on one side alternately. Spikelets sessile, coriaceous, linear-lanceolate, 4-4.5 mm long, sunken in hollow of rachis. Lower glume absent. Upper glume coriaceous, flat, linear-lanceolate, 3.5-4 x 0.6-0.8 mm, 10-12- nerved apex acute to acuminate. Lower lemma membranous, boat shaped, 2.6-2.8 x 0.5-0.6 mm, 3-nerved, apex acuminate. Palea membranous, margins inflexed, 2.5-2.6 x 0.5-0.6 mm, 2-nerved, apex acute, stamens 3, anthers 1.3-1.5 x 0.1-0.2 mm, ovary obovate, 1.5-2 x 0.4-0.5 mm. Lodicules 2, cuneate,

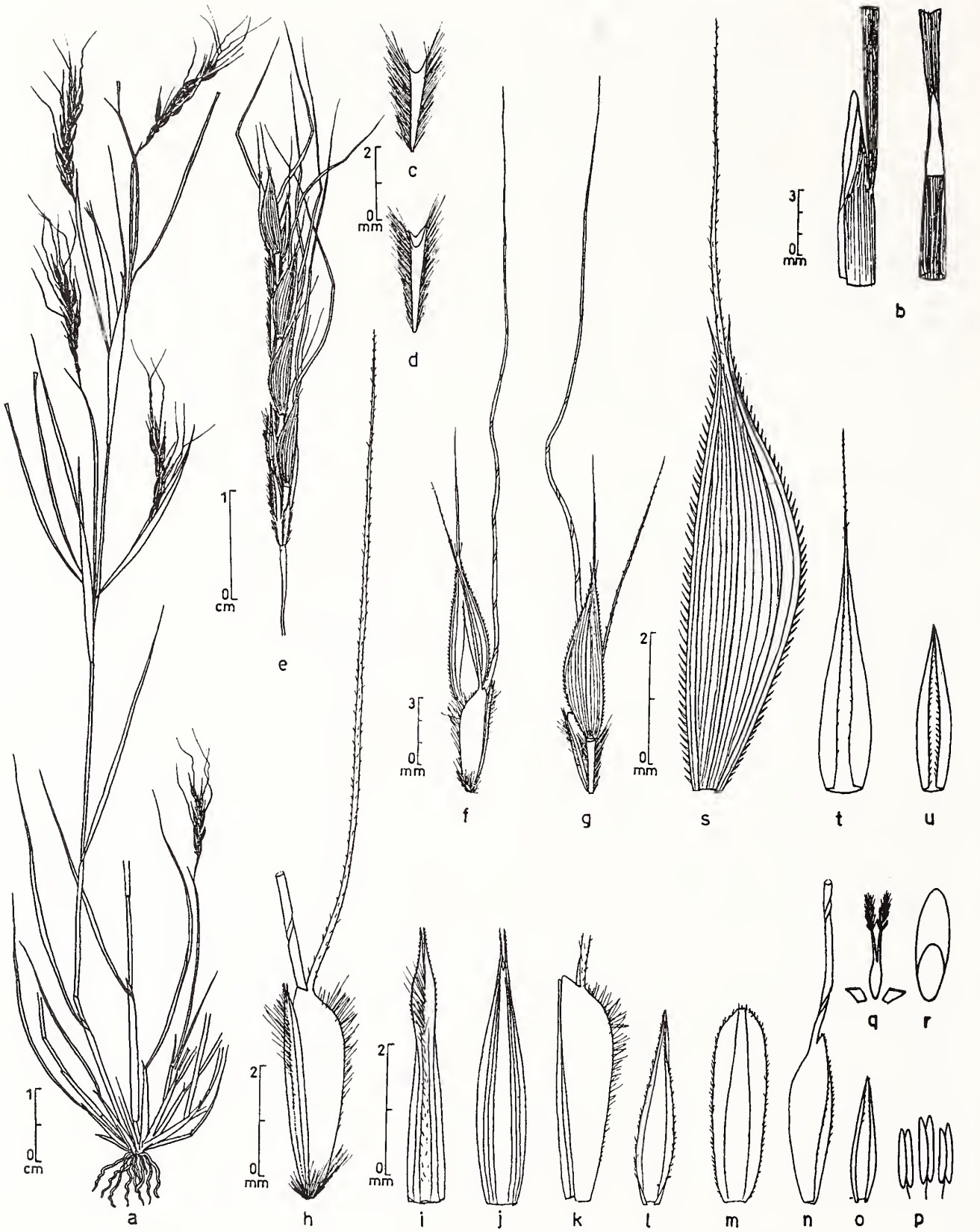

Fig. 1: *Diectomis fastigiata* (Sw.) Kunth; a. Habit; b. Collar; c. Pedicel; d. Joint; e. Raceme; f. & g. Pedicelled and Sessile spikelets; h. Sessile spikelet; i. & j. Lower glume; k. Upper glume; l. & m. Lower lemma; n. Upper lemma; o. Palea; p. Stamens; q. Pistil and Lodicules; r. Grain; s. Lower glume of pedicelled spikelet; t. Upper glume of pedicelled spikelet; u. Lemma.

Fig. 2: *Lepturus radicans* (Steud.) A. Camus; a. Habit; b. Collar; C. Spike; d. Adaxial view of upper glume; e. Abaxial view of upper glume; f. Lower lemma and Palea with upper rudimentary floret; g. Lower lemma; h. Palea; i. Stamens; j. Ovary; k. Lodicules; l. Grain.

0.4-0.5 mm. Caryopsis elliptic-obovate, 1.8-2 x 0.6-0.8 mm. Upper floret reduced to a rudimentary structure.

Fl. & Fr.: July-October.

Exsiccata: Ajara, Potdar 1566.

Note: *Lepturus radicans* was collected by us from Dandeli forest of Karnataka in June 2003. Recently, it was collected from forests around Ajara region in Kolhapur district of Maharashtra. It is common in shady places along roadsides and forest margins. The spikelet is two flowered, but the upper floret is highly reduced and represented by a small appendage on protruded rachilla.

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25. *NERVILIA INFUNDIBULIFOLIA* BLATTER & MCCANN (ORCHIDACEAE): A NEW RECORD FROM SIKKIM HIMALAYA

Nervilia infundibulifolia (Orchidaceae) was first described by Blatter & McCann from North Canara of Karnataka, India; based on the specimen from Yellapur, N. Canara, T.R. Bell mss. Icon. E. Bell.

Later, the occurrence of this taxon was known both from Western Himalaya (Garhwal) and Eastern Himalaya (only Arunachal Pradesh) (Deva and Naithani 1986; Chowdhery 1998) leaving Nepal, Sikkim and Bhutan.

The species was reported from Bhutan in 2002 for the first time by Pearce and Cribb (2002). However, it is hitherto unknown from Nepal and Sikkim. Recently, a collection of this taxon from Sikkim Himalaya (between Yoksum and Bakhim, West Sikkim) was made and is a new record for Sikkim Himalaya. Thus, it is expected that this species has a continuous distribution from Western Himalaya to Eastern Himalaya and extends eastwards to Thailand, Malay and Borneo (Pearce and Cribb 2002), along with its first record from the Western Ghats region, Maharashtra and Orissa, in India. It is possible that the species occurs in Nepal and Myanmar and also Yunnan and Hupeh region of China.

A detailed description of the taxon along with the present known distributional records is given below.

Nervilia infundibulifolia Blatter & McCann in J. Bombay Nat. Hist. Soc. 35: 725. t.3.1932; Deva & Naithani, Orchid Fl. N.W. Himalaya 85. t.83.1986; Chowdhery, Orchid Fl. Arunachal Pradesh 529. t.530.1998; Pearce & Cribb, Fl. Bhutan 3(3- Orchids of Bhutan): 58. t.59.2002.

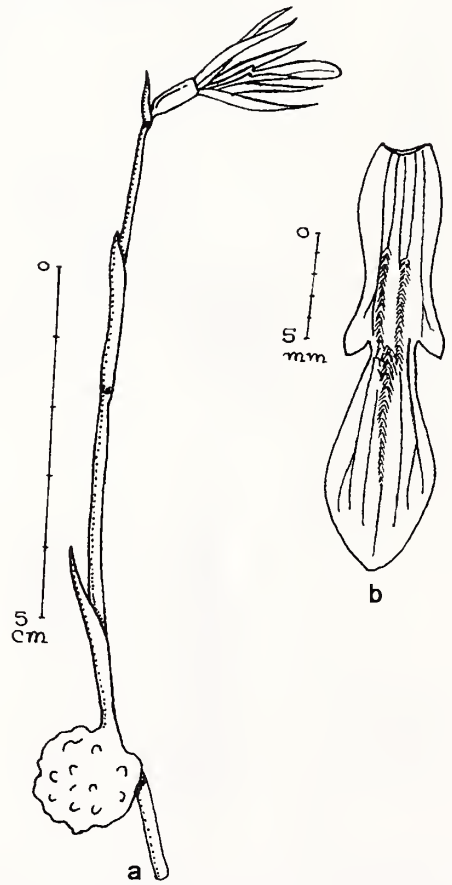

Fig. 1: *Nervilia infundibulifolia* Blatter & McCann; a. Habitat; b. Lip

Nervilia hallbergii Blatter & McCann in J. Bombay Nat. Hist. Soc. 35: 726.1932.

N. calcicola Kerr in J. Siam Soc. Nat. Hist. Suppl. 9(2): 242. t.7.1933.

Proteranthous, tuberous herb up to 15 cm tall (scape). Tuber sub-globose, 0.6-1.5 cm diam. *Leaves* broadly ovate to suborbicular, 2-4 cm across, base cordate, margin undulate to crenulate, apex acute to acuminate, glabrous, spreading on ground; petioles sheathing at base. *Flower* solitary, at right angle on scape; scape with two internodes; scape sheaths two, linear-oblanceolate, 1.5-3 cm long, apex acute to acuminate, clasping, glabrous; floral bract solitary, linear-lanceolate, 0.3-0.7 x 0.2 cm. acuminate. Flowers (sepals and petals) light maroon-green to greenish-purple to greenish-brown; nerves deep-coloured; lip apple-green to white, tinged with pink; *sepals* linear-oblanceolate, 1.3-1.8 x 0.2-0.3 cm, acute, 3-nerved; *petals* linear-oblanceolate, 1.2-1.7 x 0.15-0.2 cm, acute, 1-nerved; *lip* 1.5-2 x 0.2-0.3 cm, distinctly 3-lobed, weakly saccate at base, with 2 hairy lines on hypochile and one papilose line on epichile; lateral lobes triangular, about 0.1 x 0.1 cm; middle lobe larger, obovate to ovate, about 1 x 0.3 cm, margin entire; column straight. *Fruits* cylindric.

Specimen examined: West Sikkim, Yoksum to Bakhim, 1800 m, May 12, 2002, D. Maity & N. Pradhan 23403 - BSHC (two gatherings).

Field notes: "Terrestrial, bulb globose, juicy; sepals and petals greenish-brown; lip white, tinged with pink dots; middle lobe flat; lateral lobes very small."

Distribution: INDIA: Himalaya: Uttaranchal; Uttar Pradesh, Sikkim, Arunachal Pradesh, Orissa, Karnataka, Maharashtra; Bhutan; Thailand; Malay; Borneo; grows on open slopes, loose soils, along road sides in warm subtropical forests ascending up to 1800 m altitude.

Fl. and Fr.: May-July.

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26. *BULBOPHYLLUM REPTANS* (LINDL.) LINDL. (ORCHIDACEAE): A CRITICAL STUDY

Bulbophyllum reptans (Lindl.) Lindl. is known for its wide distribution from India (Garhwal Himalaya, Sikkim, Arunachal Pradesh) to Vietnam including Nepal, Bhutan, Bangladesh, China, Myanmar and Thailand (Seidenfaden 1979). This taxon is further enriched by two more varieties to the typical one as var. *subracemosa* Hook.f. and var. *acuta* Malhotra and Balodi.

The variety *subracemosa* Hook.f. was established by Hooker (1890) based on differentiating characters, like presence of smaller pseudobulbs; much shorter length of oblong, obtuse floral bracts than the longer pedicellate ovary. This variety was recognized by King and Pantling (1898), Srivastava (1996) and Chowdhery (1998).

The other variety *acuta* Malhotra and Balodi (1984) is differentiated by longer floral bracts than the pedicellate ovary, based on collection from Gorpatta, Gori Valley, Pithoragarh, India (*M.A. Rau*, 35340-CAL).

Seidenfaden (1979) had quoted the opinion of Guillaumin regarding the further taxonomic treatment of this taxon, that the flower of the Langbian plant is yellow with small dark red spots at tips of the petals and dark red lip with a green median line, which is not quite different from the colour description given by Hooker f. and King and Pantling, and therefore perhaps a Vietnamese variety should be recognized as a separate identity. In the Thai plant, the flowers are yellow, the dorsal sepal with three faint purple lines at base and the proximal edges of the lip being purple.

Thus, the taxon *Bulbophyllum reptans* (Lindl.) Lindl. is now considered to have two more varieties var. *subracemosa* and var. *acuta* in addition to the typical one, and a proposed unnamed (?) variety (Vietnamese variety) based on the colouration of petals and lips. Of course, Seidenfaden (1979) did not recognize the separate entity of the variety *subracemosa* Hook.f. In this regard, he had referred to *Bulbophyllum ombrophyllum* Gagnep.

Regarding the variety *acuta* Malhotra and Balodi, the distinguishing character such as the larger floral bracts than that of the pedicellate ovary, cannot be considered good taxonomic characters to establish a new variety.

While working on the floristics of Kanchenjunga Biosphere Reserve of Sikkim Himalaya, specimen (*D. Maity*, 24275-BSHC) was collected with the smallest pseudobulb (*c.* 7-8 x 7-8 mm), slightly smaller to equal to slightly longer floral bracts (*c.* 5.5 x 2 mm) than the pedicellate ovary; sepals with distinct characteristic shape as stated by Lindley in 1830 with prominent three nerves and light yellow colour; the spathulate *c.* 3.5 mm long petals having brownish- purple coloured lip.

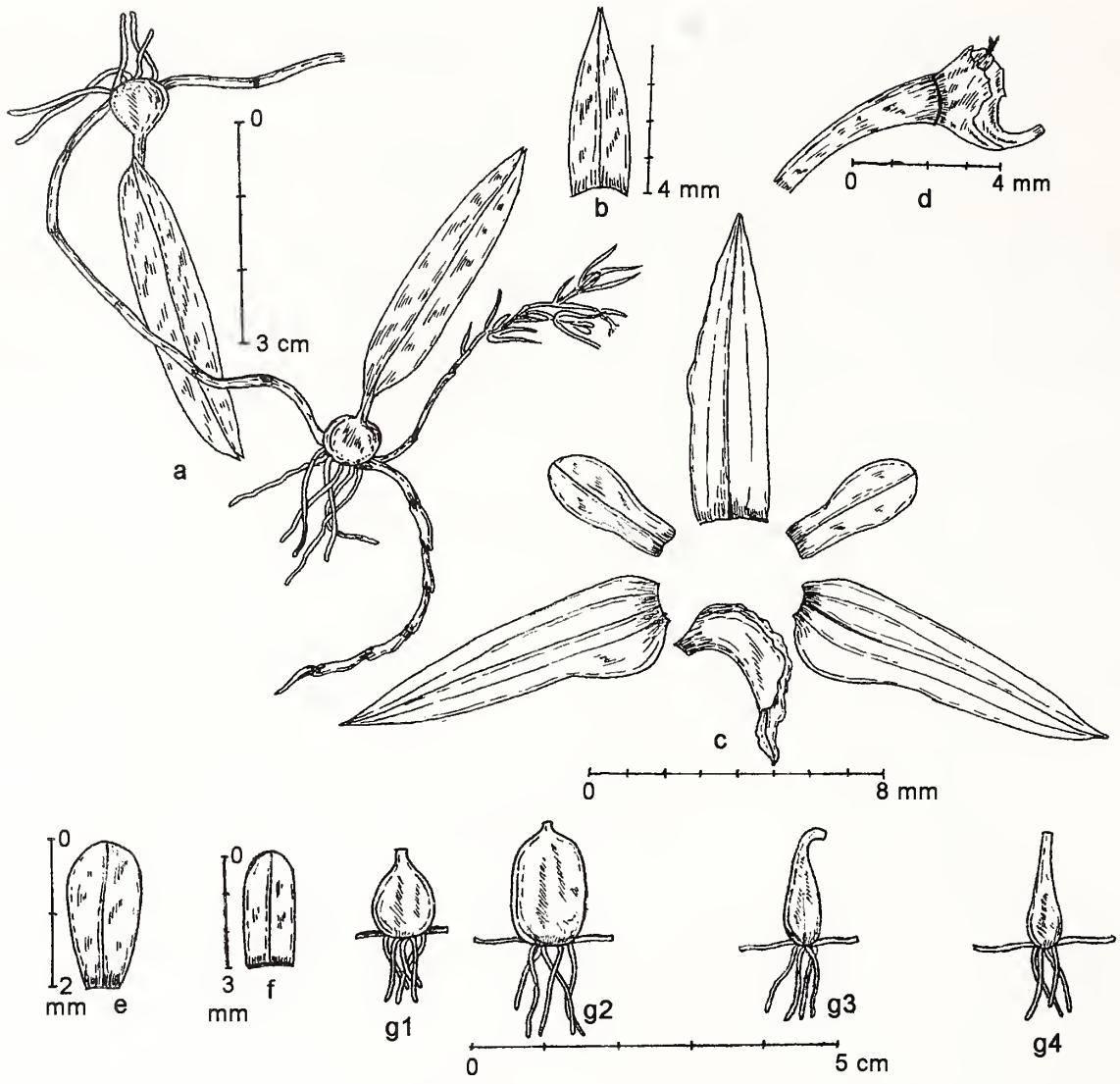

Fig. 1: *Bulbophyllum reptans* (Lindl.) Lindl., a. Habit; b. Bract; c. Floral parts; d. Column (from *Maity*, 24275-BSHC); e. Petal (*J.S. Gamble*, 10307-CAL); f. Petal (King & Pantling, 1896; *Maity & Pradhan* 25721-BSHC); g. Pseudobulbs: g1. *Polunin, Sykes & Williams*, 1825-CAL; g2. Seidenfaden, 1979, p. 111, Fig. 70-L. & C. 148; g3 & g4. *Mokin, sn.*, Acc. no. 452304-CAL (Drawn by D. Maity)

This specimen led to a critical study of the literature and the specimens were deposited at CAL. The analysis of the characters stated below shows variation of a good number of characters in *Bulbophyllum reptans* (Lindl.) Lindl. and the varieties based on the shape and size of pseudobulb, shape and size of floral bracts, sepals, petals and lip cannot be considered or treated as distinct to merit varietal status. Moreover, the colour of sepals, petals and lip etc. is not a constant character for this widely distributed species ranging from India to Vietnam. Few line-drawings are also supplemented in support of this opinion along with the citation of specimens studied at CAL gathered from different countries by different collectors (Fig. 1).

The characters of the pseudobulb: Obpyriform (*Polunin, Sykes* and *Williams*, 1825-CAL), oblong (Seidenfaden, 1979, p. 111, fig. 70-L. & C. 148), orbicular to sub-obpyriform (*D. Maity*, 24275-BSHC); floral bracts variable in length along the scape, often longer to the lower and successively smaller upwards or equal in size having uniform distribution from base to apex or it may be a mixture of longer, equal in size or smaller in the same inflorescence; the shape of the bract varies from lanceolate to oblanceolate to somewhat oblong (*J.S. Gamble*, 10307-CAL); petals are different in shape as oblong (King and Pantling, 1898-Fig. 1.F; Banerji and Pradhan, 1984; *Maity & Pradhan* 25721-BSHC), obovate-oblong (Bhutan, *J.S. Gamble*, 10307-CAL-Fig. 1. E; *Polunin, Sykes* and *Williams*

1825-CAL; *Mokin*, *s.n.*-Acc. No. 452304-CAL); spathulate (*D. Maity*, 24275-BSHC-Fig. 1.C). The colour of the petals as well as lips is often considered in the treatment of variety (vide King and Pantling 1896; Seidenfaden 1979). The present study of literature and field notes of the collections is given below, which proves that the colour is variable due to its wide range of distribution in different geographical regions: yellowish with purple spots (King and Pantling 1898; Srivastava 1996; Chowdhery 1998), yellow with small dark red spots at tips of the petals and dark red lip with green median line (Guillaumin 1958), yellowish-green (Banerji and Pradhan 1984), greenish-yellow (Hynniewta *et al.* 2000), light yellow with purple veins, lip brownish-purple (*D. Maity*, 24275-BSHC).

Thus, *B. reptans* is a variable species and the existing varieties and the variety of Seidenfaden (1979) do not deserve separate status. The variety *acuta* Malhotra and Balodi is reduced to a synonym here [syn. nov. of *bulbophyllum reptans* (Lindl.) Lindl.]

Bulbophyllum reptans (Lindl.) Lindl., [Wall. Cat. 1988, 1829 *nom. nud*]; Gen. & Sp. Orch. 51.1830; Hook.f. in Fl. Brit. India 5: 768.1890; King and Pantling in Ann. Roy. Bot. Gard. Calcutta 8: 77, t. 106. 1898; Pottinger and Prain in Rec. Bot. Surv. India 1: 268. 1898; Duthie in Ann. Roy. Bot. Gard. Calcutta 9(2): 105. 1906; Burkill in Rec. Bot. Surv. India 10(2): 377. 1925; Biswas in Ind. For. Rec. Bot. 3(1): 49.1941; Merrill in Brittonia 4(1): 35. 1941; Tuyama in Hara, Fl. E. Himalaya 426.1966; Deb *et al.* in Bull. Bot. Soc. Bengal 22:212. 1970; Rao and Joseph in Bull. Bot. Surv. India 12(1-4): 152.1965; Matthew in Bull. Bot. Surv. India 8(2): 166. 1966; Banerji and Thapa in J. Bombay Nat. Hist. Soc. 66(2): 292.1969; Hu in Quart. Journ. Taiwan Mus. 25 (1-2): 63. 1972; Rao and Balakrishnan in Rec. Bot. Surv. India 20(2): 206. 1973; Deb and Dutta in J. Bombay Nat. Hist. Soc. 71(2): 285. 1974; Hara *et al.* in Enum. Fl. Pl. Nepal 1: 33. 1978; Seidenfaden in Or. Gen. Thailand 8: 109. 1979. [Pl.-I].

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B. reptans (Lindl.) Lindl. var. *acuta* Malhotra and Balodi in Bull. Bot. Surv. India 26 (1 & 2): 110-111. 1984, syn. nov.

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27. NOTES ON RARITY AND OCCURRENCE OF *DROSERA INDICA* L. (DROSERACEAE) IN GUJARAT STATE, INDIA

While working on the project "Plant Biodiversity Survey in South Gujarat", the taxon *Drosera indica* L. was collected and identified for the first time from Dabkhal (Tal. Kaprada, Dist. Valsad) forest area (South Gujarat) in Gujarat. This taxon is found in a typical location, i.e. hilly open grasslands, in association with *Eragrostis ciliaris*, *Centranthera indica*, *Rhynchospora wightiana*, *Spermacoce hispida*, *Zornia gibbosa*. *D. indica* is an ephemeral taxon, which blooms in September for 8 days.

Interestingly, when we collected it, it was hidden in grasses and we were able to collect only 4-5 plants within an area of 2-hectare open grazed pastureland. *D. indica* is a very rare taxon and is a new record for Gujarat State. It has been reported earlier from the ghats of Khandala-Mahabaleshwar and Marathwada. Its presence here proves the continuity of the vegetation from the Western Ghats to the forests of Gujarat State.

The locality is on the Dharampur-Dabkhal road, four kilometres before Dabkhal, on a roadside adjacent to agricultural fields. It grows only on well-grazed soil among grasses.

The location is in urgent need of conservation.

Drosera indica L. Sp. Pl. 282. 1753; C.B. Clarke, in Hook.f. Fl. Brit. India 2: 424. 1878; Cooke, Fl. Pres. Bombay 1: 499. 1958 (Repr. ed.).

Herbs, slender, caulescent, up to 20 cm high with glandular-hairy stems. Leaves exstipulate; lower leaves recurved, upper leaves erect, filiform up to 3 cm long; shortly petioled. Inflorescence leaf-opposed. Flowers pink; sepals 5, acute; petals obovate. Capsules 3-valved. Seeds obovoid and strongly ridged.

Fl. & Fr.: October-November.

Distribution: Very rare, collected only once and only 4-5 plants from open grazed pastureland in Dabkhal forest areas.

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28. A NOTE ON *ATHYRIUM SCHIMPERI* MOUG. EX FEE (ATHYRIACEAE: PTERIDOPHYTA) IN INDIA

Athyrium schimperi Moug. ex Fee has been reported in India from the western Himalaya, Sikkim, Darjeeling, Arunachal Pradesh, Rajasthan and Madhya Pradesh and grows commonly and abundantly, especially in the Himalayan region (Clarke 1880; Beddome 1883, 1892; Hope 1902; Dixit 1984; Fraser-Jenkins 1997; Chandra 2000; Khullar 2000; Dixit and Kumar 2002; Pande and Pande 2003). It is made of two subspecies - *schimperi* from east Africa and *biserrulatum* (Christ) Fras.-Jenk. from west Africa and Sino-Himalaya. *A. schimperi* subsp. *schimperi* is not known to occur from Sino-Himalaya. However, Chandra (2000) and Khullar (2000) have placed *A. biserrulatum* Christ in the synonymy of *A. schimperi*.

According to Fraser-Jenkins (pers comm.), Ching (1983) noted the close affinity of the Himalayan plant to the African one, but was presumably unable to accept that the two could be conspecific vicariants. The characters which Ching 1983 gave to differentiate between the two are common to both the subspecies. It appears that Ching's concept of the African *A. schimperi* resulted from observing some specimens of the dissected species without rhizome that were actually that of *Athyrium scandicinum* (Willd.) Presl, but commonly labelled as *A. schimperi* in various herbaria. However, Ching (1983) referred the Sino-Himalayan plant material as *Athyrium biserrulatum* and kept them separate from *A. schimperi*. The East African plants, including the type of *A. biserrulatum* as stated by Khullar (2000), are slightly different in having narrower, more cuneate pinnule lobes, which tend to be slightly more distant from each other. However, some plants from the drier areas are intermediate. Fraser- Jenkins (1997) has suggested that it is best to separate the east African plants as subsp. *schimperi* as opposed to the West African and Sino-Himalayan plants, which belong to subsp. *biserrulatun* (Christ) Fras.-Jenk.

Fraser-Jenkins (pers comm.) further adds that if the rhizome is not collected it can be difficult to distinguish some

plants of *A. flabellulatum* (Clarke) Tard. from *A. schimperi* subsp. *biserrulatum*; similarly, luxuriant plants of *A. rupicola* (Edgew. ex. Hope) C. Chr. can look like narrower plants of *A. schimperi* subsp. *biserrulatum*. But both species have thick, upright apices to their rhizomes with the fronds arising together in a crown-like arrangement, not the distinctively long- creeping, thin with separate fronds of *A. schimperi* and their lowest pinnae are also different.

It is therefore suggested that the Sino-Indian materials of *A. schimperi* be treated as *A. schimperi* subsp. *biserrulatum* (Christ) Fras.-Jenk. in Indian fern literature.

Athyrium schimperi Moug. ex Fee subsp. ***biserrulatum*** (Christ) Fras.-Jenk., New Sp. Syndr.Indian Pterid. & Ferns Nepal: 60 (1997); *Athyrium biserrulatum* Christ, Bull. Acad. mt. Geogr. Bot. Mans 17: 135 (1907). *Athyrium schimperi* (Moug. ex Fee) A.Br. in Schweinf.,Beitr. Fl. Aethiop. 1: 224 (1867), non (Hook) J. Smith (1875); Dixit, Census Indian Pterid.:129 (1984); Chandra, Ferns India: 134 (2000); Khullar, Ill. Fern Fl. West Him. 2:73. t. 26 (2000). *Asplenium filix-femina* Bernh. var. *polysporum* (Clarke), Trans. Linn. Soc. Lond. 2Bot. 1: 493. t. 61(1888). *Athyrium filix-femina* (L) Roth var. *polysporum* (Clarke) Bedd., Handb. Ferns Brit. India: 170 (1883). *Asplenium filix-femina* Bernh. var. *schimperi* (Moug. ex Fee) Clarke & Baker, J. Linn. Soc. Lond. 8: 12 (1888). *Athyrium polysporum* (Clarke) Ching ex Mehra & Bir, Amer. Fern J. 50: 289 (1960). *Athyrium wumonshanicum* Ching in Ching & Hsieh, Acta Bot. Bor.-Occ. Sin. 6: 20 (1986).

Rhizome thin, long-creeping, occasionally branching. Stipe long, with few scattered, pale brown, narrow scales towards the base, stipe base dark, rest of stipe and rachis pale or stramineous. Fronds arising at intervals along the rhizome. Lamina lanceolate to ovate-lanceolate, widest above or just above the middle, the lowest pinnae with rather a wide gap between them and the next pair, shorter than the second pair, but frond base somewhat truncate, herbaceous; pinnae triangular-lanceolate, wide, pinnate, becoming bipinnatifid in large plants, widely separated below, more or less contiguous above; pinnules nearly symmetrical above their axes or becoming slightly more developed at their acroscopic bases, narrowly attached to the costa but often slightly adnate and usually joined at their bases by a narrow wing of laminar tissue, triangular-lanceolate, apices acute, margins prominently lobed to about half their depth on each side or sometimes more, with somewhat narrow, acute lobes, the lobes and apices have prominent, long-acute teeth; costae bear weak, short setae above near the pinna-apices; costules have small crested ridges above. Sori crowded all over the lower surface of the lamina, usually rather large, hippocrepiform to sub-reniform, becoming confluent, indusiate; indusia prominent, large, but shrivelling markedly on maturity. Spores dark brown, perinate; perine broad, translucent, convoluted into folds forming ridges.

Ecology: Abundant throughout the western Himalaya, becoming somewhat less common further into the Himalaya in the east and occurs at mid- to higher altitudes in the outer and mid-ranges of the Himalaya between 1800 and 3500 m along streams and grassy slopes or road banks in forested areas, sometimes forming its pure stands.

Distribution: India (Kashmir, Jammu, Himachal Pradesh, Uttaranchal, Darjeeling, Sikkim, Arunachal Pradesh, Madhya Pradesh, Rajasthan), Pakistan, Nepal, Bhutan, N. Myanmar, S.E. Tibet, S.W. China, W. Africa (Cameroon, Nigeria, Ghana, Liberia and Guinea).

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29. *ATHYRIUM NEPHRODIOIDES* (BAKER) CHRIST (ATHYRIACEAE: PTERIDOPHYTA): AN ADDITION TO THE FERN FLORA OF INDIA

Dixit (1984) enumerated the total species of ferns and fern-allies of present day political boundary of India, together with their distribution in India and world, and reported 67 families belonging to 191 genera spread over more than 1000 species. Recently, Chandra (2000) further attempted to compile the total ferns of India primarily based on previous records and enumerated 34 families, 144 genera and more than 1100 species from India with a note on their distribution in India and the world. Khullar (2000) has published an illustrated fern flora of the western Himalaya and he too has not mentioned its occurrence in the western Himalaya. It is interesting to note that these authors, together with many others, have not recorded *Athyrium nephrodioides* from India so far. It is being reported for the first time from India and forms an interesting addition to the Indian fern flora.

A brief description, ecology and distribution in India and the world are provided in this paper along with voucher specimens examined by Fraser-Jenkins in India and abroad.

Athyrium nephrodioides (Baker) Christ, Bull. Soc. Bot. Franc. 52, Mem. 1:47 (1905).

Asplenium nephrodioides Baker, J. Bot. Lond. 1887: 170 (1887). *Athyrium tibeticum* Ching in C.Y. Wu Fl. Xizangica 1: 137 (1983). *Athyrium stenopodum* Ching & S.K. Wu in C.Y. Wu Fl. Xizangica 1: 137 (1983).

Rhizome upright, thick, often branching to form a small clump, surrounded by many old, pale, widened stipe bases. Stipe short, bearing somewhat scattered, mid-or reddish-brown, twisted scales, becoming slightly dense at base, terete, but widened and flattened at its base, stipe and rachis pale or stramineous. Fronds ± delicate, bipinnatifid. Lamina narrowly lanceolate with an acuminate apex and tapering markedly to an attenuated, very narrow base, widest above the middle, herbaceous; pinnae many, ± short, elongated triangular-lanceolate, or ± linear, with narrow acute apices, shallowly to deeply pinnatifidly-lobed, the basal acroscopic pinna lobe often longer than the rest, lowest pinnae becoming ± distant and slightly reduced; pinna lobes crowded, ± triangular, unlobed or only very shallowly lobed at the margins, their apices rounded-pointed, bearing short, acute teeth at the margins and particularly at the apex. Sori borne half-way between the pinna-lobe midrib and margin, often becoming confluent when ripe, small, oval or elongated, indusiate; indusia small, thin, soon shrivelling. Spores small, bean-shaped, ± smooth, with some minute papillae, non-perisporiate.

This species is very close in frond morphology to *Athyrium rupicola* (Edgew. ex Hope) C. Chr., but differs from it in its lamina being more markedly tapering and the pinnae less deeply lobed, with the pinna-lobes hardly lobed and by its non-perisporiate spores.

Ecology: Grows at high altitudes in the main Himalayan ranges between *c.* 2700 and 3500 m altitudes on steep, rocky slopes, among boulders or screes in open places or among bushes and small shrubs.

Specimens examined: Sikkim (S. S. Bir 2242, 2245, 4998 PAN! & 2254 K!); Kumaon: Pithoragarh district, above Budhi in Kali valley J.F. Duthie, *s.n.* K!); Arunachal Pradesh (Tawang, Kameng), A.K. Baishya 90493 Assam!). All *det.* by Fraser-Jenkins.

Distribution: INDIA (Uttaranchal, Sikkim, Arunachal Pradesh), E. Nepal, Bhutan, Myanmar, S.E. Tibet, S.W. and C. China (Yunnan, Szechuan, Hupeh and Kansu).

August 11, 2003

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30. *DEPARIA ACUTA* (CHING) FRAS.-JENK. (ATHYRIACEAE: PTERIDOPHYTA): A NEW RECORD FOR KUMAON HIMALAYA

While compiling the pteridophytic flora of Uttaranchal, a few specimens of the genus *Deparia* Hook. & Grev. (Athyriaceae) were collected from Pindari glacier areas in Kumaon Himalaya and these specimens were lying with some common species of *Deparia* in our Herbarium. After a detailed study of these specimens, they turned out to be *Deparia acuta* (Ching) Fras.-Jenk. This tentative identification was later confirmed by Fraser-Jenkins. A perusal of recently

published literature, dealing with fern flora of Kumaon Himalaya (Dhir 1980; Dixit 1984; Khullar *et al.* 1991; Fraser-Jenkins 1997; Khullar 2000; Chandra 2000; Pande and Pande 2002; Dixit and Kumar 2002), has not indicated its presence in Kumaon so far. In fact, Ching (1964) described *D. acuta* from specimens in Herb. Schagintweit *s.n.* collected in the year 1855 from Chamoli Garhwal (Badrinath) between 3000 and 3300 m altitude in India. Chandra (2000) has given the locality Chamoli Garhwal in the north-western Himalaya for this widespread Himalayan species and of high Asia. However, Khullar (2000) has given its distributional range from Pakistan, Kashmir, Himachal Pradesh and Chamoli Garhwal (Badrinath) in Uttaranchal between 2300 and 3800 m altitude in the western Himalaya. It was also reported from the same localities by Dixit and Kumar (2002). However, Fraser-Jenkins (pers comm.) indicated that he has found this species occurring throughout the Indo-Himalaya from Pakistan, Kashmir, Himachal Pradesh (Kulu, Shimla, Narkanda) Uttaranchal (Chamoli Garhwal, Badrinath), Nepal, Sikkim, presumably further east, S.E. China, S.W. Tibet.

This species is being collected and reported for the first time from Kumaon Himalaya, and thus forms a new record for its fern flora. Voucher specimens are deposited in the Herbarium, Department of Botany, D.S.B. Campus, Kumaon University, Nainital.

Deparia acuta (Ching) Fras.-Jenk., New Sp. Syndr. Indian Pterid. & Ferns Nepal: 104 (1997): Khullar. Ill. Fern Fl. West Him. 2:107. t. 37 (2000). Chandra. Ferns India: 144 (2000): Dixit & Kumar. Pterid. Uttaranchal: 100 (2002). *Lunathyrium acutum* Ching. Acta Phytotax. Sinica 9: 73 (1964).

Ecology: Grows on hilly-forested slopes in open situations near streams between 2600 and 2800 m altitude.

Specimens examined: Kumaon Bageshwar District, Madhari pass (Pangtey & Samant 1415); Chakhuwa (Pangtey & Samant 1514); above Namik village (Pangtey & Samant 1515).

Distribution: India (Kashmir, Himachal Pradesh, Uttaranchal, Sikkim), Nepal, S.E. China, S.W. Tibet.

I thank Mr. C.R. Fraser-Jenkins, British Museum, London for his help in the identification, literature and encouragement. Thanks are due to Head, Department of Botany, D.S.B. Campus, Kumaon University, Nainital for providing facilities.

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31. *MATTEUCCIA INTERMEDIA* C. CHR. (ONOCLEACEAE: PTERIDOPHYTA): AN ADDITION TO THE FERN FLORA OF INDIA

The fern flora of India is very well known today with respect to taxonomy, ecology and distribution through the works of Clarke (1880), Beddome (1883, 1892), Hope (1900), Dixit (1984) and Chandra (2000) and several others. However,only one species of *Matteuccia* i.e. *M. orientalis* (Hook.) Trev has been reported from India so far.

From the north-western Himalaya of India also, only one species *M. orientalis* has been reported (Duthie 1906; Dhir 1980; Khullar 2000; Pande and Pande 2002; Dixit and Kumar 2002) based on the collections made by Gamble in 1894 and Duthie in 1897 from Lokandi peak / hill in Jaunsar Garhwal Hope (1900) and Pangtey *et al.* (1988) from Kumaon. There are only three collections available from western Himalaya, two from Garhwal Himalaya by Duthie and Gamble in Hope (1900) and one from Kumaon by S.S. Samant in Pangtey *et al.* (1988).

While compiling the fern flora of Uttaranchal, I re-examined the specimens of this species in the Herbarium of the Department of Botany, D.S.B. Campus, Kumaon University, Nainital and found that these specimens differ

greatly from *M. orientalis*. The two species may be readily separated by the following key.

KEY TO SPECIES

1. Sterile fronds taper gradually right down to a very narrow base and more shallowly lobed; fertile fronds truncated but little narrower at the base ..... *M. intermedia*
2. Sterile fronds widely truncated and lobed; fertile fronds similarly truncated at their bases ..... *M. orientalis*

M. intermedia was described by C. Christensen (1913) from west China and Sikkim. Strangely, previous workers, especially Dixit (1984) and Chandra (2000), have made no reference to this species in Indian fern flora so far. Fraser-Jenkins (pers comm.) informs me that he has collected this species from near Lachung in north Sikkim. He has collected both, *M. intermedia* and *M. orientalis* in Nepal, but they never grow together. Thus, the collection of this species, from Uttaranchal, is an addition to the fern flora of the western Himalaya, in particular and India, in general; and extends its distributional range from Sikkim to Uttaranchal in India. This species is so far known from India, Nepal and W. China.

In the present paper; a brief description, ecology and distribution have been provided to facilitate its easy identification in the field. Voucher specimens are deposited in the Herbarium, Department of Botany, D.S.B. Campus, Kumaon University, Nainital.

Matteuccia intermedia C. Chr., Bot. Gaz. (Chicago) 56: 337 (1913).

Rhizome erect, ascending, thick, densely scaly; scales brown, lanceolate. Fronds dimorphic; stipes light-brown, 15-30 cm long, thick, densely scaly and fibrillose; scales light-brown, concolorous, linear-lanceolate, entire, acuminate; rachis similar to stipe; sterile lamina, lamina pinnate, ovate-oblong, texture herbaceous, glabrous; pinnae many pairs, alternate, sessile, close, lanceolate, margin shallowly lobed less than half way to costa, lobes many, broad, oblong-falcate, acute, margin generally entire, slightly recurved, lower pinnae gradually taper right down to a narrow base; veins free, 5-7 pairs per lobe, pinnate or forked, glabrous, costae scaly on lower surface, scales brown, linear-lanceolate, entire, acuminate; fertile lamina as long as sterile lamina or little shorter, pinnate, pinnae many, very much contracted, oblong, margin reflexed covering the entire surface, dark-brown, glabrous, lower pinnae little narrower; sori indusiate; spores perinate, bilateral, monolete.

Ecology: Extremely rare and grows in moist-shaded, dark humus rich ground, along perennial streams in oak forest *c.*2500 m altitude.

Specimens examined: Kumaon Bageshwar District, *en route* Sundardhunga Glacier in Pindari valley (S.S. Samant 1243).

Distribution: India (Kumaon, Sikkim), Nepal, W. China.

ACKNOWLEDGEMENTS

I thank Mr. C.R. Fraser-Jenkins, British Museum, London for his help in the identification, literature and encouragement. Thanks are due to Head, Department of Botany, D.S.B. Campus, Kumaon University, Nainital for facilities provided.

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32. *PTERIS HETEROMORPHA* FEE PTERIDACEAE: A NEW DISTRIBUTIONAL RECORD FOR ANDHRA PRADESH

During a recent pteridophyte exploration of Andhra Pradesh, some rare and interesting specimens of *Pteris* were collected. After thorough checking of literature, the present report describes a rare and interesting taxon, which is identified as *Pteris heteromorpha* Fee. This species was earlier described by Nair and Ghosh (1978) and believed to be rare in Orissa. It was recently collected by us and also G. Madulla from the Visakhapatnam district of Andhra Pradesh. This species has not been recorded earlier from Andhra Pradesh; hence, it is reported as a new record. A short description of the species is given with an illustration, correct nomenclature, brief diagnostic characters, collection site, Field Numbers, notes on ecology and distribution of the taxa have been recorded.

Pteris heteromorpha Fee. Gen. fil.127, 1852; Hook sp. fil. 2; 166; t.1278, 1858, Hook. et Baker, syn. fil. 156.1867; Beddome, Ferns Brit. India 1865; *P. propinqua*, J.m. Jour. Bot. 3: 405 (1841); *P. cretica* var. *heteromorpha* (Fee). Bedd. Handb. Ferns. Brit. India. 106. 1883, with supplement 106, 1892.

Rhizome short, erect covered with brownish linear scales up to 1 cm long, hairs marginal, root wiry. Stipes 12-30 cm long, base with very few scattered scales similar to those on the rhizome, naked above, erect. Fronds 25-40 cm long, 8-15 cm broad, ovate, lanceolate, subcoriaceous. Pinnae with the lower portion sinuate and provided with a few short linear lobes; lateral pinnae erectopatent; the higher one linear lanceolate 7-10 cm long up to 1.5 cm broad, simple with 1-4 lobes near the base; lower pinnae 3-6 cm apart, 10-20 cm long, cut down nearly to the costa with 2-6 linear oblong, very long terminal segments, the lateral lobes varying from very short to 2 cm long up to 1 cm. margin sub crenate. Veins prominent, reaching up to the margin, usually with one fork. Sori continuous, but not reaching to the apex. Indusium narrow membranous (Fig. 1).

Specimen examined: India, Andhra Pradesh, Visakhapatnam, Coll. G. Madulla February 8, 2002, Manickam (XCH21672).

Field Notes: It occurs rarely along exposed dry deciduous forest at 450 m (G. Madulla). Pinnae with the lower portion sinuate and provided with a few short linear lobes, lateral pinnae erectopatent.

Distribution: *Pteris heteromorpha* was first discovered from Luzon (Philippines) by Cumming, subsequently it was reported from Java, Myanmar and Celebes (Alderberlet van Rosenberg 1908; Christensen 1906)

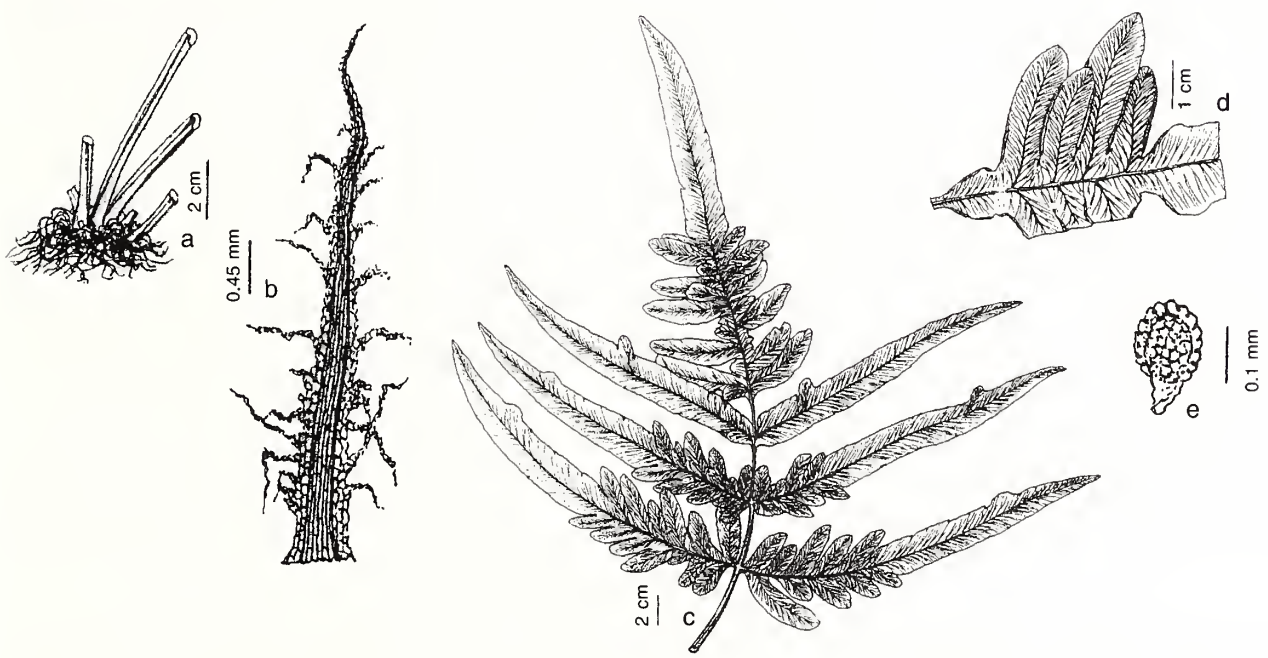

Fig. 1: *Pteris heteromorpha* Fee. a. Rhizome; b. Rhizome scale; c. Lamina; d. Pinna enlarged showing venation and sori; e. Sporangium

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33. *GRACILARIOPSIS LEMANEIFORMIS* (BORY) DAWSON – A RED ALGA REPORTED FROM CERTAIN BACKWATERS OF KERALA

A long cylindrical thalloid multifariously branched red alga was reported from Dhalawapuram (Ashtamudi lake), Kadalundi (Kadalundinagaram) and Mopla Bay (Kannur) and was later identified as *Gracilariopsis lemaneiformis* (Fig. 1). The salinity in all these regions ranged from 14 to 20 ppt during the non-monsoon period; during the SW monsoon, this species could not sustain drop in salinity below 8.0 ppt. The species grows attached loosely to the sediment along with subdominant forms of green algae such as *Enteromorpha linza* and *Chaetomorpha linum*. The density ranged from 300-900 gm/sq. m in Mopla bay and 150-600 gm/sq. m in Dhalawapuram during the peak growth season of October to January. The standing crop in both the estuarine areas of about 20 hectares was estimated to be 12-15 tonnes (wet wt.)/yr.

In India, *Gracilariopsis lemaneiformis* was reported from Pamban, Mandapam and Visakhapatnam by Umamaheswara Rao (1972). Preliminary survey conducted in certain areas of Ashtamudi lake revealed the presence of agarophytes, alginophytes and carrageenophytes (Nair *et al.* 1982); no attempt was made to quantify them and occurrence of this species was not reported. Resource assessment survey conducted by Chennubhotla *et al.* (1988) along the Kerala coast also did not record the occurrence of this alga; the present report is the first from the Kerala coast.

The polysaccharide content in this species ranged from 18 to 26% dry wt. The moisture content in the thallus was 87%. Since this alga has affinity towards sandy loam bottom, bottom set nets/rafts can be used for cultivation trials as polyculture with mussels or oysters.

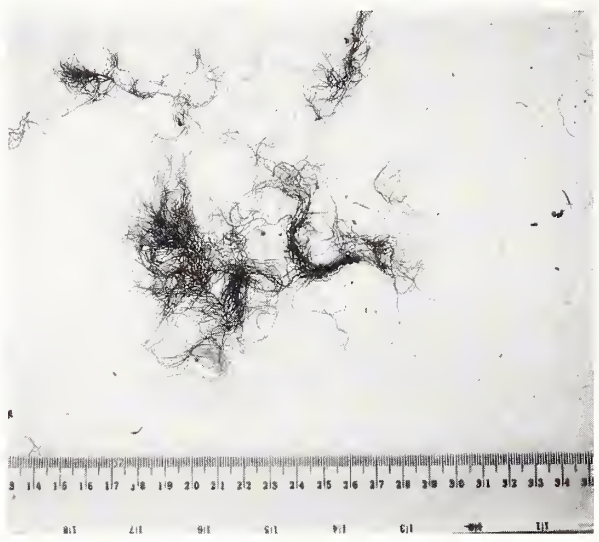

Fig. 1: *Gracilariopsis lemaneiformis* collected from Dhalawapuram (Ashtamudi lake)

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34. ADDITIONS TO THE TYPE MATERIAL IN THE HERBARIUM OF BOTANICAL SURVEY ON INDIA, WESTERN CIRCLE, PUNE

It is well known to taxonomists that names of plant groups at the rank of family and below must be based on nomenclatural types. A nomenclatural type is that constituent element of the taxon on which the name of that particular taxon is permanently attached, whether as a correct name or a synonym. As per the International Code of Botanical Nomenclature (ICBN), publication of the name of a new taxon of the rank of family or below on or after January 1, 1958 is valid only when the nomenclatural type of the taxon is indicated.

Singh and Deshpande (1980) enumerated 465 type sheets deposited in the Western Circle herbarium of the Botanical Survey of India (BSI). These types belong to 91 species and 4 varieties, and include the historically important collections of T. Cooke and W.A. Talbot.

Information on 105 type specimens and one type photograph are presented here which were added to the type section of the herbarium BSI, Pune in recent past. These type materials belong to 62 taxa including 49 species, 1 subspecies and 12 varieties under 23 families and 39 genera. Out of the 105 type specimens 7 are Holotypes, 67 Isotypes and 31 Paratypes. Category of the type is not indicated in the photograph mentioned above.

The original publications or protologue of each taxon mentioned in this paper was searched, and confirmed the types deposited in the herbarium BSI. Type specimens of few taxa published by Prof. V.N. Naik and his associates were found in BSI. In the relevant protologues it is mentioned that these types are deposited in the herbarium of Department of Botany, Marathwada University (MU), Aurangabad, Maharashtra. But later on these types were shifted to BSI for safe custody.

Also type specimens of the few taxa published by the researchers of some other institutes like Blatter Herbarium (BLAT), Mumbai, Botany Department Herbaria of Shivaji University, Kolhapur and University of Goa are also deposited in the BSI.

Generally, isotypes and paratypes are found in BSI, Pune and the Holotypes are usually deposited in the Central National Herbarium (CAL) at Howrah. Including the recent additions, at present there are a total number of 570 type materials in BSI, Pune that includes 26 Holotypes, 208 Isotypes, 290 Paratypes, 35 Syntypes and 2 Neotypes. Also as reported by Singh and Deshpande (1980) 5 type photos and 4 type sheets, which are not categorized, are also included. These type materials represent 157 taxa, including 140 species, 1 subspecies and 16 varieties.

CAPPARIDACEAE

Capparis cleghornii Dunn ex Gamble, Fl. Pres. Madras 46. 1915 (1: 33. 1957, repr.).

Type photo (1): Balabroydroog (Ballalarayanadruga), Karnataka, *Cleghorn* D 176, 13.iv.1846. Kew Negative No. 5723.

TAMARICACEAE

Tamarix kutchensis B.V. Shetty & R.P. Pandey in Bull. Bot. Surv. India 31: 152. (1989) 1992.

Holotype: Mundra - Mandvi, Gujarat, *Jain* 11735, 2.ii. 1957.

Note: It is mentioned in the protologue that *Isotype* is also in BSI, but could not be located.

MALVACEAE

Abelmoschus manihot (L.) Medik. ssp. ***tetraphyllus*** (Roxb. ex Horn.) Borss. var. ***megaspermus*** Hemadri in Bull. Bot. Surv. India 11: 338. (1969) 1972.

Isotype: Pimparwadi, 20 km west of Junnar, Poona Dist., Maharashtra, *Hemadri* 106812 B, 5.x.1965.

Paratypes: Inglun, 20 km west of Junnar, Poona Dist., Maharashtra, *Hemadri* 107380, 26.ix.1965; Religaon, 10 km west of Junnar, *Hemadri* 107313, 24.ix.1965; Dhak forest, 28 km west of Junnar, *Hemadri* 107452, 29.ix.1965; Bhivade khurd, 24 km west of Junnar, *Hemadri* 108164, 20.i.1966; Girnar, Junagadh, Gujarat, *Ansari* 59880, 23.xii.1959; Inglun, 20 km west of Junnar, Poona Dist., Maharashtra, *Hemadri* 99782, 20.x.1964.

TILIACEAE

Triumfetta tungarensis Billore in J. Econ. Tax. Bot. 3: 621.1982 (A synonym of ***Triumfetta rhomboidea*** Jacq.).

Isotypes: Mazivili R.F., Mandvi forest range, Thane Dist., Maharashtra, *Billore* 115873 B-C, 23.xi.1968.

MELIACEAE

Azadirachta indica A. Juss. subsp. ***vartakii*** Kothari *et al.* in Bull. Bot. Surv. India 39: 181, f. 1. (1997) 2001.

Isotypes: Rani-Amaravati, Amaravati Dist., Maharashtra, *Kothari* 173100 C-F, 6.iii.1997.

FABACEAE

Crotalaria decasperma Naik in Indian Forester 92: 760, f. A-D. 1966.

Isotype: Ghatangri, Osmanabad Dist., Maharashtra, *Naik* 976 D, 15.xi.1964.

Indigofera duthiei Drumm. ex Naik in Proc. Ind. Acad. Sci. 71 (B): 227. 1970. (Synonym of ***Indigofera trifolia*** L. var. ***duthiei*** (Drumm. ex Naik) Sanj., Legumes of India 196. 1991).

Holotype: Ram-Ling forest, Osmanabad town, Maharashtra, *Naik* 1319, 16.x.1966.

Note: Naik, *l.c.* validated the name *Indigofera duthiei* by providing the description and quoted the above mentioned specimen (*Naik* 1319) as the type. Photograph provided in the protologue is of the same specimen.

Zornia quilonensis Ravi in J. Bombay Nat. Hist. Soc. 66: 489. 1969.

Paratype: Residency, Quilon, Quilon (Kollam) Dist., Kerala, *Ravi* 308 A, 14.viii.1967.

CAESALPINIACEAE

Cassia kolabensis Kothari, Moorthy & M.P. Nayar in Proc. Indian Acad. Sci. (Pl. Sci.) 90 (3): 199, f. 1.9.1981.

Isotype: Penn to Khopoli Road, Kolaba, Raigad Dist., Maharashtra, *Kothari* 147461 B, 27.ix.1976.

Note: *Paratypes* (147910B & 115377) were not found, though mentioned in the protologue.

APIACEAE

Heracleum dalgadianum M.R. Almeida in Indian forester 111: 158, f. 1.5.1985.

Paratype: Amboli, Sindhudurg Dist., Maharashtra, *Almeida* MRA-1627 C, 2.x.1981.

Pimpinella rollae Billore & Hemadri in Indian Forester 108: 712. 1982.

Isotype: BSI Experimental garden, Poona (Raised from the seeds from Kedarnath hill slope, Harishchandragarh, Thane Dist., Maharashtra), *Billore* 115986 B-E, 15.vii.1969.

Note: *Partypes* (115489 B-F) were not found, though mentioned in the protologue.

RUBIACEAE

Tarenna agumbensis Sundararagh. in Bull. Bot. Surv. India 10: 341. 1968.

Paratype: Chytramane, Agumbe, Shimoga Dist., Karnataka, *Sundararaghavan* 80583 A-B, 14.v.1962.

Note : Singh & Deshpande, *l.c.* have not included the *paratypes*, but *Isotypes* only).

ASCLEPIADACEAE

Brachystelma ciliatum Arekal & T.M. Ramakrishna in Curr. Sci. 50(3): 145, f. 1 A-J. 1981.

Isotype: Sonnipally, Kolar Dist., Karnataka, *Ramakrishna* 1311 c, 27.vi.1979.

Paratypes: Sonnipally, Kolar Dist., Karnataka, *Ramakrishna* 1316, 29.vi.1979; 1340 A, 24.viii.1979.

Ceropegia anantii S.R. Yadav, M.M. Sardesai & S.P. Gaikwad in J. Bombay Nat. Hist. Soc. 101: 141. 2004.

Isotype: Salva hills, Sindhudurg Dist., Maharashtra, *Yadav* 495, 15.ix.1998.

LENTIBULARIACEAE

Utricularia janarthanamii S.R. Yadav, M.M. Sardesai & S.P. Gaikwad in Rheedea 10(2): 107. 2000.

Isotype: Kolhapur, Kolhapur Dist., Maharashtra, *Sardesai* MMS 233 C, 17.viii.1997.

Utricularia naikii S.R. Yadav, M.M. Sardesai & S.P. Gaikwad in Rheedea 10(2): 110. 2000.

Isotypes: Amboli, Sindhudurg Dist., Maharashtra, *Sardesai* MMS 1911 C & G, 29.ix.1999.

GESNERIACEAE

Paraboea nagalandiana Deb & R. Dutta in J. Bombay Nat. Hist. Soc. 85: 168. 1988.

Paratype: Sarpung, Naga hills, *Meebold* 7230, Dec. 1907.

ACANTHACEAE

Dicleptera nasikensis Lakshmin. & B.D. Sharma in J. Econ. Tax. Bot. 7: 481, f. 1-9b. (1985) 1986.

Isotypes: Dangsaundane (Satana range), Nasik Dist., Maharashtra, *Narasimhan* 163977 B-E, 20.v.1983.

Paratypes: Dangsaundane (Satana), Nasik Dist., Maharashtra, *Narasimhan* 167696 A-F, 17.v.1985.

EUPHORBIACEAE

Croton caudatus Geisel var. ***obovoides*** Balak. & Chakrab. in Bull. Bot. Surv. India 25: 190. (1983) 1985.

Paratype: Kuzhuthuruthy river bank, Kerala, *Subramanian* 70886, 4.v.1961.

Dalechampia stenoloba Sundararagh. & B.G. Kulk. in Kew Bull. 35(2): 325. 1980.

Isotypes: Sukhalhatti forests, Lakkavali range, Chikmagalur Dist., Karnataka, *Raghavan* 126547 B-C, 22.x.1970.

Note: Coll. No. 126547 D & E were not found in BSI, though mentioned in the protologue.

Euphorbia concanensis Janarthanam & S.R. Yadav in Rheedea 5(2): 148. 1995.

Isotype: Achirane between Phonda and Vaibhavadi, Sindhudurg Dist., Maharashtra, *Janarthanam & Yadav* 1002, 20.ix.1993.

ORCHIDACEAE

Coelogyne schultesii S.K. Jain & S. Das in proc. Ind. Acad. Sci. 87B: 121. 1978.

Paratype: Jowai, Jaintea hills, Prain's collector 159, May 1899.

ZINGIBERACEAE

Amomum ghaticum K.G. Bhat in Ind. J. For. 11: 322, f. 1-9. 1988.

Isotype: Sampaji Ghat, near Jodu-pala, Coorg (Kodagu) Dist., Karnataka, *Bhat* 1971, 9.v.1986.

Paracautleya bhatii R.M. Smith in Notes R.B.G. Edinb. 35: 368. 1977.

Isotype: Manipal, near Medical college, South Kanara (Dakshina Kannada) Dist., Karnataka, *Bhat* 204, 1.vii.1975.

LILIACEAE

Camptorriza indica S.R. Yadav, N.P. Singh & B. Mathew in Kew Bull. 48: 735, f. 1. 1993.

Isotype: Ratnagiri (Bhatia - Tisari Dharmashala), Maharashtra, *Yadav* y-1867 A, 20.vi.1990.

Iphigenia magnifica Ansari & R.S. Rao in Bull. Bot. Surv. India 20: 162. (1978) 1979.

Isotypes: Mukti lake area, Dhule, Dhule Dist., Maharashtra, *Pataskar* 118218 B-C, 5.x.1969.

Paratypes: Mukti lake area, Dhule, Dhule Dist., Maharashtra, *Ansari* 104945, 8.ix.1970; Matheran hill, Kolaba, Raigad Dist., Maharashtra, *Ansari* 104948, 30.vii.1973.

Iphigenia sahyadrica Ansari & R.S. Rao in Bull. Bot. Surv. India 20: 163. (1978) 1979.

Isotype: Hulical, Shimoga Dist., Karnataka, *Raghavan* 90209 B, 25.viii.1963.

Paratype: Hulical, Shimoga Dist., Karnataka, *Ansari* 104952 A-B, 24.viii.1973.

ARACEAE

Arisaema sivadasanii S.R. Yadav, Patil & Janarth. in Aroideana 20: 53, f. 1-4. 1997.

Paratype: Amboli, Sindhudurg Dist., Maharashtra, *Yadav* 4695 B, 22.x.1995.

Note: The above mentioned specimen (4695 B) is marked as *Isotype*. It cannot be a duplicate of the *Holotype* (No. 4688), though collected from the same locality, but can be treated as a *Paratype*.

APONOGETONACEAE

Aponogeton bruggenii S.R. Yadav & Govekar in Rheedea 4(1): 34. 1994.

Isotype: Nerurpar, Sindhudurg Dist., Maharashtra, *Yadav* 1, 10.ix.1992.

ERIOCAULACEAE

Eriocaulon karnatakense S.P. Gaikwad, M.M. Sardesai, U.S. Yadav & S.R. Yadav in Rheedea 14: 63. 2004.

Isotype: Khemangudi, Karnataka, *Yadav* GSP-3. 15.ix.2000.

Eriocaulon kolhapurense S.P. Gaikwad, M.M. Sardesai & S.R. Yadav in Rheedea 12: 133. 2002.

Isotype: Chikewadi, (Ranga Fort), Kolhapur Dist., Maharashtra, *Sardesai* 5350. 30.ix.1998.

Eriocaulon ratnagiricus S.R. Yadav, S.P. Gaikwad & M.M. Sardesai in Rheedea 8: 145, f. 1. 1998.

Isotype: Dharmashala, about 3 km from Ratnagiri on way to Pavas, Maharashtra, *Gaikwad* 1 B, 1.x.1996.

HYDATELLACEAE

Trithuria konkanensis S.R. Yadav & Janarth. in Rheedea 4(1): 18. 1994.

Isotype: Achirane, Sindhudurg Dist., Maharashtra, *Yadav & Janarthanam* 1001, 20.ix.1993.

CYPERACEAE

Fimbristylis ambavanensis V.P. Prasad & N.P. Singh in J. Bombay Nat. Hist. Soc. 96 (3): 454. 1999.

Isotypes: On top of the fort, Ambavane, Pune Dist., Maharashtra, *Venkatta Reddi* 99049 A-B, 6.ix.1964.

Fimbristylis ratnagirica V.P. Prasad & N.P. Singh in J. Econ. Tax. Bot. 21(3): 673. 1997.

Isotype: Osargaon plateau, Kasal, Ratnagiri Dist., Maharashtra, *Kulkarni* 131758 A, 18.viii.1971.

Fimbristylis simpsonii V.P. Prasad & N.P. Singh in J. Bombay Nat. Hist. Soc. 96(3): 456. 1999.

Isotype: Kanagal gudd, Tirthahalli, Shimoga Dist., Karnataka, *Sundararaghavan* 90025 A, 19.viii.1963.

Pycreus kanarensis V.P. Prasad & N.P. Singh in J. Econ. Tax. Bot. 21(3): 667. 1997.

Isotypes: Karwar, Kanara, Uttara Kannada Dist., Karnataka, *Chibber s.n.* (Acc. No. 2519 & 2520), Nov. 1910.

POACEAE

Brachiaria brizantha (Hochst. ex A. Rich.) Stapf var. ***ciliata*** Basappa & Muniy. in Proc. Ind. nat. Sci. Acad. B 49: 378. 1983.

Isotype: Department garden, Manasagangotri (Fiji origin, introduced through USDA, USA: 355712), Mysore, Karnataka, *Basappa & Muniyamma* 1004 -b, 11.ix.1980.

Brachiaria chennaveraiana Basappa & Muniy. in Proc. Ind. nat. Sci. Acad. B 49: 378. 1983.

Isotype: Near Gomukh, Mount Abu, Rajasthan, *Basappa & Muniyamma* 2195-b, 15.x.1980.

Brachiaria eruciformis var. ***divericata*** Basappa & Muniy. in Proc. Ind. nat. Sci. Acad. B 49: 379. 1983.

Isotype: Bogadi, near Mysore, Mysore Dist., Karnataka, *Basappa & Muniyamma* 1451-b, 12.viii.1979.

Brachiaria hybrida Basappa & Muniay. in Proc. Ind. nat. Sci. Acad. B 49: 379. 1983.

Isotype: Near Tunga dam, Gajanur, Shimoga Dist., Karnataka, *Basappa & Muniyamma* 2851-b, 10.ix.1979.

Brachiaria munae Basappa in Proc. Ind. Acad. Sci. (Plant Sci.) 93: 53, f. 1. 1984.

Isotype: Madurai Kamaraj University Campus, Madurai Dist., Tamil Nadu, *Basappa* 3001-b, 20.xii.1979.

Brachiaria ramosa Stapf var. ***pubescens*** Basappa & Muniy. in Proc. Ind. nat. Sci. Acad. B 49: 380. 1983.

Isotype: Benakanahalli, Shimoga Dist., Karnataka, *Basappa & Muniyamma* 2171-b, 20.viii.1980.

Brachiaria reptans Gard. & Hubb. var. ***hispida*** Basappa & Muniy. in Proc. Ind. nat. Sci. Acad. B 49: 380. 1983.

Isotype: Govinakovi, Shimoga Dist., Karnataka, *Basappa & Muniyamma* 2302-b, 10.x.1980.

Brachiaria semiundulata Stapf var. ***intermedia*** Basappa & Muniy. in Proc. Ind. nat. Sci. Acad. B 49: 380. 1983.

Isotype: Near Doopada Bore, Bedaguli, Mysore Dist., Karnataka, *Basappa & Muniyamma* 2602-b, 8.viii.1979.

Brachiaria semiundulata Stapf var. ***lanata*** Basappa & Muniy. in Proc. Ind. nat. Sci. Acad. B 49: 380. 1983.

Isotype: Near Doopada Bore, Bedaguli, Mysore Dist., Karnataka, *Basappa & Muniyamma* 2603-b, 8.viii.1979.

Brachiaria setigera var. ***albistyla*** Basappa & Muniy. in Proc. Ind. nat. Sci. Acad. B 49: 380. 1983. (Synonym of ***Urochloa setigera*** var. ***albistyla*** (Basappa & Muniy.) Karthik. *et al.*, Fl. Ind. Enum. Monocot. 273. 1989).

Isotype: Agriculture College Campus, Coimbatore Dist., Tamilnadu, *Basappa & Muniyamma* 2716-b, 25.x.1980.

Brachiaria stapfiana Basappa & Muniy. in Proc. Ind. nat. Sci. Acad. B 49: 379. 1983.

Isotype: Near Ugra Narasimha Temple, Hampi, Bellary Dist., Karnataka, *Basappa & Muniyamma* 2100-b, 20.ix.1979.

Brachiaria villosa A. Camus var. ***glaberrima*** Basappa & Muniy. in Proc. Ind. nat. Sci. Acad. B 49: 381. 1983.

Isotype: Near Monkey point, Kasauli, Siwalik Hills, Chandigarh, *Basappa & Muniyamma* 2911-b, 26.xi.1981.

Coelachne ghatica Naik in Reinwardtia 9: 393. 1980 *et* in Indian Forester 106: 732, f.9. 1980. (A synonym of ***Coelachne minuta*** Bor)

Holotype: Amboli, Western Ghats, Maharashtra, *Naik* 1300 a, 13.ix.1971.

Isotype: *Naik* 1300 b.

Eulalia shrirangii C.B. Salunke & G.G. Potdar in Kew Bull. 59: 625. 2004.

Isotype: Kas plateau, Satara Dist., Maharashtra, *Salunke* 8170. 9.x.1994.

Glyphochloa henryi Janarth., Joshi & Rajkumar in Rheedea 10: 99. 2000.

Isotype: Tisk, Usgao, Goa, *Janarthanam & Rajkumar* 1661, 27.ix.1998.

Glyphochloa veldkampii Fonseca & Janarth. in Rheedea 13: 35. 2003.

Isotype: Kasauli, along the Panaji-Belgaum highway (NH 4A), in the outskirts of Bhagwan Mahavir Wildlife Sanctuary, Goa, *Janarthanam & Fonseca* 1901. 21.x.2001.

Isachne bicolor Naik & Patunkar in Bull. Bot. Surv. India 15: 157. (1973) 1976.

Isotype: Mhaismal, Aurangabad Dist., Maharashtra, *Patunkar* 1849 D, 8.x.1973.

Isachne swaminathanii Ved Prakash & S.K. Jain in Proc. Ind. Acad. Sci. (Plant Sci.) 92: 19, f. 10. 1983.

Paratypes: Mahabaleshwar, Satara Dist., Maharashtra, *Puri* 25641 & 25642 A-B, 5.x.1957; Near Valvan dam, Lonavala, Pune Dist., Maharashtra, *Venkata Reddi* 98729 A-B, 26.ix.1964; Harichandragarh, Thane Dist., *Wadhwa* 127804, 27.ix.1970.

Note: Coll. Nos. 25641 & 25642 are not included in the protologue, but found in BSI marked as paratypes.

Mnesithea veldkampii G.G. Potdar, S.P. Gaikwad, C.B. Salunke & S.R. Yadav in Kew Bull. 59: 629. 2004.

Isotype: Mavashi plateau, Satara Dist., Maharashtra, *Yadav* 1466. 6.xi.2002.

Panicum deccanense Naik & Patunkar in Reinwardtia 9: 405. 1980.

Holotype: Mirzapur - Degloor, Nanded Dist., Maharashtra, *Patunkar* 2350 a, 24.ix.1974.

Isotype: *Patunkar* 2350 d.

Panicum paianum Naik & Patunkar in Reinwardtia 9: 407. 1980.

Holotype: Rajghar, Nanded Dist., Maharashtra, *Patunkar* 2430 A, 26.x.1974.

Isotypes: *Patunkar* 2430 C&D.

Panicum paianum Naik & Patunkar var. ***minor*** Naik & Patunkar in Reinwardtia 9: 409. 1980.

Holotype: Rajghar, Nanded Dist., Maharashtra, *Patunkar* 2439 A, 26.x.1974.

Isotype: *Patunkar* 2439 E.

Panicum phoiniclados Naik & Patunkar in Reinwardtia 9: 403. 1980.

Holotype: Ganjgaon, Nanded Dist., Maharashtra, *Patunkar* 2468 A, 17.xi.1974.

Isotype: *Patunkar* 2468 C.

Themeda pseudotremula G.G. Potdar, C.B. Salunke & S.R. Yadav in Kew Bull. 58: 243. 2003.

Isotype: Tillari ghat, Kolhapur Dist., Maharashtra, *Potdar* 801. 12.xi.2001.

Tripogon polyanthus Naik & Patunkar in Bull. Bot. Surv. India 15: 158. (1973) 1976.

Isotype: Daulatabad, Aurangabad Dist., Maharashtra, *Patunkar* 1859 D, 18.x.1973.

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July 11, 2003

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REFERENCE

SINGH, N.P. & U.R. DESHPANDE (1980): Type material in the Herbarium of the Botanical Survey of India at Poona. *J. Bombay Nat. Hist. Soc.* 76: 24-32.

35. ADDITIONS TO THE FLORA OF KARNATAKA

While investigating the flora of the Western Ghats and coastal belt of Karnataka, I came across three species of plants not recorded previously from Karnataka. The following list gives their correct nomenclature, distribution and, flowering and fruiting seasons. The specimens are deposited at Botanical Survey of India (BSI) and in the Herbarium of Poornaprajna College,Udupi.

1. ***Cerasiocarpum bennettii*** (Miq.) Cogn. in DC. Monog. Phan. 3: 729. 1881; Gamble, Fl. Pres. Madr. 3: 541. 1919; Chakr. in Fasc. Fl. India II: 18. 1982. *Bryonopsis bennetti* Miq., Fl. Ind. Bat. 1: 657. 1855. *Aechmandra zeylanica* Thw., Enum. 125. 1858. *Cerasiocarpum zeylanicum* (Thw.) Hook. f in Gen. Pl. 1: 832. 1862; Clarke in Hook. f., Fl. Brit. India. 2: 629. 1879. (Cucurbitaceae)

There is no record of this rare cucurbit from Karnataka so far, although Chakravarthy (*l.c.*) gives the distribution range as Peninsular India. It is quite likely that this species may occur at many more localities in the forests of Western Ghats.

Fl. and Fr.: July-October

Exsicc.: Shimoga Dist.: Agumbe, October 8,1989, K.G. Bhat 7169; Dakshina Kannada Dist.: Kudremukh Ghat, July 25,1999, K.G. Bhat 11325.

2. ***Polygonum capitatum*** Buch.-Ham. in D. Don, Prod. Fl. Nep. 73.1825; Hook. f., Fl. Brit. India 5: 44.1886. (Polygonaceae)

In India, this species has so far been recorded only from the subtropical and temperate Himalaya and Palni hills. This species seems to be an adventive plant in S. India.

Fl. and Fr.: September-December.

Exsicc.: Kodagu Dist.: Kodagarahalli, near Suntikoppa, November 8, 1990, K.G. Bhat 10138.

3. ***Spermacoce malabarica*** (Sivar. & Mani.) Sivar. *et al.* in Proc. Indian Acad. Sci. (Plant Sci.) 97: 355. 1987. *Borreria malabarica* Sivar. & Mani. in Bull. Bot. Soc. Univ. Sagar 19: 31. 1972; Mani. & Sivar., Fl. Calicut 136. 1982. (Rubiaceae)

This endemic species is so far known only from Kerala (Sivarajan *et al.*, *l.c.*). The recent collection of this species from Dakshina Kannada is a new record of its extended distribution in southern India.

Fl. and Fr.: August-October.

Exsicc.: Dakshina Kannada Dist.: Kaikamba, near Mangalore, growing along roadside, August 20, 1993, K.G. Bhat 11203.

ACKNOWLEDGEMENTS

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Acknowledgements: Acknowledgements should be brief and relevant.

References: Responsibility for the accuracy of references rests with the author(s). Abstracts of papers presented at scientific meetings may be cited. References to literature should be alphabetically arranged under author's name, with the abridged titles of journals or periodicals in italics and titles of books or papers in Roman type, thus:

ALURI, RAJU J.S. & C. SUBHA REDDI (1995): Ecology of the pollination in two cat-mint species. *J. Bombay Nat. Hist. Soc. 91(1)*: 63-66.

PRATER, S.H. (1971): The Book of Indian Animals. 3rd Edn. Bombay Natural History Society, Mumbai. pp. 35-48.

Species names should carry the Author's name and subspecies (trinomials) should only be used where identification has been authentically established by comparison of specimens actually collected.

For the standardised common and scientific names of the birds of the Indian subcontinent refer to *Buceros* Vol. 6, No. 1 (2001).

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CONTENTS

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