









ANNALS  
OF THE  
NATAL MUSEUM

EDITED BY  
ERNEST WARREN, D.Sc.(LOND.), DIRECTOR.



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# CONTENTS.

## VOLUME II.

### PART 1, ISSUED JULY, 1909.

	PAGE
Zulu Medicine and Medicine-men By Rev. ALFRED T. BRYANT, Natal . . . . .	1
On <i>Lafœa dispolians</i> sp. n., a Hydroid parasitic on <i>Sertularia bidens</i> Bale. By ERNEST WARREN, D.Sc.Lond. (With Plate I and 2 Text-figs.) . . . . .	105
Notes on the Life-Histories of Natal Termites, based on the Observations of the late Mr. G. D. Haviland. By ERNEST WARREN, D.Sc.Lond. . . . .	113
Some Observations on the Dentition of <i>Chrysochloris</i> , and on the Tritubercular Theory. By R. BROOM, D.Sc., M.D., C.M.Z.S., Victoria College, Stellenbosch. (With Plate II) . . . . .	129

### PART 2, ISSUED DECEMBER, 1910.

Petrographical Notes on the Dolerites and Rhyolites of Natal and Zululand. By G. T. PRIOR, M.A., F.G.S., Keeper of Minerals in the British Museum. (With Plates III-VI) . . . . .	141
The Slugs of Natal. By WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S., Berkhamsted . . . . .	159
On South African Marine Mollusca, with Descriptions of New Species. By EDGAR A. SMITH, I.S.O., F.Z.S. (With Plates VII, VIII) . . . . .	175

	PAGE
On Some Nudibranchs from the Coast of Natal. By Sir CHARLES ELIOT, K.C.M.G. . . . .	221
The Discovery of Fish-remains in the Ecca Shales, near Ladysmith. By F. H. HATCH, Ph.D., F.G.S. . . . .	227
Notes on Palæoniscid Fish-scales from the Ecca Shales, near Ladysmith. By A. SMITH WOODWARD, LL.D., F.R.S., of the British Museum. (With Plate IX) . . . . .	229
A Note on a Fossil Wood from Intombi Camp, Ladysmith. By E. A. NEWELL ARBER, M.A., F.L.S., F.G.S. . . . .	233
On a Black Hairless Duiker and Dog, and a Bulldog-headed Calf. By ERNEST WARREN, D.Sc.Lond. (With Plates X-XIII and 1 Text-fig.) . . . . .	235

## PART 3, ISSUED MAY, 1912.

The Vegetation of Natal. By J. W. BEWS, M.A., Professor of Botany, Natal University College. (With Plates XIV-XXIII and Map) . . . . .	253
On Afrodonta Melv. and Pons., with Descriptions of New Species. By HENRY CLIFDEN BURNUP, Keeper of the Conchological Collections, Natal Museum. (With Plate XXIV) . . . . .	333
On Some Specimens of Fossil Woods in the Natal Museum. By ERNEST WARREN, D.Sc.Lond. (With Plates XXV-XXVII and Text-figs.) . . . . .	345
A Spherulitic Dolerite from Vryheid, Natal. By W. CAMPBELL SMITH, B.A., F.G.S., Assistant in the Mineral Department, British Museum. (With Plates XXVIII-XXX and Text-fig.) . . . . .	381
Note on an Interesting Contact of Dolerite with Sandstone from the Ecca Beds of Elandsplaagte, Natal. By F. H. HATCH, Ph.D., F.G.S., M.Inst.C.E. (With Plate XXXI)	393

## PART 4, ISSUED AUGUST, 1913.

	PAGE
The Oligochaeta of Natal and Zululand. By WILHELM MICHAELSEN. (With Plate XXXII) . . . . .	397
On Freshwater Entomostraca from Various Parts of South Africa. By G. STEWARDSON BRADY, M.D., LL.D., D.Sc., F.R.S. (With Plates XXXIII-XXXVIII) . . . . .	459
Description of <i>Heleophryne natalensis</i> , a New Batrachian from Natal; and Notes on Several South African Batrachians and Reptiles. By JOHN HEWITT, B.A.Camb. (With Plate XXXIX) . . . . .	475
An Ecological Survey of the Midlands of Natal, with Special Reference to the Pietermaritzburg District. By J. W. BEWS, M.A., D.Sc.(Edin.). (With Plates XL-XLVI and Map) . . . . .	485

## ISSUED NOVEMBER, 1916.

Title-page of Vol. II . . . . .	i
Contents of Vol. II . . . . .	iii
Index of Mollusea . . . . .	547
General Index . . . . .	553
Errata . . . . .	587



## Zulu Medicine and Medicine-men.

By

**Rev. Alfred T. Bryant,**  
Natal.

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### (1) INTRODUCTION.

ALTHOUGH the Zulu native is sadly lacking in the equipment requisite for the civilised life, he is quite astonishingly learned in the domain of his own environment. It is by no means an exaggeration to affirm that comparatively the average Zulu can boast of a larger share of pure scientific knowledge than the average European.

I suppose, if it were possible for us to go back to the dawn of human intellect and to measure how much of intelligent thought has been expended on each of the several branches of mundane knowledge, we should find that probably by far the greater part has been spent on the subject of medical science.

From the origin of primitive man on to the time when the art of writing was invented marks one period in the history of medical knowledge—the first dark period of unwritten progress. And from the days when Imhotpon, son of Ptah, first wrote “soon after the creation” at Memphis, and Hippocrates at Cos, on to these times of modern medicine marks another, in which we still find ourselves. With this latter period I am not here concerned, but I should like to glance into that great book of unwritten lore, such as may have existed among aboriginal peoples prior to the dawn of

literary enlightenment in Egypt and Greece. True, that was an unwritten book; but it existed all the same, writ large in the traditions and practice of those peoples. Has it even now ceased to exist? Or may we not find fragments of the ancient lore still extant among the primitive races of mankind, wherewith to reconstruct in some degree the ancient pages?

The Kafirs of South Africa, upon the arrival of the white man among them, were, I am convinced, in virtually the same state of life and knowledge as they must have been in the days when the ancient Egyptians first appeared on the Nile. This was a state of life so primitive of its kind that it scarcely permitted any further reduction to a simpler standard, at any rate for anything calling itself a human being.

The Kafir's dwelling, merely a rough binding-together of twigs and grass, marked only one step in advance of the cave-dwellers. His single weapon, an indifferently made stabbing-instrument, consisting of a crude iron blade affixed to the end of a stick, indicated only the first emergence from the Stone Age. His dress, of a single strip of skin covering the pudenda, with absolutely no knowledge of any kind of cloth, was the simplest advance on the fig-leaf.

His acquaintance with only two, or at most three, species of edible cereal (*amaBele* or *Sorghum cafrorum*, *uNyawoti* or ? *Penicillaria spicata*, and *uPoko* or Eleusine *coccinea*—the maize-plant having been introduced in comparatively recent times by the Portuguese), with not more than half-a-dozen varieties of other cultivated vegetable food, and all prepared for eating by the merest process of water-boiling, exhibited a culinary art of the most rudimentary description. His pottery was almost identical with that in vogue in north Africa in the very earliest period of Egyptian history.

This is how we found him two centuries back, and how, for the most part, he still remains. Have we any reason to believe he was more advanced than this 6000 years ago—he could scarcely have been less? There seems every reason to believe that he was just where he is. Why, then, should we suppose that he has made any considerable progress in his

knowledge and treatment of disease? A study of these latter as existent to-day will no doubt present us with a very fair picture of how they must have been before Imhotpon and Æsculapins became gods.

## (2) THE GENERAL STATUS AND INITIATION OF THE MEDICINE-MAN.

Compared with the sleek and imposing personality of the chief the medicine-man presents quite a mean appearance, though picturesque and awesome withal. Along with the chief he shares the greatest power in the savage tribe—not, it is true, the power of supreme authority, but a power over life and death not less effective and real, though hidden and mysterious. His well-wrinkled features bear the unmistakable stamp of a thinking mind, and his intelligent eye has that flash of deep cunning so well suited to one who has so often been the accomplice, behind the scenes, to sinister deeds. His lean, wiry frame betokens a life of toilsome, if well-rewarded, activity rather than of luxury and repose—an activity consisting mainly in constant arduous journeyings throughout the land, and frequently even into the foreign lands of adjoining tribes.

Out in the full panoply of a professional progress, his body is betrimmed with a medley of the most fantastic trappings. A plume of feathers waves above his head-ring, and a circlet of lion-claws surrounds his neck. Various cow-tails dangle from his arms and chest, supplementing the square strip of leopard-skin and the bundle of genet-tails that cover his nakedness behind and before. Numerous bunches of goat-horns, blackened with the smoke of his hut, and sundry small grass-woven baskets and bundles of rag-packages, brown with dirt, containing his strange assortment of drugs and charms, are strung from every point of vantage about neck, shoulders and body. A long pouch, holding his snuff-box, and made from the whole skin of an unborn calf, dangles from his left

hand, and in the other he carries his long walking-staff or a couple of stout sticks.

Thus, silently followed by his menial, bearing on his head his master's roll of sleeping-mats, blanket, smoke-horn and head-rest, the Zulu medicine-man goes forth to conquer death—or to administer it.

The high dignity and diploma of medicine-man is open to all who may have the wealth and inclination to seek it. Lack of ambition and individual initiative is a chief characteristic of the African nature, and accounts for the utter absence of young men launching out on independent projects of their own. But should one perchance be so precocious as to aspire to the medicine-man's estate, he must first of all undergo a long period of initiation. He enters the service of some doctor of repute as his *imPakutha* or assistant. His business is to act as the messenger, the herb-gatherer and general help of his master in professional matters, accompanying him on all his excursions as medicine-bearer, and picking up by observation and instruction whatever of knowledge and skill he can. In an irregular way this kind of study may continue for years, until at length the tyro feels that he is capable of dealing with a good many ailments on his own account, pays his master the required fee of two or three head of cattle, and betakes himself to his own home, where he soon surrounds himself with a comfortable practice. He constantly adds to his store of knowledge by consultation and the mutual exchange of remedies with neighbouring doctors, until, after perhaps twenty years or more, he has picked up all there is worth knowing in the Kafir pharmacopœia and Kafir pathology.

But all this is the rare and exceptional course. As a matter of fact, the medical profession is with the Zulus hereditary, one of the medicine-man's sons being compulsorily introduced by him into the trade, as his assistant, during life, and inheriting his legacy of bags and bundles of medicine after his death.

(3) ORIGIN OF THE ZULU NAME *i-nyanga*—MEDICINE-MAN.

The Kafirs call their medicine man, in Zulu, an *i-nyanga*, and in Xosa, an *i-nyangi* (although in the latter language a totally different term, viz. *i-gqira*, is in more common use nowadays, probably derived from the Hottentot: cf. Nama-Hot. *gqeira*, pertaining to witchery, from *gqei-di*, bewitch, from *gqei*, belch. Note here the universal habit among witch-doctors, Zulu included, of inaugurating their spiritualistic seances with an inevitable prelude of belching).

Whether or not there may be any kinship between the Kafir roots indicated above and the constantly recurring element, *ag*, *ga*, or *gi* in the Aryan languages, e. g. Skr. *gir*, speech; Pers. *mag*, priest; Gr. *magos*, wizard; L. *augur*, soothsayer; *gar-rive*, chatter; Eng. *mag*, chatter, and the like, I leave to the philologists to decide. Certainly a remarkably similar element, viz. *anga*, in the sense of "wizard" or "medicine-man" is very prevalent in the present-day vocabulary of the nasalising Bantu tribes of Africa, and was no doubt equally so in the archaic speech of pre-Egyptian times.

Thus we find *n-ganga* (doctor) in the Swahili opposite Zanzibar, and the same in Kaguru of Sagaraland. The Nyamnyam, of the Nuba-Fula group, have *n-zanga* (doctor) and *wu-wanga* (medicine).<sup>1</sup> Passing to the Hausa, of the Negro group, between Lake Tshad and the Niger, we have *magani* (medicine) and *maimagani* (doctor). In the Dualla of the Cameroons, *bw-anga* means "medicine"; and in the Pongwe or Gaboon language *n-ganga* appears as "doctor." Moving southward along the western coast, we meet with *n-ganga* (doctor) both in the Congo and Angola speech. Still southward of these, at the south-western extremity of the Bantu field, the Herero has *on-ganga* (doctor). Returning across the continent, we find *n-gaka* (doctor) among the

<sup>1</sup> In regard to some of the examples here given, the writer is not prepared to vouch for the absolute accuracy of the division, as here indicated, of the prefixes from their roots.

Sutos; *in-ganga* (doctor) in Mashonaland; the same again among the Tongas seaward of the Victoria Falls; and we complete the circuit with *un-ganga* (doctor) among the Nkonde north of Lake Nyasa.

#### (4) THE MEDICINE-MAN AND WITCH-DOCTOR COMPARED.

Among most primitive peoples the medicine-man, the priest and the diviner was, and still generally is, one and the same individual, following the one indivisible trade. All powers and functions that possessed about them anything of the mysterious and uncanny, whether they were employed to eradicate disease or to reveal hidden doings, to bestow good fortune or to charm away the bad, were to the savage mind so identical in their nature as to be most properly combined in the same profession and same professional—they were but varied manifestations of the one same power.

The African medicine-man (so called by Europeans), may therefore very possibly be the direct descendant of the aboriginal "priest" who worked at once moon, medicine and magic. With the Kafirs, however, both Zulu and Xosa, the office has, throughout all historical time (i. e. at any rate since the advent of the white man) been divided.

The Zulu medicine-man is a personage totally distinct from the Zulu diviner or so-called witch-doctor. Even so, the two professions do still considerably overlap, the medical man dealing very largely in magic and charms, and conversely the witch-doctor possessing an extensive acquaintance with disease and curative herbs, although his office is rather to indicate than to actually administer. Both are commonly called an *i-nyanga*, though the medicine-man is sometimes distinguished as the *i-nyanga yokwelapha* (the doctor for curing), and the witch-doctor as the *i-nyanga yokubhula* (the doctor for divining).

This latter has the further titles, solely confined to his own class, of *um-ngoma* (apparently originally meaning "the drumming-one"—c f. Swahili, Ganda, etc., *m-goma*, drum;

Kikuyu, *n-goma*, temporary madness), and *isa-nisi* (the smeller-out—probably from a now obsolete Zulu word *nukisa*, abbrev. form *nusa* meaning to “help to smell out”), and so called from their practices respectively of drumming or beating on a hide, or perhaps originally on a drum, during certain ceremonies, and of “smelling out” all manner of secret evil and the workers thereof.

#### (5) THE NATURE OF NATIVE MEDICAL PRACTICE.

If we examine the Kafir doctor's pathological knowledge we find it mostly amounts to *nil*. His entire acquaintance with the structure of the human body is drawn from its analogy with the anatomy of the beasts, with whose bodily structure he is, indeed, remarkably familiar. You could put to him few questions as to the placing of the bones and the various organs in the body of an ox, pig, or monkey that would considerably embarrass him. He could tell you something, at any rate, about the form and appearance in health and disease of the respiratory, digestive, and circulatory organs; but the whole nervous system, save the bare existence of the brain and spinal cord, is to him a perfect blank. He possesses no name for nerves and knows naught of their existence. A similar state of ignorance reigns throughout the whole domain of physiology. He could not even give a school-boy explanation of the functions of any one of the principal organs. He knows that the blood “runs” through the body, but he is not aware of any connection between the circulation of the blood and the beating of the heart.

Despite the fact that the Kafir doctor is so uninformed as to the causes and nature of diseases, he is conversant enough with their symptoms. Indeed, to him the symptoms are the disease, and the great rule of his pathology is: As many symptoms, so many diseases. A person might be suffering with an unhealthy liver and so be afflicted with pain in the right shoulder. The latter would be regarded as a separate complaint and called *isiBhobo*, while the former (or liver symptoms)

would be called *isiBindi*. In a case of paraplegia you may find the doctor vigorously carving rows of incisions about the paralysed lower limbs and rubbing therein fiercely irritating powders, which might well be expected to stimulate any cripple to almost superhuman activity ; but he is all the time quite innocent of the fact that the evil is not there at all, but away at the other end, in the brain.

The method of the native doctor, then, in fighting disease is to deliver a fierce frontal attack against each symptom individually, which, as we may readily imagine, to one so innocent of the nature, strength, and position of the enemy, must often result disastrously. A patient down with severe dysentery, that will tolerate no checking, he will proceed to drench at once from above and below with a combination of the most drastic astringents varied with a dose of the most drastic purgatives.

In spite of such blind empiricism it cannot be denied that the native doctor does sometimes work a cure, sometimes quite a startling cure, where the efforts of European physicians have proved utterly unavailing. Remedies he has, as we shall see, without number, and some of them truly helpful, suited to every ill—physical, mental, moral and social—that man is heir to. Frequently it is to these we may attribute his success ; but not so in those phenomenal cases above referred to.

In the opinion of the writer the secret of many Kafir cures, and, it may be added, of many Kafir ailments, is not in the action of matter on matter, of drug on flesh, but in those occult regions where mind works on mind and mind on flesh.

It is not the quack's innocent mixture of tap-water and burnt sugar that drives out the malady, but that powerful battery of mental forces—confidence, imagination and will—hitherto inert within the patient's own self, and which the quack has so cunningly, and in the case of Kafir doctors, perhaps quite unconsciously, excited to activity by his convincing volubility and inspiring methods. We often say the native is favoured with remarkable recuperative powers. Are these attributable solely to a more robust physical system,

and not rather, and in a very large degree, to his possession of a mind working in more perfect harmony with the requirements of the body ?

A native cannot understand disease in any plant or animal as being in accordance with the natural order of its destiny. The only manner of death that is at all comprehensible to him is that of senile decay—when a thing has run its allotted course and expended its powers and sinks serenely back once more into the lap of Mother Earth. Of the aged who pass away in this “natural” way the native never says that “they have died” (*ba-fle*), but simply “they have gone home” (*ba-godukile*). Where is the reasonableness in a thing withering away in the very prime of its existence ? Obviously this can only be brought about by some pernicious influence interfering from without. He has fixed on only two such external agents of harm—malice and magic—as best suggesting themselves to his own innate suspiciousness of character. He is convinced that fully 90 per cent. of those who die “prematurely” have been done away with by the malice of their neighbours. (Generally speaking, the only form of contractible disease for which an *umThakathi*\* is not held to be responsible is that heterogeneous agglomeration of ailments which he combines under the generic term *umKhuhlane*, which may be roughly described as “fevers,” and which he is satisfied are somehow conveyed through the medium of the air.

The result of all this is to produce a medical science very unlike our own. The Kafir doctor is not only called upon to combat diseases already actually in the system, but he has also to combat the machinations and black arts of the *venefici* of his race by charms and counter-magic. As we elsewhere observe, medicine and magic among primitive peoples always proceed together. They are one science, one art ; and to the primitive mind both are equally feasible, equally natural. In their view it makes no greater demand on reason to believe that a piece of vegetable root tied round the neck

<sup>1</sup> *umThakathi* describes in Zulu a person given to the secret killing off of others.

can preserve a man from impending evil (say of getting wounded in battle), than that it can save him from its effects after it has actually befallen him. In fact the accomplishment of the former feat would appear to involve less difficulty than the latter. It is obviously just as reasonable to expect Nature to have provided antidotes against the secret malpractices of brother-man as against the mischief worked in human beings by those much more abstruse forces causing disease and death. The office of the medicine-man thus requires him to administer magic and charms as often as health-giving drugs. He would stand aghast at the magnitude of your ignorance if you were bold enough to ridicule his ability to confound the knavery of the *umThakathi* by plentifully sprinkling *inTelezi*-medicine about the kraal, or to ward off the lightning by erecting a medicated stone in its vicinity.

But while he assumes the power of being able to ward off and fortify against all manner of possible corporal and physical evils, he knows too how to induce them; and the proneness of human nature to work evil, especially for gain, being well recognised by the Kafirs, the most skilled medicine-man is with them invariably suspected of being also the greatest *umThakathi*.

#### (6) THE NATIVE MEDICINES.

Crawling into the doctor's hut we may find him in the act of making up a prescription, for he is his own chemist. Squatting alone on the floor on the right side of the hut, a vast array of small objects, of all shapes, all colours, all characters, lies spread out in an orderly fashion before and about him. From time to time, after a thoughtful survey, he picks up one or other of the curious objects, pares off a few tiny slices, or drops a few particles on to the rag-patch outstretched before him, until a small heap has been accumulated, perhaps half a tea-spoonful or so, sufficient for one or more doses according to the strength of the ingredients.

There are baked insects and dried reptiles; the dung of lions in powders and the fat of the water-sprite in bottles; the shrivelled flesh of the white man and the hardened menses of the baboon; an incongruous assortment of oddities—Spanish-fly powder, asbestos, glass prisms, washing-soda, flint, spa, crystal, coral, rare geological specimens of every description; skins and bones of every conceivable animal, and hundreds of barks, roots, berries and leaves—in a word, choice selections innumerable and wonderful, medicinal and magical, useful, harmful, and inert, from the whole range of mineral, vegetable, and animal kingdoms, terrestrial and marine.

There are *amaKhubalo*, to be eaten for self-fortification against evil; and *imiKhaudo*, to be set for destroying the power in others. There are *imBhulelo*, to be laid on the enemy's path, that, in passing, a fatal disease may befall him; and *izinTelezi*, for sprinkling about the kraal to ward off the lightning or discomfit the *umThakathi* in his impious endeavours; *izimPundu*, for confusing him when in the act, and *izinGqunda*, for "taking the edge off" the act when accomplished.

There are *imiThi emnyama*, "black medicines," so called from their colour or the colour of their decoction, generally drastic in their nature, and, from their potency, the first to be administered to the patient for the energetic expulsion of the evil afflicting him.

There are *imiThi emhlophe*, "white medicines," also so called from their colour, to be administered subsequently to the black, as a kind of tonic or sedative, to work off the effects of the latter and to restore the patient once more to a state of complete healthfulness.

And there are *amaKhambhi*, "green medicines"—herbs and roots freshly culled from the veld—the largest and most useful class of all.

I have actually registered, in the pages of my Zulu-English Dictionary, some 777 different plants, and in the case of 225 of these (apart from the charms) some medicinal use or

property is indicated. A valuable and exhaustive account of about 150 South African medicinal plants, as used by the Xosa and Fingo Kafirs in the Cape Colony, has already been supplied by Mr. Andrew Smith, M.A., in his book entitled 'A Contribution to South African Materia Medica,' and the names of 240 other such, mentioned in this article as in use among the Zulus, will indicate to medical botanists where their future investigations might be most profitably pursued.

It is a curious thing that so many of our health-giving plants, should, at the same time, be capable of killing, and the Kafir pharmacopœia is as abundant in such poisons as is our own. For the benefit of such as desire to be warned, I should say all of the following should be labelled at any rate as dangerous, many of them being most certainly fatally poisonous, and that, with some constitutions, even in minute quantities. It must be recollected, however, that every part of a plant is not always equally poisonous; that the noxious properties are not at all seasons equally great, and that they may at times be completely removed or neutralised by the method of medicinal preparation. There are the *uQwengu* or (*N*)<sup>1</sup> *iLozane* (*Tephrosia macropoda* and *T. diffusa*), *iNcohiba* (*Gomphocarpus* sp.), *imFulwa* (*Ophiocaulon gummifera*), *imPila* (*Callilepis laureola*), *uMahedeni* (*Phytolacca abyssinica*), *inGwolo*, *inGeino* (*Scilla rigidi-folia*), *iLabatheka* (*Hypoxis latifolia*), *inKomfe* (*Hypoxis* sp.), *umZilanyoni* bush or (*N*) *uMinya*, *uMalusi*, *inThlungunyembhe* (*Acocanthera thunbergii*), the graminaceous *inDlolothi*, *umDlandlasi*, *uLovwane*, *uNtlangothi*, *amaNgwe*, *umDlebe* (*Synadenium arborescens*), *inKwa* (*Dioscorea rupicola*),<sup>2</sup> *uDlutshana* (*Aster asper*), *iDungamuzi* or

<sup>1</sup> The sign (*N*) indicates a Natal name, as distinct from that in use in Zululand.

<sup>2</sup> This plant belongs botanically to the yam group. Though its large tubers are said to cause a roving madness if eaten raw, the Zulus have discovered that, when boiled, they furnish quite a harmless food in times of famine.

(N) *isiZimane* (*Enclea natalensis*), *umHlatholana* (*Turraea obtusifolia*), *umKhuhlu* (*Trichilia emetica*), *iHlulemambha*, *uGobandhlovu* (*Secamone gerrardi*), *uQhume* (*Hippobromus alatus*), *uSukumbhili* (*Hypericum æthiopicum*), *uSolo* or Flat-crown (*Albizzia fastigiata*), *uThangazana* (*Cucumis hirsutus*), *uMahlabekufeni* (*Croton gratissimum*), *umZilanyoni* (*Croton sylvaticum*), *isi-Ndiyandiya* (*Bersama lucens*), and many others.

#### (7) THE PREPARATION OF MEDICINES AND GENERAL TREATMENT.

Native methods of preparing medicines are much like our own, though, of course, accomplished in a much cruder manner. There are cold infusions (*isiChouco*), made by pouring a requisite amount of cold water upon a certain quantity of pounded or chopped herb, bark or root; hot infusions (*imFudumezelo*), prepared like tea, wherein the medicine is steeped in hot or boiling water; decoctions (*imPeko*), in which it, as a rule, is slightly simmered, though also sometimes thoroughly boiled; and powders, in which the remedy is air-dried or roasted on a pan and subsequently pulverised, or is even burnt to ashes.

The methods of treatment are likewise, in a similarly rude manner, akin to our own. The natives are strong advocates of blood-letting, and they have their way of cupping, in which a hollow cow's horn is held firmly over incisions cut in the flesh, and a vacuum is created by another person withdrawing the internal air by the mouth and so allowing the blood to flow.

They use poultices made of bruised vegetable substances and applied warm or cold; and lotions, in which the liquid extract of the medicine is used for dropping into or pouring upon the affected part.

They have vegetable, animal and earthy ointments, consisting of clays, ashes and bruised pastes, to be smeared on the body.

One of their commonest modes of curing local pains is by rubbing powdered medicine into incisions made on the spot.

They have their vapour-baths, in which the patient, crouching over a boiling pot, is enclosed, along with the latter, within the ample embrace of a large skin or blanket; and their sweating-baths, similarly administered; or else a roomy pit, with a narrow entrance-hole, is dug in the earth, a large fire lighted therein, and the ashes having been extracted, the patient is required to enter and enjoy a rude kind of Turkish bath, the entrance-hole being lightly covered with a blanket or hide to keep out the cold air and keep in the warm.

The clyster and emetic are special favourites with all natives. I suppose they resort to this means of treatment more than to any other, even than to actual dosing. Practically all those common attacks of passing indisposition to which one is periodically liable, as well as most of the more important febrile complaints, are ascribed by them to the bile (*iNyongo*), and their first step is to clear the excess of this fluid out of the system by one or other, or both, of the above methods.

#### (8) PHYSICAL AND CONSTITUTIONAL TRAITS OF THE NATIVE.

The Zulu in his native state is one of the finest physical types of mankind. Both height and chest measurements are, I believe, above the average of most European races. A feature typical of the pure Zulu is the massive thigh and calf, and the great development of these parts is no doubt largely due to the amount of foot-exercise he is accustomed to do. The wrist is another exceptionally strong part of his anatomy, due to his propensity for stick-fencing and fighting. In the women, besides an extraordinary breadth of hip, we notice a strength and size of neck quite abnormal to their sex, and caused by their having habituated themselves from early childhood to carrying heavy weights upon the head.

Anterior to the white man's invasion, there is reason to

believe that the Zulu race was singularly long-lived and free from disease, but endemic and epidemic fevers, especially malaria and dysentery, were periodically prevalent, and demanded a heavy toll at every outbreak, owing to the intimate social habits of the natives. These it was that he regarded as pre-eminently the natural diseases, not caused by human malice or magic; and he grouped them all indiscriminately together under the one generic name *umKhublane*. Whether typhus and typhoid existed is problematical, as even now, among the country Kafirs, they are seldom, if ever, met with. Constitutional and organic diseases—consumption, rheumatism, kidney, bladder and uterine complaints—were all there prior to the advent of the European; but they were markedly rarer than with us, and on account of this rarity were unnamed and only hazily recognised, and were attributed, not to natural causes, but solely to malicious and magical origin. Leprosy and the venereal diseases were absolutely unknown, and so were probably also scarlatina and whooping-cough, while smallpox, from the absence of pock-marked faces, must have been extremely uncommon,<sup>1</sup> notwithstanding that pock-marked features are quite remarkably numerous among the neighbouring Tonga tribes to the northward—tribes for several centuries in close contact with Arabs and Portuguese.

Under the altered conditions of the present day, when the native is removed from the open air of the veld into the vitiated atmosphere and congested dwellings of European towns, this immunity from disease bids fair to cease.

The black races would appear to be unusually susceptible to new diseases, though hardened enough to the old. Yet at the same time they possess a larger share than we of animal vitality and recuperative energy. But whether these innate powers of resistance will prove stronger than the enemy attacking them remains for longer experience to show.

<sup>1</sup> The epidemic of small-pox during Mpande's reign was regarded by the natives as quite an unprecedented event.

## (9) TREATMENT OF DISEASES.

## Scrofula.

There was, however, one ailment—rather a constitutional taint than specific disease—which was from the beginning, and still is, particularly rife among them, presenting, I suppose, their national physical weakness. It is scrofula, called by them *umZimbl'omubi* (bad flesh) or *umChoboko* (the breaking-up or breaking-out disease). It is hereditary, and there are few families without it. It may have originated in the tribe by something harmful in their mode of life, perhaps chronic stomach derangement owing to improper and indigestible food, less probably impure air or want of exercise. It is, perhaps, the explanation of their extreme impressibility to the infection of new diseases, as well as of the strange fact that, despite their robustness of nature, they are nevertheless much more frequently down with indisposition than the European.

It shows itself in the usual glandular swellings, erratic tumours, periodical outbreaks of refractory sores, impotency, tendency to persistent, though apparently not very harmful, chest complaints, peculiar and indefinite internal disorders. It follows the orthodox rule of scrofula, in that it is mostly to be looked for at once among the extremely dense-headed and the precociously intelligent; among the coarse-featured, wrinkle-faced, generally deep-black, and most repulsively ugly of the Zulu people, and among those of markedly delicate, finely-formed features, generally of a fair complexion, the beautiful of their race. It is as prevalent in the royal family as among the poorer classes of Zululand. I believe the disease is gradually being eradicated, probably owing to better food, among the younger generations in Natal.

It is possible that the disposition to extreme obesity in the Zulu royal house is in some way attributable to this blood-taint. Both Mkungo, still living, and his father, King Mpande, are, or were, so hugely fat as to be utterly incapable of walking or even of leaving their hut or chair.

A constant warfare is kept up against the universal enemy. It is treated rather domestically than professionally. Abundant herbal remedies are in use, all commonly known to the fathers and mothers of families. The plan is to administer an *imBhiza* or combined decoction of several blood-purifying drugs. Take the roots of the bitter herbs *iThethe* (*Polygala oppositifolia*)<sup>1</sup> and *uMathanjana* (? *Raphionacme* sp.), of each a small bunch, such as can be easily grasped by the single hand; the bulbous roots of the *umDuze* (Natal lily) and *uMathunga* (*Cyrtanthus obliquus*); the bark of a foot's length of the stout root of the *umNungwane* (Knobwood, *Xanthoxylon capense*), *iQwawingi* (*Capparis corymbifera*), *uuHlamhamanzi* (*Rauwolfia natalensis*), and *isiZimane* (the *iDungamuzi* of Zululand, *Enclea natalensis*). Break up the ingredients by chopping or pounding, and boil all together for a few minutes in a small quantity of water. When cool, take a dessert or table-spoonful of the decoction once every morning and evening until relieved. The relief will come, in that the impurities in the blood will be expelled chiefly through the skin and also through the secretions. Immediately before the treatment the body is stimulated to healthy activity by the patient, completely enshrouded in a large blanket, sitting bent over the boiling decoction-pot, and this induces a profuse perspiration. As a result of the medicine, tumours, quickly going on to suppuration, form in any part of the body; or, should they have been present already, will now rapidly be brought to a head. This latter can also be accelerated by the poulticing of the

<sup>1</sup> It must be remembered that this article is intended to be simply an ethnological study of the Zulu people from the medical standpoint. The methods of treating disease here described are not thereby recommended for adoption by European persons. However, the medical plants enumerated, some of which are undoubtedly good, others as certainly poisonous, are seriously offered to progressive medical science for analysis and perhaps even cautious experimental application. Grateful recognition is here due to J. Medley Wood, Esq., F.L.S., Director of the Botanical Gardens, Durban, for the very generous assistance given in the identification of most of the indigenous plants herein referred to.

swellings with *iYoli* (Stramonium) leaves. The leaves of the *umThoubho* (*Cissampelos torulosa*) runner are used for the same purpose. From time to time a clyster, consisting of one large cupful of the decoction, may be administered.

Though other plants are used in the Cape Colony—the *umBangandlala*, or, as there called, *umBangandlela* (*Heteromorpha arborescens*), for instance—the method of treatment of the Xosa doctors is almost identical with that above given, and the effect of their remedies, though the plants are different, is said to be the same. Of the plants used by the Zulus, the *iThethe*,<sup>1</sup> *uMathanjana*, *uMathunga*, are probably really good medicines. Others, like the *isiZimane*, are to be used cautiously, as probably powerfully poisonous. The *iThoundo* climber is also used for the relief of the chest symptoms of scrofula, and the *imFuzane* herb for those of the stomach.

### Intestinal Parasites.

#### *Ikhambhi.*

There is a complaint comparatively common among the Kafirs of these parts which seems to be unknown to medical science. It appears to be caused by an intestinal parasite called by the Zulus *iKhambhi* (sometimes *iQhotho* or *iBlungane*). This is an imago of a beetle measuring from a quarter to half an inch in length, with greenish-black elytra. The beetle is almost identical in appearance with the dung-beetle found in fresh cow-dung.

Specimens of the beetle were obtained by me in June, 1903, at first hand from a sick native girl in my charge in Zululand, who had been passing them periodically in as many as a dozen or more at a single evacuation throughout a period of ten years or more. The specimens were submitted to Dr. Warren, Director of the Natal Museum at Maritzburg, and they were passed on by him to Dr. L. Peringuey, the well-known

<sup>1</sup> An allied plant of the same genus as the *iThethe*, viz. the *Polygala senega*, has a place in the British Pharmacopœia as a valuable stimulating expectorant for chronic chest ailments.

coleopterist at Cape Town. All the information that these gentlemen could impart was that the insects appeared to be a species of an ordinary dung-beetle (*Aphodius marginicollis* Har.).

An old Zulu doctor declared to me that he was well acquainted with three different varieties or species of the human parasite: one, the commoner greenish-black; another, which he called "white" from its having a white mark on the back; and a third of a dark brown colour, with faintly defined spots about the thorax and sides.

The symptoms, as far as my experience goes, seem to be of the nature of intense nervous irritation, similar to that sometimes attributed to worms—gnawing pains, fits and, as the natives assert, and, I think, with some probability, also madness.

The natives attach to these parasites many fanciful ideas; for instance, after the expulsion of the beetles from the bowels they must be immediately killed lest they take to flight, in which case dire calamity would result, their host following suit, himself "flying" about the veld and hills mad.

The strangest circumstance connected with the *iKhambhi* is the assertion, universally made by the natives, that it exists alive in the imago condition in the host. One could understand the larvæ of a beetle existing in the human intestine, just as the larvæ of certain flies have been occasionally found, but for the whole metamorphosis to take place in the intestine requires strong evidence in order to be believed.

In weighing the evidence it should be remembered that it is an indispensable formality in the treatment of the *iKhambhi* that the stools be passed, never on the grass or in the bush, but only either into a broken pot or upon a specially cleared gravelly space, for it is imperative on the patient that he immediately kill the beetle on expulsion. If it is preferred to regard the native story as a delusion it is difficult to explain why the beetles are only found after certain specifics have been administered to the sick person.

It was desired that the larvæ of the beetle might be found;

and certain living grubs, passed by the Zulu girl above-mentioned, were sent to Dr. Warren for identification, in the hope that they might prove to be such. The grubs, however, were those of a fly (*Sarcophaga* sp.), and the beetle-grub is still to be found.

The native not only affirms the presence of these beetles in the human intestines, but he is also well provided with remedies for their expulsion, and can invariably produce them for your satisfaction by the administration of those remedies. Generally a mixture of several herbs is made, each bringing its own quota of effectiveness. The roots of the familiar tambootie-grass or *isiQunga* (*Andropogon marginatus*), of the *inKomfe enkula* (*Hypoxis* sp.), and of the shrub *umKhwangu was'entabeni*, together with the leaves of the *umNukambhiba* (*Clausena inæqualis*), of the *umQaqougo* (*Clerodendron glabrum*), of the *iPhahla* (*Brachylæna discolor*), of the *umNyamathi* (*Ekebergia meyeri*), of the *umNungwane* (*Xanthoxylon capense*), and of the *inKuzwa* bush, a small handful of each, are pounded and infused like tea. A cupful of the infusion is drunk when cool, the dose acting as a parasiticide and purgative. A clyster of the root-bark of the *umDukane* (*Apodytes dimidiata*) and of the *umNungwane*, together with any of the leaves as above, boiled and administered when slightly warm, one cupful on the first occasion, increased to two or three on a repetition,<sup>1</sup> is also employed with effect, which would seem to indicate that the beetles lodge themselves chiefly in the large intestine. Other remedies are the *umSokosoko* (*Ethulia conyzoides*) and the *isiThelelo* (*Aster erigeroides*); of the latter a hot infusion is made with a double handful of the leaves and about two cupfuls of water, to be administered as a clyster.

Most people have read of the popular amulets of the ancient Egyptians called scarabs. I am not aware that it has been in any way finally determined that the myth of the scarab, as

<sup>1</sup> The quantities indicated in this article are such as are administered to a native adult.

it existed in the religion of the ancient Egyptians, was something primarily invented and imported into Africa by them, and was not rather an indigenous superstition appropriated by them from the black races they displaced upon their first arrival on the Nile. If the latter were the case, and the Egyptians adopted the African belief in the human beetle-parasite—but without contracting the disease, and, therefore, ignorant of the exact character of the parasite—we should not be surprised at their transferring the whole myth along with the magic connected with it to the only dung-beetle they knew, viz. the common tumble-dung-beetle of the paths (*Scarabæus sacer*). The Egyptian name for the scarab was the same as that of one of the four great cosmic gods, viz. Kheper, meaning “he who rolls,” “to be,” “to come into being”; and there is certainly some philological resemblance between this word and the Zulu word *iKhambhi* for the human parasite.

Egyptologists (see Budge, ‘Egyptian Magic,’ p. 38) tell us that the beetle was named Kheper on account of its rolling propensities, comparing it with the sun, which rolls day by day across the heavens. Is it not quite as likely that it was so named because of its strange habit of suddenly emerging fully fledged from the bowels of a human being, and without any apparent previous entry therein? It would suggest the thought of “coming into being,” of “self-creation.”

#### Round-worms—Ascarids.

The bulbs of the plant *inJobo*, taken even in the raw state, are very effective. I have known two dozen of these worms to be expelled from one adult who had taken two of these bulbous roots, each one and a half inches in diameter. The roots were pounded very finely and boiled in meat broth.

#### Tape-worm.

Despite our world-wide experience we have been able to bring the native no more powerful expellent of tape-worms

than the extract of male fern (*N. filix-mas*). Yet the Zulu doctor had in use a number of indigenous species of this *Nephrodium* (*N. filix-mas*, *N. athamanticum*, etc.), generically called by him *iNkomankoma*, as his principal specific for tape-worm from time immemorial. He was probably aware of their vermifugal powers long before we were. Of course his cure, being administered only in the raw state, in the form of the dry and powdered root (a level dessert-spoonful to the dose), proves much less efficient than the concentrated extract of our druggists.

Other native vermifuges are the *uMahlabathi* herb, of whose small roots a handful is thoroughly pounded into a paste and eaten in a cupful of thin Kafir-corn porridge, a full meal of this latter being taken immediately after to assist the action. Others eat raw a good quantity of the leaves or black berries of the *iBhinini* bush (*Embelia kraussii*). Both of these plants are specifics for tape- and round-worms alike. For the tape-worm alone, besides the above, we have the roots of the *iDololenkonyane* (*Rumex ecklonianus*), and of the *um-Nukambhiba* (*Clausena inæqualis*), and the leaves of *uMakhuthula* (*Agrimonia eupatoria*) shrub, of which a handful are thoroughly pounded and drunk in a little cold water.

Round- and thread-worms are expelled also by the leaves of the *umQaqongo* (*Clerodendron glabrum*), or by a couple of tablespoonfuls of the ripe berries of the *uMaguqu* (*Mæsa* sp.) dried and ground. This latter belonging to the same botanical group as the *iBhinini* above, it is probable that this class of plant really has some vermifugal powers.

The *umQalothi* (*Strychnos henningssii*) and the *uHlambhikloshane* (*Gerbera kraussii*) and the *iNcamu* (*Othonna natalensis*) are described as worm-cures, but it is just as possible (though not proven) that their action is simply an alleviation of the flatulence and other stomach pains due to indigestion, and erroneously attributed by the natives to worms. Of the *uHlambhikloshane*, about ten leaves are taken, pounded, and mixed with a cupful of water, which is drunk.

The *imPila* (*Callilepis laureola*) is sometimes used by reckless natives as a vermifuge, a piece of the root, one inch cube, being boiled in a cupful of water and drunk. Inasmuch as this plant has proved fatal to human beings, there seems no reason to doubt its powers on worms, which it would probably first poison and then expel with the purging.

An occasional, though somewhat rare, complaint among the natives is called *inThumbha*, which seems to be due to tape-worm cysticerci, infesting mostly the back and the region of the knees. The cure is in their extraction by the knife. The term *inThumbha* is likewise sometimes applied to ophthalmic granulations (perhaps of trachoma), which are said to be "extracted" in a similar fashion.

#### Stomach and Intestinal Complaints.

I have said that the Kafirs have very hazy ideas, if indeed any at all, about the liver, kidneys, or stomach proper. A large number of abdominal disorders are therefore treated in quite an empirical way on the offchance of effecting some good. For instance, a concoction may be made of a handful of the leaves (a small quantity being taken of each) of the *isiBangamlotha* (*Antidesma venosum*), the *umNungwane* (*Xanthoxylon capense*), the *iDlebelendlorn* (*Trimeria alnifolia*), the *umFuthwamini* (*Plectronia ventosa*), and the *inKunzi* or *iBheja* (*Bopusia scabra*), the whole being pounded and steeped in a couple of pints of cold water, of which a large cupful is drunk and the remainder taken as an enema. Or the drastically operating *uDlutshana* (*Aster asper*), *iXolo* or (N.) *umKhulu* (*Trichilia emetica*), *iDungamuzi* or (N.) *isiZimane* (*Euclea natalensis*) and the *umHlatholana* (*Turræa obtusifolia*), may be prepared and administered separately, as elsewhere described. When there is much internal pain in the abdomen, the *isiThelelo* (*Aster erigeroides*) is prescribed, a double handful of the tiny leaves being infused in a couple of cupfuls of boiling water and injected per rectum.

For indigestion the native has some really valuable medi-

cines that would, I think, be an acquisition to our own pharmacopœia. I believe a scientifically prepared extract of the *uMondi* (*Chlorocodon whitei*), the *inDawo* (*Cyperus esculentus*) and the *umHlwazi* tree would be of especial value. All are perfectly harmless plants and not unpleasant to the palate. Every native fortunate enough to procure them habitually carries about with him a supply of one of these drugs. Of the *uMondi* he carries portions of the root and chews the same whenever the digestion may seek relief. The nodulous roots of the *inDawo* and the bark of the *umHlwazi* are nibbled and chewed in the same way. The *inDawo* is especially mentioned as a cure for foul breath. Heartburn is relieved by a decoction of the chopped bark or root of the *umNyamathi* (*Ekebergia meyeri*), six inches of whose stout root may be simmered in three or four pints of water and taken as an emetic. The roots of the *inTondo* (*Argyrolobium marginatum*) herb, which are crushed, infused with a cupful of boiling water and a table-spoonful drunk from time to time, have the reputation of being helpful in the case of hiccough arising from stomach disorders. The roots of the *umTheute* grass (*Imperata arundinacea*) are a specific for the same purpose.

A common feature of stomach complaints is nausea. The native does not attempt to seek the cause but uses indiscriminately one or other of several plants. As a fact the nausea would seem to be due to intestinal worms and bile more frequently than to anything else. He may crush the roots of the *iNcamu* (*Othonna natalensis*) herb, and drink the cold water infusion prepared therefrom. This may be effective, because the plant possesses vermifugal properties. Half an inch square of the bark of the *umQalothi* (*Strychnos henningsii*) tree, pulverised and drunk in a spoonful of cold water, is used for the like purpose, and seems to act in the same way, having the same vermifugal powers. When, however, the nausea proceeds from biliousness, either the *ubuHlungwana* (*Wedelia natalensis*), or the *isiNama* (*Achyranthes avicularis*) cum *uMasigcolo* (*Osteospermum nervatum*) emetics

may be relied upon to clear the stomach of the bile, if doing nothing else. A decoction or even cold infusion of the fresh runners of the *inTshungu* (*Momordica foetida*) or of the *inTshungwana yehlathi* (*Momordica involucrata*) creeper is reported as being very soothing for a squeamish stomach, as is also the preparation of *inTondo* (*Argyrolobium marginatum*) tubers described above for hiccough. Should the sick sensation be attributable to nauseating medicine, the *uDongabathwa* (*Ceratotheca triloba*) has already been indicated.

For general stomach-ache, oftentimes, no doubt, due to flatulence, we have the *inDawo*, above mentioned, again prescribed. The large, white daisy *uHlambhikhoshane* (*Gerbera kraussii*) finds its usefulness here. Two or three of its large leaves are pounded in a couple of tablespoonfuls of cold water and the whole mixture drunk. Or an infusion in boiling water of a handful of the leaves of the *uNgwaleni* (*Cluytia pulchella*) herb is taken in the same way. The very bitter *uHlongane* or *iNyathelo* (*Vernonia woodii*) is said to possess useful properties as a stomachic. The same remark applies to the *iBoza* (*Moschosma riparia*) shrub. Of the leaves or roots of the wild *uSelwa* (*Luffa spherica*) and of the *uQadolo* (*Bidens pilosa*) or Blackjack weed a double-handful may be infused with a large cupful of hot water and drunk; or a larger quantity of the herbs in a sufficiency of water may be given as a clyster.

Numerous other plants have a good reputation as remedies for general stomach disorders and bowel pains. Among them we may note the *umNungwane* (*Xanthoxylon capense*), a foot-length of whose stout root is dug up, the bark thereof simmered in three large cupfuls of water and given as an injection; the *ubuHlungwana* (*Wedelia natalensis*) as already prescribed—although women in child should avoid it, as this plant is said to bring about abortion; the bark of the *umNono* tree, which is chewed; the pink-flowered *umSokosoko* (*Ethulia conyzoides*); the iridaceous *inDawoluthi emhlophe* (*Belamcanda* sp.); the *umDlandlasi* climber; the

bark of the *umGugudo* tree; the thorny weed *inKunzana* (*Emex spinosa*); and the *umMhezi* tree, of whose large soft root a piece as large as a child's fist is pounded finely and cooked as porridge, the action being purgative.

The more powerful purgatives as croton oil, jalap and the like are much esteemed by the natives. There are at least two species of *Croton* indigenous to Natal—*Croton gratissimum* and *C. sylvaticum*. Both are called *uMahlabekufeni* by the natives, though the last-named species is more generally known as *umZilanyoni*, i. e. the tree abstained from by birds, owing to its orange-coloured berries being severely avoided by these latter, to whom they are said to be fatally poisonous. The valuable medicinal properties, both as cathartic and as eruptive irritant, of these crotons are well known to the Zulu doctors, affording once again undeniable evidence of the oftentimes accurate knowledge and extensive botanical investigations of these people. When employed as a purgative—generally when severe abdominal disorder of an indefinite nature is present—a piece of the bark, half as large as one's thumb, is pulverised in half a cupful of milk or broth, and the mixture drunk.

The true jalap plant, of course, does not exist in South Africa, but there is an allied indigenous plant possessing similar powers, though, I think, in an inferior degree. This is the *Ipomœa purpurea*, a convolvulus-like climber common in the coast bush. Certain is it that it had no native name prior to the advent of the white man; but this alone is not sufficient proof that its purging powers were not well known.

At the present time it is one of their favourite remedies, and is universally known as *iJalambhu* or *iJalamu* (a corruption of the English word "jalap.") It is the tuberous root of the Mexican species that is officially used, but of the Natal species it is the stalks, the roots being merely insignificant fibres. Another species of *Ipomœa* is also used as a purgative for a generally disordered stomach, and its powers seem to about equal those of the former variety. It is the *umKhokha wehlathi* (*Ipomœa ficifolia*), a double

handful of whose leaves is bruised in cold water and a cupful of the mixture drunk.

All species of the *Euclea*—the *iDungamuzi* of Zululand, or in Natal *isiZimane* (*E. natalensis*), the *iDungamuzi* of Natal (male of *E. lanceolata*), and the *umShekisaue* (female of *E. lanceolata*)—seem to contain very strong cathartic principles, if not, indeed, injuriously so, since they are said to frequently draw blood. The bark is taken from a piece of the two-inch root, six inches long, and infused with, or even slightly simmered in, a couple of milk-tins of water. This liquid, if of the *Euclea natalensis*, is either drunk, or mixed with more warm water, injected *per rectum*. There is a tendency to vomit the medicine, which, however, is restrained. The effect is that of a powerful cathartic. The preparations from either variety of the *E. lanceolata* appear to be stronger still, and are never taken by the mouth, but only as enema.

Another drastically purgative veld-herb is the *imPila* (*Callilepis laureola*), but this seems without any doubt to be a virulent poison. Native doctors invariably mix the *imPila* with other remedies, which, perhaps, tend to neutralise its injurious principle. Half an inch of its root, powdered and infused in half a teacupful of warm water, is said to be incapable of working any harm to an adult. Others take a handful of the leaves, make a hot infusion with two large cupfuls of water, and inject as clyster. Another very strong cathartic, demanding great caution in its use, is the *umHlatholana* (*Turraea obtusifolia*). A good handful of the bark from the roots or trunk, or of the leaves, is thoroughly pounded and steeped in a pint or so of hot water. A teacupful of this is retained, and the rest, along with sufficient extra warm water, injected as a clyster. The portion set aside is immediately afterwards drunk mixed in warm porridge or gruel, the result being a complete washing out of the bowels. An equally strong purgative is the *imFuzane* herb, half a teaspoonful of whose ground root is mixed in a little gruel and taken gradually in mouthfuls.

The *iXolo* or (N.) *umKhukhu* (*Trichilia emetica*) is a tree possessing very powerful medicinal properties, amongst others those of a purgative. A piece of the bark, of the length and breadth of two fingers, is pulverised and mixed into two teacupfuls of hot water as an enema, in which form this drug is usually administered. The *isiThelvelo* (*Aster erigeroides*), with its pinky-white daisy, is also a strong purgative, a double handful of the small leaves being steeped in two cupfuls of boiling water and injected as clyster. The bulb of the *inGuduza* is also used, being chopped up, thoroughly boiled so as to leave a pint of extract, and administered as the previous remedy.

The castor-oil (*umHlakwa*), like the Stramonium (*iYoli*), is one of those valuable plants, growing in wild profusion around every old kraal, of whose medicinal value the natives know nothing. This is strange, since they have discovered the oil itself contained in the castor-oil seeds, and have extracted it from time immemorial as a suppling agent for hides.

Other cathartic plants are the *uMalusi* and *uMaukenketha* herbs, the bark of the *uMabilwana* tree, the roots of the pink umbellate *iHulelemambha*, and those of the blistering *um-Nqandane wezimpisi* or *inDodemnyama* (*Royena villosa*).

### Dysentery and Diarrhœa.

Dysentery (*isiHudo*) and, in a lesser degree, diarrhœa (*ukuHuda*, *uHudo*) are two predominant diseases among natives. The cause is no doubt found, firstly, in their impure water-supply, in very many localities from stagnant pools and contaminated streams, and, secondly, from their domestic system not permitting sanitary methods of living. Though they are aware of the difference in the symptoms of these two complaints, they do not recognise any essential difference in their nature or treatment. Their sole effort in both cases is to stay the flux. Purgatives and astringents of the most drastic nature are what they mainly rely upon. The *isiZimane*,

the *unHlatholana*, in a word, any of the cathartics above described, might be inflicted on a dysenteric patient.

But what is of more interest to us just here are the restraining remedies they use. Although all the following plants are said to possess the property of effectually allaying the dysenteric symptoms, it does not thereby follow that they are all astringents. One of the native remedies of highest repute for the complaint is the *ubuHlungwana* (*Wedelia natalensis*). As we shall see later on, this herb is an excellent wound and sore healer, and it is possible that its value in dysentery consists precisely in its powers for healing the dysenteric ulcers within the bowels. It is administered as an enema, a hot infusion being made of a handful of the pounded roots with two cupfuls of water, and injected. The action, again, of the *uZipho* or *iKhambhi leziduli* (*Cardiospermum helicacabum*) can scarcely be of a binding nature. We shall find that the pungent leaves of this climber are described as highly successful in the curing of syphilitic sores, and their usefulness in dysentery may also be due to their healing properties. A double-handful of the leaves and stalks are pounded, and a hot infusion made with a couple of pints of water, to be injected, when cool, as an enema.

The following are further held in high repute among native doctors: The *unVuthwamini* bush (*Plectronia ventosa*), a plant probably worth studying. A handful of its leaves are bruised, and kneaded into a cupful of milk, which is gradually drunk in mouthfuls. A lump of the crimson inner-bark of the *uNgazi* tree, about a couple of inches square, and the same quantity of the bark of the *uMaphipha* tree, is ground into powder, and eaten in a little porridge. The bulbous root of the *iuTsulwa* herb has also decided binding qualities. An infusion is prepared of the pounded root in a cupful of hot water, and the liquid drunk.

The *iuTolwane* (*Elephantorrhiza burchellii*) is another much-esteemed remedy. The outer-bark is removed from a couple of its large and very red roots, and the interior portion pounded and made into a hot infusion with a quart of water,

which, after straining and cooling, is administered as a clyster. The woody carrot-like root of the allied plant *isiKhubabende* (*Indigofera* sp.) is another favourite. Of this a single red root may be pulverised, after the outer bark has been removed, and boiled along with a handful of ground *uJiba* (an astringent variety of Kafir-corn), the porridge being then eaten.

The young man's philtre *isiKhwa* or *umWelela* is said to do good service in restraining bloody stools, a handful of the small tubers being chopped up, infused in a quart of boiling water and injected. Or, again, the acidulous leaves of the *imFeyesele* or (*N*) *imFeyenkala* (*Dissotis incana*), so beloved of native children, may be used, a couple of handfuls being thoroughly bruised and a hot infusion made with a quart of water to be administered as an enema; or a slightly boiled decoction of the *isiKelekehlane* (*Crassula rubicunda*) given in the same way.

Several iridaceous plants, as, for instance, the *umLunge* (*Antholyza paniculata*), furnish some of the most important native cures for dysentery and diarrhœa, the disc-like portions of the root being generally used.

The common bramble, *iJingijolo* (*Rubus rigidus*), has the reputation of being a very effective remedy, six inches of the stout root being pounded and boiled in a pint or so of water and injected into the rectum. The leaves of the *uNgvaleni* (*Cluytia pulchella*) are sometimes made into an infusion, and a couple of dessert-spoonfuls drunk as a dose. A small quantity of the bark of the *umBanda* tree, of the *isiSefo* and of the *umDlaruza* is also ground, mixed with water to taste, and taken in doses of a spoonful at a time.

Other plants frequently recommended are the horny roots of the root-parasites *iHlule* and the *uMafumbhuka*, as well as those of the *iGololenkawn* (*Sapindus oblongifolius*), the *umGxamu* or *iHluze* (*Schotia brachypetala*), and the *uDulamuthwa* (*Vangueria lasiantha*), of the last-named a double handful of the leaves being pounded, mixed with a little cold water and the mixture drunk; or the bark from the roots of the *iNqayi* (*Elæodendron velutinum*), about a

handful in quantity, may be pounded in a cupful of cold water and drunk, a similar quantity of bark being further infused in two cupfuls of hot water for administration, when cool, as an enema. Many of these remedies are probably simply astringents, from the large amount of tannin they possess; but it is likely that some are not so, and among these one might come across something worth having. But only a thorough analysis and experimentation can prove or disprove this.

Piles (*ukweleka*) are not clearly distinguished by the natives from chronic dysentery, and for them I find the *isiKhwa* is employed, as described above. Also the roots of the *iCimamilo* (*Pentania variabilis*) and the bark of the *umKhorothi* (*Chaetachme meyeri* or *aristata*) are used.

#### Gangrenous rectitis.

A loathsome disease, occasionally met with in Zululand, Natal and Pondoland, and much dreaded by the natives, is the *isiGwebedla* (otherwise called *inGumbhane*, *umGubhane*, or *uMoya*). It may be, and I think probably is, a form of gangrenous rectitis, although Sir Patrick Manson, in his book on 'Tropical Diseases,' does not mention that disease as existent in these parts, nor do the symptoms of both, as explained by him, exactly coincide.

The course of the South African disease is as follows. It sets in with fever, headache, abdominal pains, generally about the navel, and sometimes vomiting; diarrhoea with blood, or bloody mucus, passed along with or after the stools; subsequently, in some cases, an eruption of small pimples, distributed irregularly about the body, not going on to suppuration, and afterwards dying away, but always a more pronounced eruption of similar pimples about the pudenda (anus, vagina and penis), subsequently suppurating and uniting in one exuding sore surface. There is no itching or pain attached to this eruption, which has been likened to the eruption occurring about the mouth in cases of feverish catarrh. There is loss of appetite, with absolute prostration, so that the patient has not even strength enough to sit up.

The tissue of the rectum becomes rapidly attenuated, disintegrates, and small pieces are expelled with the stools, the latter finally attaining the appearance of boiled arrowroot. Similarly, the tissue at the pudendal orifices corrodes, leaving the orifices considerably enlarged. In females the septum separating the rectum and vagina may be eaten completely through. Sometimes the spine and neck are said to be affected, rendering it impossible to hold the head erect. There is a general haziness of vision, with dizziness of the brain.

The disease seems to be tractable enough when treated in its initial stages; but owing to the absence of pain, or any other alarming symptom, within or about the rectum, at the commencement of the attack, the disease very frequently fails to be recognised until the danger is far advanced. Once the advanced stage is reached, though cures are occasionally accomplished, a fatal result may be anticipated—death occurring, with great abdominal pain (perhaps from peritonitis), accompanied by writhing, though without convulsions, during the second, or, more rarely, the third week.

The disease is apparently infectious, several cases frequently occurring in the same kraal; also epidemic, there being generally many cases at the same time in the same locality; and perhaps endemic, apparently being more common in certain districts. It seems, however, to select no particular period of the year, such as the season of green mealies (suggested by Sir P. Manson, if I recollect aright, in connection with the phagedænic rectitis of America), for one particular outbreak known to the writer occurred at the end of the winter and commencement of spring, when only dry grain foods and sweet potatoes were being partaken of.

In treating this serious disease the medicine-man, conscious of the peril of contagion, commences by fortifying himself against the danger, in that he bathes his body beforehand in a decoction of *umGanu* (*Sclerocarya cafra*) bark. This performance has the look of a charm rather than of anything else, but before ridiculing, it would be well to recollect that

the fruit of this tree has the reputation of being a potent insecticide (being used in Zululand for the destruction of ticks), and it may be also a germicide. He then administers some of the same decoction to the patient internally; but what is chiefly relied on is the application of certain remedies locally. These consist, as a rule, of the *inKunzi* (otherwise *uGweje* or (N.) *iBheja*—*Bopusia scabra*)—which seems to be a valuable nostrum for all kinds of intractable sores—the *uuBomvane* (*Ochna atropurpurea*), and the *umPhuphutho* herb. Of these the roots are taken, pounded, simmered, and the decoction, when cool, administered as a clyster or simply as a lotion for bathing the parts. This clyster or bathing is repeated five or six times daily. Another method is to pound the same dried roots into powder and then sprinkle over the sore parts. The result is said to be a rapid healing of the ulcer.

The *umGannu* and *umBomvane* are said to be rich in tannin; but perhaps they contain also other curative properties. Of the nature and working of the *inKunzi* and *umPhuphutho* we know nothing.

The *ubuVimbha* (*Withania somnifera*) is also a specific for this disease. A warm infusion is made of a small handful of its roots, and the same quantity of those of the *iCimantlilo* (*Pentanisia variabilis*), with sufficient water to form a clyster. A useful clyster is also made of a small bundle, about one inch thick, of the roots of the *isaMuyisane* (*Spermacece natalensis*).

The most curious clyster I ever came across was the following. It will be remembered that the *inGumbhane* ulcer eats away the tissue at the rectal orifice until it becomes a gaping aperture, perhaps two inches in diameter, and the healing of which is prevented by the constant discharge of irritating stools. A quantity of fat clay is, therefore, taken and injected, in a semi-liquid state, into the rectum. There it dries and effectually blocks the passage for so long a time as the muscular tissue at the anus may require to heal and contract. The clay is afterwards removed by a further clyster of

warm water. As a draught for this disease a cold infusion of the *umSuzwane* (*Lippia asperifolia*) leaves is taken.

#### Catarrh, etc.

The several native specifics for the more serious chronic coughs accompanying lung diseases, scrofula, etc., will be detailed below, and any of these would be experimented with to remove the transient cough of the simpler *umKhuhlane*, influenza, catarrh, and the like. The following are some others more suitable for this use.

Of the *uMathoyisa* (*Lepidium capense*), one may cut up the large tuber, pour upon it about one cupful of boiling water and drink therefrom a dessert-spoonful from time to time. A handful of the leaves of the *uXhaphozi* (*Ranunculus pinnatus*) may be bruised and infused with a couple of table-spoonfuls of hot water and the whole drunk off to relieve the cough. Or a double handful of the leaves of the bitter *uHlonyane* or *iNyathelo* (*Vernonia woodii*) may be infused with about a quart or more of water. Of this a cupful may be put aside and drunk in dessert-spoonfuls from time to time, and the remainder used, while still warm, as a clyster. Or a double handful of the leaves of the *uMachakazi* (*Conyza incisa*) may be slightly boiled and a table-spoonful of the decoction occasionally drunk.

To relieve the headache which is so generally an accompaniment of these febrile attacks, a few leaves of the *iMunyane* (*Leonotis leonurus*) are pounded and steeped in cold water and the liquid drawn into the nostrils. The pungent leaves of the *uZipho* or *iKhambhi leziduli* (*Cardiospermum halicacabum*) may be rubbed together in the hands and the fumes inhaled through the nose. Another plant is the *imBhozisa*, whose root is pounded in a little cold water and the liquid drawn up the nostrils. The roots of the *uDlutshana* (*Aster asper*), of the *uQhume* (*Hippobromus alatus*) and of the *iBhinini* (*Embelia kraussii*) are used in a similar fashion. One of the thick leaves of the *umDlebe* (*Syn-*

adenium arborescens) may be broken up and the pungency inhaled through the nostrils; or the same may be pounded along with the leaves of the *isiShoshokazana* (*Ranunculus* sp.) mixed in a little water and drawn into the nose.

A snuff for headache is sometimes made from the powdered bark of the *umKlwangu* and the *uMaluleka* trees; or the roots of the *ubuLibazi* herb may be burned and then sniffed at. Should the head-pains be the result of some old skull wound (*inGozi*), the dark portion of the *uMathunga* root (*Cyrtanthus obliquus*), or the roots of the *inKominophondo* are ground and sniffed up the nose. Other plants used for headache are the *umEmbhesa*, *uKhalimele* (*Rhynchosia* sp.), *inDawoluthi*, *uPhico*, and *uLethi*.

#### Chest Complaints.

The Zulu has his weak parts, and perhaps the chief of these, nowadays at least, is the respiratory organs. Since the adoption of clothing and town-life in insanitary hovels, chest complaints have multiplied exceedingly. They come now, not in the form of comparatively harmless scrofulous coughs, but in the more perilous guise of pleurisy, pneumonia, bronchitis and consumption, all of which are answerable for many deaths annually.

Among a people so scrofulous as the Zulu, I suppose it would be only reasonable to expect the presence of typical phthisis even prior to the advent of the white man in the land. And yet I am not aware of any absolute evidence that it was so. But this is by no means equivalent to saying that pulmonary complaints of a tuberculous nature were unknown. Though rare, they were very well known and much dreaded, for the so-called *iXhwala* was undoubtedly of this nature.

The term *iXhwala* really indicates a kind of bovine swelling or tumour. The virus from this, the Zulu theory declares, has been secretly and maliciously introduced into the system of the sufferer by an *umThakathi*, probably through the medium

of food. This explanation will appear at first sight farcical enough; but is it impossible that this particular morbid growth in cattle may be of a tuberculous nature, and, as such, capable of conveying some tuberculous affection to human beings? European phthisis, we must remember, is probably contractible from cattle, not solely through the respiratory, as is popularly supposed, but also through the digestive organs.

The unhealthy growth in cattle called *iXhwala* is not the same as the glandular swellings of bovine tuberculosis, which latter disease is known to the Zulus (at any rate in these present days) as *umMbhila*.

It is a noteworthy fact that the complaint in natives commonly diagnosed by European doctors as consumption is not absolutely identical in its symptoms with the phthisis of our own race. With the natives the wasting of the lungs sets in first at the bottom of the organ; in European phthisis, on the contrary, at the top—a remarkable difference that alone may give ground to suspicion. The duration of the native disease, further, covers a much longer period of time than does the European variety, often continuing over a very large number of years. Is it that among these African people we are confronted, not only with the ordinary type of consumption, but also with a new form of pulmonary tuberculosis called *iXhwala*, and akin to, though distinct from, the former? Personally I have a belief that there are other species of tubercle bacillus infesting the human system besides that of Koch, each giving rise to its own peculiar complaint, yet all so similar as to have been hitherto regarded simply as varying “forms” of the same disease. The bacillus of the native pulmonary complaint has been identified as that of Koch, but perhaps the cases examined were those of real phthisis and not of *iXhwala*; or else the closely allied bacillus of this latter disease may exhibit appearances so similar as to escape ready detection.

Whatever this *iXhwala* disease may be, its incurable nature is universally recognised by the natives; but this does not deter the medicine-man from making valiant efforts to

restore his patient by fearful concoctions of expectorants, sedatives and germicides, though naturally with no enduring success.

A person dying of the *iXhwala* is never "wailed" for; because whoever cries over such a one will assuredly contract the disease himself. This superstition would almost lead us to believe that the natives have already observed the tendency the malady has of breaking out again in the same family or society, in other words, they have an idea, which they can neither understand nor express, that the disease is infectious. Their injunction on all and sundry to "keep their mouths shut" when in the vicinity of a dead consumptive was not far wrong after all.

Consumption, of whichever type, in its incipient form, while still confined to the lower end of the lung, would not yet be recognised as *iXhwala*. It would then be regarded as another complaint, called *isiBele* (the "breast" disease), from the fact of the pain being felt about the nipple. In this stage it is often confounded with pneumonia in the chronic form leading to consumption, or with abscess or gangrene of the lung following pneumonia, to all of which the term *isiBele* might be applied.

An acute attack of pneumonia would not be regarded as the *isiBelè* disease, and would probably receive no more distinguishing designation than the generic term *umKhuhlane omkhulu* (a severe fever).

The incipient dry cough of any form of consumption would also be neither *isiBele* nor *iXhwala*, but simply *uDosi*—a name also applied to chronic bronchitis. The *uDosi*, be it known, is the hair of a lion or other such "poisonous" wild beast, which, having been maliciously introduced by an *umThakathi* into the air-passages of an individual, sets up an irritation resulting in a persistent dry cough. A skilful medicine-man claims to be able to extract the *uDosi* from the chest, after which feat the patient immediately recovers!

The prominent feature in pleurisy of a sharp, catching pain in the side would cause that disease to become confused with,

and called by the same name, viz. *uHlabo* or *iHlaba*, as pleurodynia or rheumatic costal stitch.

Any chronic form of chest complaint, if accompanied by a persistent cough, is oftentimes called by the generic term *isiFuba* or *uFuba*, that is, simply "chest disease," and may be either consumption, asthma, or chronic bronchitis.

An acute catarrh, if accompanied by general constitutional derangement with feverishness, would be classed as an *umKhuhlane*; but if it were a simple cold, with the cough as the sole feature, it would be termed merely an *ukuKhorchlela*, or coughing.

The habitual tickling cough, accompanying chronic laryngitis or other throat ailment, would be known as an *uSi* or *uPhepha*.

The native doctor's prescription of drugs is as confused as his nomenclature. A large number of plant-remedies have been found useful in relieving one or other of the symptoms accompanying the various chest diseases, and he prescribes in turn allsoever he is acquainted with, attacking the symptoms either singly, or in common by a compound mixture.

For the *uHlabo* in any form (plenrodynia or pleurisy), four or five pieces, six inches long, of the roots of the *uHlunguhlungu* (*Vernonia corymbosa*) are taken, boiled well in one cupful of water, and the decoction drunk gradually in spoonfuls, giving early relief from the stabbing pain. Or the roots of the *iDungamuzi*, (N.) *isiZimane* (*Euclea natalensis*) and of the *iQwaningi* (*Capparis corymbifera*), together with the thorns of the *iSundu* palm (*Phoenix reclinata*) and of the *inGqwangane* (*Celastrus buxifolius*) bush, are tied together in a small bundle, such as can be grasped by the one hand, and an iron awl thrust through the middle of the bundle so as to project at each end. The whole is now boiled. Having taken the bundle from the pot, and holding it by the protruding blunt end of the stout needle, the doctor vigorously stabs the patient here and there about the painful region with the sharp point of the iron, at the same moment blowing with his mouth into

the wound a puff of the hot steam rising from the bundle of boiled roots. Perhaps so uncouth a method obtains its usefulness from acting as a rough kind of counter-irritant.

A less barbarous treatment, and, perhaps, a more effective remedy, is the bark of the *umMahlabekufeni* (*Croton gratissimum*) and the *umZilanyoni* (*Croton sylvaticum*). A certain German doctor has attained to some degree of popular fame by affixing his name to a certain patent "oil," which I have found to produce very good results as an eruptive rubefacient in cases of internal inflammation, particularly of the chest. Now, this "oil" is said to consist mainly of half and half croton and olive oils. The Zulus were familiar with this property of the crotons and its employment as a counter-irritant probably long before any European was. The method of application is to ground up the dry bark very finely and rub the powder into incisions cut in the skin.

Decoctions of the leaves or roots of the *umKhokha* (*Abrus precatorius*),<sup>1</sup> as also those of the *isitobobo* (*Asparagus* sp.), are sometimes used for this same *uHlabo* complaint; or the leaves and stalks of the *iBohlololo* (*Senecio speciosus*) may be burned, and the ashes rubbed into incisions made on the spot.

Chest pains generally—an accompaniment, of course, of all of the more serious lung diseases—are said to be relieved by

<sup>1</sup> This small coast-shrub is the identical "weather plant" (*Abrus precatorius nobilis*)—or else a closely allied species or variety—now rendered famous by the reputed discoveries of Professor Nowack, of Austria, in regard to its supposed powers of foretelling atmospheric and seismic disturbances, generally, of course, of a disastrous nature. Strangely enough, with the Zulus, the plant is used as a common charm for the bringing of "good" fortune, on which account its little red and black bean-like seeds may be often found carried by natives in the purse, pocket or basket. It is, further, a member of the same botanical sub-order as the liquorice plant (*Glycyrrhiza glabra*), and its roots may contain similar properties. Now, the roots of liquorice are well known as a European medicine for catarrhs and irritation of the air-passages in man. So that we have here another of those numerous instances of the keenness and accuracy of observation of the native doctors.

a decoction of the *iHlinzanyoka* tree (? *Celastrus* sp.), a handful of whose roots, six inches long, are thoroughly boiled in three cups of water, and the extract slowly drunk off while still warm.

For any variety of chronic coughing of a serious nature, whether it arise from consumption, asthma, scrofula, or what not, any of the following measures may be adopted. Take a small handful of the roots of the larger white-flowered *inTlashane* (*Lichtensteinia interrupta*), pound, and boil in a large cupful of water till reduced to one half; of this drink a teaspoonful from time to time. This is allied to our anise (*Pimpinella anisum*), which has a very ancient reputation in Europe for pulmonary affections. Or boil well together, after having been crushed, four or five pieces, six inches long, of the root of the *uThangazana* (*Cucumis hirsutus*), and a small handful of the small roots of the *uDutshana* (*Aster asper*), in about a quart of water, and, when cool, take a small dessert-spoonful once a day. A teacupful of the decoction, diluted with another cupful of warm water, may be further administered as a clyster.

The *uThangazana* has the reputation of giving especial relief in such coughs as are more particularly troublesome at night. For this purpose, a piece of the root, as thick as one's thumb and six inches long, is crushed and boiled in a small cupful of milk, the result being sipped occasionally throughout the night. A warm infusion of the roots of the *inTsaugwana* (*Tephrosia kraussiana*) is also drunk for the same purpose; or the roots of the herb *Ursinia tenuiloba* may be boiled in milk and slowly drunk while still hot.

A strong general specific for violent chronic coughs of whatever nature is prepared as follows: chop and pound together a foot length of the stout root, two inches thick, of the *iQwaningi* (*Capparis corymbifera*), of the *umNungwane* (*Xanthoxylon capense*), of the *uMabnsana* (*Capparis gueinzii*), of the *uMadlozana*, and a portion of the bulb of the *uMathunga* (*Cyrtanthus obliquus*) as large as a boy's fist; boil all for an hour in two quarts of water, of

which drink a tablespoonful three or four times a day, and take the major portion of the decoction, with the addition of further warm water, if necessary, as an emetic. Or, of the *uMayehlezana* or *uSi* shrub (*Crotalaria* sp.), one may take a bundle of the roots, six inches long, such as can be grasped by one hand, infuse with four or five cupfuls of cold water, and drink off the liquid. With some stomachs there is a liability to vomit the medicine, which is not desirable.

Another favourite remedy is the *umNyamathi* (*Ekebergia capensis* or *meyeri*), of which a piece of the root, six inches long, is chopped up and simmered in three pints of water and administered as an emetic. A large dishful of the pounded bark of the *umPhafu* (*Zizyphus mucronata*), made into a hot infusion with a quart or more of water; or a single tablespoonful of the decoction of the root of the *iDumbhi lika'ntloyile* (*Hæmanthus natalensis*), are also sometimes taken in the same way.

If any of these chronic coughs be accompanied by habitual expectoration of blood, *uMabusana* (*Capparis gueinzii*) is especially indicated.

Many of these native emetics are supposed to be of especial utility as expectorants, relieving the chest by clearing the air-passages and, perhaps, diminishing the inflammation therein. The *uSunnundu* (*Acalypha peduncularis*) herb is such a one, and of it a handful of the roots, a foot in length, is bruised and infused with a quart or more of warm water. Another is the *iBoza* (*Moschosma riparia*), of which a handful of the pounded leaves is infused with a cupful of cold water and drunk, being subsequently followed by sufficient warm water to excite vomiting. Or sometimes the leaves are boiled, and the extract preserved in pot or bottle, a spoonful being taken as required.

Though not acting as an emetic, a good expectorant for any kind of dry cough is said to be the *isiBhaha* tree, a good pinch of whose powdered bark is drunk in a spoonful of cold water; or it may be mixed with hemp-leaves (*inTsangu*) and smoked.

The natives attribute many of their chronic coughs to scrofula, especially such dry coughs as, although persistent, are not accompanied by any general constitutional disturbance. Under this category the native would, I believe, include even asthma (*isiFuba somoya*).

A remedy highly spoken of for such scrofulous coughs is the *uMathuuga* (*Cyrtanthus obliquus*). Having removed the external covering of a four-inch bulbous root, the whole of the inner portion is boiled in a quart or so of water, and a dessert-spoonful of the decoction taken once daily over several weeks or even for a couple of months. A clyster is also occasionally given, consisting of about a cupful of the warm decoction, diluted with another of simple warm water. A meal of Kafir-corn porridge is eaten at the same time, with the result that a thorough purging takes place, supposedly clearing out the system generally. The *uDlutshana* (*Aster asper*) is another specific for these scrofulous coughs. A tablespoonful of the crushed roots is thoroughly boiled so as to leave about a small cupful of liquid, of which a teaspoonful is taken once a day. Or an emetic may be made of a slightly larger quantity of the crushed root thoroughly boiled in water so as to leave a large cupful of extract, which is drunk and soon afterwards followed by copious draughts of simple warm water to ease the vomiting. Any other of the remedies prescribed for scrofula might also be used for these scrofulous coughs.

The natives seem to be ignorant of the anti-spasmodic properties of stramonium (*iYoli*) in case of asthma, notwithstanding that the plant grows as a weed on almost every old kraal-site. But for the shortness of breath accompanying this last-named, as well as heart diseases, the roots of the blue-flowered *uMampeshana* (*Oldenlandia decumbens*) are crushed, boiled, and the decoction drunk.

The *uDosi* or wild-beast's hair, supposed to be present in the air-tubes and to cause bronchitic and similar coughs, is "removed" by the *iDumbhi-lika'ntloyile* (*Hæmanthus natalensis*). Of this the roots are boiled and the liquid drunk as an emetic.

## Febrile Complaints.

Everyone who has had to deal with sick natives will have remarked with what puzzling frequency their ailment is described by them as an *umKhuhlane*. It is impossible to express this very comprehensive term by any single expression in English. It indicates almost any general constitutional derangement of a febrile and generally infectious nature, and may include enteric, scarlet and malarial fevers; small-pox and measles; pneumonia, acute bronchitis and influenza, as well as all the commoner minor catarrhs and bad coughs to which one is periodically liable. Practically nothing is understood of the nature of these important diseases, and the treatment is confined to a simple alleviation of such symptoms as are conspicuously evident, as the eruptions, the cough, and more especially the bile (*iNyongo*).

Every *umKhuhlane* is accompanied by an excessive secretion of some kind or another, and it is this secretion, be it expectoration or bile, be it discharged through the mouth or the rectum, that the natives universally regard as the principal delinquent, responsible for the whole bodily derangement. And in this view they are not without very respectable company; for the immortal Hippocrates himself held a similar view, viz. that the blood, the phlegm and the bile were the three primary seats of disease. His treatment, like that of the natives, aimed no doubt at ridding the system of whatever was abnormal in these bodily fluids.

With the natives the bile is held to be the cause, not only of the stomach and bowel disorders, but even of the chest inflammations and cough. The doctor's attack is therefore vigorously directed against this feature, and for the purpose he uses emetics, enemas and purgatives. A common method is to bruise a small handful of the roots, six inches long, of both the *isiNama* (*Achyranthes avicularis*) and the *uMasigcolo* or *inKuphulana* (*Osteospermum nervatum*), infuse with a couple of cupfuls of warm water, drink, and follow with sufficient simple warm water to cause vomiting.

Another course is to make a warm infusion of a handful of the leaves and roots of the *ubuHlungwana* (*Wedelia natalensis*) with one cupful of boiling water. This is drunk and followed as before by a copious draught of warm water as an emetic. A larger quantity of the plant is prepared in the same way, but with about a quart of water, for use as a clyster. A tablespoonful of the infusion may be also drunk from time to time.

Another remedy is the *uHlongwane* or *iNyathelo* (*Vernonia woodii*), of which a double handful is taken of the leaves and an infusion made with a quart or more of water to be administered as a clyster. A dessert-spoonful of the extract may also be occasionally drunk.

The *inKonazana* herb (*Alysicarpus wallachii*) is used for the same purpose, a bundle of the roots, about one inch through, being pounded and made into a hot infusion with a quart or more of water and taken as an emetic. So, also, is the *umFusamru* tree (*Pittosporum viridiflorum*), a piece of the bark, about three inches by two, being pounded and steeped in a pint of boiling water, which is drunk, and afterwards followed by sufficient simple water to excite vomiting. Sometimes an enema is prepared of a double quantity of this same bark (which, however, does not seem to possess any independent purging properties) steeped in enough boiling water for the purpose. Another common bile-emetic is the *uMadintsana* herb (? *Tripteris* sp.), of a handful of whose leaves a hot infusion is made with one cupful of water supplemented by a copious draught of plain warm water so soon as the inclination to vomit takes place. An infusion in a pint of hot water of a single handful of the six-inch roots of the *umSenge* (*Cussonia spicata*) is prepared and administered in the same way.

The commonest purgative, of course, used for expelling the "bile" in the bowels caused by an *umKhuhlane* is the *iJalambhu* (*Ipomœa purpurea*), of whose stalks, six inches long, a handful may be bruised in a half pint of boiling water or fowl-broth and the liquid drunk.

A general specific for an *umKhuhlane* is the *umHlonyane* (*Artemisia afra*—Wormwood), a double handful of the leaves being infused as tea with a quart or so of hot water, and administered either as clyster or emetic.

As a kind of tonic or stimulant, to remove the general seediness or depression caused by the complaint, a piece of the stout root, an inch and a half thick and six inches long, of the poisonous *imFulwa* (*Ophiocaulon gummifera*) is chopped and infused with three or four pints of boiling water as an emetic.

Other remedies used for an *umKhuhlane* and generally as emetics are the poisonous *uMahedeni* (*Phytolacca abyssinica*), the red roots of the *inTolwane* (*Elephantorrhiza burchellii*), those of the *uMayime* (*Clivia miniata*), and of the *umLomommandi*.

Malarial fever (also nowadays commonly called simply an *umKhuhlane*, and recently in Natal, from the shivering symptoms, *umQhuqho*) is one of the most destructive enemies the native of Zululand has ever had to contend against. When the last *grande armée* of Shaka, composed of the whole male population of Zululand and Natal, was sent forth northwards to fight Soshangane, beyond Delagoa Bay, it was practically wiped out by *iMbho* (as the malignant type of the disease was then called) before it had so much as reached the enemy's territory. Although the natives, even such as have been born within the malarial areas, are not quite so liable as are the Europeans to the severer forms of attack, still, they are very far from being immune against them. Every year in the malarial districts of Zululand a very large number of natives succumb, and some years as large a number as to all other diseases combined. Yet so far they have not succeeded in discovering any efficient remedy against it. Their method is to attack the disease with emetics and purgatives, which, by ridding the system of its excessive accumulation of bile, gives a temporary easement to some of the more distressing symptoms, and so, perhaps, facilitates recovery. We are bound to own that, with the natives, this method is

attended with quite astonishing success. The peppery bark of the *isiBhaha* tree, the veld-herb *isiHlazi*, or any other of the already-mentioned emetics, enemas, and purgatives found growing in their districts would be their usual plant specifics.

Whether enteric fever was or was not an aboriginal disease of the African races, it is certainly met with on rare occasions nowadays in the kraals. One of the chief specifics of the natives for this, or perhaps any similarly eruptive fever, is the poisonous *uQwengu* or (N) *iLozane* (*Tephrosia macropoda*). The root is first externally charred on the fire—a process said to reduce the strength of the poisonous principle. The unburnt central portion is then ground to a powder, of which a pinch of 5 to 10 gr. is taken, mixed with a like quantity of the inner root-bark of the *inKunzi* or *iBheja* (*Bopusia scabra*) herb and a little liquid fat or oil.

In the case of eruptive fever, like smallpox and measles, the eruption is mistaken for the disease and is consequently the main object of treatment. Needless to say, not much benefit can accrue from such methods, although, in the case of smallpox, the disfigurement may be somewhat lessened. For this latter the dry roots of the *inKunzi* or *iBheja* herb, together with those of the medicinal *isiDikili* (*Lasiosiphon* sp.) are pulverised and mixed into a paste with wetted termite earth and plastered over the body. For measles, urticaria and other rashes, a common specific is the *inKokhane* climber, of whose crushed leaves a hot infusion is made and used as a lotion twice a day, a cupful of the medicine being also drunk. The ground roots of the *isaMuyisane* (*Spermacoce natalensis*) mixed with termite earth are also smeared over the seat of the outbreak. The bark of the *umHlam-bhamanzi* (*Rauwolfia natalensis*) and the leaves of the *umSuzwane* (*Lippia asperifolia*) are other cures. For any of the ordinary body rashes, a double-handful of the leaves of the *uMaholwana* (*Ipomœa palmata*) is crushed in a cupful of cold water and the whole drunk.

## Urinary Diseases.

A large number of maladies connected with the urinary organs, and which seem to be mainly kidney diseases, though sometimes of the bladder and generative organs, are lumped together by the Zulus under the one generic term *iZembhe* or *uJovela*.

To be afflicted with this complaint, whatever form it may take, is somewhat of a disgrace, for it is held to be the result of illicit intercourse with the wife of another man who has previously "treated" her in such a way that, although she be in no wise inconvenienced herself, she shall nevertheless be capable of conveying this disease to her paramour. The charm used by a husband for this purpose is also usually called *iZembhe* or *umSizi*, and consists mostly of parts of certain wild beasts (*iziNyamazane*), charred and pulverised.

The chief specifics for this disease are the *uMakhandaka'utsele* (*Eucomis undulata*), and the bark of the *imPisikajihlangulwa* tree. The poisonous *uMahedeni* or *inGubivumile* (*Phytolacca abyssinica*) is also mostly used in this connection. A small handful of the paste of the bruised leaves, sufficient to cover the palm, is administered, mixed in a big draught of Kafir beer. Soon a profuse perspiration breaks forth, followed by vomiting and ultimately purging. The root, however, is said to be much more potent than the leaves; a piece, half the size of one's thumb, is mixed, after pulverisation, in a cupful of water and given to the patient to drink. As before, a copious perspiration takes place, then violent vomiting. This is assisted by the administration of large draughts of water, time after time, whenever an inclination to vomit manifests itself. Before long purging sets in. At this stage a large portion of beer is given, which is said to allay the vomiting, and the drug works itself off by purging within about twenty-four hours. Should the vomiting and purging continue for a considerably longer period, say for a couple of days, a fatal climax may be feared. Although so dangerous and often lethal, skilled native doctors place an unusual reli-

ance on this bushy climber. Its action undoubtedly exhibits all the symptoms of a virulent vegetable poison, but nevertheless it may contain valuable curative qualities, as it is certain that remarkable cures sometimes follow its application.

Backache or fixed pains about the loins are a common accompaniment of kidney and other abdominal complaints. These are said to be relieved by a half teaspoonful of ground *im Fuzane* root taken in a little gruel; or by the *iXolo* preparation already described. The roots of *uSukumbhili* (*Hypericum æthiopicum*) are also used as a clyster for the same purpose. Again, incisions may be made at wide intervals round the loins, into which the bulbous root of the amaryllid *uMahlokoloza* is rubbed. A festering of each incision follows, which is supposed to "draw out" the internal ill.

The native pathology of bladder diseases is akin to that of the kidneys. They are mostly lumped together under the single name *iQondo*, whether the complaint be calculus, bilharzia, simple cystitis or what not. Like the *iZembhe* so also the *iQondo* implicates the sufferer in the evil reputation of being a fornicator. Bladder affections predominate among the youthful male population, and it is believed that they commonly follow illicit sexual indulgence. The harm, really caused by their own excess, is universally held to have been contracted from the girl. The father or the accepted lover of this latter may have suspicions of her faithfulness, and he thereupon secretly treats her—on lines similar to those of the *iZembhe* aforementioned—or he may even treat the "lair" in the bush which the couple are supposed to frequent, with some magic medicament, which, while doing no injury to the girl, will inflict an *iQondo* on the youth.

We may remark among aboriginal peoples, still in the elementary stages of medical knowledge, a constant predilection for the homœopathic principle. Thus, a plant is found to cure a certain ailment; the same plant will therefore produce it! This is the principle exemplified in the native views regarding the cause and curing of both the *iZembhe* and the *iQondo* diseases.

A youth, suspecting his girl of faithlessness, will procure an *iBhucu* (*Bulbine natalensis*) plant and make an infusion, mixing therein a quantity of selected, magical, animal powders. He will drink the mixture, and it acts as a sedative diuretic. The "evil" properties of the *iBhucu* and the various animal powders are then supposed to infect the girl after intercourse without injuring her, but they are subsequently absorbed into the bladder of the rival youth.

On becoming aware that he has contracted the disease, his first endeavour is to discover which particular *iQondo* poison (for there are several) may have been used in his own instance. Having made this discovery (perhaps by the aid of a witch doctor), he physics himself with the same plant to bring about a cure. In the case of the *iBhucu* the slimy juice from a few of the thick soft leaves is squeezed into water and drunk.

The next thing the native doctor might advise him to do would be to apply over the bladder, having first anointed the skin with oil or fat, a poultice made of the leaf-paste of the *umDlonzo* (*Mikania capensis*), the *umSintsi* (*Erythrina caffra*), the *uZipho* or *iKhambhi leziduli* (*Cardiospermum halicacabum*) and the *uXhaphozi* (*Ranunculus pinnatus*), all of which are caustic in their action, working, probably, like mustard, as a counter-irritant. The plaster is allowed to remain until it becomes unpleasantly hot for the patient, which is said to be in about an hour's time. The last two plants, being particularly caustic, should be applied only in a small quantity.

A handful of the roots of the big-leaved *uLimilwenkomo* or (N) *uLimilwenyathi* (*Berkheya* sp.) is sometimes boiled in a cupful of water and drunk. Others take half-a-dozen of the small roots of the *isiThumana* (*Solanum capense*) of the termite nests, pound and boil them well in a pint of milk, and drink a tablespoonful of the decoction three times a day.

Should, however, more drastic measures be imperative, the doctor thrusts a small hollow reed through the penis into the bladder, and blows into the latter a pinch of the pulverised

bark of the *uNukani* (? Stinkwood or *Ocotea bullata*) along with that of the *uMahlabekufeni* tree and a little ginger. Stinkwood bark is known to be a tannic astringent.

All kinds of penial irritation, from inflammation of the urethra, sores and the like, are treated with a lotion of the pounded leaves and stalks of the *uCathucathu* (*Hibiscus surattensis*), or dressed with an ointment prepared from the same mixed with powdered *isiBhaha* bark and any kind of fat. Or a pill of the leaf-paste of the *isiThumana* above-mentioned may be inserted well up the urethra, and allowed to remain until urination, following a copious draught of beer to be subsequently taken, washes the whole channel thoroughly out.

Stricture is a dangerous complication or result of urethral and bladder disorders. Whatever may be the real cause of the consequent difficulty of urination—whether stricture, urethral spasms, defective muscular force or hysteria—the *uGobo* (*Gunnera perpensa*) and the Natal Lily or *umDuze* are prescribed. Of the former a large handful of the pounded roots is boiled, along with the chopped bulb of the latter, in half a pint or so of water, and the decoction drunk. The preparation of the *isiThumana*, above-given for cystitis, is likewise administered as a remedy for stricture. Some also use the *uBangalala* herb, one of whose roots is boiled in milk and a mouthful taken from time to time. The bark of the *umLahleni* tree, mixed with urine, is sometimes used as a charm by evil-intentioned persons to cause stricture in those they hate. On the usual homœopathic principle, we may think it possible that the Kafirs have found this same bark useful also as a curative agent for that complaint.

#### Venereal Diseases.

Previous to the advent of the white man there is every reason to believe that venereal diseases were absolutely unknown among the Zulus.

It is averred that the Cape Colony Xosa doctors treat

syphilis (*Z. iBuba*, *isiPatsholo*, *uGcusulu*), with good results, while in its primary and secondary stages, by preparations of *ubuVimbha* (*Withania somnifera*), of *umThuma* (*Solanum melogena*), and several species of the *umThombho* (*Cissampelos tornlosa*, etc.). In Natal, as compared with the Cape Colony, the disease is a comparatively recent introduction, and yet, when not too far advanced, the local medicine-men seem generally able to get the better of it. I have not heard of their using any of the above-mentioned Xosa specifics for this purpose, although they are fully aware of the really antiseptic or germicidal properties of the *ubuVimbha*, for it furnishes them with one of their chief remedies for the malignant rectal ulcers of the *isiGwebedla* disease, while the blood-purifying powers of the *umThombho* are also known, it being universally used for scrofulous affections.

The Natal men, I find, administer internally a decoction of the roots and leaves of the *uNjalwana* veld-herb, also a decoction of the leaves of the common aloe or *umHlaba* (*A. ferax*); and they sprinkle on the external sores the same leaves charred and ground, or better, a paste of the bruised leaves of the *uZipho* or *iKhambhi leziduli* (*Cardiospermum halicacabum*), the *umDlonzo* (*Mikania capensis*), the *umSintsi* (*Erythrina caffra*), and the *uXhaphozi* (*Ranunculus pinnatus*), is laid on as a poultice. All of these latter plants (especially the first and last named) possess intensely caustic properties, and should therefore be allowed to remain on the body but a short time, perhaps not more than an hour. They are said to burn and bring away all the foulness of the ulcerated parts, leaving them clean, and stimulating them to rapid healing.

For all urethral and vaginal discharges or sores of a generally venereal nature, as in gonorrhœa or gleet (*uGola*, *iKlilabhu*, *iDilophu*, or sometimes by the generic terms *uJovela* or *iQondo*), a large pill is made of the pounded leaves of the *uZipho*, which is then thrust into the vagina or penis, and allowed to remain. A copious draught of beer is subsequently

taken, presumably in order to induce a washing-out by urination. Or the leaves and stalks of the *uCathucathu* (*Hibiscus surattensis*) are crushed very finely in cold water and the strained milky liquid is injected into either of the channels. The urethral affections are also relieved by the *isiThumana* (*Solanum capense*), of which six of the small roots are pounded, boiled in a pint of milk, and a tablespoonful of the decoction drunk three times a day. The preparation of the *iBhucu* already mentioned is also taken internally to render the urine bland.

#### Uterine Disorders.

I need scarcely say that the distinguishing nature of the various uterine disorders is not recognised. As a general specific we often find the following method employed: the pulverised bark of the *uNukani* tree (?*Ocotea bullata*) is mixed with that of the *uMahlabekefeni* tree (*Croton gratissimum* and *C. sylvaticum*) and a little ginger and blown, through a small hollow reed, into the womb.

What the properties of the *uNukani* tree may be I am unaware, but I have an opinion that they are of a caustic nature. Those of the crotons, as a cutaneous eruptive irritant and stimulant, are well known. If the crotonic principle, then, is so powerful when applied to the external skin, we may conclude that its action will be considerably stronger when applied to the much tenderer tissue of the internal organs. In this way, perhaps, it may be of some real value when introduced into the womb in cases of inflammation, or where that organ is overcoated with morbid matter requiring cauterising.

In cases of injuries to the womb from obstetrical operations, of uterine inflammation and the like, a hot infusion is made of the leaves of the *umJuluka* running herb, a portion being drunk and the rest injected either into the womb or into the rectum.

## Impotency and Barrenness.

With all primitive peoples, all that pertains to the sexual functions, involving as it does the propagation of the species and the preservation of the tribe, is a matter of paramount importance. Impotency on either side is with them more than a disgrace, it is a calamity. Should the male organs fail altogether to produce the seminal fluid, the roots of the *imPindisa* (*Rubia cordifolia*) are boiled and drunk at bedtime, resulting in an early emission. A hot milk infusion of the roots of the *uQontsi* (*Eriosema cordatum* and *E. salignum*) herb has a similar effect. Or the powdered root of the *iHlamvu* (*Gloriosa virescens*) may be drunk in whey. The pulverised root of the amaryllid *uMahlokoloza* is sometimes blown through the urethra.

Should the seminal discharge be present, but lack vitality and fail to produce conception, a prize specific is the creeper *uNgibonisele*, of whose roots a hot infusion is drunk by both husband and wife. It is, however, imperative to success that the latter be quite unaware of the husband's having also drugged himself with the medicine.

The roots of the *iBhuma* bulrush (*Cyperus* sp.), along with those of the *iQwaningi* (*Capparis corymbifera*), furnish another remedy; and the *uBangalala* herb enjoys a particularly high reputation, one of its roots being boiled in milk and a little of the decoction drunk from time to time; as does also the veld-herb *uNjalwana* or *iKhambhi lesipatsholo*, whose roots and leaves are boiled and a small quantity of the decoction drunk three or four times daily for a few days. In a word, almost anything calculated to produce irritation of the sexual organs is greedily availed of as a means to remedy impotency. The *imBhabazane*, or common stinging-nettle, the *umHlwazimambha*, another nettle-like creeper, the roots of the herb *amaQate* or (N) *uBhusha* are all called upon to do service to this end.

Where simply a lack of nervous or muscular power is supposed to be the defect, the bulbous roots of the *uNdwendweni*

or *iMabelejongosi* (*Eulophia arenaria*) are slightly boiled, and a tablespoonful of the liquid occasionally drunk.

The prospect of at last attaining to the crown of maturity is hailed with proud delight by both boys and girls alike. All kinds of measures are employed by them to hasten its accomplishment. Should the menstruation be delayed—and this equally applies to all subsequent retarded periods—resort is had to the *imPindisa* (*Rubia cordifolia*). Over-eager children even eat the raw roots of the plant; but the orthodox method is to boil them and drink the decoction. Another first-menstruation specific is the *inDawo* (*Cyperus esculentus*), a handful of whose nodulous roots are boiled and mashed in a little *amabele* porridge and then eaten; but the action of this may perhaps be that of a general stomach tonic rather than of an emmenagogue.

So constantly does this plant *imPindisa* reappear in all native treatment of all sexual ailments that one is almost forced to believe that it must possess some useful quality. One might at first have supposed this property to be of a nature inducing “heat” or local excitement, seeing that it is indicated for impotency as well as retarded menses. But this can scarcely be the case, if those native doctors be right who prescribe it also in cases of metrorrhagia.

For profuse menstruation of all kinds, the roots of the *imPindisa* are mixed with those of the *umTshiki* grass (*Eragrostis plana*), boiled, and the liquid drunk. The *menstrua cynocephali*, deemed so necessary an ingredient by the native doctor, for the homœopathic reason that the complaint is held to be due to a malicious poisoning of the individual with such substance, need not be mentioned here.

When the monthly process is accompanied by pain—a disorder coming under the generic term *isiLumo* (any unrecognised abdominal “gnawing”)—relief is sought in the pink-flowered *isiDwa* (*Gladiolus Lindwigii*). Two double handfuls of its nut-like roots are crushed and boiled in two cups of water, which is then injected per rectum, and may

be repeated every day as long as required. Another larger kind of gladiolus (also termed *isiDwa*) having a raceme of large-sized orange-yellow flowers, is likewise employed for the same purpose. Or the large tuberous root of the *isiNwazi* (*Cissus cuneifolia*) is chopped and boiled in a quart or so of water to form an enema. Other remedies are the *isiNdiyandiya* tree (*Bersama lucens*), of which the bark is used; and the *umTimatane* or *isiNywane* (*Royena lucida*), prepared as an enema.

Dysmenorrhœa is most generally due to chlorosis or anæmia, and for such iron is the orthodox European specific. It is another proof of the curiously correct insight of the Zulu doctors that they, too, were aware of this latter fact, and in their treatment of painful menstruation regularly prescribed, in the old iron-smelting days, a powder made from the dross or slag.

If impotency is lamented in the case of the male, sterility in the female is even more deplored, if only that a heavy price has been paid for her. The native understands nothing of the causes of barrenness, for the reason that he is ignorant of the whole physiology of procreation. Nevertheless, he has several remedies which, when they chance to find the conditions corresponding to their peculiar properties, appear to be efficacious.

A common specific is the beautiful liliaceous *iHlamvu* (*Gloriosa virescens*), whose roots are pounded, mixed with food and eaten by husband and barren wife, with the result, as they say, that the latter conceives. We have recently heard of a discovery that yeast has proved an effective cure for barrenness in cows, and the explanation given (whether correct or not, I cannot venture to say), was that the yeast had the effect of killing the particular microbes responsible for the uterine disease. Now, if there be any truth in such a statement, the *iHlamvu*, inasmuch as it is a well-known lice-killer, may also have the nature of a germicide, and act on human beings in a similar way to the yeast on cattle.

Other native doctors prescribe the flowers of the *isiNuma*

*esibomvu sehlathi* (*Pupalia* sp.) which, after bruising, are rolled into a couple of small paste-balls, one of which is swallowed by the man, the other inserted into the womb, with the result that in due time conception takes place. Or, the roots of the *uNgibonisele* climber may be boiled, a portion of the decoction being drunk and the remainder injected into the womb. Another favoured remedy is a mixture of the roots of the *iBhuma* rush (*Cyperus* sp.) and the root-bark of the *umThuma* (*Solanum sodomæum*). The *iLabatheka* (*Hypoxis latifolia*) is also sometimes used.

Should a painful menstruation be an accompaniment of the inability to conceive (as might happen in the case of fibroid tumours), the roots of the *uMpondonde* (a species of aloe) are employed in the same way as those of the *uNgibonisele* above.

In some females there is a disposition to deliver prematurely or miscarry. This misadventure may be prevented by the administration of any *umSekelo* (a generic name for any medicine of this class), for instance, a certain bush climber (*Pyrenacantha scandens*). Of this the roots are selected, pounded, steeped in cold water and the infusion drunk in cupfuls from time to time.

To facilitate delivery, or to procure it when retarded—medicines generally called an *iNembhe*—several plants are indicated. Of these one of the chief is the *iNothwane* or *inDola encane* (*Trinmfetta rhomboidea*). A bundle, such as one can easily grasp in the hand, of the six-inch roots is pounded, a hot infusion prepared with a cupful of boiling water, which is then drunk. Other remedies are the *iBhuma* (*Cyperus* sp.) rush, the bulbous root of the *uHlakahla* herb, the veld-shrub *uHlunguhlungu* (*Vernonia corymbosa*), the bush *iKlolo* or *iLalanyathi* (*Grewia occidentalis*), the *uMayime* herb (*Clivia miniata*), the climber *isiNwazi* (*Cissus cuneifolia*), and the herb *uGobo* or *uKlenya* (*Gunnera perpensa*).

But the mother's troubles are not yet at an end. There is that perilous contingency of parturition known as puerperal

fever. In order to facilitate the due expulsion of the after-birth and the proper clearing of the womb, the natives employ the roots of the aforesaid *uGobo*, along with those of the *isiDwa* (*Gladiolus ludwigii*).

The native doctors seriously assert that they can not only alter the sex of the offspring habitually borne by any woman, but they can actually procure the birth of whichever sex they will. Use is made of that beautiful orange lily (*Gloriosa virescens*) already referred to, and which is commonly called the *iHlamvu lomfana nentombhazana*. The peculiarity of this plant is in its root; some roots are said to exhibit the shape of the female organ, while others represent the male. All that is necessary is to physic the wife before coition with a decoction of a root which resembles in shape the organs of whichever sex is desired!

I once received the following interesting information as a valuable professional secret. "Your goats perchance have the undesirable habit of bearing always useless males. Catch a weasel (*Pœcilogale albinucha*), dry it whole, grind it to powder, and administer in water to the she-goats before covering. The result will be female offspring."

#### Rheumatism, Heart Complaints, Dropsy, etc.

Rheumatism in all its forms is very common among the natives owing to the habitual sleeping and sitting on damp ground-floors, and to the constant neglect to change wet clothing.

In these cases an up-to-date Zulu doctor has first resort to the *iPhungulo* or steam-bath. The process is described in my Zulu-English dictionary as follows: Certain medicines (which are erroneously supposed by the natives to be the curative element) are boiled in a large pot, over which the patient sits, closely surrounded by grass mats or blankets, until he becomes thoroughly steamed out, the steam being maintained by the insertion into the water of two or three large red-hot stones. The patient is afterwards sprinkled over the bare body with the same or another similar decoction

while boiling hot, the sprinkling being done by a small bunch of the leafy stalks of the *umGunya*, *iCimamlilo*, *uMagwanyana* and other herbs, whose property is said to be to render the boiling water harmless. The native doctor thus first clears out and "softens down" the body through a vapour-bath, and then endeavours to excite a shock or thrill throughout the system by means of the hot-water sprinkling. This treatment is further supplemented by medicinal draughts.

To allay the pains of rheumatic fever, the whole viscous bulb of the *inGcino* (*Scilla rigidifolia*) veld-herb is thoroughly boiled in a quart of water, of which one tea-spoonful is taken morning and evening for one day only. Or a large handful of the *uGobo* root (*Gunnera perpensa*) is pounded and boiled along with the chopped bulb of the *umDuze* or Natal Lily, and the decoction drunk. Other general remedies are the roots and bark of the *umNyezane* (*Dovyalis rhamnoides*), which are boiled and the extract drunk. Or the roots of the *umLuloma* (*Turraea heterophylla*) along with *umQalothi* bark (*Strychnos henningsii*) may be prepared in the same way. The pungent bark of the *isiBhaha* is also praised as a specific for rheumatism, and I am of opinion that the peppery bark of the *umNanguwane* (*Xanthoxylon capense*) would prove equally efficacious.

Local treatment sometimes takes the form of a simple sprinkling of the painful part, by means of a small brush, with the boiling decoction of the *iCimamlilo* (*Pentanisia variabilis*), this plant, the pretty wild forget-me-not of the veld, having the reputed property, as mentioned above, of preventing burning liquids from injuring the tissue. Similarly, the roots of the *uShaga* (*Berkheya* sp.) may be boiled, its leaves pounded and mixed with cold water, which is then added to the boiled root-decoction, and the mixture used to foment the painful limb, any benefit derived therefrom being probably due to the fomentation rather than to the herb, which is generally held to be simply astringent.

For stiff-neck the bark of the *umSongi* tree is used.

Heart troubles are an accustomed complication of rheumatism. The native doctor knows nothing about the functions of the heart, though acquainted with the symptoms of heart diseases (commonly termed *uValo*, because supposedly located in the cartilage at the end of the sternum), and, in his feeble way, he is able to meet the call made on his skill.

He takes the roots of the blue-umbelled *uBani* (*Agapanthus umbellatus*), makes therewith a hot infusion in a quart of water, to be administered as an emetic and repeated daily. Such a daily emetic may be also prepared from the red roots of the *umDabu* shrub (? *Elephantorrhiza* sp.); or these same roots may be dried, pounded, and rubbed into incisions below the breast. A handful of the leaves of a species of *Mesembryanthemum* (called by the natives by the generic term *iKhambhi lamabulawo*) is sometimes infused in a little boiling water and used as an emetic against the fearful dreams symptomatic of heart weakness. For such dreams the *iLabatheka* (*Hypoxis latifolia*) is also used, a hot infusion being made of its bulb and taken as an emetic. The inner bark of the white-flowering *uNtliziyonkulu* or *umuWane* tree, as also the bark of the *uMoyavocungu* tree and the roots of the *umVuma* (*Turraea floribunda*) tree, taken as an emetic, are other remedies.

The *inDabulalualo* (chips of crystal or natural glass hawked in from Basutoland) so valued by the natives, is not worth referring to, unless to show what absurd and injurious practices (for the glass is broken up and taken internally!) these people are capable of mixing up with much otherwise reasonable treatment. The like remark applies to the specific of some doctors for palpitation, viz. the dried hearts of the *inDhlondhlo* snake and the *uXamu* (*Monitor niloticus*); but the roots of the *uMampeshana* (*Oldenlandia decumbens*) herb, crushed, infused in boiling water and drunk, which are used for this same purpose of palpitation and shortness of breath, may perchance be of some benefit.

Dropsy of the lower limbs (called *uMankuukunku*, *isiKhu-khukhu*, or *iKhuukulo*, by which latter name rheumatic swellings

are also called) is a frequent accompaniment of heart troubles, and is regarded as the result of *takata* poisoning. Several such "poisons" are mentioned, vegetable and animal, but among the commonest is the diodon or globe-fish (*Tetraodon stellatus* and *inermis*) found along the Natal coast. Now, we do know that some varieties of this fish are really poisonous, although I am not aware how the poisonous principle acts on the human system. It is just possible that it may affect the heart, and so really give rise to dropsy of the limbs. Whatever the cause, the native treatment is the same. Chief reliance is had on the vapour-bath, already described under rheumatism. Certain species of *inTsema* or dwarf euphorbia (*E. pugniformis* and *E. bupleurifolia*) are also employed, the roots being dried, burnt, and the ashes rubbed into incisions made about the affected parts.

There is a vaguely described complaint with the natives called *isiBhobo* or *amaNxeba*, which appears to be mostly intercostal neuralgia, at other times muscular rheumatism, or a symptom of liver disease. It is another of the *takata* maladies. The *amaNgwe* and the *umZilanyoni*<sup>1</sup> or (*N*)*uMinyu* bushes are among the chief poisons supposed to cause it. The latter bush is so named because all birds avoid it. The witch-doctor is usually consulted by the patient as to which poisonous plant may have been used, and the same plant becomes once more the antidote. Should it have been either of the above, the roots are boiled and given as an emetic, a small portion being also drunk; or they may be ground and rubbed into incisions.

Sometimes the roots of the *umQaqougo* (*Clerodendron glabrum*) are mixed with those of the *iBoza* (*Moschosma riparia*), a hot infusion made with a quart of water and taken as an emetic. Another remedy is the *iBohlololo* or (*N*) *inZwabuhlungu* (*Senecio speciosus*), whose leaves and stalks are burnt and the ashes rubbed into incisions. Or the

<sup>1</sup> This is said (though personally I have some doubts) to be a different plant to the *umZilanyoni* or *uMahlabekufeni* tree (*Croton sylvaticum*) already mentioned.

bark of the *uMahlabekufeni* tree (*Croton gratissimum* and *C. sylvaticum*) and the dry root of the amaryllid *uMahlokoloza* may be ground to powder and rubbed in as before. The male of the (N.) *iDungamuzi* (*Euclea lanceolata*) and the *isiBhaha* are other reputed cures.

A good counter-irritant for any kind of fixed internal pain is said to be the *umNgandane wempisi* (*Royena villosa*), a bush found along the coast, whose leaves or pounded roots are bruised and laid over the painful spot for perhaps half an hour or an hour, as the plant has strong caustic properties. The compound plaster, or indeed any single one of the ingredients—*umDlonzo*, *uZipho*, *uXhaphozi* and *umSiutsi*—already mentioned under bladder complaints, is equally efficacious for the same purpose. An effective eruptive rubefacient for lung, and probably also for any other internal inflammations, is the bark of the *uMahlabekufeni* (*Croton gratissimum*) and the *umZilanyoni* trees (*Croton sylvaticum*), which is ground very finely and rubbed into incisions in the skin.

### Diseases of the Nervous System.

The medicine-man often meets with spinal diseases and prescribes the roots of the *uGobandloru* (*Secamone gerrardi*), of the *uSahlulamanye* (? *Pterocelastrus rostratus*), of the *uNgazi*, and of the *uMafumbhuka*, all ground to powder, along with the dried body of an *iGomongo* or large fruit-bat, and rubbed into incisions made along the affected part.

Paralysis is held to be a local affection of the particular limb concerned. Its specifics are the *uNtlangothi* and *umNungwane* (*Xanthoxylon capense*).<sup>1</sup> The administration of the former is described in my Zulu-English Dictionary as follows: "The patient stands in the sun, and then, commencing with the length of his shadow, the doctor makes

<sup>1</sup> An allied tree (*Xanthoxylon fraxineum*) is used in America for chronic rheumatism, which, from the crippling of the limbs, would, perhaps, in native diagnostics, be regarded as akin to paralysis. Maybe the *umNungwane* also does possess useful qualities.

incisions in it along the ground and so right away up the whole unaffected side of the body. On the following day this process is repeated with the other or affected side. Finally, the bark, after having been rubbed into the incisions, is boiled in water, and the patient, dipping his fingers into the hot decoction, is required to keep sucking the liquid from the finger-tips, afterwards smacking with them the several affected joints. A cure follows—when the omens are propitious !”

Other doctors approach nearer the mark of reason, and advocate the hot-air treatment. A hole is dug in the ground, a great fire is kindled inside, and, after the ashes have been removed, the patient enters, and the hole at the top being loosely covered over, is allowed to perspire freely for some time. He is supposed to come out more or less cured. It is possible that the shock caused by the burial in a half-roasting pit, apart from the general benefit conferred on the system by the copious perspiration, may also not be without its advantages. It seems pretty certain that the native doctors have an inkling of the curative effect of “shock” on certain nervous and muscular diseases.

A native is reported as “unable” to move his limbs—perhaps from paralysis of some kind. The doctor orders him to be placed amidst a heap of dry faggots completely encircling him, and perhaps a foot or more high, at a foot’s distance. The sticks are then set on fire, and the patient, “unable to move,” is compelled to see and to feel the nerve-disturbing flames arise on every side around him. Water medicated with *iCimamtilo* and similar herbs is constantly sprinkled by the doctor on the firebrands nearest the patient, so as to control the flames and prevent burning. This sprinkling further creates also an amount of steam about the patient scarcely less dreaded than the fire. At length the fire burns itself out; the sufferer is removed “much exhausted,” but sometimes quite recovered.

In this connection I may add how in a case of epilepsy the patient was ordered to supplement the medical treatment by

plunging, at a certain hour, into a particular pool—everywhere known to be especially infested with crocodiles, and reputedly also with pythons—in one of the rivers in further Zululand. The object of this, it seems to me, could have been nothing other than to cause a vitalising shock to the brain and nerves.

### Hysteria.

Hysteria is very common among native girls. In the majority of cases it is the result of a mental disorder, and although not necessarily caused by any physical derangement, is often sympathetically aroused, through the nerves, at those times when the sexual functions are most active, as is evidenced by the fact of hysteria occurring so frequently about the menstrual period. The Africans being a race of strong emotions, both sexually and sentimentally, we should almost expect hysteria to be rife among them.

The nature of the complaint not being understood, it is always attributed to the evil “charm” of some malicious young man. Technically the girl is said to have been “thrown at” (*phosiwe*) by him, and the charm used, and supposed to cause the hysterics, is called an *iHabiya*. These *amaHabiya* may be harmless animal substances, as the fat of lions, leopards or various birds, but they are more frequently plants. The native never administers his charm internally to the individual, mostly not even corporally at all. The same plant as is supposed to have caused the hysteria is regarded also as its antidote; which accounts for the universal custom of requiring that the same young man who has been detected “charming” a girl in this way shall also cure her, as he alone will be cognisant of the proper remedy. Among a large number of plants reputed to possess such properties, we note the roots of the *uKhathwa* herb, of the *umMbhezi* tree, or of the *amaPhofu* bush.

The root of the *inDawoluthi emnyama* (*Belamcanda punctata*) is employed to allay the hysterical crying.

Perhaps it possesses some sedative properties. A hot infusion of the fleshy stalks of the *uZillilo* (*Stapelia gigantea*) is used as an emetic for the same purpose.

The physical or mental affection with which native witch-doctors are always afflicted may be a form of hysteria, and they are sometimes medically treated. For instance, the roots of the *umHlonishwa* (*Psoralea pinnata*) and of the *uBhubhubhu* climber (*Helinus ovata*) are pounded and stirred with cold water until the liquid froths, when it is drunk as an emetic. Multifarious superstitious formalities are at the same time performed, but their mention is of no importance here.

A few years ago a curious complaint, forming quite an epidemic, was introduced into N. E. Zululand from the adjoining Tongaland. The disease attacked young persons of both sexes, but generally girls. The sufferers would congregate in bands and they would have wild convulsive fits, and fits of jumping frenzy during which the head would be completely smothered beneath several layers of cloth secured about the chest and back by braces of goat skin common to all types of Zulu witch-doctors. They would cry in uncanny tones, likened to the bellowing of a bull, and would speak in an "unknown tongue."

A person so afflicted, even after a more or less complete recovery, is known as an *iNdiki*.

The Zulu imagines that the disease is due to a new type of spirit, akin to the *iDlozi* (or ancestral familiar spirit) and *umLozikazana* (or whistling familiar spirit) and yet distinct from both.

I have prosecuted some inquiries, which have led me to the conviction that the convulsive fits were plainly those of epilepsy; that the "unknown tongue" was simply incoherent mutterings in Zulu and kindred languages, and that the rest was mainly hysteria.

#### Insanity.

Various physical derangements are apt to cause a temporary insanity or delirium (*uHlanya*) with the natives, mostly mani-

festing itself in a wild rushing about the country. When this symptom appears—which, of course, in the native view, amounts to a distinct disease—a piece as large as the fist of the very poisonous bulb of the *inGcolo* forest-climber is very thoroughly boiled in a pint or more of water, of which only one teaspoonful may be given to drink. This quantity is said to suffice of itself to cause in a healthy individual mental derangement of some kind lasting several hours; the already delirious, however, it is supposed to bring round. Another plant said to produce a similar kind of insanity (though I have not heard it prescribed as a cure for the same) is the bulb of the *iLabatheka* (*Hypoxis latifolia*).

#### Skin Diseases, etc.

Body sores, especially if intractable, are plastered with the ground roots of the *inKunzi* or *iBheja* herb (*Bopusia scabra*) moistened with a little water. This plant, we may recollect, is a chief specific for the ulcerous rectal disease called *isiGwebedla* or *inGumbhane*. No doubt it really possesses some kind of antiseptic power. This may also be the case with the running pea-like plant *uQwengu* or (*N*) *iLozane* (*Tephrosia macropoda*), which is not only curative of sores, but in leaf-extract is used for destroying head-lice, and effectually expels intestinal worms from cattle, although dangerously poisonous if rashly taken internally by human beings.

The *umNungwane* (*Xanthoxylon capense*), again, from its use in the preservation of meat and in the treatment of decayed teeth, undoubtedly contains antiseptic powers of a high order, and similarly also the *ubuVimbha* (*Withania somnifera*), the leaves of both of which are successfully employed in the healing of sores.

The leaves and roots of the *uShaga* or *uShwawu* (*Berkheya* sp.), pounded and steeped in cold water, furnish an excellent astringent remedy for the same purpose.

A general outbreak of sores throughout the body is treated

with a dose of *uZipho* (*Cardiospermum halicacabum*), a handful of the leaves being pounded in warm water and drunk.

The leaf of the common kraal-weed *iYoli* (*Datura stramonium*), freed of its mid-rib, and laid over a painful wound or sore, is certainly delightfully soothing, if not indeed also curative. Another plant used in this connection is the green-podded *isiNama* (*Priva leptostachya*), of which the seeds are ground and spread on as a plaster. A leaf-paste of the shrub *Polygonum serrulatum* is also an efficient sore-healer.

For cancerous growths (*isiDla*), as ulcerative or gangrenous stomatitis, and popularly (though doubtfully) even for true cancer, the large *umHlontlo* *Euphorbia* (*E. grandidens*) holds a universal reputation throughout South Africa of being the one sovereign remedy. The so-called cancer bush (*Sutherlandia frutescens*) has likewise a reputation as a cancer cure, though I am not aware that its reputed properties in this respect are known to the natives here.

Thrush of infants (*amaLorula*) is cured by rubbing over the sore parts of the mouth the crushed leaves of the sorrel-like *isiThathe* or (X) *isiNungu* (*Oxalis semiloba*).

For itch (*uTwayi*), eczema (*umFula*, *unuNa*) and similar cutaneous diseases the common specific is a lotion made with hot or cold water, of the pounded bark and roots of the *uSolo* or Flat Crown (*Albizzia fastigiata*). The juice expressed from the leaves of the *iBhucu* (*Bulbine natalensis*) is also used.

### Ophthalmia.

Owing to the prevalence of scrofula, ophthalmia (*inTelo*) of the strumous form is common among the natives. It is regarded as the work of an *umThakathi*, and the skilful doctor claims to be able to extract from the organ the injurious bodies, which are declared to resemble small grains of Kafir-corn! This statement seems to be merely a childish

exaggeration of the granulations sometimes formed on the inner side of the eyelids after purulent ophthalmia.

For pustular ophthalmia generally, incisions are first of all made above and about the eyes; then a quantity of the leaves of the small red-berried *isiThumana* (*Solanum capense*), found about termite nests, is boiled, and the face, held over the steaming pot, treated to a vapour bath. The eyes are subsequently bathed in the decoction, and the juice of the berries may be rubbed into the incisions. There are several other uses of this plant which tend to indicate that it contains germicidal properties of some real value.

The large rough leaves of the *uLimilwenkomo* or (N) *uLimilwenyathi* (*Berkheya* sp.) are employed in a similar manner to the above.

Another germ-killing plant is the *umEmbhesa* shrub, whose roots are used as a lotion for sore eyes, as well as a powder for destroying head-lice.

The *isiHlosa* herb is another remedy for ophthalmia.

The inflammation or redness of the eyeball occurring in all forms of this disease, especially in the common catarrhal form, is relieved by an application of the pungent root of the *uSolo* (*Albizzia fastigiata*), an inch of which is pounded in a small quantity of cold water, and a drop or two of this latter poured into the eye from time to time. The leaves of the green-podded *isiNama* (*Priva leptostachya*), as also those of the *umThunduluka* or Natal plum (*Ximenia caffra*), are employed in the same way.

The peppery roots of the medicinal *isiDikili* (*Lasioisiphon* sp.), as well as the leaves of the *uMpondonde* aloe, are burned to ash, and a pinch of the latter inserted into the eye. Or the flowers of the *imPepho* herb are pounded, mixed with soot, and dropped into the eye before going to bed.

A universal household remedy is to apply in the same way a little of the pulverised backbone of the cuttle-fish, or even of the shell of the common snail—a simple remedy said to be really efficacious with both men and beasts.

Although the real sarsaparillas of South and Central

America are not found in S. Africa, a single species of the same genus is indigenous to the coastal bush of Natal and Zululand. This is the *inGqaqabulani* or (N) *iYali* or *uLimilwenyathi* (*Smilax kraussiana*). It is an entangling bush-climber with stems about a quarter of an inch in thickness, bearing tiny hooked thorns. It constitutes one of the minor eye remedies of the natives when afflicted with ophthalmia, though generally in conjunction with one or other of the plants already mentioned, a decoction being made, and the eyes held for a time over the steaming pot.

#### Earache.

Pain in the ear is relieved most usually by the thick mottled leaves of the dwarf *isiKholokocho* (*Sansevieria thyrsofolia*), which are warmed over the fire and a drop of the juice let flow into the ear. The roots of the *umFana-ka'sihlanjana* (*Stylochiton* sp.), boiled in a little urine, or the leaves of the *isiNama* (of the kind used to provide smoking-tubes) crushed and steeped in the same fluid are other cures for earache. The *umSintsi* (*Erythrina caffra*) leaves are also sometimes crushed, infused in hot water, and a drop of the liquid placed in the ear. The *umHlakuwa* is another common household remedy for this purpose.

#### Toothache.

Before the advent of the white man, dentistry was an unknown art among the Zulus. They were a people not yet attained to the inventive stage, and they turned instinctively to Nature for aid in all their needs.

Owing to the lack of suitable implements for extraction, the aim of the native doctor is to destroy the troubling tooth *in situ*. He claims to possess medicines which, when applied to a decaying tooth, cause it to drop out forthwith. This is merely an exaggerated statement of a property certain plants have, when inserted within the decayed cavity, of causing such teeth to break up, thus falling out piecewise. Such

plants commonly allay the pain at the same time by killing the nerve. Carbolic acid is a good example of this kind of drug with us.

The famous thorny *isiKhumukela* bush, growing in the bushveld, is one of the principal native medicines. The dried roots are ground into a powder and inserted into the cavity of the tooth, having the above-mentioned effect. The small reddish-berried *isiThumana* (*Solanum capense*) is said to possess the same powers and is prepared in the same way. The root-bark of the *umNungwane* (*Xanthoxylon capense*) is pungent and disinfectant. Applied as before it is said to relieve the pain very rapidly, and no doubt at the same time destroys the corroding bacilli.<sup>1</sup>

The powdered root of the *umKhovothi* (*Chaetachme meyeri*) and the leaf-paste of the *ubuHlungwana* (*Wedelia natalensis*) have the reputation of being equally efficient as dental anodynes.

Others poultice the painful tooth with a paste of the pounded roots of the *umHlakwa* or castor-oil plant, or chew the roots and leaves of the *isiSinini* herb, or the very bitter, milky roots of the *umThombho* climber (*Cissampelos torulosa*).

Not only can the native doctor speedily rid you of toothache, but he will tell you with equal conviction that, by imitating the peculiar cry of the *imBhulu* rock-monitor (*Veranus albigolaris*) you may as speedily induce it!

#### Extraction of Thorns.

The professions of the native doctors in regard to the extraction of thorns are no whit less marvellous than those in regard to the extraction of teeth. A few *uNyavothi* (? *Penicillaria spicata*) seeds are taken, one half thereof ground very finely and inserted into the wound, the other half sown whole in the

<sup>1</sup> It is curious that the kindred tree (*Xanthoxylon fraxineum*) should be used in America for identically the same purpose, and be there locally known as the Toothache-Tree. This fact testifies to the probable usefulness also of the Natal species.

soil. At the same moment as the sown seed sprouts through the earth the thorn will emerge from the flesh in which it is embedded!

Others insert a pinch of pulverised *inKomankoma* root (N. filix-mas) into the wound with an equally propitious result.

#### Wounds.

Quite 50 per cent. of Zulu men bear ugly scars (*iziGozi*) about the head or body as souvenirs of faction or other fights. Some of these, covering split or splintered bones, cause them periodical pain (*iziLalo*) throughout all their after-life. For wounds, when fresh, whether caused by assegai or stick, the native possesses nothing better than the *ubuHlungwana* herb (*Wedelia natalensis*). The leaves are bruised and steeped in a little cold water, a few drops of the extract are poured into the wound and the whole of the leaf-paste plastered over it and bound on like a poultice. The action of the herb is to prevent inflammation, with all its consequent pain and supuration, thus ensuring immediate healing. Another herb used under like circumstances is the *uGodide* (*Jatropha hirsuta*), the dried bulbous root being pulverised and sprinkled on the fresh wound.

#### Broken Limbs and Sprains.

Broken limbs are not so frequent with this bellicose people as are broken skulls, and yet they must necessarily occur at times, especially from falls. Considering the remarkable lack of inventive genius among the natives, it almost surprises us to find that they had already discovered the use of splints even before the white man's coming. True, it was only a rude contrivance, formed of a couple of split dog's bones, which were firmly bound on each side of the fractured limb and acted well enough. But their main reliance was on certain herbs, which were said to have the wonderful power of "making fractured bones unite." Chief amongst these we note the *uMathunga*

(*Cyrtanthus obliquus*). The dark-coloured portion of the root below the bulb was dried, pulverised, and rubbed into incisions made at the seat of breakage. Equally effective, and applied in the same way, is the herb *uNgweleni* (*Cluytia pulchella*). Others employ the root-bark of the coast-tree *umNqandane wempisi* or *inDodemnyama* (*Royena villosa*) along with the root of *uMathunga* as above; roast both on a pot-lid till dry, pulverise, and rub into incisions as before.

For simple sprains (notwithstanding that the natives frequently refer to these also as breakages or *ukwaphuka*) the *uNyanya* (*Rhamnus prinoides*) and the iridaceous *inDawo-lucwatha* are used as embrocations.

### Snake-bite.

The treatment of snake-bite must always hold an important place in the medicine of the aborigines of a snake-infested country like Zululand and Natal. It has been asserted by European experts over and over again that snake-poison, when taken into the system through the stomach, is harmless and inert, and yet, as far as I can discover, the homœopathic principle reigns supreme among all those races of mankind that have been born and reared amongst snakes, and the antidote is taken through the mouth. The orthodox antidote of the Zulu doctor, no less than of the Indian of Brazil, is the snake itself, and by preference the very snake that has bitten, or, if this be unprocurable, another of its species.

There are venomous snakes of several distinct kinds in South Africa, each with its own peculiar poison, and demanding its own peculiar treatment. There are the colubrine black (*Dendraspis angusticeps*) and the green *iMambha*; the vipers, *iBhululu*, or puff-adder (*Bitis arietans*) and the *uMaqandalingophi*—all lethal snakes; and the nias or so-called cobras, *imFezi* and *iPhimpi*, scarcely less poisonous.

A native snake-specialist would keep a regular supply of the dried bodies—the head, bile, liver, heart and lungs—of

all these, to be ground into powder and administered by the mouth on demand. It is seriously averred that some native doctors have so saturated their blood with these poisons by frequent small doses as to become at length absolutely immune to any kind of snake-bite.

No doubt these animal antidotes of the natives would be more effective if it were possible to inject them into the blood more directly than through the alimentary canal. The South American Indian is fully aware of this, and the Zulu doctor has already an inkling of the fact, and is even now, in his rude way, making a manifest effort (as we shall presently see) to find some readier access to the blood than through the mouth. Personally, I believe that the future will prove the native theory to be correct, that snake-poison is assimilable through the stomach, and can both cure from and immunise against the effects of bite, and that the secret of success lies only in the proper method of administration, chiefly as regards the timeliness of application and the quantities to be taken.

European experts have not yet advanced one inch on the Kafir in discovering any more certain antidote than the snake-poison itself. They supplement their serum (anti-venom), hypodermically injected, with chloride of gold or of lime, strychnine, ammonia and permanganate of potash; and the native doctor supplements his dried snake-head and bile with innumerable plant-remedies.

Smith, in his 'South African Materia Medica,' mentions the *iMunyane* (*Leonotis leonurus*) and the *umCwili* (*L. ovata*) as the most powerful remedies known in the Cape Colony. The knowledge, he says, was carried there by the Fingo refugees, and these, we know, came from Natal and Zululand. The Zulu doctors are well aware of the powers of these plants, and they even believe that, when sprinkled in decoction about a kraal, they will keep snakes away. But I have not heard that they are regarded by them as the best snake-bite antidotes. Indeed, I find the Zulus rarely like to rely on any single remedy; they are more accustomed to mix

together a large number of reputed cures, although naturally any single plant would be used if others were wanting.

The method of one Zulu doctor was to mix a quantity of the ground root of the *isiThumana* (*Solanum capense*) with another of pulverised snake, and give the sufferer to drink. Another compounded together the roots of the *isiThumana*, the roots or green fruit (excepting shell) of the *umHlala* (*Strychnos spinosa*), the roots of the *iMunyane* (*Leonotis leonurus*), and other plants, made therewith a hot infusion in about a quart of water, gave the major portion to drink as an emetic, then, taking himself a mouthful of the remainder, set about vigorously biting the patient (so as to draw blood) in all parts of the body, allowing, as he did so, the medicine in his mouth to enter the wound. This is the nearest approach the Zulu doctor has made to subcutaneous injection.

The fatal action of snake venom seems in some species, as with the mambas, to be that of a nerve poison, with consequent paralysis and the like; in others that of a blood poison, as probably with the puff-adders; in others, again, perhaps of both combined. Now, the *umHlala* tree is a *Strychnos*, and its roots or fruit therefore probably contain a certain percentage of that most powerful nerve-stimulant strychnia, which has been proclaimed by Dr. Müller as practically a cure for some, at any rate, of the worst Australian snakes. This is another example of how penetrating the observation and how correct the knowledge may be of these untutored savages in regard to the properties and uses of the numberless medicinal plants surrounding them.

The *isiThumana*, again, is known to be effective in cases of stricture and palsy of the bladder-muscles, so that as a counter-agent to the paralyzing action of snake poison it also has been quite rationally selected. What the exact working of the *iMunyane* may be is not so manifest; but inasmuch as it is capable of inducing intoxication and delirium, it also probably carries some property of a nervine character.

Among other plant remedies of high repute, and used as specifics for snake-bite, we may mention the *inKokhane*

climber, of whose leaves a handful are bruised in a hot infusion and drunk. The *umNungwane* (*Xanthoxylon capense*), being a reputed cure for paralysis, and further, well known as a disinfectant, may also be said to be reasonably used for snake-bite, for which a decoction of the root is employed. A small handful of the six-inch roots of the *umEmbesa* shrub may be pounded in a quart or so of hot water and drunk. The roots from four plants of the *isiDikili* (*Lasiosiphon* sp.) may be crushed and thoroughly boiled so as to leave a pint of liquid, which is drunk. Of the *umQaqongo* (*Clerodendron glabrum*) a quantity of the roots may be pounded, made into an infusion, and drunk—this remedy being especially indicated in cases of *mamba* bite.

The shrub *Cassia occidentalis*, as also the climber *Ipomœa ficifolia*, are other notable *iziHlungu* or snake-bite antidotes. Of the former a double handful of the leaves and stalks are pounded together with the pips of one green *umHlala* fruit (otherwise one foot length of the root), mixed in one cupful of cold water and drunk. Of the latter a similar quantity of the leaves may be taken and administered in the same way, a portion of the liquid being used also to bathe the wound. The *iPhombhane* runner and the roots of the *uMayime* (*Clivia miniata*) are likewise employed for this same purpose.

Most of these plants work as emetics, in which kind of treatment the natives somehow place great reliance.

#### Vermin-Killers.

There are a few good plants used as vermin-killers. Among those used for destroying lice on the head we have the pea-like *uQwengu* or (N) *iLozane* (*Tephrosia macropoda* and *diffusa*), and the shrubs *umEmbhesa* and *iNyathelo* or *uHlonyane* (*Vernonia woodii*). The modes of preparation are various, sometimes the roots being boiled and the head washed in the decoction, at others a paste is made of the

ground roots or pounded leaves and well rubbed into the hair.

For the destruction of maggots in cattle-sores the sovereign remedy is the *umKhiphampethu* (*Calpurnia lasiogyne*). The bulb of the *iLabatheka* (*Hypoxis latifolia*) is ground and placed in food for the destruction of all small vermin.

### Alcoholism.

So up-to-date have the Zulu doctors become that they actually have a cure for inebriates (vide my Zulu-English Dictionary under *isiDakwa*), as well as remedies for the shivering fits, *umQhuqho* or (N) *umZuzo*, and the alcoholism (*uValo*) following habitual inebriation. These shivering fits are a curious feature in native alcoholic poisoning. Some natives get them invariably, even after a "reasonable" indulgence, and none are safe from them if they go to habitual excess. The whole body trembles, the teeth chatter, and since the patient is invariably found huddling over a fire, we may assume that he experiences a sensation of intense cold. In a word, the symptoms so far are identical with those manifested in malarial fever. But beyond this shivering fit the attack rarely goes. I have never heard among the raw Zulus of a case of absolute delirium,<sup>1</sup> although they do at times get as far as a state of nervous collapse, showing itself in an abnormal timidity or restlessness. I should therefore suppose that this *umQhuqho* or *umZuzo* must be a mild variety of alcoholism peculiar to Kafir beer or Kafir corn poisoning, since among European inebriates we do not hear of such shivering.

### Hair-Restorer.

Certain African races regard hair-dyeing as a very necessary improvement of their physical beauty. Although the Zulu women have the habit of regularly colouring the hair with

<sup>1</sup> This does not refer to the *isiShimeyana* (treacle-mead) drinkers of Natal, among whom I have found several cases of delirium.

red ochre, they have not yet discovered an actual dye. But if they have not yet got as far as hair-dyes, they are already possessed of a hair-restorer. Several diseases cause a falling out of the hair of the head. To remedy this and render the hair strong and its growth vigorous, they use a wash made of the pounded leaves of the *uFukuzela* herb (*Ocimum obovatum*).

#### CONCLUSION.

I have now completed a list of some 240 Zulu medicinal plants, giving what the natives believe to be their properties and the manner in which they use them. This may be about as many as a good average native doctor will be acquainted with. But it is far from being all. There are perhaps another 240 named medicinal plants, of equal value, used in different parts of Zululand and Natal, but not included here; and there is certainly quite another 240 which, although possessing valuable curative qualities, have no distinguishing native names, being simply referred to by the generic terms, such as *iKhambhi* (medicinal herb), *isiPhungo* (cough-cure), *umHlabelo* (embrocation), *isiHlungu* (snake-antidote), and so on. It is probable that we should not be far wrong if we calculated the medicinal plants of Natal and Zululand, already known to the natives, as being somewhere about 700 in all.

So much, I think, will suffice for this, as I believe, the first published contribution to the Zulu materia medica. A good deal of investigation in this entertaining and, indeed, profitable subject remains still to be done, especially in regard to the botanical identification of the various remedial plants, the exact symptoms they are capable of relieving, and the proper doses in which they should be administered. But what I have written here—the result of long, extensive and difficult research—will at any rate point out the way to those desirous of prosecuting still further inquiries into the domain of South African medicine and medical plants; and will prove to us, moreover, that the native doctor, though still indeed groping in the darkness of profound ignorance, is nevertheless groping along quite in the right direction.

[The following lists have been compiled from Father Bryant's article, since they will summarize in a convenient form the results obtained. They will also clearly show the gaps in our knowledge of the botanical identification of the native drugs.

It is highly desirable that a competent chemist should undertake an investigation into the active principles of the more important drugs herein enumerated; and all possible assistance in the supply of material or information would be gladly rendered by the Natal Museum.—EDITOR.]

## TABLE OF ZULU MEDICINAL PLANTS ARRANGED IN BOTANICAL ORDER.

Order RANUNCULACÆ.				
Latin name.	Native name.	Portion used.	Use.	Page.
Ranunculus pinnatus <i>Poir.</i>	uXhaphozi	Leaves	Catarrh, etc.	34
Ditto	..	..	Urinary complaints	49
Ditto	..	..	Venereal diseases (syphilis)	51
Ranunculus sp.	isiShoshokazana	..	Catarrh, etc.	35
Order MENISPERMACEÆ.				
Cissampelos torulosa <i>E.M.</i>	umThombho	—	Venereal diseases	51
Ditto	..	Roots	Toothache	69
Ditto	..	Leaves	Scrofula	18
Order CRUCIFERÆÆ.				
Lepidium capense <i>Thb.</i>	uMathoyisa	Tuber	Catarrh, etc.	34
Order BIXINEÆ.				
Dovyalis rhamnoides <i>B. &amp; H.</i>	umNyezane	Roots and bark	Rheumatism	58
Trimeria alnifolia <i>Planch.</i>	iDiebelendlovu	Leaves	Stomach and intestinal complaints	23
Order PITTOSPOREÆ.				
Pittosporus viridiflorum <i>Sims</i>	umFusamvu	Bark	Febrile complaints	44

## Order POLYGALEÆ.

Latin name.	Native name.	Portion used.	Use.	Page.
<i>Polygala</i> sp.	iThethe	—	Scrofula	18
<i>Polygala oppositifolia</i> Linn.	„	Roots	„	17

## Order CAPPARIDEÆ.

<i>Capparis corymbifera</i> E.M.	iQwaningi	Roots	Chest complaints (pleurisy)	38
Ditto	„	„	Impotency and barrenness	53
Ditto	„	Bark of root	Scrofula	17
Ditto	„	Root	Chronic coughing	40
<i>Capparis guiezii</i> Sond.	uMabusana	—	Chest complaints (expectoration of blood)	41

## Order HYPERICINEÆ.

<i>Hypericum æthiopicum</i> Thunb.	uSukumbhili	—	Poisonous	12
Ditto	„	Roots	Urinary complaints (backache, etc.)	48

## Order MALVACEÆ.

<i>Hibiscus surattensis</i> Linn.	nCathucathu	Leaves and stalks	Urinary complaints	50
Ditto	„	Leaves	Venereal diseases, gonorrhœa, etc.	52

## Order TILIACEÆ.

<i>Grewia occidentalis</i> Linn.	iKlolo or iLalanyathi	—	Impotency and barrenness	56
<i>Triumfetta rhomboidea</i> Jacq.	iNothwane or inDola encane	Roots	„	56

## Order GERANAIACEÆ.

<i>Oxalis semiloba</i> Sond.	isiThathe or isiNungu	Leaves	Skin diseases (infantile thrush)	66
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## Order RUTACEÆ.

<i>Clausena inæqualis</i> Bth.	umNukambhaha	Roots	Tapeworm	22
Ditto	„	Leaves	Intestinal parasites— Ikhambi	20
<i>Zanthoxylum capense</i> Harv.	umNungwane	Bark of root	Scrofula	17
Ditto	„	Leaves	Intestinal parasites— Ikhambi	20

Latin name.	Native name.	Portion used.	Use.	Page.
<i>Zanthoxylum capense</i> <i>Harr.</i>	umNungwane	Leaves	Stomach and intestinal complaints	23
Ditto	„	Bark of root	Stomach complaints	25
Ditto	„	Root	Chest complaints (chronic coughing)	40
Ditto	„	—	Paralysis	61
Ditto	„	Leaves	Skin diseases (sores)	65
Ditto	„	Root-bark	Toothache	69
Ditto	„	Roots	Snake-bite	74
Order OCHNACEÆ.				
<i>Ochna atropurpurea</i> <i>D.C.</i>	umBomvane	Roots	Gangrenous rectitis	33
Order MELIACEÆ.				
<i>Ekebergia meyeri</i> <i>Presl.</i>	umNyamathi	Root	Indigestion and heartburn	24
Ditto	„	Leaves	Intestinal parasites— Ikhambi	20
<i>Ekebergia capensis</i> <i>D.C.</i> or <i>meyeri</i> <i>Presl.</i>	„	Root	Chest complaints (coughing)	41
<i>Trichilia emetica</i> <i>Vahl.</i>	umKhuhlu or iXolo	—	Very poisonous	13
Ditto	„	Bark	Stomach and intestinal complaints	28
<i>Turraea obtusifolia</i> <i>Hochst.</i>	umHlatholana	—	Very poisonous	13
Ditto	„	Bark and leaves	Stomach and intestinal complaints	23, 27
<i>Turraea floribunda</i> <i>Hochst.</i>	umVuma	Roots	Heart complaints	59
Order OLACINEÆ.				
<i>Apodytes dimidiata</i> <i>E.M.</i>	umDakane	Root-bark	Intestinal parasites— Ikhambi	20
<i>Pyrenacantha scandens</i> <i>Planch.</i>	umSekelo	Roots	Impotency and barrenness	56
<i>Ximenia caffra</i> <i>Sond.</i> (Natal plum)	umThunduluka	Leaves	Ophthalmia	67
Order CELASTRINEÆ.				
<i>Celastrus buxifolius</i> <i>Linn.</i>	inGowangane	Roots	Chest complaints (pleurisy)	38
<i>Celastrus</i> sp.	iHlinzanyoka	„	Chest complaints (chest pains)	40

Latin name.	Native name.	Portion used.	Use.	Page.
<i>Elæodendron velutinum</i> <i>Harv.</i>	iNqayi	Bark of roots	Dysentery and diarrhœa	30
<i>Pterocelastrus rostratus</i> <i>Walp.</i>	uSahlulamanye	Roots	Spinal disease	61
Order RHAMNEÆ.				
<i>Helinus ovata</i> <i>E.M.</i>	uBhubhubhu	Roots	Hysteria	64
<i>Rhamnus prinoides</i> <i>L'Herit.</i>	uNyenya	—	Sprains	71
<i>Zizyphus mucronata</i> <i>Willd.</i>	umPhafa	Bark	Chest complaints (coughing)	41
Order AMPELIDÆÆ.				
<i>Cissus cuneifolia</i> <i>E. and L.</i>	isiNvazi	Root	Impotency and barrenness	55, 56
Order SAPINDACÆÆ.				
<i>Bersama lucens</i> <i>Szys.</i>	isiNdiyandiya	—	Very poisonous	13
Ditto	„	Bark	Impotency and barrenness	55
<i>Cardiospermum helicacabum</i> <i>Linn.</i>	uZipho or iKhambhi leziduli	Leaves and stalks	Dysentery and diarrhœa	29
Ditto	„	Leaves	Catarrh, etc.	34
Ditto	„	„	Urinary complaints	49
Ditto	„	„	Venereal diseases (syphilis)	51
Ditto	„	„	Skin diseases (sores)	66
<i>Hippobromus alatus</i> <i>E. and L.</i>	uQhume	--	Very poisonous	13
Ditto	„	Roots	Catarrh, etc.	34
<i>Sapindus oblongifolius</i> <i>Sond.</i>	iGololenkawu	„	Dysentery and diarrhœa	30
Order ANACARDIACÆÆ.				
<i>Sclerocarya caffra</i> <i>Sond.</i>	umGanu	Bark	Gangrenous rectitis	32
Order LEGUMINOSÆ.				
<i>Albizzia fastigiata</i> <i>Oliv.</i>	uSolo	—	Very poisonous	13
Ditto	„	Bark and roots	Skin diseases (eczema)	66
Ditto	„	Root	Ophthalmia	67
<i>Argyrolobium marginatum</i> <i>Bohns.</i>	inTondo	Roots	Hiccough through stomach disorders	24
Ditto	„	Tubers	Stomach sickness	25

Latin name.	Native name.	Portion used.	Use.	Page.
<i>Abrus precatorius</i> <i>Linn.</i>	umKhokha	Leaves or roots	Chest complaints (pleurisy)	39
<i>Alysicarpus wallichii</i> <i>Wight and Arn.</i>	inKonazana	Roots	Febrile complaints	14
<i>Calpurnia lasyogyne</i> <i>E. M.</i>	umKhipham-pethu	—	Maggots in cattle sores	75
<i>Cassia occidentalis</i> <i>Linn.</i>	—	Leaves and stalks	Vermin-killer	75
<i>Crotalaria</i> sp.	uMayehlezana, or uSi	Roots	Chest complaints (chronic coughing)	41
<i>Elephantorrhiza burchelli</i> <i>Bth.</i>	inTolwane	Interior of roots	Dysentery and diarrhoea	29
Ditto	„	Roots	Febrile complaints	45
<i>Elephantorrhiza</i> sp.	umDabu	„	Heart complaints	59
<i>Erythrina caffra</i> <i>Thb.</i>	umSintsi	Leaves	Urinary complaints	49
Ditto	„	„	Venereal diseases (syphilis)	51
Ditto	„	„	Earache	68
<i>Eriosema cordatum</i> <i>E.M.</i>	uQontsi	Roots	Impotency and barrenness	53
<i>Indigofera</i> sp.	isiKhubabende	Root	Dysentery and diarrhoea	30
<i>Psoralea pinnata</i> <i>Linn.</i>	umHlonishwa	Roots	Hysteria	64
<i>Rhynchosia</i> sp.	uKhalimele	—	Catarrh, etc.	35
<i>Schotia brachypetala</i> <i>Sond.</i>	umGxamu or iHluze	Roots	Dysentery and diarrhoea	39
<i>Tephrosia kraussiana</i> <i>Meisn.</i>	inTsangwana	„	Chest complaints (chronic coughing)	40
<i>Tephrosia macropoda</i> <i>E.M.</i> and <i>diffusa</i> <i>E.M.</i>	uQuengu or iLozane	—	Very poisonous	12
Ditto	„	Root	Febrile complaints	46
Ditto	„	—	Skin diseases (sores)	65
Ditto	„	Roots and leaves	Vermin-killer	74
Order ROSACEÆ.				
<i>Rubus rigidus</i> <i>Smith</i>	iJingyolo	Root	Dysentery and diarrhoea	30
<i>Agrimonia euphatoria</i> <i>Linn.</i>	uMakhuthula	Leaves	Tape-worm	22
Order CRASSULACEÆ.				
<i>Crassula rubicunda</i> <i>E.M.</i>	isiKeleklane	—	Dysentery and diarrhoea	30

## Order HALORAGÆÆ.

Latin name.	Native name.	Portion used.	Use.	Page.
<i>Gunnera perpensa</i> <i>Linn.</i>	uGobo	Root	Urinary complaints	50
Ditto	„	—	Impotency and barrenness	56
Ditto	„	Root	Rheumatism	58

## Order MELASTOMACEÆ.

<i>Dissotis incana</i> <i>Naud.</i>	imFeyesele or imFeyenkala	Leaves	Dysentery and diarrhoea	30
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## Order PASSIFLOREÆ.

<i>Ophiocaulon</i> <i>gummifera Hk. f.</i>	imFulwa	—	Very poisonous	12
Ditto	„	Root	Febrile complaints	45

## Order CUCURBITACEÆ.

<i>Cucumis hirsutus</i> <i>Sond.</i>	uThangazana	—	Very poisonous	13
Ditto	„	Roots	Chest complaints (chronic coughing)	40
<i>Luffa spherica</i> <i>Sond.</i>	uSelwa	Leaves or roots	Stomach complaints	25
<i>Momordica</i> <i>involverata E.M.</i>	inTshungwana yehlathi	—	Stomach and intestinal complaints	25
<i>Momordica fetida</i> <i>Schum.</i>	inTshungu	—	Stomach and intestinal complaints	25

## Order FICOIDEÆ.

<i>Mesembryanthemum</i> sp.	iKhambhi lamabulawo	Leaves	Heart complaints	59
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## Order UMBELLIFERÆ.

<i>Heteromorpha</i> <i>arborescens</i> <i>Ch. and Sch.</i>	umBangandlala	Leaves	Scrofula	18
<i>Lichtensteinia</i> <i>interrupta E.M.</i>	inTlshane	Roots	Chest complaint (chronic coughing)	40

## Order ARALIACEÆ.

<i>Cussonia spicata</i> <i>Thb.</i>	umSenge	Roots	Febrile complaints	44
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## Order RUBIACEÆ.


<i>Oldenlandia</i> <i>decubens Hiern.</i>	uMampeshana	Roots	Chest complaints and heart disease	42, 59
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Latin name.	Native name.	Portion used.	Use.	Page.
<i>Petania</i> <i>variabilis</i> <i>Harr.</i>	iCimamlilo	Roots	Piles	31
Ditto	„	„	Gangrenous rectitis	33
Ditto	„	—	Rheumatism	58
<i>Plectronia</i> <i>ventosa</i> <i>L.</i>	umVuthwamini	Leaves	Stomach and intestinal complaints	23
Ditto	„	„	Dysentery and diarrhœa	29
<i>Rubia cordifolia</i> <i>Linn.</i>	imPindisa	Roots	Impotency and barrenness	53, 54
<i>Spermacoce</i> <i>natalensis</i> <i>Hochst.</i>	isiMuyisane	„	Gangrenous rectitis	33
Ditto	„	„	Febrile complaints	46
<i>Vangueria</i> <i>lasiantha</i> <i>Sond.</i>	uDuhmuthwa	Leaves	Dysentery and diarrhœa	30
Order COMPOSITEÆ.				
<i>Artemisia afra</i> <i>Jacq.</i> (wormwood)	umHlonyane	Leaves	Febrile complaints	45
<i>Aster asper</i> <i>Less.</i>	uDlutshana	Roots	Very poisonous	12
Ditto	„	„	Stomach complaints	23
Ditto	„	„	Chronic coughing	40
Ditto	„	„	Chest complaints	42
<i>Aster erigeroides</i> <i>Harc.</i>	isiThelelo	Leaves	Intestinal parasites	20, 23, 28
<i>Berkheya</i> sp.	uLimilwenkomo or uLimilwenyathi	Roots	Urinary complaints	49
Ditto	uShaqa	„	Rheumatism	58
Ditto	„	Leaves and roots	Skin diseases (sores)	65
Ditto	„	Leaves	Ophthalmia	67
<i>Bidens pilosa</i> <i>Linn.</i>	uQadolo	Leaves or roots	Stomach complaints	25
<i>Brachylæna</i> <i>discolor</i> <i>D.C.</i>	iPhahla	Leaves	Intestinal parasites	20
<i>Callilepis laureola</i> <i>D.C.</i>	imPila	—	Very poisonous	12
Ditto	„	—	Virulent poison	27
Ditto	„	Root	Tape-worm	22
<i>Conyza incisa</i> <i>Ait.</i>	uMachakazi	Leaves	Catarrh, etc.	34
<i>Ethulia conyzoides</i> <i>Linn.</i>	umSokosoko	—	Intestinal parasites	20
Ditto	„	—	Stomach complaints	25
<i>Gerbera kraussii</i> <i>Sch. Bip.</i>	uHlambhiloshane	Leaves	Tape-worm	22
Ditto	„	„	Stomach-ache	25

Latin name.	Native name.	Portion used.	Use.	Page.
<i>Mikania capensis</i> <i>D.C.</i>	umDlonzo	Leaves	Urinary complaints	49
Ditto	"	"	Venereal diseases	51
<i>Othonna natalensis</i> <i>Sch. Bip.</i>	iNcamu	—	Tape-worm	22
Ditto	"	Roots	Stomach and intestinal disorders (nausea)	24
<i>Osteospermum nervatum</i> <i>D.C.</i>	uMasigcolo	—	Stomach and intestinal complaints	24
Ditto	"	Roots	Febrile complaints	43
<i>Senecio speciosus</i> <i>Willd.</i>	iBohlolo	Leaves and stalks	Chest complaints	39
Ditto	"	"	Dropsy	60
? <i>Tripteris natalensis</i> <i>Harr.</i>	uMadintsana	Leaves	Febrile complaints	40
<i>Ursinia tenuiloba</i> <i>D.C.</i>	—	Roots	Coughs	40
<i>Vernonia woodii</i> <i>Hoffm.</i>	uHlonyane	—	Stomach disorders	25
Ditto	"	Leaves	Catarrh, etc.	34
Ditto	"	Roots	Chest complaints	38
Ditto	"	Leaves	Febrile complaints	44
Ditto	"	Roots or leaves	Vermin-killer	74
<i>Vernonia corymbosa</i> <i>Less.</i>	uHlungu-lungu	—	Impotency and barrenness	56
<i>Wedelia natalensis</i> <i>Sond.</i>	ubuHlungwana	—	Stomach and intestinal complaints	24
Ditto	"	Roots	Dysentery and diarrhœa	29
Ditto	"	Leaves	Febrile complaints	44
Ditto	"	"	Wounds	70
Order MYRSINÆÆ.				
<i>Embelia kraussi</i> <i>Harr.</i>	iBhini	Leaves or black berries	Tape-worm	22
<i>Mæsa</i> sp.	uMaguqu	Ripe berries (dried and ground)	Tape-, round-, and thread-worms	22
Order EBENACEÆÆ.				
<i>Euclea natalensis</i> <i>A.D. C.</i>	isiZimane or iDungamuzi	—	Poisonous	12
Ditto	"	Bark of root	Scrofula	17
Ditto	"	Bark	Intestinal complaints	23, 27
Ditto	"	Root	Chest complaints (pleurisy)	38

Latin name.	Native name.	Portion used.	Use.	Page.
<i>Euclea lanceolata</i> <i>E.M.</i> ♀	umShekishlane	Bark	Stomach and intestinal complaints	27
Ditto ♂	iDungamuzi	—	Dropsy	61
<i>Royena villosa</i> <i>Linn.</i>	umNqandane wezimpisi or inDodennyama	Root	Stomach and intestinal complaints	28
Ditto	„	Roots	Dropsy	61
Ditto	„	Root-bark	Broken limbs and sprains	71
<i>Royena lucida</i> <i>L.</i>	umTimatane or isiNywane	—	Impotency and barrenness	55

## Order ASCLEPIADACEÆ.

<i>Chlorocodon</i> <i>whiteii</i> <i>Hk. f.</i>	uMondi	Root	Indigestion	24
<i>Gomphocarpus</i> sp.	iNeohiba	—	Very poisonous	12
<i>Raphionacme</i> sp.	? uMathanjana	Roots	Scrofula	17
<i>Secamone gerrardi</i> <i>Harv.</i>	uGobandhlovu	„	Poisonous	13
Ditto	„	„	Spinal disease	61
<i>Stapelia gigantea</i> <i>N.E.B.</i>	uZililo 	Fleshy stalks	Hysteria	64

## Order APOCYNACEÆ.

<i>Rauwolfia natalensis</i> <i>Sond.</i>	umHlambham- anzi	Bark of root	Scrofula	17
Ditto	„	Bark	Febrile complaints	46

## Order LOGANIACEÆ.

<i>Strychnos henning- sii</i> <i>Gily.</i>	umQalothi	—	Tape-worm	22
Ditto	„	Bark	Stomach and intestinal complaints	24
Ditto	„	„	Rheumatism	58
<i>Strychnos spinosa</i> <i>Lam.</i>	umHlala	Roots or green fruit	Snake-bite	73

## Order CONVULVULACEÆ.

<i>Ipomea ficifolia</i> <i>Ldl.</i>	umKhokha wehlathi	Leaves	Intestinal complaints	26
Ditto	—	„	Snake-bite	74
<i>Ipomea purpurea</i> <i>Roth.</i>	iJalambhu or iJalamu	Root	Stomach and intestinal complaints	26
<i>Ipomea palmata</i> <i>Forsk.</i>	uMaholwana	Leaves	Febrile complaints (rash)	46

## Order SOLANACEÆ.

Latin name.	Native name.	Portion used.	Use.	Page.
<i>Datura stramonium</i> <i>Linn.</i>	iYoli	Leaf	Skin diseases (wounds and sores)	66
<i>Solanum capense</i> <i>L.F.</i>	isiThumana	Roots	Urinary complaints	49
Ditto	„	„	Veneral diseases (syphilis)	51
Ditto	„	Leaves	Ophthalmia	67
Ditto	„	—	Toothache	69
Ditto	„	Root	Snake-bite	73
<i>Solanum melongena</i> <i>Linn.</i>	umThuma	—	Veneral diseases (syphilis)	51
<i>Solanum sodomæum</i> <i>Linn.</i>	„	Root-bark	Impotency and barrenness	56
<i>Withania somnifera</i> <i>Don.</i>	ubuVimba	Roots	Gangrenous rectitis	33
Ditto	„	—	Veneral diseases (syphilis)	51
Ditto	„	Leaves	Skin diseases (wounds and sores)	65

## Order SCROPHULARIACEÆ.

<i>Bopusia scabra</i> <i>Presl.</i>	inKunzi or iBheja	Leaves	Stomach and intestinal complaints	23
Ditto	inKunzi, iBheja or uGweje	Roots	Gangrenous rectitis	33
Ditto	inKunzi or iBheja	Inner root- bark	Febrile complaints (enteric fever)	46
Ditto	„	Roots	Skin diseases, etc. (body sores)	65

## Order PEDALINEÆ.

<i>Ceratotheca triloba</i> <i>E.M.</i>	uDonqabathwa	—	Stomach and intestinal complaints	25
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## Order VERBENACEÆ.

<i>Clerodendron glabrum</i> <i>E.M.</i>	umQaqongo	Leaves	Intestinal parasites— Ikhambhi	20
Ditto	„	„	Tape-, round-, and thread- worms	22
Ditto	„	Roots	Dropsy	60
Ditto	„	„	Snake-bite	74
<i>Lippia asperifolia</i> <i>Rich.</i>	umSuzwane	Leaves	Gangrenous rectitis	34
Ditto	„	„	Febrile complaints (measles)	46
<i>Priva leptostachya</i> <i>Juss.</i>	isiNama	Seeds	Skin diseases (sores and wounds)	66
Ditto	„	Leaves	Ophthalmia	67

## Order LABIATE.

Latin name.	Native name.	Portion used.	Use.	Page.
<i>Leonotis leonurus</i> <i>Brown</i>	iMunyane	Leaves	Catarrh, etc.	34
Ditto	„	—	Snake-bite	72
Ditto	„	Roots	„	73
<i>Leonotis ovata</i> <i>Spreng</i>	umCwili	—	„	72
<i>Moschosma riparia</i> <i>Hochst.</i>	iBoza	Roots	Dropsy	60
Ditto	„	Leaves	Chest complaints (expectoration of blood)	41
Ditto	„	—	Stomach disorders	25
<i>Ocimum obovatum</i> <i>E.M.</i>	uFukuzela	Leaves	Hair-restorer	76

## Order AMARANTACEÆ.

<i>Achyranthes avicularis</i> <i>E.M.</i>	isiNama	—	Stomach and intestinal complaints (nausea)	24
Ditto	„	Roots	Febrile complaints	43
<i>Pupalia</i> sp.	isiNama esi-bomvu sehlathi	Flowers	Impotency and barrenness	55

## Order PHYTOLACCACEÆ.

<i>Phytolacca abyssinica</i> <i>Hoffm.</i>	uMahedeni	—	Febrile complaints	45
Ditto	uMahedeni or inGubivumile	Leaves	Poisonous; urinary diseases	12, 47

## Order POLYGONACEÆ.

<i>Emex spinosa</i> <i>Campd.</i>	inKunzama	—	Stomach and intestinal complaints	25
<i>Polygonum serrulatum</i> <i>Lag.</i>	—	Leaf	Skin diseases (sores)	66
<i>Rumex ecklonianus</i> <i>Meisn.</i>	iDololenkonyane	Roots	Tapeworm	22

## Order LAURINEÆ.

<i>Ocotea bullata</i> <i>E.M.</i> (stinkwood)	? uNukani	Bark	Urinary complaints	50
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## Order THYMELEACEÆ.

<i>Lasiosiphon</i> sp.	isiDikili	Roots	Febrile complaints (smallpox)	46
„	„	„	Ophthalmia	67
„	„	„	Snake-bite	74

## Order EUPHORBIACEÆ.

Latin name.	Native name.	Portion used.	Use.	Page.
<i>Acalypha peduncularis Meisn.</i>	uSununundu	Roots	Chest complaints; expectoration of blood	41
<i>Antidesma venosum E.M.</i>	isiBangamlotha	Leaves	Stomach and intestinal complaints	23
<i>Clytca pulchella Linn.</i>	uNgwaleni	..	Stomach-ache	25
Ditto	..	..	Dysentery and diarrhoea	30
Ditto	..	—	Broken limbs and sprains	71
<i>Croton gratissimum Burch.</i>	uMahlabekefeni	Bark	Very poisonous	13
Ditto	Ditto	..	Stomach and intestinal complaints	26
Ditto	Ditto	..	Chest complaints (pleurisy)	39
Ditto	Ditto	..	Uterine disorders	52
Ditto	Ditto	..	Dropsy	61
<i>Croton sylvaticum Hochst.</i>	umZilanyoni	..	Very poisonous	13
Ditto	..	..	Stomach and intestinal complaints	26
Ditto	..	..	Chest complaints (pleurisy)	39
Ditto	..	—	Dropsy	61
<i>Jatropha hirsuta Hoch.</i>	uGodide	Root	Wounds	70
<i>Ricinus communis Linn.</i>	umHlakuva	Roots	Toothache	69
<i>Synadenium arborescens Hk. f.</i>	umDlebe	—	Very poisonous	12
Ditto	..	Leaves	Catarrh, etc.	34

## Order URTICACEÆ.

<i>Chætachme méyeri Harv.</i>	umKhovothi	Root	Toothache	69
<i>Chætachme aristate Planch.</i>	..	Bark	Piles	31
<i>Urtica urens Linn.</i>	imBhabazane	—	Impotency and barrenness	53

## Order ORCHIDEE.

<i>Eulophia arenaria Bohn</i>	uNdwendweni or iMabeleyongosi	Bulbous roots	Impotency and barrenness	53
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## Order HÆMORACEÆ.

<i>Sansevieria thyrsofolia Thb.</i>	isiKholokotho	Leaves	Earache	68
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## Order IRIDEÆ.

Latin name.	Native name.	Portion used.	Use.	Page.
<i>Antholyza paniculata Klatt</i>	umLunge	Root	Dysentery and diarrhoea	30
<i>Gladiolus ludwigii Pappe</i>	isiDwa	„	Impotency and barrenness	54, 57

## Order AMARYLLIDÆÆ.

<i>Clivia miniata Regel</i>	uMayime	Root	Febrile complaints	45
Ditto	„	—	Impotency and barrenness	56
Ditto	„	Roots	Snake-bite	74
<i>Crinum (Natal Lily)</i>	umDuze	Bulb	Scrofula	17
Ditto	„	„	Urinary complaints	50
<i>Cyrtanthus obliquus Ait.</i>	uMathunga	„	„	17
Ditto	„	Root	Catarrh, etc.	35
Ditto	„	Bulb	Chest complaints (chronic coughing)	40
Ditto	„	Bulbous root	Scrofulous cough	42
Ditto	„	Root below bulb	Broken limbs and sprains	70
<i>Hypoxis sp.</i>	inKomfe	—	Very poisonous	12
Ditto	inKomfe enkula	Root	Intestinal parasites	20
<i>Hypoxis latifolia Hook</i>	iLabatheka	—	Very poisonous	12
Ditto	„	Bulbs	Heart complaints	59
Ditto	„	—	Impotency and barrenness	56
Ditto	„	—	Insanity	65
Ditto	„	Bulbs	Vermin-killer	75
<i>Hæmanthus natalensis Pappe</i>	iDumbhi-lika'-ntloyile	Root	Coughing	41
Ditto	„	„	Chest complaints	42

## Order DIOSORACEÆ.

<i>Dioscorea rupicola Kth.</i>	inKwa	—	Very poisonous	12
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## Order LILIACEÆ.

<i>Agapanthus umbellatus L'Herit</i>	uBani	Roots	Heart complaints	59
<i>Aloe ferox Miller</i> (Common Aloe)	umHlaba	Leaves	Venereal diseases (syphilis)	51
<i>Aloe sp.</i>	uMpondonde	Roots	Impotency and barrenness	56
Ditto	„	„	Ophthalmia	67

Latin name.	Native name.	Portion used.	Use.	Page.
<i>Asparagus</i> sp.	isiGobo	Leaves and roots	Chest complaints	39
<i>Bulbine natalensis</i> <i>Baker</i>	iBhneu	—	Urinary complaints	49
Ditto	„	Leaves	Skin diseases (eczema)	66
<i>Eucomis undulata</i> <i>Ait.</i>	uMakhanda ka'ntsele	—	Urinary diseases	47
<i>Gloriosa virescens</i> <i>Ldl.</i>	iHlamvu	Root	Impotency and barrenness	53
Ditto	iHlamvu comfana nentombhazana	Bulbs	„ „ „	57
<i>Scilla rigidifolia</i> <i>Kth.</i>	inGeolo, inGeino	—	Very poisonous	12
Ditto	Ditto	Bulb	Rheumatism	58
<i>Smilax kraussiana</i> <i>Meisn.</i>	inGqaqabulani, iYali, or uLimilwenyathi	—	Ophthalmia	68
Order PALMÆ.				
<i>Phoenix reclinata</i> <i>Jacq.</i>	iSundu	Roots	Chest complaints (pleurisy)	38
Order AROIDEÆ.				
<i>Stylochiton</i> sp.	umFana-ka'- sihlanjana	Roots	Earache	68
Order CYPEREÆ.				
<i>Cyperus</i> sp.	iBhuma	Root	Impotency and barrenness	53, 56
<i>Cyperus esculentus</i> <i>Linn.</i>	inDawo	„	Indigestion	24
Ditto	„	„	Impotency and barrenness	54
Order GRAMINEÆ.				
<i>Andropogon marginatus</i> <i>Steud.</i> (Tambootie grass)	isiQunga	Root	Intestinal parasites— Ikhambhi	20
<i>Eragrostis plana</i> <i>Nees</i>	umTshiki	Roots	Impotency and barrenness	54
<i>Imperata arundinacea</i> <i>Cyr.</i>	umThente	Root	Hiccough through stomach disorders	24

TABLE OF ZULU MEDICINAL PLANTS ARRANGED IN ALPHABETICAL ORDER.

Zulu name.	Botanical name.	Use.	Page.
umBanda	—	Dysentery and diarrhœa	30
umBangandlala	Heteromorpha arborescens <i>Ch. &amp; Sch.</i>	Serofula	18
uBangalala	—	Urinary complaints	50
Ditto	„	Impotency and barrenness	53
isiBangamlotha	Antidesma venosum <i>E.M.</i>	Stomach and intestinal complaints	23
uBani	Agapanthus umbellatus <i>L'Herit.</i>	Heart complaints	59
imBhabazane	Urtica urens <i>Linn.</i>	Impotency and barrenness	53
isiBhaha	—	Chest complaints (dry cough)	41
Ditto	„	Febrile complaints	46
Ditto	„	Urinary complaints	50
Ditto	„	Rheumatism	58
Ditto	„	Dropsy	61
iBhinini	Embolia kraussii <i>Harv.</i>	Tape-worm	22
Ditto	„	Catarrh, etc.	34
imBhozisa	—	„	34
iBhucu	Bulbine natalensis <i>Baker</i>	Urinary complaints	49
Ditto	„	Venereal diseases (gonorrhœa, etc.)	52
Ditto	„	Skin diseases (eczema)	66
iBhuma	Cyperus sp.	Impotency and barrenness	53, 56
uBhubhubhu	Helinus ovata <i>E.M.</i>	Hysteria	64
iBohlololo	Senecio speciosus <i>Willd.</i>	Chest complaints (pleurisy)	39
iBohlololo or	„	Dropsy	60
inZwabuhlungu			
umBomvane	Ochna atropurpurea <i>D.C.</i>	Gangrenous rectitis	33
iBoza	Moschosma riparia <i>Hoch.</i>	Stomach disorders	25
Ditto	„	Chest complaints (expectoration of blood)	41
Ditto	„	Dropsy	60
iBuba	—	Syphilis	51
uCathucathu	Hibiscus surattensis <i>Linn.</i>	Urinary complaints	50
Ditto	„	Venereal diseases (gonorrhœa, etc.)	52
iCimamlilo	Pentanisia variabilis <i>Harv.</i>	Piles	31
Ditto	„	Gangrenous rectitis	33
Ditto	„	Rheumatism	58
Ditto	„	Paralysis	62
umCwili	Leonotis ovata <i>Spreng.</i>	Snake-bite	72

Zulu name.	Botanical name.	Use.	Page.
umDabu	? <i>Elephantorhiza</i> sp.	Heart complaints	59
umDakane	<i>Apodytes dimidiata</i> <i>E.M.</i>	Intestinal parasites— Ikhambhi	20
inDawo	<i>Cyperus esculentus</i> <i>Linn.</i>	Indigestion	24
Ditto	„	Stomach-ache	25
Ditto	„	Impotency and barrenness	54
inDawolucwatha	—	Sprains	71
inDawoluthi emhlophe	<i>Belamcanda</i> sp.	Stomach and intestinal com- plaints	25
inDawoluthi emnyama	<i>Belamcanda punctata</i> <i>Moench.</i>	Hysteria	63
inDawoluthi isiDikili	—	Catarrh, etc. (headache)	35
Ditto	<i>Lasiosiphon</i> sp.	Febrile complaints (smallpox)	46
Ditto	„	Ophthalmia	67
Ditto	„	Snake-bite	74
umDlandblasi	—	Very poisonous	12
Ditto	„	Stomach and intestinal com- plaints	25
umDlavuza	„	Dysentery and diarrhœa	30
umDlebe	<i>Synadenium aborescens</i> <i>Hk. f.</i>	Very poisonous	12
Ditto	„	Catarrh, etc.	34
iDlebelendlovu	<i>Trimeria alnifolia</i> <i>Planch.</i>	Stomach and intestinal dis- orders	23
umDlonzo	<i>Mikania capensis</i> <i>D.C.</i>	Urinary complaints	49
Ditto	„	Venereal diseases (syphilis)	51
Ditto	„	Dropsy	61
inDlolothi	—	Very poisonous	12
uDhutshana	<i>Aster asper</i> <i>Less.</i>	„	12
Ditto	„	Stomach and intestinal com- plaints	23
Ditto	„	Catarrh, etc.	34
Ditto	„	Chest complaints (chronic coughing)	40
Ditto	„	Chest complaints (scrofulous coughs)	42
iDololenkonyane	<i>Rumex ecklonianus</i> <i>Meisn.</i>	Tape-worm	22
uDonqabathwa	<i>Ceratotheca triloba</i> <i>E.M.</i>	Stomach and intestinal com- plaints	25
uDulamuthwa	<i>Vangueria lasiantha</i> <i>Sond</i>	Dysentery and diarrhœa	30
iDumbhi	<i>Hæmanthus natalensis</i>	Chest complaints (coughing)	41
lika'ntloyile	<i>Pappe.</i>	„	„
Ditto	„	Chest complaints	42
iDungamuzi	Male of <i>Euclia lanceolata</i> <i>E.M.</i>	Stomach and intestinal com- plaints	27

Zulu name.	Botanical name.	Use.	Page
iDungamuzi	Male of <i>Euclea lanceolata</i> <i>E.M.</i>	Dropsy	61
iDungamuzi or isiZimane	<i>Euclea natalensis A.D.C.</i>	Very poisonous	12
Ditto	„	Stomach and intestinal complaints	23, 27
Ditto	„	Chest complaints (pleurisy)	38
umDuze	<i>Crinum</i> (Natal Lily)	Scrofula	17
Ditto	„	Urinary complaints	50
Ditto	„	Rheumatism	58
isiDwa	<i>Gladiolus ludwigii Papp.</i>	Impotency and barrenness	54, 57
umEmbhesa	—	Catarrh, etc. (headache)	35
Ditto	„	Ophthalmia	67
Ditto	„	Snake-bite	74
Ditto	„	Vermin-killer	74
umFana-ka' sihlanjana	<i>Stylochiton</i> sp.	Earache	68
imFeyesele or imFeyenkala	<i>Dissotis incana Naud.</i>	Dysentery and diarrhoea	30
uFukuzela	<i>Ocimum obovatum E.M.</i>	Hair-restorer	76
imFulwa	<i>Ophiocaulon gummifera Hk.f.</i>	Very poisonous	12
Ditto	„	Febrile complaints	45
umFusamvu	<i>Pittosporum viridiflorum</i> <i>Sims.</i>	„	44
imFuzane	—	Scrofula	18
Ditto	„	Stomach and intestinal complaints	27
Ditto	„	Urinary diseases	48
umGanu	<i>Sclerocarya cafra Sond.</i>	Gangrenous rectitis	32, 33
inGeolo or inGeino	<i>Seilla rigidifolia Kth.</i>	Very poisonous	12
Ditto	„	Rheumatism	58
Ditto	„	Insanity	65
uGeusulu	—	Syphilis	51
uGobandlovu	<i>Secamone gerrardi Harv.</i>	Very poisonous	13
Ditto	„	Spinal diseases	61
isiGobo	<i>Asparagus</i> sp.	Chest complaints (pleurisy)	39
uGobo	<i>Gunnera perpensa Linn.</i>	Urinary complaints	50
uGobo or uKlenya	„	Impotency and barrenness	56
Ditto	„	Rheumatism	58

Zulu name.	Botanical name.	Use.	Page.
uGodide	<i>Jatropha hirsuta Hoch.</i>	Wounds	70
iGololenkawu	<i>Sapindus oblongifolius Sond.</i>	Dysentery and diarrhoea	30
inGqaqabulani, iYali, or	<i>Smilax kraussiana Meisn.</i>	Ophthalmia	68
uLimilwenyathi			
inGqwangane	<i>Celastrus buxifolius Linn.</i>	Chest complaints (pleurisy)	38
inGuduza	—	Stomach and intestinal complaints	28
umGugudo	„	„	25
umGunya	„	Rheumatism, heart com- plaints, dropsy, etc.	58
umGxamu or iHluze	<i>Schotia brachypetala Sond.</i>	Dysentery and diarrhoea	30
umHlaba	<i>Aloe ferox Miller</i>	Venereal diseases (syphilis)	51
uHlakahla	—	Impotency and barrenness	56
umHlakuva	<i>Ricinus communis Linn.</i>	Earache	68
Ditto	„	Toothache	69
umHlala	<i>Strychnos spinosa Lam.</i>	Snake-bite	73
umHlambha- manzi	<i>Rauwolfia natalensis Sond.</i>	Scrofula	17
Ditto	„	Febrile complaints (measles, etc.)	46
uHlambhishlo- shane	<i>Gerbera kraussii Sch. Bip.</i>	Tape-worm	22
Ditto	„	Stomach-ache	25
iHlamvu	<i>Gloriosa virescens Ldl.</i>	Impotency and barrenness	53, 55
iHlamvu	„	„	57
lomfana			
nentombhazana			
umHlatholana	<i>Turraea obtusifolia Hochst.</i>	Very poisonous	13
Ditto	„	Stomach and intestinal complaints	23, 27
Ditto	„	Dysentery and diarrhoea	29
isiIllazi	—	Febrile complaints (malarial fever)	46
iHlinzanyoka	? <i>Celastrus sp.</i>	Chest complaints (chest pains)	40
umHlonishwa	<i>Psoralea pinnata Linn.</i>	Hysteria	64
umHlonyane	<i>Artemisia afra Jacq.</i>	Febrile complaints	45
uHlonyane or iNyathelo	<i>Vernonia woodii Hoffm.</i>	Stomach disorders	25
Ditto	„	Catarrh, etc.	34
Ditto	„	Febrile complaints	44
isiHlosa	—	Ophthalmia	67

Zulu name.	Botanical name.	Use.	Page.
iHlule	—	Dysentery and diarrhoea	30
iHlulelemambha	„	Very poisonous	13
Ditto	„	Stomach and intestinal complaints	28
uHlunguhlungu	<i>Vernonia corymbosa Less.</i>	Chest complaints (pleurisy)	38
Ditto	„	Impotency and barrenness	56
ubuHlungwana	<i>Wedelia natalensis Sond.</i>	Stomach and intestinal complaints (nausea)	24
Ditto	„	Dysentery and diarrhoea	29
Ditto	„	Febrile complaints	44
Ditto	„	Toothache	69
Ditto	„	Wounds	70
umHlwazi	—	Indigestion	24
umHlwazi-mambha	„	Impotency and barrenness	53
iJalambhu or iJalamu	<i>Ipomœa purpurea Roth.</i>	Stomach and intestinal complaints	26
Ditto	„	Febrile complaints	44
uJiba	—	Dysentery and diarrhoea	30
iJingijolo	<i>Rubus rigidus Smith</i>	„	30
inJobo	—	Round Worms—Ascarids	21
umJuluka	„	Uterine disorders	52
isiKelekehlane	<i>Crassula rubicunda E.M.</i>	Dysentery and diarrhoea	30
uKhalimele	<i>Rhynchosia sp.</i>	Catarrh, etc. (headache)	35
iKhambhi lamabulawo	<i>Mesembryanthemum sp.</i>	Heart complaints	59
uKhathwa	—	Hysteria	63
umKhiphampethu	<i>Calpurnia lasiogyne E.M.</i>	Vermin-killer (maggots in cattle-sores)	75
umKhokha	<i>Abrus precatorius Linn.</i>	Chest complaints (pleurisy)	39
umKhokha wehlathi	<i>Ipomœa ficifolia Ldl.</i>	Stomach and intestinal complaints	26
isiKholokotho	<i>Sansevieria thyrsofolia Thb.</i>	Earache	68
umKhovothi	<i>Chatachme aristata Planch.</i>	Piles	31
Ditto	„	Toothache	69
isiKhubabende	<i>Indigofera sp.</i>	Dysentery and diarrhoea	30
umKhuhlu	<i>Trichilia emetica Vahl.</i>	Very poisonous	13
isiKhumukela	—	Toothache	69
isiKhwa or umWelela	„	Dysentery and diarrhoea	30
Ditto	„	Piles	31
umKhwangu	„	Catarrh, etc.	35

Zulu name.	Botanical name.	Use.	Page.
umKhwangu	—	Intestinal parasites—	20
was'entabeni		Ikhambhi	
iKlolo or	<i>Grewia occidentalis</i> <i>Lin.</i>	Impotency and barrenness	56
iLalanyathi			
inKokhane	—	Febrile complaints (measles and rashes)	46
Ditto	„	Snake-bite	73
inKomankoma	<i>N. filix-mas</i> <i>Rich.</i> or <i>Lastrea inaequale</i> <i>Hk.</i>	Extraction of thorns	70
inKomfe	<i>Hypoxis</i> sp.	Very poisonous	12
inKomfe enkula	„	Intestinal parasites —	20
		Ikhambhi	
inKominophondo	—	Catarrh, etc.	35
inKonazana	<i>Alysicarpus wallichii</i> <i>Wight</i> & <i>Arn.</i>	Febrile complaints	44
inKunzana	<i>Emex spinosa</i> <i>Campd.</i>	Stomach and intestinal complaints	25
inKunzi or	<i>Bopusia scabra</i> <i>Presl.</i>	„	23
iBheja			
Ditto	„	Febrile complaints (enteric fever, smallpox)	46
Ditto	„	Skin diseases, etc. (body sores)	65
inKunzi or	„	Gangrenous rectitis	33
uGweje			
inKuzwa	—	Intestinal parasites—	20
		Ikhambhi	
inKwa	<i>Dioseorea rupicola</i> <i>Kth.</i>	Very poisonous	12
iLabatheka	<i>Hypoxis latifolia</i> <i>Hook</i>	„	12
Ditto	„	Impotency and barrenness	56
Ditto	„	Heart complaints	59
Ditto	„	Insanity	65
Ditto	„	Vermin-killer	75
umLahleni	—	Urinary complaints	50
uLethi	„	Catarrh, etc. (headache)	35
ubuLibazi	„	Catarrh, etc.	35
uLimilwenkomo or	<i>Berkheya</i> sp.	Urinary complaints	49
uLimilwenyathi			
Ditto	„	Ophthalmia	67
umLomomnandi	—	Febrile complaints	45
uLovwane	„	Very poisonous	12
umLulama	<i>Turraea heterophylla</i> <i>Sm.</i>	Rheumatism	58
umLunge	<i>Antholyza paniculata</i> <i>Klatt.</i>	Dysentery and diarrhoea	30
uMabilwana	—	Stomach and intestinal complaints	28

Zulu name.	Botanical name.	Use.	Page.
uMabusana	<i>Capparis gueinzii Sond.</i>	Chest complaints (chronic coughing)	40
Ditto	„	Chest complaints (expectoration of blood)	41
uMachakazi	<i>Conyza incisa Ait.</i>	Catarrh, etc.	34
uMadintsana	? <i>Tripteris natalensis Harv.</i>	Febrile complaints	44
uMadlozana	—	Chest complaints (chronic coughing)	40
uMafumbhuka	„	Dysentery and diarrhœa	30
Ditto	„	Spinal diseases	61
uMaguqu	<i>Mæsa</i> sp	Tape, round and thread worms	22
uMagwanyana	—	Rheumatism	58
uMahedeni	<i>Phytolacca abyssinica Hoffm.</i>	Very poisonous	12
Ditto	„	Febrile complaints	45
uMahedeni or inGubivumile	„	Urinary diseases	47
uMahlabathi	—	Tape-worm	22
uMahlabekufeni	<i>Croton gratissimum Burch.</i>	Very poisonous	13
Ditto	„	Stomach and intestinal complaints	26
Ditto	„	Chest complaints (pleurisy)	39
Ditto	„	Urinary complaints	50
Ditto	<i>Croton gratissimum Burch.</i> and <i>C. sylvaticum Hochst.</i>	Uterine disorders	52
Ditto	<i>Croton gratissimum Burch.</i>	Dropsy	61
uMahlokoloza	—	Urinary complaints (backache, etc.)	48
Ditto	„	Impotency and barrenness	53
Ditto	„	Dropsy	61
uMaholwana	<i>Ipomea palmata Forsk.</i>	Febrile complaints (rashes)	46
uMakhandaka'ntsele	<i>Eucomis undulata Ait.</i>	Urinary diseases	47
uMakhuthula	<i>Agrimonia eupatoria Linn.</i>	Tape-worm	22
uMahuleka	—	Catarrh, etc.	35
uMalusi	„	Stomach and intestinal complaints	28
uMampeshana	<i>Oldenlandia decumbens, Hiern.</i>	Chest complaints and heart diseases	42,59
uMankenketha	—	Stomach and intestinal complaints	28
uMaphipha	„	Dysentery and diarrhœa	29
uMasigcolo	<i>Osteospermum nervatum D.C.</i>	Stomach and intestinal complaints (nausea)	24
uMasigcolo or inKuphulana	„	Febrile complaints	43

Zulu name.	Botanical name.	Use.	Page.
uMathanjana	? Raphionacme sp.	Scrofula	17, 18
uMathoyisa	<i>Lepidium capense Thb.</i>	Catarrh, etc.	34
uMathunga	<i>Cyrtanthus obliquus Ait.</i>	Scrofula	17, 18
Ditto	„	Catarrh, etc.	35
Ditto	„	Chest complaints (chronic coughing)	40
Ditto	„	Chest complaints (scrofulous coughs)	42
Ditto	„	Broken limbs and sprains	70
uMayehlezana or uSi	<i>Crotalaria</i> sp.	Chest complaints (chronic coughing)	41
uMayime	<i>Clivia miniata Regel.</i>	Febrile complaints	45
Ditto	„	Impotency and barrenness	56
Ditto	„	Snake-bite	74
umMbhezi	—	Stomach and intestinal complaints	25
Ditto	„	Hysteria	63
uMondi	<i>Chlorocodon whitei Hk.f.</i>	Indigestion	24
uMoyawovungu	—	Heart complaints	59
uMpondonde	„	Impotency and barrenness	56
Ditto	„	Ophthalmia	67
iMunyane	<i>Leonotis leonurus Brown</i>	Catarrh, etc.	34
Ditto	„	Snake-bite	72, 73
isaMuyisane	<i>Spermacoce natalensis Hochst.</i>	Gangrenous rectitis	33
Ditto	„	Febrile complaints (measles, etc.)	46
isiNama	<i>Achyranthes avicularis E.M.</i>	Stomach and intestinal complaints (nausea)	24
Ditto	„	Febrile complaints	43
Ditto	<i>Priva leptostachya Juss.</i>	Skin diseases (wounds and sores)	66
Ditto	„	Ophthalmia	67
Ditto	„	Earache	68
isiNama esibomvu sehlathi	<i>Pupalia</i> sp.	Impotency and barrenness	55
iNcamu	<i>Othonna natalensis Sch. Bip.</i>	Tape-worm	22
Ditto	„	Stomach and intestinal disorders (nausea)	24
iNcohiba	<i>Gomphocarpus</i> sp.	Very poisonous	12
isiNdiyandiya	<i>Bersama lucens Szyz.</i>	„	13
Ditto	„	Impotency and barrenness	55
uNdwendweni or iMabelejongosi	<i>Eulophia arenaria Bolus</i>	„	53
uNgazi	—	Dysentery and diarrhœa	29

Zulu name.	Botanical name.	Use.	Page.
uNgazi	—	Spinal diseases	61
uNgibonisele	„	Impotency and barrenness	53, 56
uNgwaleni	<i>Cluytia pulchella Linn.</i>	Stomach-ache	25
Ditto	„	Dysentery and diarrhœa	30
Ditto	„	Broken limbs and sprains	71
amaNgwe	—	Very poisonous	12
Ditto	„	Intercostal neuralgia	60
uNjalwana	„	Venereal diseases (syphilis)	51
uNjalwana or iKhambh̄i lesi- patsholo	„	Impotency and barrenness	53
iNkomankoma	<i>Nephradium filix-mas Rich.</i> ( <i>Lastrea inæquale Hk.</i> ), <i>Nephradium</i> or <i>Lastrea</i> <i>athamanticum Hk.</i>	Tape-worm	22
umNono	—	Stomach and intestinal com- plaints	25
iNothwane or inDola encane	<i>Triumfetta rhomboidea Jacq.</i>	Impotency and barrenness	56
umNqandane wezimpisi or inDodemnyama	<i>Royena villosa Linn.</i>	Stomach and intestinal com- plaints	28
Ditto	„	Dropsy	61
Ditto	„	Broken limbs and sprains	71
iNqayi	<i>Elæodendron volutinum Harv.</i>	Dysentery and diarrhœa	30
uNtlangothi	—	Very poisonous	12
Ditto	„	Paralysis	61
uNtliziyonkulu or umuWane	„	Heart complaints	59
umNukambhiba	<i>Clausena inæqualis Bth.</i>	Intestinal parasites – Ikhambhi	20
Ditto	„	Tape-worm	22
uNukani	? <i>Ocotea bullata E. Mey.</i>	Urinary complaints	50
Ditto	„	Uterine disorders	52
uNungwane	<i>Zanthoxylum capense Harv.</i>	Scrofula	17
Ditto	„	Intestinal parasites— Ikhambhi	20
Ditto	„	Stomach and intestinal complaints	23, 25
Ditto	„	Chest complaints (chronic coughing)	40
Ditto	„	Paralysis	61
Ditto	„	Skin diseases, etc. (sores)	65
Ditto	„	Toothache	69
Ditto	„	Snake-bite	74

Zulu name.	Botanical name.	Use.	Page.
isiNwazi	<i>Cissus euneifolia E. &amp; Z.</i>	Impotency and barrenness	55, 56
umNyamathi	<i>Ekebergia meyeri Presl.</i>	Intestinal parasites— Ikhambhi	20
Ditto	„	Indigestion (heartburn)	24
Ditto	<i>Ekebergia capensis D.C.</i> or <i>meyeri Presl.</i>	Chest complaints (coughing)	41
iNyathelo or uHlonyane	<i>Vernonia woodii Hoffm.</i>	Vermin-killer	74
uNyawothi	? <i>Penicillaria spicata Willd.</i>	Extraction of thorns	69
uNyenya	<i>Rhamnus prinoides L'Herit.</i>	Sprains	71
umNyezane	<i>Dovyalis rhamnoides B. &amp; H.</i>	Rheumatism	58
isiPatshola	—	Syphilis	51
imPepho	„	Ophthalmia	67
umPhafa	<i>Zizyphus mucronata Willd.</i>	Chest complaints (coughing)	41
iPhahla	<i>Brachylæna discolor D.C.</i>	Intestinal parasites— Ikhambhi	20
uPhico	—	Catarrh, etc. (headache)	35
iPhombhane	„	Snake-bite	74
amaPhofu	„	Hysteria	63
umPhuphutho	„	Gangrenous rectitis	33
imPila	<i>Callilepis laureola D.C.</i>	Very poisonous	12
Ditto	„	Tape-worm	22
Ditto	„	Stomach and intestinal com- plaints	27
imPindisa	<i>Rubia cordifolia Linn.</i>	Impotency and barrenness	53, 54
imPisikayihlan- gulwa	—	Urinary diseases	47
uQadolo	<i>Bidens pilosa Linn.</i>	Stomach complaints	25
umQalothi	<i>Strychnos henningsii Gilg.</i>	Tape-worm	22
Ditto	„	Stomach and intestinal com- plaints (nausea)	24
Ditto	„	Rheumatism	58
umQaqongo	<i>Clerodendron glabrum E.M.</i>	Intestinal parasites— Ikhambhi	20
Ditto	„	Tape, round, and thread-worms	22
Ditto	„	Dropsy	60
Ditto	„	Snake-bite	74
amaQate or uBhusha	—	Impotency and barrenness	53
uQhume	<i>Hippobromus alatus E. &amp; Z.</i>	Very poisonous	13
Ditto	„	Catarrh, etc.	34
uQontsi	<i>Eriosema cordatum E.M.</i> and <i>E. salignum E.M.</i>	Impotency and barrenness	53

Zulu name.	Botanical name.	Use.	Page.
isiQunga	<i>Andropogon marginatus Steud.</i>	Intestinal parasites — Ikhabmbhi	20
iQwaningi	<i>Capparis corymbifera E.M.</i>	Scrofula	17
Ditto	"	Chest complaints (pleurisy)	38
Ditto	"	Chest complaints (chronic coughing)	40
Ditto	"	Impotency and barrenness	53
uQwengu or iLozane	<i>Tephrosia macropoda E.M.</i> <i>T. diffusa E.M.</i>	Very poisonous	12
Ditto	"	Febrile complaints	46
Ditto	"	Skin diseases, etc. (sores)	65
Ditto	"	Vermin-killer	74
uSahlulamanye	? <i>Pterocelastrus rostratus Walp.</i>	Spinal diseases	61
isiSefo	—	Dysentery and diarrhœa	30
umSekelo	<i>Pyrenacantha scandens Planch.</i>	Impotency and barrenness	56
uSelwa	<i>Luffa spherica Sond.</i>	Stomach complaints	25
umSenge	<i>Cussonia spicata Thb.</i>	Febrile complaints	44
uShaqa	<i>Berkheya sp.</i>	Rheumatism	58
uShaqa or uShwawu	"	Skin diseases	65
umShekishane	Female of <i>Euclea lanceolata E.M.</i>	Stomach and intestinal complaints	27
isiShoshokazana	<i>Ranunculus sp.</i>	Catarrh, etc.	35
isiSinini	—	Toothache	69
umSintsi	<i>Erythrina caffra Thb.</i>	Urinary complaints	49
Ditto	"	Veneral diseases (syphilis)	51
Ditto	"	Dropsy	61
Ditto	"	Earache	68
umSokosoko	<i>Ethulia conyzoides Linn.</i>	Intestinal parasites— Ikhabmbhi	20
Ditto	"	Stomach and intestinal complaints	25
uSolo	<i>Albizzia fastigiata Oliv.</i>	Very poisonous	13
Ditto	"	Skin diseases (eczema)	66
Ditto	"	Ophthalmia	67
umSongi	—	Stiff-neck	58
uSukumbhili	<i>Hypericum æthiopicum Thunb.</i>	Very poisonous	12
Ditto	"	Urinary complaints (backache, etc.)	48
iSundu	<i>Phoenix reclinata Jacq.</i>	Chest complaints (pleurisy)	38
uSunnunundu	<i>Acalypha peduncularis Meisn.</i>	Chest complaints (expectoration of blood)	41

Zulu name.	Botanical name.	Use.	Page.
umSuzwane	<i>Lippia asperifolia Rich.</i>	Gangrenous rectitis	34
Ditto	„	Febrile complaints (measles, etc.)	46
uThangazana	<i>Cucumis hirsutus Sond.</i>	Very poisonous	13
Ditto	„	Chest complaints (chronic coughing)	40
isiThathe or isiNungu	<i>Oxalis semiloba Sond.</i>	Skin diseases (infantile thrush)	66
isiThelelo	<i>Aster erigeroides Harr.</i>	Intestinal parasites— Ikhaumbhi	20
Ditto	„	Stomach and intestinal complaints	23, 28
umThente	<i>Imperata arundinacea Cyr.</i>	Hiccough through stomach disorders	24
iThethe	<i>Polygala oppositifolia Linn.</i>	Scrofula	17, 18
umThombho	<i>Cissampelos torulosa E.M.</i>	„	18
Ditto	„	Venereal diseases (syphilis)	51
Ditto	„	Toothache	69
iThondo	—	Scrofula	18
umThuma	? <i>Solanum melongena Linn.</i>	Venereal diseases (syphilis)	51
Ditto	<i>Solanum sodomœum Linn.</i>	Impotency and barrenness	56
isiThumana	<i>Solanum capense L.f.</i>	Urinary complaints	49, 50
Ditto	„	Venereal diseases (gonorrhœa, etc.)	52
Ditto	„	Ophthalmia	67
Ditto	„	Toothache	69
Ditto	„	Snake-bite	73
umThunduluka	<i>Ximenia caffra Sond.</i>	Ophthalmia	67
umTimatane or isiNywane	<i>Royena lucida L.</i>	Impotency and barrenness	55
inTlashane	<i>Lichtensteinia interrupta E.M.</i>	Chest complaints (chronic coughing)	40
inTolwane	<i>Elephantorrhiza burchellii Bth.</i>	Dysentery and diarrhœa	29
Ditto	„	Febrile complaints	45
inTondo	<i>Argyrolobium marginatum Bolus.</i>	Hiccough through stomach disorders	24
Ditto	„	Stomach sickness	25
inTsangu	<i>Cannabis sativa Linn.</i> Wild hemp	Chest complaints (dry cough)	41
inTsangwana	<i>Tephrosia kraussiana Meisn.</i>	Chest complaints (chronic coughing)	40
umTshiki	<i>Eragrostis plana Nees</i>	Impotency and barrenness	54
inTshungu	<i>Momordica foetida Schum.</i>	Stomach and intestinal complaints	25

Zulu name.	Botanical name.	Use.	Page.
inTshungwana yehlathi inTsulwa	Momordica involucreta <i>E.M.</i> —	Stomach and intestinal com- plaints Dysentery and diarrhoea	25 29
ubuVimbha Ditto Ditto umVuma umVuthwamini Ditto	Withania somnifera <i>Don.</i> " " Turraea floribunda <i>Hochst.</i> Plectronia ventosa <i>L.</i> "	Gangrenous rectitis Venereal diseases (syphilis) Skin diseases (sores) Heart complaints Stomach and intestinal com- plaints Dysentery and diarrhoea	33 51 65 59 23 29
uXhaphozi Ditto Ditto Ditto iXolo or umKhuhlu Ditto	Ranunculus pinnatus <i>Poir.</i> " " " Trichilia emetica <i>Vahl.</i> " "	Catarrh, etc. Urinary complaints Venereal diseases (syphilis) Dropsy Stomach and intestinal complaints Kidney disease	34 49 51 61 23, 28 48
iYoli	Datura stramonium <i>Linn.</i>	Skin diseases (wounds and sores)	66
umZilanyoni umZilanyoni or uMahlabekufeni umZilanyoni umZilanyoni or uMinya umZilanyoni uZililo isiZimane or iDungamuzi Ditto uZipho or iKhambhi leziduli Ditto Ditto Ditto Ditto Ditto Ditto	Croton sylvaticum <i>Hochst.</i> " " " " " Stapelia gigantea <i>N.E.B.</i> Euclea natalensis <i>A.D.C.</i> " " " " " " " " " "	Very poisonous Stomach and intestinal com- plaints Chest complaints (pleurisy) Intercostal neuralgia, rheu- matism Dropsy Hysteria Scrofula Dysentery and diarrhoea " Catarrh, etc. Urinary complaints Venereal diseases (syphilis) Venereal diseases (gonorrhoea, etc.) Dropsy Skin diseases (sores)	13 26 39 60 61 64 17, 18 28 29 34 49 51 51 61 66



On *Lafœa dispolians* sp. n., a Hydroid parasitic  
on *Sertularia bidens* Bale.

By

**Ernest Warren, D.Sc.Lond.**

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With Plate I and 2 Text-figs.

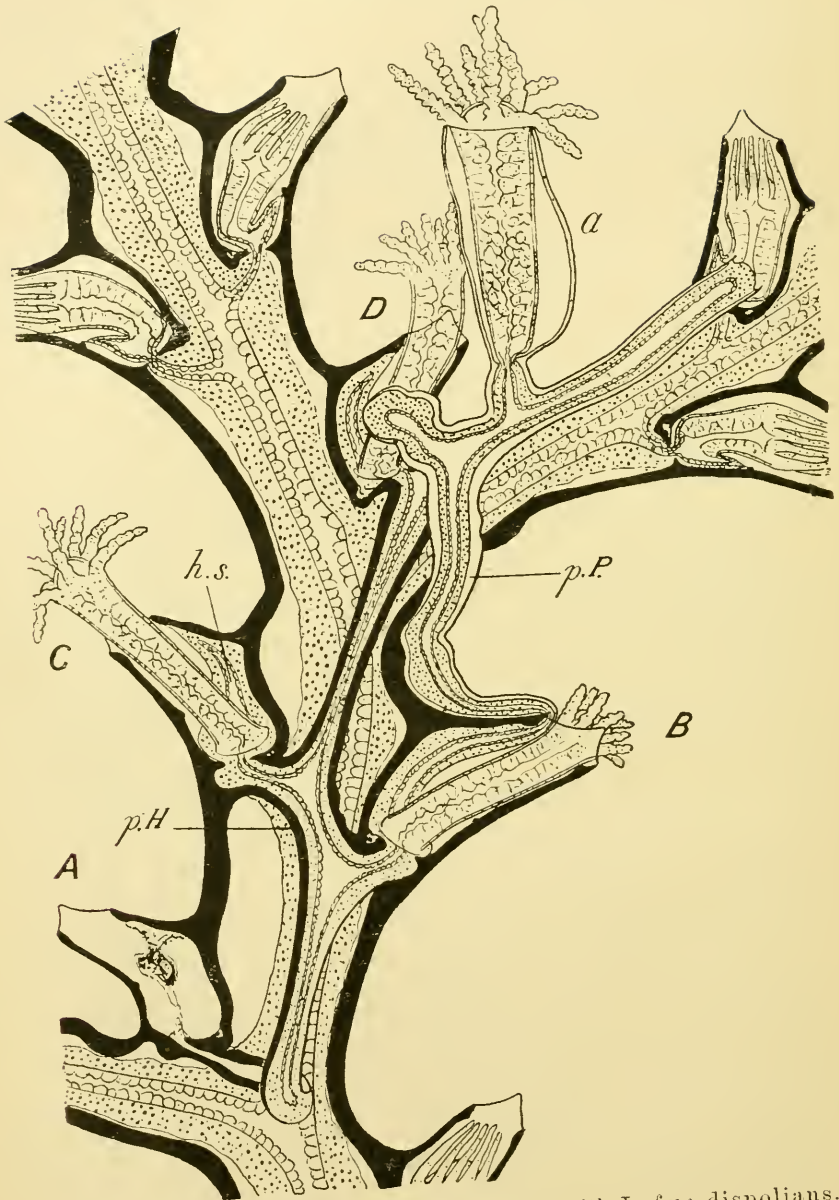
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THIS hydroid is especially interesting on account of its parasitic habit.

Only two small colonies have been found; they both occurred at Isipingo, Natal, and the host was a species of *Sertularia*. The *Sertularia* closely resembles *S. bidens* *Bale*, recently re-figured and described in the 'Annals of the Natal Government Museum,' vol. i, p. 310. There are, however, certain differences, in that there is no well-developed double tooth of perisarc on the abcauline side of the mouth of the hydrotheca, and also the spiral groove at the base of the pinnate portion of the stem is replaced by an oblique joint. These differences are small and do not appear to be sufficient to justify the formation of a new species.

Text-fig. 1 represents one of the specimens. The parasite evidently first attacked the hydranth *A* of the host. Possibly a swimming planula of the *Lafœa* was swallowed by the polyp of the host, and the subsequent growth of the parasite caused the death of the hydranth of the *Sertularia*. The hydrorhiza of the parasite then passed through the aperture at the base of the hydrotheca into the cœnosarc of the host, and grew upwards, invading the hydrothecæ *B*, *C* and *D*, and replacing the original polyps of the *Sertularia* by its own

TEXT-FIG. 1.

Main stem of *Sertularia bidens* infested with *Lafeea dispolians*.

hydranths. The hydrorhiza on entering the hydrotheca grows along the adcauline surface and forms a sac (*h. s.*). From the base of the sac there springs a hydranth which occupies the remainder of the hydrotheca. It should be noticed that the hydranth of the parasite is unprovided with a hydrotheca of its own.

In the case of the hydrotheca *B* the hydrorhiza-sac of the parasite has continued its growth and has crept round the margin of the mouth to the exterior, and has grown along the outer surface of the host and produced a typical Lafœa-like hydrotheca and hydranth (*a*). On emerging from the hydrotheca of the host the hydrorhiza of the parasite provides itself with a substantial perisarc (*p. P.*).

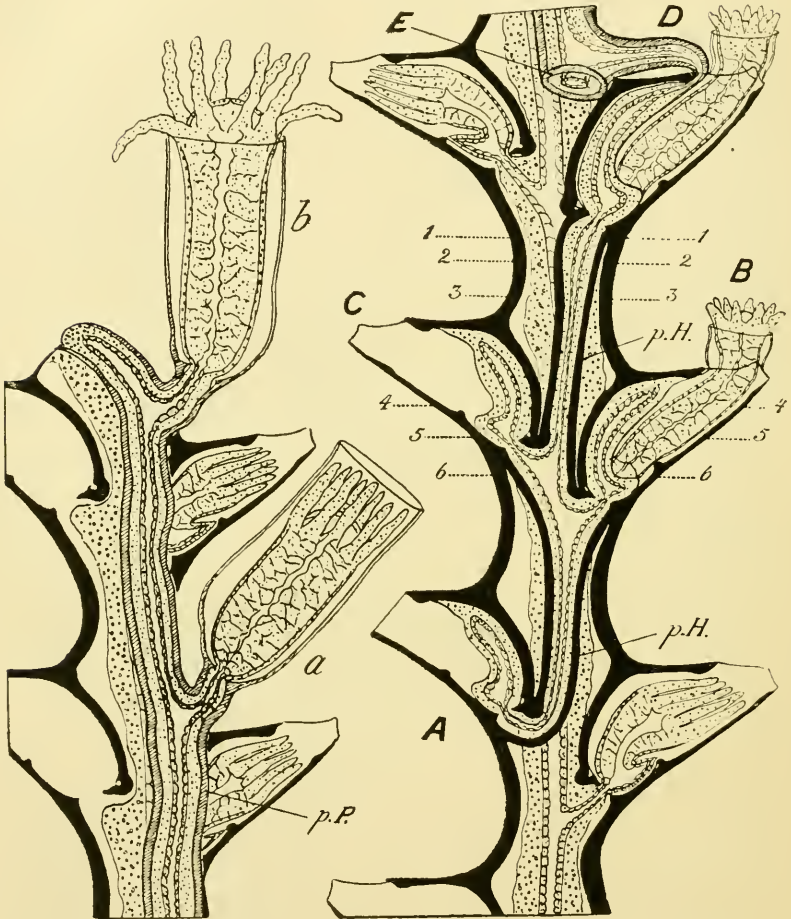
A very similar history is shown in Text-fig. 2, which represents the second specimen. In this case it was a pinna that was infested, while in the former case it was the main stem.

The parasite started its growth at *A* and the hydrorhiza-sac is seen on the adcauline surface of the hydrotheca, but there was no polyp. Within the host the parasite has grown upwards to the hydrothecæ *B*, *C* and *D*. At *C* a polyp was not formed or it had disappeared. At *D* the hydrorhiza-sac (*h. s.*) has continued its growth and has passed through the opening of the hydrotheca to the exterior, where it has forked into two (*E*); one branch has grown upwards and has produced two typical hydrothecæ and polyps (*a* and *b*), and the other has grown downwards and the growing apex ended at the level of the line 5, 5. The downward-growing branch has, for the sake of clearness, been omitted from the drawing, and is represented cut off at *E*. This specimen is interesting in that the polyps *B*, *D* of the parasite have shown some attempt at forming their own hydrothecæ, the hydrotheca of the host being lengthened by a collar-like prolongation secreted by the Lafœa.

The second specimen was carefully imbedded in paraffin and cut into transverse sections, in order that the effect of the parasite on the cœnosarc of the host might be observed. From the surface aspect it was not possible to discern whether

the parasite actually invaded the tissues of the host or simply crept in the cavity between the perisarc and cœnosarc.

TEXT-FIG. 2.



Pinna (cut into two) of *S. bidens* infested with *L. disploiaus*.

In Pl. I, figs. 1-6, are represented cross-sections at the six levels indicated in Text-fig. 2. In fig. 1 the hydrorhiza of the parasite (*P. i.*) is seen on the side of the hydrocaulus of

the host where the greater part of the cœnosarc lies, and opposite to the hydrocauline cavity. The parasite is shut off from the cœnosarc of the host by a layer of perisarc (*p. H.*) which is continuous with a layer running partly round the inside of the Sertularian tube. It is clear that the growing apex of the parasite forces itself into the cœnosarc of the host, which responds by secreting a partition separating it from the invading Lafœa. In fig. 3 the parasite has grown away from the perisarc tube of the host into the middle of the ectoderm of the cœnosarc, and the Sertularia has secreted a continuous tube of perisarc (*p. H.*) around the parasite. Fig. 2 represents an intermediate condition between that seen in fig. 1 and fig. 3.

Within the host the parasite secretes practically no perisarc, but it may be represented by the thinnest possible layer as at *p. P.*, figs. 4 and 6.

Thus, in Text-figs. 1 and 2 what looks like the perisarc of the Lafœa is really a tube of chitin secreted by the host to shut off the parasite. Outside of the host the hydrorhiza of the Lafœa assumes greater dimensions than inside, as at *P. o.*, figs. 1-3.

In fig. 4 the cross-section shows the Sertularian hydrothecæ of the two sides. On the left the hydrorhiza-sac (*h. s.*) of the parasite, adhering to the adcauline surface, is seen, and on the right side in addition to the sac a transverse section of the base of the Lafœa (*b. H.*) polyp is present.

In fig. 5 the cross-section shows the parasite passing through the lower opening of the hydrotheca, and it is still separated from the ectoderm of the host by a partition of perisarc (*p. H.*). It would appear that only in the region of the growing apex of the parasite does the living tissue of parasite and host remain in contact.

In fig. 6 the junction of the base of the polyp (*b. H.*) and the hydrorhiza-sac (*h. s.*) is seen.

In fig. 7 there is shown under greater magnification the cœnosarc of the Sertularia, containing the hydrorhiza of the parasite encircled by a tube of perisarc secreted by the

ectoderm of the host. On each side of the endoderm-tube there may be noticed a clump of large cells (*gl. c.*) containing globules resembling those seen in the endoderm cells.

The example of parasitism is interesting in that, as far as I am aware, it is unique, and it exhibits in a striking manner the struggle of the host to squeeze out the parasite and shut it off from its depredations. It also illustrates the economy exercised by the parasite in the secretion of perisarc. While within the body of the host it produces practically no perisarc, and utilises the hydrothecæ of the host; but when for any reason the hydrotheca is too short, it may be lengthened as in Text-fig. 2, *B, D*. Immediately on passing out to the exterior a substantial perisarc is formed. The fact of being housed and partially fed by the host during the younger stages in the growth of the parasite, must certainly be a great advantage to the Læfœa, as it thereby escapes some of the dangers of this critical period.

With reference to the specific characters of the Læfœa there is but little to state, since, as is so usual in specimens of this genus, no gonangia were present.

Hydrorhiza. — Creeping and apparently irregularly branched.

Diameter, when outside the host, 0·10 mm.

Thickness of perisarc, 11  $\mu$ .

Hydrocaulus.—Represented by the short pedicels of the hydrothecæ, smooth or slightly wrinkled.

Diameter about 0·05 mm.

Hydrothecæ.—Carried on short pedicels, and rather sparingly scattered on the hydrorhiza when the parasite is outside of the host. Cylindrical, margin not perceptibly everted.

Length, 0·39 mm.; breadth, 0·18 mm.

Thickness of perisarc, 5  $\mu$ . There is a slight indication of a diaphragm.

Hydranth.—Cylindrical, with a crown of eight tentacles, which are somewhat moniliform. Hypostome hemispherical. The ectoderm of the polyp tends to be thin, while the endo-

derm is thick. The endoderm of the hypostome is modified, and consists of tall, narrow, columnar cells, which are exceedingly granular and stain very readily (fig. 8, *e*, *h*).

Nematocysts, variable in size, the commonest variety being about  $3.5\ \mu$  in length and  $1.3\ \mu$  in breadth. The endoderm tube of the cœnosarc, when the parasite is outside of the host, just as in the case of the Sertularia, contains on one side many globules of a fatty nature. This character is, however, more marked in the Sertularia host (figs. 1, 2, and 3). The ectoderm of the cœnosarc of the hydrorhiza may contain nematocysts (fig. 3, *n*).

#### EXPLANATION OF PLATE I,

Illustrating Dr. Ernest Warren's paper "On *Lafœa dispolians* sp. n., a Hydroid Parasitic on *Sertularia bidens* Bale."

FIG. 1.— $\times 325$ . Cross-section along the line 1, 1 (see Text-fig. 2) showing parasite inside (*P. i.*) and outside (*P. o.*) the host. *p. H.* is perisarc secreted by the host and shutting off the parasite.

FIG. 2.— $\times 325$ . Cross-section along the line 2, 2 of Text-fig. 2. Showing the parasite separating itself from the perisarc-wall of the host.

FIG. 3.— $\times 325$ . Cross-section along the line 3, 3 of Text-fig. showing parasite completely separate from the perisarc-wall of host. The parasite is surrounded by a tube of perisarc (*p. H.*) secreted by the host.

FIG. 4.— $\times 325$ . Cross-section along the line 4, 4 of text-fig. cutting through the hydrothecæ of the two sides. The parasite is separated by perisarc-partition (*p. H.*) secreted by the host. The perisarc of the parasite (*p. P.*) is exceedingly thin. In the hydrotheca of the left side the hydrorhiza-sac (*h. s.*) is seen, and on the right side a cross-section of the base of the polyp (*b. H.*) is also shown.

FIG. 5.— $\times 325$ . Cross-section along the line 5, 5 of Text-fig. cutting through the basal aperture of the hydrotheca. The parasite is seen passing into the hydrotheca. A sheet of perisarc (*p. H.*) secreted by the host separates the parasite from the cœnosarc of the Sertularia.

FIG. 6.— $\times 325$ . Cross-section along the line 6, 6 of text-fig. It shows the junction of the hydranth and hydrorhiza-sac of the parasite. *e. H.* is the remnant of the ectoderm of the host on the perisarc-wall.

FIG. 7.— $\times 700$ . Cross-section through the cœnosarc of the host in which is embedded the hydrorhiza of the parasite surrounded by perisarc secreted by the Sertularia. Nematocysts (*n*) occur in the ectoderm. The endoderm-tube of the host is composed on *one* side of especially elongated cells (*gl. c.*) which are filled with refringent yolk-like globules. Similar globules occur in certain swollen cells (*gl. c.*) in the ectoderm on each side of the endoderm-tube.

FIG. 8.— $\times 600$ . Oblique cross-section through hypostome, and longitudinal section through tentacle of parasite. It shows the modified endoderm of the hypostome, consisting of elongated narrow cells with deeply staining granules. A piece of the hydrotheca of the parasite is seen at *p. P.*

#### EXPLANATORY REFERENCES FOR PLATE AND TEXT-FIGURES.

*a, b.* Hydrothecæ and hydranths of parasite. *A., B., C., D.* Hydrothecæ of host infested with parasite. *b. H.* Base of hydranth of parasite. *e. h.* Endoderm of hypostome. *e. H.* Ectoderm-remnant of host. *g. A.* Growing apex of parasite. *gl. c.* Swollen cells of ectoderm filled with globules. *gl. e.* Endoderm cells filled with globules. *h. s.* Hydrorhiza-sac of parasite. *i. p.* Inner layer of perisarc. *l. e.* Lining ectoderm of perisarc-wall of host. *n.* Nematocyst. *p. H.* Perisarc secreted by host and shutting off the parasite. *p. P.* Perisarc of parasite. *P. i.* Parasite inside host. *P. o.* Parasite outside host. 1, 1; 2, 2; 3, 3; 4, 4; 5, 5; 6, 6. Planes in Text-fig. 2 through which the sections drawn in the Plate were taken.



Warten ed.

LAFIEA DISPOLIANS Sp. n.



**Notes on the Life-Histories of Natal Termites,  
based on the Observations of the late Mr.  
G. D. Haviland.**

By

**Ernest Warren, D.Sc.Lond.**

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THE material for this paper is drawn from the work of the late Mr. G. D. Haviland. This careful and keen observer had resided for some years in Natal, and, as is well known, he had done most valuable work on the termites of Natal and of the Malay region.

In the Linnean Society's Journal, vol. xxvi, 1897, Mr. Haviland published an important paper entitled "Observations on Termites, with Descriptions of New Species," which is a systematic memoir on the species of termites which had come under his notice.

Subsequently to the publication of that paper he made many interesting observations on the habits of the Natal species, and these were carefully recorded in diaries and in other manuscript notes.

In addition to these observations, Mr. Haviland made an extensive series of measurements of the breadth of the head of the various castes in the nests of certain species, more especially of *Termes natalensis*. The measurements were undertaken with a view to determine the mutual relationships and variabilities of the different castes. The investigation is of special interest in that in this species there is but one queen and king in a nest from which all the castes originate.

Mr. Haviland's measurements were left in an unreduced condition, but they have now been tabulated, and the results will be included in a paper which will probably be shortly published in the statistical journal 'Biometrika.'

I am much indebted to Mr. A. E. Haviland, of Estcourt, Natal, brother of the deceased gentleman, who has generously placed at my disposal the whole of the collection and the manuscript notes.

The observations, as presented in this account, will necessarily appear somewhat fragmentary, as it is not desired to repeat what has already been published in Mr. Haviland's paper. For this reason systematic descriptions of the species will not be given. The species which will be referred to are :

- Rhinotermes sp.
- Hodotermes havilandi *Sharpe*,
- Calotermes durbanensis *Haviland*,
- Termes natalensis *Haviland*,
- Termes latericius *Haviland*,
- Termes vulgaris *Haviland*,
- Termes incertus *Hagen*,
- Termes parvus *Haviland*,
- Termes bilobatus *Haviland*,
- Termes trinervius *Rambur*,

and they will be dealt with in the above order.

#### Rhinotermes sp.

The species has been found only in the Botanical Gardens, Durban. The termite appears to nest in the interior of the trunks of trees, but the general economy and the nature of the nest have not been worked out. The termites build covered ways up the trunks of trees, consisting of the red ferruginous sand of the district.

Imagos have not been discovered, and it is accordingly unwise at present to name the species.

The soldiers and workers closely correspond to the descrip-

tions given of an American species, *Termes nasutus* Hagen. The soldiers have a minute foramen above the epistoma. Labrum is bilobed, and nearly covers the mandibles when in the position of rest.

There are two sizes of soldiers, and, it is also stated, that there are two sizes of workers.

The large soldier has a total length, 6.1 mm.; length of head, 2.4 mm.; breadth of head, 1.9 mm.; length of mandible, 0.9 mm. There are two teeth to the left mandible and one to the right. Pronotum, mesonotum, and metanotum are all of about the same breadth of 1.3 mm. The antennæ have 17 joints.

The small soldier has a total length, 3.9 mm.; length of head, 1.5 mm.; breadth of head, 0.92 mm.; length of mandible, 0.48 mm. The antennæ have 15 joints.

Large workers have a total length, 5.6 mm.; length of head, 1.8 mm.; breadth of head, 1.4 mm. The antennæ have 17 joints.

The small workers, which are reputed to occur, are not represented in the collection.

#### *Hodotermes havilandi* Sharp.

This species occurs in the thorn-country. Mr. Haviland found it at Weenen and Colenso in Natal, and I have found it abundantly at Hlabisa in Zululand.

The imago is unknown.

Two sizes of workers have been found, but only one size of soldiers.

Total length of soldier about 13 mm., head-breadth 4.2 mm.; length of large worker about 10 mm., head-breadth 3.8 mm.; length of small worker about 7.5 mm., head-breadth 2.6 mm.

The termites are found in the ground in long tunnels, which branch and inter-communicate over extensive areas. Mr. Haviland did not succeed in finding a definite nest, although on several occasions days were spent in following such tunnels

for many yards in the hope of finding the queen and larvæ. The tunnels frequently run horizontally at a depth of about 18 in., but they sometimes reach a depth of even  $2\frac{1}{2}$  ft. The tunnels may open into little lenticular-cells about  $\frac{1}{8}$  in. high and 2 in. in diameter; the floor is flat, and a dozen or more individuals may be found in the cell. From these cells three or four tunnels may branch out in different directions.

These termites cut grass, but it is not stored in the cells. The only grass that was found occurred in a pocket of a tunnel near the surface of the ground.

Mr. Haviland noted that the workers in the deeper tunnels were of the smaller kind, while those at or near the surface were generally of the larger variety. The proportion of soldiers to workers in the burrows was about one to four.

#### *Calotermes durbanensis Haviland.*

This species was found in the Umbilo bush, Durban, also in the Botanical Gardens.

The body of a winged imago is strikingly like that of a worker, and it is about 8 mm. in length.

There is only one size of soldier and one of worker.

The soldier is about 8 mm. long, and the breadth of the head is about 1.8 mm. The number of segments of the antennæ varies from 10-14. In *Calotermes* the antennæ are more inconstant in the number of segments than in *Termes*.

The worker is about 8 mm. long, and the breadth of the head is about 1.5 mm.

The termite lives in the trunks of trees, and they have been found in orange trees, although it has been stated that orange trees are not attacked by *Calotermes*. Burrows are made in living wood, and the wood around the borings becomes discoloured and decayed. The decay extends further in the direction of the long axis of the fibres (vertically) than in the transverse direction.

At the time of swarming it has been noticed by Dr. Grassi,

that in the species, *Calotermes flavicollis*, the males come out of the nest three to four hours before the females. In the different species of *Termes* the males and females usually issue simultaneously.

Mr. Haviland noticed that when some individuals were placed in experimental tubes neoteinic<sup>1</sup> forms were commenced.

Mr. Haviland also remarked that the workers of this genus are larval in appearance, and that "it is probable that all to whom accidents do not happen eventually become winged fertile individuals."

#### *Termes natalensis* Haviland.

*Termes natalensis* is found in Natal, from the sea-coast to an altitude of about 4000 ft.

The winged imago is about 1.9 mm. long, head-breadth about 3.6 mm.

There are two sizes of soldiers and two of workers.

The length of the large soldier is about 13 mm., head-breadth 4.4 mm.; small soldier is 8 mm. long, and head-breadth 2.4 mm.; large worker 6 mm. long, and head-breadth 2.6 mm.; small worker 4.5 mm. long, and head-breadth 1.6 mm.

The nests are covered by sub-conical mounds from 4-6 ft. in height. The sides meet the ground at very nearly a right angle. The termites add continually to the height of the mound; but they soon cease to add to the breadth of the base. Inside the mound are wide, branching passages running mostly in a vertical direction; they are sometimes 2 in. in diameter and lead nearly to the surface of the mound. Some communicate by small apertures with the exterior, but many end blindly. It is probable that these large passages are for the purpose of ventilation, and it is especially, or almost

\* Fertile individuals that have never had wings capable of being used for flight.

exclusively, amongst species which are fungus-growers that such schemes of ventilation occur.

The nest proper is situated at the base of the mound. Wide passages lead from the nest into the surrounding ground and extend to a depth of 1-6 ft. below the surface. The passages may be 3-4 in. in diameter; the vertical diameter is generally greater than the horizontal. There may be as many as 100 of these passages radiating from the nest; they branch and inter-communicate.

The nest is dome-shaped and is occupied by the queen-cell and a frame-work of clay supporting large thick-walled fungus-beds. The queen-cell is a large, heavy mass not clearly defined from the surrounding clayey frame-work; the cavity is lenticular with flat floor and arched roof; it contains only one queen and king. Occasionally the holes of entrance are large enough for the king to escape from when the nest is opened.

The fungus-beds occupy the rest of the nest, and very few of them extend upwards into the mound or downwards into the surrounding soil. There is no vacant space at the top of the dome-shaped nest as Smeathman described in *Termes bellicosus*.

Occasionally a small quantity of dry vegetable matter may be found in a nest, collected for immediate use. Fungus-growing species of termites have not been observed cutting grass; although it is possible that they do so at night to a small extent, but not sufficiently to leave traces of their work.

The nymphs are very plentiful in July, and become winged in September and October. The imagos fly in November after rain in the dusk of the evening, and as is usual in such cases, the chitin is testaceous and less dark than in imagos of species which issue in the day-time.

In the Natal species, *Termes natalensis*, *incertus*, and *trinervius*, the imagos have brown chitin and they do not issue until after sunset; while in the species *T. vulgaris latericius*, *parvus* and *bilobatus* the imagos have dark-coloured chitin, and they issue before sunset.

When a nest is opened, workers, soldiers and nymphs flee into the surrounding soil, except those that are in the neighbourhood of the queen-cell; also, a few hide in the fungus-beds where the larvæ are.

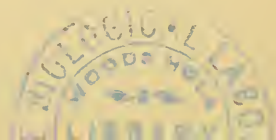
The large-headed workers and the small soldiers soon return on the cessation of digging, and the former at once set to work to repair the damage. They each bring a pellet of earth in their mouth and moisten it with a saliva-like secretion; proctodæal discharges are not used in the process of building. The small-headed workers do not return. The large-headed soldiers return after a time; but more slowly than the small soldiers. The large soldiers can make a rattling sound by knocking their heads against the ground. Both forms of soldiers shun the light.

The workers carry the pellets of earth between the lingua and the labium with the maxillæ at the sides. The mandibles are scarcely used for carrying, but they are employed for placing the pellets in position.

It is chiefly the large-headed workers which are found attacking and eating dead stumps of trees, a few small workers accompanying them. If at all exposed they build a thick earthy crust over the places they are at work upon.

In a fully-formed nest the estimated number of large soldiers was 300 and of small 3000. The workers, larvæ, and the imagos (at certain seasons) are very numerous. The small-headed workers seem more numerous than the large workers. The total number of workers was estimated at 30,000.

Several nests have been dequeened, and on subsequent examination after several months only in one instance was a new queen and king discovered. The nest was always found to have been partially repaired, and sometimes workers and soldiers still inhabited it, but at other times it was deserted. When workers were found they generally exhibited a peculiar white appearance of the abdomen, due to the condition of the fat-bodies, perhaps arising from the fact that there was no queen to feed.



The larvæ on leaving the egg seem all alike. The eggs are carried from the royal cell and deposited, either on the fungus-beds, or on the clayey framework of the nest.

The larvæ from which the six castes develop have 12 segments to the antennæ. The male and female imagos will have 19 segments; soldiers of both kinds, 18 segments; and workers of both kinds, 17 segments. The king and queen of a nest always lose a few terminal segments.

In *T. natalensis*, as in all fungus-growers, neoteinic individuals have not been observed. It is not improbable that a male and female winged imago may occasionally be elected king and queen, which shed their wings without leaving the nest.

With reference to the duties of the different castes it may be noted that the soldiers defend the openings of the nest, while the workers close them when occasion arises. The soldiers have a weak thorax and abdomen, which they endeavour not to expose. The soldiers have large salivary vesicles reaching to the apex of the abdomen, and when angry they discharge the contents, which appear as a clear viscid drop between the mandibles. The secretion does not seem to be an irritant. The soldiers are blind, and direct their mandibles with very little skill.

Large soldiers seldom go far from the nest, but small soldiers always accompany the workers on a foraging expedition. The large workers do the foraging, while the small workers attend to the fungus-growing and to nursing, but they also are often found away from the nest.

The nests of *T. natalensis* are frequently infested by the large ant, *Carabara vidua*. The nest of the ant generally traverses the termite nest in a very irregular way. The termites always keep a wall between themselves and the ants. This wall is smooth and firm on the termite side, but rough and loose on the side of the ants. The ants certainly derive great benefit from the warmth of the termite nest.

*Termes latericius Haviland.*

This species occurs in Natal from the sea-coast to an altitude of about 4,500 feet.

The winged imago is about 14 mm. long, head-breadth, 2·2 mm.

The soldiers are all of one size, and the workers are of two sizes.

The length of the soldier is about 5 mm., and the head-breadth 1·4 mm.; large worker, 5 mm. long, head-breadth, 1·8 mm.; small worker, 4 mm. long, head-breadth, 1·1 mm.

The nest has no mound. There are three to four vent-holes which lead into pipes running vertically into the ground. The holes are roughly placed on the circumference of a circle, with a diameter of 6–12 ft. The diameter of the vertical shafts varies from 1–6 in. The depth is usually about 4 ft., but it may extend to 6 ft. The shafts do not lead directly into the nest, and frequently their connection with the nest is not easy to make out. The external opening of the shaft may be prolonged as a tube above the surface of the ground, even as much as 2 ft. The vent-holes may be closed over in the winter.

The nest is placed in the middle of the circle formed by the vent-holes, and is situated at a depth of 3–6 ft. The royal cell is irregular in position and shape, and through its floor it may be in wide communication with the nest. Two, or even three, queens may be found in the cell. It often happens that the royal cell is not in the nest at all, but is hollowed out in the earth which forms the walls of the nest.

The fungus-beds have thin delicate walls, and are arranged chiefly in horizontal layers. The fungus globules are densely crowded on the under surface of the beds, but occur only sparsely scattered on the upper surface.

The imagos fly in the early part of the wet season, November to December. They issue from the nest in great numbers, generally about 8 a.m. Males and females come out simultaneously. They do not issue from the vertical shafts, but by

small holes made for the purpose by the workers. After flying for a time in the direction of the wind the female settles on the ground, choosing a spot more or less clear of grass. She stands with the apex of the abdomen elevated, and with wings extended and vibrating. If a male be put near her he runs to her abdomen; she puts her wings in the position of repose and begins to run, the male following her. She soon stops and sheds her wings, first on one side and then on the other, and then continues to run on. The male sheds his wings in a similar manner. If the male stops she stops too, with the apex of the abdomen upturned; if he still lingers, she turns round to look for him. Directly he approaches she begins to run again. If two males are put near her they both run after her; but she runs fast, and the males get in each other's way, and soon one gets a little behind and loses the track.

The soldiers do not run away when the nest is being opened, but they stand on the fungus-beds with uplifted heads and threatening jaws. If one further angers a soldier by breathing on it, a thick viscid red fluid is discharged from the salivary glands, and remains as a drop between the open jaws. If the hand is placed in the nest the soldiers make their jaws meet in the skin, and discharge the viscid secretion over it, which causes a stain lasting for several days.

The workers retire when the nest is opened. In wet weather the workers may often be seen increasing the height of the tubular mouths of the ventilation-shafts by means of pellets of earth.

During the damp summer weather, on turning over cow-dung on the veld the workers of this species may often be seen at work underneath.

#### *Termes vulgaris Haviland.*

Found in Natal: from the coast to an altitude of 5000 ft. or more. Winged imagos have been caught at an altitude of 6000 ft.

Winged imago is about 14 mm. long, and has a head-breadth of 2·6 mm.

The soldiers are all of one size and the workers of two sizes.

The soldiers are about 5 mm. long, head-breadth, 1·6 mm.; the large workers are about 5 mm. long, and have a head-breadth of 1·6 mm.; the small workers are 3·8 mm. long, and head-breadth, 1·1 mm.

The nests are situated not far from the surface of the ground, and are surmounted by a low mound 1-3 ft. high on a broad irregular base.

Branching passages of considerable diameter exist, but they do not possess a free opening at the surface of the ground.

The nest proper is ill-defined at its circumference, and it is generally shallow. The fungus-beds are small and delicate, and the plentiful globules are not chiefly confined to the under surface of the laminae as in *Termes latericius*.

The royal cell is small, thin-walled and closed. It is generally near the middle of the nest; but it may be placed at one side, or adherent to the top. It is not uncommon to find two queens and two kings in the royal cell.

The imagos fly by day, and at any time of the year from October to June. They have been seen to swarm at various times of the day—soon after sunrise, about noon, in the afternoon, and occasionally even after sunset. Males and females issue simultaneously from some 4-6 holes. Swarming may take more than an hour. Soldiers and workers guard the holes of issue, and run about outside the nest, and in so doing they have been seen to be killed by exposure to the heat of the sun. The least disturbance at the exit holes will cause the stream of imagos to cease.

When a nest is being opened both the workers and soldiers run away and hide, and this they do more readily than in other species.

*Termes incertus Hagen.*

Found in Natal from coast to altitude of 4500 ft.

The winged imagos are about 8.5 mm. long, and have a head-breadth of 1.3 mm.

The soldiers and workers are of one size only.

The soldiers are 4 mm. long, head-breadth, 0.76 mm.; workers are 4.5 mm. long, head-breadth, 0.88 mm.

The nest consists of cavities in the ground joined by narrow passages. Some of the cavities contain fungus-beds, and are then more or less spherical. The tunnels which do not contain fungus-beds are lenticular with a flat floor.

The fungus-beds are delicate, and the fungus-globules are smaller than in the other species. Both king and queen can move from one cavity of the nest to another, as the communicating passages are frequently large enough for the queen, whose abdomen is long and rather slender.

This species generally forms its nest in the nests of the larger species of fungus-growers, but it is sometimes found independently. In the latter case the nest may occur at a variable depth below the surface, from a few inches to several feet. This species is never found in the mounds of *T. trinervius* or in those of other non-fungus-growers.

The smaller species does not appear to be parasitic on the larger fungus-growing species, except in the sense that the mounds of the latter are suitable places for their nests.

When such an infested nest is being opened it is not infrequent to see one or two workers and soldiers of *T. incertus* clinging to the legs of an individual of the larger species, but the latter does not appear to heed them in the confusion caused by opening the nest.

The nymphs are abundant during the cold season; they obtain their wings in September and October, and swarm during November and December. They issue from the nest soon after sunset.

The soldiers are as small as the workers, and are not readily

distinguished from them by the naked eye except by a red patch at the base of the abdomen, which is due to the colour of the contents of the salivary vesicles.

Neither workers nor soldiers appear to get very excited when the nest is opened; they both behave much in the same way and slowly seek retreat.

Owing to the freedom with which the kings and queens wander about when the nest is opened, it is difficult to determine how many there are in a colony, or what are the limits of a colony. Occasionally three or four queens are found not far apart; kings are less often found. On one occasion Mr. Haviland found in the royal cell of a nest of *T. latericius* a queen of *T. incertus* in addition to a queen of the former species. No king of either species was found, but a number of workers and soldiers of *T. latericius* occurred. It is probable that the queen of *T. incertus* entered the royal cell whilst the nest was being opened.

#### *Termes parvus Haviland.*

Found in Natal from the sea-coast to an altitude of about 5000 ft. The winged imagos may be seen on the tops of hills up to an altitude of 6000 ft.

Winged imagos are 4.5 mm. long, and have a head-breadth of 1.1 mm.

The soldiers and workers are of one size only.

The soldiers are 4 mm. long, and head-breadth, 0.83 mm.; the workers are 3.5 mm. long, head-breadth, 0.77 mm.

The nests are sometimes built practically on the surface of the ground, but they are often some little distance below, and occasionally several feet. The nest is an irregular cellular structure. There may be but one king and queen, but two kings and two queens not infrequently occupy the same cell. The queen's abdomen is slender, and she and the king can move about the nest.

Occasionally there are no true kings and queens, but a considerable number of neoteinic queens.

Swarming takes place in the afternoon about 3 p.m. from November to April. Sometimes it occurs after a shower, but not necessarily so. When swarming, the imagos fly around some object, such as a bush, just like ants. On pairing, the male attaches himself to the under surface of the abdomen of the female with his head directed posteriorly. He now generally contrives to shed his wings, and the female flies off with him in the direction of the wind.

*Termes bilobatus Haviland.*

This species occurs in the higher districts of Natal up to an altitude of about 4500 ft. It has not been met with at the coast.

Winged imagos are 5.5 mm. long, head-breadth, 1.1 mm.

Soldiers and workers are of one size only.

The soldiers are 6.5 mm. long, head-breadth, 1.5 mm.; the workers are 4.5 mm. long, head-breadth, 0.98 mm.

Mr. Haviland never found more than about fifty soldiers in a nest, and sometimes no soldiers at all were present.

In fairly low altitudes the nests are practically on the surface of the ground, and consist of a low mound of hard earth with moderately large, thick-walled inter-communicating cells. In high altitudes the termites occur, but no distinct nest has been located. The nest is sometimes placed below the surface of the ground, and in that case its limits are not well defined.

Only one king and one queen are generally found in the nest, and they can move freely about. Neoteinic forms have been found on one occasion.

At Ulundi (altitude 5000 ft.) Mr. Haviland found a king and queen beneath a stone with a few workers. They were in a concavity under the stone, which formed a cell for them. No soldiers have been found at these high altitudes, and mounds with hard material do not occur.

Nymphs are present in the nest in the winter (May-September), but during this season no eggs or larvæ are to be found. Even as early as May there may be winged imagos in the nest, but it is not usual for them to fly before September.

Swarming takes place in early summer after rain. They fly around bushes and ultimately settle on them. The male seizes the ventral surface of the abdomen of the female with his wings projecting in front of her head. The female flies away with him in the direction of the wind. On settling, the male loosens his hold, and both male and female shed their wings. The female then proceeds to look for a place of shelter, the male following her. If they should happen to get separated before shedding the wings, the female would fly back to the original bush. The males never seem to shed their wings before being carried off by the female.

In high altitudes *T. bilobatus* were frequently found working in damp cow-dung.

The species sometimes occurs in deserted, or partially deserted, nests of *T. trinervius*, or at the edges of flourishing nests of *T. natalensis* and of *T. trinervius*.

#### *Termes trinervius Rambur.*

It is found all over Natal up to an altitude of 4500 ft. Their mounds are so numerous and conspicuous that there is probably no insect whose distribution could be so readily mapped out.

Winged imagos are 10 mm. long, head-breadth, 1·9 mm.

Soldiers are of two sizes and workers of one size.

Large soldiers are 5·5 mm. long, head-breadth, 1·4 mm.; small soldiers are 4·5 mm. long, and head-breadth, 0·89 mm.; workers 5·8 mm. long, head-breadth, 1·7 mm.

The mounds are sub-hemispherical, and reach a diameter of 4-5 ft. at the base. The outer shell is hard and strong. The interior of the mound is made up of large inter-communicating cells; those immediately below the crust are stuffed with bits of grass. The nest is added to in the wet season only. The old shell is pierced in the part to be enlarged and a new crust is built over it. The old crust beneath is gradually removed.

There is only one king and one queen to the nest. They generally live near the centre, but they can move about the

nest, and when disturbed they may escape into the surrounding soil.

Neotenic forms have not been found.

The imagos get their wings in September–October, and issue by night during the month of November. They generally swarm after rain; but all the imagos of a nest do not emerge on the same night. They issue from crescentric holes made in the shell of the nest by the workers; these are opened in the evening and closed next morning. The marks of the holes persist for months after they have been permanently closed, for the closing plugs are not flush with the surface of the shell.

When the shell of a mound is broken into and then tapped upon with the spade, the large soldiers come out in great numbers with uplified rostrum, and with a fine thread of clear viscid fluid hanging from it or floating in the air. This thread dissolves in spirit, whereas the salivary discharge of the soldiers of the fungus-growers and the discharge from the head of the soldiers of *T. gestroi* harden in spirit. A few small soldiers also come out, but not many. When the nest is thoroughly broken into, the small soldiers stand on the broken surface without retreating. The workers retreat at once and can be driven into any part of the nest; they frequently retreat into the underground passages around the nest. These passages are narrow and keep close to the surface of the soil.

The workers cut grass during the wet season, chiefly during the night; but they may sometimes be watched at work early in the morning, and in dull weather even in the middle of the day. Like *Hodotermes*, they stand head downwards on a stem of grass, and with their mandibles gradually cut round the stem until it is sawn through.

Jackals appear to feed largely on this species of termite.

Quite frequently the nests of *T. trinervius* are seen to be perforated by a hole on one side, which leads to the centre; Mr. Haviland thought it was the work of some small rodent.

## Some Observations on the Dentition of Chrysochloris, and on the Tritubercular Theory.

By

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With Plate II.

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THE dentition of *Chrysochloris* differs so greatly from that of most mammals that it has received a considerable amount of attention. Unfortunately, specimens are so rare in collections that workers have been much hampered, and have sometimes been led to doubtful conclusions through having only been able to examine a very limited number of imperfect specimens. Much of the interest in the dentition centres in the question of the molar structure. Cope considered that the somewhat triangular molars represented a primitive type not unlike that seen in some Secondary Mammals, and from which all the later molar types have been evolved. This view has been supported by Osborn, but in his recently published work on the 'Evolution of the Mammalian Molar Teeth' he apparently adopts the view of Gidley that the molars of *Chrysochloris* are simplifications of the more ordinary Insectivorous type, and that the "trituberculy of *Centetes* and *Chrysochloris* is a secondary acquirement or pseudo-trituberculy." According to Gidley, the high main cusp of the upper molars is a fusion of the paracone and metacone of the ordinary type, and the small internal ledge is the protocone. This is almost the same view as that sug-

gested by Mivart in 1868, differing only in that Mivart believed the internal ledge to be a fusion of the protocone and metacone. A somewhat different view is that of Woodward, who believed that the *Chrysochloris* upper molar corresponded "only with the paracone triangle of the mole's tooth."

Before discussing the homologies of the cusps, it may be well to look at the facts in some detail. In the best known species, *Chrysochloris asiatica* (= *C. capensis* vel *C. aurea*), the molars are more degenerate than in any other species except *C. granti*, and it is probable that it is this species that was studied by Cope. When the teeth of the larger and less degenerate types are examined, the nature of the molars becomes more apparent.

*Chrysochloris villosa* and *C. trevelyani* are the two large species, and there is some reason to believe that most of the small species are degenerate descendants of a larger form, such as either of these two. Though many specimens of *C. trevelyani* are available, it will be more convenient to take *C. villosa* as the typical *Chrysochloris*, as in this latter both the milk and permanent teeth are known.

In figs. 3 and 4 are shown the upper and lower milk-teeth in an unworn condition. In figs. 1 and 2 the permanent set, with the three true molars much worn. The most striking points of difference between the two sets are in the premolars. There is little difference in size, but the upper  $dp^1$  is smaller than  $p^1$ , and shows no trace of the protocone, while  $p^1$  has a small protocone. The two posterior premolars are both a little shorter antero-posteriorly than the milk premolars.

The lower milk teeth are interesting, in that a distinct talonid is present on all the incisors, as well as on the canine and three premolars. On the canine there is a small cusp corresponding to the metaconid. In the first premolar the metaconid is well developed, and there is a small paraconid present. In the other premolars the trigonid is well formed.

The permanent teeth of the lower jaw are in the main fairly like those of the milk set. The canine is large and has a

distinct posterior cusp corresponding apparently to the talonid, a trace of a paraconid, and possibly even a rudiment of a metaconid. The first premolar has a well-developed talonid, and a quite distinct though small trigonid, both the paraconid and the metaconid being quite distinct. In all the other premolars and molars except the rudimentary last molar the teeth are formed of an elevated trigonid with a small posterior talonid.

In *Chrysochloris asiatica* the first upper milk premolar is triangular but with no trace of protocone. The permanent first premolar is smaller and with the anterior part less developed. The other premolar teeth of both sets and the true molars have a well-developed protocone. The lower teeth resemble considerably those of *C. villosa*. The milk canine has a large main cusp and a well-developed posterior talonid cusp. The first milk premolar has a large main cusp, a well-developed talon, and distinct though rudimentary paraconid and metaconid cusps. There is, however, no trigonid formed. The other premolars are remarkable from having lost the talon. The teeth of the permanent set are smaller, and the first premolar has the paraconid and metaconid well formed, but not large enough to make a trigon. There is on both the milk and permanent first premolar a distinct talon, and on the second premolar a faint rudiment, but on all the other premolars and molars there is not a vestige of a talon.

In *C. hottentota* the main cusps of the molariform teeth are exceptionally large, and in the unworn condition so much higher than the others that the teeth appear to differ considerably from those of some of the other species. The first milk premolar is small and has no trace of a protocone. In all the others, however, a protocone is present. In the inferior teeth a posterior talonid cusp is present in all except the first incisor. In the first premolar there is a large talon, a feeble metaconid and a rudimentary paraconid. In the other premolars and molars the talon is very large. The paraconid and metaconid are much shorter than the protocone. Approxi-

mately the talon rises to one third of the height, and the para- and metaconids to two thirds of the height of the protocone.

In *C. obtusirostris* the first premolar is distinctly molariform in both upper and lower jaws. The upper has no trace of a protocone, and the other molariform teeth have a much smaller protocone than in other species. The lower premolars have got a small talonid, and in the first molar this is rudimentary and in the second absent.

The premolars are practically identical in structure with the molars in both upper and lower jaws. Even the incisors and canines seem to foreshadow the cusp development of the molars, and one is irresistibly driven to the conclusion that the main cusps are homologous throughout. Whether the teeth are degenerate or not does not affect the question, at least in so far as the lower teeth are concerned. And as the milk premolars and permanent premolars are practically identical it does not matter which we consider, but as in all species apparently the milk set are the set which serve the greater part of the animal's life—certainly in *C. villosa*, *C. asiatica*, and *C. hottentota*—we may as well confine our attention to merely the milk set.

When we look at the lower canine first premolar and second premolar we clearly see how the cusps develop. The main cusp or protocone we may safely regard as homologous in each. The feeble posterior basal ledge in the canine becomes the talonid in the premolars. The feeble cusp behind and internal to the protocone of the first premolar becomes the well-developed metacone in the second premolar, and the minute anterior cusp becomes the paracone. The molars are all of the same pattern—three elevated cusps forming a trigonid, and a distinct though small talonid. The interesting thing about such a tooth is that it is identical in almost every respect with the molars of many of the Jurassic and Cretaceous mammals, and also very similar to those of many of the primitive Eocene types. The lower molars of *Amphitherium* only differ slightly in the relative proportions of the

cusps. *Phascolestes* has also nearly the same type of lower molar. The molars of the Oligocene Insectivores *Apternodus* and *Micropternodus* are also essentially similar, and even those of *Palæosinopa* and *Palæonictis* differ but slightly. When we compare the lower molars with those of such recent animals as *Erinaceus*, *Dasyurus*, or *Perameles*, we find that the only difference is that in these the talonid is well developed and has a pair of large cusps. Whether the *Chrysochloris* tooth is degenerate or primitive the parts are pretty certainly homologous with those of *Amphitherium*, and the trigonid is certainly homologous with the anterior part of the molars of *Dasyurus*.

In the upper teeth we meet with a number of difficulties. As in the lower jaw we seem to have no difficulty in tracing the main cusp from the incisors along to the molars. Nay, we even see how a simple conical canine, such as is present in *C. hottentota*, may become triangular by the development of a postero-external cusp, and nearly molariform in *C. obtusirostris*. The first premolar in most species is like the canine in *C. obtusirostris*, and the second differs by the addition of an antero-external cusp and a small internal ledge. There is thus formed a trigon of three cusps with an internal basal one, and the question arises, what are they? It seems almost certain that the main cusp is homologous in each of the teeth, for the main cusp in the triangular canine of *C. obtusirostris* is manifestly the homologue of the conical canine in *C. hottentota*, and we may therefore safely conclude that the main cusp in the second and third premolars is the fundamental cusp of the tooth, and one would like to call it the "protocone." Unfortunately, when we come to the molars we find that the term "protocone" has been applied to the small basal cusp, and it is difficult to see how the confusion is to be avoided.

According to the older Cope-Osborn theory the superior premolars followed a different order of cusp addition from the molars, and quite different names were given to the cusps. Thus, the antero-internal cusp of the first molar was called

the protocone, but it was the antero-external cusp in the premolar that was given the same name, and when the premolar becomes quite molariform we have the unfortunate confusion as seen in *Hyracotherium*, that the last premolar and the first molar, though almost identical in structure, have all the main cusps differently named.

Huxley, Wortman and others have maintained that the molars and premolars have developed in a similar fashion and only differ in the molars having usually become more complex. In *Chrysochloris* the premolars are so nearly similar to the molars that no person could tell readily whether a detached tooth were a molar or premolar, and it is very difficult to doubt that the cusps of the one are homologous with the similarly situated cusps of the other. If the premolar analogy theory is correct—and to my mind the case for it seems very strong—then the premolars and molars of *Chrysochloris* can be described as consisting of a high main cusp near the inner side of the tooth connected with two smaller external cusps and forming with them a narrow trigon, and with a small internal cusp low down on the side of the main cusp.

When we endeavour to identify these cusps we find it impossible to be dogmatic. The small internal cusp, however, we can, I think, identify with certainty. It meets the talonid of the lower molar in much the same way as the inner cusp of *Dasyurus* meets the talonid, and hence must be the cusp that is called protocone. Not that it corresponds to the reptilian cone, but because the name "protocone" has come to be attached to the antero-internal cusp of the mammalian molar and seems likely to stick to it, even though the reason for giving the name be wrong. As I do not feel justified in opposing the current names, I am provisionally accepting the names of the molar cusps and transferring them to the premolars, though one would prefer to call the main one the protocone.

The next homology one has to try and settle is that of the main cusp, and the first question that arises is whether it cor-

responds to two ordinary molar cusps conjoined or to a single one? Mivart and Gidley have both held that the trigon of the upper molar of *Chrysochloris* represents a fusion of the two external triangles of typical mammals, such as *Talpa* or *Dasyurus*, and they unquestionably bring forward some strong evidence. In *Potamogale* and *Mygale* we seem to have an intermediate stage, where the two triangles are partly fused. I, however, rather side with Woodward in believing that the single triangle of the *Chrysochloris* molar corresponds to only the anterior triangle of typical molars. In almost every instance in osteology where two structures in an ancestor are replaced by one in a descendant, it is by the loss of one, not by the fusion of the two, and we have reason to believe that this holds good for molar cusps. The last molar in primitive mammals is at least not simpler than the anterior ones, but in large numbers of the descendants we find the last molar reduced. In *Dasyurus* the last molar consists of a single triangle with internal protocone—a tooth, in fact, almost of the *Chrysochloris* type. If we look at the last molar of *Perameles* we find a well-developed triangle, a small protocone, and a small posterior cusp, which represents all that remains of the posterior triangle. Even in *Talpa* the last molar does not show a fusion of triangles, but a dwindling of the posterior one. In *Proscalops* the posterior triangle is almost gone. In *Sorex* it is quite gone. Even *Potamogale* seems to me to show, not a fusion, but a dwindling of the posterior triangle. The lower molars of *Dasyurus* may be looked upon as two triangles in much the same way as the upper, yet the evidence is quite conclusive that the single triangle in *Chrysochloris asiatica* is not formed by the fusion of the two, but by the gradual reduction and ultimately complete loss of the posterior talon.

Though the lower molars of *Chrysochloris* are extremely like those of *Amphitherium*, and the upper molars somewhat like some of the early types, it seems probable that both types are really degenerate derivatives of more normal types, such as seen in *Dasyurus*, and they are of particular value

in that by showing how the degeneration has taken place we get a clue as to the mode of original development.

In tracing the phylogeny of mammalian molars it is to be regretted that we have so few specimens of upper molars of the Jurassic and Cretaceous types, but we have sufficient lower molars to guide us some way on sure ground. We can safely conclude that a series of simple conical teeth in some reptilian ancestor gave rise to more or less simple teeth in some early mammalian type. Even without leaving the reptilian groups we find teeth becoming complicated by the addition of cusps. In the Pareiasauria the teeth have a series of lateral cusps which give them an appearance not unlike those of *Zeuglodon*. In the *Dinocephalia* we find an elaborate development of cusps in the incisors of *Titanosuchus* and *Delphinognathus*. Among the *Anomodontia* well-developed cusps are formed on the molars on *Endothiodon*, *Opisthoctenodon*, and *Pristerodon*. When we reach the *Cynodontia* we find cusps on the molar teeth of most of the genera. These reptilian cusps have probably no direct connection with those formed on the mammalian molars, but are interesting as showing that the mammal-like reptiles have the same potentiality for cusp development.

The probability seems to be that the earliest mammals had simple conical teeth such as certainly occur in some *Cynodonts*, *e. g.* *Bauria*, and that gradually cusps developed on the sides to lengthen them out and make them better cutting instruments. Most of the early mammalian jaws have teeth formed of a main cusp with a small anterior and posterior cusp, and we are probably safe in concluding that all later mammalian molars are derived from this *Protodont* type or *Triconodont* type.

Those who hold that the *triconodont* type gave rise to a *Tritubercular* type where the three cusps form triangular crowns may be perfectly correct, but the evidence is less conclusive. Teeth, such as seen in *Spalacotherium* and *Menacodon*, seem to show that in the lower molars at least there is a tendency to form triangular crowns. In the *Sea*

Leopard we see a triconodont tooth doubtless formed by degeneration, but apparently as a secondary specialisation we find the posterior molars tending to become triangular and to lock into one another. In *Chrysochloris* we see the stages by which a simple hoplodont tooth at least can become converted into a tooth with a triangular crown; and we seem justified in concluding from all the available evidence that the mammalian lower molars are all derived from a tooth with a trigon of three cusps, to which is added a posterior talon. But whether the trigon represents the three cusps of the triconodont type, or whether the talon represents the posterior one, does not seem clear. Personally, I incline to the latter alternative. From such a tooth, however, probably all later mammalian lower molars have been derived, even those of the multituberculates.

In endeavouring to trace the upper molars of higher mammals from a triconodont type, the difficulties are greater than with the lower. We may, however, I think conclude, with Gidley, that the evidence is very strongly against the antero-internal cusp being the homologue of the reptilian cone, and in favour of the antero-external cone being the homologue. Embryology is said to support this view, but I am by no means satisfied that the evidence is valid, and therefore give no weight to it. But if we accept the pre-molar-analogy theory, we must conclude that the primitive cusp is the antero-external. The evolution of the other cusps is, however, a matter of considerable uncertainty.

If the upper molars and premolars are derived from a triconodont type, it is almost necessary to assume that the anterior cusp became reduced or disappeared. The upper molars of *Dicrocynodon*, when viewed from the outside, show only the main cusp and the small posterior one, and only two cusps are generally found on the outer side of the Cretaceous upper molars. These two cusps become in later molar types the paracone and metacone. The antero-internal cusp has developed as an internal heel to meet the posterior cusp of the lower molar. Fig. 9 represents the cusps and

relations in the triconodont type; fig. 10 the reduction of the anterior cusp and formation of an internal heel in the upper, and the development of the small internal cusp in the lower. Fig. 11 shows a later modification where there is a well-developed protocone and three external styles. The lower molar has now a well-developed trigonid and two cusps on the talonid. This is the type which is retained in *Dasyurus*. Fig. 12 represents the last two upper and lower molars of the Australian Native Cat, and shows the relations of the upper and lower cusps. If these two molars be compared with those of *Chrysochloris*, as shown in fig. 13, the correspondence is so close as to leave little doubt as to the general agreement of the main cusps at least.

The cause of the loss of the postero-external triangle from the upper molars of *Chrysochloris* is probably to be looked for in the altered functions of the teeth. In normal insectivorous and carnivorous types the teeth are crushing and cutting instruments. In *Chrysochloris*, with the change of diet from insects to worms, the teeth have come to be like the reptilian teeth, mainly instruments of prehension. The various species of *Chrysochloris* bite the worms, and may break them into inch lengths, but they do not masticate them, and very frequently quite entire worms are found in the stomachs. In fact, *C. hottentota* appears to nearly completely lose its teeth on reaching sexual maturity, and it certainly can live quite satisfactorily without a single functional tooth in its head. When the molars first ceased to be cutting teeth the lower molar no longer needed to work against the upper one in front of it, and the large posterior cutting edge of the molar disappeared. The lower molar then formed with the upper ones behind each a biting arrangement, while the one tooth overlapped the other. In the majority of species the little talonid still meets the inner cusp, but in *C. asiatica* and others all trace of the talonid is gone, and the teeth, in biting, completely pass one another.

EXPLANATION OF PLATE 11,

Illustrating Dr. R. Broom's paper, "Some Observations on the Dentition of *Chrysochloris*, and on the Tritubercular Theory."

FIG. 1.—Right upper teeth of *Chrysochloris villosa*.  $\times 7$ . The three molars are so worn down that the paracone is completely obliterated. The anterior teeth are but slightly worn.

FIG. 2.—Left lower teeth of *Chrysochloris villosa*.  $\times 7$ .

FIG. 3.—Upper deciduous teeth of *C. villosa*,  $\times 7$ , in an unworn condition.

FIG. 4.—Lower deciduous teeth of *C. villosa*,  $\times 7$ , viewed from within.

FIG. 5.—Lower molar of *Amphitherium*.

FIG. 6.—Lower molar of *Deltatherium*.

FIG. 7.—Last two upper molars of *Perameles nasuta*.  $\times 5.2$ .

FIG. 8.—Last two upper molars of *Dasyurus viverrinus*.  $\times 5.2$ .

FIG. 9.—Diagram of molars of *Triconodont* type.

FIG. 10.—Diagram of molars of type where internal ledge of upper meets talonid of lower.

FIG. 11.—Diagram of typical primitive carnivorous type of molars.

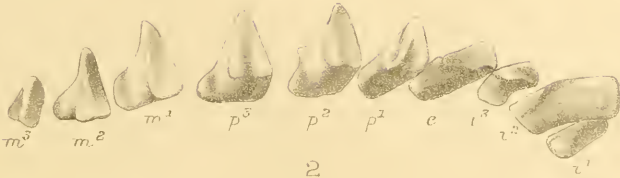
FIG. 12.—Diagram of last molars of *Dasyurus*.

FIG. 13.—Diagram of molars of *Chrysochloris*.

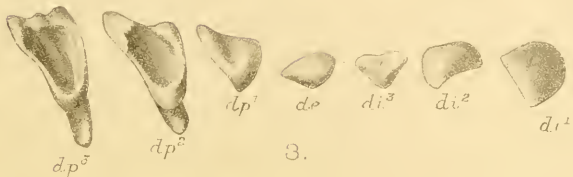




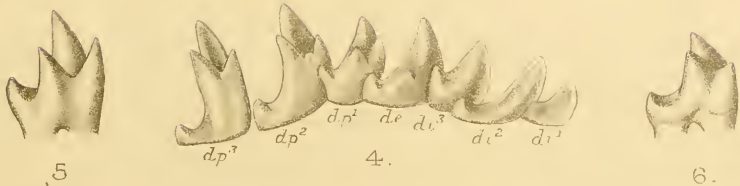
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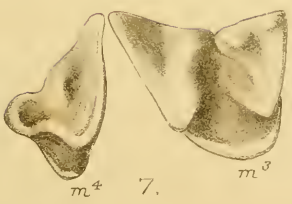
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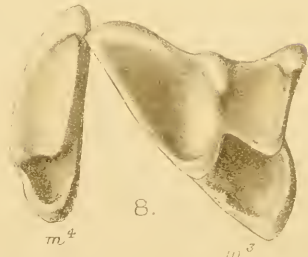
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**Petrographical Notes on the Dolerites and  
Rhyolites of Natal and Zululand.**

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With Plates III-VI.

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THE following petrographical notes are the result of an examination of a large number of rock specimens, which were collected by Mr. W. Anderson when acting as Government Geologist of Natal during the years 1899-1905. The specimens are mainly of igneous rocks, which are briefly referred to in the three Reports of the Geological Survey of Natal and Zululand published in 1901, 1904, and 1907 respectively, under Mr. Anderson's direction. Small fragments, together with thin slices of the rocks were placed at my disposal for examination by Dr. E. Warren, Director of the Natal Government Museum at Pietermaritzburg; and the following brief notes, the result of that examination, are here placed on record, since they present some points of interest, although unfortunately they cannot be accompanied by any very detailed descriptions of the mode of occurrence of the rocks in the field.

Most of the specimens are of the dolerites which occur so ubiquitously as intrusive dykes and sills in the Karoo formation of South Africa, but the collection also includes rhyolitic

rocks of the Lebombo Range, and norites and pyroxenites of the Umqueme Range in north Zululand, as well as pebbles from the Dwyka Conglomerate at Park Rynie, Natal, and a few examples of granites, gneisses, pyroxene-granulites, and hornblende-schists of the Archæan Series.

#### DOLERITES.

The widespread occurrence of intrusive dolerites is one of the characteristic features of South African geology. In Natal and Zululand, according to Anderson, they are almost universal in their occurrence as dykes and sills of enormous extent, intrusive in all formations up to the top of the Upper Karoo.

Of the numerous localities in Natal from which specimens were obtained may be mentioned Dundee, Ladysmith, Newcastle, and Majuba Hill in the north; the coast region between the mouths of the Sinkwazi, Umvoti, Tongaat, and Umlhali rivers in the east; the Hlangweni Valley, Glendale, Kearsney, and Stanger in the Lower Tugela district; and Ixopo Creek and Inhlazan Mountain (almost the entire mass of which is stated to consist of dolerite) in the south-western district.

In Zululand, according to Anderson, these rocks attain their greatest development immediately to the south and east of the St. Lucia coal-field, and form the Entondweni Mountains and the eastern half of the Makowe Hills. Besides specimens from these localities the collection contains others from the Hlabisa District, Intambanana Creek, Mona Creek, Umlalaas, Nkandla, and the Umqueme Range.

The mineral and structural characters of dolerites from South Africa have been often described. In their general characters the specimens from Natal and Zululand in the present collection are similar to those (chiefly from Cape Colony) minutely investigated by Cohen and others.<sup>1</sup> The

<sup>1</sup> See Cohen, 'Neues Jahrb. f. Min., etc.,' V. Beil Band, 1887, p. 195; and Rogers, 'The Geology of Cape Colony,' 1909, p. 258.

following account is therefore devoted mainly to a description of the more interesting structural variations presented by these rocks.

**Mineral Composition.**—The rocks consist mainly of labradorite, brown augite, which is nearly colourless in thin slices, and (generally in comparatively small amount) iron ores (magnetite and ilmenite). Accompanying the monoclinic pyroxene, in many specimens, is enstatite, a constituent which does not appear to have been noted in South African dolerites previously described. Biotite and original hornblende, mentioned as often present in the dolerites of Cape Colony,<sup>1</sup> were not found in these rocks of Natal and Zululand.

Olivine is present in large amount only in a few specimens of coarse-grained ophitic dolerites, such as the rocks from "dyke in the Metamorphic Series," half way up Bosman's Folly, north of the Umhlatuzi River in Zululand (442),<sup>2</sup> from the top of a hill near Ingogo battle-field (20), and from Inhlazan Mt., thirty miles west of Pietermaritzburg, Natal (245). These show numerous irregular olivines, mostly enclosed in large ophitic plates of augite. In a dolerite intrusive in coal-measure sandstone at Ugata Hill, Hlabisa, Zululand (424), the olivine, like the augite, occurs in irregular plates, interpenetrated by and enclosing felspar laths (see Pl. III, fig. 1). In other specimens (e. g. dolerites from Majuba Hill, Natal; Makowe Hills and Umlalaas, Zululand) the olivine occurs in small grains only sparingly distributed. By far the greater number of dolerites in the collection are without olivine.

Many of the specimens (e. g. a coarse-grained, gabbro-like rock, intrusive in sandstones and shales at the mouth of the Umhlali River, Natal (160), and altered dolerites from the Makowe Hills in Zululand) show in thin sections patches of more acid material, with quartz in spherulitic and micropegmatitic intergrowth with felspar, such as occur so commonly in the dolerites of Cape Colony. In this and many other respects (mode of occurrence, mineral composition, etc.) these

<sup>1</sup> See Rogers, l. c., p. 273.

<sup>2</sup> The numbers in brackets refer to the list of specimens.

rocks present striking similarities with the dolerites which were found by H. T. Ferrar, the Geologist to the Discovery Antarctic Expedition, occurring in numerous dykes and sills in the "Beacon Sandstone" of South Victoria Land.<sup>1</sup> They are also very similar to the dolerites ("quartz-diabases") intrusive in the Newark (Triassic) sandstones and shales of New Jersey.<sup>2</sup>

**Structural Variations.**—In structure the specimens show great variations, in all probability depending mainly upon the distance from the sedimentary rocks into which the dolerite dyke or sill is intrusive. In some of the more coarse-grained varieties the augites show under the microscope irregular prismatic sections, generally twinned and exhibiting the well-known "herring-bone" structure due to fine striations parallel to the basal plane. In most of the coarse-grained specimens, however, strongly marked ophitic structure is naturally the most common. Beautiful examples of this structure are afforded by the olivine-dolerites mentioned above, and also by olivine-free dolerites intrusive in sandstone at Newcastle and at Ashwell on the Umvoti River, Natal.

From well-marked ophitic structure all gradations are passed, by diminution in the size of the augite-plates, to a granular intersertal structure, in which the augite occurs in small grains in the interstices of the felspar laths. Of examples of sub-ophitic type may be mentioned dolerites intrusive in coal-bearing rocks on Umhlali beach, and rocks intrusive in Ecca shales on Ixopo Creek, Natal. In many of these rocks the sub-ophitic plates of augite exhibit a curious undulose extinction, a black bar sweeping round as the nicols are rotated.

In this place may be mentioned the fine-grained "amygdaloidal pipe-basalts" of Anderson (see 'First Report,' p. 61), which occur to the north of the Lower Umfolosi Magistracy in Zululand (125), for, except that they contain a few amyg-

<sup>1</sup> See National Antarctic Expedition, 1901-4: vol. i, 'Geology,' pp. 49, 136.

<sup>2</sup> J. V. Lewis, 'Geol. Surv. of New Jersey,' Annual Report for 1907, 1908, p. 97.

dules of calcite and epidote or green earth, they show for the most part a granular intersertal or variolitic structure and other characters similar to those exhibited by contact-specimens of undoubtedly intrusive rocks, such as the dyke-rock (73) cutting black shales three miles east of Incongwane Hill, Zululand, the dolerite (177) in sandstone near Glendale, and the sill (191) in coal-measure sandstone north of Isebeni Creek, between the mouths of the Umhlali and Umvoti Rivers, Natal. In connection with these basaltic rocks, a specimen (179) from three miles north of the mouth of the Tongaat River, Natal, which shows an absolutely abrupt passage from a coarse-grained dolerite to a fine-grained basalt, is noteworthy. The dolerite of this specimen consists of a coarse-grained aggregate of plates of labradorite, prismatic colourless augites, and much interstitial micro-pegmatitic material, while the basalt in contact with it shows small porphyritic labradorites, colourless augites, and a few altered olivines (some surrounded by a fringe of purplish augite) in a base dense with magnetite.

Of more compact and finer-grained structure than these basaltic rocks are other specimens which were doubtless taken close to the contact with the sandstone or shale, into which the dolerites were intruded, for they present a similar gradation in structural characters to that exhibited by dolerites of the Ferrar Glacier, South Victoria Land, taken within six inches of the contact with the sandstone.<sup>1</sup> Very similar to the rock figured in Pl. X, fig. 3 of the 'Discovery Report,' are, for example, specimens from a dolerite (74) intrusive in black shales in the bed of the Umsunduzi River, two miles east of Incongwane Hill, Zululand, and from a dyke (24) 17 feet wide at the 200 feet workings, Newcastle Colliery, Natal. These consist of radiating felspar laths and small prismatic augites, with interstitial patches of base black with magnetite. Other specimens show a radiating variolitic structure like that figured in Pl. X, fig. 4 of the 'Discovery Report.' One such specimen (205) from a sill intrusive in shales on Umhlali

<sup>1</sup> See l.c., vol. i, 'Geology,' pl. x, figs. 2-5.

Beach, Natal, contains large glomero-porphyritic masses of clear, glassy feldspar, broken up and invaded by the variolitic base, as seen in Pl. III, fig. 2. Most of the feldspar shows no twin-striations, but one section in which albite twinning was observed gave symmetrical extinction about the twin-lamellæ as high as  $30^{\circ}$ . A few phenocrysts of enstatite are also present in the slide. Of still denser variolitic character are pale grey specimens of so-called "felsite" from the Coal Measures, Umhlali, Natal. One of these (215) shows a few porphyritic labradorites, micro-pegmatitically intergrown with quartz (see Pl. IV, fig. 1), and one or two small, rounded augites, in a dense base consisting of variolitic feldspathic material, through which runs a complicated network of lines made up of a doubly refracting mineral enclosing thickly distributed grains of magnetite. These interlacing lines are distinct from the long radiating feldspar-needles of the variolitic feldspathic base; in some specimens they have high extinction angles and consist probably of augite; in others, however, they give nearly straight extinction, and in these cases the augite has doubtless been altered to hornblende. The structure is strikingly similar to that presented by many iron-slugs. Precisely similar specimens come from Intambanana Creek (388), and from "a hill north of Umhlaluzi crossing above middle drift," Zululand (428), where the rock is intrusive in Ecca shales. In the rock from Intambanana Creek the interlacing curved lines of doubly refracting material with included grains of magnetite present a most fantastic appearance (see Pl. IV, fig. 2), and consist for the most part of strings of globulites. In another specimen (385) from the same creek, the fine needles of augite, giving high extinction-angles and enclosing magnetite grains, are shorter and suggest by their arrangement a more or less well-defined flow structure; still another specimen (386) from the same locality is a dense brown tachylyte showing incipient spherulites. These are all probably junction specimens of the coarser-grained sub-ophitic dolerite (387) from the same locality, while specimen 428 from above the middle drift,

Zululand, is doubtless a junction specimen of the enstatite dolerite (426), described later on p. 148.

#### NORITES, PYROXENITES, AND ENSTATITE-DOLERITES.

The igneous rocks, of "granitic type," as described by Anderson,<sup>1</sup> which form the Umqeme Range, and are stated to be older than the Table Mountain sandstone, are mainly norites or coarse-grained enstatite-dolerites. From their mineral character they might very well be more deeply seated rocks derived from the same magma which supplied the dolerites just described. They occur about three or four miles north of Dingatuli Hill, between the Hlabisa and Lebombo Magistracies. They vary from dark pyroxenites (81 and 85), consisting almost entirely of a slightly pleochroic enstatite with very little felspar, to colourless granite-like rocks (84, 86, 87, 411, 414) allied to anorthosites, since they consist mainly of felspar (labradorite with symmetrical extinctions of 22°-27°) with very sparingly distributed crystals of pale brown enstatite. Iron ores in these particular extremes are almost entirely absent. Of intermediate character is a coarse-grained olivine enstatite dolerite, or olivine norite from the eastern end of the Umqeme Range (408). This is a dark brown gabbro-like rock, in which the enstatite and olivine are in excess of the felspar. The enstatite is in large crystals showing traces of prism faces, and depolarising only in grey tints. It is of later growth than the felspars, since it encloses or is penetrated by the latter in sub-ophitic fashion. Associated with the enstatite is a more strongly refractive augite, which in thin slices under the microscope is seen in broad, irregular, ophitic plates, sometimes penetrated by tongues of enstatite from an adjacent crystal, or enclosing small fragments of enstatite in optic continuity with an adjacent crystal (see Pl. V, fig. 1). This structure is somewhat similar to that exhibited by intergrowths of hypersthene

<sup>1</sup> See 'Second Report,' p. 66, and 'Third Report,' p. 133.

and diallage in the "diallage-norites" of Zwartkoppies, north-east of Pretoria, described by Henderson.<sup>1</sup> The olivine in the present rock occurs in large amount in irregular sections, only one or two of the larger ones showing traces of prism faces. Some of the sections show curious inclusions of iron-ore, consisting of minute bundles of radiating rods, of which those directed parallel to the vertical axis of the olivine are much more elongated than the rest. Almost precisely similar characters to those of this rock from the Umqueme Range are presented by a rock (190) from "pieces of quern," to the north of the mouth of the Umhlali River, Natal. Of olivine-free rocks a diallage-norite (458) "intrusive between granite and Table Mountain sandstone" on the Madengela Ridge, east of Nkandla, Zululand, is noteworthy, since it resembles closely the rocks from the Transvaal, described by Henderson, to which reference has just been made. In this rock the orthorhombic pyroxene is faintly pleochroic from nearly colourless (with a very faint greenish tint) to pale pink, and is enclosed and intergrown with a diallage-like augite showing the well-known "herring-bone" structure.

Of finer-grained ophitic and sub-ophitic dolerites like those described in the preceding section, but containing enstatite in small amount in addition to augite, may be mentioned specimens from the same locality as the above coarse-grained norites, viz. north of Dingatuli Hill in the Umqueme Range, and also specimens from a sill in shales north of the mouth of the Umhlali River, Natal, and from a "hill north of the Umhlatusi Crossing above Middle Drift," Zululand (426). In the latter rock the phenocrysts of enstatite are surrounded by a sharply defined zone of augite (see Pl. V, fig. 2). A chemical analysis of the last-mentioned rock gave the following result under I:—

<sup>1</sup> 'Norites, Gabbros and Pyroxenites and other South African Rocks,' London, 1898, pp. 14 and 18, and pls. iii and iv, figs. 15-18.

	I. (Zululand.)	Moler per- centages.	II. (Knob Head.)	III. (Londorf.)
SiO <sub>2</sub> . . . . .	53·29	53·21	53·26	53·52
TiO <sub>2</sub> . . . . .	1·14	0·84	0·70	1·84
Al <sub>2</sub> O <sub>3</sub> . . . . .	13·20	7·79	15·64	13·56
Fe <sub>2</sub> O <sub>3</sub> . . . . .	1·14	0·42	0·24	4·93
FeO . . . . .	10·72	9·11	7·44	6·61
MnO . . . . .	0·15	—	0·11	—
CaO . . . . .	6·81	7·19	12·08	7·39
MgO . . . . .	7·78	11·68	8·64	7·37
K <sub>2</sub> O . . . . .	1·40	0·90	0·58	0·68
Na <sub>2</sub> O . . . . .	2·38	2·28	1·25	3·22
P <sub>2</sub> O <sub>5</sub> . . . . .	0·08	—	0·04	—
H <sub>2</sub> O (below 110°) .	0·71	2·39	0·35	} 1·03
H <sub>2</sub> O (above 110°) .	1·22	4·19	0·41	
	100·02	100·00	100·74	100·15

The analysis corresponds to the following "norm"—

Quartz . . . . .	2·94	} 49·65
Orthoclase . . . . .	8·34	
Albite . . . . .	19·91	
Anorthite . . . . .	21·40	
Augite { CaSiO <sub>3</sub> . . . . .	4·98	} 41·50
and { FeSiO <sub>3</sub> . . . . .	17·02	
Enstatite { MgSiO <sub>3</sub> . . . . .	19·50	
Magnetite . . . . .	1·62	
Ilmenite . . . . .	2·13	
Water . . . . .	1·93	

99·77

and the rock in the American system would be classed as Camptonose. Under II, for comparison, is given the analysis of a dolerite from Knob Head on the Ferrar Glacier, South

Victoria Land,<sup>1</sup> and under III the analysis of a glassy dolerite from Londorf, Vogelsgebirge.<sup>2</sup>

In connection with the dolerites a peculiar hybrid rock is worthy of description. It is intrusive in granite about five miles above the crossing of the Mapamulo and Isidumbeni road over the Umvoti River, Natal. The specimen (226) of this rock in the collection is labelled "basalt which has absorbed granite, only leaving porphyritic crystals of felspar." It has a minette-like appearance, and shows under the microscope (see Pl. VI, fig. 1) small reddish-brown biotites and pale green augites, plentifully and evenly distributed in a felspar mosaic. With the augite is associated a little faintly pleochroic enstatite; the feldspars are mainly of oligoclase, showing albite twinning, and having a refraction slightly higher than that of Canada-balsam. There are present also included patches of micro-pegmatitic material (quartz de corrosion) similar to that in the granite associated with the rock, and large crystals of oligoclase showing symmetrical extinctions about the twin-lamellæ of about  $10^\circ$ , and containing small blebs of pale-green augite, grains of magnetite, and rods of biotite. A few quartz grains, occasionally micro-pegmatitically intergrown with felspar, are present in the mosaic; grains of magnetite are only very sparingly distributed. All the constituents are clear and fairly free from inclusions. Another specimen (225), from the same locality, shows the junction of a coarse-grained granite with a somewhat similar rock to the above, except that in this case a green to yellow hornblende takes the place of the augite. This rock bears some resemblance to the hybrid rocks from Skye described by Harker.<sup>3</sup>

The granite which is said to occur as "seams" in the hybrid rock is a coarse-grained rock consisting of large orthoclases and microperthites with some oligoclase in a coarse

<sup>1</sup> L. c., vol. i, 'Geology,' p. 137.

<sup>2</sup> Streng, 'Neues Jahrb. f. Min., etc.,' 1888 (2), p. 217.

<sup>3</sup> Harker, "The Tertiary Igneous Rocks of Skye," 'Mem. Geol. Surv.,' 1904, p. 182.

quartz-mosaic. The oligoclases are much altered with development of a fibrous hornblende mineral and patches of micropegmatite similar to those in the hybrid rock. The "fine-grained granite vein" in the hybrid rock is similar, but of finer grain, and consists of similarly altered oligoclases in a mosaic of quartz, orthoclase, and microcline, with altered biotite only in small amount.

Much altered dolerites (amphibolites, and typical epidiorites with uraltic hornblende and clear plagioclastic feldspar) occur as dykes in the granite-gneiss between the eighteenth and twentieth mile-pegs on the Melmoth and Eshowe Road, Zululand.

Most of the pebbles in the Dwyka Conglomerate at Park Rynie, Natal, are of dolerites which have been much altered with development of epidote, uraltic hornblende and leucoxene; they generally show coarse interstitial micropegmatitic material like so many of the dolerites intrusive in the Karoo formation.

Associated with the dolerites in Cape Colony, as is well known,<sup>1</sup> are granophyric rocks said to be differentiation products of the magma which supplied the dolerites, so many of which contain granophyric patches. In the present collection there are a few specimens of these rocks. One of them (197), labelled "decomposed dyke," comes from Umhlali Beach, Natal. It is a white rock showing no ferro-magnesian constituents. Under the microscope it is seen to consist of small feldspar prisms and skeletal crystals of quartz surrounded by spherulitic material. In thin slices (Pl. VI, fig. 2) under the microscope central square sections of feldspar, giving straight extinction, are seen surrounded by a clear zone of quartz with diagonal extinction, which in its turn is surrounded by spherulitic material. The skeletal crystals of quartz give sections of various shapes, triangular, nearly rectangular (with diagonal extinction), or elongated along a central axis with lateral notched projections (see Pl. VI, fig. 2). They appear to be mostly bipyramidal crystals. That they consist

<sup>1</sup> See Rogers, l. c., p. 275, and pl. xix, p. 277.

of quartz appears to be certain from the fact that the refraction is practically the same as Canada-balsam, and that some of the triangular sections show in convergent light a well-defined positive uniaxial figure. In another rock (15) "cropping out in middle of plain to the south-east of Dundee, Natal," the structure is of the more usual type, with rounded grains of quartz surrounded by spherulitic and granophyric material.

Perhaps the most interesting point brought out by the examination of the dolerites is their general resemblance to those of the Ferrar Glacier in South Victoria Land. In both regions, dykes and sills of a somewhat similar dolerite, of medium acidity and of Pacific type, occur over a large area, intrusive in sandstone and shale formations, which, it seems not unreasonable to suggest, may possibly be of about the same age. In both the actual Continental areas over which these ancient dolerite intrusions are spread, no volcanic rocks of recent date are found, but in each case in neighbouring islands (Ross Island, etc., in South Victoria Land, Madagascar in South Africa) in later geological times volcanic eruptions have taken place, of which the products are in both regions of very similar character, viz. soda-rich phonolitic rocks of decidedly Atlantic type.

#### RHYOLITES OF THE LEBOMBO RANGE.

Most of the specimens from the Lebombo Range are of acid glassy rocks. Though on the whole best classed as rhyolites, some of them, containing less silica and more lime-soda felspar than typical rhyolites, approach to trachytes of the Toscanite type of Washington.<sup>1</sup> Closest to typical rhyolites are a number of specimens of glassy rocks from near "Crossly's Store" at the southern end of the Lebombo Range. In some of these the original glassy base is altered and devitrified; in most, however, the glass and also the enclosed felspars and augites are quite fresh and unaltered.

<sup>1</sup> See 'Journ. of Geol., Chicago,' v (1897), p. 37.

A typical specimen of a pitchstone-like rock (116) comes from Manuan Creek near Crossly's Store where the rhyolites are in contact with Cretaceous beds. This rock shows under the microscope fairly numerous but small phenocrysts of unstriated felspar, with a few small and altered pale green augites, in a glass showing well-marked flow-structure and less pronounced perlitic structure, and rendered dense by thickly distributed short needle-like microliths. The felspar phenocrysts, although showing no twin-striations, are probably near to anorthoclase as the refraction is about equal to that of Canada-balsam. An interesting accessory constituent, occurring in one or two small crystals, is in all probability allanite: one of the sections is a twin with symmetrical extinction of about  $32^\circ$ , and another shows oblique extinction of about  $38^\circ$  and pleochroism from dark brown (nearly opaque) to reddish-brown: traces of cerium earths were detected in the course of the chemical analysis of the rock (see p. 154).

Other specimens from Crossly's Store show similar phenocrysts of orthoclase and anorthoclase in a base which is no longer glassy but devitrified and incipiently spherulitic. Still other specimens (408) are brecciated, and consist mainly of fragments of a beautifully perlitic glass, banded brown and white. In a rhyolitic agglomerate (112) from the same locality some of the fragments consist of a mass of minute spherulites giving well-marked crosses between crossed nicols.

A chemical analysis of the specimen (116) from Manuan Creek described above gave the following result under I.

The numbers under II were obtained in the analysis of another sample of the glass, which was made in order to confirm the comparatively high percentage of alumina. Under III is given the molecular composition of the rock, and under IV the analysis of a spherulitic "liparite pitchstone" from Silver Cliff, Colorado.<sup>1</sup>

<sup>1</sup> Eakins and Cross, 'Bull. Phil. Soc. Wash.,' xi, 1891, p. 420.

	I.	II.	III.	IV.
	(Manuan Creek.)			(Colorado.)
SiO <sub>2</sub> . . . . .	71.41	71.20	69.51	71.56
TiO <sub>2</sub> . . . . .	0.01	—	—	—
Al <sub>2</sub> O <sub>3</sub> . . . . .	13.94	13.81	8.00	13.10
Fe <sub>2</sub> O <sub>3</sub> . . . . .	0.63	1.64	0.23	0.66
FeO . . . . .	0.78		0.70	0.28
MnO . . . . .	0.09			0.16
CaO . . . . .	0.62	—	0.76	0.74
MgO . . . . .	0.09	—		0.14
Ce earths . . . . .	traces	—	—	—
K <sub>2</sub> O . . . . .	4.74	—	2.92	4.06
Na <sub>2</sub> O . . . . .	3.75	—	3.51	3.77
P <sub>2</sub> O <sub>5</sub> . . . . .	traces	—	—	—
H <sub>2</sub> O (at 110°) . . . . .	0.34	—	1.11	5.52
H <sub>2</sub> O (above 110°) . . . . .	4.09	—	13.26	
	100.49		100.00	99.99

Calculation of the "norm" gave the following result:—

Quartz . . . . .	29.88
Orthoclase . . . . .	27.80
Albite . . . . .	31.44
Anorthite . . . . .	3.06
Al <sub>2</sub> O <sub>3</sub> . . . . .	1.63
MgSiO <sub>3</sub> . . . . .	0.20
(FeMn)SiO <sub>3</sub> . . . . .	1.06
Magnetite . . . . .	0.93
Water . . . . .	4.43

In the American classification the rock would be classed under Liparose.

A dark glassy rock (402) from Indulawane Hill, south of Crossly's Store, is of more basic composition. Under the microscope the rock shows small, well-shaped phenocrysts of felspar in a glassy base crowded with microliths; magnetite grains and pale-green augites are sparingly distributed. Of the porphyritic felspars some show the minute twin-striations characteristic of anorthoclase while others show Albite twinning, with symmetrical extinctions about the twin-lamellæ of

about  $16^\circ$ . The glassy base, which is dense with globulites, contains also long needle-like microliths of augite, with high extinction angles, and small prismatic feldspars generally showing albite twinning and nearly straight extinction. Of somewhat similar character as regards phenocrysts but with holo-crystalline instead of glassy base are specimens (447-450) from the Mkuzi River. One of these (447) is a red and white speckled rock showing to the naked eye a few small phenocrysts of feldspar. These phenocrysts, which are mostly of plagioclase showing albite twinning with symmetrical extinctions as high as  $18^\circ$ , together with a few small, pale-green augites, occur in a ground-mass consisting of quartz and feldspar, the quartz being either in micropegmatitic intergrowth with the feldspar or forming a paste round small feldspar prisms.

A chemical analysis of the glassy rock (402) from Indulawane Hill gave the following result under I:—

	I. (Indulawane Hill.)	II.	III. (Toscanite.)
SiO <sub>2</sub>	66.40	65.94	64.04
TiO <sub>2</sub>	0.54	0.42	0.28
Al <sub>2</sub> O <sub>3</sub>	12.91	7.57	14.48
Fe <sub>2</sub> O <sub>3</sub>	3.87	1.43	1.73
FeO	2.56	} 2.20	4.35
MnO	0.09		—
CaO	2.32	2.50	4.00
MgO	0.53	.77	1.03
K <sub>2</sub> O	3.09	1.96	3.65
Na <sub>2</sub> O	3.30	3.16	4.14
P <sub>2</sub> O <sub>5</sub>	0.16	—	—
H <sub>2</sub> O at $110^\circ$	1.09	3.57	—
H <sub>2</sub> O above $110^\circ$	3.16	10.48	2.06
	100.02	100.00	99.76

Under II is given the molecular percentage composition, and under III the analysis of a Toscanite from Monte Bracciano, Italy.<sup>1</sup>

<sup>1</sup> 'Journ. Geol. Chicago,' v (1897), p. 49.

The numbers obtained in the analysis correspond to the following "norm":—

Quartz . . . . .	28.92
Orthoclase . . . . .	18.35
Albite . . . . .	27.77
Anorthite . . . . .	11.40
(CaMgFe) SiO <sub>3</sub> . . . . .	3.15
Magnetite . . . . .	5.56
Ilmenite . . . . .	1.06
Water . . . . .	4.25

In the American system of classification the rock would be classed as Toscanose.

The rhyolitic rocks of the Lebombo Range appear to be of about the same age as the dolerites and basalts, for whereas in one part of the Range they are said to lie "conformably upon the basaltic series which overlie the coal-bearing Ecca series" in another part they appear to be cut by dolerite dykes.<sup>1</sup> Like the granophyres, they are probably a differentiation product of the same magma which supplied the dolerites. Although the microscopic characters of some of the rocks suggest at first some resemblance to the Kenytes, the analyses show that on the whole the rocks are nearer to the Pacific than to the Atlantic type.

### EXPLANATION OF PLATES III—VI,

Illustrating Dr. G. T. Prior's paper, "Petrographical Notes on the Dolerites and Rhyolites of Natal and Zululand."

#### PLATE III.

FIG. 1.—Ophitic dolerite from Ugata Hill, Zululand (p. 143). Olivine penetrated by and enclosing felspar laths. The felspars are represented as seen between crossed nicols. Magnification 60 diam., 1-in. objective.

FIG. 2.—Contact-dolerite from Umhlali Beach, Natal (p. 146). Glomero-porphyrific masses of clear glassy felspar in variolitic base. Magnification 60 diam., 1-in. objective.

<sup>1</sup> See Anderson, 'First Report,' pp. 60, 62, and Kynaston, 'Trans. Geol. Soc. S. Africa,' ix (1906), p. 27.

## PLATE IV.

FIG. 1.—Contact-dolerite from Umhlali, Natal (p. 146). Porphyritic feldspars micropegmatitically intergrown with quartz in variolitic base. The feldspars are represented as seen between crossed nicols. Magnification 60 diam., 1-in. objective.

FIG. 2.—Contact-dolerite from Intambanana Creek, Zululand (p. 146). Fantastically arranged strings of augite and magnetite in variolitic base. Magnification 60 diam., 1-in. objective.

## PLATE V.

FIG. 1.—Olivine-norite from Umqueme Range, Zululand (p. 147). Intergrowth of enstatite and augite, with feldspar (as seen between crossed nicols) and olivine (left lower corner). Magnification 60 diam., 1-in. objective.

FIG. 2.—Enstatite-dolerite from north of Umhlatuzi crossing, Zululand (p. 148). Phenocryst of enstatite (in centre) surrounded by zone of augite. Magnification 60 diam., 1-in. objective.

## PLATE VI.

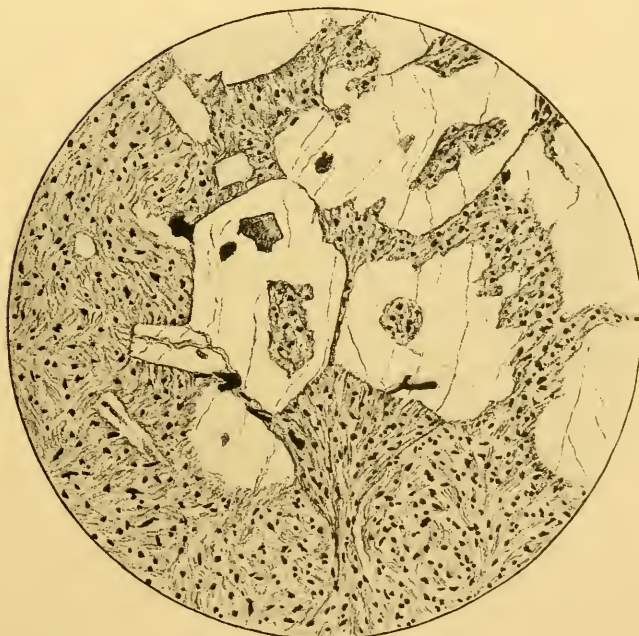
FIG. 1.—Hybrid rock from five miles above crossing of the Mapamulo and Isidembeni roads over Umvoti river, Natal (p. 150). Small reddish-brown biotites and pale green augites with enstatite in feldspar-mosaic. Magnification 60 diam., 1-in. objective.

FIG. 2.—Granophyre from Umhlali Beach, Natal (p. 151). Small feldspar prisms surrounded by skeletal crystals of quartz, which in turn are surrounded by spherulitic material. Magnification 60 diam., 1-in. objective.





1.



2.

G. T. Gwilliam, del

London Stereoscopic Co imp.

ROCKS FROM NATAL AND ZULULAND.

1 Ophitic dolerite

2 Contact-dolerite





1



2

G. T. Gwilliam, del.

London, Stereoscopic Co. Imp.

ROCKS FROM NATAL AND ZULULAND.

1 Contact-dolerite

2 Contact-dolerite





1



2

G T. Gwilliam, del.

London Stereoscopic Imp

ROCKS FROM NATAL AND ZULULAND.

1. Olivine-norite.

2 Enstatite-dolerite





1.



2.

G. T. Gwilliam, del.

London Stereoscopic Co. imp.

ROCKS FROM NATAL AND ZULULAND.

1. Hybrid rock

2 Granophyre



## The Slugs of Natal.

By

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Birmingham.

### CONTENTS.

	PAGE
1. INTRODUCTION . . . . .	159
2. SYSTEMATIC . . . . .	160
LIMACIDÆ <i>Leach</i> . . . . .	160
LIMAX <i>Linn.</i> . . . .	160
MILAX <i>Gray</i> . . . . .	161
AGRIOLIMAX <i>Mörch.</i> . . . .	161
UROCYCLIDÆ <i>Simroth</i> . . . . .	161
UROCYCLUS <i>Gray</i> . . . . .	161
APERAIIDÆ, <i>fam. nov.</i> . . . .	163
APERÄ <i>Heynemann</i> . . . . .	163
History of the Genus . . . . .	163
Description of the Genus . . . . .	165
Description of the Species . . . . .	165
Habits and Habitat . . . . .	168
Distribution . . . . .	169
Affinities and Systematic Position . . . . .	169
ARIONIDÆ <i>Gray</i> . . . . .	170
OPELTA <i>Mörch.</i> . . . .	170
ARION <i>Fér.</i> . . . .	170
VERONICELLIDÆ <i>Gray</i> . . . . .	170
VERONICELLA <i>Blainv.</i> . . . .	170
ONCHIDIIDÆ <i>Gray</i> . . . . .	171
ONCHIDIUM <i>Buchan.</i> (em. Plate) . . . . .	171
3. BIBLIOGRAPHY . . . . .	172

### 1. INTRODUCTION.

No separate account of those molluscs, known as slugs, of Natal has hitherto been published. Towards the end of 1901

(7) I published a check list of the slugs of South Africa, which included twenty-eight species, of which nine were common to Natal.

In the intervening eight years Mr. Henry C. Burnup, of Pietermaritzburg, has lost no chance that has presented itself of adding to this list; indeed, had it not been for his unremitting labour the preparation of the present account of those species of slugs common to Natal would have been impossible.

It is therefore with sincere pleasure that I here place on record the indefatigable and untiring energy and interest he has shown, and the valuable assistance he has at all times given me.

Apart from Krauss's (15) well-known work, and the list previously mentioned, there is no account of the slugs of Natal. The various references to the writings of different authors on particular species will be found scheduled under each.

As it stands at the present time the slug fauna of Natal is a most interesting, and at the same time a most curious one. It contains representatives of six great families, and includes fifteen species. Of these four have undoubtedly been introduced, and one genus—*Apera*—has not yet been found to occur outside South Africa.<sup>1</sup>

## 2. SYSTEMATIC.

Fam. LIMACIDÆ *Leach.*

Sub-fam. LIMACINÆ *W. G. Binn.*

Genus LIMAX *Linn.*

*Limax flavus* *Linn.*

*Limax flavus* *Linné*, *Syst. Nat.*, 1758, vol. i (ed. x), p. 652 = *L. variegatus* *Auctt.*

<sup>1</sup> Dr. Simroth (27) has described a peculiar and possibly allied slug from South Africa (Cape Flats) to which he has given the name *Ceratoconcha schultzei*.

This has undoubtedly been introduced, and is fairly common in Pietermaritzburg, and probably elsewhere.

Genus *MILAX* Gray.

*Milax gagates* (Drap.).

*Limax gagates* *Draparnaud*, Tabl. Moll., 1801, p. 100, No. i; Hist. Moll. France, 1805, p. 122, pl. ix, fig. 1.

As I have elsewhere pointed out (7, p. 230) the South African examples of this species which have passed through my hands have mostly differed slightly in anatomical details from the European *gagates*, but these are not of sufficient importance to warrant separation from that species.

Hab.—Pietermaritzburg.

Genus *AGRIOLIMAX* Mörch.

*Agriolimax agrestis* (Linn.).

*Limax agrestis* *Linné*, Syst. Nat., 1758, vol. i (ed. x), p. 652.

All the examples I have seen of this slug are practically identical with those found in Great Britain.

Hab.—Pietermaritzburg.

Fam. *UROCYCLIDÆ* *Simr.*

Genus *UROCYCLUS* Gray.

*Urocyclus kirkii* Gray.

*Urocyclus kirkii* *Gray*, Proc. Zool. Soc., 1864, p. 251; Gibbons, Quart. Journ. Conch., 1879, vol. ii, p. 139; Heynemann, Jahrb. d. Deutsch. Mal. Ges., 1885, Bd. xii, p. 293; Cockerell, Conchologist, 1893, vol. ii, p. 187; Simroth, Deutsch. Ost-Afr. IV, Naachtschn., 1895, p. 6.

Amongst the many South African specimens belonging to this genus which have passed through my hands I have met with nothing that could be referred to this species.

*Urocyclus flavescens* (Keferst.).

*Parmarion flavescens* Keferstein, Malak. Blatt., 1866, p. 70, t. ii. figs. 1-8.

*Urocyclus flavescens* (Keferst.); Gibbons, Quart. Journ. Conch., 1879, vol. ii, p. 138; Heynemann, Jahrb. d. Deutsch. Mal. Ges., 1885, Bd. xii, p. 293; Cockerell, Conchologist, 1893, vol. ii, p. 187; Simroth, Deutsch. Ost-Afr. IV, Naektschn., 1895, p. 6.

Hab.—Pinetown, Pietermaritzburg.

*Urocyclus fasciatus* v. *Martens*.

*Urocyclus fasciatus* v. *Martens*, Jahrb. d. Deutsch. Mal. Ges., 1885, Bd. xii, p. 293; Cockerell, Conchologist, 1893, vol. ii, p. 187; Simroth, Deutsch. Ost-Afr. IV, Naektschn., 1895, p. 6.

Gibbons recorded a species of *Urocyclus* in 1879, which he referred to *U. flavescens* *Kef.* Cockerell (9) regarded it as referable to *fasciatus* *Marts.*, and judging from the description this is probably correct.

Hab.—Mozambique and Pietermaritzburg.

*Urocyclus pallescens* *Okll.*

*Urocyclus pallescens* *Cockerell*, Ann. Mag. Nat. Hist., 1891 (6 ser.), vol. viii, p. 101; Conchologist, 1893, vol. ii, p. 187.

“Length (in alcohol)  $31\frac{1}{2}$  mm.; uniform pale greyish ochre, spotless. Mantle reticulated, the opening only a narrow slit, or small, rather oblong hole, very much smaller than in *kirkii*, and inconspicuous. Mucus-pore smaller than in *kirkii*. Respiratory orifice as in Heynemann’s figure of *fasciatus*. Reticulation on body in longitudinal squarish series, about twelve on each side. Mantle bluntly angulate behind. Keel indistinct, no lateral ridges.

“The mantle is 12 mm. long, with the slit or opening very near its hind edge.

“Central area of sole about as wide as either lateral area.

“Shell, long. 6, lat. 4 mm., strong, well-formed.

“Hab.—Durban, Natal (A. E. Craven, 1875). Two specimens in British Museum.”

The above was described by Prof. Cockerell in 1891, but I have not met with any specimens that could be referred to this species.

*Urocyclus kraussianus* (Heyn.).

*Limax* (*Arion*) sp.? *Krauss*, Südafr. Moll., p. 73.

*Limax kraussianus* *Heynemann*, Malak. Blatt., 1862, Bd. ix, p. 217.

*Urocyclus* ? *kraussianus* (*Heynemann*), Jahrb. d. Deutsch. Mal. Ges., 1885, Bd. xii, p. 293; Cockerell, Ann. Mag. Nat. Hist., 1891 (6 ser.), vol. vii, p. 102; Conchologist, 1893, vol. ii, p. 187; Simroth, Deutsch. Ost-Afr. IV, Nachtsehn., 1895, p. 6.

Although I have examined large numbers of specimens of this genus, nothing that has passed through my hands could be referred to this species.

The description given by Krauss is very inexact.

Fam. APERAIDÆ, *fam. nov.*

Genus APERA *Heyn.*

= CHLAMYDEPHORUS *W. G. Binney*.

But little has been written upon the slugs of this genus. It was originally constituted by Binney (2) in 1879 under the name of *Chlamydephorus*, for *A. gibbonsi* (*W. G. Binney*), a slug collected by Mr. J. S. Gibbons “under a stone in a wood” in the Umgeni Valley, Natal.

Four years previous to this Mr. J. S. Gibbons, in a letter to the late Mr. G. Sheriff Tye, of Birmingham, wrote as follows:

“S. S. ‘Lulu,’ Sept. 30th, 1875.

“While at Natal this last time . . . I also found a very peculiar slug, that has puzzled me greatly. It has no shield; the respiratory orifice is placed on a slight prominence in the mesial line, about  $\frac{1}{2}$  in. from end of tail. The slug when fully extended is about  $3\frac{1}{2}$  in. long, and tapers gradually to head, which is very small. Tentacles, two pairs, very short and cylindrical; a third pair of small colourless false tentacles, formed by a prolongation of the corner of the foot. This slug approaches nearer to a Testacella than anything else I know, and yet it is clearly not a Testacella. I forgot to mention that when reposing it brings together the margin of its foot, retracts the head and turns under the tail, thus [two rough figures follow]. The above is a rude sketch of the slug, not very accurate, but it may enable you to find out the genus to which it belongs.”

Binney's diagnosis was (almost necessarily) very imperfect, and in some features incorrect.

In 1885 Heynemann (13) suggested the name *Apera*, as Binney's name indicated a false characteristic, viz. the presence of a mantle lobe. This author also, as a result of an examination of the external characters, suggested that the genus belonged to the Testacellidæ, and also gave figures of this species.

In 1892 Mr. Edgar A. Smith (29) drew attention to the fact that Agassiz (1) had used the name *Chlamyphorus* for a group of Mammals, and that practically it was the same as that employed by Binney. In this same communication he described a new species, collected near to Pietermaritzburg by Mr. H. C. Burnup, to which he gave the name *A. burnupi*.

Prof. T. D. A. Cockerell (10) in 1893 pointed out that the name *Apera* was pre-occupied in botany, and was of opinion that Binney's name with the original spelling was preferable.

In 1897 (4) I gave a short but very imperfect account (from the condition of the material) of certain parts of the anatomy of *A. burnupi*, with figures of the same.

In 1900 (5) I described a further species, *A. natalensis*,

collected at Richmond, Natal, nearly in the centre of a rotten log, by the Rev. J. R. Ward, whilst searching for *Peripatus*. Mr. Ward forwarded the specimen to the South African Museum, Cape-Town, and it was ultimately submitted to me. In this paper I gave figures, from an alcoholic specimen, of *A. burnupi*, and also of the new species.

Later (6) I gave a further description and figure of the generative organs of *A. burnupi*, and in the same year described a new species—*A. purcelli*—from Cape Town (7).

It will thus be seen that we have four species belonging to this genus, viz. *A. gibbonsi* (*W. G. Binney*), *A. burnupi* *E. A. Sm.*, *A. natalensis* *Cllege.*, and *A. purcelli* *Cllege.*, the first three of which are found in Natal.

#### *APER*A *Heyn.*

*Chlamydephorus* *W. G. Binney*, Bull. Mus. Comp. Zool. Harvard, 1879, vol. v, p. 331.

*Apera Heynemann*, Jahrb. d. Deutsch. Mal. Gesell., 1885, p. 20.

Animal limaciform; cylindrical; dorsum rounded, head small: keels may or may not be present. There are a series of radiating lines from the respiratory orifice, and two prominent mid-dorsal ones. Peripodial groove faintly marked. Foot fringe distinct. Rugæ usually prominent. Respiratory orifice postero-dorsal. No caudal mucous pore.

Simroth wrongly states that there is no shell, while Cooke (11, p. 440) describes it as "a single plate, internal."

As Heynemann (13) has pointed out, Binney contradicts himself in his description of the genus, for on p. 331 (2) he states correctly "no caudal mucous pore," but on p. 358 he speaks of a caudal mucous pore.

#### *Apera gibbonsi* (*W. G. Binney*).

*Chlamydephorus gibbonsi* *W. G. Binney*, Bull. Mus. Comp. Zool. Camb., U.S.A., 1879, vol. v, p. 331, pl. ii, figs. A, B.

*Apera gibbonsi* (*W. G. Binn.*); Heynemann, Jahrb. Deutsch. Malak. Gesell., 1885, Bd. xii, p. 17, t. ii, figs. 5-7.

Animal elongate, slender, cylindrical; keels absent.

Colour a dull orange with dark brown mottling dorsally and laterally; mottling almost absent in the dorso-median line and entirely so latero-ventrally.

Peripodial groove obscure. Foot-fringe and foot-sole a dull orange (almost white or creamy white in alcohol), not differentiated into median and lateral planes.

Length (in alcohol) 27 mm., breadth of foot-sole 11 mm.

Hab.—Croftlands, Equeefa, near Umzinto; Port Shepstone; Thornybush, near Pietermaritzburg.

There is a considerable amount of variation in this species according to the age. Young specimens, measuring from 20-30 mm., are more brightly coloured and lighter.

*Apera burnupi* *E. A. Sm.*

*Apera burnupi* *E. A. Smith*, Ann. Mag. Nat. Hist., 1892 (ser. 6), vol. x, p. 466; Collinge, *ibid.*, 1897 (ser. 6), vol. xx, p. 221, pl. v; Collinge, Journ. of Malac., 1901, vol. viii, p. 71, fig. 1.

The type is described (29, p. 466) as being 28 mm. long. The largest example I have seen measured 79 mm.

This is undoubtedly the commonest species of the genus. Amongst the many specimens I have examined I have noted but little variation.

In some notes on appearance in life of this species, Mr. Burnup writes:

“Shape.—Elongate hexagonal, but when in motion the foot hides a great part of the ventro-lateral surfaces, giving the slug a more quadrate appearance. Thickest part about three-fifths of the distance from head to tail, tapering gradually towards the head, where it is squarely truncate, and more rapidly, convexly, toward the tail, ending in a point.

“Size.—Two and a half inches long, 7 mm. wide at widest

part ( $1\frac{1}{2}$  in. from head). Foramen situated about  $\frac{1}{2}$  in. from tip of tail.

“Colour.—Chestnut-brown, becoming darker towards tail, paler along the keels and on top of the tubercles or granules; no black markings, the deeper tone of the anastomosing lines and striæ appearing more the effect of shade than of pigment; no yellow tint on any part; foot brownish pinky-grey (like a sunburnt hand).

“While crawling the angles become less conspicuous and the concavity of the surfaces much shallower than when inactive. When touched with the finger the body becomes more rigid, the keels much accentuated, and the concavity between deeper.

“The lateral keels, like the dorsal, reach the whole way from head to tail.

“The two parallel striæ on the dorsal surface, and the one striæ on each of the lateral surfaces, are very distinct, and no similar line is visible on the ventro-lateral surfaces.

“The keels are not so accentuated in spirit as they are in life while the slug is being handled.

“There are very few radiating striæ from the foramen. Lower pair of bifid tentacles very small, and seldom protruded, being quickly withdrawn on contact with the damp blotting-paper on which the slug was crawling. The lower fork of these second tentacles is nearly white, the upper being the same colour as the foot, but with black points, like the eyes in the upper tentacles.

“The slug leaves a mucous track.”

#### *Apera natalensis* Collinge.

*Apera natalensis* Collinge, Ann. S. Afr. Mus., 1900, vol. ii, p. 3, pl. i, figs. 3, 4.

Animal limaciform, sub-cylindrical, broad posteriorly, tapering anteriorly; dorsally reddish-brown with dark greenish-blue mottling; sides of body orange-red, or dark orange with greenish-blue mottling, which becomes scarce towards the

peripodial groove. Commencing from the head the dorsum gradually rises, and at about one third of the animal's length from the posterior end it slopes downwards, forming a somewhat spatulate-shaped tail. All the keels are well marked. The radiating lines from the respiratory orifice are very plain, especially those directed posteriorly; the two mid-dorsal ones are also very prominent. Peripodial groove distinct. Generative orifice below and behind the right lower tentacle. Foot-sole orange-red, not differentiated into median and lateral planes. Tail flattened and slightly overlapping the foot-sole, terminating bluntly. Rugæ small. Length (in alcohol) 65 mm.; breadth of foot-sole 9·5 mm.; breadth of dorsum, mid-length, 10 mm., behind respiratory orifice 13·5 mm.

Shell internal, situated posterior to the respiratory orifice.

Hab.—Richmond, Natal. Rev. J. R. Ward, 1899. Type in the collection of the South African Museum.

It is curious that this handsome species has not been found again since its discovery in 1899.

#### Habits and Habitat.

Very little is known about the habits and habitat of members of the genus. It seems very probable that they burrow and spend most of their time underground or in trees or dense bush. Their food consists of both animal and vegetable matter. As already pointed out Mr. J. S. Gibbons noticed that the specimen [probably referable to *A. gibbonsi* (*W. G. Binn*)] when in repose assumes a very peculiar appearance by retracting the head and bending the tail portion beneath the foot-sole, bringing the lateral borders of the foot-sole almost together. Mr. Burnup, who has sent me a series of rough sketches from life of *A. burnupi*, has also noticed that this latter species curls itself up.

When alive the lateral keels are not so pronounced as in preserved specimens.

## Distribution.

With the exception of one species, *A. purcelli* *Collge.*, all the species are confined to Natal and Zululand.

## Affinities and Systematic Position.

When examining the internal structure of the genus *Apera*, I have more than once been struck with what I believe to be cases of morphological modification coupled with degeneration, and these points must be carefully borne in mind when attempting to define the systematic position and affinities of this genus.

Hitherto the genus has been regarded as a member of the Testacellidæ, but the unsatisfactory assemblage of molluscs which have there been included demand a careful examination before we assent to place the genus under discussion therein.

The Sarasins (22) in their beautiful work on the land mollusca of the Celebes, expressed the opinion that *Apera* was an ancestral form of *Atopos* *Simr.*<sup>1</sup> The late Dr. Heynemann (in litt, 1903) wrote me—"It seems to me that the Sarasins are in the wrong," and I fully agree with that view.

In my opinion there are no grounds, beyond a very faint superficial resemblance, for regarding it as in any way related to the genus *Atopos* *Simr.*, or any of the Rathouisiidæ.

All the Testacellid characters can be accounted for quite apart from any phylogenetic affinity with the genus *Testacella* *Cuvier*, thus affording another instance of parallel evolution which is so admirably illustrated by numerous diverse families of pulmonate gastropoda.

Whether or not the genus *Schizoglossa* of Hedley bears any relationship to *Apera* I very much doubt; from what little we know of the internal structure I should be inclined to regard it as belonging to the Testacellidæ.

<sup>1</sup> For an account of this genus and its affinities see Collinge, 'Journ. Malacology,' 1902, vol. ix, p. 86.

So far, then, as our present knowledge warrants us in assigning a place to the genus we must be content to let it stand by itself, in all probability as a remnant of a very ancient stock of carnivorous pulmonates which have undergone considerable morphological modification.

Fam. ARIONIDÆ *Gray.*

Genus OOPELTA *Mörch.*

Although various species of this genus occur in Cape Colony, and I have also examples from Zululand received from Mr. Burnup, it is somewhat remarkable that it has not been found in Natal.

Genus ARION *Fér.*

*Arion fuscus* (*Müll.*)

*Limax fuscus* *Müller*, *Verm. Hist.*, 1774, vol. ii, p. 11.

*Arion fuscus* *Mörch*, *Vidensk. Medd. naturhist. For. Kjobenhavn*, 1863, p. 273; *Lehmann, Leb. Schneck. Stettins.* 1873, p. 17, t. ii, fig. 2.

*Prolepis fusca* *Malm*, *Skand. Land-Singlar.* 1870, p. 43, pl. ii, fig. 4.

*Arion fuscus* *Mull.*; *Pollonera, Atti. Acc. Sci. Torino.* 1887, p. 302, t. iii, fig. 14; *Boll. Mus. Zool. e. Anat. Torino*, 1890, vol. v, p. 12.

Hab.—Pietermaritzburg.

Fam. VERONICELLIDÆ *Gray.*

Genus VERONICELLA *Blainv.*

*Veronicella natalensis* (*v. Rapp.*).

*Vaginulus natalensis v. Rapp.*; *Krauss, Südafr. Moll.*, 1848, p. 72.

*Vaginula natalensis v. Rapp.*; *Simroth, Deutsch. Ost-Afr. IV*, *Nacktschn.*, 1895, p. 13.

*Veronicella natalensis (v. Rapp.)*; *Cockerell, Conchologist*, 1893, vol. ii, p. 194; *Collinge, Ann. S. Afr. Mus.*, 1901, vol. ii, p. 235.

Hab.—Port Shepstone.

This fine species is evidently one that occurs in large numbers.

*Veronicella saxicola* *Ckll.*

*Veronicella saxicola* *Cockerell*, *Conchologist*, 1893, vol. ii, p. 216.

Prof. Cockerell described this species from specimens in the British Museum as follows: Dark red-brown, unicolorous below, mottled-streaked with black or blackish above; a pale middle line slightly indicated posteriorly. When young, paler, with a more obvious pale middle line. Sole not projecting posteriorly; mantle granulose, no raised warts, no sort of keel. Length 57 mm., 14 mm. broad, sole 6 mm. broad. Female orifice 2 mm. from sole and 32 from head.

Hab.—Port Elizabeth, under stones (A. E. Craven), Pietermaritzburg.

Fam. ONCHIDIIDÆ *Gray.*

ONCHIDIUM *Buchan.* (em. Plate, 1893).

*Onchidium peroni* *Cuv.*

*Onchidium peronii* *Cuvier*, *Ann. Mus. Nat. Hist.*, 1804, vol. v, p. 38,  
pl. vi.

*Peronia mauritziana* *Blainville*, *Man. Malac.*, 1825, p. 489, pl. xlvi,  
fig. 7.

*Onchidium tonganum* *Quoy and Gaimard*, *Voyage de l'Astrolabe*,  
1832, p. 210, pl. xv,  
figs. 17, 18.

*Onchidium peronii* *Cuvier*; *Krauss*, *Südafr. Moll.*, 1848, p. 72;  
*Collinge*, *Ann. S. Afr. Mus.*, 1900,  
vol. ii, p. 7.

*Onchidium peronii* *Cuvier*; *Plate*, *Zool. Jahrb., Abth. f. Anat.*,  
1891, Bd. vii, p. 172.

Hab.—Congella, near Durban.

*Onchidium burnupi* *Cllege.*

*Onchidium burnupi* *Collinge*, *Journ. of Malac.*, 1902, vol. ix, p. 17,  
figs. 1, 2.

Notum finely granulated, yellowish irregularly blotched with blackish green, these blotches being prominent at the edge and in the middle of the notum. Dorsal eyes irregularly scattered. Head large. Hyponotum greenish-grey. Foot-sole greyish-yellow, faintly marked with fine transverse wrinkles. Male generative orifice on the right side of the head, on the inner side of the right upper and lower tentacles. Female generative orifice in front of the anus, partially hidden by the posterior border of the foot-sole. Anal aperture slightly to the right of the median line.

Length of notum (in alcohol) 11 mm.; breadth 9 mm.; hyponotum 3 mm. broad; foot-sole 8.5 mm. long, 3 mm. broad.

Hab.—Umblaas Lagoon, Natal.

#### *Onchidium savignyi* Semper.

? = *Onchidium peroni* Savigny; see E. A. Smith, Proc. Malac. Soc., Lond., 1903, vol. v, p. 401.

*Onchidium savignyi* Semper, Reis. Arch. Philip., 1870, Bd. iii, p. 260.

Hab.—Scottburgh.

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ADDENDUM.

Since this paper was written further new species of South African slugs have been received from Mr. Burnup from Zululand, and from Capt. Connolly from Cape Colony, which I hope to find time to describe shortly. It would therefore seem as if my prediction of 1900 (5) were well founded.

**On South African Marine Mollusca, with  
Descriptions of New Species.<sup>1</sup>**

By

**Edgar A. Smith, I.S.O., F.Z.S.**

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Plates VII, VIII.

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SINCE the publications in these Annals of a paper by the present writer under the above title, a considerable amount of material has accumulated which it has now seemed advisable to deal with. Through the kindness of Mr. Henry Burnup, as on previous occasions, I have had the opportunity of examining the results of his collecting on the Natal coast, and although most of the new species obtained by him are small, among them are some very interesting forms, notably the *Clistoconcha insignis*, a Pelecypod in which the valves are united all round excepting at the posterior siphonal end. Other species of interest have also been sent me by Mr. F. Quekètt, and others obtained at Port Elizabeth by Mr. J. Farquhar. Most of the larger forms of Mollusca from the shores of South Africa have probably been discovered, but doubtless additional small species will from time to time be found. Systematic dredging around the coast will, it is expected, add much to the known fauna judging from the results obtained during the marine investigations by Dr. Gilechrist.

It is hoped that the present paper will bring the list of the known fauna up to date.

As an appendix to it I have added an account by Sir Charles Eliot, K.C.M.G. of a few Nudibranchs also collected by Mr. H. Burnup.

<sup>1</sup> Published by permission of the Trustees of the British Museum.

Order **Pulmonata**.*Siphonaria cyaneomaculata* *Sowerby*.

*Siphonaria cyaneomaculata* *Sowerby*, 'Proc. Malac. Soc.,' vol. vii, p. 37, fig. (1906).

Hab.—The Kowie.

Order **Opisthobranchia**.*Archidoris capensis* *Bergh*.

*Archidoris capensis* *Bergh*, 'Trans. S. Afr. Phi. Soc.,' vol. xvii, Pt. I, p. 42 (1907).

Hab.—Cape Point.

*Archidoris granosa* *Bergh*.

*Archidoris granosa* *Bergh*, op. cit. p. 43, Pl. V, figs. 16–18.

Hab.—Off mouth of Tongaat River, 36 fathoms, and Woodstock beach.

*Archidoris* ?? *scripta* *Bergh*.

*Archidoris* ?? *scripta* *Bergh*, op. cit. p. 44, Pl. XI, figs. 19–25.

Hab.—Dredged off Hongazi River.

*Staurodoris verrucosa* (*Cuvier*).

*Doris verrucosa* *Cuvier*, 'Ann. du Mus.,' vol. iv, p. 451, Pl. LXXIII, figs. 4–7 (1804).

*Staurodoris verrucosa* *Bergh*, op. cit. p. 46, Pl. XI, figs. 26–27.

Hab.—Amongst rocks at St. James.

*Geitodoris capensis* *Bergh*.

*Geitodoris capensis* *Bergh*, op. cit. p. 47, Pl. XII, figs. 2–5.

Hab.—Off Glendower Beacon.

*Diaulula capensis* Bergh.

*Diaulula capensis* Bergh, op. cit. p. 48, Pl. V, figs. 19-22.

Hab.—Mossel Bay, Cape Colony, 11 fathoms.

*Diaulula ? morosa* Bergh.

*Diaulula ? morosa* Bergh, op. cit. p. 50, Pl. V, figs. 23-26.

Hab.—Mossel Bay, Cape Colony.

*Thordisa punctutifera* Bergh.

*Thordisa punctutifera* Bergh, op. cit. p. 50, Pl. VI, figs. 1-4.

Hab.—False Bay, Cape Colony, 23 fathoms.

*Thordisa burnupi* n. sp.

See Eliot, postea p. 223.

Hab.—Natal (Burnup).

*Doris* (Gen.?) *pseudida* Bergh.

*Doris* (Gen.?) *pseudida* Bergh, op. cit. p. 52, Pl. VI, figs. 7, 8.

Hab.—Near Table Bay, 154 fathoms.

*Doris* (Gen.?) *perplexa* Bergh.

*Doris* (Gen.?) *perplexa* Bergh, op. cit. p. 53, Pl. VI, figs. 5, 6.

Hab.—Off Cape St. Blaize, Cape Colony, 39 fathoms.

*Doris* (Gen.?) *glabella* Bergh.

*Doris* (Gen.?) *glabella* Bergh, op. cit. p. 54, Pl. VI, figs. 9-13.

Hab.—Buffalo Bay, 30 fathoms.

*Discodoris cœrulescens* Bergh.

*Discodoris cœrulescens* Bergh, "Mal. Untersuch." in 'Semper's Reisen Philip.,' Heft xvi, pp. 805-807, Pl. LXXXIII, figs. 6-12 (1888).

See Eliot, postea p. 222.

Hab.—Natal (Burnup); Mauritius (Bergh).

*Chromodoris albolimbata* Bergh.

*Chromodoris albolimbata* Bergh, op. cit. p. 55, Pl. VI, figs. 18-24.

Hab.—Off Sebastian Bluff, 20 fathoms.

*Chromodoris euelpis* Bergh.

*Chromodoris euelpis* Bergh, op. cit. p. 56, Pl. VI, figs. 14-17.

Hab.—Off Umhloti River, 45 fathoms.

*Chromodoris* sp.

*Chromodoris* sp. Bergh, op. cit. p. 57, Pl. VI, figs. 25, 26.

Hab.—False Bay, Cape Colony, 23 fathoms.

*Chromodoris runcinata* Bergh.

*Chromodoris runcinata* Bergh, 'Semper's Reisen,' Heft xii, pp. 479-481, Pl. LI, figs. 32, 33; Pl. LIII, figs. 5-12 (1877); Eliot, 'Proc. Malac. Soc.,' vol. vi, p. 232 (1905).

Hab.—Scottburgh, Natal (H. Burnup).

*Chromodoris porcata* Bergh.

*Chromodoris porcata* Bergh, "Mal. Untersuch." in 'Semper's Reisen Philip.,' Heft xvi, pp. 831-833, Pl. LXXXII, figs. 1-8 (1888).

See Eliot, postea p. 224.

Hab.—Natal (Burnup); Mauritius (Bergh).

*Chromodoris carnea* Bergh.

*Chromodoris carnea* Bergh, "Mal. Untersuch." in 'Semper's Reisen Philip.,' Heft xvi, pp. 836, 837, Pl. LXXXIII, figs. 20-29 (1888).

See Eliot, postea, p. 225.

Hab.—Natal (Burnup); Mauritius (Bergh).

*Chromodoris* (?) *lineata* (Souleyet).

*Chromodoris* (?) *lineata* (Souleyet); Eliot, 'Proc. Zool. Soc.,' 1904, vol. i, pp. 396, 397, Pl. XXIV, fig. 7; 'Proc. Malac. Soc.,' vol. vi, p. 233 (1905).

Hab.—Scottburgh, Natal (H. Burnup).

*Chromodoris annulata* Eliot.

*Chromodoris annulata* Eliot, 'Proc. Zool. Soc.,' 1904, vol. i, pp. 389, 390; 'Proc. Malac. Soc.,' vol. vi, p. 233 (1905).

Hab.—Scottburgh, Natal (H. Burnup).

*Chromodoridella mirabilis* Eliot.

*Chromodoridella mirabilis* Eliot, 'Proc. Malac. Soc.,' vol. vi, p. 233 (1905).

Hab.—Scottburgh, Natal (H. Burnup).

*Aphelodoris* ?? *brunnea* Bergh.

*Aphelodoris* ?? *brunnea* Bergh, op. cit. p. 58, Pl. XI, figs. 28-29; Pl. XII, fig. 1.

Hab.—Kalk Bay, Cape of Good Hope, on rocks.

*Doriopsis capensis* Bergh.

*Doriopsis capensis* Bergh, op. cit., p. 60, Pl. XIV, fig. 4.

Hab.—Off Umlanga River.

*Doriopsis callosa* Bergh.

*Doriopsis callosa* Bergh, op. cit. p. 61, Pl. VIII, figs. 1-4,

Hab.—False Bay, Cape of Good Hope, 17-27 fathoms.

*Doriopsis cæsia Bergh.**Doriopsis cæsia Bergh*, op. cit., p. 62.

Hab.—Near Roman Rock Lighthouse, 10 fathoms.

*Doriopsis* sp.*Doriopsis* sp. *Bergh*, op. cit. p. 63, Pl. VIII, figs 5, 6.

Hab.—Swart Klip, 10 fathoms.

*Doriopsilla capensis Bergh.**Doriopsilla capensis Bergh*, op. cit. p. 64, Pl. VIII, fig. 7.

Hab.—Cape St. Blaize, Cape Colony.

*Hexabranhus* (?) *adamsii Gray.**Hexabranhus* (?) *adamsii Gray*, MSS.; H. and A. Adams, 'Gen. Rec. Moll.,' vol. ii, p. 59, Pl. LXIII, fig. 9; Eliot, 'Proc. Malac. Soc.,' vol. vi, p. 235.

Hab.—Scottburgh, Natal (H. Burnup).

*Triopa lucida Stimpson.**Triopa lucida Stimpson*, 'Proc. Acad. Nat. Sci.,' Philad., vol. vii, p. 388 (1855); *Bergh*, op. cit. p. 66, Pl. XII, figs. 6-7.Hab.—Simon's Bay, Cape of Good Hope (Stimpson); near mouth of Tugela River, Natal (*Bergh*).*Nembrotha capensis Bergh.**Nembrotha capensis Bergh.*, op. cit. p. 68, Pl. XII, figs. 8-17.

Hab.—On rocks, Kalk Bay.

*Euplocamus croceus Phil.*, var. *capensis.**Euplocamus croceus Phil.*, var. *capensis Bergh*, op. cit. p. 71, Pl. XII, figs. 12-24.

Hab.—Off Great Fish Lighthouse, off Cape Hangklip, and off Cape Point Lighthouse.

*Kalinga ornata* *Alder and Hancock*.

*Kalinga ornata* *Alder and Hancock*, 'Trans. Zool. Soc.,' vol. v, p. 135, Pl. XXXII, figs. 7-10; *Bergh*, op. cit. p. 75, Pl. XIII, figs. 1-5.

Hab.—Coromandel Coast (A. and H.); off Amatikulu Conical Hill (*Bergh*).

*Idaliella amœnula* *Bergh*.

*Idaliella amœnula* *Bergh*, op. cit. p. 80, Pl. XIII, figs. 6-11.

Hab.—Gordon's Bay, on rocks.

*Tritonia pallida* *Stimpson*.

*Tritonia pallida* *Stimpson*, 'Proc. Acad. Nat. Sci.,' Phidad., vol. vii, p. 388 (1855); *Bergh*, op. cit. p. 83, Pl. XIII, figs. 12-15; Pl. XIV, fig. 1.

Hab.—False Bay.

*Tritonia indecora* *Bergh*.

*Tritonia indecora* *Bergh*, op. cit. p. 85, Pl. XIII, fig. 16; Pl. XIV, figs. 2-3.

Hab.—Off Cape Point.

*Marionia arborescens* *Bergh*.

*Marionia arborescens* *Bergh*, "Mal. Untersuch." in 'Semper's Reisen Philip.,' Heft xvii, pp. 891-894, Pl. LXXXVIII, figs. 31-39 (1890). See *Eliot*, postea, p. 222.

Hab.—Natal (Burnup); Amboina (*Bergh*).

*Tritonidoxa capensis* *Bergh*.

*Tritonidoxa capensis* *Bergh*, op. cit. p. 87, Pl. VIII, figs. 8-13.

Hab.—Off Glendower Beacon, 66 fathoms.

*Janolus capensis* Bergh.

*Janolus capensis* Bergh, op. cit. p. 90, Pl. VII, figs. 6-21.

Hab.—Rocky Bank, False Bay, 17-27 fathoms.

*Glaucus atlanticus* Forster.

*Glaucus atlanticus* Forster, in Blumenbach's 'Abbild. Nat. Hist. Gegend,' No. 48 (1800); Bergh, op. cit. p. 94.

Hab.—In rock pool Muizenberg.

*Melibe rosea* Rang.

*Melibe rosea* Rang, 'Mannel des Moll.,' pp. 129, 130, Pl. III, fig. 3; Bergh, op. cit. p. 96, Pl. IX, figs. 1-12.

Hab.—Cape of Good Hope (Rang); Woodstock Beach, Table Bay (Bergh).

*Plenrophyllidia capensis* Bergh.

*Plenrophyllidia capensis* Bergh, op. cit. p. 99, Pl. VIII, figs. 23, 24.

Hab.—Off East London, 37-39 fathoms.

*Pleurophyllidia gilchristi* Bergh.

*Pleurophyllidia gilchristi* Bergh, op. cit. p. 101, Pl. VIII, figs. 14, 15.

Hab.—Off Sebastian Bluff, 40 fathoms; off Cape St. Blaize, 35 fathoms; off Cape Point Lighthouse.

*Plenrophyllidia enchroa* Bergh.

*Plenrophyllidia enchroa* Bergh, op. cit. p. 102, Pl. VII, figs. 1-5; Pl. VIII, fig. 25.

Hab.—Off Cape Hang Klip, 50 fathoms; Buffalo Bay, 30 fathoms; off Cape Point Lighthouse; Seal Island, 16 fathoms.

*Pleurophyllidia microdonta* Bergh.

*Pleurophyllidia microdonta* Bergh, op. cit. p. 103, Pl. VIII, figs. 17-22.

Hab.—Off Constable Hill, 33 fathoms.

*Lencotina natalensis* n. sp. Pl. VII, fig. 1.

Testa ovata, supra acuminata, nivea, rimata, leviter nitida; anfractus 6-7, apicalis hyalinus, laevis, involutus, cæteri convexiusculi spiraliter tenuiter sulcati, sulcis in anfractu penultimo septem, in ultimo circiter 18, lineis incrementi obliquis sculptis; liræ inter suleos planæ, suleis latiores; apertura inverse auriformis, longitudinis totius  $\frac{1}{2}$  subæqnans; columella incrassata, anguste reflexa, superne leviter indidentata vel plicata; labrum tenue, arenatum.

Longit. 10·75, lat. 4·5 mm; apertura 5 mm. longa, 2·3 lata.

Hab.—Isezela, Natal (Mrs. Crossley).

This species differs from *L. concinna* of A. Adams, which I regard as synonymous with *casta*, *A. Ad.*, in form, the body-whorl being much larger in proportion to the spire, and the spiral sulci are less numerous. The shell recorded by Mr. Sowerby as *casta*, *A. Ad.* ('Marine Shells of South Africa,' p. 52) does not, in my opinion, belong to that species, but is more closely related to his own *Lencotina elongata*, with which it agrees exactly in sculpture, but it is a much shorter shell.

*Daphnella casta*<sup>1</sup> of Hinds, which was founded on a broken specimen, now in the British Museum, undoubtedly belongs to the genus *Lencotina*. Hence the name *casta* subsequently given to a species of this genus by A. Adams cannot be used, but as I regard it as the same species as *concinna* of A. Adams there will be no need to invent a fresh name for it.

*L. modesta* *A. Adams* is rather like the present species in form, but the shape of the aperture and the columella are different. The sulci in *L. natalensis*, especially on the body-whorl, are broader, and the lines of growth in the grooves are stronger.

*Smaragdinella andersoni* (*G.* and *H. Nevill*).

*Glaucanella andersoni* *G.* and *H. Nevill*, 'Journ. Asiat. Soc. Bengal,' vol. xl, Pt. 2, p. 2, Pl. I, fig. 13.

<sup>1</sup> Voy. "Sulphur," p. 25, pl. vii, fig. 20.

*Smaragdinella andersoni* (G. and H. Nevill); Pilsbry, 'Man. Conch.,' vol. xv, p. 260, Pl. XXXIII, figs. 40, 41.

Hab.—Isipingo, Natal (H. Burnup).

Other localities are Ceylon, Penang, and Suez.

#### *Ringicula australis* Hinds.

*Ringicula australis* Hinds, 'Proc. Zool. Soc.,' 1844, p. 97; Morlet, 'Journ. de Conch.,' 1878, vol. xxvi, p. 125, Pl. V, fig. 10, spire too blunt.

*R. australis* Crosse, MS.; Crosse, 'Journ. de Conch.,' 1865, vol. xiii, p. 44, Pl. II, fig. 5; Sowerby, 'Marine Shells of South Africa,' p. 25.

Hab.—Congella (H. Burnup); Port Lincoln, South Australia (Hinds); Spencer's Gulf (Crosse); Adelaide (Brit. Mus.).

Specimens of this species from Congella vary much in size, some being twice as large as others. It is a smooth shell, without spiral striae. Apparently neither Crosse nor Sowerby knew that this species was described by Hinds in 1844.

#### *Philine aperta* (Linn.).

In his 'Marine Shells of South Africa,' p. 53, Mr. Sowerby separates this species as distinct from *P. schrœteri* of Philippi. On the other hand, they are united by Jeffreys, Pilsbry, and Bergh,<sup>1</sup> and I must confess I cannot see how they are to be distinguished conchologically. Moreover, both Linné's and Philippi's locality was Cape of Good Hope, and Krauss recorded only one species from South Africa. Therefore, unless some difference in the European and South African animals can be shown I think they should all stand under the name *aperta*, which is usually applied to the common British species.

#### *Philine berghi* n. n.

*Philine capensis* Bergh, 'Trans. S. Afr. Phil. Soc.,' vol. xvii, p. 27, Pl. V, figs. 11-15 (1907).

<sup>1</sup> 'Trans. S. Afr. Phil. Soc.,' vol. xvii, p. 24, Pl. v, figs. 5-10 (1907).

Hab.—Off Cape Point Lighthouse, 27 fathoms.

“The shell as long and large as the mantle, chalk-white, not thin, but rather fragile, of usual form” (Bergh). Length 9 mm., diameter 5. No further description of the shell is given and only an apical view of it appears on the plate.

The specific term “capensis” was employed many years ago by Pfeiffer, and therefore it has necessitated another being substituted.

*Doridium capense* Bergh.

*Doridium capense* Bergh, ‘Trans. S. Afr. Phil. Soc.,’ vol. xvii, p. 29.

Hab.—Shore at East London, Cape Colony.

*Cavolinia inflexa* (Lesueur).

*Hyalæa inflexa* Lesueur, ‘Nouv. Bull. Soc. Philom.,’ vol. iii, p. 285, Pl. V, fig. 3; Boas, ‘Spolia Atlantica,’ p. 123, Pl. I, fig. 11; Pl. II, fig. 21; Pl. VI, fig. 98.

*Cavolinia inflexa* (Lesueur); Pelseneer, ‘Challenger Pteropoda,’ p. 85.

Hab.—Alexandra Junction, Natal (H. Burnup); Cape of Good Hope (Pelseneer).

*Clio* (*Creseis*) *acicula* (Rang).

*Creseis acicula* Rang, ‘Ann. Sci. Nat.,’ vol. xiii, p. 318, Pl. XVII, fig. 6 (1828).

*Cleodora acicula* (Rang); Souleyet, ‘Voy. Bonite, Zool.,’ vol. ii, p. 194, Pl. VIII, figs. 10–17; Boas, ‘Spolia Atlantica,’ p. 59, Pl. vi, figs. 94 *p-u*.

Hab.—Scottburgh, Natal (H. Burnup). World-wide.

*Clio* (*Creseis*) *virgula* (Rang) and var. *flexa*.

*Creseis virgula* Rang, *op. cit. supra* p. 316, Pl. XVII, fig. 2; Souleyet, ‘Voy. Bonite, Zool.,’ vol. ii, p. 196, Pl. VIII, figs. 18–25, *Cleodora*.

*Cleodora flexa* Pfeiffer, ‘Monatsb. preuss. Akad. Wiss.,’

Berlin, 1879, p. 241, figs. 15, 16; Boas, 'Spolia Atlantica,' Pl. VI, figs. 94 *k-n*.

Hab.—Scottburgh, Natal (H. Burnup).

*Cuvierina columnella* (*Rang*).

*Cuvieria columnella* *Rang*, 'Ann. Sci. Nat.,' vol. xiii, p. 323, Pl. XLV, figs. 1-8.

*Cuvierina columnella* (*Rang*); Boas, 'Spolia Atlantica,' p. 132, Pl. III, fig. 39; Pl. VI, figs. 95 *a-p*.

Hab.—Natal (H. Burnup). World-wide.

*Tethys gilchristi* (*Bergh*).

*Aplysia gilchristi* *Bergh*, 'Trans. S. Afr. Phil. Soc.,' vol. xvii, p. 2, Pl. I, figs. 1-3; Pl. X, fig. 1.

Hab.—False Bay.

*Tethys allochroa* (*Bergh*).

*Aplysia allochroa* *Bergh*, op. cit. p. 4, Pl. I, figs. 4-10.

Hab.—Knysna at low tide.

*Tethys gargantua* (*Bergh*).

*Aplysia gargantua* *Bergh*, op. cit. p. 5, Pl. 1, figs. 11-21; Pl. II, fig. 1.

Hab.—Beach at Simon's Town.

*Tethys lobata* (*Bergh*).

*Aplysia lobata* *Bergh*, op. cit. p. 8, Pl. II, figs. 8-12.

Hab.—Woodstock beach, Table Bay.

*Tethys eusiphonata* (*Bergh*).

*Aplysia eusiphonata* *Bergh*, op. cit. p. 9, Pl. III, figs. 5-15.

Hab.—East London, Cape Colony.

*Tethys poikilia* (*Bergh*).

*Aplysia poikilia* *Bergh*, op. cit. p. 10, Pl. II, figs. 20, 21; Pl. III, figs. 1-4.

Hab.—Kalk Bay.

*Tethys woodii* (*Bergh*).

*Aplysia woodii* *Bergh*, op. cit. p. 12, Pl. II, figs. 13-19.

Hab.—Shore at East London.

*Tethys monochroa* (*Bergh*).

*Aplysia monochroa* *Bergh*, op. cit. p. 13, Pl. I, figs. 22-24; Pl. II, figs. 2-7.

Hab.—Hermaus.

*Tethys nigrocineta* (*Martens*).

*Aplysia nigrocineta* *Martens*, in Möbins' 'Meeres Fauna Mauritius and Seychellen,' p. 307, Pl. XXI, fig. 3.

*Tethys nigrocineta* (*Martens*); Pilsbry, 'Man. Conch.,' vol. xvi, p. 107, Pl. XVII, figs. 14-16 (after *Martens*); Burne, 'Proc. Malac. Soc.,' vol. vii, p. 56, fig. 9, anatomy.

Hab.—Scottburgh, Natal (H. Burnup); Mauritius (*Martens*).

*Tethys elongata* (*Pease*).

*Siphonota elongata* *Pease*, 'Proc. Zool. Soc.,' 1860, p. 24.

*Aplysia* (*Siphonota*) *elongata* (*Pease*); *Martens* and *Lankavel*, 'Donum Bismarckianum,' p. 54, Pl. III, figs. 6 *a-b* (shell).

*Tethys elongata* (*Pease*); Pilsbry, 'Man. Conch.,' vol. xvi, p. 93, Pl. LIX, figs. 35-38 (shell); Burne, 'Proc. Malac. Soc.,' vol. vii, p. 57.

Hab.—Port Shepstone (H. Burnup); Sandwich Is. (*Pease*).

*Tethys operta Burne.*

*Tethys operta Burne*, 'Proc. Malac. Soc.,' vol. vii, p. 51, figs. 1-4.

Hab.—Isipingo and Scottburgh (H. Burnup).

*Tethys burnupi Burne.*

*Tethys burnupi Burne*, op. cit. p. 54, figs. 5-8.

Hab.—Durban (H. Burnup).

*Notarchus cirrhifer (Quoy and Gaimard).*

*Aplysia cirrhifera Q. and G.*, 'Voy. Astrolabe,' vol. ii, p. 311, Pl. XXIV, fig. 8.

*Notarchus cirrhifer (Q. and G.)*; Pilsbry, 'Man. Conch.,' vol. xvi, p. 142, Pl. XVII, fig. 11 (after Q. and G.).

*Aclesia cirrhifera (Q. and G.)*; Bergh, 'Trans. S. Afr. Phil. Soc.,' vol. xvii, p. 20, Pl. III, figs. 16-24; Pl. IV, figs. 1-7.

Hab.—Port Alfred, Knysna, Mouth of the Nahoon, and East London (Bergh); Mauritius (Q. and G.)

*Pleurobranchæa capensis Vayssière.*

*Pleurobranchæa capensis Vayssière*, 'Journ. de Conch.,' 1900, vol. xlviii, p. 10; 'Ann. Sci. Nat.,' sér. 8, vol. xii, pp. 46-49, Pl. IV, figs. 232-237; Bergh, op. cit. pp. 30-32, Pl. IV, figs. 8-11; Pl. XI, figs. 1-8, var.; Smith, 'Proc. Malac. Soc.,' vol. v, p. 358.

Hab.—Cape of Good Hope and Cape Hangklip.

*Pleurobranchæa melanopus Bergh.*

*Pleurobranchæa melanopus Bergh*, op. cit., p. 33, Pl. IV, figs. 12-15.

Hab.—Off Cape Point, 650 fathoms.

*Oscaniopsis pleurobranchæana Bergh.*

*Oscaniopsis pleurobranchæana Bergh*, op. cit. p. 35, Pl. IV, figs. 16-21.

Hab.—Off Tugela River, Natal.

*Oscaniella nigropunctata* Bergh.

*Oscaniella nigropunctata* Bergh, op. cit. pp. 37, 38, Pl. IV, figs. 22–26; Pl. XI, figs. 9–18; Pl. IV, figs. 22–26, var.?

Hab.—Off Cape Infanta, Cape Colony, and the var.? off Cape St. Blaize.

*Berthella granulata* (Krauss).

*Pleurobranchus granulatus* Krauss, 'Südafrik. Moll.,' p. 61; Pilsbry, 'Man. Conch.,' vol. xvi, p. 208.

*Berthella granulata* (Krauss); Vayssière, 'Ann. Sci. Nat.,' vol. viii, p. 268, Pl. XVI, figs. 14–16 (1898); Bergh, op. cit. p. 40, Pl. IV, figs. 27, 28; Pl. V, figs. 1–4.

Hab.—False Bay (Krauss); Kalk Bay (Bergh).

Order **Pectinibranchia.***Terebra filmeræ* Sowerby.

*Terebra filmeræ* Sowerby, 'Proc. Malac. Soc.,' vol. vii, p. 37, fig.

Hab.—Pondoland.

*Conus catus* Hwass.

*Conus catus* Hwass: Reeve, 'Conch. Icon.,' vol. i, figs. 79a, b.

Hab.—Scottburgh, Natal (H. Burnup).

*Conus moreleti* Crosse.

*Conus elongatus* Reeve (non Chemnitz), 'Conch. Icon.,' vol. i, fig. 157; Kiener, 'Coq. Viv.,' Pl. XXXIII, fig. 1.

*Conus oblitus* Reeve, 'Emendations'; Sowerby, 'Thes. Conch.,' vol. iii, Pl. CLXXXIX, fig. 37; Pl. CXCI, fig. 100 (name preoccupied for a fossil); Tryon, 'Man. Conch.,' vol. vi, p. 45, Pl. XIII, fig. 58.

*Conus moreleti* Crosse, 'Rev. et Mag. de Zool.,' 1858, vol. x, p. 122.

Hab.—Scottburgh, Natal (H. Burnup).

*Conus gubernator* *Hwass.*

*Conus gubernator* *Hwass.*: Reeve, 'Conch. Icon.,' vol. i, figs. 59 *a-c*.

Hab.—Isezela.

*Conus tulipa* *Linn.*

*Conus tulipa* *Linn.*: Reeve, 'Conch. Icon.,' vol. i, figs. 128 *a-b*.

Hab.—Isezela.

*Mangilia beckeri* *Sowerby.*

*Mangilia beckeri* *Sowerby*, 'Proc. Malac. Soc.,' vol. vii, p. 38, fig.

Hab.—The Kowie.

*Mangilia elizabethæ* n. sp. Pl. VII, fig. 2.

Testa elongata, turrata, cancellata, alba, pellucida, apicem versus pallide rufescens, infra suturam maculis fuscis picta; anfractus quinque, primus magnus lævis, supra rotundus, sequentes convexi, costis obliquis circiter 17 et liris spiralibus 6-7 cancellati, ultimus liris circa 16 cinctus, ad basim columellæ fusco tincta; apertura parva, longit. totius  $\frac{1}{2}$  haud æquans; labrum vix incrassatum, superne late sed haud profunde sub-sinuatum; columella in medio leviter arcuata, callo tenui induta; canalis anticus mediocriter latus.

Longit. 4.5, lat. 1.75 mm.; apertura 1.75 longa, .75 lata.

Hab.—Four miles south of Port Elizabeth (J. Farquhar).

The points of intersection of the costellæ and the spiral liræ are somewhat nodulous. The upper ends of some of the riblets between the brown blotches are rather opaque white instead of pellucid, and the freshest specimen exhibits traces of an interrupted opaque band about the middle of the body-whorl.

*Clathurella westcotti* n. sp. Pl. VII, fig. 3.

Testa parva, elongata, turrata, flavescens cerea, infra medium anfract. ultimi rufescens; anfractus circiter 8, supe-

riores læves ?, cæteri supra declives, leviter concavi, infra convexiusculi, costis tenuibus obliquis circa 20 et liris spiralibus 4-5 nodose cancellati; costæ supra concavitatem obsoletæ, in anfr. ultimo antice infra medium desinentes; cauda anfr. ultimi oblique tenuiter striata vel lirata; labrum extra varicosum, intus incrassatum, rufo bizonatum, ad marginem tenue supra profunde sinuatum; columella recta, rufescens, callo tenui induta, supra unituberculata.

Longit. 8, diam. 2.75 mm. Apertura 2.75 longa, intus 1 lata.

Hab.—Durban (G. W. Westcott). Type in Brit. Mus.

This species belongs to a group of Pleurotomoids, which includes rava *Hinds*, cardinalis *Rve.*, zonulata *Angas*, etc.

*Daphnella*? *minuscula* n. sp. Pl. VII, fig. 4.

Testa minima, elongata, turrita, omnino succinea, spiraliter cingulata; anfractus  $4\frac{1}{2}$ , apicales  $1\frac{1}{2}$  magni, læves, mammæformes, sequentes convexiusculi, cingulis spiralibus 2-3 cincti, ultimus liris circiter 9 (interdum plus minus nodulosis) instructus; apertura parva, longit. totius  $\frac{1}{2}$  haud æquans; labrum tenue, extra extremitatibus cingulorum fimbriatum; columella vix arcuata, callo tenui induta; canalis anticus latus, recurvus.

Longit. 3, lat. 1.25 mm.; apertura 1 mm. longa, .5 lata.

Hab.—Four miles south of Port Elizabeth (J. Farquhar); Port Alfred (Turton in Brit. Mus.).

In some specimens the spirals are distinctly nodulous through being crossed by conspicuous lines of growth almost amounting to costellæ. The spirals upon the body-whorl are visible within the aperture through the pellucid texture of the shell. The species belongs to the same genus as *D. sulcata*, which was originally described as doubtfully belonging to the genus *Cominella*.

*Marginella ingloria* n. sp. Pl. VII, figs. 5, 5a.

Testa parva, cylindræcea, hyalina, zonis quatuor rufescentibus obscure cincta, antice ad basim anfr. ultimi rufo tincta; spira brevissima, obtuse conoidea; anfractus quatuor, apicalis

rotunde obtusus, duo sequentes levissime convexi, ultimus cylindraceus, antice plicis columellaribus quaternis instructus; apertura superne angustissima, antice latior; labrum album, leviter incrassatum et incurvum, supra fere ad apicem spiræ productum, ibique rufo tinctum, intus læve.

Longit. 4, diam. 2 mm.

Hab.—Kowie, Cape Colony (H. Burnup).

Of the four bands upon the body-whorl the posterior and anterior are thicker than the other two. The termination of the anterior zone forms a conspicuous red spot at the end of the labrum, and there is a similar spot upon the anterior columellar fold, which is the largest of the four, the others diminishing in size.

#### Mitra (Pusia) tuberculata *Kiener*.

*Mitra tuberculata* *Kiener*, 'Coq. Viv.,' pp. 91 and 120, Pl. XXVII, fig. 87 (1839); Küster, 'Conch. Cab. Volutacea,' p. 134, Pl. XVIIb, fig. 9.

*Mitra cancellarioides* *Anton*, 'Verzeichn. Conch.,' p. 68 (1839); Küster, 'Conch. Cab. Volutacea,' p. 79, Pl. XIV, figs. 17-19.

*Mitra nodosa* *Reeve* (non Swainson), 'Conch. Icon.,' vol. ii, figs. 196*a*, *b* (1844); Sowerby, 'Thes. Conch.,' vol. iv, Pl. CCCLV, figs. 268, 269; Tryon, 'Man. Conch.,' vol. iv, p. 193, Pl. LVI, figs. 638-640.

Hab.—Park Rynie, Natal (H. Burnup).

This species and the variety *cancellarioides* have been recorded from Mauritius, Red Sea, China, Philippine Islands, Lord Hood Island, the Panmotus, etc.

It bears the name of *M. nodosa* *Swainson* in the monographs of Reeve, Sowerby, and Tryon. Reeve (1844) states that "it was described many years since in the 'Philosophical Magazine' by Swainson," and Tryon (op. cit. p. 229) gives the reference "'Philos. Mag.,' 401, 1823." On referring to that work I find a paper by Swainson, but certainly no mention of a *Mitra nodosa*. Swainson did, however, make use of the name *nodosa* in his 'Treatise on Malacology' (1840), p.

319, and applied it to a species figured in the 'Encyclopédie Methodique,' Pl. CCCLXXIII, fig. 2. *Mitra tuberculata* *Kiener* and *M. cancellarioides* *Anton* were both published in 1839, but as the latter was unaccompanied by a figure I have preferred to adopt the name *tuberculata*. *Küster* has retained the two forms as distinct species, but I certainly agree with *Reeve* in uniting them. *Cancellarioides* is merely a coloured variety. The distribution of the two forms has not been particularised, and I have not the South African shell before me to state to which variety it belongs. *M. pinguis* *Reeve* may be a dwarf form of the present species.

*Columbella moleculina* *Duclos*.

*Columbella moleculina* *Duclos*, 'Hist. Nat. Coq. Univ. Marin.,' Pl. IX, figs. 1, 2 (1835); id. in *Chenu's* 'Illust. Conch.,' Pl. IX, figs. 1, 2; *Kobelt*, 'Conch. Cab.,' p. 315, Pl. XL, fig. 7; *Tryon*, 'Man. Conch.,' vol. v, p. 117, Pl. XLVII, fig. 48.

Hab.—Port Shepstone, Natal (H. Burnup).

A single specimen sent with *C. shepstonensis*, n. sp. Other localities are Amirantes, Solomon Islands, Lifu (Brit. Mus.).

*Columbella shepstonensis*, n. sp. Pl. VII, fig. 6.

Testa parva, ovato-fusifformis, nitida, albo-pellucida, zona conspicua castanea, punctis niveis interrupta, supra suturam et circa medium anfractus ultimi ornata, linea continua graciliore castanea et serie punctorum pallidiorum circa medium anfractuum picta, infra medium anfr. ultimi lineis numerosis undulatis brevibus fuscis longitudinalibus decorata, infra suturam zona pellucida cincta; anfractus 6 plani; spira conica, ad apicem violacea, haud acuta; anfr. ultimus antice circa extremitatem sulcis obliquis 6-7 sculptus, interstitiis fusco et albo punctatis; apertura parva, angusta; labrum leviter incrassatum, minute denticulatum, dente

supremo aliis majori; columella supra dente crasso obtuso instructa, callo tenui induta.

Longit. 4·75, diam. 2 mm.; apertura 2 mm. longa, 75 lata.

Hab.—Port Shepstone (H. Burnup); Zanzibar (J. T. Last).

This species is well characterised by the style of its colour markings. The most conspicuous feature is the dark chestnut band interrupted with opaque white spots, which, encircling the body-whorl, passes up the spire above the suture. Above this is a much thinner chestnut line which is not interrupted, and again, above this, a row of small, paler, oblong dots or short lines. A broad, pellucid band is below the suture. The short, wavy lines upon the lower part of the body-whorl are of a lighter tint than the zones above. The prominence upon the upper part of the columella in immature specimens forms a striking, obtuse, tooth-like plica.

Three specimens from Zanzibar in the British Museum agree in all respects with those from Natal, excepting in coloration. Only the broad, interrupted colour band is present, and this is broader, as if the thin line above was fused with it. The series of small dots above the thin line is also wanting. The rest of the body-whorl is marked the same as the South African form.

*Coralliophila coronata* H. Adams.

*Coralliophila coronata* H. Adams, 'Proc. Zool. Soc.,' 1869, p. 272, Pl. XIX, fig. 4; Tryon, 'Man. Conch.,' vol. ii, p. 210, Pl. LXVI, fig. 373, after Adams.

Hab.—Durban (F. Quekett); Mauritius (Adams).

*Coralliophila fragosa* n. sp. Pl. VII, fig. 7.

Testa breviter fusiformis, sordide albida; anfractus 6, supra declives, in medio rotunde subangulati, oblique fortiter costati et conferte spiraliter squamose lirati, costis obliquis in anfr. penultimo et ultimo 9, infra medium anfr. ultimi attenuatis et obsoletis, liris tenuibus alternatim majoribus, interstitiis oblique striatis; apertura alba, intus liris intran-

tibus circiter 11 instructa, cum canali longit. totius  $\frac{1}{2}$  paulo superans; columella obliqua, supra arcuata, callo albo induta; canalis anticus obliquus, rubrecurvus.

Longit. 28, diam. 14 mm; apertura cum canali 15 mm. longa, 5.5 lata.

Hab.—Scottburgh, Natal (H. Burnup).

The single specimen examined seems distinct from any of the other species recorded from South Africa.

It is a somewhat worn shell, but sufficiently well preserved to show that the spiral liræ in fresh specimens would be finely scaled. They number about fourteen on the penultimate whorl, and are alternately fine and coarser. There are about thirty-six on the body-whorl, including that at the extremity, which is thicker than any of the others.

*Argobuccinum (Paralagena) clandestinum (Dillwyn).*

*Murex clandestinus (Chemnitz) Dillwyn*, 'Cat. Rec. Shells,' p. 723 (1817).

*Triton clandestinus (Dillwyn)*; Lamarck, 'Anim. S. Vert.,' vol. vii, p. 187, (1822); Reeve, 'Conch. Icon.,' vol. ii, fig. 13.

Hab.—Port Shepstone (H. Burnup). Other localities are Mauritius, Madagascar, Ceylon, Nicobar Islands, Philippine Islands; Australia (Tryon); Polynesia (Martens); Galapagos Is. (Reeve).

*Colubraria bacillum (Reeve).*

*Triton bacillum Reeve*, 'Conch. Icon.,' vol. ii, fig. 94; Kobelt, 'Conch. Cab.,' p. 216, Pl. LX, fig. 7 (after Reeve).

Hab.—Scottburgh (H. Burnup).

*Colubraria obscura (Reeve).*

*Triton obscurus Reeve*, 'Conch. Icon.,' vol. ii, fig. 63; Kobelt, 'Conch. Cab.,' p. 212, Pl. LX, figs. 1, 2.

Hab.—Durban (F. Quekett); East Indies (Reeve); Réunion (Deshayes); Maldive Is. (Smith); Mauritius (Martens).

*Cypræa cruenta* (*Monstr.*).

*Cypræa cruenta*, var. *tortirostris* *Sowerby*, 'Proc. Malac. Soc.,' vol. vii, p. 39, text-fig.

Hab.—The Kowie.

Three similarly abnormal specimens were recorded.

*Trifora burnupi* n. sp. Pl. VII, fig. 8.

Testa parva, angusta, subulata, albida circa medium anfractuum linea saturate fusca cincta, et inter gemmules supra liras spirales dilute fusco notata; anfractus 17, superiores quatuor fusi, longitudinaliter tenuiter lirati, tertius et quartus circa medium liris spiralibus duo cincti, quintus ad octavus seriebus gemmarum duabus (seria infima majori) instructi, cæteri liris quatuor inæqualibus ornati, lira infra lineam fuscam distincte gemmata; anfr. ultimus ad peripheriam gemmato-carinatus, infra concavus, lira unica instructus; apertura rotunde piriformis; canalis obliquus, recurvus, præter extremitatem clausus.

Longit. 7, diam. 1.5 mm.

Hab.—Durban (H. Burnup).

Of the four liræ upon the later whorls, that below the brown line is the most conspicuous and most distinctly gemmate. The lira or thread above the brown line is the most slender and faintly gemmate, and the lira above that is the least gemmate of all, and exhibits here and there only very faint traces of the light brown dotting which occurs between the gemmules on the other liræ.

*Cerithiopsis ? peilei* n. sp. Pl. VII, figs. 9-9a.

Testa elongata, producta, imperforata, tenuis, subpellucida, cornea, spiraliter sulcata; anfractus 8 rotundati, lente accrescentes, sutura profunda seuncti; apicalis probabiliter lævis, secundus et tertius longitudinaliter tenuiter costulati, cæteri spiraliter sulcati et lirati, liris plus minus minute granulatis, granulis in anfr. ultimo fere obsoletis; apertura parva irre-

gulariter rotunda; columella incrassata, recta, antice truncata; labrum probabiliter haud incrassatum, infra columellam fissum, canalem brevissimum formans.

Longit. 7 mm., diam. 3·25. Apertura 2 mm., longa, 1·5 lata.

Hab.—Port Elizabeth, Cape Colony (Major A. J. Peile).

It is with considerable doubt that this shell is placed in the genus *Cerithiopsis*. It is of less slender form than other species of that group, and in some respects recalls certain forms of *Nassa*, although the spire is conspicuously long for that genus, and the outer lip, in the unique shell described, is not thickened as in *Nassa*. It is impossible to say with certainty, but it has not the appearance as if it would ever become much strengthened. The liræ between the sulci are flattened, twelve in number on the body-whorl, six on the penultimate, five on the next, and four on the two above. The fine costulae on the second and third whorls are not crossed by spiral sulci, and consequently they are smooth and not tuberculated. On the next whorls the spirals become more pronounced than the costulae, which are represented by the tuberculation. This, as the shell grows, becomes less marked, so that upon the body-whorl it is only faintly indicated.

*Lippistes helicoides* (*Gmelin*). Pl. VII, figs. 10, 10a.

*Turbo helicoides* *Gmelin*, 'Syst. Nat.,' vol. vi, p. 3598.

*Turbo separatista* *Chemnitz*, 'Conch. Cab.,' vol. x, p. 298, figs. 1589–1590; Dillwyn, 'Cat. Recent Shells,' p. 867.

*Separatista chemnitzii* *A. Adams*, 'Proc. Zool. Soc.,' 1850, p. 45; H. and A. Adams, 'Genera Moll.,' Pl. XIV, fig. 6; Tryon, 'Man. Conch.,' vol. ii, p. 213, Pl. LXVIII, fig. 398; vol. ix, p. 45, Pl. VIII, fig. 70, both figs. after Adams; Chenu, 'Man. Conch.,' vol. i, p. 172, fig. 854, after Adams.

Hab.—Isezela and Port Shepstone (H. Burnup); East Indies (Chemn.); Philippines (Adams).

*Gmelin* named another shell *Turbo helicoides* (*op. cit.*

p. 3602) now known as *Aulopoma helicinum* (*Chemu*). *Trichotropis blainvilleanus* *Petit* is probably the same as the present species.

*Siphonium* (*Dendropoma*) *leucozonias* *Mörch* ?

*Siphonium* (*Dendropoma*) *leucozonias* *Mörch*, 'Proc. Zool. Soc.,' 1861, p. 155.

Hab.—Isipingo, Natal (H. Burnup).

The single specimen at hand is attached to the spire of a *Conus ceylanensis*, and is so much corroded like the shell also that it is not possible to say with certainty that it belongs to this species, originally described by *Mörch* from West Africa. The colour is the same, but I cannot trace the longitudinal sculpture ("liris circiter vi obsoletissime nodulosus") as described by *Mörch*. The growth-lines or wrinkles are quite strong as in *leucozonias*.

*Turritella natalensis* n. sp. Pl. VII, fig. 11.

Testa elongata, subulata, pallida, fusco oblique strigata, spiraliter lirata et striata; anfractus 12, primus levis, globosus, sequentes 3-4 convexiusculi, cæteri planiusculi, inferne ad suturam leviter constricti, liris inæqualibus cincti, sutura obliqua sejuncti, ultimus ad peripheriam rotundatus, vix angulatus, infra in medio leviter concavus, concentricè inæqualiter liratus; apertura rotunde subquadrata, albida, longit. totius  $\frac{1}{3}$  haud æquans; columella areolata.

Longit. 40, diam. 9.5 mm.; apertura 6 mm. longa, 4 lata.

Hab.—Bluff, Durban (G. W. Westcott); Isezela (Mrs. Crossley).

A species without striking features. Of the spiral liræ, one which borders the constriction at the lower part of the whorls is most conspicuous. Altogether there are about seventeen liræ on the penultimate whorl with a few intervening threads here and there.

Of the two specimens examined, that from Isezela has the oblique brownish strigæ more broken up into dots than the other.

*Fossarus ambiguus* (Linn.).

*Fossarus ambiguus* (Linn.); Tryon, 'Man. Conch.,' vol. ix, p. 271, Pl. lii, figs. 3-5.

Hab.—Tongaat, Natal.

A single specimen inseparable from this variable species.

It ranges from the Mediterranean along the north and north-west coast of Africa, and has been recorded as far south as St. Helena.

*Fossarus capensis* Pilsbry.

*Fossarus capensis* Pilsbry: Smith, 'Proc. Malac. Soc.,' vol. v, p. 382.

Hab.—Scottburgh, Natal (Burnup).

Some specimens with three keels as figured by Pilsbry, others with four.

*Heliacus crenellus* (Linn.).

*Turbo crenellus* Linn.; Hanley, 'Ipsa Linn. Conch.,' p. 337.

*Solarium infundibuliforme* (Gmel.); Philippi, 'Conch. Cab.,' p. 11, Pl. II, figs. 8, 9; Hanley in Sowerby's 'Thes. Conch.,' vol. iii, p. 243, Pl. CCLIV, figs. 91-93, var. *strigata*, fig. 94; Tryon, as *Torinia*, 'Man. Conch.,' vol. ix, p. 19, Pl. VI, figs. 97-99.

*Solarium cylindraceum* Hanley (non Chemn.), op. cit. p. 242, Pl. CCLIV, figs. 98, 99, fig. 100, monstrosity.

*Solarium chemnitzii* Kiener, 'Coq. Viv.,' p. 12, Pl. IV, fig. 8.

Hab.—Tongaat, Natal.

The three small shells from Tongaat are prettily spotted with reddish or blackish-brown at the periphery, one of the spotted keels winding up the spire above the canaliculate suture. The species has been recorded from various localities in the Indian and Pacific Oceans.

The generic name *Torinia*, which has been adopted in the

Manuals of Woodward, H. and A. Adams, Phillipi, Fischer and Tryon, and in the monographs of Solarium by Philippi, Hanley, Reeve and Tryon cannot be used. It first appeared in 'The Synopsis of the Contents of the British Museum,' ed. 42, p. 147, published in 1840, in a mere list of names, without any description, and without any species being quoted under it. Under these circumstances it can only be regarded as a nomen nudum, and consequently *Heliacus* of D'Orbigny, published in 1842, in Ramon de la Sagra's 'Hist. Cuba Moll.,' vol. ii, p. 68, must be employed.

In the 44th edition of the 'Synopsis,' p. 60, Gray gave two lines of description of the operculum, but did not quote any species; we cannot therefore know with certainty what shells he referred to, although there is not much doubt that he included the species usually classed under *Torinia* in the Monographs. However, we can hardly accept the description of an operculum only, as the definition of a genus, when no species is indicated. Moreover, as both *Heliacus*,<sup>1</sup> and *Torinia* as described appeared in 1842, I think the former is preferable, as it was characterised and a type was mentioned.

*Rissoa farquhari* n. sp. Pl. VII, fig. 12.

Testa ovato-turrita, imperforata, succinea, pellucida, spiraliter lirata; spira turrita, ad apicem obtusa; anfractus  $4\frac{1}{2}$  perconvexi, regulariter crescentes, superiores  $1\frac{1}{2}$  tenuiter spiraliter striati, cæteri lirati et sulcati, liris in anfr. penultimo circa quatuor, in ultimo octo ad novem; apertura parva, ovata, longit. totius  $\frac{1}{3}$  adæquans; peristomium continuum, margine externo vix incrassato, columellari leviter reflexo.

Longit. 2, diam. 1 mm. Apertura .75 longa, .5 mill. lata.

Hab.—Four miles south of Port Elizabeth (J. Farquhar).

Belonging to the same group as *R. vaga*,<sup>2</sup> *R. æqua*,<sup>2</sup> and others.

<sup>1</sup> According to Herrmannsen 'Ind. Gen. Malac.,' vol. i, p. 504, the date of publication of this genus was 1841, but Mr. Davies Sherborn informs me that it should be 1842.

<sup>2</sup> 'Proc. Zool. Soc.,' 1890, pl. xxiv, figs. 15, 18.

*Rissoa adjacens* n. sp. Pl. VII, fig. 13.

Testa microscopica, ovata, imperforata, pellucida, polita, dilute fuscescens; anfractus  $3\frac{1}{2}$ –4 convexi, celeriter crescentes, ultimus antice descendens; apertura piriformis, parva, contracta; peristomium continuum, fuscescens, incrassatum, supra ad insertionem fortiter callosum.

Longit. 1, diam. .5 mill.

Hab.—Four miles south of Port Elizabeth (J. Farquhar).

Very closely allied to *R. atomus* *Smith*<sup>1</sup>; but faintly tinted, with a brown peristome which is more distinctly continuous; the aperture also is more contracted, the whorls rather more convex, and the last descends near the aperture.

*Mitrularia equestris* (*Lin.*).

*Calyptræa equestris* (*Linnaeus*); Reeve, 'Conch. Icon.,' vol. xi, figs. 1–1c.

Hab.—Durban and Scottburgh (Quekett and Burnup).

Other localities are Mauritius, Persian Gulf, Andaman Is., Maldivé Is., Malay Archipelago, Queensland.

The genus *Cheilea*, used by some authors for this species, as founded by Modeer,<sup>2</sup> included the Linnean species *Patella fornicata*, *porcellana*, *crepidula*, *chinensis*, and *equestris*.

*Vanikoro natalensis* *Smith*.

*Vanikoro natalensis* *Smith*, 'Proc. Malac. Soc.,' vol. viii, p. 113 fig.

Hab.—Scottburgh (H. Burnup); Bluff, Durban (Wescott); Natal (Récluz).

*Lamellaria perspicua* (*Lin.*).

*Lamellaria perspicua* (*Lin.*); Sowerby, 'Marine Shells S. Afr.,' p. 23.

<sup>1</sup> *Ibid.*, 1890, p. 309, pl. xxiv, fig. 14.

<sup>2</sup> 'K. Vet. Ac. Nya Handl.,' vol. xiv, p. 110 (1793).

*Marsenia perspicua* (*Linn.*); Bergh, 'Trans. S. Afr. Phil. Soc.,' vol. xvii, p. 104, Pl. XIV, figs. 5-9 (1907).

Hab.—Port Elizabeth (Sowerby); off Umlilanga River (Bergh).

A well-known European Mollusc, of which an interesting account is given by Jeffreys ('British Conchol.,' vol. iv, pp. 235-238, Pl. III, fig. 6).

*Lamellaria capensis* (*Bergh*).

*Marsenia capensis* *Bergh*, op. cit. p. 105, Pl. IX, figs. 13-16.

Hab.—Off Cape Point, 650-800 fathoms; and Lion's Head, 131-204 fathoms.

*Lamellaria leptocoencha* (*Bergh*).

*Marsenia leptocoencha* *Bergh*, op. cit. p. 106, Pl. IX, figs. 17-20; Pl. X, figs. 1-2.

Hab.—Off Cape Point, 700-800 fathoms.

*Sigaretus planulatus* *Récluz*.

*Sigaretus planulatus* *Récluz*; Sowerby, 'Marine Shells S. Afr. Suppl.,' p. 12; Bergh, op. cit. p. 108, Pl. X, figs. 4-16.

Hab.—Durban (Sowerby); off Umvoti River, 27 fathoms (Bergh).

*Recluzia jehennei* *Petit*.

*Recluzia jehennei* *Petit*, 'Journ. de Conch.,' 1853, vol. iv, p. 118, Pl. V, fig. 3; Tryon, 'Manual Conch.,' vol. ix, p. 39; Pl. X, fig. 28 (copy of Petit).

Hab.—Shore at Tongaat, Natal (Burnup).

I am of opinion that the number of species of the genus *Recluzia* is very limited, and that such forms as *R. rollandiana* *Récluz*, *Montrouzieri* *Souverbie*, and probably even *hargravesi* *Cox* should be united with the present species.

As in the case of the genus *Ianthina*, the form of the

shells is very variable. There is, however, the same uniform, light-brownish colour, and similar sculpture in all.

The *Helix johnii* of Chemnitz, which appears in Tryon's manual as a *Recluzia*, and also in Mr. Hedley's 'Marine Fauna of Queensland,' is a very doubtful species. It was placed by Gray<sup>1</sup> in the genus *Pupa*, and by Férussac<sup>2</sup> in *Cochlogena* among the helicoids.

Chemnitz describes the last whorl as subkeeled ("subcarinato"), a feature which I have not observed in any specimen belonging to the genus *Recluzia*. Moreover, it is said to be snow white and bluish brown in places towards the upper part.

The original localities for the species quoted above are Arabian Gulf for *jehennei*, off Mazatlan for *rollandiana*, New Caledonia for *montrouzieri*, and New South Wales for *hargravesi*.

This wide distribution does not, however, militate against the identity of those forms, as pelagic species are often almost world-wide in their distribution.

*Epitonium macromphalus* n. sp. Pl. VII, figs. 14, 14 *a*.

Testa parva, alba, late umbilicata, depresso turbinata; spira elata; anfractus 6-7 convexi, lamellis confertis numerosis tenuissimis obliquis instructi; apertura fere circularis; peristomium tenue, margine columellari leviter incrassato et anguste reflexo. Diam. maj. 6, min. 5.25, alt. 5.25 mm.

Hab.—Tongaat, Natal (H. Burnup).

This species is remarkable for its depressed and openly umbilicated form and for the close-set very delicate lamellæ of growth. It may attain to larger dimensions, but as with most species of this genus (= *Scalaria*) it is impossible to state whether a shell is full grown or not.

<sup>1</sup> 'Ann. Phil.,' 1825, vol. ix, p. 12.

<sup>2</sup> 'Tabl.-Syst.,' p. 61.

*Epitonium shepstonense* n. sp. Pl. VII, fig. 15.

Testa elongata, pyramidalis, alba, imperforata; anfractus 8, tres superiores convexi, læves, pellucidi, nitentes, cæteri perconvexi, lamellis tenuissimis 24–26 instructi, inter lamellas lævigati; apertura rotundata; peristomium continuum, margine columellari reflexo.

Longit. 4·75, diam. 2·2 mm.; apertura 1·5 longa et lata.

Hab.—Port Shepstone (H. Burnup).

This species is distinguished by the numerous and very fine lamelliform ribs, of which there are twenty-six upon the body-whorl in the specimen whose dimensions are given above. In a slightly more slender form, also from Port Shepstone, there are only twenty-four. The measurements given probably do not represent the adult size to which the species may grow.

*Eulima leptostoma* n. sp. Pl. VII, fig. 16.

Testa elongata, subulata, nivea, vix pellucida; anfractus 12–13 angusti, leute accrescentes, plani, læves, politi, sutura lineare sejuncti, ultimus in medio rotundatus; apertura minima, piriformis, longitudinis totius circiter  $\frac{1}{4}$  æquans; columella incrassata, reflexa, callo tenui labro juncta; labrum tenue, curvum, prope suturam leviter sinuatum. Longit. 18·5, diam. 5·5 mm.; apertura 4·5 mm. longa, 2 lata.

Hab.—Isezela, Natal (Burnup).

Remarkable on account of the striking smallness of the aperture. The nuclear whorls in all three specimens examined are wanting.

#### Order Scutibranchia.

*Neritina souverbiana* *Montrouzier*.

*N. souverbiana* *Montrouzier*, 'Journ. de Conch.,' 1863, pp. 75, 175, Pl. V, fig. 5; Martens, 'Conch. Cab.,' p. 251, Pl. XXIII, figs. 29–31.

*N. (Vitta) pulcherrima* *Angas*, 'Proc. Zool. Soc.,' 1871, p. 19, Pl. I, fig. 25.

Hab.—*Congella* (H. Burnup).

After a careful comparison of South African specimens with examples from Port Jackson (the types of *pulcherrima*) I can pronounce with certainty that they all belong to the same species. It is one of the smallest known forms, and, like some others in this genus, very variable in colour-markings. It was originally described from New Caledonia.

*Turbo argyrostoma* *Lin.*

*Turbo argyrostoma* *Lin.*; Reeve, 'Conch. Icon.,' vol. iv, fig. 7; Pilsbry, 'Man. Conch.,' vol. x, p. 197, Pl. XL, fig. 18 Pl. XLII, fig. 41; Pl. XLVI, fig. 8.

Hab.—S. Africa (H. Burnup).

It occurs both in the Indian and Pacific Oceans.

*Trochus* (*Infundibulops*) *cariniferus* *Reeve.*

*Trochus cariniferus* (Beck, MSS.) *Reeve*, 'Conch. Syst.,' vol. ii, Pl. CCXVIII, fig. 8; Pilsbry, *op. cit.* p. 41, Pl. V, figs. 38–42.

Hab.—Durban (Quekett).

Other localities are Red Sea, Indian Ocean, China Sea.

*Calliostoma crossleyæ* n. sp. Pl. VII, fig. 17.

Shell small, turbate, conical, imperforate, pale brownish-yellow, with large blotches of reddish-brown, spirally granosely lirate, liræ alternately large and small, interstices crossed by oblique lines of growth; whorls about eight, rather convex, upper ones with three principal granose liræ and three to four much finer intervening ones; last whorl with four principal liræ, the lowermost at the periphery; the base is concentrically granosely lirate, of a light yellowish-brown tint, dotted with reddish-brown; one or two of the liræ around the umbilical region are rather larger than the rest; the lines of growth are also conspicuous on the base; aperture a little oblique, quadrately rounded, whitish within, not pearly; columella thickened, porcellanous, white, glossy,

reflexed over the umbilical region, where there is the slightest chink.

Height 10, diam. of base 9 mm.

Hab.—Isezela, Natal (Mrs. Crossley); Port Shepstone (H. Burnup).

Only two specimens have been examined, but they are quite distinct from any other South African form.

*Cyclostrema pellucida* n. sp. Pl. VII, figs. 18–18 *b*.

Testa parva, orbicularis, depressa, aperte perspective umbilicata, hyalino-alba, nitida, carinata; spira depressa, ad apicem obtusa, supra anfr. ultimum leviter elata; anfractus  $4\frac{1}{2}$ , superiores duo laeves, convexi, ultimus tricarinatus, carinis conspicuis, una superiori, secunda peripheriali, tertia duplice, umbilicem cingente, inter carinas convexiusculus; apertura subcircularis; peristomium tenne, marginibus haud continuis, sed callo tenui junctis, columellari ad insertionem levissime reflexo.

Diam. maj. 3.5 mm., alt. 1.2.

Hab.—Port Shepstone, Natal (H. Burnup).

There is another smaller keel above that upon the upper surface of the body-whorl, but it only extends from the peristome about half-way round the volution. The keel around the umbilicus may be described as double, or it may be said that there are two fine keels side by side.

*Haliotis (Padollus) queketti* n. sp. Pl. VIII, figs. 1–1*a*.

Shell ovate-depressed, with the raised ridge parallel to the row of holes only slightly raised; the upper surface exhibiting numerous spiral lirae, minutely squamose through the close elevated lines of growth; holes rather prominent, four open; space between the holes and the outer margin concave or channelled, brownish white, with radiating blood-red streaks, narrow at the suture and gradually widening outwards; left outer edge crossed by oblique, alternating, dark olive, and pale stripes; interior beautifully iridescent, ridged and

grooved; columellar plate whitish pearly, flattened, edged externally with a thin red line.

Length 41, diam. 29·5 mm.

Hab.—Isezela, Natal (F. Quekett).

This species somewhat resembles *H. emmæ* Gray, but it is more coarsely sculptured and has no radiating plicæ, and the raised ridge is less prominent, and more remote from the row of holes than in that species.

In the present form there are only about twelve spiral ridges between the series of perforations and the suture, whereas in *H. emmæ* there are twice that number.

*H. (Padollus) parvus*, another South African form, is remarkable for the fineness of its sculpture, and very distinct from the present species. I have named this species after Mr. F. Quekett, who kindly sent it to me for examination.

*Scissurella jucunda* n. sp. Pl. VIII, figs. 2-2*a*.

Testa minuta, oblique suborbicularis, tenuis, pellucida, late umbilicata; anfractus tres, celeriter crescentes, convexi, longitudinaliter tenuissime costulati, costulis supra anfractum primum numerosissimis, in anfr. sequentibus sensim majjīs remotis, liris spiralibus quoque tenuibus cancellati, liris supra costulas minute tuberculatis; anfr. ultimus ad scissuram bicarinatus, infra carinam inferiorem haud profunde constrictus; scissura per  $\frac{1}{3}$  anfractui extendens; apertura obliqua, subovata; peristomium tenue, margine dextro in medio interrupto, columellari supra leviter dilatato, margine externo juncto.

Diam. maj. 1, alt. ·75 mill.

Hab.—Four miles south of Port Elizabeth (J. Farquhar).

The sculpture should be examined under a compound lens.

The longitudinal riblets are much closer together upon the first whorl than upon the last two.

*Schismope carinata* (A. Adams). Pl. VIII, fig. 3.

*Scissurella carinata* A. Adams, 'Ann. Mag. Nat. Hist.,' 1862, vol. x, p. 346.

Hab.—Durban, Natal (H. Burnup); Japan (A. Ad.).

A single specimen, agreeing in all respects with examples from Japan in the British Museum from the collection of Henry Adams, which he doubtless received from his brother. The specific name *carinata* being pre-occupied, the species described by Watson under that name should be changed if distinct.

*Schismope insignis* n. sp. Pl. VIII, figs. 4, 4a.

Testa minuta, subturbinata, mediocriter umbilicata; anfractus tres celeriter crescentes, perconvexi, primus vix elatus, planorbiformis, tenuissime longitudinaliter et confertim liratus, secundus liris vel costellis circiter septem remotis validis instructus, ultimus liris duobus tenuibus spiralibus supra medium ornatus, supra carinam superiorem striis incrementi oblique arcuatis minutis sculptus, infra carinam inferiorem costis validis octo remotis et striis spiralibus circiter duodecim ornatus; foramen oblongum, ab margine labrali paulo remotum; peristomium subcirculare, continuum.

Diam. .8, alt. .5 mill.

Hab.—Four miles south of Port Elizabeth (J. Farquhar).

Three of the spiral lines upon the base of the body-whorl are much stronger than the rest, and, under the microscope, have the appearance of liræ somewhat broken up by the costæ which cross them. The two parallel carinæ only extend over the dorsal portion of the body-whorl from the foramen. There is a marked difference between the fine sculpture of the apical whorl and that of the rest of the shell.

*Glyphis australis* Krauss.

Hab.—Pongaat, Natal (Burnup).

This specimen is peculiar in having no apical perforation. In very early youth it may have had one, for there is a slight depression at the extreme apex as if it may have been open. However, it is completely closed now, and within there is no distinct hole-callus such as occurs in normal specimens. There is merely an undefined deposit of callus at the apex.

Apparently the absence of a perforation is not a matter of vital importance, for otherwise the shell is quite normal. A similar absence of perforations in the genus *Haliotis* was noticed by me in 'The Conchologist,' vol. ii, p. 75.

*Emarginula micans* *A. Adams.*

*Emarginula micans* *A. Ad.* 'Proc. Zool. Soc.,' 1851, p. 84; Sowerby, 'Thesaurus,' vol. iii, Pl. CCXLVI, fig. 60, as *E. elongata*; Pilsbry, 'Man. Couch.,' vol. xii, p. 257, Pl. LXIV, fig. 15, after Sowerby.

Hab.—Tongaat, Natal (H. Burmp); Rains Island, North Australia (A. Ad.).

The Natal specimen of this species is considerably larger than the type, which probably is not a full-grown shell. It was described by Adams as "pallida fusca," but one of the shells preserved with the type in the Cuming collection is entirely white, so also is the specimen from Natal. In the type there are about fifty radiating riblets, and in the South African shell about sixty-eight. This increased number is owing to its being a larger shell and the occurrence of small intercalating riblets. The type has about fifteen concentric liræ (nodulous on the riblets) besides a few fine indistinct ones near the apex. In the Tongaat specimen, which is twice as large, there are about thirty. The fissure in the type is 2.5 mm. in length. This is the first record of the genus *Emarginula* from South Africa.

*Patella patriarcha* *Pilsbry.*

Hab.—Kalk Bay, Cape of Good Hope.

This is the largest of the South African limpets. There are specimens in the British Museum  $5\frac{7}{10}$  in. in length. It is the *P. rustica* *Reeve* (not of Linn.) and of Sowerby's 'Marine Shells of S. Africa,' p. 49. The true *rustica* of Linnæus, as demonstrated by Hanley and others, is a Mediterranean species. It is not very easy to distinguish the present form from *P. barbara*, and Sowerby observes, l. c., "I doubt very much whether this (*plicata*, which is a synonym of

barbara) is anything more than a variety of *P. rustica*," = patriarcha.

In barbara the radiating ridges are generally more prominent and produce a more strongly dentate margin. The reddish colour of patriarcha will assist in separating the two forms. As a rule there is very little colour in specimens of barbara, and as described by Pilsbry ('Mammal Conch.,' vol. xiii, p. 96), they are "white, tinged with brown, the spines usually tipped with brown." The border, however, cannot be said to be "colourless." Although not striking, it is of a pale greyish tint. I have never seen specimens of barbara attaining anything like the dimensions of patriarcha.

#### Order Polyplacophora.

##### *Callochiton dentatus* (*Spengler*).

*Chiton dentatus* *Spengler*, 'Skrivt. Naturhist.-Selsk.,' vol. iv, p. 88, Pl. VI, fig. 16 (1797).

Hab.—Cape of Good Hope (*Spengler*).

Considered by Möreh ('Mal. Blät.,' vol. xvii, p. 112) the same as *Chiton fulgetrum* *Reeve* ('Conch. Icon.,' vol. iv, fig. 71).

##### *Callochiton planatus* (*Spengler*).

*Chiton planatus* *Spengler*, op. cit. p. 91.

Hab.—Cape of Good Hope (*Spengler*).

*Pilsbry* ('Man. Conch.,' vol. xv, p. 68) suggests that this species "is probably the same as *C. dentatus*, and both seem to agree with *C. fulgetrum* *Reeve*."

##### *Chætopleura papilio* (*Spengler*).

*Chiton papilio* *Spengler*, 'Skrivt. Naturhist. Selsk.,' vol. iv, pp. 86, 103, No. 15, Pl. VI, fig. 15 (1797).

Hab.—Cape of Good Hope (*Spengler*).

This species appears in *Krauss* ('Sudafr. Moll.,' p. 41), and

Sowerby ('Marine Shells S. Afr.,' p. 51), under the name of *Chiton watsoni*. For other synonyms see Pilsbry, 'Man. Conch.,' vol. xv, p. 72. *Chiton* (*Callochiton*) *gaimardi Clessin* ('Conch. Cab.,' p. 65, Pl. XXIII, fig. 7) is also a synonym.

*Ischnochiton* (*Chondropleura*) *simplicissimus Thiele*.

*Ischnochiton* (*Chondropleura*) *simplicissimus Thiele*, 'Deutsch. Tiefsee-Exped.,' "Valdivia," vol. ix, Lief 2, p. 335, Pl. XXIX, figs. 21-25 (1906).

Hab.—Off Cape of Good Hope, 318 m. (Thiele).

*Lepidopleurus sykesi* (*Sowerby*).

Hab.—Off the Cape of Good Hope (Thiele).

This species was originally described as a *Hanleya*, but Dr. Thiele has shown that it should be placed in the genus *Lepidopleurus* ('Deutsch. Tiefsee-Exped.,' "Valdivia," vol. ix, Lief 2, p. 328, Pl. XXIX, figs. 6-8).

*Acanthochites variegatus Nierstrasz*.

*Acanthochites variegatus Nierstrasz*, 'Zool. Jahrbüch.,' vol. xxii, p. 500, Pl. XXVII, figs. 31-37 (1906).

Hab.—Natal Coast (Nierstrasz).

*Acanthopleura spinigera* (*Sowerby*).

*Acanthopleura spiniger* (*Sowerby*); Pilsbry, 'Man. Conch.,' vol. xiv, p. 221, Pl. XLVIII, figs. 22-32; Nierstrasz, 'Notes Leyden Mus.,' vol. xxv, p. 151 (1905).

Hab.—Cape of Good Hope (Nierstrasz).

Widely distributed from the Red Sea, through the Malay Archipelago to the South Sea Islands.

*Acanthopleura brevispinosa* (*Sowerby*).

*Acanthopleura brevispinosa* (*Sowerby*); Pilsbry, 'Man. Conch.,' vol. xiv, p. 231, Pl. XLVII, figs. 18-21.

Hab.—Cape of Good Hope (Paris Museum).

This locality is doubted by Pilsbry.

*Acanthopleura granulata* (*Gmelin*).

*Acanthopleura granulata* (*Gmelin*); Pilsbry, 'Man. Conch.,' vol. xiv, p. 227, Pl. L, figs. 39, 49; Nierstrasz, 'Notes Leyden Mus.,' vol. xxv, p. 152 (1905).

Hab.—Cape of Good Hope (Nierstrasz). A well-known West Indian form.

A valuable account of the South African chitons is given by H. F. Nierstrasz in the 'Zoologische Jahrbücher,' vol. xxiii, pp. 487-520, Pls. XXVI, XXVII (1906).

Class **Pelecypoda**.*Chlamys noduliferus* (*Sowerby*).

*Pecten noduliferus* *Sowerby*, 'Thesaur. Conch.,' vol. i, p. 64, Pl. XIII, figs. 38, 39; Pl. XIV, fig. 94; Reeve 'Conch. Icon.,' vol. viii, fig. 27.

Hab.—Durban (Quekett).

Known also from the Mauritius, Bourbon, Amirantes, Seychelles, Maldive Islands.

*Chlamys cuneolus* (*Reeve*).

*Pecten cuneolus* *Reeve*, 'Conch. Icon.,' vol. viii, fig. 131.

Hab.—Durban, Natal.

The specimens from Durban were whitish with opaque white fleckings, or whitish with scarlet markings on the left valve besides the white fleckings.

*Chlamys testudineus* (*Reeve*).

*Pecten testudineus* *Reeve*, 'Conch. Icon.,' vol. viii, fig. 160; Melvill and Sykes, 'Proc. Malac. Soc.,' vol. iii, p. 46, Pl. III, fig. 4.

Hab.—Durban (H. Burnup); Amboyna (Reeve); Andaman Is. (Brit. Mus.).

One of the specimens sent by Mr. Burnup was 44 mm. in length, 47 in height from the umbo to the ventral edge, and 13.5 in diameter. It was coloured like Reeve's type, which is

only a young shell. Another example from Durban was 51 mm. long, 55 high (umbo to lower margin), and 16 in diameter.

*Chlamys natalensis* *Smith*.

*Chlamys natalensis* *Smith*, 'Ann. Natal. Gov. Mus.,' vol. i, p. 60, Pl. VIII, figs. 7-8a.

Hab.—Durban (McBean and Burnup).

A pretty, orange-coloured variety was obtained by Mr. Burnup.

*Vulsella vulsella* (*Linn.*).

*Mya vulsella* *Linn.*, 'Syst. Nat.,' ed. 12, p. 1113.

*Vulsella lingulata* *Lamarck*, 'Hist. Nat. Anim. S. Vert.,' ed. 2, p. 267; Reeve, 'Conch. Icon.,' vol. xi, fig. 6; Clessin, 'Conch. Cab.,' Malleacea, p. 17, Pl. V, fig. 4.

Hab.—Tonga, Natal (H. Burnup); Port Essington, North Australia (Brit. Mus.); Queensland (Hedley); Red Sea (Reeve); Indian Ocean (Lamarck).

Only a single abnormal specimen was sent from Tonga. It is a small shell, 35 mm. in length, of irregular growth, and peculiar on account of the great divergence of the umbones from one another, leaving enormous ligamental areas. I do not doubt, however, that it belongs to this species, as it presents the characteristic brown lines which often run in pairs or threes.

*Melina perna* (*Linn.*).

*Ostrea perna* *Linn.*; Hanley, 'Ipsa Linn. Conch.,' p. 117, Pl. II, fig. 7.

*Perna sulcata* *Lamk.*; Hanley, 'Recent Bivalve Shells,' p. 258.

*Perna (Isognomon) samoensis* *Baird*, in Brenchley's 'Crnise of the Curaçoa,' p. 454, Pl. XLII, fig. 8.

Hab.—Scottburgh (H. Burnup); Samoa Is. (Baird); Keeling Is. (Brit. Mus.).



*Standella ægyptiaca* (Chemnitz).

*Maetra ægyptiaca* Chemnitz; Reeve, 'Conch. Icon.,' vol. viii, fig. 112.

Hab.—Congella (Burnup).

Only a single dead valve obtained.

*Sphenia natalensis* n. sp. Pl. VIII, figs. 5, 5 a.

Testa parva, oblonga, subæquilateralis, postice paulo longior, truncata et hians, obtuse rostrata, antice clausa, arcuata, sordide albida, subpellucida, tenuis; valvæ leviter inæquales (dextra paulo convexiore), lineis incrementi striatæ, marginem ventralem versus, etiam ad extremitatem posticam periostraco tenui indutæ, ab umbone ad medium linea vel stria instructæ; umbones paulo ante medium siti; fossa resiliæ obliqua, triangularis, pone umbones sita; cicatrix anterior indistincta, postica irregulariter rotunda, conspicua; linea pallii indistincta.

Longit. 4, alt. 2, diam. 1.5 mm.

Hab.—Durban.

Judging from the dimensions it is probable that the shell described is not adult, but, although the form may vary when other specimens are found, as is usual in species of this genus, I think the radiating stria from the umbone to the centre of the valves will be found to be a good specific character. It does not look accidental, as it commences quite at the tip of the umbones, and is a fine raised ridge within the valves. It recalls the fissure in the shells of *Anatina*, but I do not think the little form in question belongs to that genus. The character of the ligament-pit is not the same; the form is more that of *Sphenia*, and the interior of the valves is less nacreous.

*Saxicava lirata* n. sp. Pl. VIII, figs. 6, 6 a.

Testa oblonga quadrata, valde inæquilateralis, inæquivalvis, sub periostraco tenui flavescente alba, utrinque oblique truncata, marginibus superiore et ventrali subparallelis; valvæ radiatim tenuiter liratæ, postice angulo obliquo instructæ,

lira ad angulum et altera in medio areae posticae quam aliis majoribus, subsquamatis, lineis incrementi irregularibus striatae, intus albae; valva sinistra dextra minor; umbones ad apicem nitidi, longe ante medium siti, subterminali; dens cardinalis unicus in valva sinistra; valva dextra edentula; cicatrices et linea pallii obscurae.

Longit. 5·25, alt. 3, diam. 2 mm.

Hab.—Tongaat, Natal (H. Burnup).

This species must not be confused with the young of *S. arctica*, from which it can at once be separated by the fine radiating and somewhat wrinkly lira. The posterior area of the valves is marked off by a somewhat squamous ridge forming an angle from the umbones to the hinder extremity of the ventral margin. A second similar squamous lira is situated between the angle and the dorsal line. The surface of the valves is rather irregular, presenting somewhat rough lines of growth.

*Saxicava arenacea* n. sp. Pl. VIII, fig. 7.

Testa parva, oblonga, valde inaequilateralis, compressa, tenuis, vix pellucida, antice rotundata, postice latior, oblique arcuatim truncata; valvae aequales, lineis incrementi striatae, undique quasi arenaceae, marginem versus pallide fuscescentes; umbones parvi, minime prominentes, ad apicem pellucidi, nitentes, rotundati, longe ante medium siti; dens unicus in utraque valva, in valva dextra sub apicem umbonis, in sinistra ante apicem; ligamentum parvum; margo dorsi posticus infra ligamentum incrassatus; pagina interna nitida; cicatrices indistinctae, anterior posteriore latior; linea pallii inconspicua.

Longit. 4·5, alt. 2·5, diam. 1·5 mm.

Hab.—Durban, Natal (H. Burnup).

This is not the young state of *Saxicava arctica*, being different in form, and having a dull arenaceous surface. It may, however, attain larger dimensions than the shells described.

*Martesia striata* (*Linnaeus*).

Hab.—Tonga, Natal. Boring in floating seeds of an Indian species of *Barringtonia* (*B. speciosa*).

I have as yet seen only young specimens of this species from South Africa.

The *Martesia falcata* of Sowerby's 'Marine Shells of S. Africa,' p. 54, is also the early stage of this species. He quotes it as of Gray, and refers to his father's monograph in the 'Conchologia Iconica.' The shell there described<sup>1</sup> as *Pholas falcata Gray*, MS., Brit. Mus. (!), and figured Pl. XII, fig. 51, is *cuneiformis Say*, but whether it is the same species as the *Pholas falcata* of Wood<sup>2</sup> is very doubtful.

*Xylotrya stutchburyi* (*Sowerby*). Pl. VIII, figs. 8–8 *b*.

*Teredo stutchburyi* (Leach MSS.) *Sowerby*, 'Conch. Icon.,' vol. xx, Pl. II, figs. 5 *a–c*.

*Teredo skutschburyi* (sic!) *Leach*; Clessin, 'Conch. Cab.,' *Pholadea*, p. 68, Pl. XVI, figs. 14–16 (after Sowerby).

Hab.—Port Elizabeth and Durban (H. Burnup); Sumatra (Coll. Leach in Brit. Mus.); Pulo Bidang, North of Penang (Skeat Coll. in Brit. Mus.); Christmas Island, Indian Ocean (Brit. Mus.).

The figures in the 'Conchologia Iconica' are most crude, and do not give the least idea of the characters of this species. The sculpture on the central area of the valves is finer than that of the anterior area; indeed, it is so fine that it is invisible, excepting under a very powerful lens. It is then seen that the longitudinal minute threads are excessively finely granose.

The form of the anterior area differs entirely from the figures of it, 5 *a*, 5 *b*, and in reality is much more nearly repre- by fig. 11 *a* on Pl. III.

<sup>1</sup> The locality given, "Hudson's Bay," should have been Honduras, as written on the Museum tablet.

<sup>2</sup> 'General Conchology,' p. 84, pl. xvi, figs. 5–7 (1815); 'Index Test,' p. 9, pl. ii, fig. 8 (1825).

The Port Elizabeth specimens are accompanied by a piece of bored wood, showing borings lined with shelly tubes, both with and across the grain.

*Uperotis clava* (*Gmelin*).

*Teredo clava* *Gmelin*, 'Syst. Nat.,' p. 3748 (1790).

*Teredo nucivorus* *Spengler*, 'Skript. Naturhist. Selsk.,' 1792, vol. ii. Pt. 1, p. 105, Pl. II, fig. d.

*Teredo nucivora* *Sowerby*, 'Conch. Icon.,' vol. xx, Pl. IV, figs. 17 a-c.

*Fistulana gregata* *Lamarck*, 'Anim. sans Vert.,' vol. v, p. 435 (1818).

*Teredo* (*Hyperotus*) *gregata* *Sowerby*, 'Marine Shells of South Africa,' p. 54.

*Teredo gregata* *Sowerby*, 'Thesaurus,' vol. v, p. 123, Pl. CCCCLXIX, fig. 16.

Hab.—Tongaat, Natal.

Mr. Medley Wood identified the seeds in which the specimens from Tongaat were found as belonging to an Indian species of *Barringtonia* (*B. speciosa*), which always occurs by the sea-coast and on the borders of estuaries and lagoons, and is very plentiful in India. These seeds are "occasionally cast up on the beach, and in some cases the shelly tubes fill the whole space formerly occupied by the kernel" (Burnup).

*Lucina rosea* *Angas*.

*Lucina rosea* *Angas*, 'Proc. Zool. Soc.,' 1878, p. 860, Pl. LIV, fig. 6.

Hab.—Natal (*Angas*).

The only specimen I have seen is the unique type described by *Angas*, presented to the British Museum by Mr. Henry Harvey, the present possessor of the Hanley Collection.

*Clistoconcha* n. g.

Testa bivalvis, valvis marginibus superiore, ventrali, et antico conjunctis, subglobosa, irregularis, postice breviter ros-

trata, hians; cardo edentulus; ligamentum internum in fossa obliqua situm; valvæ sutura obliqua, rostrum præscribente, inæqualiter bipartitæ.

The principal distinguishing features of this genus are the joining of the valves along the dorsal, ventral, and anterior margins, and their bisection by an oblique suture. The ligament has a strong shelly support, and the outer edge of it, near the umbo in the right valve, might be mistaken for a cardinal tooth. The suture which bisects the valves is not an accidental crack, as it occurs in all specimens, and marks off the short rostrate posterior end of the valves. It even bisects the umbones at their apices. The posterior adductor scar is very strongly marked, deep, and the thickened edge, which borders it on the anterior side, extends upwards, and unites with the shelly support of the ligament.

The form of the shell is very irregular, no two specimens being alike. This would seem to indicate that the species lived in places inconsistent with regular growth, such as crevices of rocks. This, however, is mere conjecture, and, indeed, it might well be a parasitic form.

*Clistoconcha insignis* n. sp. Pl. VIII, figs. 9-9 c.

Testa parva, tenuis, forma irregularis, subglobosa, postice brevissime rostrata, hians, antice clausa, albida, vix pellucida; valvæ tenues, subæquales, extra irregulares, striis incrementi tenuissimis sculptæ, stria arenata, ab umbonibus ad marginem ventralem radianti et rostrum præscribente, instructæ, ad marginem ventralem conjunctæ; umbones parvi, in medio stria radianti bipartitæ; pagina interna nitida, stria radianti conspicua bipartita; cardo edentulus; resilium obliquum pone umbones, in fossa distincta situm; cicatrix antica parva, obscura, postica conspicua, profunda, irregulariter rotundata, distincte circumscripta; linea pallii haud conspicua.

Longit. 4.75, alt. 4.25, diam. 3 mm.

Hab.—Tongaat, Natal (H. Burmp).

The exterior of these curious shells is so irregular that at a casual glance they have not the appearance of bivalves at

all. They vary considerably in size, and yet the smallest appears to be quite as adult as the largest. Doubtless in their young condition the valves would not be united ventrally. The oblique suture-like line which bisects the valves recalls the crack or fissure which is generally seen in specimens of the genus *Anatina*.

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EXPLANATION OF PLATES VII AND VIII,

Illustrating Mr. Edgar A. Smith's paper "On South African Marine Mollusca, with Descriptions of New Species."

PLATE VII.

- FIG. 1.—*Leucotina natalensis* n. sp.  
 FIG. 2.—*Mangilia elizabethæ* n. sp.  
 FIG. 3.—*Clathurella westcottii* n. sp.  
 FIG. 4.—*Daphnella?* *minuscule* n. sp.  
 FIGS. 5, 5 *a*—*Marginella ingloria* n. sp.  
 FIG. 6.—*Columbella shepstonensis* n. sp.  
 FIG. 7.—*Coralliophila fragosa* n. sp.  
 FIG. 8.—*Trifora burnupi* n. sp.  
 FIGS. 9, 9 *a*—*Cerithiopsis?* *peilei* n. sp.  
 FIGS. 10, 10 *a*—*Lippistes helicoides* (*Gmel.*).  
 FIG. 11.—*Turritella natalensis* n. sp.  
 FIG. 12.—*Rissoa farquhari* n. sp.  
 FIG. 13.—*Rissoa adjacens* n. sp.  
 FIGS. 14, 14 *a*—*Epitonium macromphalus* n. sp.  
 FIG. 15.—*Epitonium shepstonense* n. sp.  
 FIG. 16.—*Eulima leptostoma* n. sp.  
 FIG. 17.—*Calliostoma crossleyæ* n. sp.  
 FIGS. 18–18 *b*—*Cyclostrema pellucida* n. sp.

PLATE VIII.

- FIGS. 1, 1 *a*—*Haliotis* (*Padollus*) *queketti* n. sp.  
 FIGS. 2, 2 *a*—*Scissurella jucunda* n. sp.

FIG. 3.—*Schismope carinata* (*A. Adams*).

FIGS. 4, 4 *a*.—*Schismope insignis* n. sp.

FIGS. 5, 5 *a*.—*Sphenia natalensis* n. sp.

FIGS. 6, 6 *a*.—*Saxicava lirata* n. sp.

FIG. 7.—*Saxicava arenacea* n. sp.

FIGS. 8-8 *a*.—*Xylotrya stutchburyi* (*Sowerby*); 8 *b*.—Style.

FIGS. 9-9 *c*.—*Clistoconcha insignis* n. g. et. n. sp.



J. Green del. lith. et imp.





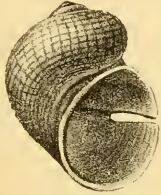
2.



4



4a.



2a.



1



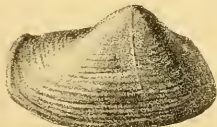
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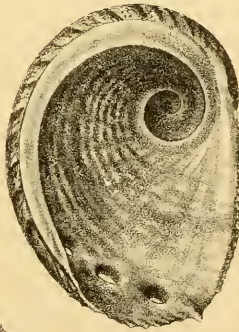
5



6.



5a.



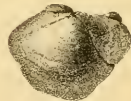
1a



6a.



7.



9.



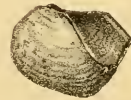
8b



9b.



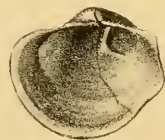
8.



9a.



8a.



9c

J Green del lith et imp.



## On Some Nudibranchs from the Coast of Natal.

By

**Sir Charles Eliot, K.C.M.G.**

A SMALL collection of Nudibranchs made by Mr. Burnup in Natal, and kindly submitted by him to me for examination, contains the following five species:

Name.	No. of specimens.	Previous records.
<i>Marionia arborescens</i>	. 4 .	Amboina, Philippines, East Equatorial Africa, Red Sea.
<i>Discodoris cœrulescens</i>	. 1 .	Mauritius.
<i>Thordisa burnupi</i> n. sp.	. 1	
<i>Chromodoris porcata</i>	. 1 .	Mauritius.
<i>Chromodoris carnea</i>	. 1 .	Mauritius.

Another small collection made by him on the same coast consisted of *Chromodoris runcinata*, *Chr. annulata*, *Chr. lineata*, *Chromodoridella mirabilis*, and *Hexabranchus adamsii* (see Eliot in 'Proc. Mal. Soc.,' vi, 1905, pp. 232-6). Thus of ten species from Natal eight belong to the Indo-Pacific fauna, and the two new species are not incongruous with it. It would seem that in the southern portion of the East African coast the Nudibranchs are much the same as those found near the Equator, as well as on the shores of Mauritius and Madagascar. Bergh's account of the Opisthobranchiata of South Africa (in 'Trans. S. Afr. Phil. Soc.,' xvii, 1907) confirms this to some extent, as the collection which he examined included such Indo-Pacific forms as *Chromodoris*, *Doridopsis*, *Kalinga*, *Nembrotha*,

and Melibe, but it also contained another element represented by *Idalia*, *Stanrodoris verrucosa*, and several new Dorids. But this collection appears to have been made at the Cape, and on both the east and west sides of South Africa, so that it probably represents more than one marine district.

*Marionia arborescens* Bergh.

*Marionia arborescens* Bergh, "Mal. Unters.," in 'Semper's Reisen,' Heft xvii, 1890, pp. 891-4, Pl. LXXXVIII, figs. 31-39.

Four specimens are preserved. The only note is "? *Dendronotus*—Port Shepstone."

The largest specimen is 43 mm. long, and all have much the same appearance. They are greenish yellow with spots of bright white or light yellow. These spots are especially numerous on the back and are raised, the larger ones forming flat tubercles. There are eleven branchial tufts on either side of the back. The oral veil bears eight simple processes and two grooved tentacles.

The internal organs are as usual in the species. The formula of the radula is about  $58 \times 27 + 1 + 1 + 1 + 27$  in the middle rows. The stomach plates are yellow.

*Discodoris cœrulescens* (?) juv. Bergh.

*Discodoris cœrulescens* Bergh, "Mal. Unters.," in 'Semper's Reisen,' Heft xvi, 2, pp. 805-7, Pl. LXXXIII, figs. 6-12.

The notes on the living animal are as follows: "Measurements  $12 \times 3$  mm. The dorsal surface is rough and whitish, mottled with irregular darker blotches composed of black lines of irregular length, thickness, and direction. Foot almost white."

The preserved specimen is much as described. The back is roughly granulated. The foot is grooved in front, but not notched. The oral tentacles are digitate. The labial arma-

ture is not much developed. It consists of two small hatchet-shaped plates composed of greyish rods. The formula of the radula is  $21 \times 25 \cdot 0 \cdot 25$ . The teeth are hamate, not denticulate, and rather large. The two to three outermost teeth are erect and thin.

This is an immature *Discodoris*, perhaps *D. cœrulescens*.

*Thordisa burnupi* n. sp.

The notes on the living animal are as follows: "No measurements taken. Dorsal surface orange, closely sprinkled with lighter orange or yellow spots and with a light area between the tentacles (i. e. rhinophores) and around the branchial pocket. The whole dorsal surface except these areas plentifully covered with black-pointed bristles.<sup>1</sup> Tentacles (i. e. rhinophores) white, with a branched reddish-brown line on the inner side of each. Foot yellow with black spots round the upper side of it."

The preserved specimen is 15.5 mm. long and 8 mm. broad. It is coloured much as described, but the large rhinophores appear to be entirely black. On a closer examination it is seen that the perfoliations are black but divided by a fine longitudinal white line both in front and behind. The pockets of the rhinophores and branchiæ are slightly raised and round. The branchiæ are five, not large, greyish and veined with black. The whole dorsal surface is villous, as if it were covered with short wavy hair. The foot is grooved and notched, the upper lamina being developed into rather large lappets. The oral tentacles are white, thin and finger-shaped.

There is no trace of a labial armature. The radula consists of twenty rows, which in the widest part have a formula of  $3 + 17 \cdot 0 \cdot 17 + 3$ . The teeth near the rhachis are of the ordinary hamate shape and rather large, but towards the end

<sup>1</sup> The preserved specimen suggests that this phrase is not quite correct. Only some of the bristles are black; most are yellow.

of the row they become more erect and less hooked. The three outermost are erect and bear on the apex a group of hair-like denticles resembling a brush. The intestines are soft and decayed, but no trace of armature was found on the genitalia.

This animal seems to be a true *Thordisa*, and one would expect it to prove identical with some of the species already described as *Th. maculigera*, *Th. maculosa*,<sup>1</sup> and *Th. punctulifera*.<sup>2</sup> But they do not entirely agree with it in external characters, and they differ decidedly in the radula, which in the present species is unusually narrow. The animal must therefore be provisionally recognised as *sp. nov.*, but it has points of resemblance to the *Doris setosa*<sup>3</sup> of Pease and the *Doris aripona* of Kelaart, two forms which are imperfectly described but could be probably identified with living animals. The soft hair-like texture of the present species is very noticeable.

#### *Chromodoris porcata* Bergh.

*Chromodoris porcata* Bergh, "Mal. Unters." in 'Semper's Reisen,' Heft xvi, 2, pp. 831-3, Pl. LXXXII, figs. 1-8.

The notes on the living animal are as follows: "21 × 7 mm. Dorsal surface whitish, irregularly mottled with yellowish brown; a few irregular plum-coloured blotches all round near the edge of the mantle. Tentacles (i.e. rhinophores) brown with white thread-like rings, depressed behind, where they are connected by one longitudinal white line. Branchiæ white; under surface white."

The liver is of a bright plum colour in the preserved specimen and visible through the lower integuments. The branchiæ are eight and simply pinnate. White lines are still visible on them and on the rhinophores. Globular glands are

<sup>1</sup> Bergh, 'Siboga Exped. Opisthob.,' pp. 123-4 (1905).

<sup>2</sup> Bergh, 'Trans. South Afr. Phil. Soc.,' vol. xvii, pp. 50-52 (1907).

<sup>3</sup> But it is equally probable that *D. setosa* is *Kentrodoris labialis*. See Eliot, 'Journ. Linn. Soc. Zool.,' xxxi, 1908, pp. 112-13.

visible in the mantle margin, but they are situated inside the integuments, and project only slightly or not at all.

The labial armature is large and forms a nearly complete circle. It is composed of large well-made bifid hooks. The radula consists of fifty-five rows containing forty to forty-five teeth on either side of the rhachis, which bears triangular thickenings. The teeth are tall and erect and bear six to eight strong denticles. The innermost teeth have also at least three denticles on the inner side.

This appears to be Bergh's *Chr. porcata* from Mauritius. The coloration is the same in essentials and the buccal parts and mantle margin agree with his description.

#### *Chromodoris carnea* Bergh.

*Chr. carnea* Bergh, "Mal. Unters." in 'Semper's Reisen,' Heft xvi, 2, pp. 836-7, Pl. LXXXIII, figs. 20-29.

The notes on the living animal are as follows: "14 × 2½ mm. Dorsal surface whitish with a few interrupted pure white longitudinal lines; tentacles (i. e. rhinophores) whitish with orange thread-like revolving line; head, point of tail, and branchiæ whitish, ornamented with branched orange lines: mantle bordered with an occasionally interrupted band of plum colour, turning white at extreme edges; dorsal surface sparsely and irregularly spotted with crimson and orange; under surface white."

In the preserved specimen the mantle is narrow at the sides but expanded over the head. The foot is expanded in front. The labial armature is greyish-yellow and much as described by Bergh. The elements are mace-like in shape. The radula is also as described by Bergh. The formula is about 50 × 30 . 0 . 30. The majority of the teeth are bifid with four to five small denticles under the bifurcation.

This appears to be a pale variety of Bergh's *Chr. carnea* recorded from Mauritius.



## The Discovery of Fish-Remains in the Ecça Shales, near Ladysmith.

By

**F. H. Hatch, Ph.D., F.G.S.**

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DURING an examination of an occurrence of mineral phosphate on the Townlands of Ladysmith for my report to the Government of Natal,<sup>1</sup> I collected several specimens of phosphate nodules at Intombi Camp, which on being broken open were found to contain scales of fish and fragments of bone which have been determined as Labyrinthodont. This discovery appeared to me to be of importance, since hitherto the Ecça Shales had proved remarkably barren of fossils, and on my return to England I handed the specimens to Dr. Smith Woodward for determination. His report on the fish-scales, as well as one by Mr. E. A. Newell Arber on some fragments of fossil-wood, are appended. Specimens of the nodules containing fish-scales are exhibited in the collection presented by me to the Natal Museum (see specimen No. 520).

Fossil remains are found only rarely in the phosphate nodules; usually all trace of organisms has disappeared, and the tri-calcium phosphate is present as an amorphous mineral. The phosphate nodules may, in fact, be compared in point of origin to the flint nodules of the English Chalk formation, where the silica of the flints was in the first place derived from the hard siliceous part of organisms, such as diatoms, sponges, etc.

<sup>1</sup> 'Report on the Mines and Mineral Resources of Natal (other than Coal),' by F. H. Hatch, London, 1910, p. 102.

The phosphate nodules occur both as isolated bodies in the shales and as portions of nodular layers. A considerable amount of phosphatic material is also found in the form of hard seams, in which no nodular structure is developed. In this case the tri-calcium phosphate appears to have been removed in solution from the original skeletal remains which contained it, and distributed more or less uniformly over considerable areas. This explains why the phosphatic seams ("reefs") are found to be poorer in phosphate than the nodules.

The beds in which the phosphates occur are the well-known black, fine-grained, laminated shales of the Ecca Series, and the loose fragmentary material into which the shales weather forms a very characteristic and rather sterile-looking landscape. In Natal the Ecca Shales, which overlie the Dwyka conglomerate conformably, are of great thickness (about 1000 feet near Pietermaritzburg). The horizon on which the phosphates occur is near the top of the series, i. e. a little below the point where the shales commence to pass into the arenaceous beds ("Ecca Sandstone"), which carry the coal measures of Natal.<sup>1</sup>

<sup>1</sup> I follow Anderson in classifying the Natal coal measures as Ecca rather than as Beaufort. There is complete conformity from the Ecca to the Beaufort, and it is immaterial whether the division between the Ecca and the Beaufort be drawn above or below the coal measures.

## Note on Palæoniscid Fish-scales from the Ecça Shales, near Ladysmith.

By

**A. Smith Woodward, LL.D., F.R.S.,**

Of the British Museum.

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With Plate IX.

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THE ganoid scales from the Ecça Shales of Intombi Camp, handed to me for description by Dr. F. H. Hatch, are scattered through a hard nodule, but some of them still remain in small groups in their original relative position, and all probably belong to one individual fish. Their outlines are for the most part distinct, but their bony tissue is so thick that nearly all are much splintered, and it is difficult to determine the character of their external surface. They are rhombic in shape, with nearly straight upper and lower borders in their exposed portion, and their most conspicuous feature is the deep pectination or digitation of their hinder border. They are united by a large peg-and-socket articulation which is sometimes very prominent; but, as shown in fig. 1, this articulation is not strengthened by any vertical ridge or thickening on the inner face. The extent of their overlap is uncertain, though the shape of the ventral scales suggests that it was considerable. The outer exposed face can only be observed in impressions, which may be partly obscured by concentric growth-lines, which did not originally form surface-markings. The upper and lower thirds of each scale, however, seem to have been ornamented by regular, antero-posteriorly directed ridges, which are finer and more numerous than the hinder pectinations, and are sometimes striated; while the middle

third is ornamented by still finer ridges, which are concentric and bend sharply downwards in the postero-superior portion (figs. 2, 5). The principal flank-scales (fig. 3) seem to have been about as wide as deep in their exposed portion, and the number of their pectinations varies from six to twelve. These pectinations are longest in the upper part of each scale and gradually shorten towards its lower border (figs. 4, 5). In an imperfectly preserved oblong scale (fig. 6), presumably from the tail, they are comparatively small and delicate, eight in number. In some of the small ventral and dorsal scales (fig. 7) the pectinations are relatively large and only four or five in number. Many of the larger oblong dorsal and ventral scales have the antero-superior angle much produced, and the peg-and-socket articulation especially large (fig. 1).

With the scales are associated other fragments of the fish, but all are unsatisfactory. A few anterior fin-rays (fig. 8) may be compared with the basal part of the pectoral fin in *Acrolepis*.

Coarsely pectinated scales, much resembling those from Intombi Camp, have already been discovered in the Karoo Formation of Cape Colony,<sup>1</sup> and in the Permo-Carboniferous of Rhodesia<sup>2</sup> and Nyassaland.<sup>3</sup> Of these, the scales from Rhodesia are most nearly similar to the Natal specimens now described; and as the former are definitely proved to belong to the Palæoniscid *Acrolepis*, the latter may also be ascribed to the same genus. The Rhodesian and Natal scales appear, indeed, to be almost identical in ornament and pectination, only differing a little in shape. In most of the scales of the Rhodesian *Acrolepis molyneuxi* (fig. 9) the upper and lower borders are sigmoidally bent, while in the new scales they are gently curved or nearly straight. The scales from

<sup>1</sup> *Acrolepis* (?) *digitata* A. S. Woodward, 'Catal. Foss. Fishes Brit. Mus.,' pt. ii (1891), p. 508, Pl. xv, fig. 4.

<sup>2</sup> *Acrolepis molyneuxi* A. S. Woodward, 'Quart. Journ. Geol. Soc.,' vol. lix (1903), p. 285, Pl. xx.

<sup>3</sup> *Colobodus africanus* R. H. Traquair, 'Quart. Journ. Geol. Soc.,' vol. lxxvi (1910), p. 249, Pl. XIX, figs. 1-5; *Acrolepis* (?) *africana* R. H. Traquair, in H. Drummond, 'Tropical Africa' (1888), p. 194.

Intombi Camp may therefore represent a hitherto unknown species of *Acrolepis*, but it is desirable to await the discovery of more satisfactory specimens before assigning to the fish a specific name.

It may be added that with these fish-scales were found fragments of a Labyrinthodont jaw and a piece of fossilised wood; and on the latter a report has been prepared by Mr. E. A. Newell Arber.

### EXPLANATION OF PLATE IX,

Illustrating Dr. A. Smith Woodward's "Note on Palæoniscid Fish-scales from the Ecca Shales, near Ladysmith."

FIG. 1.—Inner view of scale showing peg-and-socket articulation.

FIG. 2.—Scale showing structure and ornament, outer view.

FIG. 2A.—The same.  $\times 2$ .

FIG. 3.—Group of flank-scales, broken, outer view.

FIG. 4.—Flank-scale, inner view, showing socket for peg.

FIG. 5.—Scale showing structure and ornament, outer view.

FIG. 5A.—The same.  $\times 2$ .

FIG. 6.—Caudal scale.

FIG. 7.—Ventral or dorsal scales.

FIG. 8.—Base of anterior pectoral fin-rays.

FIG. 9.—Flank-scales of *Acrolepis molyneuxi* from the Permian-Carboniferous, Sengwe Coalfield, Rhodesia (Brit. Mus., no. P. 9840).

Unless otherwise stated, the figures are of the natural size.

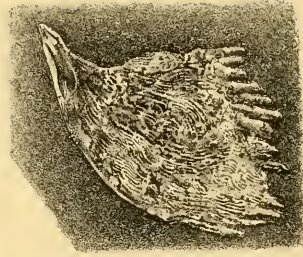




1.



2.



2a x2.



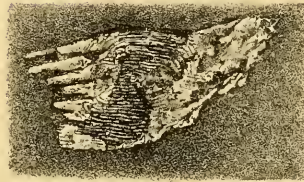
4.



5.



3.



5a x2.



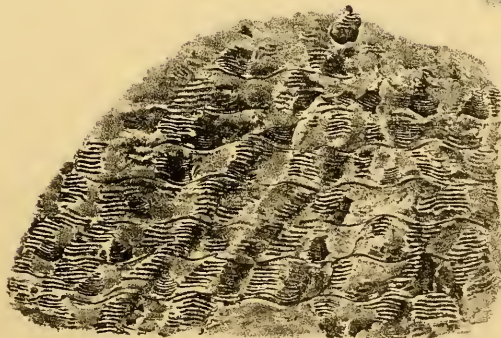
6.



7.



8.



9.

ACROLEPIS

J Green del. lith et imp.



## A Note on a Fossil Wood from Intombi Camp, Ladysmith.

By

**E. A. Newell Arber, M.A., F.L.S., F.G.S.**

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THE sections of a fossil wood found at Intombi Camp, Ladysmith, and forwarded to me for examination by Dr. Hatch, appear to agree in general structure with the species of *Dadoxylon*, associated with the *Glossopteris* Flora in many regions of Gondwanaland.<sup>1</sup> The preservation is, however, imperfect, and it would therefore be unwise to attempt a specific determination on the present material.

This Gymnospermous wood has the following features. The xylem is alone present. It consists of centrifugally developed tracheides, rather small in size and rectangular in section. The annular rings of growth are well marked, but in some cases irregular, the successive zones varying considerably in breadth. The tracheides bear on their radial walls a single series of bordered pits. Occasionally the pits are biseriolate. The medullary rays are numerous, often of considerable height, but, as a rule, uniseriate. The ray cells communicate with the tracheides by large oval, somewhat oblique, simple pits. No gum-canals or resin-cells were observed.

This specimen differs from *Dadoxylon australe* Arber,<sup>2</sup> in the fact that the bordered pits are uniseriate or at the most biseriolate. In *D. australe* Arber, the pits are usually multi-seriate or crowded, though not infrequently uni- or biseriolate. The difference is thus not important, and, pending the discovery of better-preserved specimens, the Ladysmith wood may be provisionally termed *Dadoxylon* sp.

<sup>1</sup> Arber, "Monogr. *Glossopteris* Flora," 'Brit. Mus. Catal.', 1905, pp. 190-204.

<sup>2</sup> Arber, *ibid.*, p. 191, text-figs. 40-43.



## On a Black, Hairless Duiker and Dog, and a Bulldog-Headed Calf.

By

**Ernest Warren, D.Sc.Lond.**

With Plates X—XIII, and Text-figure.

THE abnormalities about to be described are striking examples of those curious sports or large variations which occur in a spontaneous manner, and to which we are at present quite unable to assign any definite cause. In all three cases the same abnormality occurred more than once, and the fact of this recurrence adds considerably to the interest of the observations.

In June, 1910, Mr. Alick P. Martens, who resides on his farm at Table Mountain some ten miles from Pietermaritzburg, brought to the Museum an eviscerated specimen of a rather small, but apparently mature, male duiker [*Cephalophus grimmi* (*Linn.*)]. It was remarkable in the skin being black, and mostly devoid of hair. Normally the skin of the common duiker is white, and the hair is speckled yellow and brown, but there is considerable variation in the general colour of the coat.

The black specimen was born of parents that lived in an enclosure on the farm, and it seemed quite healthy, and was supposed to have been killed by a dog. The next offspring produced by the same parents had also a black skin and was a male, but there was considerably more hair than in the first case. The animal appeared delicate, and lived only twelve months, dying, so it was assumed, of sun-stroke. The ewe by the same ram then produced a normal offspring.

About nine months afterwards she was unfortunately killed by a blesbuck, and on being opened a female fœtus of about seven months (the full period being eight months) was found. It was black on its back and sides, but white ventrally, and there was very little hair on it.

Mr. Martens had kept a careful diary of his breeding operations, and it will be of value to place some of the facts on record.

The enclosure in which the duikers were kept was made of 200 yards of wire-netting some six feet in height. One side was planted with trees, and the other with grass; and little shelters were erected for protection during night, and against violent storms. The animals were provided every evening with a bucket of crushed mealies, of which they were very fond, and also with a large bundle of green herbage, lucerne, etc. In this enclosure there were kept one male and seven female duikers, one female oribi, and one male steenbok. Quite recently a couple of blesbok were included. The male duiker was exceedingly tame, and was often allowed outside the enclosure, and ran about the farm.

This ram was caught in the wild in June, 1900, when about two months old, and has always been in good health. The ewe that produced the black young by the above ram was born in April, 1903. The parentage of this ewe is recorded as follows: "The female was caught in the wild about eight miles from the farm in May, 1899, when about one week old. She died in 1904. The male was caught in the near vicinity of the farm in September, 1898, when about three months old, and was set free in 1904." We thus see there was apparently no blood-relationship between the parents of the abnormal offspring.

At the time of the birth of the fifth and sixth offspring, I am informed that there was absolutely no difference in the environment, food, etc., and that other ewes were then producing quite normal young. The parentage was the same in all cases, since there was only one ram in the herd.

The following table gives a complete list of the offspring:

<i>Ram</i> , caught in the wild; born about April, 1900.			
<i>Ewe</i> , born in enclosure, April, 1903.			
Offspring.	Date of birth.	Sex.	Colour.
1st	January, 1905	Female	Normal, died at 2 years.
2nd	September, 1905	Male	Normal.
3rd	June, 1906	..	..
4th	March, 1907	..	..
5th	November, 1907	..	Black, died January, 1910, perhaps killed by a dog.
6th	December, 1908	..	Black, died when 1 year old.
7th	January, 1910	Female	Normal.
8th	(Mother killed by blesbok, July, 1910)	..	7 months foetus, black above, white ventrally.

Some details with regard to the fifth offspring will now be given. It was born in November, 1907, and it was noticed that it grew slower than others of the same age. The ram appeared to take a dislike to it, and sometimes drove it away. It died in January, 1900, perhaps through being worried by a dog. Thus it was two years and two months old at the time of death. Pl. X is a reproduction of a photograph of the mounted animal. The following are some comparative measurements of a normal ram, and of the specimen under discussion :

Measurement.	Normal ram.	Abnormal ram.
	Inches.	Inches.
Height from ground to shoulder . . . . .	23·5	19·0
Total length with head and neck stretched out in line with body (tail not included).	38·5	31·7
Length from tip of nose to front margin of ear-opening . . . . .	7·7	6·5
Length of pinna of ear measured from front margin of opening to tip . . . . .	4·1	3·3
Length of body measured from base of neck to base of tail . . . . .	24·0	21·0
Length of hind limb measured along the mid-axis . . . . .	19·5	16·5
Length of tail . . . . .	4·3	3·5
Length of right horn . . . . .	4·2	5·5
Length of inner hoofs of fore-feet . . . . .	1·9	1·9
Length of chord of arc of curved outer hoofs of fore-feet . . . . .	—	2·9

It will thus be seen that all the measurements, with the exception of those of the horns and hoofs, are considerably smaller in the black duiker than in a normal specimen. The measurements of the normal ram were made on a mounted specimen; but as they are in substantial agreement with those given by W. L. Sclater for the common duiker ('Mammals of South Africa,' vol. i, p. 159) they may probably be regarded as roughly accurate.

The abnormal ram appears to be proportionally shorter in the head and neck than in the body-length, since the difference in body-measurement in the abnormal and normal rams is only three inches, while the difference in the total length is over six inches. Omitting the length of the horns and hoofs, and comparing the remaining measurements, the abnormal duiker may be said to be about four-fifths the size of a typical ram.

In addition to the dwarf condition we find abnormality in the skin, hair, hoofs and horns.

The skin was deeply pigmented throughout, and was of a nearly uniform black, both ventrally and dorsally. In no sense was the skin diseased; it appeared, in fact, to be perfectly healthy.

At no time of life was the skin provided with the ordinary coating of hair. A few scattered hairs occur on the sides of the body and on the legs, with a distribution of two or three to the square inch; while along the back and on the face, forehead, outside of the thighs, and tail the hair is rather more plentiful. The coloration of the hair is perfectly normal; thus, in those places where in the ordinary animal the hair is black, such as between the horns and on the middle line of the tail, there the few scattered hairs are also black. On the sides of the body and head the hairs are typical in having the terminal third white, followed by a black or brown band. On the ventral surface the few hairs that do occur are white as in the normal animal. The hairs are of normal length.

The hoofs also exhibit abnormality. Those of the hind limb are as large as those of a full-sized duiker, while those

of the fore-limb are remarkable, in that the outer hoof of each foot had curved upwards and grown into about a quarter of a circle with a chord of nearly three inches. The inner hoof of each fore-limb is normal. The formation of such abnormal hoofs is known in sheep, oxen, etc., and has been attributed in certain cases to damp ground and the absence of wear under artificial conditions. In the present case, however, the conditions were as nearly natural as possible; also, the other duikers kept under the same conditions did not exhibit the peculiarity; and further, the character developed symmetrically, and only in the outer hoofs of the fore-limbs.

There was an obvious tendency for pronounced growth of hoofs, as those of the fetlocks are larger than usual.

Correlated with the unusual development of hoofs, the horns are abnormal. The right horn measures 5·5 in. in length. Roland Ward gives 5·5 in. as the record, and it should be remembered that the present animal is four-fifths smaller than an ordinary duiker. The usual length is about  $3\frac{3}{4}$  in. The horn is smoother than a typical one; one or two rings are only faintly marked towards the base, and the longitudinal striation, which is strongly marked in the normal horn, is here but slightly developed. The circumference of the horn at the base was a little less than normal.

The distal third of the left horn is bent backwards, as if through injury in early life.

We thus see that in the epidermal organs, the skin, hair, hoofs and horns, this animal was strikingly abnormal.

In the sixth offspring of the same parentage, which lived only twelve months, and was supposed to die of sunstroke and not of any obvious disease or accident, quite similar abnormalities were present; but they were not quite so strongly marked. The skin was black, but perhaps a little paler on the ventral surface. Hair was much more abundant than in the above described ram.

The unborn ewe of about seven months presented a pigmented skin on the dorsal surface of the body and head, and also on the sides; while the ventral surface was not pig-

mented. Hair was present in only very small amount, it was thicker on the top of the head than elsewhere.

From this account we see that the abnormal black young arose in what appears to be a purely spontaneous manner. The parentage was the same in all cases, and the first four offspring were quite normal, the fifth and sixth were abnormal, the seventh normal, and the eighth and last also abnormal, but in a somewhat lesser degree. Whatever the causes may be that produced the variation they would seem to have acted through the female, since the offspring of the ram with other ewes at the same time and with the same environment have all been perfectly normal. We have already noted that there was no blood-relationship between the parents.

A somewhat similar abnormality occurs among the Chillingham or park cattle which appear to be the nearest representatives to the now extinct European wild ox or aurochs. These park cattle are white, and according to R. Lydekker,<sup>1</sup> "they usually have the muzzle and the inside of the ears reddish."

In a popular article by E. M. Harting in the 'Queen' newspaper, January 29th, 1910, it is stated that a calf of the white park breed has recently been born in the London Zoological Gardens, and the author says: "The interesting point about the calf is that it is white like the parents. Two calves from this cow were white, then three black ones were born in successive years, and these are now followed by a white one," and further ". . . the occasional occurrence of black calves has long been known in certain herds of park cattle, notably at Vaynor."

It is not stated whether the skin was in any way pigmented, or whether the hair was normal or scanty in amount.

In an ordinary black and white ox the epidermis in the regions covered with black hair tends to be slightly pigmented, while such pigmentation is absent in the portions provided with white hair.

In the case of the abnormal black duiker the small quantity

<sup>1</sup> R. Lydekker, 'Wild Oxen, Sheep and Goats,' London, 1898.

of hair that was present was normal in colour, and the black pigment was mostly confined to the epidermis.

From the point of view of the development, origin and function of the pigment there is probably little difference whether it is mostly passed into the hair to form a black pelage, or retained in the epidermis to form a black skin.

A quite similar condition was noticed in a specimen of the Indian water buffalo (*Bos bubalis Linn.*). A cow imported into Natal from India for breeding purposes was observed to be nearly hairless, except on the head and face, and the skin was deeply pigmented. It is usual in this species for the hair-covering to become very thin in adult life. I have had no opportunity to examine other specimens, but it is possible that as an animal increases in age and the hair becomes scanty, so the skin itself becomes more pigmented.

It will be of interest to supplement this account with a description of another example of the sudden production of hairless black offspring. It is the case of a black hairless fox-terrier which was one of a litter of six or seven, the remainder being quite normal.

The dog is a healthy and intelligent animal, and is owned by Miss Margaret L. Murchie of Durban, to whom I am greatly indebted for the following details of his life-history.

The mother was an ordinary black and white fox-terrier with a black or tan patch on the head, and one in front of each shoulder, and was obtained in Zululand as a pup (Pl. XI, fig. 1). She was attached to a regiment at the time of the birth of the pups. The litter was born in Dundee, Natal, about Christmas, 1900. The male parent was unknown; but it was certainly not a hairless dog, as such would have been noticed and commented on in a limited community like that of a very small town.

The bitch was about twelve months old, and the litter was her first. She was afterwards lost when out with a patrol party of the regiment.

Of the six or seven pups the normal ones were black and white, and quite similar to the mother. The abnormal pup

was a male ; it was nearly uniform black, except for a white patch with two black spots on the chest (see Pl. XI, fig. 1), and almost completely hairless.

The adult dog (Pl. XI, fig. 2) has a certain amount of hair on the head over an area extending from between the ears to the nostrils ; also, a few hairs on the tail and on the feet. It is stated that there are no hairs at all on the body, except a solitary one on a wart. The individual hairs are black, tan, or variegated. The variegated hairs are black and tan, the lower third being tan and the rest black, except that sometimes the tip is also coloured brown. It is further remarked that the hair on the feet has lately become grey. Originally there appeared to be no differentiation in the colour of the hair in different parts of the body, while in the case of the hairless duiker such a differentiation did occur. The dog is now nearly ten years old, and measures twenty-five inches from the tip of the nose to the root of the tail, and stands thirteen inches at the shoulder. He has a strong constitution, and has always been healthy. His habits are normal, except that he is particularly intelligent, as is shown by the following incident : The troopers were accustomed to give the animal beer, for which he developed a liking, and on one occasion, after taking too large a quantity, he became more than ordinarily inebriated and ill, and ever since then he has refused to touch the offending liquid.

Another point of considerable importance in this interesting case is the fact that the hairless condition is an inheritable character.

The dog was paired with a pure white terrier, and a litter of four was produced. Two were white, a male and female, with ordinary hair like that of the mother, and two were hairless. The skin of the abnormal hairless pups was white at first, but it gradually became mottled with black ; they were male and female, and grew very slowly. The male when a year old had a height of only about eight inches at the shoulder, and the female about six inches. It is unfortunate that subsequently these animals were destroyed, as

they were not very healthy. It would have been very interesting to have ascertained if the formation of pigment in the skin would have continued until the animals had become completely black like the father. In this connection it should be remembered that the father when a pup possessed a white patch on the skin of the chest, as can be seen in the photograph already referred to, and this patch became pigmented as the animal grew up.

William Bateson<sup>1</sup> gives some interesting cases of the hairless condition. Examples of naked mice (*Mus musculus*) and shrew (*Sorex*) are mentioned, and these were not albinos, although there was no general pigmentation of the skin. The author further states: "Naked horses have often been exhibited. Such a horse caught in a semi-feral herd in Queensland was described by Tegetmeier. The skin was black and like india-rubber."

With reference to hairless dogs, Belt<sup>2</sup> remarks that they are to be met with in Central America, and "that they are of a shiny dark colour, and are quite without hair, excepting a little on the face and on the top of the tail. Both in Peru and Mexico this variety was found by the Spanish conquerors." The hairless dogs of China have apparently been common from very early times. Although this race of hairless dogs is common in Peru, yet it does not appear to have been artificially preserved. Consequently it would seem that either the race is more or less sterile when crossed with ordinary hairy dogs, or the character is inherited with great intensity, and is an example of a character like eye-colour which does not readily mix in sexual reproduction.

In this connection it is of much interest to note that some of the offspring of the hairless fox-terrier above described were hairless, while the remainder of the litter were completely normal. There is thus distinct evidence that the "hairless" and hairy characters do not as a matter of fact

<sup>1</sup> W. Bateson, 'Materials for the Study of Variation,' London, 1894, p. 56.

<sup>2</sup> T. Belt, 'The Naturalist in Nicaragua,' London, 1874, p. 205.

readily mingle, for if they did the offspring should all have been thinly covered with hair.

The next abnormality to be described is more of the nature of a monstrosity than of a so-called mutation; but, nevertheless, it exhibits certain characters of considerable interest.

On the farm of Mr. W. J. Christy at Scotsville, near Pietermaritzburg, the cattle have been compulsorily confined owing to the prevalence of East Coast fever; but they are exercised twice daily, and are living under healthy conditions. On June 26th, 1910, a half-bred short-horn cow crossed by a Kerry bull produced a remarkable calf of the bulldog-headed type.

The calf was a male of seven months (Pl. XII, fig. 1); but it measured only about 22 in. in total length and 27 in. in circumference around the middle of the body. The body was cylindrical in shape; and the legs, ending in little hoofs, were only  $3\frac{1}{2}$  in. in length and were too short to reach the ground. The circumference of the head measured over the forehead and under the chin was  $21\frac{1}{2}$  in.

An abnormal growth forming a kind of tumour, and projecting backwards some  $4\frac{1}{2}$  in., occurred between the scrotum and the anus.

The upper lip or margin of the mouth was deeply cleft (Pl. XII, fig. 2), and there was obviously a great shortening of the upper jaw and snout. The lower jaw and lip projected forwards about  $1\frac{3}{4}$  in. beyond the upper jaw. The tongue protruded, and it was apparently not possible for the animal to close its mouth. The neck was exceedingly short and not separable from the trunk. The hair was short, and the general colour was black with irregular white areas. The tail measured about  $4\frac{1}{2}$  in. A penis and a pair of small scrotal sacs were present just in front of the tumour above mentioned.

The limbs were only a few inches in length, and they exhibited no obvious joints or divisions save the presence of hoofs.

The veterinary attendant states that at the time of birth the offspring was alive, but that owing to the birth being a difficult one it was killed before it could be extracted.

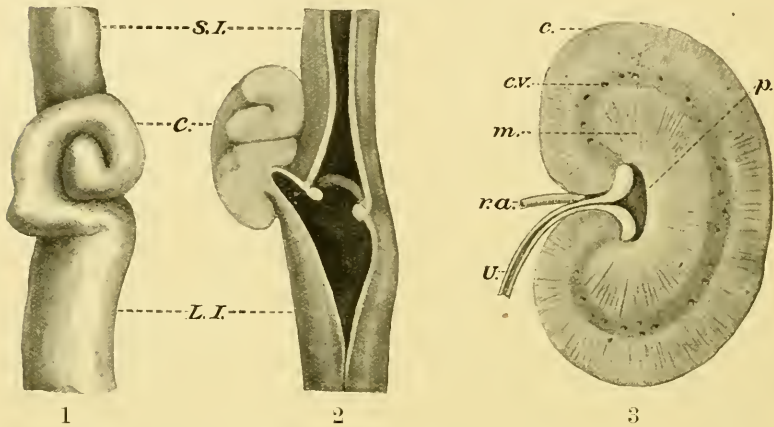
A few days later another cow crossed by the same bull and in the same stable produced a six-months calf which externally was practically identical with the one above described. It was also a male, and possessed a similar abnormal tumour-like swelling at the perinæum. In the case of the first calf the viscera were unfortunately removed and thrown away, but the remainder of the body was handed to the Museum. In the second calf the viscera were also removed, but they were subsequently sent to the Museum in brine. The rest of the body was inspected and seen to be externally quite similar to the first calf, but it had been disposed of, and was not further available for anatomical purposes.

#### VIScera OF THE SECOND CALF.

The stomach was simple, like that of a horse or pig, and not like that of a ruminating ungulate. It was placed transversely across the body, and measured about  $3\frac{1}{2}$  in. from right to left, and  $2\frac{1}{4}$  in. from before backwards. Internally it was quite undivided, but possessed prominent longitudinal ridges. The distinction between a smooth cardiac portion and a ridged pyloric portion, seen in the horse, was not well marked. The proximal limb of the duodenum was about 7 in. in length and  $\frac{3}{8}$  in. in breadth. The small intestine was much convoluted, and possessed a total length of about 5 ft. The small intestine was separated from the large intestine by a prominent ridge forming a projecting ring. The cæcum communicated with the large intestine by an aperture which occurred immediately below the projecting ring [Text-fig. (1, 2.)].

The cæcum was short and spirally coiled, and was attached by its outer surface to the small intestine. It was smooth, and in shape and position resembled the cæcum of a dog rather than that of an ox. Only a portion of the colon remained in the specimen; it was smooth, with no longitudinal bands of muscle.

The liver was divided into the typical mammalian lobes, and thus was more like the liver of the hog than that of an ox. A falciform ligament divided the liver into right and left divisions. A small left central, a larger left lateral ( $3\frac{1}{2}$  in. in length and  $2\frac{1}{4}$  in. in width) and a Spigelian lobe occurred on the left side. On the right side the right central lobe was deeply cleft posteriorly for the reception of a well-developed



- 1 and 2. Junction of caecum, large intestine and small intestine.  
 3. Horizontal section of kidney. Natural size. c. Caecum.  
 c. Cortex. c.v. Capillary vessel. L.I. Large intestine. m. Medullary portion. p. Pelvis of kidney. r.a. Renal artery. S.I. Small intestine. u. Ureter.

gall-bladder, then a right lateral was present, and also a caudate fitting over the anterior surface of the kidney.

A bile-duct passed from the gall-bladder, and opened into the top of the duodenum about  $1\frac{1}{2}$  in. below the pylorus.

A pancreas was present as a narrow strip of gland running along the proximal limb of the duodenum. A pancreatic duct could not be found.

The spleen was suspended by the great omentum, and was not in contact with the stomach as it is in the case of the ox. It measured about  $4\frac{3}{4}$  in. in length by  $1\frac{1}{4}$  in. in width, and was

of elongated shape and broader at the inner end. The great omentum was loaded with narrow bands of fat.

The kidneys were placed normally, the right being at a slightly higher level than the left, and covered anteriorly by the caudate lobe of the liver. The kidneys, measuring  $1\frac{1}{2}$  in. by  $1\frac{3}{8}$  in., were perfectly smooth in outline like those of a dog, and internally the pelvis was not divided up by lobes of medullary substance or pyramids [Text-fig. (3)].

The heart appeared quite normal in structure. The lungs were also normal, consisting of four lobes on the right and three on the left.

#### SKELETON OF THE FIRST CALF.

The skull exhibited great modification. The pre-maxillæ were short, and the nasals were very greatly reduced, being represented by small, somewhat rounded bones (Pl. XIII, fig. 1). The mandibles projected nearly two inches in front of the end of the pre-maxillæ, and could not bite on them. The frontals were relatively large and very convex, thus causing the cranial cavity to be globular.

A true palate was completely absent, there being no palatal portions of the maxillæ and palatines. A median, well-developed vomer was present. On account of there being no palate the nostrils opened direct into the cavity of the mouth (Pl. XII, fig. 3, *i.n.*), and the maxillo-turbinals (*m.t.*) and ethmo-turbinals (*e.t.*) formed the roof of the front portion of the mouth. Mesethmoid, presphenoid, and basisphenoid could be distinguished. The periotics extended internally to the middle of the floor of the skull, and there they took the place of basioccipital. The exoccipitals showed no condyles, and the foramen magnum was placed somewhat out of the middle line. The tympanic bulla and auditory meatus were flattened. A stylo-tympanic process (*s.p.*), and a paroccipital process (*p.p.*) of the exoccipital can be seen in Pl. XIII, figs. 3 and 4.

The hyoid was represented by a short stylo-hyal, which

was attached to the skull immediately below the paroccipital process.

The vertebral column was very monstrous. Some eight thoracic vertebræ were fused together, and all the remaining vertebræ were very asymmetrical in shape and irregularly placed. The ribs were flattened and not normally curved.

The right and left pectoral girdles were quite similar to each other, and were of abnormal shape. The scapula appeared to consist chiefly of "spine" (Pl. XII, figs. 5-8), and bore a superficial resemblance to the scapula of *Monotremes*. The anterior and posterior borders of a typical scapula were scarcely represented. The surface in contact with the ribs may be regarded as an expansion of the lower portion of the spine, since the edges of the surface were confluent with the subscapular margin of the spine (fig. 8).

The pelvic girdle consisted of an abnormally short ilium with curiously lobed dorsal edges (figs. 9 and 10); the ischium was large, and the pubis small. The symphysis was short, and was formed both from ischium and pubis. The acetabulum was an irregular depression formed by the three bones, and an obturator foramen occurred below.

The skeleton of the limbs consisted of some short, disc-like bones separated by thick ligamentous masses. The bones could not be satisfactorily homologised with the typical bones of a mammalian limb.

Taken altogether, if we omit the obvious monstrosities and deformities, the viscera and skeleton exhibit characters of a more generalised type than that of an ox. William Bateson<sup>1</sup> has collected some material and facts which it may be of interest and value to here recall. He says, "Among domestic animals of many kinds races are known in which the bones of the face do not grow to their full size, while the bones of the jaw are, or may be, of normal proportions.

"Familiar examples of this are the bulldog, the pug, the Japanese pug, the Niata cattle of La Plata, some short-faced breeds of pigs, and others. In the case of these domestic

<sup>1</sup> *Ibid.*, p. 57.

animals the part which selection has taken in their production is unknown, and the magnitude of the original variations cannot be ascertained."

Prof. Bateson is inclined to think that from the first the variation leading to the short-faced condition was definite and striking.

Short-faced or bulldog-headed fishes are comparatively common, and this variation or "sport" has been noticed in several different species. In the case of the trout there even seems to be a local race of short-faced individuals in Lochdow, near Pitmain, Inverness-shire.

In the bulldog-headed carp (*Cyprinus carpis*) the face ends more or less abruptly in front of the eyes, while the toothed lower jaw projects forwards. Quite similar variations have been noticed in the chub, minnow, mullet, pike, salmon, and trout.

Although the specimens of the bulldog-headed calves above described can only be regarded as monstrosities, yet they are of interest in disclosing the possibilities of variation in a living organism.

The causes which lead to such a variation are, of course, very obscure; but in the present case hereditary influences had to be carefully considered, as it was improbable that the direct action of the environment would have such a profound effect on the offspring, especially since many quite normal calves were, and are being, born under the same conditions.

Mr. Christy has been good enough to supply me with details of the ancestry of the abnormal offspring.

Some eighteen years ago a bull and cow, which were not related to each other, were imported from the Cape. They were hornless, and were of a breed resulting from a cross between the Friesland and Kerry. The cow had a markedly wrinkled brow and rather broad snout.

The result of this union was a bull owned by Mr. Campbell. This bull was subsequently mated with another imported Cape cow, which was a Dexta Kerry with no horns. There resulted a Kerry bull, which was acquired by Mr. Christy. The bull

had no horns, he was exceedingly ugly, and had a broad, much wrinkled forehead, and a rather short snout.

This Kerry bull was mated with an ordinary local cow (a cross between a Friesland and Africander ox) with short horns, and there resulted a hornless cow (No. 1). Subsequently the Kerry bull was mated with a Friesland cow with short horns, and a bull (No. 1) was produced with short horns. Cow No. 1 and bull No. 1, who were consequently half-brother and sister, were mated, and the offspring produced, which was the first of the cow, was abnormal, and approached the bulldog-headed calf above described. This occurred some ten years ago.

Bull No. 1 was mated with an unrelated Friesland cow with short horns, and produced a cow (No. 2). Subsequently he was mated with another Friesland cow with short horns, and there resulted a bull (No. 2) with horns some five inches in length. Cow No. 2 and bull No. 2 were therefore half-brother and sister. They were paired and produced the six-months bulldog-headed calf of which the viscera have been described.

Bull No. 2 was also mated with his half-aunt, cow No. 1, and the result was the seven-months bulldog-headed calf of which the skeleton has been above described.

About a year and a half ago bull No. 2 was paired with an unrelated local cow, and a similar abnormal result was produced.

Bull No. 2 has crossed some nine or ten cows, related and unrelated, and altogether there have resulted twenty or more calves; out of these, three similarly abnormal offspring have been produced, while the remainder have been perfectly healthy and normal.

The close in-breeding does not appear to have been the cause of the abnormalities, since in the case of a quite unrelated cow a similar calf was produced.

The grandfather of bull No. 2 was very exceptionally wrinkled and ugly, and this character appears to have been inherited from the imported Cape cow, and to have reappeared in a greatly aggravated form in the descendants.

In addition to the peculiarities of the compressed snout and the open palate, the skeleton and viscera exhibited more primitive and generalised characters than those normally belonging to the ruminating ungulates, such as the simple stomach, the subdivision of the liver into lobes, the smallness of the *cæcum*, the simple, unlobed condition of the kidney, etc.

It appears that in this strain of cattle there was a distinct tendency for sudden breaks to occur in the hereditary transmission, and since some four similar bulldog-headed calves had originated in the strain, it is obvious that the breaks or accidents which occurred were all of a similar nature.

Owing to these breaks in hereditary transmission the specific moulding power in the embryo had been weakened; and the germ had to fall back, so to speak, on distant memories of ancestral history, and consequently the appearance of certain primitive characters might have been anticipated.

The erratic manner in which the abnormalities appeared must also be noted, since with the same parents perfectly normal offspring were born both before and after the birth of the bulldog-headed calves. It should be noticed that it was quite the same in the case of the hairless duiker and fox-ferrier.

The present evidence shows that in all probability these mutations, sports, or monstrosities arose suddenly through mishaps in the mechanism of hereditary transmission and not through environmental conditions.

## EXPLANATION OF PLATES X—XIII,

Illustrating Dr. E. Warren's paper "On a Black, Hairless Duker and Dog, and a Bulldog-headed Calf."

### PLATE X.

$\times \frac{2}{1\frac{1}{8}}$ . Photograph of mounted black hairless duiker (offspring No. 5): died when two years of age.

## PLATE XI.

FIG. 1.—Photograph of the mother of the abnormal pup with some of the litter. A white area may be noticed on the chest of the black pup; this disappeared later.

FIG. 2.— $\times \frac{2}{4}$ . Photograph of black, hairless fox-terrier when ten years of age.

## PLATE XII.

- FIG. 1.— $\times \frac{3}{16}$ . Side view of bulldog-headed calf.  
 FIG. 2.— $\times \frac{3}{16}$ . Front view of the face.  
 FIG. 3.— $\times \frac{2}{3}$ . Under-surface of skull and roof of the mouth.  
 FIG. 4.— $\times \frac{2}{3}$ . Left ramus of lower jaw.  
 FIG. 5.— $\times \frac{1\frac{3}{16}}$ . Outer surface of right scapula.  
 FIG. 6.— $\times \frac{1\frac{3}{16}}$ . Anterior surface of right scapula.  
 FIG. 7.— $\times \frac{1\frac{3}{16}}$ . Posterior surface of right scapula.  
 FIG. 8.— $\times \frac{1\frac{3}{16}}$ . Subscapular surface.  
 FIG. 9.— $\times \frac{1\frac{3}{16}}$ . Side view of pelvic girdle.  
 FIG. 10.— $\times \frac{1\frac{3}{16}}$ . Front view of pelvis.

## PLATE XIII.

- FIG. 1.— $\times \frac{2}{3}$ . Dorsal surface of skull.  
 FIG. 2.— $\times \frac{2}{3}$ . Side view.  
 FIG. 3.— $\times \frac{2}{3}$ . Sagittal section.  
 FIG. 4.— $\times \frac{2}{3}$ . Ventral view.

## EXPLANATORY REFERENCES.

*ac.* Acetabulum. *Ant.* Anterior. *bs.* Basisphenoid. *et. t.* Ethmo-turbinal. *ex.* Exoccipital. *f. m.* Foramen magnum. *fr.* Frontal. *Il.* Ilium. *Is.* Ischium. *i. n.* Internal nostril. *leh.* Lacrymal. *m. t.* maxillo-turbinal. *me.* Mesethmoid. *ml.* Malar. *mæ.* Maxilla. *na.* Nasal. *O. f.* Obturator foramen. *P.* Pubis. *p. p.* Paroccipital process of exoccipital. *pa.* Parietal. *per.* Periotic. *pl.* Palatine. *pmæ.* Pre-maxilla. *Post.* Posterior. *ps.* Presphenoid. *pt.* Pterygoid. *s. s.* Subscapular surface. *s. p.* Styloform process of tympanic. *sp.* Spine. *sq.* Squamosal. *st.* Stylohyal. *t. b.* Tympanic bulla. *vo.* Vomer.



BLACK, HAIRLESS DUIKER.

*Adlard & Son, Impri.*



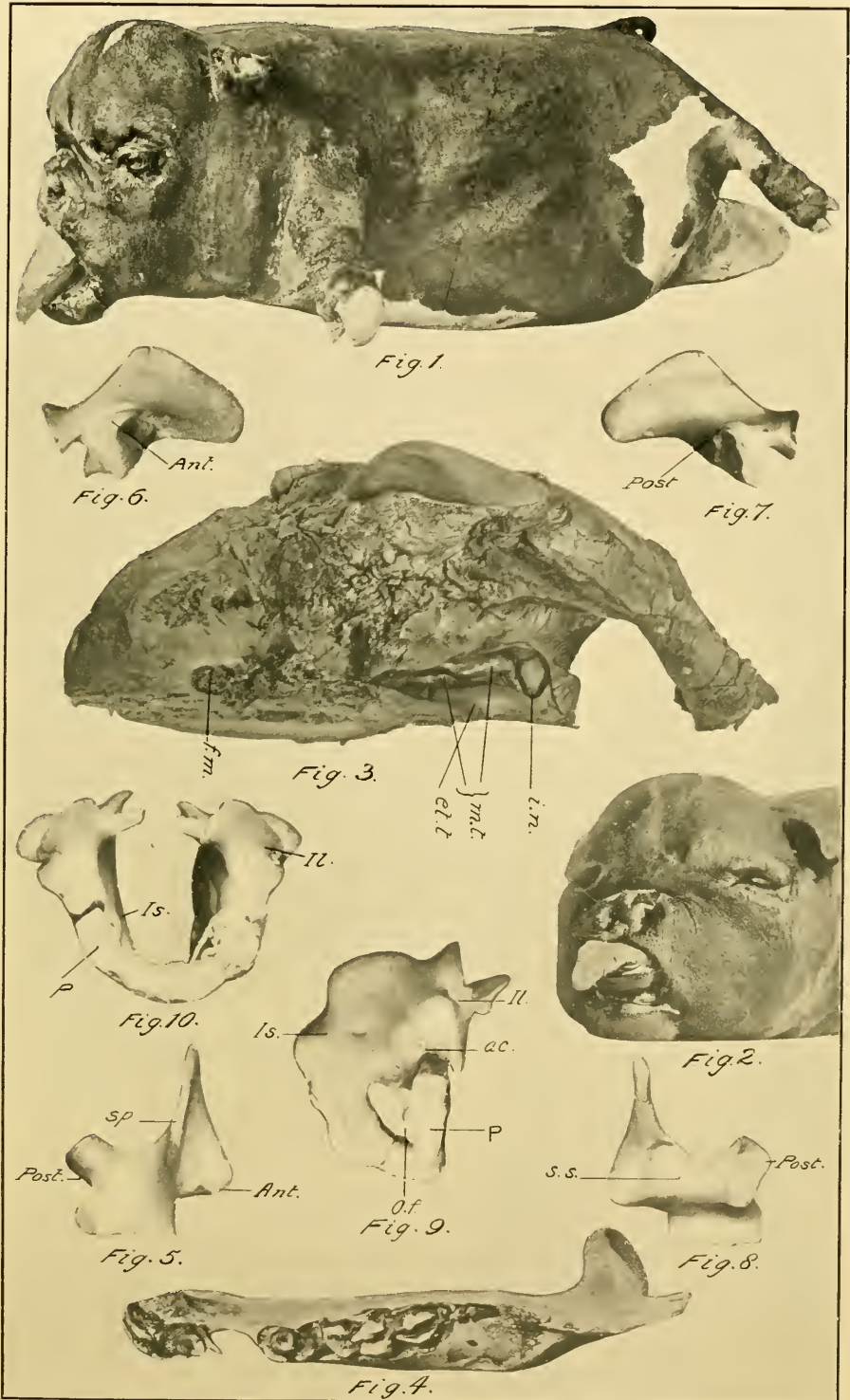


FIG. 1.



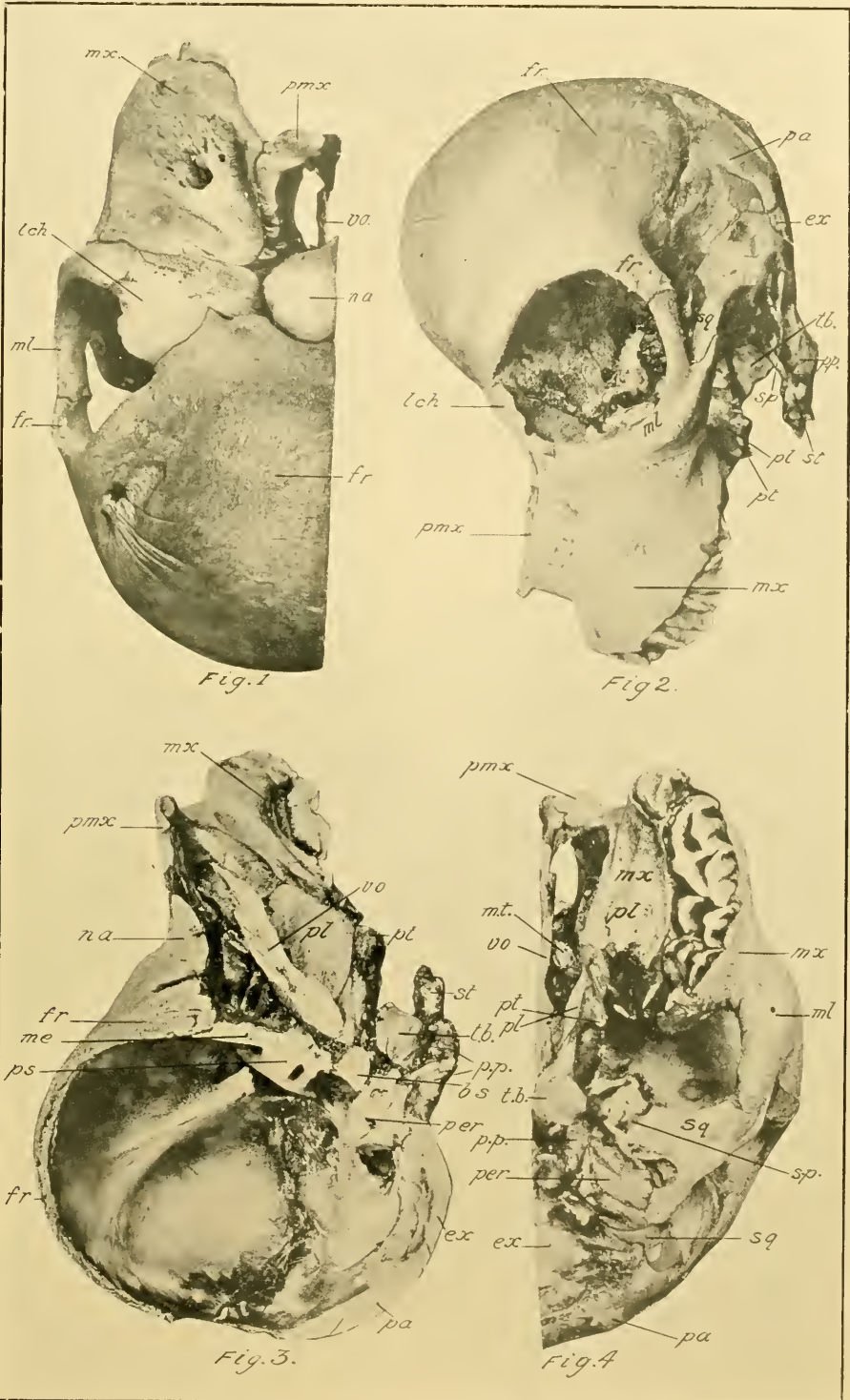
FIG. 2.—BLACK, HAIRLESS FOX-TERRIER.





BULLDOG-HEADED CALF.





BULLDOG-HEADED CALF.



## The Vegetation of Natal.

By

**J. W. Bews, M.A., B.Sc.(Edin.),**  
Professor of Botany, Natal University College.

With Plates XIV-XXIII and Map.

### CONTENTS.

	PAGE
INTRODUCTION . . . . .	254
I. REGIONAL FACTORS:	
(1) GEOLOGICAL STRUCTURE AND SOIL CONDITIONS . . . . .	255
(2) RAINFALL AND MIST . . . . .	260
(3) TEMPERATURE . . . . .	272
(4) LIGHT . . . . .	283
(5) MOVEMENTS OF THE AIR . . . . .	286
(6) FIRE . . . . .	289
(7) ANIMALS . . . . .	289
II. PLANT FORMATIONS AND ASSOCIATIONS:	
SHORE VEGETATION:	
(1) HALOPHILOUS ASSOCIATIONS . . . . .	293
(2) PSAMMOPHILOUS BUSH FORMATION . . . . .	294
(3) LAGOON TYPE, MANGROVE FORMATION . . . . .	297
(4) BARRINGTONIA ASSOCIATION . . . . .	298
INLAND VEGETATION: BUSH:	
(5) SCATTERED BUSH TOWARDS THE COAST . . . . .	299
(6) SCATTERED MIDLAND BUSH . . . . .	300
(7) YELLOW WOOD BUSH . . . . .	302
(8) ROCKY STREAM FLORA . . . . .	307
(9) THORN VELD . . . . .	309

GRASSLAND OR VELD :	
(10) HIGH LEVEL VELD, GRASSES . . . . .	314
(11) LOW LEVEL VELD, GRASSES . . . . .	316
(12) ASSOCIATED VELD PLANTS . . . . .	318
(13) MARSH OR VLEI TYPES, DOMINANT PLANTS . . . . .	320
(14) ASSOCIATED PLANTS OF THE VLEIS . . . . .	322
(15) AQUATIC TYPES . . . . .	323
(16) SECONDARY ASSOCIATIONS . . . . .	324
LIST OF ENGLISH, DUTCH AND KAFIR NAMES OF PLANTS . . . . .	325
EXPLANATION OF PLATES . . . . .	329

#### INTRODUCTION.

SINCE taking up my duties at the Natal University College, I have devoted a considerable amount of time to the study of the flora of Natal, chiefly from the œcological standpoint, and on the invitation of Dr. Warren I propose giving in this paper a general account of the facts that I have learned.

The initial difficulties involved in becoming acquainted with what was to me an entirely new flora have been lessened by the fact that I have had the help of Mr. T. R. Sim, late Conservator of Forests for Natal, who has always been most willing to give me the benefit of his great botanical knowledge and experience, and whose assistance throughout has been more than I can adequately acknowledge.

I am also indebted to Mr. Medley Wood who has put at my disposal the excellent Government Herbarium at Durban. His assistant, Miss Franks, has also assisted me. Mr. W. Abbit has very kindly supplied me with meteorological data. Finally, I have to thank the many kind friends, in various parts of the Colony, whose hospitality I have enjoyed while engaged in this work.

This paper will be divided into two parts. In the first part an account of the nature of the factors influencing plant life in Natal will be briefly discussed, and in the second part a preliminary sketch of the plant formations and associations in Natal will be given.

## I. THE REGIONAL FACTORS.

## (1) GEOLOGICAL STRUCTURE AND SOIL CONDITIONS.

The general physical features of Natal are as follows: On the west it is bounded by lofty ranges of the Drakensberg, which form the escarpment of the high inland plateau. The highest peaks rise to an altitude of over 10,000 ft. on the borders of Basutoland, and consist chiefly of volcanic amygdaloid rock of considerable thickness. Below these are the Cave Sandstones, the Red Beds and the Molteno Beds of the Stormberg Series. The lower ranges and foot-hills of the Drakensberg are formed by the sandstones and mudstones of the Beaufort Series. Passing from these downwards towards the coast, the whole succession of the Ecca Series is laid bare, consisting of sandstones and shales cut through everywhere by doleritic trap rocks. The Upper Ecca beds are the coal-bearing sandstones of Natal. Below the Ecca beds lies the Dwyka Conglomerate which marks the base of the Karoo System. These formations cover by far the greater part of Natal and Zululand.

Below the Dwyka Conglomerate comes the Table Mountain Sandstone, and below this again are the metamorphic rocks of the Swaziland System, exposed along the valleys of the Tugela and other rivers of Zululand, and also appearing in the south-east corner in the Lower Unzinkulu district. The Swaziland complex forms a sort of central core which is flanked on both sides by the Table Mountain Sandstone. A belt of these metamorphic rocks runs parallel to the coast east of Camperdown, but it is only in the deeply cut river valleys that such rocks are seen further inland. The belt is invaded in places by large granitic intrusions, and the whole of this strip of country is of a very broken character.

The overlying Dwyka Conglomerate and Ecca Beds reappear in a narrow strip along the coast line of Natal proper; while along the flat coast of Zululand from the Umlalazi River

northwards there are the younger Cretaceous and Tertiary formations.

From this very brief sketch it will be seen that Natal is a country with a moderately complex geological structure. It descends steeply from the lofty Drakensberg to the sea by a series of terraces. The main terrace levels may be taken to be roughly as follows :

First terrace (coast belt)	up to 1000 ft.
Second terrace	„ 2000–2500 ft.
Third terrace	„ 3000–4000 „
Mountain regions	5000 ft. and upwards.

These are indicated on the accompanying map, for which I am indebted to Mr. A. Hammar.

From the Drakensberg all the main rivers of Natal have their source, and the river valleys have been deeply cut through the successive terraces. In addition to the main terrace system we therefore have a system of river valleys at a low level, and ridges between them at a high level, and this fact introduces still greater complexity into the conditions affecting plant-life.

The soil will naturally be found to vary according to the rock from which it has been derived. On the tops of the ridges between valleys it lies more or less *in situ*, the product of the disintegration of the rocks underneath. In the river valleys and vleis (marshes) the soil on the other hand has been transported for a greater or less distance, though nowhere in Natal can such transporting be described as more than local.

Over the wide area covered by the Ecca series of shales and sandstones the soils would be of the poorest description were it not for the intrusive basic igneous rocks which occur everywhere. Nearly every kopje is capped by a sheet of dolerite. These trap rocks consist of felspar, augite, magnetite, etc., and give rise by decomposition to hæmatite, limonite, and other iron oxides, magnesia, lime, soda, and often potash. The quantity of lime, however, as shown by analyses of soils, is nearly always very small, and the soils

generally are also extremely poor in phosphates. Iron is very abundant, and where the soil is not well aerated it exists in the protoxide form  $\text{Fe O}$ .

On the higher levels this soil is loose and friable, and when it becomes dry it forms a fine dust. It is red or brown in colour owing to the large quantity of iron it contains. The surface layers, however, are often much darker in colour. Where exposed this soil tends to get blown down into the valleys by the wind. It is a good soil mechanically, well aerated, and suitable for tree growth where other conditions are favourable. It is poor in available plant-food, and the ordinary cereals will not grow on it without manuring. As will be shown later, it is covered with tall grass veld, with forest on the sheltered slopes, and in the smaller valleys. (Pl. XX, fig. 1).

At the lower valley levels the soil is a stiff heavy clay, which becomes dry and baked. It contains nodules of lime or dolomite, as well as a greater proportion of the valuable mineral constituents of the basic igneous rocks. Limonite nodules are also abundant in places. Further, the organic constituents are relatively high.

The soil is dark in colour. It is a rich soil chemically, but owing to its compact hard clayey nature, its lack of proper aëration, and its great dryness, which is due partly to the fact that the lower valley levels get less rain, the plants found on it are of the most extreme xerophilous character. After it has been properly cultivated and aerated by exposure, it raises rich crops, e. g. of maize.

The larger particles are seen to be water-worn, and the soil is therefore shown to have been washed down from the higher levels. It is the soil of the Thorn Veld (Pl. XX, fig. 2).

It must not be inferred that all soils in this wide area can be referred to the two types above mentioned. There are endless local variations. On the tops of the kopjes, for instance, the soil may either be washed away almost entirely, leaving bare boulders of rock, or the heavier oxides of iron and larger particles of silica may be left behind giving a hard sandy soil.

The soil derived from the Dwyka Conglomerate is also a rich soil chemically, but it is also very stiff and dry, and, as in the case of the lower valley soils of the Ecça Series, water does not easily percolate through it.

The Table Mountain Sandstone gives rise to a sandy soil, often mixed with clay from the Dwyka Conglomerate and Ecça Shales, which have locally overlain the Table Mountain beds in many places. Where basic igneous rock has also contributed its share, the soil is remarkably fertile. Most of the district occupied by the Table Mountain Sandstone is also well watered by springs.

In the area occupied by the metamorphic and granitic rocks one would expect the soil to be richer, since the chemical constituents of the rocks include potash, lime, magnesia and phosphates, in addition to silica and alumina. However, as has already been stated, this area has been denuded so as to give a most rugged type of country. As a result water drains away rapidly from the steep slopes, and the valuable constituents of the soil are washed away, leaving a barren quartz sand behind. Soil gathers in the cracks and crevices of the rocks, and in such places various bulbous plants are common.

Under favourable conditions, where the ground is sufficiently flat for a proper soil to accumulate, it is a rich one, and here and there in this region good mealie crops are raised. The natural grasses are the taller species of *Andropogon*. Hornblende is a common mineral in these rocks, and by its decomposition gives rise to hæmatite, so that the soil is again red in colour.

Along practically the whole coast of Natal there is a line of sand dunes covered with trees (*Psammophilous Bush*). The sand is brownish in colour, being derived partly from the iron-containing rocks already described, but it is mixed with calcareous shell débris. It is therefore rich in lime, the constituent that is lacking in most Natal soils. On the whole it is rather a moist soil.

The soils of the Drakensberg are poor, the reason again

being chiefly a physical one. In such rugged mountainous country either the soil cannot accumulate at all, or if it does, the valuable soluble constituents are washed out of it, leaving a barren sand behind. The characteristic plants are the *Ericas* and *Proteas* (Pl. XIX).

The following table of soil analyses is taken from the records of the Cedara Experiment Farm, Natal :

No.	Locality.	Moisture.	Organic and volatile.	Insoluble.	Phosphoric acid.	Potash.	Lime.	Magnesia.	Iron oxide and alumina.
1	Reit Vallei . . .	6·96	7·84	73·09	·10	·21	·18	·18	8·62
2	„ . . .	4·18	2·85	55·68	·05	·16	·18	·23	4·85
3	„ . . .	4·28	5·80	79·86	·08	·16	·32	·18	5·06
4	„ . . .	6·45	6·28	77·86	·03	·26	·24	·23	6·72
5	„ . . .	2·05	2·55	84·83	·06	·12	·76	·21	6·86
6	Glencoe Junction . . .	3·00	7·01	78·39	·01	·33	·01	·07	10·56
7	Estecourt . . .	1·46	1·78	94·66	·009	·13	·08	·06	1·80
8	Ingogo . . .	10·69	8·40	64·99	·01	·22	1·40	·80	12·90
9	Curry's Post . . .	4·74	20·64	56·38	·54	·28	·51	·24	17·18
10	Balgowan . . .	7·70	18·15	—	·12	·21	·07	·08	19·55
11	Tweedie . . .	3·90	13·82	56·14	·12	·15	·005	·14	25·30
12	„ . . .	6·47	19·08	44·91	·12	·17	·02	·18	28·70
13	„ . . .	6·99	21·07	38·05	·11	·18	·04	·12	33·23
14	Camperdown . . .	3·34	5·28	81·20	·05	·27	·22	·21	7·78
15	„ . . .	2·75	4·80	82·70	·07	·29	·24	·19	6·78
16	„ . . .	0·55	1·41	95·45	·06	·03	·12	·03	2·16
17	Durban . . .	14·20	9·03	57·30	·06	·54	·53	·71	19·56
18	Tongaat . . .	·71	1·49	—	·03	·16	·05	—	—
19	„ . . .	·32	·87	—	·01	·15	·05	—	—
20	Ifafa (surface soil). . .	4·87	8·30	—	·03	·22	·25	·21	9·64
21	„ (subsoil of same). . .	11·24	7·10	—	·04	·20	·15	·42	18·50
22	„ (surface soil). . .	5·78	6·71	—	·02	·12	·13	·10	6·63
23	„ (subsoil of same). . .	4·25	4·20	—	0·5	·11	·10	·05	5·32
24	Clifton Tea Estate . . .	1·91	4·48	—	·02	·13	·10	·04	4·98
25	Do. (above Diorite) . . .	7·12	8·45	—	·66	·12	·26	·31	18·60
26	Clifton Tea Estate . . .	2·56	4·87	—	·04	·13	·02	·08	6·96
27	„ . . .	1·72	3·66	—	·01	·20	·05	·05	2·75

## (2) RAINFALL AND MIST.

Natal is a region of summer rainfall, 77 per cent. of the average annual rainfall coming between October and March, and only 23 per cent. between April and September. The months of June and July are frequently rainless. The wet summers and dry winters have a general influence on the vegetation of Natal, and this factor deserves the fullest attention when the end in view is a comparison of the plant life of Natal, with that of outside areas, e. g. with the west side of the Cape Province.

1. THE LOCAL VARIATION IN RAINFALL.—To help to explain the variation in the character of the vegetation *within* Natal the following facts are of most importance :

A. The higher ridges and hills receive a considerably greater rainfall than the lower valley levels. All the main river valleys are dry valleys. The rain clouds pass over them without depositing much moisture.

B. The forest areas being cooler receive a much greater rainfall. When air which is almost saturated with moisture strikes any cooler area the moisture is, of course, deposited. The forests of Natal, as we shall see, occupy the places where the rainfall for other reasons would be greatest even if they were not covered with trees, but the fact that they are forest areas increases the rainfall.

C. The rain clouds are borne by the south-easterly winds from the Indian Ocean. As soon as they strike the coast a certain amount of moisture is deposited. Stations on the coast, therefore, show a fairly high annual rainfall. The rain here is also somewhat more uniformly distributed throughout the year. It is not unusual to find that even during the dry months of June and July there have been a few wet days on the coast. At Port Durnford in Zululand, I am informed by Mr. A. Hammar, Government Surveyor, that there are surprisingly heavy rains during winter. The warm Mozambique current flows down along the East African

coast, carrying above it moisture-laden warm air. A counter current close to the land flows northwards, and, it being a cold current, carries above it colder air. At Port Durnford, owing to the coast-line bending outwards, the cold current is forced to bend round also. The two currents meet, and the warmer air has to deposit its moisture. This rain, Mr. Hammar informs me, rarely extends more than a few miles inland.

D. From the coast landwards the rainfall decreases till the edge of the first terrace is reached. Here the land rises steeply for 1000 feet or so, and with the rising altitude the air, becoming less dense, is forced to deposit more of its moisture. Places at the edge of this terrace have again, therefore, a higher rainfall. The rain clouds do not, however, deposit much of their moisture in the deeply cut river valleys. After the rain-clouds have passed upwards on to the first terrace we have a repetition of what happened from the coast inland. Less and less moisture is deposited till the edge of the next terrace is reached, where the land again rises steeply. Then the rainfall is again greater and so on. Finally the Drakensberg Range is reached, the region of heavy rain-storms in summer and snow in winter.

2. MIST.—In addition to the actual rainfall recorded the amount of moisture condensed as dew and mist is of enormous importance. Reference may be made to the experiments carried out by Dr. Marloth under the famous mist-cloud or “tablecloth” of Table Mountain, Cape Town. He used two rain-gauges, one exposed in the ordinary way, the other placed underneath a framework, on which rushes one foot high were placed. From December 21st, 1902, to February 15th, 1903, he collected in the open rain-gauge 4·97 in., while in the other he obtained 79·84 in., and he states: “It is not too much to assume that, as the season of south-east clouds extends over double that time, there would consequently be a condensation of moisture exclusive of all rain of at least 150 inches during the summer alone.”

In Natal the same thing happens. Under the mist-clouds

there is an enormous deposition of moisture. One cannot walk along the edge of the bush without being immediately drenched, and the soil underneath is also soaking in moisture.

This kind of deposition is for the same reason greatest where the rainfall is also greatest, namely, on the high ridges, along the coast, at the edges of the terraces, and on the forest areas.

The practical importance of this kind of deposition of moisture has already been sufficiently demonstrated in the growing of Wattle (*Acacia mollissima*). It is found that it does not grow well outside the "mist-belt" even where the soil is suitable.

In addition to this summer mist there is a cold winter mist, which settles down into the valleys. It is due to the fact that the colder air in the absence of winds sinks down to the lower levels, and being able to hold less moisture owing to the falling temperature a cold frosty mist is formed. In the early morning from a hill top the other hills can be seen rising above the white sea of mist like so many black islands. I shall have occasion to refer again to this cold winter mist in dealing with temperature.

It is very important to note as carefully as possible in what form moisture is deposited. As we have seen, a very considerable amount—how much it is difficult to say exactly—is deposited as mist. This affords a constant supply of water to plants growing in the mist-belts during the summer.

3. RAIN AND HAIL.—A large amount of the recorded rainfall falls in the form of heavy thunderstorms. This water drains away very rapidly, flooding the rivers and washing down soil. Such thunderstorms may be accompanied by hail.

Hail-storms are especially frequent at the higher altitudes in the vicinity of the Drakensberg. They travel great distances, usually in a narrow strip. Sir Percy Fitzpatrick, in a note to 'Jock of the Bushveld,' says that he took a plaster cast of a hailstone—a slab of white ice—and found that it measured  $4\frac{1}{2}$  in. by  $3\frac{1}{2}$  by  $1\frac{1}{8}$ . The hailstones usually vary in size up to that of a fowl's egg. Their destructive effect is

very great, especially on animal life; sheep and even cattle being killed if caught in a bad storm. Foliage is battered down by such hailstorms.

Local thunderstorms are very frequent in mid-summer; in places they occur almost daily. Occasionally there comes an altogether phenomenal rainstorm. On May 31st, 1905, 15.05 in. fell at Umzinto, Natal, and to that may be added 2.40 in. which fell on the following day. I reproduce a table (Table V, p. 271) supplied from the Natal Observatory, giving cases of a recorded rainfall of over 5 in. on one day. The actual number of occasions where there was a rainfall of 5 in. is probably greater, as there were only four stations in addition to Durban in 1893. Perhaps three such rainstorms every two years would represent an average.

The effect of from 10–15 in. of rain in one day can be imagined. The rivers very rapidly rise in flood and much soil is washed down into them. The aquatic vegetation, which has been slowly accumulating in the river beds and along their courses, is swept out to the sea. The great rush of water deepens the river channels and sweeps away the sand bars from the estuaries, and consequently produces effects that may be permanent.

4. RAINFALL RECORDS.—With the exception of Durban and one or two of the other stations, the meteorological records for Natal are irregular and unsatisfactory. To demonstrate clearly and in detail all the above facts by means of figures would be possible only if there were a much greater number of stations than there are. The figures that are given in the tables will serve, however, to illustrate the various points.

I have arranged the stations according to the terraces to which they belong. Durban, Port Shepstone, Stanger, Verulam and Umzinto represent the first terrace. The annual rainfall for places on the coast is shown to be higher than for those further in on the terrace. On comparing Port Shepstone and Umzinto it will be seen that the former has a considerably higher rainfall than the latter. Port Shepstone

is fully exposed to the rain-bearing clouds from the Indian Ocean. A high plateau rises immediately behind it, and the lower spurs of the Drakensberg approach nearer to the sea at this point than anywhere else. Umziuto, on the other hand, is a few miles inland, and is sheltered behind the first range of hills. Under these circumstances it is not surprising to find that Port Shepstone has the higher rainfall.

On the second terrace similar effects are seen. Richmond has a higher rainfall than Maritzburg. Behind Richmond the Byrne range rises for at least another 1000 ft., and the rainfall in front of this range, i. e. in the Richmond district, is naturally fairly high. Maritzburg, on the other hand, lies in a valley, and is surrounded by hills. It misses a good deal of the rain which the hills surrounding it receive. Greytown has just about the same rainfall as Maritzburg. It also lies in a hollow at the end of the Blinkwater range and in front of the third terrace. It is a place where thunderstorms are frequent. It marks the boundary between the Thorn Veld of the lower valley levels and the Close Bush of the higher levels.

Howick, Estcourt, Newcastle and Dundee represent the third terrace and do not call for any special remark.

Most instructive of all is a comparison of Weenen and Qudeni. Weenen is typical of the deeply cut, dry, hot river valleys—the region of the Thorn Veld. Qudeni is at a high altitude and is covered with dense forests. The average annual rainfall of Qudeni is about twice that of Weenen.

TABLE I.—Average Rainfall.<sup>1</sup>

		Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total for year.
Natal	Average rainfall in inches .	5.15	4.04	4.69	2.56	1.05	0.58	0.33	1.09	2.18	3.40	3.90	5.12	34.09
	No. of wet days . . . . .	16	11	14	9	5	3	3	5	8	13	14	16	117

Percentage fall in Summer, October to March, 77.  
 " " Winter, April to September, 23.

TABLE II.—Average Rainfall.<sup>2</sup>

Place.	Altitude in feet.	Period of observations.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total for year.
Durban, 29° 51' S., 31° 0' E.	260	1884-1901	4.36	4.61	4.69	3.18	2.00	0.82	0.79	1.37	4.18	5.03	4.26	4.12	39.71
Fort Napier (Maritzburg) 29° 36' S., 30° 23' E.	2220	1868-1898	6.51	5.82	5.74	2.57	1.07	0.35	0.35	1.05	1.89	3.64	5.43	5.66	40.20
Umzimkulu (Natal Coast) 30° 15' S., 30° 0' E.	2500	1885-1894	4.01	3.62	3.37	1.70	0.95	0.37	0.39	1.01	2.08	2.70	3.30	4.35	28.40

<sup>1</sup> C. M. Stewart, B.Sc., "Meteorology," Science in South Africa, 1905.

<sup>2</sup> Norman Lockyer, F.R.S., 'Mean Annual Variations of Barometric Pressure and Rainfall,' published for Solar Physics Committee, 1905.

TABLE III.—*Monthly Rainfall.*

Altitude and position.	Place.	Rainfall.	Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
On the coast and fully exposed	Port Shepstone	Total in inches	1902	4.68	4.26	4.71	1.63	1.57	—	—	2.82	8.95	2.36	3.72	3.51	
		No. of wet days	1903	—	2.12	3.81	13.48	.04	.00	.00	1.39	3.79	—	1.28	8.85	3.11
		Greatest amount on one day	1903	—	8	7	13	2	6	—	3	2	7	13	11	11
143 ft. 4 or 5 miles from the sea	Stanger	Total in inches	1902	1.30	2.05	1.32	1.10	.74	—	—	1.23	5.80	.43	.89	.99	
		No. of wet days	1903	—	8	7	13	2	6	—	3	2	7	13	11	
		Greatest amount on one day	1903	—	8	7	13	2	6	—	3	2	7	13	11	
167 ft. About 3 miles from the sea	Verulam	Total in inches	1902	7.18	.62	4.23	1.21	1.33	1.19	.51	3.34	1.48	5.28	6.71	4.68	
		No. of wet days	1903	1.91	3.92	2.73	3.31	1.33	.59	.66	2.03	.75	1.67	7.84	6.11	
		Greatest amount on one day	1904	3.46	7.41	4.65	.73	.99	1.52	.94	.09	.91	1.46	2.27	5.75	
276 ft. About 7 miles from the sea in a valley	Umzinto	Total in inches	1902	2.5	1.4	26	12	9	2	5	14	12	14	16	19	
		No. of wet days	1903	21	16	15	21	10	5	8	14	12	21	21	24	
		Greatest amount on one day	1904	19	18	16	8	10	6	8	6	17	20	20	19	
167 ft. About 3 miles from the sea	Verulam	Total in inches	1902	2.68	.40	.76	.56	.76	.85	.29	1.12	.91	1.35	1.61	1.29	
		No. of wet days	1903	.81	1.01	1.72	1.10	.80	.35	.30	1.32	.46	.73	2.68	1.86	
		Greatest amount on one day	1904	1.15	2.35	1.52	.50	.42	1.26	.81	.09	.60	.66	1.25	1.00	
276 ft. About 7 miles from the sea in a valley	Umzinto	Total in inches	1902	5.61	1.44	10.51	.45	.73	.80	.18	3.59	2.36	2.53	5.08	4.15	
		No. of wet days	1903	2.90	1.50	2.74	6.59	.53	.57	.53	1.20	.37	.37	1.21	7.82	
		Greatest amount on one day	1904	5.47	5.85	3.26	.11	.23	.19	.94	.08	.37	.37	2.66	4.77	
276 ft. About 7 miles from the sea in a valley	Umzinto	Total in inches	1902	1.9	1.2	18	6	3	2	3	7	10	14	8	13	
		No. of wet days	1903	16	14	10	13	5	5	7	6	6	1	8	18	
		Greatest amount on one day	1904	15	15	12	3	4	4	4	1	1	2	8	13	
276 ft. About 7 miles from the sea in a valley	Umzinto	Total in inches	1902	2.38	.65	5.23	.24	.60	.58	.13	1.50	1.42	.74	1.48	1.08	
		No. of wet days	1903	1.05	.56	1.38	1.05	.38	.33	.33	.18	.34	.17	.47	2.50	
		Greatest amount on one day	1904	3.45	1.83	1.02	.05	.23	.10	.94	.08	.22	.77	.77	1.27	
276 ft. About 7 miles from the sea in a valley	Umzinto	Total in inches	1902	4.56	3.83	5.90	1.33	1.13	1.16	.34	3.41	5.93	2.66	5.15	6.33	
		No. of wet days	1903	3.64	1.71	3.46	4.80	1.11	.18	.92	2.26	.08	.08	2.14	9.13	
		Greatest amount on one day	1904	3.32	7.36	3.27	.19	.32	.05	.09	.26	2.05	2.17	2.62	4.90	
276 ft. About 7 miles from the sea in a valley	Umzinto	Total in inches	1903	9	3	7	10	4	2	4	4	6	6	9	6	
		No. of wet days	1904	6	11	5	3	2	3	2	2	2	2	4	13	
		Greatest amount on one day	1902	1.55	1.25	1.75	.45	.78	.66	.25	1.02	2.00	1.35	1.45	2.42	
276 ft. About 7 miles from the sea in a valley	Umzinto	Total in inches	1903	2.05	1.45	1.41	1.92	.52	.13	.28	1.32	.06	1.18	3.19	2.56	
		No. of wet days	1904	1.46	1.87	1.16	.09	.30	.06	.09	.21	.78	.57	1.62		

Altitude and position.	Place.	Rainfall.	Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.			
2817 ft. On second terrace, but hills near it rise another 1000 ft.	Richmond	Total in inches	1902	5.07	5.68	5.24	1.38	1.68	1.73	.24	2.02	.92	3.11	3.07	4.60			
			1903	3.01	2.75	3.27	7.05	.47	1.05	.81	1.07	.64	.64	2.16	9.30	4.37		
			1904	4.48	10.18	3.61	.57	.30	.73	.00	.63	1.54	1.54	3.48	4.50	4.49		
		No. of wet days	1902	24	13	18	10	7	2	2	2	5	11	15	18	18		
			1903	20	14	13	7	4	4	4	6	4	5	13	23	12		
			1904	17	18	15	6	2	2	0	0	2	11	13	18	16		
		Greatest amount on one day	1902	.51	1.24	1.14	.42	1.29	1.00	1.14	1.21	.22	.33	.59	.62	.76		
			1903	.46	.52	.81	1.95	.23	.60	.67	.44	.99	1.74	.44	.99	1.52	1.74	
			1904	1.37	2.04	1.15	.28	.22	.73	.00	.35	.43	.83	.81	.86			
			1902	4.90	3.48	5.01	1.26	.63	1.02	.23	.27	1.32	1.53	3.02	4.03			
2218 ft. Second terrace; in a valley surrounded by hills	Maritzburg	Total in inches	1903	1.23	2.55	2.31	1.06	.57	.21	.34	1.00	.61	1.28	6.77	5.72			
			1904	8.27	8.46	2.81	.26	.11	.34	.00	.24	.62	2.46	3.67	4.27			
		No. of wet days	1902	20	10	17	11	3	2	2	2	3	6	7	10	17		
			1903	16	15	11	13	2	2	4	4	4	5	10	20	17		
			1904	19	19	9	5	4	4	0	1	8	11	19	16	16		
		Greatest amount on one day	1902	.69	1.21	1.18	.34	.52	.60	1.0	1.01	.62	.38	.62	.62	1.01		
			1903	.18	.68	.69	1.45	.48	.12	.13	.60	.44	.49	1.45	1.06			
			1904	2.73	1.84	.70	.18	.05	.19	.00	.24	.25	1.25	.53	.80			
			1902	4.83	6.11	5.69	.84	.57	1.27	.11	2.36	.53	2.98	2.26	5.51			
			1903	.52	4.49	1.42	5.90	.10	.46	.64	.92	.07	1.38	8.71	6.53			
2594 ft. Second terrace; sloping country; hills to the north-west	New Hanover	Total in inches	1904	5.40	7.10	5.06	.48	.20	.77	.00	.45	.75	2.02	4.91	3.09			
			1902	23	13	15	10	4	2	4	2	4	6	11	15	16		
		No. of wet days	1903	11	14	10	16	2	4	5	4	5	4	2	13	18	12	
			1904	16	15	14	3	23	.86	.06	1.40	.18	.57	.39	1.34			
		Greatest amount on one day	1902	1.15	1.75	1.77	.53	.23	.52	.45	.57	.07	.65	1.55	1.52			
			1903	.18	2.17	.45	1.93	.10	.26	.10	.77	.00	.45	.21	.72	.83	.70	
			1904	1.28	6.10	1.25	.26	.10	.77	.00	.45	.21	.72	.83	.70			
		Total in inches	1902	5.80	6.40	7.27	1.12	.93	1.92	.11	1.73	.56	4.06	2.68	4.67			
			1903	4.59	3.77	—	—	—	—	—	—	—	—	—	—	—	—	
		3446 ft. In a valley; third terrace rises behind it	Greytown	Total in inches	1904	5.36	5.05	3.94	.91	.31	.26	.10	.45	.57	1.20	5.65	6.33	
	1902			20	11	18	7	3	2	2	2	5	9	15	17	9		
No. of wet days	1903			11	11	—	—	—	—	—	—	—	—	—	—	—	—	
	1904			19	13	8	1	3	3	3	3	1	5	4	17	22		
Greatest amount on one day	1902			.95	1.74	1.95	.50	.64	1.60	.06	.83	.20	1.52	.58	1.75			
	1903			—	1.86	—	.81	—	—	—	.74	.09	.47	.402	3.60			
	1904			1.30	1.23	1.49	.55	.25	.42	.10	.45	.25	.55	.55	1.31	.80		

Altitude and position.	Place.	Rainfall.	Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.		
3439 ft. Third terrace	Howick	Total in inches	1902	4.22	3.81	4.30	.93	.17	1.25	.38	1.59	.85	1.59	1.97	3.88		
			1903	3.01	2.75	3.27	7.05	.47	1.05	.81	1.07	.61	.930	2.16	9.30	4.37	
			1904	6.95	8.36	2.77	.28	.19	.22	2	3	3	8	14	1.84	4.05	2.76
		No. of wet days	1903	22	17	16	10	5	2	3	1	1	8	13	14	16	18
			1904	23	17	13	7	2	3	3	1	1	6	9	23	17	14
			1904	17	18	14	13	2	4	5	5	5	5	6	9	23	17
		Greatest amount on one day	1903	.43	1.35	1.40	.39	.08	.81	.22	.77	.27	.77	.27	.39	.70	1.12
			1901	1.64	1.70	.77	.71	.11	.15	.02	.14	.21	.63	.10	.94	1.61	1.39
			1902	5.60	4.77	4.47	.66	.05	1.20	.15	1.45	.55	1.45	.55	3.36	1.08	4.24
			1903	5.10	3.55	.74	3.88	1.15	.00	.60	.80	.15	.80	.15	1.74	3.57	3.72
3533 ft. Third terrace	Estecourt	Total in inches	1904	11.00	7.58	4.30	.70	.35	.10	.06	.00	.40	.65	3.02	1.55		
			1902	16	12	11	6	2	1	2	1	5	3	11	9	13	
			1903	8	9	3	10	7	0	1	1	1	3	7	9	13	
		No. of wet days	1904	18	17	10	2	3	3	3	1	0	2	5	16	9	
			1902	1.00	1.10	1.30	.26	.05	1.20	.15	.80	.45	1.30	.55	1.75	1.50	
			1903	2.25	2.03	.40	1.70	.35	.00	.60	.80	.15	.85	.15	.85	1.75	
		Greatest amount on one day	1904	2.50	1.30	1.05	.35	.15	.05	.05	.00	.00	.00	.30	.45	.83	
			1902	6.53	.80	4.20	3.35	.00	1.12	.35	.46	.47	2.08	.16	5.21		
			1903	5.79	1.74	1.05	6.60	.74	.00	.62	1.60	1.00	3.18	4.74	3.33		
			1904	11.40	8.94	3.67	.17	.05	.32	.00	.08	.10	.08	.50	.47	1.32	
4098 ft. Third terrace	Dundee	No. of wet days	1902	7	5	4	3	0	2	2	3	3	10	8	12		
			1903	13	4	8	10	6	0	2	2	2	2	4	10		
			1904	11	13	9	2	1	2	0	1	1	2	3	8		
		Greatest amount on one day	1902	2.90	.40	1.40	3.00	.00	.62	.36	.36	.36	.25	.51	.08		
			1903	1.56	1.18	.68	1.50	.27	6	.59	1.30	.90	1.82	1.57	1.82		
			1904	2.40	2.00	.62	.12	.05	.17	.00	.08	.06	.06	.36	1.93		

Altitude and position.	Place.	Rainfall.	Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.		
3893 ft. Third terrace, Drakensberg 10 miles away	Newcastle	Total in inches	1902	4.61	4.36	5.33	.12	.00	.99	.00	.31	.51	1.48	.37	6.33		
			1903	4.59	2.16	.96	4.61	.65	.57	.19	.39	.23	.20	2.01	4.20	3.36	
			1904	7.39	7.97	6.90	.36	.00	.00	.00	.00	.00	.00	.30	.40	4.67	4.34
			1902	10	7	11	3	0	2	3	2	2	3	4	14	9	15
			1903	10	11	10	13	5	1	2	1	2	2	6	7	14	15
2841 ft. Dry valley type	Weenen	Greatest amount on one day	1904	17	14	17	2	0	1	1	0	2	7	16	11		
			1902	2.15	1.21	.73	.12	.00	.80	.00	.80	.00	.31	.37	.54	.22	2.52
			1903	1.99	.90	.47	1.48	.27	.57	.19	.23	.23	.23	.23	1.60	1.39	.84
			1904	1.58	1.95	2.09	.36	.00	.00	.00	.00	.00	.00	.30	.40	2.01	1.43
			1902	4.55	3.23	4.53	2.38	.08	1.56	1.14	1.18	.35	2.63	1.05	5.37	1.05	5.37
5686 ft. Mountain type	Qudeni	Total in inches	1903	4.31	3.33	1.28	3.77	.87	.00	.61	1.00	.04	.70	4.77	2.53		
			1904	5.27	5.30	2.93	.45	.25	.40	.03	.02	.45	.65	.65	2.96	1.33	
			1902	13	11	13	5	2	2	3	3	3	4	4	9	10	13
			1903	12	13	9	10	5	1	2	2	2	2	6	5	14	13
			1904	16	14	13	3	2	2	2	1	1	1	6	6	13	9
		Greatest amount on one day	1902	1.26	1.10	1.78	2.01	.08	1.06	.11	.68	.23	1.00	.30	1.02		
			1903	1.70	1.23	.52	1.07	.47	.00	.40	.75	.04	.25	.25	2.23	.77	
			1904	1.29	1.29	1.07	.25	.25	.35	.06	.02	.22	.42	.42	.80	.45	
			1902	9.84	4.64	9.76	2.71	.75	1.87	.68	1.43	.91	5.40	5.28	7.40		
			1903	4.59	5.89	3.14	6.02	2.36	.97	1.38	.49	2.27	8.36	7.33			
		No. of wet days	1904	6.84	7.11	6.72	1.51	.41	.23	.12	11	18	20	26	24		
			1902	24	21	24	22	14	8	12	11	8	20	20	26	24	
			1903	23	22	20	22	15	7	14	11	12	13	22	18	21	
			1904	21	23	23	15	15	8	6	8	13	21	20	27	18	
			1902	1.72	1.27	2.92	.90	.28	1.21	.36	.59	.24	1.55	1.58	1.91		
		Greatest amount on one day	1903	2.03	2.17	.45	1.05	.63	.69	.63	.58	.14	.50	2.53	1.86		
			1904	1.15	1.4.6	1.85	.69	.21	.10	.04	.21	.11	1.13	1.55	1.58		

The figures in this table have been taken from the Reports of the Government Astronomer for Natal.

TABLE IV.—*Annual Rainfall.*

Altitude and position.	Place.	1883	1884	1885	1886	1887	1888	1889	1900	1901	1902	1903	1904	1905	1906	1907	1908	Ave- rage.
On coast and fully exposed	Port	73.60	38.38	—	49.92	—	50.45	35.95	34.57	59.02	—	—	—	—	—	39.61	—	52.76
143 ft. About 5 miles inland	Shepstone	115	89	—	125	—	130	152	135	157	—	—	—	—	—	160	—	94
167 ft. About 3 miles inland	Stanger	52.24	41.66	45.22	41.22	33.80	51.03	34.34	27.11	44.34	37.79	32.85	32.70	40.03	39.11	40.53	—	45.43
276 ft. About 7 miles inland	Verulam	50.30	34.79	47.55	34.93	31.19	44.45	28.06	27.39	45.80	37.43	30.45	27.72	42.64	29.80	45.20	—	38.81
2817 ft. Second terrace	Umzimto	108	104	118	100	122	127	137	111	141	115	119	87	76	82	106	—	111
2218 ft. Second terrace	Richmond	—	—	50.00	41.58	34.78	51.64	35.19	33.63	36.26	35.37	35.95	34.63	44.05	37.11	56.11	—	40.70
3416 ft. In front of third terrace	Maritzburg	—	—	144	142	133	137	132	120	140	141	138	119	144	116	146	—	136
3439 ft. Third terrace	Howiek	—	—	—	35.82	31.66	43.64	31.78	25.18	37.76	28.73	26.68	31.51	42.10	34.18	51.64	—	34.87
3833 ft. Third terrace	Estcourt	—	—	—	165	137	142	134	112	144	125	119	115	136	123	146	—	134
3893 ft. Third terrace	Newcastle	—	—	—	43.62	35.92	43.91	29.52	20.06	38.02	37.25	—	30.17	—	23.90	41.38	—	35.04
2841 ft. Dry valley type	Weenen	—	—	—	131	140	147	142	155	101	133	117	99	—	97	139	—	128
5086 ft. Mountain type	Qudeni	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		—	—	—	30.06	35.59	34.77	29.98	24.69	29.14	27.58	25.00	29.71	35.76	26.82	32.18	—	28.64
		—	—	—	87	107	147	92	74	103	91	71	86	88	61	86	—	68
		—	—	—	35.87	36.20	23.22	31.74	—	41.46	24.41	23.92	32.33	41.44	39.47	56.27	—	35.09
		—	—	—	71	101	78	86	—	100	80	93	88	111	88	102	—	86
		—	—	—	—	—	—	—	—	28.91	27.05	23.24	20.07	—	21.07	33.07	—	31.52
		—	—	—	—	—	—	—	—	86	93	88	92	—	—	—	—	87
		—	—	—	—	—	—	—	—	57.41	50.70	43.77	47.07	49.54	—	—	—	49.7
		—	—	—	—	—	—	—	—	21.4	22.4	199	190	209	—	—	—	207

<sup>1</sup> The figures in this table have been taken from the Reports of the Government Astronomer for Natal, 1893-1908.

<sup>2</sup> T = Total in inches. N = Number of wet days.

TABLE V.—*Excessive Rainfall, 1897-1910.*<sup>1</sup>

Locality.	10 inches and over.												Over 5 and under 10 inches.															
	March 21st, 1897.	May 31st, 1905.	June 1st, 1905.	April 19th, 1908.	Sept. 29th, 1893.	Oct. 8th, 1893.	Nov. 20th, 1893.	Feb. 13th, 1895.	April 4th, 1898.	March 8th, 1902.	March 9th, 1902.	Sept. 2nd, 1902.	April 27th, 1903.	May 31st, 1903.	June 1st, 1903.	March 18th, 1903.	Feb. 4th, 1907.	Nov. 18th, 1907.	April 18th, 1908.	April 19th, 1908.	Jan. 19th, 1909.	Jan. 21st, 1909.	May 11th, 1909.	Dec. 20th, 1909.	March 27th, 1910.	April 1st, 1910.	Dec. 9th, 1910.	
Durban . . . . .			10.70	10.59		6.07				5.02									8.40									
Winkle Spruit . . . . .			12.00		9.93							5.80	5.75						5.50									
Port Shepstone . . . . .				10.38	5.53				7.10	5.23																		
Umzinto . . . . .	11.09	15.05				5.10																						
Verulam . . . . .		11.24																										
Stanger . . . . .																												
Ndwedwe . . . . .																												
Umbozintwini . . . . .																												
Uhoombo . . . . .																												
Ingwavuna . . . . .																												
Mtunzini . . . . .																												
Kwa Hanover . . . . .																												
Mid-Illovo . . . . .																												
Cedara . . . . .																												
Dundee . . . . .									5.26																			

<sup>1</sup> Report of the Government Astronomer for Natal.

## (3) TEMPERATURE.

As regards temperature the following are the most important points :

1. ALTITUDE.—On the coast the temperature hardly ever falls below freezing-point. This absence of frost from the coast-belt is undoubtedly the most important fact as far as temperature is concerned, since certain species are able to grow which could not exist further inland, for the reason that they would be killed by the winter frosts. In general there is a fall in the mean temperature corresponding to altitude. This fall may be taken as  $3^{\circ}$  F. per 1000 ft. Consequently it is not difficult to find species characteristic of the different zones from the coast upwards, and Thode<sup>1</sup> has attempted to divide Natal into botanical regions according to altitude. As will be pointed out later there is a change in the bush from the coast upwards, but the difference is more floristic than œcological. As a matter of fact many of the dominant species, especially in the Grass Savannah, extend from the coast right up to the Drakensberg.

2. VARIATION IN TEMPERATURE.—There is much less variation in temperature on the coast-belt, due largely to the amount of cloud. The daily range is not nearly so great. It is neither so warm at mid-day nor so cold at night. In the midlands in the winter months a difference of  $50^{\circ}$  F. in daily shade temperature is not at all uncommon, and at sunset the fall is often extremely sudden. These sudden changes in temperature form one of the most striking features of the Natal climate.

3. TEMPERATURE OF VALLEYS.—In the winter season the valleys contain air which is much colder during night time than that of the higher levels of the hills and ridges. As one descends into a valley a sudden change in temperature is noticeable. It may be quite warm down to a certain

<sup>1</sup> Thode, Justus, 'The Botanical Regions of Natal determined by Altitude.' Durban, 1901.

level, but after that is passed a sudden chill is felt. The cold continues until one ascends to the same level on the opposite side. Looking back, a white mist-cloud can be seen forming in the valley—the cold winter mist already referred to.

The cold air flows downwards along the valley. The upper end is usually warmer than the lower end. Where a small side valley opens out into a larger and deeper one the cold air flows out of the former. As a consequence plants in the side valley may be little affected by frosts. This doubtless explains why in the Chase Valley near Pietermaritzburg it is found possible to grow certain of the sub-tropical fruits. The Dorp Spruit, which is at a lower level, cuts across the end of Chase Valley and drains off the cold mist. In the same way it is found that plants at the upper end of a valley suffer less from frosts than those at the lower end.

4. TEMPERATURE OF BUSH.—The woodland areas are like the coast-belt in having less variation in temperature. The great amount of transpiration from the extensive leaf-surface has the effect of lowering the temperature during the day. Further, there is less rapid cooling during the night. Frosts are rare inside the bush. This fact is of very great importance, for, though the winter is dry, the trees have not at the same time to grow in a frozen soil, and consequently very few deciduous trees occur.

5. TEMPERATURE RECORDS.—The tables for temperature illustrate in a general way the above-mentioned points. On the first terrace (coast-belt) the temperature is only once shown to have fallen below freezing-point—at Stanger in 1893. There is less range of temperature shown on the coast-belt, though occasionally very high shade temperatures are recorded, the highest being 116° F. for Stanger in 1901.

The places have again been arranged according to the terraces and the usual fall in temperature with rising altitude is shown. From places on the second terrace and upwards we get winter frosts.

Attention should again be directed to Weenen and Qudeni, since these places represent respectively the dry Thorn

Veld and the close type of Bush. Taking the averages of the mean results, Weenen is shown to be the hottest in summer and the coldest in winter of the places for which records are available, though the absolute maxima do not quite come up to those of Stanger on the north coast. For Weenen the range is very great; for Qudeni the range is much less. The average of absolute maxima for Weenen is  $107^{\circ}$ , of absolute minima,  $23^{\circ}$ , a difference of  $84^{\circ}$ . The average of absolute maxima for Qudeni is  $89^{\circ}$ , of absolute minima,  $27^{\circ}$ , a difference of  $62^{\circ}$ . Again, the average of the mean maxima for Weenen is  $84.4^{\circ}$ , for Qudeni,  $68.6^{\circ}$ . Even during winter at Weenen a frost at night may be followed by a shade temperature of  $85^{\circ}$  next day.

TABLE VI.—*Temperature at Durban, Natal.*

Year.	Fahrenheit scale.							Cloud.*		Day.	
	Mean 9 a.m.	Mean 3 p.m.	Mean maximum in shade.	Mean minimum in shade.	Absolute maximum in shade.	Absolute minimum in shade.	Absolute maximum in sun.	Mean maximum in sun.	9 a.m.		3 p.m.
1885	69.7	72.9	81.4	60.0	98.9	43.7			4.4	4.9	4.7
1886	70.3	73.7	81.1	61.1	106.8	44.7			4.7	4.9	4.8
1887	68.9	72.7	80.3	60.2	97.6	45.7			4.5	4.6	4.6
1888	69.9	73.4	81.4	61.7	98.4	45.0			5.2	5.2	5.2
1889	71.1	74.6	82.5	62.1	104.7	46.6			4.3	4.8	4.6
1890	69.4	76.2	82.4	61.9	110.6	47.4			4.6	4.9	4.8
1891	69.7	73.1	80.7	61.5	97.8	47.5			4.7	5.3	5.0
1892	69.9	73.9	80.7	62.0	105.2	46.1			4.9	5.3	5.1
1893	69.1	72.8	78.7	61.1	92.9	45.7	158.8	129.8	4.9	5.3	5.1
1894	69.7	73.3	79.0	61.2	91.6	42.3	155.3	130.6	4.5	5.0	4.8
1895	69.4	72.8	79.2	61.4	97.9	47.4	156.3	127.6	4.6	5.0	4.8
1896	71.3	74.3	81.1	62.9	109.6	46.5	161.3	132.1	4.5	4.7	4.6
1897	70.9	74.3	80.2	62.0	102.9	49.5	155.2	132.3	4.2	4.6	4.4
1898	69.7	73.1	79.3	60.7	98.8	41.8	155.0	130.6	4.0	4.2	4.1
1899	70.2	73.9	79.2	61.8	101.7	46.8	153.0	129.8	4.7	4.9	4.8
1900	71.4	75.0	81.0	62.8	106.2	47.2	159.0	130.3	4.6	4.8	4.7
1901	69.7	72.9	79.0	61.5	98.8	43.2	158.8	127.8	4.6	4.7	4.7
1902	69.4	72.6	79.2	61.0	105.6	47.4	156.1	128.7	4.6	4.6	4.6
1903	69.5	72.7	79.2	61.2	96.1	46.1	152.3	127.4	4.4	4.6	4.5
1904	70.1	73.4	79.4	61.5	101.1	48.8	159.2	129.7	4.1	4.1	4.1
1905	69.5	72.5	78.1	61.4	90.7	45.4	154.2	130.4	4.9	4.6	4.8
1906	69.8	72.7	78.5	61.3	97.2	46.1	154.8	130.2	4.2	4.6	4.4
1907	69.4	72.1	78.0	61.2	90.7	41.1	153.6	129.7	4.3	4.6	4.5
1908	69.1	72.0	77.7	61.6	99.9	45.0	154.6	128.0	4.6	4.4	4.5

\* Mean amount of cloud. Overcast sky taken as 10.

TABLE VII.—*Monthly Temperatures.*

Altitude and position.	Place.	Temperature (Fahrenheit scale).	Year.													
			Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.		
On coast and fully exposed	Port Shepstone	Mean max.	1902	82.3	84.4	81.9	78.9	77.9	—	71.6	74.2	78.1	81.0	85.4		
			1903	—	88.2	85.0	78.8	79.3	80.0	—	82.8	82.8	78.1	78.8	88.5	
		Mean min.	1902	65.6	71.8	68.7	66.7	63.3	—	50.2	52.4	54.8	56.2	60.9		
			1903	—	58.7	55.2	53.2	50.7	47.9	—	53.4	52.4	56.6	56.1	61.9	
		Absolute max.	1902	89	90	91	85	82	—	88	89	89	91	89	94	
			1903	—	92	90	85	84	83	—	91	—	83	87	94	
	143 ft. 4 or 5 miles from the sea	Stanger	Absolute min.	1902	57	64	62	58	54	—	46	46	50	48	52	
				1903	—	49	49	43	47	41	44	48	50	48	56	
			Mean max.	1902	83.9	90.2	86.4	81.8	80.8	77.3	79.6	74.9	82.3	82.8	83.5	85.1
				1903	90.2	87.7	83.7	78.8	81.5	78.0	76.2	78.6	76.9	82.0	82.2	87.5
			Mean min.	1904	85.3	86.3	83.7	78.2	78.2	81.7	74.8	82.4	81.4	82.2	86.9	82.8
				1902	64.6	65.2	62.7	62.9	57.6	53.8	52.2	53.1	55.0	57.5	60.0	63.2
167 ft. About 3 miles from the sea	Verulam	Absolute max.	1903	68.7	69.1	61.1	59.5	57.7	50.3	51.5	52.9	53.4	58.5	57.2		
			1904	65.3	65.0	63.3	60.9	55.2	52.1	51.4	51.0	53.1	58.1	64.7	61.3	
		Absolute min.	1902	104	103	101	94	94	87	93	89	110	110	98	99	
			1903	115	97	109	90	98	88	85	98	95	111	98	99	
			1904	104	99	96	98	94	96	80	90	105	98	107	97	
			1902	59	60	60	59	53	47	48	45	47	48	50	58	
	167 ft. About 3 miles from the sea	Verulam	Absolute min.	1903	60	59	54	53	47	43	45	49	49	51	48	
				1904	55	60	55	58	51	46	44	49	42	49	56	53
			Mean max.	1902	86.4	91.1	87.6	83.0	80.4	75.9	77.0	76.0	79.9	82.1	82.3	86.0
				1903	89.9	88.9	87.5	82.8	81.3	75.7	72.5	76.6	77.5	82.9	83.3	88.7
			Mean min.	1904	89.1	89.7	86.7	85.5	81.8	80.7	75.1	78.1	80.0	82.9	87.2	84.4
				1902	67.3	68.5	66.8	62.4	56.6	50.3	50.0	54.1	57.6	59.2	62.2	67.1
167 ft. About 3 miles from the sea	Verulam	Absolute max.	1903	69.5	68.2	65.2	62.6	56.7	49.5	50.9	54.5	55.7	61.9	63.2		
			1904	70.5	69.8	67.3	62.3	56.5	51.6	52.1	53.5	57.1	60.8	64.7		
		Absolute min.	1902	100	99	96	92	86	81	90	83	106	111	96	95	
			1903	110	97	104	95	89	85	82	90	94	105	95	98	
			1904	99	98	94	94	92	90	82	87	101	95	104	96	
			1902	61	57	62	50	49	44	44	47	51	50	56	59	
	1903	57	62	55	53	48	42	38	46	48	53	56	60			
	1904	64	65	60	53	50	45	48	47	48	54	56	56			

Altitude and position.	Place.	Temperature (Fahrenheit scale).	Year.	Jan.	Feb.	Mar.	April	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.		
276 ft. About 7 miles from the sea, in a valley	Umzimto	Mean max.	1902	81.6	86.6	84.1	83.1	79.0	82.8	84.5	80.5	81.4	84.4	85.5	87.8		
			1903	83.3	85.8	85.0	79.0	76.7	77.4	78.3	80.3	80.3	87.4	87.4	82.0	88.1	
		Mean min.	1902	61.8	67.7	62.8	62.5	49.4	45.1	46.5	49.7	48.0	55.0	56.9	56.9	61.4	
			1903	54.7	55.0	64.8	61.7	60.3	48.4	44.7	44.6	55.4	55.4	55.7	52.5	59.3	
		Absolute max.	1904	60.9	59.3	58.8	62.3	57.4	47.3	49.1	53.4	49.1	60.2	60.2	66.1	57.1	
			1902	90	93	91	90	86	86	87	86	106	106	94	98	98	
	2817 ft. On second terrace.	Richmond	Absolute min.	1903	105.5	92.5	94	93	81	85	85	85	94	98	94	93	96
				1904	98	99	94	88	85	80	82	89	90	98	90	98	98
				1902	60	62	58	58	45	42	43	44	47	43	52	54	56
				1903	52.5	52	53	52	49	42	42	41	50	52	46	46	54
				1904	53	54	53	55	50	44	45	47	44	54	54	63	53
			1902	76.5	81.3	75.8	73.9	74.0	70.2	74.3	71.1	72.2	74.1	77.7	74.1	80.4	
		Mean max.	1903	84.9	83.6	80.9	73.3	75.1	70.7	78.0	74.3	77.2	74.3	77.2	79.3	74.4	80.2
		1904	81.7	80.7	79.8	81.3	76.2	73.0	71.8	77.4	76.4	77.4	76.4	77.7	80.7	76.5	
Mean min.		1902	59.4	59.9	58.4	52.5	49.1	42.5	43.7	45.6	48.1	51.7	52.9	57.7	57.7		
		1903	60.2	59.2	54.8	52.3	47.2	40.4	42.0	42.0	45.6	49.0	51.2	54.7	58.1		
Absolute max.	1904	60.6	59.0	58.2	53.4	44.6	43.7	41.3	45.1	45.1	48.2	51.1	57.6	54.9			
2218 ft. On second terrace, in a valley	Maritzburg		1902	93	94	88	85	82	81	84	84	96	99	99	101	98	
			1903	102	99	96	89	85	82	84	90	101	100	93	98	98	
			1904	103	99	91	93	85	84	84	89	95	95	95	105	95	
			1902	53	53	52	44	38	36	34	33	37	39	44	44	49	
			1903	48	54	40	42	36	33	35	33	34	39	35	46	48	
			1904	52	54	51	41	36	32	34	39	35	39	35	48	45	
	Mean max.	1902	81.7	86.6	81.9	77.7	76.8	74.1	75.8	74.4	76.0	79.3	80.8	83.3	83.3		
		1903	87.9	86.3	83.6	77.1	76.9	73.7	71.6	76.2	79.1	81.2	79.1	81.2	78.5	82.6	
		1904	82.5	82.4	81.0	82.3	78.1	77.3	73.5	78.5	79.5	78.5	79.5	81.7	82.8	79.7	
	Mean min.	1902	61.0	62.0	59.6	54.1	47.9	40.0	43.5	49.6	46.5	50.6	54.5	55.0	58.6		
		1903	60.5	58.2	—	54.0	49.0	40.3	41.9	46.5	50.6	54.5	57.3	60.2	57.3		
		1904	62.1	60.3	59.5	54.6	45.3	42.4	40.4	44.4	46.5	50.6	53.5	57.7	55.9		
	Absolute max.	1902	98	98	95	88	85	84	87	86	97	103	102	106	106		
	1903	105	102	99	92	87	85	87	85	87	92	101	99	100			
	1904	100	97	91	92	89	89	85	88	95	98	95	98	105	96		
Absolute min.	1902	54	54	54	45	37	33	34	35	40	40	40	40	40	50		
	1903	52	50	—	44	36	30	34	38	34	38	34	41	48	51		
	1904	56	55	52	40	36	34	36	34	35	35	37	45	46			

Altitude and position.	Place.	Temperature (Fahrenheit scale).	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.		
2594 ft. on second terrace. Sloping country Hills to the north-west	New Hanover	Mean max.	1902	85.3	84.8	80.5	77.6	76.6	72.6	73.8	75.9	76.6	80.1	82.6	85.1		
			1903	91.8	87.4	84.1	75.1	75.1	69.6	69.1	69.6	69.1	76.8	80.0	85.0	81.7	85.4
		Mean min.	1904	84.8	84.5	80.8	81.8	75.4	72.3	73.0	72.3	73.0	80.1	82.1	85.1	86.5	83.5
			1902	59.6	60.1	56.8	52.0	44.8	38.4	40.9	46.0	48.5	51.5	54.2	59.8	54.2	59.8
			1903	62.3	60.5	54.0	52.8	45.1	37.9	40.3	45.0	45.0	50.2	53.6	55.9	57.7	57.7
	Greytown	Absolute max.	1904	61.6	59.4	59.3	51.5	42.3	38.6	38.0	38.0	43.3	48.4	54.0	58.3	57.2	57.2
			1902	101	95	91	88	85	86	83	88	88	96	101	101	104	104
			1903	104	103	97	92	85	82	83	83	83	93	103	100	100	99
		Absolute min.	1904	98	100	90	90	84	81	84	81	83	93	96	97	104	96
			1902	53	51	47	42	34	30	33	33	33	33	39	38	47	50
3416 ft. In a valley in front of the third terrace	Greytown	Mean max.	1904	51	53	50	38	32	29	33	36	32	32	42	45	45	
			1902	85.9	87.4	84.8	85.1	80.3	74.3	80.8	80.2	81.5	81.1	85.6	81.1	85.6	87.0
			1903	—	—	—	80.7	—	—	—	—	—	78.2	83.7	84.8	82.1	85.0
		Mean min.	1904	82.1	84.7	82.9	83.6	79.3	77.0	77.0	75.8	78.6	87.1	87.9	84.5	81.3	81.3
			1902	61.2	63.0	60.9	54.9	48.1	42.9	42.7	48.1	48.1	48.2	49.6	49.6	53.9	56.0
	Howick	Absolute max.	1904	59.0	62.4	57.0	52.4	47.5	44.2	46.4	46.4	52.2	57.7	59.2	57.8	56.6	
			1902	95	93	90	90	86	84	86	86	85	93	94	92	93	
			1903	—	—	—	84	—	—	—	—	—	83	94	92	91	90
		Absolute min.	1904	93	95	93	89	83	81	81	81	89	93	92	96	90	90
			1902	56	53	54	53	43	31	35	35	32	43	41	46	50	50
3439 ft. Third terrace.	Howick	Mean max.	1904	50	54	53	49	42	35	38	42	45	49	45	45		
			1902	80.1	83.4	83.3	72.2	75.5	71.5	72.8	72.5	73.2	77.2	79.8	81.6	81.6	
			1903	86.3	86.9	81.8	75.5	73.6	68.7	67.7	75.1	77.1	77.1	81.7	76.7	81.7	
		Mean min.	1904	82.0	79.9	78.2	79.9	73.8	71.9	70.2	76.1	76.6	79.1	82.5	80.6	80.6	
			1902	58.3	57.9	57.0	49.8	41.3	34.2	36.1	40.7	46.3	50.5	51.8	56.3	56.3	
	Howick	Absolute max.	1903	59.2	57.8	53.6	50.4	44.0	32.7	35.7	35.7	40.4	44.6	49.2	53.2	56.1	
			1904	58.7	57.2	56.8	48.6	38.9	35.6	33.3	37.9	46.6	50.2	55.2	54.3	54.3	
			1902	97	96	93	87	85	80	84	85	84	85	93	98	93	99
		Absolute min.	1903	98	97	96	87	84	80	80	80	80	86	98	96	93	94
			1904	93	94	87	90	83	83	83	81	87	92	93	102	93	93
	1902	51	50	49	37	30	25	28	29	38	32	47	48	48	48		
	1903	50	50	40	42	33	27	27	32	30	32	30	38	45	50		
	1904	51	52	48	35	30	24	27	30	27	30	28	42	42	45		

Altitude and position.	Place.	Temperature (Fahrenheit scale).	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.		
3833 ft. On third terrace	Estcourt	Mean max.	1902	85.2	85.3	81.8	78.2	76.3	69.7	71.7	72.8	76.3	79.6	85.8	86.9		
			1903	89.5	87.6	85.0	75.3	72.9	70.4	69.6	74.5	78.6	84.0	84.0	84.3	87.0	
			1904	84.1	81.3	79.2	79.8	74.0	70.2	69.6	73.8	78.0	84.7	85.4	85.9	85.9	
			1902	58.6	58.0	57.3	48.9	41.4	32.7	32.9	40.3	45.2	49.8	53.6	58.7	58.7	
			1903	59.0	60.1	54.2	50.5	39.9	32.4	40.2	45.2	51.1	51.4	53.4	53.4	53.4	
			1904	54.7	52.2	52.6	46.0	37.1	32.8	33.0	—	42.2	50.9	55.5	53.8	53.8	
			1902	98	94	92	86	87	80	80	85	98	99	98	100	98	100
			1903	100	97	95	89	82	76	80	82	46	97	99	101	99	101
			1904	101	91	87	87	82	78	76	80	90	97	104	100	97	104
			1902	53	50	49	40	32	27	27	31	34	52	48	47	48	47
1903	47	54	40	39	30	26	29	32	32	42	42	45	42	45			
1904	48	47	46	34	28	25	30	—	30	42	42	42	42	42			
4098 ft. On third terrace	Dundee	Mean max.	1902	83.9	86.7	86.3	84.6	80.6	74.2	77.1	76.9	—	78.3	90.1	94.8		
			1903	92.1	91.4	81.5	77.8	76.1	74.5	78.4	72.5	73.9	82.7	81.8	86.2		
			1904	81.7	79.3	76.3	77.8	72.7	67.6	67.4	74.5	76.5	79.6	83.9	80.7		
			1902	57.9	58.5	56.8	45.1	35.3	31.4	33.6	34.9	—	55.7	49.5	64.0		
			1903	63.4	52.7	55.0	54.7	35.6	33.0	39.6	47.1	50.9	57.1	57.3	61.7		
			1904	61.5	60.1	57.9	53.6	45.8	39.8	39.8	43.4	47.6	52.6	56.8	54.5		
			1902	98	94	93	89	84	78	81	80	—	92	96	98		
			1903	97	95	93	84	80	80	78	80	91	93	95	103		
			1904	98	95	83	83	79	74	73	85	85	91	97	92		
			1902	52	48	51	40	33	29	31	33	—	37	44	61		
1903	54	50	44	47	34	31	32	40	42	48	48	53					
1904	52	51	52	39	40	32	35	37	31	43	44	42					
3893 ft. On third terrace. Ten miles from Drakensberg	Newcastle	Mean max.	1902	94.8	88.8	82.9	77.5	70.1	70.4	71.3	71.6	75.5	85.2	90.5	91.1		
			1903	92.6	91.5	84.0	74.2	68.1	63.2	61.8	71.0	75.1	87.6	90.9	92.4		
			1904	91.1	87.4	80.1	75.2	69.2	64.4	68.6	74.5	80.4	90.0	91.7	90.1		
			1902	69.0	64.8	51.5	42.4	39.4	37.2	38.8	46.6	45.0	53.8	61.4	65.5		
			1903	71.9	53.5	49.0	41.3	34.2	40.5	43.5	45.1	56.8	59.3	62.1	62.1		
			1904	62.5	61.3	54.0	46.8	39.7	36.4	37.4	42.5	46.3	56.7	57.8	51.5		
			1902	103	96	90	80	75	73	75	77	90	97	97	105		
			1903	100	96	91	87	80	68	70	76	91	94	97	100		
			1904	101	98	89	89	76	73	75	82	93	93	97	101		
			1902	57	56	45	39	36	32	32	36	38	44	49	52		
1903	63	59	46	40	33	30	30	36	38	48	53	50					
1904	54	50	47	36	34	25	28	34	39	47	50	34					

Altitude and position.	Place.	Temperature (Fahrenheit scale).	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
2841 feet. Dry valley type	Weenen	Mean max.	1902	92.3	92.6	88.6	83.3	79.7	72.4	73.9	76.0	80.0	83.4	90.7	93.8	
			1903	—	92.9	88.9	81.3	77.6	72.5	71.9	78.0	82.6	88.9	88.9	88.5	93.5
		Mean min.	1904	90.7	88.7	85.7	85.9	79.7	75.2	81.0	84.5	90.0	92.1	90.2	90.2	90.2
			1902	60.6	60.7	59.2	50.7	40.3	31.6	31.0	39.2	46.6	50.8	56.4	59.6	59.6
5686 feet. Mountain type	Qudeni	Absolute max.	1903	62.1	60.3	54.9	51.6	39.6	28.9	33.3	39.8	44.7	51.5	56.1	59.9	
			1904	62.1	60.3	57.0	48.2	38.1	32.5	36.0	44.2	54.7	58.6	56.5	56.5	
		Absolute min.	1902	105	102	97	92	86	83	85	87	96	102	105	106	106
			1903	—	103	99	93	87	81	83	88	101	101	101	105	105
5686 feet. Mountain type	Qudeni	Mean max.	1904	105	100	94	96	89	85	82	93	97	102	106	101	
			1902	56	53	52	38	30	26	25	31	35	36	48	50	
		Absolute min.	1903	—	54	43	42	29	23	24	32	32	32	38	44	54
			1904	54	55	48	36	29	26	25	28	30	45	44	44	
5686 feet. Mountain type	Qudeni	Mean max.	1902	72.3	74.3	69.4	67.8	64.7	60.6	61.6	63.4	64.6	67.5	70.8	72.7	
			1903	76.2	75.3	72.3	64.9	64.2	59.7	59.2	64.4	66.0	71.9	70.8	74.4	
		Mean min.	1904	73.2	71.9	69.4	71.3	64.6	61.6	60.8	67.1	69.1	71.5	74.5	69.6	
			1902	52.9	52.6	50.5	47.2	42.4	37.8	39.9	41.5	42.9	45.3	48.1	52.4	
5686 feet. Mountain type	Qudeni	Absolute max.	1903	54.1	53.4	48.0	46.0	42.4	36.1	38.4	42.2	43.5	48.3	49.1	52.5	
			1904	54.5	52.3	51.5	47.6	41.9	39.7	39.0	41.7	45.2	48.2	49.2	49.2	
			1902	89	85	81	76	71	70	69	78	85	89	86	89	86
			1903	87	87	83	75	75	70	69	75	87	84	86	86	
5686 feet. Mountain type	Qudeni	Absolute min.	1904	90	87	78	80	73	71	69	80	85	85	89	84	
			1902	46	36	42	37	30	22	31	32	30	34	39	40	
			1903	40	47	35	38	30	27	30	31	31	31	36	35	41
			1904	45	42	41	38	36	28	33	32	32	29	35	42	39

The figures in Tables VI, VII, and VIII are taken from the reports of the Government Astronomer for Natal, 1893-1908.

TABLE VIII.—*Yearly*

Altitude and position.	Place.	Temperature (Fahrenheit scale).	1893.	1894.	1895.	1896.	1897.
On coast and fully exposed	Port Shepstone	Mean max.	78·7	79·6	—	79·9	—
		Mean min.	59·6	59·1	—	62·1	—
		Abs. max.	92	92	—	107	—
		Abs. min.	44	40	—	48	—
143 ft. 5 miles from the sea	Stanger	Mean max.	84·6	81·0	77·5	79·8	79·1
		Mean min.	58·3	59·5	57·5	59·3	62·1
		Abs. max.	108	109	109	112	102
		Abs. min.	30	43	33	40	48
167 ft. 3 miles from the sea	Verulam	Mean max.	83·3	84·6	84·4	86·3	83·1
		Mean min.	56·1	58·5	58·6	60·7	61·2
		Abs. max.	99	101	105	115	102
		Abs. min.	36	36	33	41	44
276 ft. 7 miles from sea in a valley	Umzinto	Mean max.	—	—	—	—	—
		Mean min.	—	—	—	—	—
		Abs. max.	—	—	—	—	—
		Abs. min.	—	—	—	—	—
2817 ft. Second terrace	Richmond	Mean max.	—	—	76·8	78·1	77·1
		Mean min.	—	—	51·6	52·8	52·7
		Abs. max.	—	—	100	105	108
		Abs. min.	—	—	32	32	35
2218 ft. Second terrace in a valley	Maritzburg	Mean max.	—	—	—	80·6	80·6
		Mean min.	—	—	—	54·1	53·5
		Abs. max.	—	—	—	103	108
		Abs. min.	—	—	—	33	35
3416 ft. In front of third terrace	Greytown	Mean max.	—	—	75·7	78·4	76·3
		Mean min.	—	—	56·1	57·6	56·8
		Abs. max.	—	—	94	96	95
		Abs. min.	—	—	36	37	38
3439 ft. Third terrace	Howick	Mean max.	—	—	—	—	76·8
		Mean min.	—	—	—	—	49·1
		Abs. max.	—	—	—	—	100
		Abs. min.	—	—	—	—	28
3833 ft. Third terrace	Estcourt	Mean max.	—	—	77·5	78·9	76·3
		Mean min.	—	—	47·8	49·0	56·8
		Abs. max.	—	—	100	97	95
		Abs. min.	—	—	21	28	38
3893 ft. Third terrace	Newcastle	Mean max.	—	—	78·0	78·3	78·1
		Mean min.	—	—	52·4	52·3	52·4
		Abs. max.	—	—	101	100	103
		Abs. min.	—	—	30	26	28
2841 ft. Dry valley type	Weenen	Mean max.	—	—	—	—	83·2
		Mean min.	—	—	—	—	49·2
		Abs. max.	—	—	—	—	107
		Abs. min.	—	—	—	—	25
5686 ft. Mountain type	Qudeni	Mean max.	—	—	—	—	—
		Mean min.	—	—	—	—	—
		Abs. max.	—	—	—	—	—
		Abs. min.	—	—	—	—	—

*Temperatures (1893-1908).*

1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	Ave- rage.
77.4	77.6	79.2	75.3	—	—	—	—	—	77.9	80.1	77.7
59.7	60.2	61.2	—	—	—	—	—	—	55.8	54.3	59
97	92	96	98	—	—	—	—	—	93	102	85.4
41	45	46	49	—	—	—	—	—	41	42	49
81.4	80.4	83.3	80.9	82.4	81.9	82.6	82.1	81.2	80.7	80.5	81.2
59.1	60.0	60.3	59.3	58.8	58.5	58.5	59.7	60.2	60.2	—	65.3
109	102	115	116	110	115	107	111	113	108	114	110
42	44	46	43	45	43	42	40	44	46	40	41
82.4	81.8	83.7	82.1	82.3	82.3	83.4	81.9	84.5	84.3	82.4	83.4
59.8	60.9	61.9	65.5	60.2	60.5	60.9	63.6	60.6	60.9	59.7	60.3
108	101	108	110	111	110	104	102	111	106	114	107
37	41	43	40	44	38	45	49	41	40	40	49
79.5	79.1	82.2	—	83.4	82.6	82.3	81.7	81.4	80.4	83.4	81.5
56.1	59.5	57.9	55.0	55.6	54.8	56.8	61.6	54.3	53.7	53.1	56.2
102	99	102	100	106	106	99	96	102	99	102	101
41	48	42	44	42	41	43	47	44	41	44	43
74.7	73.9	76.4	74.6	75.1	76.8	77.8	77.5	76.7	75.7	75.7	76.1
52.0	52.5	53.6	52.4	51.8	51.2	51.5	53.0	51.2	50.8	51.3	52.2
102	101	99	101	101	102	105	102	100	99	99	102
29	34	35	35	33	33	32	30	28	28	30	32
79.3	78.9	81.6	78.8	79.0	79.6	79.9	78.7	79.3	77.5	78.3	78.6
52.0	53.1	54.4	52.2	52.6	—	52.2	—	52.4	51.3	52.3	52.7
106	107	104	105	106	105	105	105	109	103	102	105
27	31	34	33	33	30	34	33	28	28	29	31
76.9	76.5	81.2	82.5	82.8	—	82.1	—	78.4	78.8	76.8	79.6
55.8	56.6	56.8	55.2	52.5	—	54.4	—	46.9	45	45.8	53.3
97	97	96	96	95	—	96	—	101	109	100	97
34	37	24	26	31	—	35	—	25	24	24	31
76.4	76.2	79.4	76.7	77.3	77.7	77.6	78.0	76.3	75.0	75.7	76.9
47.7	48.7	49.8	48.4	48.4	48.1	47.8	48.1	47.7	47.8	48.2	48.2
102	101	98	100	99	98	102	96	101	105	98	100
21	25	25	25	25	27	24	25	19	22	22	24
79.7	79.0	81.4	77.5	79.1	79.9	78.8	78.8	79.1	78.5	79.5	77.5
47.8	48.6	49.6	47.9	48.1	47.6	—	47.3	—	47.5	47.5	48.9
100	102	100	100	100	101	104	101	109	100	104	101
16	26	28	25	27	26	25	24	23	24	24	25
77.9	—	—	—	80.8	80.2	80.2	—	80.1	78.5	—	79.1
51.8	—	—	52.3	51.3	52.1	49.4	48.3	49.1	50.3	—	51.2
101	—	—	—	105	100	101	105	102	100	—	102
25	—	—	28	32	30	25	24	23	24	—	27
82.8	83.3	85.6	83.3	83.9	—	85.0	—	86.6	84.1	86.1	84.4
48.1	49.9	50.7	49.2	48.9	—	48.4	—	47.5	48.7	48.4	52.9
109	109	105	106	106	105	106	—	109	106	107	107
18	25	25	22	25	23	25	—	21	21	24	23
—	—	—	66.9	67.8	68.3	68.7	68.4	—	—	—	68.6
—	—	—	46.5	46.1	46.2	46.9	46.9	—	—	—	46.5
—	—	—	89	89	87	90	90	—	—	—	89
—	—	—	28	22	27	28	29	—	—	—	27

6. COMPARISON BETWEEN HILL AND VLEI (MARSH).—The following table gives a comparison between the hill station at Cedara and a neighbouring vlei for the year 1905. It will be seen that the maximum temperatures are greater and the minimum temperatures less for the vlei than for the hill. The figures for absolute minima are particularly instructive and show the prevalence of winter frosts in the midland vleis. The rainfall on the hill was greater than on the vlei, the totals for the year being 35·30 inches and 34·05 inches respectively.

TABLE IX.<sup>1</sup>*Cedara Hill.*

Month.	Temperature (Fahr. degrees).				Rainfall (in inches).			
	Means for month.		Max. for month.	Min. for month.	Total for month.	No of Days.	Heaviest fall on one day.	
	Max.	Min.					Fall.	Day.
January . . . . .	—	—	—	—	5·69	13	1·20	8th
February . . . . .	76·2	53·6	93	45	7·49	18	2·18	14th
March . . . . .	74·5	52·7	93	40	2·94	14	·48	2nd
April . . . . .	76·1	52·4	84	47	2·55	11	·82	14th
May . . . . .	70·3	43·6	80	32	5·67	5	5·30	31st
June . . . . .	65·3	38·8	75	28	·16	3	·09	8th
July . . . . .	69·6	40·1	80	30	·14	2	·11	7th
August . . . . .	67·6	40·7	81	32	·52	5	·20	1st
September . . . . .	74·3	47·4	91	35	·84	6	·43	12th
October . . . . .	75·9	51·0	94	40	·68	10	·22	24th
November . . . . .	75·4	53·4	95	42	3·51	14	·80	24th
December . . . . .	81·7	58·2	95	48	4·91	18	·94	14th

<i>Cedara Vlei.</i>								
January . . . . .	83·0	55·1	96	45	5·60	14	1·27	8th
February . . . . .	76·0	55·7	94	43	7·27	19	2·12	14th
March . . . . .	74·4	50·0	90	36	2·99	16	·48	22nd
April . . . . .	76·4	46·5	84	35	2·06	16	·59	19th
May . . . . .	71·9	35·0	81	25	5·72	5	5·30	31st
June . . . . .	65·3	32·6	75	23	·14	3	·08	10th
July . . . . .	69·7	31·3	80	23	·16	2	·11	7th
August . . . . .	67·9	36·6	81	26	·56	6	·20	1st
September . . . . .	75·4	43·2	91	32	·84	7	·43	12th
October . . . . .	77·3	47·4	101	32	·51	8	·20	24th
November . . . . .	—	—	98	38	3·47	14	·85	24th
December . . . . .	—	—	97	48	4·73	16	1·18	14th

<sup>1</sup> Report of the Government Astronomer for Natal, 1905.

## (4) LIGHT.

1. DURATION.—The relative lengths of day and night are as follows for Pietermaritzburg and Durban.

Date.	Place.	Sunrise.	Sunset.	Length of day.
June 25th, 1906 (mid-winter)	Maritzburg	6.54 a.m.	5.7 p.m.	10 hr. 13 min.
	Durban	6.52 „	5.4 „	10 hr. 12 min.
December 24th, 1906 (mid-summer)	Maritzburg	4.58 „	6.58 „	14 hr.
	Durban	4.56 „	6.55 „	13 hr. 59 min.

Darkness falls quickly after sunset, and there is no long twilight as at higher latitudes. Since there is only one minute difference in duration of light between Durban and Maritzburg, it is obvious that the whole of the province of Natal is practically uniform in this respect, and that no differential effect on the vegetation of the various parts is produced.

Owing, however, to the physical configuration of the country—the rapid rise from sea-level to an altitude of over 10,000 feet—plants on the Drakensberg are under conditions as regards light which, in other respects than mere duration, differ widely from those on the coast.

2. INTENSITY.—No figures were available of the relative intensities of light in different places. I can only give rough figures obtained by using a Watkin's actinometer, such as is used in photographic work.

In the brilliant sunshine the sensitive paper darkens so quickly that it was found that at Pietermaritzburg in the month of April (when I began taking observations) at midday the normal tint usually employed could often be obtained in a little over two seconds. To insure as great accuracy as possible it was found necessary to have a series of graded tints, five in number, and in open sunlight to allow the paper to darken to the darkest tint, the time required for this being sixteen times that required for the lightest tint.

The object of the investigation was to discover what fraction of the total sunlight reached plants growing in various places. A few observations were first taken in the open, and the average ascertained. Then, with the smallest possible delay, an observation was taken in the shade. In the latter case usually only one observation was taken as there is less possibility of error, owing to the paper taking longer to darken.

The following are the most important of the general results obtained.

In the scattered type of bush, coast and midland, and in the Yellow Wood bush, which will be described fully in the second part of this paper, there is rarely more than  $\frac{1}{600}$  of the full sunlight which penetrates to the ground at mid-day. In some places we have the full succession of upper canopy, lower canopy, under-shrubs, under-herbs, and great numbers of lianes climbing up over the whole. In other cases the upper canopy alone is so dense that practically nothing grows underneath. This is the case with *Xymalos monospora* for instance. There are all intermediate stages. If the upper canopy is less dense the lower canopy may be more dense, and if both allow a fair amount of light through them there is more rank undergrowth. In the Yellow Wood bush the upper and lower canopies of trees, together with the lianes, absorb most of the light, and there is comparatively little undergrowth.

In the rocky stream bush the amount of light which penetrates is much more variable. In the bed of the stream an average of eight observations in different places gave  $\frac{1}{60}$  as the amount. In other parts as little as  $\frac{1}{600}$  was again recorded. In places there are open gaps, but unless where these are very wide, though apparently the actinometer is exposed to full sunlight, the reading shows that the full amount is not penetrating. This may be due to the mantle of water-vapour that is always present in the bush.

In describing later this kind of bush it will be pointed out that certain species of plants favour the denser shade, while others prefer to have more light.

The observations so far referred to were those taken near mid-day. At that time the full amount of sunlight is so great that though the relative amount of light which penetrates is very small the absolute amount is not so. Earlier in the day the absolute amount is less, but the relative amount is greater. This kind of bush always grows on the south-eastern slopes, and the slanting rays of the rising sun are better able to penetrate underneath the canopy. This is most marked near the edge of the bush, and is also more the case in the less dense rocky stream bush than in the closer types.

In the Thorn Veld the trees usually grow isolated, and only occasionally form clumps. The intensely xerophytic species of *Acacia* give but little shade. The typical form is the flat-crowned umbrella-shape, and the light penetrating through the branches gives a variegated shadow-pattern on the ground. It is difficult, therefore, to measure the total amount penetrating. As the result of several observations taken under a large specimen of *Acacia arabica* var. *kranssiana*, I came to the conclusion that at mid-day about  $\frac{1}{6}$  of the full sunlight passed through. But the amount is exceedingly variable, and for a large part of the day the plants growing around the base of the trees in the Thorn Veld are exposed to full sunlight.

Among the tall grasses of the veld the varying intensity of light is of great importance, especially with reference to the associated plants.

It is the custom to burn the grass regularly once a year, and I have classified the associated plants into :

(1) those that flower immediately after the burning of the grass;

(2) those that flower after the first rains and before the grass grows tall enough to shade them;

(3) those that grow with the grass, and flower late.

The first two classes flower while they are obtaining the full amount of sunlight, and perform their vegetative work afterwards. The third class consists of taller species that grow as high or higher than the grasses. It will be seen,

therefore, that during spring such plants receive full light, and as the grass grows they become more and more shaded.

My observations were taken when the grass was full-grown. In the commonest of the veld grass-associations, *Anthistiria imberbis* with *Andropogon ceresiæformis*, on an average  $\frac{1}{30}$  of the full sunlight reached the leaves of species of *Helichrysum* growing prostrate on the ground. Among the still taller grasses, *Andropogon nardus* and *Andropogon filipendulus*, only  $\frac{1}{50}$  reached the leaves of *Eucomis undulata*.

Again, in a vlei (marsh) with *Phragmites communis*, *Cyperus latifolius*, and *Erianthus capensis*, where the last-named was growing to a height of 10 ft., only  $\frac{1}{150}$  of the total sunlight reached the leaves of *Commelina gerrardi*, though the latter was straggling up through the grasses.

### (5) MOVEMENTS OF THE AIR.

As far as winds are concerned the following is the succession of events throughout the year.

It has been already pointed out that the south-east winds during summer bring the rain-clouds in from the sea. While these rain-bearing south-east winds prevail the anticyclonic area is far out from the coast. The air coming from it has traversed a wide stretch of sea before it reaches the land, and consequently it arrives saturated with water vapour. During the whole summer, while the sun is south of the equator, the land plateau of the interior is being heated, and the hot air rising, the cooler air flows in from the sea to take its place. It deposits its moisture as it passes over Natal in the way already described.

As winter advances the anticyclone approaches near to the land, and winds coming from the former, having traversed only a short distance of sea, arrive without much moisture. Owing to exceptional cross-currents, however, Port Durnford, in Zululand, as has been shown, gets a good deal of rain during

winter. June and July are months when winds are infrequent, and this fact also has an important effect, for with a still atmosphere the cold air at night sinks into the valleys, and we get the cold mists and valley frosts already described.

At the end of winter hot dry winds from the north-west occur. These usually blow for two or three days in succession. The temperature in the shade goes up to over 90° F. and a fine dust is carried along. All vegetation exposed to the full effect of such a wind becomes scorched and withered. It sweeps down the valleys in full force and the northern slopes are fully exposed to it. These winds are undoubtedly of the utmost importance in determining the distribution of the two types of woodland, the isolated umbrella-shaped and extremely xerophytic thorn trees on the one hand, and the close type of bush on the other.

While hot winds are most frequent from August to November they occur occasionally at other times of the year. Dr. Mann, in his 'Guide to Natal,' gives the result of observations at Pietermaritzburg extending over eight years. The average annual number of such hot winds was twenty-six, distributed as follows: January, 1.5; February, 1.2; March, .7; April, .9; May, 1.2; June, .9; July, 2.4; August, 3.2; September, 5.1; October, 4.2; November, 3.0; December, 1.7.

Dr. Mann has not attempted to define exactly what he considered a hot wind, and the figures may be somewhat misleading. It is from August to November that the hot winds are most severe and of longest duration.

During these months there is a fairly regular succession of events as follows: two or three days of hot dry wind from the north, then cooler air from the sea bringing rain for a day or two, then an interval of cool delightful weather, followed by the same cycle over again.

I give the detailed meteorological data for Pietermaritzburg during such a hot wind beginning on August 19th, 1911.

Date.	Barometer.	Rainfall in inches.	Temperature.	
			Day (maximum in shade).	Night (minimum).
August 19th	28.00	—	78° F.	52° F.
.. 20th	27.15	—	88° ..	50° ..
.. 21st	27.16	—	92° ..	51° ..
.. 22nd	27.16	—	95° ..	59° ..
.. 23rd	27.15	—	75° ..	58° ..
.. 24th	27.15	—	74° ..	55° ..
.. 25th	27.18	.22	56° ..	42° ..
.. 26th	2.80	1.18	52° ..	44° ..
.. 27th	28.1	.43	62° ..	34° ..
.. 28th	27.6	—	75° ..	38° ..
.. 29th	28.2	--	78° ..	51° ..

For the week preceding the 19th, the maximum and minimum temperatures varied only a few degrees, the maximum keeping between 70° and 80°. On the 20th when the hot wind began the temperature went up to 88°, and it rose still higher, to 92° and 95° F., on the two following days. Then the hot north wind ceased and it was succeeded by a south-easterly breeze bringing clouds. Rain fell on the 25th, 26th and 27th, and it ended in a fall of snow, which covered the hills surrounding Pietermaritzburg and lay there for a couple of days. Although the temperature always falls, it is quite exceptional to have a fall of snow. On the 29th the conditions had returned to what they were up to the 19th. During the time of the disturbance, and for a few days before, the barometer showed constant variations, rising and falling about an inch.

I will give another good example of this kind of disturbance. The maximum shade temperatures for Pietermaritzburg were: on September 25th 80°, on the 26th 86°, on the 27th 100°, on the 28th 76°, on the 29th 69°, on the 30th 64°, on October 1st 75°. Rain began on September 29th and continued until October 2nd. At Pietermaritzburg 5.99 in. were recorded, but this was very much below the average for Natal. Durban had 15.66 in., at the Cornubia Estate

25.62 in. were recorded, and at Verulam a record amount of 28 in. in thirty-three hours fell. Snow fell on the Drakensberg and over the border in the Transvaal. Extensive flooding with much resulting destruction, particularly in the coast districts, was recorded.

Hot winds in some cases appear to originate in a different manner and to be somewhat local, although usually they affect the greater part of Natal. I shall not attempt to enter fully into the causes that are at work. They are similar in some respects to the Foehn winds as described in the Rocky Mountains by Prof. Davis.<sup>1</sup> The air at the lower level flows out to supply an area of less pressure somewhere else, and the air from above descends. Being warmed by compression as it descends, it becomes a hot, dry wind. After a time it rises again, and cooler moister air comes in, and then the conditions return to what they were before the disturbance began.

#### (6) FIRE.

This is a factor that is undoubtedly of great importance in determining the distribution of woodland and grassland, as well as affecting the character of both.

Over practically the whole of Natal it is usual to burn the grass once a year. The chief effects will be fully discussed in connection with the separate plant formations.

Fires appear never to originate in the bush except through deliberate intention. It must, however, be pointed out in this place that the grass fires affect the bush by gradually eating into the margins.

#### (7) ANIMALS.

1. TERMITES.—The termites or white ants have an important effect both on soil and on vegetation directly. The commonest

<sup>1</sup> Davis, 'Report on the Forest Conditions of the Rocky Mountains,' Washington, 1889.

species found in Natal are *Termes trinervius Rambur*, *Termes latericius Haviland*, and *Termes natalensis Haviland*. They form nests varying in form and position according to the species. Their nests agree in having the outer parts carefully closed so as to exclude their enemies the true ants. Mounds a foot or two in height and several yards in circumference are common dotted all over the veld. A system of subterranean tunnels often extends over wide areas. I am informed by Dr. Warren that the species *Hodotermes havilandi Sharp* is abundant in parts of Zululand, forming such underground tunnels. The white ants are thus constantly excavating the soil, and bringing earth to the surface. In their nests the earth pellets are cemented together. The natives use the soil obtained from termite nests to form the floors of their huts. Further, the termites carry up considerable quantities of soil over dead and living tree-trunks, forming covered-in passages under which they work on the wood in the dark. This soil is ultimately washed down by the heavy rains. The general effect of the white ant on the soil and the enormous amount of transporting that is done by it can only fully be realised by those who have seen the results of its activity.

Great, however, as their effect on the soil is, it is more than equalled by their direct effect on the vegetation.

They act as the scavengers of the forest. Dead trees and other plants are rapidly demolished. Nests of *Termes trinervius* seem always to contain great quantities of little pieces of grass stems. The vegetation, generally in the form of wood, which is thus chewed up by the white ants, is used largely for forming fungus-gardens, and there is room for a great deal of investigation on this most interesting subject. As a result of the activities of the white ant the bush presents a remarkably clean appearance and there are few dead tree trunks to be seen. Dead leaves, however, do accumulate and remain undecomposed for a long time. Termites prefer wood, and leaves are left alone. The ordinary processes of decay, as brought about by bacteria, are not particularly

rapid. The bacteriology of the soil is a subject that would repay attention.

Though the white ant prefers dead wood it also attacks living trees, cutting the bark below the surface of the soil, and ultimately killing them.

2. LOCUSTS.—During the last few years systematic poisoning by means of arsenic solutions, petroleum, and infecting with a parasitic fungus has led to a considerable diminution in this pest; but formerly locust swarms wrought considerable destruction. A large swarm of locusts forming a dense cloud, say, a mile long and half a mile wide, would destroy practically all the foliage in the track which it traversed. Mr. Sim, however, informs me that he has noticed cases where only certain plants were eaten, while the others were untouched.

3. CATERPILLARS.—There are, of course, numerous insect pests which cannot be mentioned here. It may, however, be noted that the larva of a Psychid moth (*Animula* sp.), known as the bag-worm, which is really a thorn-tree insect, sometimes causes considerable damage to wattle plantations owing to its excessive abundance. The caterpillar of the Saturnid moth (*Nudaurelia belina* *Westw.*) in certain seasons is very plentiful, and strips the foliage of trees, especially that of the oak. The larva of the so-called Procession moth (*Anaphe panda*), which forms a rounded colonial cocoon some 6-7 in. in diameter, may be very numerous and destructive.

4. EARTHWORMS.—A large species of earthworm, which grows to the length of a yard, carries up much soil from the subsoil, and forms large castings which sometimes accumulate in great quantities. In some places many tons of soil per acre are thus brought to the surface in a single season. Where it occurs the effect is most striking; but the worm is local and does not seem to be at all generally distributed through Natal. Where it is found the soil is usually of the loose type. Another species of earthworm lives in the vleis, and it is said to produce those curious humps

and hollows known as "kommetjes" by the Dutch farmer. Such kommetjes almost always overlie ferruginous gravel.

5. MAMMALS.—Among the mammals the rodents produce the chief effect on vegetation. The Cape Gerbille, *Gerbillus afer Gray*, is sometimes exceedingly common, and a portion of veld may be riddled with the burrows. The food consists of bulbs and seeds. The common rat appears to be a brown variety of the black rat, *Mus rattus Lin.*, and it does considerable damage in consuming large quantities of grain. The mole rat, *Georchus hottentotus (Lesson)*, is common; it burrows like a sand-mole, throwing up heaps of mould at intervals. Bulbs and tubers constitute the chief food; the Cape species is said to remove the "eyes" of potatoes and the central bud of bulbs to prevent sprouting. The springhaas, *Pedetes caffer (Pallas)*, occurs plentifully in the northern portions of Natal. It forms extensive deep burrows and feeds on roots and also green vegetation, and may be destructive to crops. The cane rat, *Thryonomys swinderianus (Temm)*, is common in certain districts, especially in the sugar-fields. It consumes large quantities of roots and young green shoots, and is especially fond of sugar-cane. The porcupine, *Hystrix africae-australis Peters*, devours great quantities of potatoes, maize, pumpkins, etc.

The aard-vark or ant bear, *Orycteropus afer (Pallas)*, which feeds on termites, may be mentioned here on account of the large burrows which it forms in the veld. In disused burrows characteristic clusters of ferns (*Nephrodium athamanticum*), and possibly other plants, very frequently grow, these being absent from the general veld.

6. MAN.—Perhaps it may be permissible to mention here the destructive native. It is chiefly the bush that suffers. In building his huts he forms a frame-work of young trees. He shows the most marked preference for all the more valuable kinds. An enormous amount of valuable timber is thus destroyed. Further, it has been the custom in the past for the native to burn down parts of the bush and to grow mealies in the clearing. Though the soil of the bush is not in

itself a rich one, yet the ashes from the burning of the timber enriches it for a time. After a few mealie crops have been raised the soil becomes impoverished, and the native moves on to another patch and repeats the performance. This has led to the total destruction of large areas of woodland. Finally, a good deal of bush timber is used by the native as firewood.

## II. THE PLANT FORMATIONS AND ASSOCIATIONS.

### SHORE VEGETATION.

Practically the whole coast of Natal, with the exception of the river estuaries, is lined by Psammophilous Bush, which occupies the relatively stable substratum of the fixed sand-dunes. Between this and the sea there is a belt of shifting sand, usually less than a hundred yards in width.

#### (I) HALOPHILOUS ASSOCIATIONS.

The more conspicuous of the plant associations found on the unstable belt of sand next the sea are the following:

1. *SCÆVOLA-CYPERUS* ASSOCIATION.—*Scævola lobelia* is a plant with thick fleshy leaves and long creeping rhizomes. It is frequently associated with a tuberous stoloniferous species of *Cyperus*—*Cyperus natalensis* (the leafy form). These plants grow through the sand, and only the leaf-bearing shoots appear above it. The leaves of *Scævola* often stand high up, but again they may be covered by the drifting sand. The *Cyperus* travels for long distances through the sand, and is of considerable importance in helping to fix the dune.

2. *PES-CAPRÆ* ASSOCIATION.—This is the name given by Schimper to the association in which *Ipomœa pes-capræ* (*I. biloba*) is the dominant plant. It is found usually somewhat higher up and often behind the *Scævola* associa-

tion. Where the sand has been partially fixed by the latter, or where it is harder packed and not shifting, the *Ipomæa* creeps over it rather than through it. But it frequently also becomes buried, as is shown in Plate XIV, fig. 1. In this association a grass commonly occurs, but I have not been able to obtain it in flower.

3. MESEMBRYANTHEMUM ASSOCIATION.—*Mesembryanthemum* sp. (edule?) often covers the sand completely and grows rather over it than through it. It forms a dense green succulent covering just below the bush. Sometimes it is more straggling, and is found mixed with the *Ipomæa*.

Near the upper limits of these associations where they grade into the coast bush the following plants are found<sup>1</sup>:

*Gazania uniflora*, *Cynanchium obtusifolium*, *C. natalitium*, *Brachylæna discolor*, *Cryptostemma niveum*, *Passerina ericoides*, *Samolus porosus*, *Osteospermum moniliferum*, *Helichrysum teretifolium*, *Tephrosia canescens*, *Hydrophylax carnosa*.

In certain places, as at Isipingo and Park Rynie, the belt of shifting sand nearest to the sea is interrupted by rocks. These rocks are surrounded and sometimes half-covered by the sand, and they have the sand-dune bush behind them. There are no stretches of beach gravel. On the rocks at Isipingo the following plants are found:

*Gazania uniflora*, *Dimorphotheca fruticosa*, *Salicornia herbacea*, *Passerina* sp., *Helichrysum teretifolium*, *Carissa grandiflora*.

## (2) PSAMMOPHILOUS BUSH FORMATION.

Here the sand-dunes have become entirely fixed, and remain so unless the bush is interfered with and destroyed. The height of the dunes themselves is from 50 to 200 feet.

<sup>1</sup> In this and subsequent lists the commoner or more characteristic plants are mentioned first, and quite roughly the names tend to be arranged in order of priority with regard to dominance.

The vegetation clothing them rises almost from sea-level to a height of 20 to 25 feet above ground on the tops of the dunes. Further, though the surface of the dunes may be irregular and hummocky, the trees rise more or less to the same level, so that viewed from the sea-shore side the bush presents a singularly regular and even appearance.

On the side next the sea there is a certain admixture of the plants named as occurring among the *Pes-Caprae* and *Mesembryanthemum* associations. The *Mesembryanthemum* itself may often be found straggling up into the bush. The following plants, together with the list already given, may be taken as characteristic of the sea-side marginal belt of the bush :

*Canavalia bonariensis*, *Mimusops caffra*, *Eugenia capensis*, *Cassine albanensis*, *Cynanchium crassifolium*, *C. capense*, *Celastrus procumbens*, *C. angularis*, *Carissa grandiflora*, *Chironia baccifera*, *Aloe supra-lævis*, *Rhus* spp., *Passerina* spp.

The bush itself, as mentioned above, consists of trees that all grow more or less to the same height; there is no second canopy or undershrubs, and very little undergrowth of any kind. There is, however, an enormous variety of lianes, as shown by the list given. A certain amount of humus gathers round the roots of the trees, and forms a layer of sandy turf about six inches in depth. Below this is the dune sand. Its nature has already been described. The roots of the trees descend to great depths, and the whole root-system is extensively developed. This is well seen in places where, as sometimes happens, the sea has eaten into the bush dunes. Then the root-system is exposed, and is seen to descend 20 feet or more. Above ground the vegetation is of the usual halophytic character, and the fleshy type of leaf is common. The loose character of the sand gives thorough aëration, and consequently the roots of the trees are able to penetrate to such great depths. This is necessary to procure proper fixation. The sand is, as a rule, not very dry, since it is kept moist by the frequent precipitation.

The following are the most important trees composing the sand-dune bush:

*Mimusops caffra*, *Scolopia zeyheri*, *Apodytes dimidiata*, *Kraussia lanceolata*, *Erythrina caffra*, *Brachylaena elliptica*, *Dovyalis rotundifolia*, *Elæodendron capense*, *Rhus* (several species), *Passerina* spp., *Pterocelastrus variabilis*, and in places *Strelitzia angusta*, *Aloe supra-lævis*, and *Strychnos spinosa*.

Associated with these, but of less importance, are: *Schmidelia erosa*, *Tarchonanthus camphora*, *Euclea natalensis*, *Sapindus oblongifolius*, *Eugenia capensis*, *Scutia commersonii*, *Clerodendron glabrum*, *Celastrus buxifolius*, *Vitis cuneifolia*, *Maba natalensis*, *Celastrus maritima*, *Myrsine melanophleos*, *Grewia caffra*.

Of the lianes the following are the most common: *Vitis capensis*, *Entada natalensis*, *Acacia natalensis*, *Rubus pinnatus*, *Dregea floribunda*, *Cnestis natalensis*, *Helinus ovata*, *Cassine albanensis*, *Senecio* spp., and *Mikania capensis*.

Less abundant among the lianes are: *Scutia commersonii*, *Flagellaria guiniensis*, *Grewia lasiocarpa*, *Cynanchium crassifolium* and *C. obtusifolium*, *Popowia caffra*, *Cissampelos* spp., *Capparis* spp., *Oncinotis inandensis*, *Jasminum multipartitum*.

Apart from these numerous lianes this dune bush is singularly bare of undergrowth. One fern, *Polypodium phymatodes*, is common in places, though it, too, climbs up along the tree-trunks. *Dracæna hookeriana*, and a few grasses are found, and in moister spots *Hæmanthus albomaculatus*.

Treating this type of bush as a whole, *Mimusops caffra* may be named as the dominant tree. Where *Strelitzia angusta* does occur it is frequently dominant. At Winkle Spruit, for instance, there is a *Strelitzia-Osteospermum* association, which forms the bush. In this place also the palm, *Hyphæne crinita*, is found in the more open glades.

The sand-dune bush forms a fringing belt from a quarter to half a mile in width along practically the whole coast-line of Natal. At Port Durnford, Zululand, it begins to extend further inland till at Cape St. Lucia and northwards it reaches forty to fifty miles from the sea. Here, however, its character changes somewhat, new species coming in, such as *Landolphas*, and *Acacia* spp.

This is the Littoral Psammophilous Bush as named by Warming, and, as he points out with regard to similar bush in other parts of the world, it is difficult to say whether its xerophytic character is due mainly to the qualities of a sandy soil, or to its salinity, and to the proximity to the sea. In seeking an answer to the question, it should be borne in mind that the soil is kept moist by frequent precipitation, and also by soakage from behind, and the water is not salt.

### (3) LAGOON TYPE—MANGROVE FORMATION.

The sand-dune bush is interrupted at the river estuaries. A very good example of the lagoon type of vegetation is seen in Durban Bay, into which the Umbilo and Umhlatusan empty their waters. Mud is deposited over the lagoon, and a swamp is the result, with the water salt or brackish. In this place we get a Mangrove vegetation, which is an interesting outlier of the Eastern Mangrove Flora. It is not very rich in species, consisting only of *Avicennia officinalis*, *Rhizophora unceronata*, and *Bruguiera gymnorhiza* (Pl. XIV, fig. 2).

A *Salicornia*-*Chenolea* association occurs on the mud-flats. It consists of *Salicornia herbacea* and *Chenolea diffusa*. The *Salicornia* grows further out, and it is soon followed by the *Chenolea*, and the two together form dense clumps, which extend in among the Mangrove trees. The breathing roots of the latter often stand up through the *Salicornia* and *Chenolea* (Pl. XIV,

fig. 2). *Triglochin* sp., *Eriocaulon* sp., and *Aerostichum aureum* are also associated.

#### (4) BARRINGTONIA ASSOCIATION.

Just above the lagoons, but in wet ground, which, however, is more sandy in its nature and not brackish, we get a *Barringtonia* association. It is found also at the mouths of rivers which do not form mud swamps, e. g. the Umgeni and Umzinto.

The following are the species composing it:

*Barringtonia racemosa*, *Hibiscus tiliaceus*, *Voa canga thouarsii*, *Eugenia cordata*, and a purple climbing species of *Ipomæa*.

#### INLAND VEGETATION.

Eastern South Africa as a whole belongs to the region of ever-green dicotylous forest and grassland, and it differs from the region of sclerophyllous woodland (Schimper) in having a summer rainfall and dry winters. Parts of Natal—the lower valley levels—are, however, much drier, and the combination of various factors, such as less rainfall, exposure to hot winds and soil conditions, brings about in these places an extremely xerophytic type of vegetation made up of various thorn trees, *Euphorbias*, etc.

#### BUSH.

In the coast belt behind the sand-dunes much of the bush has been cut down to make way for tea and sugar plantations, but the composition of the type is given below:

## (5) SCATTERED BUSH TOWARDS THE COAST.

Dominant and sub-dominant.	Associated.
1. UPPER CANOPY—	
<i>Albizzia fastigiata.</i>	<i>Ficus natalensis.</i>
<i>Rhus longifolia.</i>	<i>Ficus capensis.</i>
<i>Scelerocarya caffra.</i>	<i>Strychnos gerrardii.</i>
<i>Cussonia umbellata.</i>	<i>Erythrina caffra.</i>
<i>Trichilia emetica.</i>	<i>Cassipourea verticillata.</i>
<i>Eugenia cordata</i> (in wet places).	<i>Voacanga thouarsii</i> (in wet places).
2. LOWER CANOPY—	
<i>Schmidelia monophylla.</i>	<i>Calodendron capense.</i>
<i>Clansena inæqualis.</i>	<i>Bridelia micrantha.</i>
<i>Chætachme aristata.</i>	<i>Baphia racemosa.</i>
<i>Elæodendron capense.</i>	<i>Antidesma venosum.</i>
	<i>Trimeria alnifolia.</i>
	<i>Excœcaria reticulata.</i>
	<i>Clerodendron glabrum.</i>
3. UNDERSHRUBS—	
<i>Grewia occidentalis.</i>	<i>Peddiea africana.</i>
<i>Ochna atropurpurea.</i>	<i>Oncoba kraussiana.</i>
<i>Randia rudis.</i>	<i>Kraussia lanceolata.</i>
<i>Dombeya</i> spp.	<i>Burchellia capensis.</i>
	<i>Plectronia spinosa.</i>
4. UNDER-HERBS—	
<i>Cluytia pulchella.</i>	<i>Hibiscus pedunculatus.</i>
<i>Plectranthus</i> spp.	<i>Peristrophe natalensis.</i>
<i>Adenocline</i> sp.	<i>Justicia</i> spp.
	<i>Potamophila prehensilis</i> and several other grasses.
5. LIANES—	
<i>Vitis capensis.</i>	<i>Entada natalensis.</i>
<i>Dalbergia obovata.</i>	<i>Acacia natalensis.</i>
<i>Senecio</i> spp.	<i>Flagellaria guiniensis.</i>

Dominant and sub-dominant.	Associated.
6. MARGINAL BELT—	
<i>Cluytia pulchella</i> .	<i>Berkheya</i> spp.
<i>Randia radis</i> .	<i>Vitis cuneata</i> .
<i>Celastrus buxifolius</i> .	<i>Erianthus capensis</i> .
<i>Rubus pinnatus</i> .	<i>Andropogon nardus</i> .
	<i>Andropogon filipendulus</i> .
	<i>Pellæa hastata</i> .
	<i>Strelitzia augusta</i> (local).

This type of bush extends up to the edge of the first terrace, *i. e.* to about 1500 feet. It grows on the south-eastern slopes, facing the rain clouds, and sheltered from the dry hot winds. Most of the species composing it extend through Tropical East Africa. The trees possess a notably thick bark. *Albizzia fastigiata* and *Rhus longifolia* are the two dominant trees. *Albizzia* has the umbrella-form, a clear bole and a widely expanded flat crown, a form which is characteristic of the trees composing the drier Thorn Savannah. *Sclerocarya* is also often flat-topped, but *Rhus longifolia* and the others, both sub-dominant and associated, are more rounded in form.

In the Midland similarly situated we have the—

#### (6) SCATTERED MIDLAND BUSH

of the following composition :

Dominant and sub-dominant.	Associated.
1. UPPER CANOPY—	
<i>Combretum kraussii</i> .	<i>Pygæum africanum</i> .
<i>Calodendron capense</i> .	<i>Ficus natalensis</i> .
<i>Xymalos monospora</i> (in wet places).	<i>Celtis kraussiana</i> .
	<i>Rhus longifolia</i> .
	<i>Podocarpus thunbergii</i> .

Dominant and sub-dominant.	Associated.
2. LOWER CANOPY—	
<i>Toddalia lanceolata</i> .	<i>Burchellia capensis</i> .
<i>Halleria elliptica</i> .	<i>Gardenia rothmannii</i> .
<i>Grewia occidentalis</i> .	<i>Gardenia neuberia</i> .
<i>Schmidelia monophylla</i> .	<i>Trimeria alnifolia</i> .
<i>Clausena inequalis</i> .	<i>Zizyphus mucronata</i> .
<i>Rhamnus prinoides</i> .	<i>Rhus</i> spp.
3. UNDERSHRUBS—	
<i>Cluytia pulchella</i> .	<i>Calpurnia lasiogyne</i> .
<i>Cassinopsis capensis</i> .	<i>Ehretia hottentotica</i> .
<i>Celastrus buxifolius</i> .	<i>Peddiea africana</i> .
4. UNDER-HERBS—	
<i>Echinospermum</i> sp.	<i>Pteris flabellata</i> .
<i>Thunbergia natalensis</i> .	<i>Hypolepis anthrxi-</i> <i>folia</i> .
<i>Peristrophe natalensis</i> .	<i>Asplenium erectum</i> .
5. LIANES—	
<i>Vitis capensis</i> .	<i>Dalbergia obovata</i> .
<i>Scutia commersonii</i> .	<i>Vitis cirrhosa</i> .
<i>Senecio</i> spp.	<i>Asparagus plumosus</i> .
6. MARGINAL BELT—	
<i>Rhamnus prinoides</i> .	<i>Andropogon</i> spp.
<i>Burchellia capensis</i> .	<i>Erianthus capensis</i> .
<i>Trimeria alnifolia</i> .	<i>Berkheya</i> spp.
<i>Celastrus buxifolius</i> .	<i>Mohria caffrorum</i> .
<i>Cluytia pulchella</i> .	<i>Pteris aquilina</i> .

This Midland bush does not differ very markedly in its ecological character from the bush nearer the coast. As will be seen by comparing the lists, several of the species are common to both. The Midland bush also occurs on the south-eastern slopes, and receives the highest amount of rainfall in the region.

*Calodendron capense*, one of the dominant trees, is deciduous, and so is *Celtis kraussiana*, which is associated. It must be remembered that though the bush is at an altitude where winter frosts occur, yet these are most severe in



the valleys, and rarely, if ever, occur within the bush, which always grows on the slopes.

The Midland Scattered Bush extends from 2000 up to 4000 feet, i. e. into the region where the larger Yellow Wood forest is found. It will be seen from the list that the Yellow Wood (*Podocarpus*) occurs sometimes, but it is never a dominant tree. It may generally be described as *Combretum* bush—*Combretum kraussii* being most abundant. Most of the species extend into Tropical East Africa. *Calodendron capense* is an exception, however, and of the others, *Pygæum africanum*, *Celtis kraussiana* and *Podocarpus thunbergii* are mountain species in the tropics. If we compare the midland with the coast type of bush the latter is nearer the Tropical East African forest than the former. *Rhus longifolia*, which is dominant in the coast bush and associated in the midland bush, is a species which is found everywhere abundantly in the tropics.

We next come to the—

#### (7) YELLOW WOOD BUSH

which forms the larger forest areas of Natal. It is made up of the following:

Dominant and sub-dominant.	Associated.
1. UPPER CANOPY—	
<i>Podocarpus elongata</i> .	<i>Celtis kraussiana</i> .
<i>Podocarpus thunbergii</i> .	<i>Combretum kraussii</i> .
<i>Olea lanrifolia</i> .	<i>Curtisia faginea</i> .
	<i>Myrsine melanophleos</i> .
	<i>Olea faveolata</i> .
	<i>Xymalos monospora</i> .
2. LOWER CANOPY—	
<i>Myrsine melanophleos</i> .	<i>Rhus longifolia</i> .
<i>Rhus lævigata</i> .	<i>Elæodendron croceum</i> .
<i>Kiggelaria dregeana</i> .	<i>Apodytes dimidiata</i> .
	<i>Xanthoxylon capense</i> .
	<i>Toddalia lanceolata</i> .
	<i>Celtis kraussiana</i> .

Dominant and sub-dominant.	Associated.
3. UNDERSHRUBS—	
<i>Grewia occidentalis</i> .	<i>Halleria elliptica</i> .
<i>Rinorea ardisiæflora</i> .	<i>Brachylæna elliptica</i> .
<i>Trimeria alnifolia</i> .	<i>Royena lucida</i> .
<i>Peddiea africana</i> .	<i>Eugenia zeyheri</i> .
	<i>Buddleia salviæfolia</i> .
	<i>Ehretia hottentotica</i> .
4. UNDER-HERBS—	
<i>Plectranthus</i> spp.	<i>Excœcaria caffra</i> .
<i>Justicia</i> spp.	<i>Panicum</i> sp.
<i>Pteris flabellata</i> .	<i>Pteris quadriaurita</i> .
	<i>Asplenium erectum</i> .
5. LIANES—	
<i>Vitis capensis</i> .	<i>Asparagus plumosus</i> .
<i>Dalbergia obovata</i> .	<i>Sentia commersonii</i> .
<i>Senecio macroglossis</i> .	<i>Cnestis</i> sp.
6. MARGINAL BELT—	
<i>Rhus</i> spp.	<i>Sparmannia palmata</i> .
<i>Heteromorpha arbo-</i> <i>rescens</i> .	<i>Cluytia pulchella</i> .
<i>Rhamnus prinoides</i> .	<i>Celastrus angularis</i> .

The Yellow Wood bush is similar in many respects to the scattered Midland bush, but it covers larger areas. Many of the species are the same, occurring, however, in different proportions. It is interesting to note that *Celtis kraussiana*, *Apodytes dimidiata*, *Xanthoxylon capense*, *Toddalia lanceolata*, and *Curtisia faginea*, are found in the western Cape forests.

The Yellow Wood bush is found at altitudes of 3000 ft. and upwards; again, in the places where there is heaviest deposition of rain and mist—on the south-eastern slopes. There are isolated patches of it nearer the coast, e. g. at Albert Park, Durban, and at Umhlatusi. Mr. Sim informs me that the same distribution obtains in Pondoland, namely at high altitudes and in isolated patches near the coast.

Again, we have a slight tendency towards becoming deciduous. *Celtis kraussiana* is quite so, and *Grewia occidentalis* and *Rhus lævigata* almost so. *Rhus lævigata* in autumn assumes the fall colours, but the leaves remain on until the new ones appear in spring. As compared with the bush nearer the coast there is less luxuriant under-growth. There are not very many soft under-herbs.

#### COMPARISON OF COAST, MIDLAND, AND YELLOW WOOD BUSH.

Comparing now the bush from the coast upwards we may note the following facts. The coast bush is closely allied to the Tropical East African forest. As we pass up through the Midlands, with rising altitude, the conditions become less tropical. Though the majority of the trees still extend through the tropics of East Africa, there are exceptions, and many of them that do so extend are confined to the higher altitudes of the tropics. Though there are such points of difference between these three types, and though floristically, as is shown by the lists, the difference is considerable, yet œcologically they can be grouped together as a formation. The majority of the trees flower in spring at the end of the dry season. A few flower in summer, and some are irregular in their time of flowering, e.g. *Xymalos monospora* and *Apodytes dimidiata*.

EPIPHYTES.—These are not very abundant, but the following occur. Among the orchids the various species belonging to the genera *Polystachya*, *Angræcum*, and *Mystacidium*; among ferns *Acrostichum tenuifolium*, *Polypodium africanum*, *P. incanum*, *P. lanceolatum*, *P. lycopodioides*, *Gymnogramme lanceolata*; the filmy ferns *Hymenophyllum* and *Trichomanes*, various species; *Lycopodium saururns*, *L. verticillatum*, *L. gnidioides*; *Psilotum triquetrum*; *Peperomia caffra* and *Peperomia* sp.; *Rhipsalis cassytha*, *Ficus natalensis*; *Dermatobotrys saundersii*; among mosses species of *Hypnum*, *Orthotrichum*, *Leskia*; leafy

hepatics, such as *Jungermannia* spp., and *Lejeunia* spp., and numerous lichens.

These epiphytes are found chiefly in the moister parts, often preferring plenty of sunshine when obtainable.

**HETEROPHYTES.**—There are *Cassytha capensis*, which is holoparasitic, and *Loranthus* (five species) and *Viscum* (eight species), hemiparasitic. Root-parasites are mostly veld-plants, and will be described later. The following are saprophytic orchids: *Liparis bowkeri*, *Calanthe natalensis*, *Stenoglottis fimbriata*. Saprophytic fungi are abundant, but parasitic fungi are fewer.

**CAULIFLORY** (Stem-flowering) is seen in *Ficus capensis*, *Halleria lucida*, and *Rawsonia lucida*.

**LIANES.**—These are very abundant. The most important and characteristic ones for each of the three types of bush are given in the detailed lists. Among them all there are, as far as I know, no root-climbers. They are mostly of a pliant ropy type, or thick and woody. Watch-spring tendrils are common. Many are almost, if not entirely devoid of leaves till they reach the light. Of *Ipomœa* there are twenty-five species found in Natal, most of them climbers. The Leguminosæ are well represented by the genera *Canavallia*, *Vigna*, *Phaseolus*, *Glycine*, *Dolichos* and several species of *Dalbergia*. The genus *Vitis* is another large one (seventeen species), mostly climbers. Among the *Asclepiadaceæ* there are the genera *Vincetoxicum*, *Riocreuxia* and *Dregia*; among the *Compositæ*, *Senecio*, *Mikania* and *Vernonia*, which contain climbers. There are many climbing species of *Asparagus*. *Cucurbitaceæ* are fairly well represented, and among *Passifloreæ* there are *Ophio-caulon gummifera*, *Modecca digitata* and *Ceratio-sicyos ecklonii*. Other genera are *Smilax*, *Combretum*, *Secamone*, *Cissampelos*, *Popowia*, *Acridocarpus*, *Helinus*, *Cardiospermum*, *Cnestis*, *Rubus*, *Plectronia*, *Solanum*, *Jasminum*, *Strophanthus*, *Oncinotis*, *Delechampia*, *Thunbergia*. Many of these are confined to the coast districts.

I have noted a few out of the many plants found in the marginal belt of these bushes and forests. Some are shrubs and small trees, and belong to the woodland proper, preferring the edge of it, where they get more light. Mixed with them is a great variety of herbaceous plants and ferns. A great number of the associated veld plants, particularly the taller and later flowering species, take refuge from the ever-recurring grass fires, and flourish in the moister surrounding belt of the bush. Species of *Senecio*, *Helichrysum* and *Berkheya*, *Polygala virgata*, *Artemisia afra*, *Leonotis leonurus*, *Nidorella* spp., *Plectranthus* spp. are very common. The bracken fern is often the dominant plant of the zone. The taller grasses are also characteristic of it, e. g. *Andropogon nardus* var. *marginatus*, *Andropogon filipendulus*, *Arundinella ecklonii*, *Erianthus capensis*. Growing among the taller herbs there is an endless variety of smaller forms, which during the summer enjoy plenty of deposition of moisture, and are shaded fully by the other plants among which they grow.

During some years the burning of the outside veld grasses may be accomplished without interfering with the moist marginal belt. But if it should happen that a strong wind is blowing at the time, the fire will sweep through and scorch the trees growing on the outside of the bush. Next year the trees are dry and semi-withered, and the branches are carried off by the natives for firewood. Thus, slowly the veld gains on the bush. When timber is cut out of the bush, open gaps are left in which grass grows tall, and when this also catches fire the destruction is still greater. There can be no doubt that the bush areas were at one time wider and more extensive than they are now. At the present time greater care is being taken, and as far as possible destruction of the bush is being prevented, but it is well to recognise how important this factor has been in the past.

In places where the bush has been destroyed it will grow again if protected from the grass fires. The study of such bush clearings throws much light on the question of how the

close bush is formed. The soil of the slopes, where the bush will grow, is usually covered with large and small blocks of stone. The drainage is good and the soil well aerated, and the stones conserve the moisture. Even in the driest, hottest weather, if a stone be raised, it is seen that the soil is damp underneath. In a protected bush-clearing the various associated veld plants first take the field, then the half shrubby species get the upper hand, and *Senecios*, *Berkheyas*, *Plectranthus* species, etc., soon almost entirely exclude the grasses. Among these the various bush trees grow up and the slope gradually becomes covered with bush.

#### (8) ROCKY STREAM FLORA.

Differing considerably from the types of bush already described is that which occurs in the rocky stream valleys. The streams flow through it, and each side of the valley is covered with bush. Often, however, the side which is more exposed to the hot dry winds is bare of trees except close to the bed of the stream. In places the canopy is dense, but there are open spaces that have almost full exposure to the sun. When the amount of sunlight which penetrates to the ground is measured it is found to vary considerably. (See above under "Light.")

The following lists of trees represent the composition of this type of bush in the different regions.

#### (A) ROCKY STREAM FLORA, COASTWARDS.

*Eugenia cordata*,  
*Trema bracteolata*,  
*Ficus capensis*,  
*Ficus natalensis*,  
*Myrica aethiopica*,  
*Voacanga thouarsii*,  
*Halleria elliptica*,  
*Combretum salicifolium*.

with mixed grasses and Cyperaceæ underneath, and in places *Gleichenia polypodioides* in shade, and *Nephrodium thelypteris* in open swampy ground.

(B) ROCKY STREAM FLORA, MIDLANDS.

*Combretum kraussii*,  
*Rauwolfia natalensis*,  
*Trema bracteolata*,  
*Ficus capensis*,  
*Ficus natalensis*,  
*Celtis kraussiana*,  
*Rhamnus prinoides*,  
*Pittosporum viridiflorum* }  
*Ilex capensis* } less constant,  
*Pygæum africanum* }

with mixed grass and other vegetation underneath; but with *Clivia miniata* where the canopy is dense, and with *Richardia africana* where there is lighter canopy, and the ground is swampy.

(c) MOUNTAIN STREAM FLORA, AT HIGH ALTITUDES.

*Leucosidea sericea*,  
*Cunonia capensis*,  
*Callitris cupressoides*,  
*Podocarpus thunbergii*,  
*Passerina* spp.,  
*Myrica æthiopica*,  
*Rhamnus prinoides*,

with *Erica* (two species), *Sparmannia palmata*, *Arundinaria tessellata*, and in places *Cyathea dregei*.

It will be seen that these types of bush are similar in many respects to the other types found in the Bush Savannah. They differ chiefly in being more open and irregular. The usual common lianes are found just as in the other types of bush. In fact the closer patches differ in no important respect from those other types. In the more open patches the

difference is greatest in the undergrowth. Near the water-edge on the steep rocky banks an interesting and varied Cryptogamic flora is found. Such a spot is illustrated in Pl. XVII, fig. 1. In addition to various ferns and Selaginellas and *Streptocarpus* spp., mosses and hepatics cover the faces of the rocks and fill the chinks. From the spot illustrated a number of hepatics were sent to Dr. W. H. Lang, who identified species belonging to the genera *Fimbriaria*, *Dumartiera*, *Riccia*, *Aneura* and *Anthoceros*.

In the Sweetwaters Bush, which is illustrated in Pl. XVI, *Rauwolfia natalensis* is the dominant tree. In other similar bushes one or other of the species mentioned may be dominant. So the type is more variable and indefinite than that found on the south-eastern slopes.<sup>1</sup>

The various types of bush described so far all show a very definite relationship to the different factors. They grow in the places where there is maximum deposition of moisture; they require a well-drained, well-aerated soil which may be, and in fact usually is, somewhat rocky; they do not require to withstand strong frosts; they are sheltered from the hot dry winds. It is from fires that they suffer most, and these are gradually eating into them, and in the past a considerable amount of bush has been destroyed by this means. This close type of bush is associated with the high level grassland to form the Bush Veld or Bush Savannah or Forest Savannah.

#### (9) THORN VELD.

In reaction to the very different conditions found at the low dry valley levels we get the Thorn Veld or Thorn Savannah. The trees are scattered through the veld grasses, and rarely grow close together. They present a sort of park-like aspect. Before discussing their form and relationships I will give a list of those that commonly occur.

<sup>1</sup> Dr. W. G. Smith has suggested to me that this Rocky Stream Bush represents a migratory type in contrast to the Coast, Midland and Yellow Wood bushes, which represent the formation on stable topography.

## UPPER DISTRICTS.

*Acacia horrida*,  
*Acacia caffra* var. *rupestris*,  
*Acacia* sp. (*hirtella*?),  
*Celastrus buxifolius*,  
*Ehretia hottentotica*,  
*Zizyphus mucronata*.

## MORE COASTWARDS.

The above, together with—

*Acacia arabica* var. *kraussiana*,  
*Dichrostachys nutans*,  
*Commiphora* spp. (*caryæfolia*),  
*Sclerocarya caffra*,  
*Clerodendron glabrum*,  
*Erythrina caffra*,  
*Harpephyllum caffrum*.

The form assumed by these trees varies somewhat. The umbrella-form with flat-spreading crown is most typical. *Acacia caffra*, *Celastrus buxifolius*, *Zizyphus mucronata*, *Acacia arabica* var. *kraussiana*, *Dichrostachys nutans* always have it in the Thorn Veld, but *Zizyphus* and *Celastrus* also occur in the close bush (see lists), and there they do not assume the umbrella-form. Of the others, *Acacia horrida*, and *Acacia* sp. (*hirtella*?) usually have the same form. *Sclerocarya caffra* and *Clerodendron glabrum* often have it. The others are usually rounded or vary in form. The flat-crowned form is well adapted to withstand the strong hot winds to which the trees are fully exposed. Another possible factor operating in this respect is the circumstance that their water supply is so limited that their growth in height is also restricted. They all have large root-systems though usually they do not penetrate to any great depth, but rather extend along the surface of the soil.

When we come to consider the cause of the trees growing

isolated giving the park-like character to the Thorn Veld one fact is very obvious, namely, that the trees often could grow a great deal closer together without interfering with each other. Further, I am informed by Mr. Sim that in cases where the veld has been enclosed and fires prevented the trees do tend to grow close together. But with constant recurring grass fires young trees are scorched, and only isolated ones survive. One factor that might be expected to be in operation would be the lack of sufficient water in the soil—the trees growing in the wetter spots. An examination of the soil, however, shows that there is no such variation. It is uniformly very dry.

The grass fires have still another effect. The various seeds of *Acacias* have a very hard seed coat, and it has been found that seeds often lie for a very long time without germinating. In planting Wattle (*Acacia mollissima*) it is the practice either to boil or roast the seeds for a short time. Sometimes the following method is pursued. When one Wattle crop is cut down and the bark stripped, the branches and general débris remain scattered over the ground. The seeds are mixed with it and the whole set fire to, when the young seedlings appear very soon among the ashes. In a similar way after a grass fire the young plants of the various *Acacias* of the Thorn Veld come up among the ashes. They grow for a year, and then the next grass fire kills some of them while others manage to survive.

It has already been stated that the isolated thorn trees throw but little shade as compared with that inside the close type of bush, yet the shade that is given is sufficient to change the character of the veld grasses around the base of each tree. Often the change is slight. *Anthistiria imberbis* and the other veld grasses grow taller. In other cases a variety of other plants are found, e. g. *Abutilon sonneritium*, *Solanum nigrescens*, *Sida* spp., *Cyathula* sp., *Salvia* spp., *Leucas* sp., *Bidens bipartita* and many others of the almost innumerable associated veld plants, lists of which are given later.

As in the case of the close bush it was found that the rocky stream type differed considerably from the ordinary type, so also in the Thorn Bush there are types that differ from the usual one as described above. One such type is common. It is found on dry slopes fully exposed to the hot winds up to an altitude of 2000 ft. or more. The species composing it grow scattered as in the typical thorn veld, or close together forming a dense, but at the same time extremely xerophytic type of bush.

It is made up of the following :

*Euphorbia grandidens*,  
*Euphorbia tirucalli*,  
*Schottia brachypetala*,  
*Aloe marlothii*,  
*Celastrus buxifolius*,  
*Commiphora harveyi*,  
*Acacia caffra* var. *rupestris*,  
*Acacia horrida* ;

with the lianes :

*Sarcostemma viminalis*,  
*Dregia floribunda*,  
*Vitis cuneifolia*,  
*Capparis* spp.,  
*Pelargonium peltatum*.

Of these, several have been described as being found in the typical Thorn veld. The others are very xerophytic. *Euphorbia grandidens* has the candelabra form and is practically leafless. *Sarcostemma viminalis* is also leafless. The *Euphorbias* contain a resinous caoutchouc which can be extracted in quantity, and in the case of *Euphorbia tirucalli* is being worked by a rubber company.

Another xerophytic type is found on mountain rocky situations consisting of:—

*Greyia sutherlandi*,  
*Aloe natalensis*,  
*Buddleia salviaefolia*,

*Chilianthus dyssophyllus*,  
*Cussonia spicata*;

and in the upper districts:

*Cephalanthus natalensis*.

Finally in the Drakensberg we get an Alpine xerophytic scattered type consisting of *Proteas* (*P. hirta*, *P. abyssinica*, and *P. subvestita*) and *Erica* spp., *Celastrus buxifolius*, and the palm-like tree-fern, *Cyathea dregei* (Pl. XIX). This occupies the open mountain localities.

#### GRASSLAND OR VELD.

We have now to consider the grass savannah, which extends over the whole of Natal, and in which the types of woodland occur in the particular situations mentioned. A list of the commonest grasses met with will be given first, omitting those that are characteristic of the vleis or marshes.

*Anthistiria imberbis*, *Andropogon ceresiæformis*, *A. hirtus*, *A. schirensis*, *A. amplectens*, *A. auctus*, *A. pertusus*, *A. contortus*, *A. intermedius* var. *punctatus*, *A. schœnanthus*, var. *versicolor*, *A. encomus*, *A. dregeanus*, *A. cymbarius*, *A. filipendulus*, *A. nardus* var. *marginatus*, *Digitaria eriantha*, *D. ternata*, *D. horizontalis*, *D. sanguinalis*, *D. tenuiflora*, *Panicum serratum*, *P. lævifolium*, *P. proliferum*, *P. dregeanum*, *P. natalense*, *P. curvatum*, *Eragrostis curvula*, *E. plana*, *E. chalcantha*, *E. superba*, *E. brizoides*, *E. nebulosa*, *E. ciliaris*, *Aristida junciformis*, *A. barbicollis*, *A. angustata*, *Setaria sulcata*, *S. aurea*, *S. verticillata*, *S. imberbis*, *Pennisetum natalense*, *P. unisetum*, *P. sphaecelatum*, *Chloris petræa*, *C. gayana*, *C. virgata*, *C. pycnothrix*, *Paspalum scrobiculatum*, *Trichopteryx simplex*, *Tricholæna rosea*, *Melinis minutiflora*, *Trachypogon polymorphus*, *Tristachya leucothrix*, *Eleusine indica*, *Imperata arundinacea*, *Harpechloa capensis*, *Ctenium concinnum*, *Micro-*

*Chloa caffra*, *Sporobolus indicus*, *Koeleria cristata*, *Anthoxanthum ecklonii*, *Cynodon dactylon*.

These are nearly all perennials. The only important annuals are certain species of *Digitaria* (*D. ternata*, *D. horizontalis*, *D. sanguinalis*), of *Setaria* (*S. imberbis* and *S. verticillata*), and *Elysiene indica*. They are mostly of the narrow-leaved type, though those that grow near the edges of the bush may be broad-leaved, e.g. *Setaria sulcata* which extends within the bush, and is found also beside streams. Being perennial the majority have the tufted form, with numerous innovation shoots, which may be intra-vaginal or may pierce through the subtending sheaths and form stolons. The stems and leaves are often covered with coarse hairs, though individual species vary in this respect according to the situation and soil in which they are growing. The spikelets are often hairy, as, for instance, in the silvery villous *Andropogon hirtus*, one of the most abundant grasses.

The whole of the grassland may be divided into two main types: (1) The high-level veld, growing on the loose, well-aërated soil of the higher hills and ridges (see Pl. XX, fig. 1). (2) The low-level veld growing on the hard-baked clay soil of the lower valleys (see Pl. XX, fig. 2). The former type corresponds to the sour veld or red grass veld, using the farmers' terminology, and the latter type to the sweet veld or blue grass veld. I have not adopted these terms, because I find that they are very loosely applied. Any veld where cattle do well is apt to be termed sweet veld, and the blue colour of the grass in the latter type is by no means constant.

#### (10) HIGH LEVEL VELD.

This veld is associated with the close type of bush which occupies the south-eastern slopes (Yellow Wood bush, etc.), and since it covers the higher levels it enjoys a greater amount of rainfall, a less amount of frost in winter, a soil which, though richer mechanically, is poorer chemically than

the soil of the other type of veld. The grasses found in this high veld all grow tall and all flower regularly.

*Anthistiria imberbis* is nearly always the dominant grass. It frequently has *Andropogon ceresiaformis* as a sub-dominant species, and various other species of *Andropogon* are associated. The taller species, *Andropogon nardus* var. *marginatus* (Tambootie grass) and *Andropogon filipendulus* are characteristic of the moister spots. They are transitional to the Vlei Formation, and also are characteristic of the marginal belt which surrounds the bush.

Mixed with the *Anthistiria*-*Andropogon* Associations are species of *Digitaria*, *Eragrostis* and *Panicum*. Species of *Setaria*, like the taller *Andropogons*, prefer the moister spots. There are endless local variations: *Tristachya leucothrix*, *Trachypogon polymorphus* and one or other of the various *Andropogons* in turn become sub-dominant or even dominant. *Harpechloa capensis* and *Microchloa caffra* are two characteristic mountain species. A full detailed classification into separate associations would form an interesting task, and it is one which I hope to undertake.

It is extremely important to note how the natural veld associations are changing. Over wide areas the grass *Aristida junciformis* has more or less completely ousted the more nutritious veld grasses. This is particularly the case in the Richmond district for instance. Such an *Aristida* association is also found lining for a yard or two each side of the numerous Kafir paths that cross the veld. It is the characteristic association along the railways. It is commonly known locally as "wire grass," and the name describes it well. Loosely caespitose in habit with a slender rhizome, it seems to be able to withstand conditions which kill the other grasses. When trodden underfoot the natural veld grasses soon give way to the *Aristida*, and this explains why it lines the Kafir paths. Along the railways it is customary to burn the grasses as early as possible to prevent grass-fires spread-

ing later, when the grass is all withered and could easily be ignited by sparks from the engine. *Aristida junciformis* seems better able to endure this early burning, which soon kills out the species of *Andropogon* and *Anthistiria*.

The same factor is in operation elsewhere. There seems to be a fairly general consensus of opinion among the farmers that burning the veld grass leads to deterioration, i. e. to the *Aristida* association getting the upper hand.

Sometimes the *Aristida* association is practically pure, containing nothing but *Aristida junciformis*. At other times there is a greater or less admixture of the other veld grasses, e. g., *Eragrostis curvula*. The harder-leaved *Aristida barbicollis* (used by the natives for making brushes) is not so common, but it is sometimes associated with *A. junciformis*.

There is still another factor which has a changing effect on the veld, namely over-grazing. When the cattle eat out all the ordinary grasses, others (e. g. *Cynodon dactylon*, *Eragrostis* spp., etc.) become dominant.

#### (11) LOW LEVEL VELD.

This is the type of grassland associated with the various thorn trees to form the Thorn Veld. There is little of it that does not contain thorn trees, but such treeless parts do occur, and it is better to consider it in contrast to the high level Veld. The soil is of a hard, dry, clayey type and it has the valley frosts and low rainfall. In response to these factors, the grasses are more xerophytic than those composing the other type of Veld. They differ markedly in their habit, being low-growing forms, more hairy, and frequently not flowering save here and there sporadically. Some of the associated forms, however, do grow tall and flower, so I have named it Low Level Veld rather than Low Grass Veld.

*Anthistiria imberbis* is again dominant over fairly large areas; but it is more densely tufted, seldom flowers,

and has, till it begins to wither, a deep blue colour, thus differing considerably from the form assumed by the same species on the High Level Veld.

*Andropogon hirtus* is another dominant species, but it frequently grows tall and flowers.

Other characteristic species are *Andropogon pertusus*, *A. schænanthus*, *A. amplexans*, *Sporobolus indicus*, *Eragrostis* spp., *Chloris petraea*, *Panicum* spp.

The grasses composing this type of veld are set fire to in just the same way as those on the higher levels. We have seen how these fires affect the thorn trees of the Thorn Veld. They also, together with the other factors which operate in the case of the taller grasses on the high veld, bring about changes and deterioration in this low veld. Here it is usually *Sporobolus indicus* that forms the secondary association. What has been said regarding *Aristida junciformis* holds true for *Sporobolus*. It lines the Kafir paths, etc., and in many places covers wide areas of the veld. *Aristida junciformis* sometimes also occurs in this type. *Aristida angustata* is often quite abundant, especially where there is very little soil.

Seeing that this type of veld occupies the main river valleys we find, as is to be expected, that its character alters when close to the river. There is a greater variety of grasses, including those named in the description of the vleis, as well as Cyperaceæ and other aquatic vegetation. *Pennisetum unisetum* is commonly dominant near the river side.

Ploughing the veld also leads to changes. If the ground is ploughed up and left, or left after crops, e. g. of mealies, and allowed to revert to veld, first of all some of the associated veld plants (annuals) take the field (e. g. *Senecio* spp., *Hebenstreitia* spp.). At the same time annual species of grasses, or at least grasses that flower the first year, *Paspalum*, *Digitaria*, and *Sporobolus* occur. Next year these grasses remain, and along with them *Tricholæna rosea* appears. About the third year the *Senecios*, etc., die out, and the grasses become dominant. After several

years—farmers put it at about fifteen—the ground reverts to the condition of the original veld.

(12) ASSOCIATED PLANTS OF LOW AND HIGH LEVEL  
VELD.

Scattered through the veld grasses there is a great variety of flowers, the species varying very much in different localities. (Ecologically these plants may be divided into the following classes :

1. Plants that flower immediately after the burning of the grass. The fire seems to act as a sort of stimulus to them, and it does not signify whether the burning is late or early they flower immediately afterwards. Even in the middle of the dry season they are found scattered over the blackened surface of the ground. The following are most typical :

*Gazanea longiscapa*, *Gerbera* spp., *Moræa spathacea*, *Scilla* spp., *Cyrtanthus angustifolius*, *Senecio pterophorus* var. *apteris*, *Senecio* spp., *Anoiganthus brevifolius*, *Apodolirion buchanani*, *Hydrocotyle centella*.

2. The second class includes a much greater number—the plants that flower early in the season, shortly after the first rains, and before the grass has grown tall enough to shade them. They are similar in many respects to the floor vegetation of deciduous woods, but are more xerophytic. A great number of bulbous monocotyledons occur. The general aspect of the grass veld at the time of flowering of these plants is shown in Pl. XXI, fig. 2. The grass is growing quickly, but it is more or less tufted and the full amount of sunlight reaches these associated plants.

The following list, though not so long as it might be made, will give a general idea of the variety of plants found flowering in the veld at this season :

MONOCOTYLEDONS.—*Moræa tennis*, *Moræa* spp., *Aristea* spp., *Dierama pendula*, *Gladiolus pubescens*, *Hypoxis* spp., *Hypoxis baurii*, *Crinum longifolium*, *Buphæne disticha*, *Cyrtanthus lutescens*, *Hæman-*

thus natalensis, *Asparagus* sp., *Kniphofia* sp., *Aloe natalensis*, *Aloe ferox*, *Bulbine asphodeloides*, *Eriospermum* spp., *Tulbaghia alliacea*, *Dipcadi viride*, *Albuca* sp., *Drimiopsis* sp., *Scilla* spp., *Ornithogallum* spp., *Androcymbium* sp., *Wurmbea kraussii*, *Eulophia* spp., *Habenaria* spp., *Disa* spp., *Corycium* spp.

DICOTYLEDONS.—*Heliophila* spp., *Ionidium* sp., *Polygala hottentotica*, *Hypericum* spp., *Mahernia* spp., *Oxalis* spp., *Crotalaria globifera*, *Indigofera* spp., *Oldenlandia amatymbica*, *Pentanisia variabilis*, *Scabiosa columbaria*, *Ethulia conyzoides*, *Aster* spp., *Conyza* spp., *Gnaphalium* spp., *Helichrysum* spp., *Cineraria* sp., *Senecio* spp., *Gerbera* spp., *Lactuca capensis*, *Lobelia* spp., *Wahlenbergia* spp., *Solanum capense*, *Dielis reptans*, *Cycnium* sp., *Hebenstreitia* sp., *Stachys* sp., *Ajuga ophrydis*, *Lasiosiphon* sp., *Euphorbia* sp., *Cluytia* spp., *Phyllanthus* spp., *Acalypha* sp., *Raphionacme* sp.

3. The third class is made up of the plants that grow with the grass and flower late. They are taller forms, many of them rising above the grasses. The various *Berkheya*s and tall *Helichrysum*s, and such plants as *Leonotis leonurus* form a conspicuous feature of the grass savannah in late autumn. As will be seen from the list many of the bulbous Monocotyledons are included in this class.

The following is a list of plants belonging to this third class:

MONOCOTYLEDONS.—*Watsonia densiflora*, *Watsonia meriana*, *Hesperantha* spp., *Tritonea rosea*, *Gladiolus* spp., *Gladiolus papilio*, *Gladiolus ecklonnii*, *Hypoxis oligitrichus*, *Brunsvigia josephinae*, *Nerine* sp., *Hæmanthus* spp., *Asparagus* sp., *Kniphofia* spp., *Aloe* spp., *Anthericum* spp., *Galtonia candidans*, *Eucomis* spp., *Gloriosa virescens*, *Sander-sonia aurantiaca*, *Satyrium* spp., *Disa* spp., *Brownlea* spp., *Brachycorythis* sp., *Disperis* sp.

DICOTYLEDONS.—*Polygala* spp., *Dianthus* sp., *Cerastium dregeanum*, *Hibiscus æthiopicus*, *Pelargonium aconitifolium*, *Oxalis* spp., *Crotalaria* spp., *Argyrolobium* sp., *Psoralea pinnata*, *Indigofera* spp., *Cassia mimosioides*, *Crassula* spp., *Pentanisia variabilis*, *Spermacoce natalensis*, *Vernonia dregeana*, *Aster* spp., *Nidorella* spp., *Gnaphalium* spp., *Helichrysum* spp., *Cineraria* spp., *Senecio* spp., *Cryptostemma calendulaceum*, *Gazanea* spp., *Berkheya* spp., *Dicoma argyrophylla*, *Lobelia* spp., *Wahlenbergia* spp., *Sebæa* spp., *Belmontia* spp., *Solanum* spp., *Nemesia* spp., *Striga* spp., *Striga lutea*, *Buchnera* sp., *Rhamphicarpa fistulosa*, *Thunbergia* spp., *Blepharis* spp., *Justicia* spp., *Selago* spp., *Ocimum* spp., *Salvia* spp., *Stachys* spp., *Leonotis leonurus*, *Tencrium* sp., *Lasiosiphon* sp., *Thesium* spp., *Euphorbia* spp., *Cluytia* spp., *Phyllanthus* spp., *Xysmalobium* spp., *Schizoglossum* spp., *Gomphocarpus* spp.

Of the Scrophularineæ found in the veld the genera *Striga*, *Buchnera*, *Rhamphicarpa*, *Melasma*, *Cycnium*, from the fact that they dry black, may be suspected of being root-parasites, and many of them are known to be so.

#### (13) MARSH TYPES: DOMINANT PLANTS.

Reference has been made to the wetter spots on the veld. When these become larger in area we have what is commonly termed a vlei, i. e. a marsh. Such vleis are found wherever a depression in the ground checks drainage, but owing to the steep rise of the ground generally from the sea to the Drakensberg, vleis, though numerous enough, are rarely very large. Few cover more than an acre or two of ground. They are found sometimes in rather unexpected places, on the top of a high ridge, for instance, near the edge of the slope. They are not abundant in the dry river valleys. They have

this in common with the valleys, however, that in winter they have a much lower temperature than the surrounding veld. Frosts are common in all the midland vleis.

The vegetation varies (1) according to the amount of water present, and (2) according to the degree of stagnation of the water. There are vleis which are formed simply by a streamlet spreading itself over a flat level surface. The water drains through fairly quickly. Such a vlei is driest towards the sides and wettest towards the centre. Other vleis are small circular depressions. They are usually dried up during the dry season, and wet during the rainy season. The water in them becomes stagnant. Actual lakes are not at all common, and very few reach an acre in extent. They do, however, occur in small depressions up to an altitude of 4000 feet. In many of them surprisingly few aquatic phanerogams occur.

The following lists of types include some of the commonest plant associations found in the marshes:

1. Dominant. . *Andropogon nardus* var. *margi-*  
*natus* and *Andropogon filipendu-*  
*lus*.

Sub-dominant. *Setaria aurea* and *Cyperus latifolius*.

This is the driest type of vlei. Soil moist and alluvial.

2. Dominant. . *Ischæmum fasciculatum* var. *arc-*  
*tnatum*.

Sub-dominant. *Setaria aurea*.

Here the soil is again moist and alluvial, but a stream flows through the middle of the marsh.

3. Dominant. . *Setaria aurea* and *Eragrostis nebu-*  
*losa*.

Sub-dominant. *Andropogon nardus*, *A. filipendulus*, *Cyperus* spp.

Another of the drier types.

4. Dominant. . *Cyperus latifolius* and *Erianthus capensis* var. *villosa* (see Pl. XXIII, fig. 1).

Soil again moist and alluvial; stream in the middle of the marsh.

5. Dominant. . *Cyperus latifolius* and *Phragmites communis*.

Sub-dominant. *Erianthus capensis*, *Polygonum lapathifolium*.

Associated. . *Panicum crus-pavonis*, *Typha capensis*, *Arundinella ecklonii*.  
(Pl. XXII, figs. 1 and 2).

A type of one of the larger vleis. Very wet in some places, drier in others. Stream flows through it, and spreads out over parts of it.

In giving the above list I have endeavoured to restrict myself to fairly general types. By taking the smaller vleis one after the other it would be possible to extend the list very considerably. Instead of that I shall deal with the other marsh plants under a separate heading, although many of them in the smaller marshes become dominant.

#### (14) ASSOCIATED PLANTS OF THE VLEIS.

In addition to *Cyperus latifolius* there are many other species of *Cyperus*. *Cyperus fastigiatus*, *C. sexangularis*, *C. immensus* are common. Altogether twenty-four species of *Cyperus* are recorded for Natal, mostly marsh plants. The other genera of *Cyperaceæ* are *Carex*, *Kyllinga*, *Pycneus*, *Juncellus*, *Mariscus*, *Eleocharis*, *Fimbristylis*, *Bulbostylis*, *Scirpus*, *Ficinia*, *Fuierena*, *Lipocarpa*, *Ascolepis*, *Rhynchospora*, *Costularia*, *Cladium*, *Scleria*, *Schœnoxiphium*, species of which are found scattered through the marshes, but I have not attempted to work out many of the species of this difficult group.

Of other common marsh plants the following prefer to be near running water: *Eriocaulon* spp., *Xyris* spp., *Commelina gerrardi* and other species, *Gunnera* per-

pensa, *Ludwigia* spp., *Epilobium* spp., *Schizostylis* sp., *Salix woodii*.

The following grow on the moist alluvial soil: *Crinum longifolium*, *Anoiganthus breviflorus*, *Osbeckia umlasiana*. *Richardia africana* grows either on moist alluvial soil or near running water.

#### (15) AQUATIC TYPE.

There remains the purely Aquatic Vegetation. In the wettest parts of the marshes *Typha capensis* is found. It is also typical of the small lakes forming a *Typha* association.

In addition to this the following aquatic plants are found:

*Nymphæa stellata*,  
*Nymphæa capensis*,  
*Pistia stratiotes*,  
*Lemna minor*,  
*Callitriche bolusii*,  
*Utricularia* spp.,  
*Myriophyllum spicatum*,  
*Triglochin* spp.,  
*Aponogeton natalense*,  
*Potamogeton* (7 species),  
*Trapa bispinosa*.

These occur in the fresh-water lakes, but rarely very abundantly. The leaves of *Potamogetons* do not form a complete covering over the water. On the whole, Natal is very poor in purely aquatic types of vegetation. There are, however, one or two extremely interesting plants worthy of mention. *Hydrostachys natalensis* (Podostemaceæ) occurs in the rivers, usually under a waterfall. *Sphærothylax algiformis* has also been recorded for Natal. *Drosera burkeana* is common in moist spots.

The lagoons have already been described with reference to their mangrove vegetation, but many lagoons have no mangroves. The water in such is brackish, and *Zostera*

*nana*, *Zannichellia palustris*, *Triglochin* spp. are found, with *Salicornia*, *Aerostichum aureum*, and *Phragmites communis* near the edge.

#### (16) SECONDARY ASSOCIATIONS.

It may be well to add a few words concerning the influence of man on the vegetation of Natal. The destructive influence of the native I have already dealt with, and also the effects of burning the grass, a practice followed not only by the natives but also by the European farmer.

Among what may be called the constructive effects the following are the most important :

1. *Wattle Planting*.—Large areas are now covered with plantations of *Wattle* (*Acacia mollissima*). The places selected are High Level Savannah, where the soil is an iron soil, loose, well aerated and well drained, and where the rainfall is high and summer mists occur. This *Acacia* demands a large amount of water and the drying up of vleis is a result that is commonly noticed.

2. *Tea and Sugar Planting*.—These plantations are found on the coast belt, and have led to a complete change in its appearance. Much of the bush has been cut down to make way for them.

3. *Maize Growing*.—Every native kraal has its mealie patch, and some of the farmers undertake maize growing on a large scale. The rich soil of the valleys after it has been aerated by tillage is best suited for maize.

4. *The Introduction of Foreign Grasses*.—Several of these have been introduced. Of late years it has been found that *Paspalum dilatatum* is very well suited to Natal, remaining green and succulent during the dry season. It is not improbable that in the course of a few years the veld will be entirely changed, and the native grasses replaced by others.

Pl. XXIII, fig. 2 represents various secondary associations.

## LIST OF ENGLISH, DUTCH AND KAFIR NAMES.

<i>Acacia caffra</i>	. . .	Cat-thorn. Kat-doorn. umNga-manzi.
<i>Acacia hirtella</i>	. . .	Camel thorn. umNga-punzi.
<i>Acacia horrida</i>	. . .	Thorn tree. Doorn boom. umNga.
<i>Acocanthera spectabilis</i>	. . .	Poison bush. Gift boom. inThlungunyembe, uBulungubenyoka.
<i>Albizzia fastigiata</i>	. . .	Flaterown. umHlandoti, Nebelele.
<i>Andropogon nardus</i>	var.	Tambootie grass.
marginatus		
<i>Andropogon sorghum</i>	. . .	Kafir corn. amaBele.
<i>Andropogon filipendulus</i>	. . .	Sibuzana.
<i>Anthistiria imberbis</i>	. . .	inSinda.
<i>Apodytes dimidiata</i>	. . .	White pear. Witte peer. umDakana.
<i>Artemisia afra</i>	. . .	Wormwood. umHlonyane.
<i>Avicennia officinalis</i>	. . .	White mangrove.
<i>Brachylæna discolor</i>	. . .	iPahla.
<i>Brachylæna elliptica</i>	. . .	Bitter blaar. isiDuli.
<i>Bruguiera gymnorhiza</i>	. . .	Mangrove.
<i>Buddleia salviæfolia</i>	. . .	Sagewood. Saliehout. Gwangi.
<i>Burchellia capensis</i>	. . .	Wild pomegranate. Buffels hoorn. To-bankone.
<i>Calodendron capense</i>	. . .	Wild chestnut. Wilde Kastanje. Umbaba.
<i>Carissa arduina</i>	. . .	Yum-yum. Beta-umTunzi.
<i>Carissa grandiflora</i>	. . .	Natal plum. amaTungula.
<i>Capparis citrifolia</i>	. . .	inTsihlo
<i>Celtis kraussiana</i>	. . .	Camdeboo stinkwood. umVumvu.
<i>Celastrus peduncularis</i>	. . .	Blackwood. Zwarthout. umNqai.
<i>Celastrus acuminatus</i>	. . .	Silk bark. Zijdebast, zijbast. umNama.
<i>Celastrus buxifolius</i>	. . .	umQuqoba.
<i>Chilanthus oleaceus</i>	. . .	Bastardolive. Salie, Wilde Vlier. umGeba.
<i>Chrysophyllum natalense</i>	. . .	Tungwane.
<i>Clausena inæqualis</i>	. . .	umNukambile.
<i>Clerodendron glabrum</i>	. . .	umQuaquane, umQuoquongo.
<i>Cluytia pulchella</i>	. . .	umFiyo.
<i>Combretum kraussii</i>	. . .	umDubu, weHlati.
<i>Combretum salicifolium</i>	. . .	Bush willow. um-Dubu.
<i>Cola natalensis</i>	. . .	umTenenenda.
<i>Commiphora harveyi</i>	. . .	} Corkwood. Hlunguti.
<i>Commiphora caryæfolia</i>	. . .	
<i>Cordia caffra</i>	. . .	Septee, Oudelhout, Lovu-lovu, Keen. um-Novu-novu.

- Cunonia capensis* . . . Red alder. Roode Els. umQwashube.  
*Curtisia faginea* . . . Assegai. Assegaihout. umGxina.  
*Cussonia spicata* . . . Cabbage tree. Nooiensboom. umSenge.  
*Cussonia umbellifera* . . . Cabbage tree. Nooiensboom. umKisiso,  
 umSenge.  
*Cyclostemon argutus* . . . Bastard white ironwood. umHlagella.  
*Dactyloctenium aegyptiacum* isInane.  
*Dalbergia obovata* . . . umZungulu.  
*Ehretia hottentotica* . . . Stamper wood. umHleli.  
*Elæodendron croceum* . . . Saffron wood. Saffraan hout. umBom-  
 vane.  
*Eleusine indica* . . . Mnyankomo.  
*Ekebergia capensis* . . . Cape ash, Dog plum. Essenhout. um-  
 Gwenya-uizinja.  
*Eragrostis curvula* . . . uViti.  
*Erianthus capensis* . . . umTala.  
*Euclea lanceolata* . . . Bush gwarri. Bos gwarri. umGwali.  
*Euclea natalensis* . . . iDungamuzi.  
*Eugenia cordata* . . . Water tree. Water boom. umDoni.  
*Eugenia zeyheri* . . . Wild jambos. Pappe. isiDuli, we-  
 Hlati.  
*Euphorbia grandidens* . . . umHlonhlo.  
*Euphorbia tirucalli* . . . umSululu.  
*Excœcaria africana* . . . Sandalwood. umTomboti.  
*Erythrina caffra* . . . Kafir boom. umSinsi.  
*Ficus capensis* . . . Bush fig. mKwane.  
*Ficus natalensis* . . . Wild fig. Na-touw. Wilde vijg. uHluzi,  
 umTombe.  
*Garcinia gerrardi* . . . umBindi.  
*Gardenia globosa* . . . umSugnsi.  
*Gardenia rothmannia* . . . Candlewood. Kaarshout. Aapsekost.  
*Gardenia neuberia* . . . Mispel. Kafircherry. Opcheities, Tongoti.  
*Gardenia thunbergia* . . . Wilde katjepiering, Buffelsbal. umKan-  
 gaza.  
*Gomphocarpus* spp. . . Wild cotton.  
*Grewia occidentalis* . . . Kruisbesje. umnQabaza.  
*Greyia sutherlandi* . . . Baakhout. inDalu.  
*Gunnera perpensa* . . . iPuzi-lomlambo.  
*Halleria elliptica* . . . Wild fuchsia. Nutseng, Kinderbesje.  
 umBinza.  
*Helichrysum* spp. . . Everlastings. Zevenjaartjes.  
*Harpephyllum caffrum* . . . Kafir plum. Kaffer pruim. umGwenye.  
*Helinus ovata* . . . uKumbuqwekwe.  
*Heteromorpha arborescens* umBangandhlala.

<i>Hibiscus tiliaceus</i>	. . .	umLolwa.
<i>Hydrocotyle centella</i>	. . .	Persgras.
<i>Ilex capensis</i>	. . .	Water tree. Waterboom. umDuma.
<i>Kiggelaria africana</i>	. . .	Wild peach, Natal mahogany. Spekhout. Vaderlandsroodehout. uVeti, Lovu- lovu.
<i>Kraussia lanceolata</i>	. . .	Wild coffee. umDhlesa.
<i>Lasiosiphon</i> spp.	. . .	isiDikili.
<i>Leonotis leonurus</i>	. . .	Red dagga. umFinca.
<i>Leucosidea sericea</i>	. . .	Oudehout. Dwa-dwa.
<i>Maba natalensis</i>	. . .	Smallblad.
<i>Melletia caffra</i>	. . .	umZimbeet.
<i>Mesembryanthemum</i> sp.	. . .	Hottentot fig. Kinkelboschjes. Ku- kuma.
<i>Mimusops caffra</i>	. . .	Red milkwood. Roode Melkhout. um- Nweba.
<i>Mimusops obovata</i>	. . .	Red milkwood. Roode Melkhout. um- Tunzi, Amasitole.
<i>Myrica aethiopia</i>	. . .	Waxberry.
<i>Myrsine melanophleas</i>	. . .	Cape beech. Beukenhout. isiGwane, weHlati.
<i>Notobuxus natalensis</i>	. . .	Box wattle. Luxwego. Gala-gala.
<i>Nuxia floribunda</i>	. . .	Wild elder. Vlier. umQuaqu.
<i>Nuxia congesta</i>	. . .	Bogwood. Witte salie. umKobess.
<i>Nymphaea stellata</i>	. . .	Water lily.
<i>Ochna arborea</i>	. . .	Redwood, Cape plane. Roodehout. umTensema.
<i>Ocotea bullata</i>	. . .	Laurel, Black stinkwood. Stinkhout.
<i>Olea capensis</i>	. . .	Ironwood. Yzerhout. Igqwanxe.
<i>Olea laurifolia</i>	. . .	Black ironwood. Zwart Yzerhout. umHlebe.
<i>Olea verrucosa</i>	. . .	Wild olive. Olijvenhout. umQuma.
<i>Olea foveolata</i>	. . .	Bastard ironwood. umQumaswele. umHlebe.
<i>Olinia cymosa</i>	. . .	Roodebesje. nQudu.
<i>Pavetta lanceolata</i>	. . .	Christmas tree. umDhlesa.
<i>Pavetta caffra</i>	. . .	Christmas bush.
<i>Peddiæa africana</i>	. . .	inTozane.
<i>Pentanisia variabilis</i>	. . .	iRubuxa, liDliso.
<i>Pittosporum viridiflorum</i>	. . .	umKwenkwe.
<i>Plectronia spinosa</i>	. . .	umPembetu.
<i>Plectronia mundtii</i>	. . .	Rock alder. Klip els, Sandulane. Nge- Lambila.
<i>Plectronia obovata</i>	. . .	Xululembile, umBonemfane.

<i>Plectronia ventosa</i> . . . . .	Turkey berry. Schapedrolletjes. um-Vutwamini.
<i>Podocarpus thunbergii</i> . . . . .	Real yellowwood. Rechte Geelhout. umCeya.
<i>Podocarpus elongata</i> . . . . .	Common or Bastard yellowwood. Geelhout. umKoba.
<i>Popowia caffra</i> . . . . .	Dwaba.
<i>Portulacaria afra</i> . . . . .	Spekboom. Gyanese.
<i>Protea</i> spp. . . . .	Sugar bushes. Wagon trees. Suikerboschjes. Wagen boom. Wa boom. Isiquane. isiQalaba.
<i>Psychotria capensis</i> . . . . .	Gono-gono.
<i>Ptaeroxylon utile</i> . . . . .	Sneezewood. Nieshout. umTati.
<i>Pterocelastrus variabilis</i> . . . . .	Cherrywood. Kersehout. iTwyina.
<i>Pygæum africanum</i> . . . . .	Red stinkwood. Bitter Almond. Roode Stinkhout.
<i>Randia rudis</i> . . . . .	inTsinde. nSinde.
<i>Rauwolfia natalensis</i> . . . . .	Quinine tree. umJela.
<i>Rhamnus prinoides</i> . . . . .	Blinkblaar. umGlindi.
<i>Rhizophora mucronata</i> . . . . .	Red mangrove. umHluma.
<i>Rhus lævigata</i> . . . . .	Red currant. Kareehout. Bosch Taai-bosch. umHlakoti.
<i>Ricinus communis</i> . . . . .	Castor-oil plant.
<i>Royena lucida</i> . . . . .	Blackbark. Zwartbast. umkaza.
<i>Royena villosa</i> . . . . .	Candana.
<i>Royena pallens</i> . . . . .	Blauwbos. umbongisa.
<i>Rubus pinnatus</i> . . . . .	Bramble. Braambos. amaKomulu.
<i>Scolopia mundtii</i> . . . . .	Red pear. Roode Peer. iQumza.
<i>Scolopia zeyheri</i> . . . . .	Thorn pear. Doorn Peer. iQumza elinameva.
<i>Scutia commersonii</i> . . . . .	Kat doorn. Drach-mijn-keel. isiPinga.
<i>Setaria sulcata</i> . . . . .	Buffalo grass. nBabe (omKulu).
<i>Sideroxylon inerme</i> . . . . .	White milkwood. Witte Melkhout. umQwashu.
<i>Strophanthus</i> spp. . . . .	Monkey ropes.
<i>Strychnos atherstonei</i> . . . . .	Cape teak. Kajatehout. iNama.
<i>Strychnos henningsii</i> . . . . .	Hard pear. Harde peer. umNonono.
<i>Strychnos spinosa</i> . . . . .	Kafir orange. umHlala.
<i>Tarchonanthus camphoratus</i> . . . . .	Camphorhout. Supree. Siriehout. Pappel.
<i>Toddalia natalensis</i> . . . . .	umZani. umSengu-mzani.
<i>Toddalia lanceolata</i> . . . . .	White ironwood. Witte Yzerhout. umZani.
<i>Trema bracteolata</i> . . . . .	Pigeon wood. umBengele. umVangazi.

<i>Trichilia emetica</i>	. . .	Cape mahogany. Essenhout. um-Kuhlu.
<i>Tricholæna rosea</i>	. . .	umKuana.
<i>Trimeria alnifolia</i>	. . .	Wild mulberry. Wilde Moerbeï.
<i>Tristachya leucothrix</i>	. . .	Roode Zaadgras.
<i>Vangueria infausta</i>	. . .	Wild medlar. Mispel. umVilo.
<i>Viscum</i> spp.	. . .	Mistletoe. inDembu.
<i>Vitex mooiensis</i>	. . .	Mtymtyambani.
<i>Vitis</i> spp.	. . .	Wild grape. Monkey ropes. mGneba, Sakoone.
<i>Xanthium</i> spp.	. . .	Burweed. Boetebosje.
<i>Xanthoxylon capense</i>	. . .	Knobwood. Paaredepram. umNungumabele.
<i>Xymalos monospora</i>	. . .	Wild lemon. Lemonwood. Bogabog, Limoenhout. umVeti.
<i>Zizyphus mucronata</i>	. . .	Buffalo thorn. Wait-a-bit thorn. Buffelsdoorn. umPafa.

NOTE.—The generic and specific names throughout this paper are those of Medley Wood's 'Revised List of Natal Plants,' 1907.

## EXPLANATION OF PLATES XIV–XXIII,

Illustrating Professor J. W. Bews's paper, "The Vegetation of Natal."

PL. XIV, FIG. 1.—Coast near Umgeni. *Pes-capræ* Association and Coast Bush. The foreground is occupied chiefly by *Ipomæa Pes-capræ* (*I. biloba*) growing up through the drifting sand. The larger fixed sand-dunes behind are covered with *Psammophilous* bush, of which *Mimusops caffra* is the dominant tree.

FIG. 2.—Durban Bay. *Salicornia-Chenolea* Association and Mangrove Type. *Salicornia herbacea* and *Chenolea diffusa* grow together in clumps on the mud. The tree is *Avicennia officinalis*, the breathing-roots of which are shown growing up through the *Salicornia-Chenolea* Association.

PL. XV, FIG. 1.—Bush near Zwartkop. Scattered Midland Type. The foliage is mostly that of *Combretum kraussii*. A species of *Ipomæa* is seen climbing up over it. Between the foreground, which is occupied by veld grasses (*Andropogon* species), and the bush is the Marginal Zone, here occupied by the Bracken fern, *Pteris aquilina*.

FIG. 2.—The interior of the same bush. This photograph, using same aperture, plates, etc., was given 600 times the exposure of the other. Note the great number of woody lianes. *Dalbergia obovata* is most abundant here.

PL. XVI, FIG. 1.—Sweetwaters bush. Rocky Stream Type. The side of the valley facing north is bare of bush. *Rauwolfia natalensis* is here the dominant tree.

FIG. 2.—Sweetwaters bush taken from the bed of the stream. *Piper capense* in the foreground.

PL. XVII, FIG. 1.—Sweetwaters bush. Near the waterfall. A moist bank with a varied collection of mosses, hepatics, ferns, selaginellas, *Streptocarpus* spp. To the right is *Justicia campylostemon*, a plant which has two lines of water-absorbing hairs running down the internode.

FIG. 2.—Foxhill. Thorn Veld. The low level type of grassland. *Anthistiria imberbis* is dominant. The plant shown in the foreground is *Dicoma argyrophylla*. The *Acacia* is *A. arabica* var. *kraussiana*.

PL. XVIII.—Tugela Falls, Colenso. Dry Valley Type. On the near bank in the foreground is *Acacia caffra*, which is always found near the stream. On the other side is the typical thorn savannah, low grasses, and *Acacia horrida* growing isolated giving the park-like appearance.

PL. XIX.—Drakensberg. Alpine Type. *Proteas* and *Ericas* in the valley on the right. On the left in the background a Yellow Wood Bush facing south-east. In the foreground the shrubby plant is *Metalisia muricata*.

PL. XX, FIG. 1.—Town hill, Pietermaritzburg. High Level Veld. The soil is of the loose, well-aërated type. The grasses grow tall. *Anthistiria imberbis* and *Andropogon ceresiæformis*.

FIG. 2.—Foxhill. Low Level Veld. The soil is hard packed, dry, and badly aërated. The white nodules are impure magnesian limestone. The grasses grow low and tufted. *Anthistiria imberbis* and *Sporobolus indicus*.

PL. XXI, FIG. 1.—Claridge. High Level Veld in the foreground. *Anthistiria* and *Andropogon* grading into a *Cyperus vlei*. In the background a bush clearing where various half-shrubby veld plants are taking the field; e.g. *Nidorella* sp., *Leonotus leonurus* and *Plectranthus* sp. *Richardia albomaenlata* and *Galtonia candicans* are also abundant in this place.

FIG. 2.—Zwartkop. High Level Veld. Photograph taken August 19th. The new grass growing in tufts, and numerous associated plants are scattered through it. *Ethulia conyzoides* is seen in flower.

PL. XXII, FIG. 1.—Beyond Mountain Rise, Pietermaritzburg. Vlei with *Phragmites*, *Cyperus*, *Erianthus*, *Setaria* and *Typha*.

FIG. 2.—Beyond Mountain Rise, Pietermaritzburg. General view of a *Cyperus* Grass Vlei grading into the veld on either side.

PL. XXIII, FIG. 1.—Zwartkop. The three formations, Woodland, Grassland and Marsh (bush, veld, and vlei) grading into each other. In the foreground *Cyperus latifolius*. In the background the tall grass *Erianthus capensis* and *Combretum* bush. On the left *Anthistiria* veld. On the right a bush clearing.

FIG. 2.—Near Maritzburg. Secondary Associations. In the foreground *Sporobolus indicus*. In the background *Solanum auriculatum* and various planted trees, chiefly wattle (*Acacia mollissima*), *Eucalyptus*, *Pinus insignis*.





*Bees.*

FIG. 1.—PES-CAPRE ASSOCIATION AND SAND-DUNE BUSH.



*Bees.*

FIG. 2.—SALICORNIA-CHENOLIA ASSOCIATION AND MANGROVE FORMATION.





*Bews.*

FIG. 1.—COMBRETUM BUSH. SCATTERED MIDLAND TYPE.



*Bews.*

FIG. 2.—COMBRETUM BUSH. INSIDE.





*Bews.*

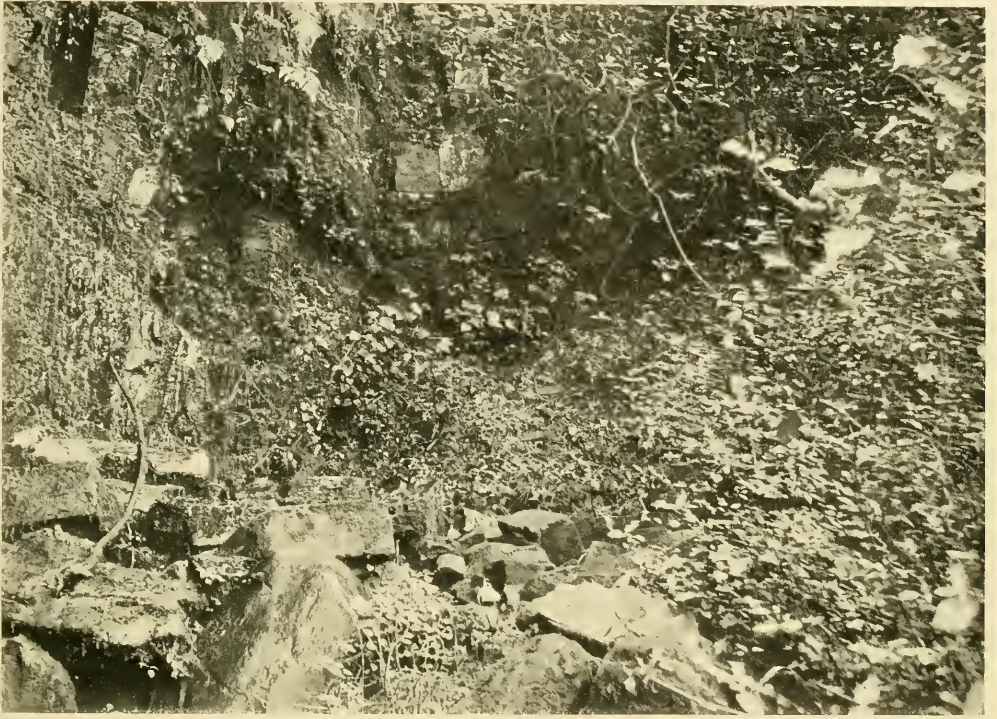
FIG. 1.—ROCKY STREAM TYPE OF BUSH.



*Bews.*

FIG. 2.—ROCKY STREAM BUSH. INSIDE.





*Bears.*

FIG. 1.—MOIST BANK NEAR WATERFALL, ROCKY STREAM BUSH.



*Bears.*

FIG. 2.—THORN VELD.









*Altenstou.*

ACPISE TYPE, DRakensberg.

*Adlard & Son, Impr.*





*Beers.*

FIG. 1.—TYPE OF SOIL AND GRASS IN HIGHER LEVELS.



*Beers.*

FIG. 2.—TYPE OF SOIL AND GRASS IN LOWER VALLEY LEVELS.





*Bers.* FIG. 1.—ANTHISTIRIA GRASS VELD IN THE FOREGROUND, VLEI AND BUSH-CLEARING IN THE BACKGROUND.



*Bers.* FIG. 2.—VELD. EARLY SPRING CONDITION.





*Beers.*

FIG. 1.—VLEI. PHRAGMITES, ERIANTHUS, AND CYPERUS.



*Beers.*

FIG. 2.—GENERAL VIEW OF A CYPERUS-GRASS VLEI AND THE VELD.





*Bees.*

FIG. 1.—CYPERUS-ERIANTHUS VLEI, COMBRETUM BUSH, AND ANTHISTIRIA GRASS VELD.



*Bees.*

FIG. 2.—SECONDARY ASSOCIATIONS. SPOROBOLUS GRASS WITH PLANTED TREES.







## On Afrodonta Melv. and Pons., with Descriptions of New Species.

By

**Henry Clifden Burnup.**

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With Plate XXIV.

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IN the year 1908 Messrs. Melvill and Ponsonby<sup>1</sup> founded the genus *Afrodonta*, of the family *Endodontidæ*, for receiving the new species *bilamellaris* *M. & P.* and *trilamellaris* *M. & P.* Subsequently Mr. Henry Suter wrote to Mr. Ponsonby pointing out the insufficiency of distinct generic characters to support such an arrangement, and suggesting the inclusion of these species in *Thaumatodon Pilsbry*, a section of the sub-genus *Endodonta Albers*, of the genus *Endodonta Albers*, to which the new forms seem intimately related.

Further correspondence between these gentlemen and myself ensued, in which the convenience of having a distinct group for the African forms was borne well in mind, and it was ultimately decided to be desirable to disrate *Afrodonta* from generic to sectional rank, parallel to *Helenoconcha Pils.*, etc., and near to *Thaumatodon*. The species, as far as is yet known, are confined to South Africa, and are probably separable from *Thaumatodon* by their generally smaller size, finer sculpture, and more transparent shell.

Lt.-Col. H. H. Godwin-Austen, who examined the ana-

<sup>1</sup> 'Ann. and Mag. Nat. Hist.,' ser. 8, vol. i (1908), p. 133.

tomical details of the type of *Afrodonta*, has also been consulted, and, I understand, has nothing to urge in opposition to the new arrangement.

This alteration, together with the discovery of further allied species, makes a modification of the original definition desirable, and in framing it I have, for the sake of convenience in comparison, followed as far as possible Pilsbry's definition of the section *Thaumatodon* as a model.

I take this opportunity of giving a revised description and new figures of a species named *Trachycystis rotula* by Melvill and Ponsonby. A close study of this species shows that it belongs to this section of *Endodonta*, and was wrongly placed in *Trachycystis*.

The specific name being pre-occupied by Hombron in the sub-genus *Charopa* (Sec. *Charopa* s.s.), I propose to substitute for it *perfida*, in reference to the false appearance of external grooves given by the internal folds, imperfectly seen through the translucent shell, as hereinafter explained.

To Messrs. Ponsonby and Suter I am indebted for their advice and help in discussing the true position of *Afrodonta*, and to Mr. J. Farquhar and Major M. Connolly for specimens for examination.

With reference to the peculiar distribution of the toothed *Endodontæ* Mr. Suter has made an interesting suggestion.

In September, 1908, on first seeing specimens of *Afrodonta*, he wrote to me as follows: "These shells are as much entitled to distinction as those of St. Helena, known as *Helenoconcha*, though all seem to be derived from a common stock. It will be remembered that in the '*Journal de Conchyliologie*'<sup>1</sup> the late Mr. Ancy maintained that *Endodonta* was a subantarctic genus, whilst I held that it was chiefly Polynesian.<sup>2</sup> Ancy said that we could not account for the occurrence of *Helenoconcha* on St. Helena unless we admitted that they had come from the Antarctic continent. The discovery of these toothed *Endodontæ* in

<sup>1</sup> '*Journ. de Conch.*,' vol. xlix (1901), p. 17.

<sup>2</sup> *Ibid.*, p. 317.

South Africa affords the missing explanation, and I have made out the following hypothesis:

"The toothed Endodonta, such as *Thaumatodon*, etc., having their headquarters in Polynesia and New Zealand, migrated by the Eocene Antarctic land (*Archinotis*) westward, reaching South Africa, where we find them still living as *Afrodonta*, and from there they must have found their way across the Eocene Archhelenis to St. Helena, being known from there as *Helenoconcha*."

Genus ENDODONTA *Albers*,<sup>1</sup> 1850.

Sub-genus Endodonta *Albers*.

Section *Afrodonta* (*Melv. & Pons.*), 1908.

Shell very small, subdiscoidal, with spire low, convex; broadly umbilicate, or excavated; whorls numerous, tightly coiled; periphery rounded; surface very minutely striate or lirate, unicoloured, translucent. Aperture having one or more internal folds upon the outer wall, or the parietal wall, or both, and one tooth-like fold low on the columella or at the base. Except the parietal folds, which sometimes extend on the body whorl beyond the aperture, all are wholly internal, sometimes out of sight from the aperture. Type *Endodonta bilamellaris* (*M. & P.*).

Distribution.—South Africa.

*Endodonta* [*Endodonta* (*Afrodonta*)] *bilamellaris*  
(*Melv. & Pons.*). Pl. XXIV, fig. 18.

*Afrodonta bilamellaris* *Melv. & Pons.*, *Ann. and Mag. Nat. Hist.*,  
vol. i (1908), p. 134, pl.  
vii, fig. 6.

"A. testa . . . conico-depressa, tenni, cornea, profunde

<sup>1</sup> *Albers*, 'Die Hel.' p. 89.

umbilicata, microscopice longitudinaliter striatula; anfractibus 5, ventricosulis, angustis; apertura lunari, peristomate tenui, bilamellata, lamella vel plica altera marginem apud columellarem in medio valde intrantem, altera basali, conspicua, dentiformi.

“Alt. 0.84, diam. 1.48 mm.

“Hab.—Dargle, Natal; Edendale Falls, June 29th, 1907 (H. C. Burnup).”

The position of the inrunning fold first mentioned in the description would be better described as on the parietal wall than near the columellar margin. In the figure as reproduced the sculpture is represented as being much coarser than it really is.

Further specimens, collected in the Tongaat Beach Bush (Natal), since the species was described, exhibit, in some instances, such contortion of the parietal fold as to give it the appearance of being bifid. Two other specimens in my collection, one from Enon Bush, near Richmond, and one from Hilton Road (both in Natal), though rather above average size, have such weak development of the plaits as to suggest a distinct variety. Each was the only example of the genus found in its locality.

Since writing the above I have also found a single specimen of this species at Ntimbankulu, Mid-Illovo (Natal).

I also give an additional figure showing the basal view of the shell (fig. 18) for comparison with the similar view of trilamellaris in Melvill and Ponsoby's paper.

Endodonta [Endodonta (Afrodonta)] trilamellaris  
(*Melv. & Pons.*).

Afrodonta trilamellaris *Melv. & Pons.*, *Ann. and Mag. Nat. Hist.*,  
vol. i (1908), p. 134. pl.  
vii, figs. 7, 7A, 7B.

“A. testa . . . minuta, cornea, late umbilicata, planorbula; anfractibus 4½, ventricosulis, undique microscopice longitudinaliter tenuistriatis; apertura lunari; peristomate

tenni, tribus lamellis plicive prædito, altera obscura ad basin, interdum incrassata, extensa, interdum dentiformi, altera collumellarem apud marginem medium, longe intrante, tertia interna, incrassata, contra aperturam extensa.

“Alt. 0·80, diam. 1·39 mm.

“Hab.—Dargle, Natal, January, 1907 (H. C. Burnup).”

Again, in the description of this species, reference is made to a columellar lamella or plait, which would be better described as about the middle of the parietal wall. In pointing out the chief distinction between the two species, bilamellaris and trilamellaris, the authors omit a character by which the shells may be distinguished in the field without the aid of a lens: bilamellaris is openly umbilicate (fig. 18), about proportionately with the three new species described hereunder (figs. 10, 13, 17), while trilamellaris is widely excavated, even in excess of perfida (fig. 4).

Endodonta [Endodonta (Afrodonta)] perfida *n. name*.

Pl. XXIV, figs. 1–6.

Trachycystis rotula *Melv. & Pons.*, Ann. and Mag. Nat. Hist.,  
vol. xix (1907), p. 99, pl.  
vi, figs. 12, 12A; *ibid.*, vol.  
i (1908), p. 135.

Shell minute, subdiscoidal, deeply and widely excavated, horn-colour, thin, translucent; whorls 5, narrow, convex, the last rounded at the periphery, deeply impressed at the sutures, very closely microscopically lirated except the first  $1\frac{1}{2}$ , which are smooth; aperture nearly erect, broadly crescentic, with thin peristome slightly thickened towards the columella, and furnished with the following internal, deep-set, strong lamellæ or folds: (A) One on the basal wall, whitish, set back from the peristome about one-fifth of the last whorl, and in-running for about one-fourth of the whorl: (B) one on the outer wall, also whitish, squarish and very strong, about the same length, and set back nearly as far from the

aperture as the basal fold, and running parallel to it; (c) one on the parietal wall, very wide, very strong, strengthening in its advance inwards, flat, angled above and below, scarcely paler than the rest of the shell, and set further back from the aperture than the other two.

Height about 0·85 to 0·95, width about 1·80 to 1·95 mm.

Hab.—Fern Kloof, Grahamstown (J. Farquhar).

The type, in the British Museum, not being available to me for exact measurement, the dimensions given above are to be taken as a fair average, ascertained from other adult examples collected by Mr. Farquhar at the same locality as the type.

The folds on the outer and basal walls, being solid, show no corresponding sulci on the outside, where, however, their positions may be seen through the semi-transparent shell. Each appears as two little pale bands nearly parallel, separated by a dark space and converging towards the ends, suggesting the presence of a groove on the outside of the shell. The reason for this complex appearance seems to be that the light, entering the thin, translucent shell from all sides, is strongly reflected from the polished exterior of the folds, thence showing, through the shell, as the pale bands: but, as it cannot escape through their solid centres, the dark spaces there intervene.

In well-matured specimens none of the folds can be clearly, if at all, discerned through the aperture before breaking away part of the outer wall, but, in younger shells, those on the outer and basal walls can be traced indistinctly.

The shell, with part of the outer wall broken away to show the internal folds, depicted in fig. 5, was, before being broken, carefully compared with the type by Mr. Ponsonby and found to correspond in every way.

Fig. 6 shows a shell with about half of the last whorl, and with it the lamellæ on the outer and basal walls, removed, exposing the parietal lamella in its full development.

Although this species is widely excavated and is furnished with three internal lamellæ, it cannot well be mistaken for *trilamellaris*, from which it differs in the following con-

spicuous characters: The shell (of *perfidia*) is larger and relatively lower, though the spire is more elevated above the last whorl; the whorls are more numerous, and the folds are longer and further from the peristome, giving a deceptive appearance of external grooves not observable in *trilamel-laris*.

*Endodonta* [*Endodonta* (*Afrodonta*)] *farquhari* *n. sp.* Pl. XXIV, figs. 7-10.

Shell minute, subdiscoidal with convex spire slightly raised, deeply and moderately widely umbilicate, horn-colour, thin, translucent, silky; whorls 4, narrow, convex, the last rounded at the periphery, deeply impressed at the sutures, very closely microscopically striate except the first  $1\frac{1}{2}$ , which are smooth; aperture nearly erect, broadly crescentic, with thin peristome slightly thickened towards the columella, and furnished with the following internal whitish lamellæ or folds: (A) One near the base of the columella, strong, thick, tooth-like, pointed above, set slightly back from the peristome and running inwards only a short way; (B) three on the outer wall, one about the periphery and the other two at nearly equal distances between it and the columellar fold, the lowest being set back from the peristome a little further than the columellar, the second a little further than the lowest, and the uppermost a little further than the second, and each being about .4 mm. long, fairly strong, and well defined; (C) two on the parietal wall, one a little above and the other a little below the middle, both long and strong, specially the lower, and extending from the indistinct callus, just outside of the aperture, inwards till lost sight of in the interior of the shell.

Height 0.81, width 1.40 mm.

HAB.—Grahamstown; also Port Elizabeth, Kowie, and Bathurst, all in the Cape Province (J. Farquhar). Major Connolly has also sent me specimens from Happy Valley, Port Elizabeth.

This striking species, though relatively scarcely higher than *bilamellaris* and *trilamellaris*, has the spire slightly more raised, the body-whorl being somewhat shallower. In the umbilical region it is very like *bilamellaris*, but the number and arrangement of the in-running folds are abundantly distinct. I have much pleasure in associating with this shell the name of its discoverer, Mr. J. Farquhar, who has supplied me with so much material for this paper.

Judging by Pilsbry's figure of *Endodonta* [*Endodonta* (*Thaumatodon*)] *derbesiana* (*Crosse*<sup>1</sup>) in 'Man. Conch.,' 2nd ser., "Pulmonata," vol. ix, pl. iv, figs. 33, 34, a species inhabiting New Caledonia, this species (*farquhari*) bears a strong superficial likeness to *Crosse's*. The lamellæ are similar in form and position, but the latter species has an additional small plait between the three on the outer wall and that on the columella. The sculpture of the New Caledonian shell is very much coarser than that of *farquhari*. I have in my collection shells, received from correspondents in widely separated countries, agreeing inter se and labelled "*Thaumatodon derbesiana Crosse, New Caledonia,*" but they do not agree with *Crosse's* description or with Pilsbry's figure of that species. I can therefore only infer that they have been wrongly identified, and I consider that they represent *Gude's* species, *E. (Thaumatodon) quadridens*,<sup>2</sup> with whose description and figures they agree very well. This species, compared with *E. (Afrodonta) farquhari*, is easily separated by the upright direction, parallel to the peristome, of the second process within the outer wall and by its much coarser sculpture.

The six lamellæ of *farquhari* naturally suggest a comparison with *E. (Thaumatodon) sexlamellata (Pfr.)*,<sup>3</sup> but that species, being much larger and widely different in detail, need not be considered.

<sup>1</sup> *Helix derbesiana Crosse*, 'Journ. de Conch.,' vol. xxiii (1875), p. 143.

<sup>2</sup> *Gude*, 'Journ. Malac.,' vol. xii (1905), p. 13, pl. iv, figs. 9 A-D.

<sup>3</sup> *Helix sexlamellata Pfr.* in 'Zeitschr. f. Mal.' (1845), p. 85.

*Endodonta* [*Endodonta* (*Afrodonta*)] *novemlamellaris* *n. sp.* Pl. XXIV, figs. 11-13.

Shell minute, depressed conic-oval, with convex spire slightly raised, deeply and moderately widely umbilicate, horn-colour, thin, translucent, silky; whorls  $4\frac{1}{2}$ , narrow, convex, the last rounded at the periphery, deeply impressed at the sutures, very closely microscopically striate except the first, which is smooth; aperture nearly erect, crescentic, with thin peristome, slightly thickened towards the columella, and furnished with the following internal, short, in-running, whitish lamellæ or folds: (A) One near the base of the columella, strong, thick, tooth-like, pointed above; (B) six on the outer wall about equidistant from each other, the first, above the periphery, very small, the second and longest (about 0.15 mm. long) about the periphery, and four below gradually getting smaller and nearer the peristome; (C) two on the parietal wall, in form and position like those of *farquhari*.

Height 0.78, width 1.22 mm.

Hab.—Grahamstown (J. Farquhar); also Kowie (Farquhar), and Kingwilliamstown (Godfrey, per Connolly), all in the Cape Province.

The smallest species of the group yet examined, this has a relative height in excess of that of *farquhari*, an effect produced, not by an increased height of the spire, but by the greater depth of the last whorl. The difference is, however, not so great as would appear from the given dimensions, which are taken from the figures, not from the shells themselves. Thus, the figure of the present species (fig. 11) shows a little more of the base than that of *farquhari* (fig. 8), so, while shortening the spire in perspective, the whole height is slightly exaggerated.

It would appear from some young specimens supplied to me by Mr. Farquhar that the folds are developed at a very early age, and that the mollusc, as it advances towards maturity,

absorbs the material from the inner ends of the lamellæ, and adds it to the outer ends; for the youngest of the shells, consisting of no more than three whorls, and measuring only half a millimetre in greatest diameter, is furnished with a complete set of lamellæ; yet in the adult none of the folds, or at least none of those on the outer wall, extends inwards more than 0.4 mm. from the peristome.

The specimen from Kingwilliamstown is slightly larger than the type, and is the largest shell of the species that I have seen, measuring 0.79 mm. in height and 1.32 in width. It belongs to the collections of the South African Museum, Cape Town.

*Endodonta* [*Endodonta* (*Afrodonta*)] *inhluzaniensis*  
*n. sp.* Pl. XXIV, figs. 14-17.

Shell minute, depressed conic-oval with convex spire slightly raised, deeply and moderately widely umbilicate, pale horn-colour, thin, translucent, dull; whorls 4, narrow, convex, the last rounded at the periphery, deeply impressed at the sutures, closely microscopically lirate, except the first  $1\frac{1}{2}$ , which are smooth; aperture nearly erect, crescentic, with a distinct callus connecting the ends of the thin peristome, which is slightly thickened towards the columellar margin. The aperture contains two strong whitish in-running lamellæ or folds as follows: one on the basal wall, rather short, set back a little from the peristome; and one on the outer wall, longer and set further back.

Height 0.86, width 1.44 mm.

Hab.—Inhluzani Mountain, Natal (Burnup).

Only four specimens of this species have yet been found, and all were dead. The pale colour and dulness of the type are probably due to the influence of the weather, for one specimen, rather smaller than the type, is darker and shows the silky lustre of the other species described in this paper. The internal folds of the type can be seen through the shell (as shown in figs. 16 and 17) only by wetting it, but in the

fresher shell they can be seen as distinctly as in the types of the preceding species. Although only bilamellate, this species cannot be confused with *bilamellaris* (*M. & P.*), which, in addition to the basal fold, has its only other process on the parietal instead of the outer wall. The sculpture of the present species, though rather coarser than that of any other known species of the section, is very much finer than that of any species of *Thanmatodon* that I have examined.

The types of the new species will be placed in the British Museum.

#### EXPLANATION OF PLATE XXIV,

Illustrating Mr. H. C. Burnup's paper "On *Afrodonta Melv. & Pons.*, with Descriptions of New Species."

FIGS. 1-6.—*Endodonta* [*Endodonta* (*Afrodonta*)] *perfida* *n. name.*

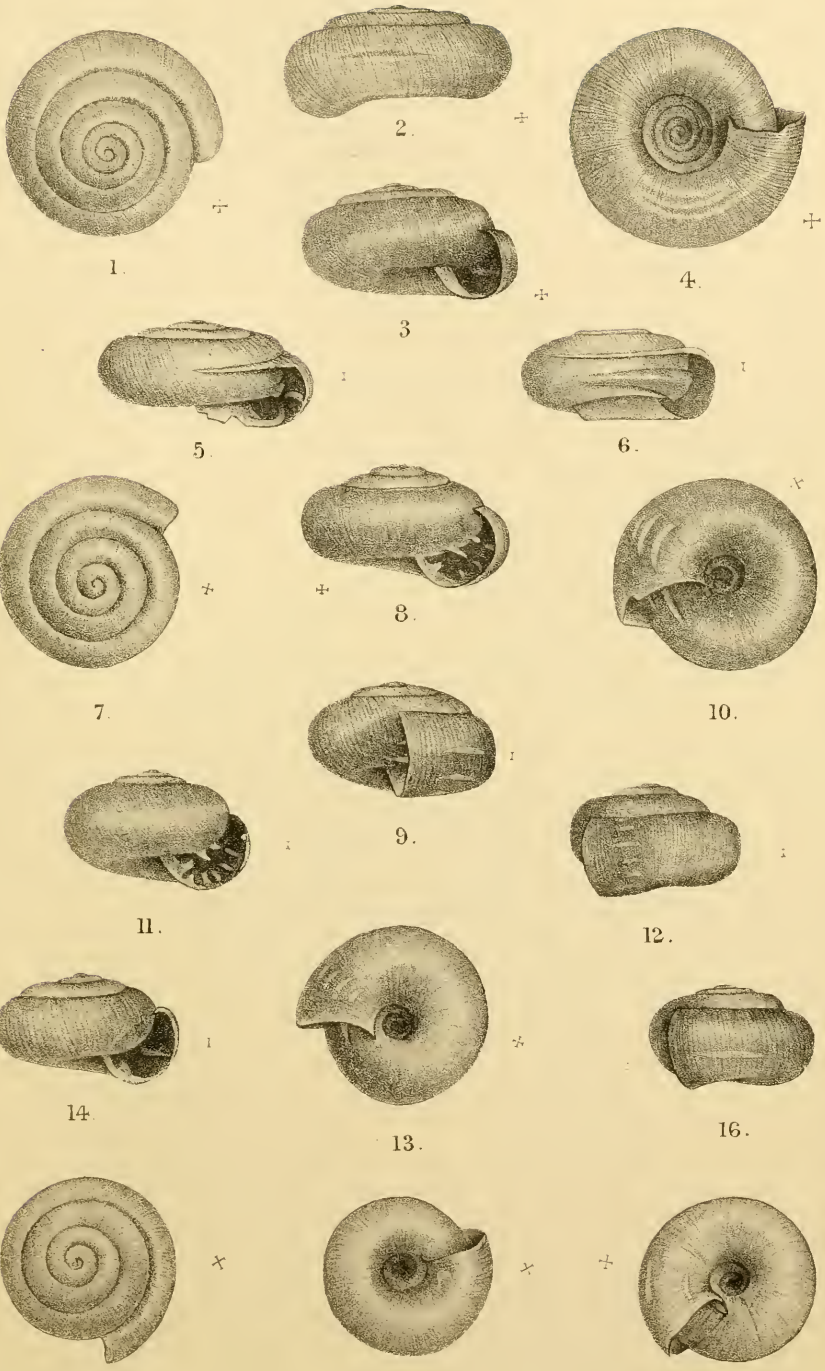
FIGS. 7-10.—*Endodonta* [*Endodonta* (*Afrodonta*)] *farquhari n. sp.* (Fig. 8 only is drawn from the type.)

FIGS. 11-13.—*Endodonta* [*Endodonta* (*Afrodonta*)] *novem-lamellaris n. sp.* (Type.)

FIGS. 14-17.—*Endodonta* [*Endodonta* (*Afrodonta*)] *inhluza-niensis n. sp.* (Type.)

FIG. 18.—*Endodonta* [*Endodonta* (*Afrodonta*)] *bilamellaris* (*M. & P.*)





15. Burnup del.

17. J. Green lith.

SOUTH AFRICAN ENDODONTÆ  
(Sec. AFRODONTIA).



## On Some Specimens of Fossil Woods in the Natal Museum.

By

**Ernest Warren, D.Sc.Lond.**

With Plates XXV—XXVII and Text-figures.

A number of samples of fossil woods from various parts of Natal and Zululand have been received from time to time by the Natal Museum.

These specimens vary considerably in general appearance, texture and specific gravity, and it was thought that it would be of interest to ascertain, if possible, whether any of them belonged to the Palæozoic coniferous species, *Dadoxylon australe* Arber,<sup>1</sup> found in the *Glossopteris* Flora of Australia.

This question is of special interest since the *Glossopteris* Flora of the *Ecca* Formations of South Africa is closely similar to that of Australia and India; and the similarity points to a land connection in those times extending both from Gondwanaland in India and from Australia to South Africa and perhaps even to South America.

A considerable series of sections had been prepared, and some work had already been done on them, when Dr. F. Hatch, in 1910, handed to the British Museum authorities a specimen of silicified wood found by him in the *Ecca* Formation near Ladysmith, Natal.

Mr. Newell Arber kindly contributed a note on the specimen to this *Journal* (*Annals of the Natal Museum*, vol. ii,

<sup>1</sup> Arber, E. A. Newell, 'Catalogue of the Fossil Plants of the *Glossopteris* Flora in the British Museum.' 1905.

part 2, 1910). The structure of the wood was not very well preserved, and the author referred the specimen to the genus *Dadoxylon*, but with the available material could not determine the species.

The exact geological horizon from which the various specimens have been derived could not usually be ascertained in the case of those sent by the general public.

This coniferous fossil wood appears to be more especially characteristic of the Upper Ecca, which includes the Natal Coal Measures.

A specimen (Mus. No. 227) in the Museum of quite similar fossil wood collected by Mr. William Anderson, late Government geologist of Natal, was labelled as being obtained from certain beds of Zululand tentatively regarded as Cretaceous. If this determination be correct, it would appear that similar coniferous types flourished from the period of the Ecca Formation to Cretaceous times.

The majority of the samples are of great hardness (6-7 of scale) and well silicified. The specimens from the phosphate bed near Weenen, Natal, consist largely of phosphate of lime and they are comparatively soft (2-3 of scale). A specimen (2.75-3 of scale of hardness) consisting chiefly of calcium carbonate was obtained from Ingwavuma, Zululand, where Cretaceous beds are in evidence.

In addition to these, specimens of a black fossilized wood (hardness about 3.25) were obtained from a kind of lignite seam out-cropping along the coast of Zululand. This seam is probably late Tertiary or even recent.

A preliminary inspection of the sections demonstrated that all the fossil woods, with the exception of the black one from Zululand, were coniferous, while the latter was undoubtedly dicotyledonous.

### CONIFEROUS WOOD.

A close examination of the sections of the coniferous woods showed that they belonged to at least two species referable to the genus *Dadoxylon*.

The following definition of the genus *Dadoxylon* *End.* is given by E. A. Newell *Arber*.<sup>1</sup>

“Petrified wood of Palæozoic age of the coniferous type closely similar to that of the modern *Araucariæ*. Rings of growth usually well-marked. Xylem centrifugally developed, tracheides as a rule pitted only on the radial walls. Bordered pits, hexagonal in outline, usually contiguous, pluriseriate, more rarely distant and uni- or biseriate. Pith usually large, fistular or solid. Cortex as a rule without gum-canals or resin-cells, but the latter are sometimes found in the cortex, wood and pith.”

*Dadoxylon australe* *Arber* from Australia is described as follows:

“Pith not preserved. Xylem with well-marked rings of growth, each as a rule between 3·5 and 8·5 mm. in radius. Sometimes the growth is irregular . . . Tracheides in transverse section, very small, narrow, square or slightly oblong, with rounded angles, about twenty-five in a millimetre of length. Tracheides short, with hexagonal-bordered pits only on the radial walls. Usually these pits are multi-seriate and crowded, but not infrequently they are found to be uni- or biseriate, distant or few. Medullary rays extremely numerous, uniseriate, very rarely two cells thick, usually 6-12 or more cells in height. The medullary ray cells communicate with the tracheides by 2-6 simple, oblique pits. Cortex absent.”

## I. DADOXYLON—FIRST SPECIES.

### (1) LIST OF SPECIMENS WITH LOCALITIES.

The specimens are arranged as far as possible in accordance with their geological horizons.

The following specimens of fossil woods in the Museum apparently belong to the same species of conifer, and are not clearly separable from *D. australe* *Arber*. They are all silicified, except when otherwise stated.

<sup>1</sup> *Loc. cit.*, p. 190.

Mus. Nos. 212, 213, 214, 215.—South of the mouth of Umhlali River. Found in sandstone near the base of Natal Coal Measures (Upper Ecca). Collected by Natal Geological Survey, 1904. Specimens consist of small pieces, mostly black in colour, and very stony in character. Preservation poor.

Mus. No. 217.—Tongaat, N. Coast, Natal. Sandstone of Natal Coal Measures. Collected by Mr. C. H. Stott, F.G.S., 1908. Preservation bad. Specimen much contorted, but annual rings clearly marked.

Mus. No. 216.—Town Hill, Pietermaritzburg. Natal Coal Measures. Collected 1910. Preservation fair.

Mus. No. 10.—Coast, Natal. Probably from Natal Coal Measures. Collected by Mrs. E. English, 1899.

Mus. No. 11.—Natal. Collected by A. J. Maritz, 1888. Two pieces of different stems, one about 4 in. in diameter, and the other about 6 in. The pith and protoxylem are preserved. This specimen exhibits certain peculiarities which will be described below.

Mus. No. 169.—Railway Cutting, near Estcourt, Natal. Natal Coal Measures (Upper Ecca). Collected about 1898. The specimens consist of large pieces of trunk from 1-3 ft. in height and 1-2 ft. in diameter. They are mostly pale brown in colour without much infiltrated black iron oxide. The annual rings are well marked. Some of the pieces are much flattened by pressure. Preservation fair.

Mus. No. 219.—Umkomaas Valley, Natal. Natal Coal Measures. Natal Geological Survey, 1905. Specimen black through infiltration of iron oxide. Preservation good.

Mus. No. 171.—Drill Hole A, Umlalazi, Natal. Natal Coal Measures. Collected by J. T. Audas, Mines Inspector, 1905. Specimen is a flattened piece of trunk, about 2 ft. in length and 1 ft. in diameter.

Mus. No. 209.—Zululand. Natal Coal Measures? Natal Geological Survey, 1904. Specimens black; one of them is a rounded stem about 4 in. in diameter, and another is a much flattened trunk about 11 in. in diameter. Annual rings very marked.

Mus. No. 223.—Surface near Mission Station beyond Ebanjeni Store, Zululand. Natal Coal Measures? Natal Geological Survey, 1904.

Mus. No. 221.—Krantzkop, Natal. Natal Coal Measures? Collected by J. Landsberg, 1907. Specimen is a piece of trunk about 15 in. in diameter. Annual rings well marked by infiltration of black iron oxide through the "spring wood." Preservation good.

Mus. No. 218.—Klipfontein, Highlands, Natal. *Ecca?*

Mus. No. 224.—Bergville, Natal. Probably Natal Coal Measures. Natal Geological Survey, 1905.

Mus. No. 174.—Orbiefontein, near Harrismith. Probably Natal Coal Measures. Collected by H. R. Smith, 1905. Specimen greyish-brown with annual rings marked out by infiltration of black oxide of iron through the spring wood.

Mus. No. 226.—Reproach Farm, Van Reenen, Natal. Probably Natal Coal Measures. Collected by W. Cullingworth, 1910.

Mus. No. 228.—Normandien, foot of Drakensberg. Natal Coal Measures. Collected by F. Stayner, 1911.

Mus. No. 220.—Phosphate Beds. Weenen, Natal. *Ecca* or Beaufort. This fossil wood consists largely of phosphate of lime. Preservation poor.

Mus. No. 225.—Dug up in donga, associated with reptile remains. "Will Brook," Esteourt, Natal. Probably Beaufort Beds. Collected by Mrs. E. Turner, 1905.

The reptile remains are characteristic of the Beaufort Beds. Neither the reptile fossils nor the pieces of silicified wood were water-worn, and it would therefore appear that they were not transported.

Mus. No. 227.—False Bay, Zululand. Cretaceous? Natal Geological Survey, 1904. The fossil wood was pale in colour and very completely silicified. The histological characters were not well preserved. In a part of a section bordered pits could be made out in one, two or three closely packed rows. The wood is undoubtedly coniferous, and there is nothing to distinguish it from the wood of the Natal Coal

Measures and Beaufort Beds; but the preservation was not sufficiently good to be able to state that it was identical in all respects.

Mus. No. 12.—Ingwayuma, Zululand. Cretaceous? Presented by J. von Mengershausen, 1904. This fossil wood consists chiefly of carbonate of lime. The specimen was about 8 in. in length and 3 in. in diameter and showed the base of a lateral branch. Preservation very poor.

We see from this series of specimens that the same or closely similar species of conifer occur in the lower portion of the Upper Ecca as at Umhlali, through the whole of the Natal Coal Measures as at Van Reenen and Harrismith, and apparently into the Beaufort or Reptile Beds as at Estcourt. There is also some evidence that a very similar, if not identical, coniferous wood occurs in the Cretaceous Beds in Zululand.

Mr. C. H. Stott, F.G.S., who has made a careful study of the local geology, informs me that he has never found such fossil wood in the Lower Ecca Series, or Ecca Shales proper.

If it can be proved that the same conifer flourished from the bottom of the Natal Coal Measures (Permo-Carboniferous) into the Cretaceous period, it would seem to indicate a remarkable uniformity of climatic conditions for a very prolonged period.

## (2) DESCRIPTION OF FIRST SPECIES.

Average width of annual rings in different samples varies from about 3 mm. to about 8 mm. There is great variation in the width even in the same piece of wood.

Tracheides squarish or oblong in cross-section, angles rounded. Average tangential width 0.034 mm. A considerable difference generally occurs between the tracheides of the "spring-wood," and those of the "autumn-wood." The former are thinner-walled, and have a greater average radial width (0.037 mm.) than the latter (0.028 mm.). The length of the tracheides is short, but apparently very variable in the

same sample: An average length is difficult to determine, and it is safest to state that many of the tracheides appear to have a length of about 0.8 mm. Bordered pits are confined to the radial walls; they are usually in three rows, and exceptionally in four, in the thin-walled spring tracheides, and biseriate or uniseriate in the autumn tracheides. In the spring tracheides the pits are closely contiguous and generally somewhat hexagonal in outline, in the autumn tracheides with one or two rows they may be closely contiguous and slightly hexagonal, or more or less separate and scattered when they are rounded in outline. There is also variation in their arrangement; when in double series the pits of each row may alternate, or they may be in pairs opposite to one another. Diameter of bordered pit 0.0081 mm., central opening generally circular (text-fig. 1, A).

Medullary rays are numerous, there being an average of about 6 to every millimetre of tangential length: usually one cell thick, varying in height from 3-14 cells, the average number being about 7. Radial length of medullary cells variable; the average is 0.139 mm., or about four times the average radial width of a tracheide. Average tangential width of medullary ray cells 0.021 mm., and vertical height about 0.027 mm.

The medullary ray cells communicate with the tracheides by simple oval pits, there being 2-8, more usually 4, of such on the surface of contact between the medullary cell and tracheide. The long axis of the pits may be oblique or horizontal. The pits are sometimes narrow and slit-like.

In some of the specimens the medullary cells contained a homogeneous yellow substance which perhaps represents resin.

One sample (Mus. No. 11) calls for special remark. The exact locality is unknown. The label attached to the specimen is: "Natal. Presented by A. J. Maritz, 1888." I have been unable to obtain further information with regard to it, and consequently the geological horizon is unknown, but it is probably Natal Coal Measures. The fossil is pale brown,

and the annual rings are not very sharply marked. The specimen consists of two pieces of different stems, one being about 6 inches in diameter and the other about 4 inches. In both pieces the pith and protoxylem are present.

DESCRIPTION.—Pith, diameter of the rounded cells about 0.037 mm. The pith cells bordering the protoxylem are somewhat flattened (text-fig. 1, C.). Outside the pith there is a variable number of spiral vessels varying in diameter from 0.30 to 0.042 mm. They may be rounded or somewhat hexagonal in cross-section. The spiral thickening may be irregular so that the vessel tends to be reticular in character as is shown in the innermost vessel in the figure. The row of dark dots bordering the edge would appear to be an optical effect of seeing the spiral thickening in profile.

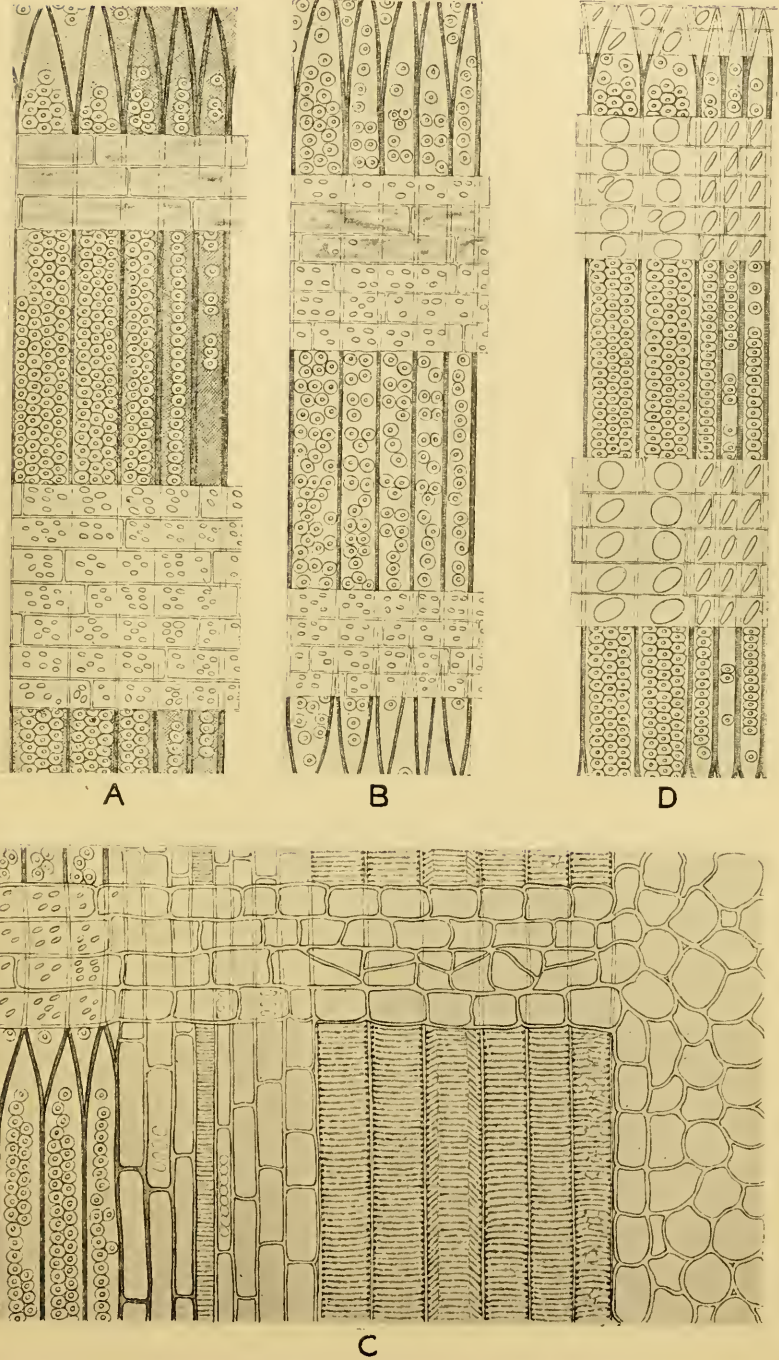
Outside the spiral vessels there may be a variable number of rows of more or less vertically elongated cells, those nearer to the vessels being shorter than the outer ones. In these the walls are thinner than in the tracheides. They may be regarded as wood parenchyma. A much narrower vessel was observed in one of the sections in the midst of this tissue. In the figure a medullary ray is seen extending inwards to the pith. In the neighbourhood of the pith the medullary cells tend to be of irregular shape.

The elongated cells between the spiral vessels and tracheides

#### TEXT-FIG. 1.

- A.— $\times 200$ . Radial section of *Dadoxylon* (probably *D. australe* *Aber.*). Umkomaas Valley. Natal Coal Measures. Mus. No. 219. Autumn and spring tracheides are shown. The cells of the upper medullary ray apparently contained resin. Pits are close set, and tend to be hexagonal.
- B.— $\times 200$ . Radial section of *Dadoxylon* (probably *D. australe*). Natal. Mus. No. 11. Pits are generally scattered; but in some parts of the same section they are much more closely packed than here represented.
- C.— $\times 200$ . Radial section of *Dadoxylon* (probably *D. australe*) through pith and protoxylem. Natal. Mus. No. 11. It may be noticed that the pits of the tracheides are more closely set than in Fig. B.
- D.— $\times 200$ . Radial section of *Dadoxylon* sp. Damnhanser. Natal Coal Measures. Mus. No. 160. The pits between the medullary cells and tracheides are mostly solitary and large.

TEXT-FIG. 1.



appear to usually possess no pits, but in one or two cases there were indications of simple pits being present between the cells themselves, and also between them and the medullary cells.

Outside this tissue there is the ordinary tracheide tissue with bordered pits, and with simple pits communicating with the medullary cells.

Average width of annual rings about 3.5 mm.

Tracheides square in cross-section, average tangential width 0.032 mm. Length variable; many of them appear to be short and about 0.75 mm. in length. Pits on the radial walls. These pits are more circular in outline and less closely packed than in the other specimens. In the majority of the tracheides they are uniseriate or biseriate, but frequently they are not in contact with one another, and even when in contact they are not closely packed, and the pits consequently exhibit no flattening. When biseriate the pits are generally arranged opposite to one another in pairs (text-fig. 1, B). In the spring-wood with wider tracheides there may be three rows of pits fairly closely packed.

Medullary rays are numerous, there being an average of about seven rays to every millimetre of tangential length: one cell thick, average number of cells in height about seven. Radial length of medullary cells about 0.115 mm., tangential width, 0.019 mm. The medullary cells communicate with the tracheides by 2-5 small oblique or horizontal pits. Resin was apparently present in many of the medullary cells.

From the description it will be seen that there is no striking distinction between this wood and that of the other specimens. The more rounded outline and the generally less crowded condition of the bordered pits are the only tangible differences. A general examination of all the sections shows that the arrangement of the pits is a very variable character, and although in this specimen they are distinctly more scattered than usual, yet it does not appear to be a sufficiently definite character for founding a new species. Possibly the tracheides of young stems tend to have the pits more loosely

arranged than in the tracheides of older trunks, or there may be some variation according to the part of the tree from which the wood has come.

## II. DADOXYLON—SECOND SPECIES.

The specimen (Mus. No. 160) about to be described was ploughed up on Cronje's Flat, Dannhauser, Natal, and sent to the Museum by Mr. William Pile, C.E., manager of the Cambrian Colliceries, 1905. The specimen consisted of a flattened trunk about 1 ft. in height and 1 ft. in diameter, and exhibited well-marked annual rings. It undoubtedly came from the Natal Coal Measures (Upper Ecca).

DESCRIPTION.—Average width of annual rings about 3 mm.

Tracheides squarish in cross-section, mean tangential breadth 0.035 mm., length frequently about 0.8 mm. Bordered pits somewhat hexagonal; in spring-wood closely packed in two or three series, in autumn-wood often in single rows, and more usually in contact and somewhat flattened. Diameter of pit 0.009 mm.

Medullary rays numerous, on the average about seven to every millimetre of tangential length: uniseriate, and the mean number of cells in vertical height is about seven. Average radial length of medullary cell 0.084 mm., tangential width, 0.017 mm., vertical height about 0.020 mm.

The surface of contact between a medullary cell and tracheide is perforated by a single large simple pit. The pit may be a long, narrow, oblique slit, or it may be wide, and even almost circular.

Remains of resin were not noticed in the medullary cells.

This species is sharply marked off from the other by the pits being single in the radial walls of the medullary cells, and by the medullary cells being generally shorter in radial length; but in all other characters there is little to separate it.

## III. SYSTEMATIC POSITION.

With regard to the systematic position of these fossil woods, there would appear to be nothing to prevent the first series being referred to the species *Dadoxylon australe* *Arber*. The second species, with single pores between medullary cells and tracheides, recalls in this character *Araucarioxylon latiporosum* *Kraus* from the Jura of Spitzbergen, but in the former the medullary cells extend across two to three tracheides, while in the figure of the latter given by Schenk<sup>1</sup> they only extend across one.

## IV. CHEMICAL COMPOSITION AND PHYSICAL PROPERTIES.

In order to ascertain the nature of the mineral substances replacing the substance of the woody tissues and more or less

Chemical substance.	Localities and analyses of specimens.							
	Natal. Mus. No. 11. Species I.	Umko- maas. Mus. No. 219. Species I.	Krantz- kop. Mus. No. 221. Species I.	Drakens- berg. Mus. No. 171. Species I.	Weenen Phos- phate bed. Mus. No. 220. Species I.	Ingwa- vuma, Zulu- land. Mus. No. 12. Species I.	Dann- hauser, Natal. Mus. No. 160. Species II.	
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
Silica . . . . .	94.90	91.70	94.38	95.90	1.20	0.03	80.30	
Oxide of iron . . . . .	3.12	2.35	1.71	2.40	2.84	0.88	2.70	
Oxide of manganese . . . . .	—	—	—	—	—	1.64	—	
Oxide of alumina . . . . .	0.08	0.65	0.24	0.80	—	0.92	2.80	
Oxide of lime . . . . .	—	0.64	0.14	0.05	49.46	52.42	7.05	
Oxide of magnesia . . . . .	—	0.05	0.11	0.03	—	0.73	0.10	
Carbon dioxide . . . . .	0.70	—	—	0.09	2.00	42.20	—	
Phosphoric anhy- dride . . . . .	Trace	0.05	0.25	0.14	40.29	.01	6.58	
Sulphuric anhydride . . . . .	..	Trace	Trace	Trace	—	Trace	Trace	
Water at 100° C. . . . .	0.30	2.45	1.77	0.38	1.40	} 1.25	0.85	
Hydrogen . . . . .	0.17	0.11	0.10	—	0.80		} 0.09	0.09
Carbon . . . . .	0.34	2.38	2.22	—	3.10			0.13

<sup>1</sup> Zittel, Karl A., 'Handbuch der Paläontologie.' II, "Paläophy-  
tologie," p. 868. 1890.

filling the cavities, and the amount of the original carbon of the wood remaining in the fossils, Mr. Neville Nevill, F.R.S., Government Chemist, kindly caused a number of the samples to be carefully analysed. The result of the analyses is given above.

These analyses at once show that the amount of carbon remaining from the wood is very small. Ordinary wood contains about 50 per cent. of carbon, while in the silicified specimens Nos. 219, 221 there is a little over 2 per cent., and in Nos. 160, 174 practically nil.

The amount of oxide of iron varies from about 1-3 per cent. In all the specimens except in the phosphatized wood (Mus. No. 220) and in the calcified wood (Mus. No. 12) the great mass of the fossil consists of silica.

The silica is largely in the crystallized form, since under polarized light the field as a whole remains equally illuminated during the revolution of the analyser, except that the tracheide walls show much less brilliance, and sometimes they are isotropic. It would thus appear that the silica, which penetrates the walls of the tracheides and cells and ultimately for the most part replaces them, may retain the amorphous form, while that which fills the cavities mostly becomes crystallized.

By ascertaining the specific gravity of the fossil wood and knowing that of the mineral constituents and the amount of such constituents, it would at first sight appear possible to approximately calculate the amount of space left unoccupied by solid matter. But the specific gravities of minerals, such as silica, vary greatly according to the physical condition of the mineral, whether crystallized or amorphous, and the method would therefore be wholly unreliable.

The following table gives the specific gravities of the seven samples, and a rough estimation of the amount of unoccupied space deduced from microscopic examination, and from the relative amount of water absorbed after an immersion for half an hour, taking the Weenen fossil wood as the standard.

Mus. No.	Locality, etc.	Sp. gr.	Rough estimation of the percentage of space unoccupied by solid matter.
11	Natal. (Silicified)	2.45	1.5
219	Unkomaas. (Silicified)	2.54	0
221	Krantzkop. (Silicified)	2.53	0
174	Drakensberg. (Silicified)	2.59	0
220	Weenen. (Phosphatized wood)	1.95	25
12	Ingwavuma. (Calcified wood)	2.51	0
160	Damhauser. (Silicified)	2.43	3

The Weenen wood is the lightest, and we have already seen that it is soft (2-3 of scale) and friable. It might, therefore, have been anticipated that a considerable amount of space is unoccupied by solid matter, and it is seen by the above table that some 25 per cent. is thus vacant. The greater the amount of such space the greater the play there would be for contortion and compression under pressure subsequent to fossilization, and as a matter of fact some of the most shattered samples possess the most vacant space (Pl. XXV, fig. 3).

#### V. FOSSILIZATION.

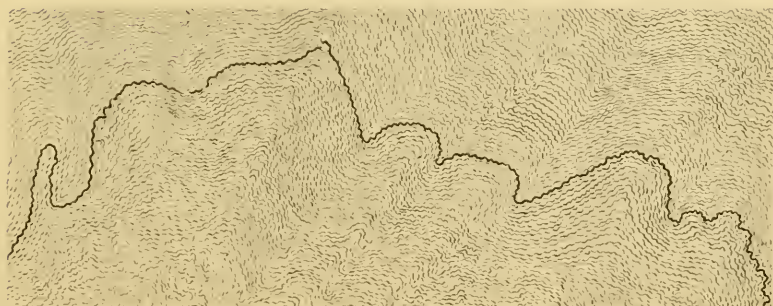
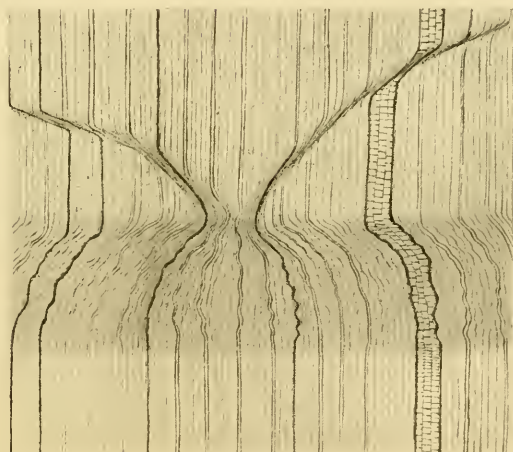
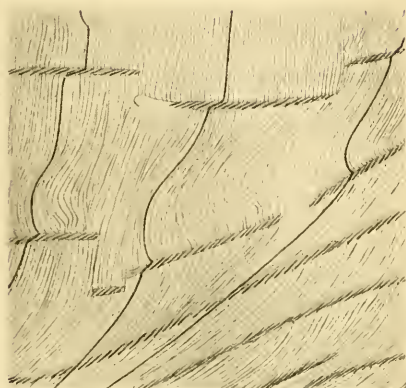
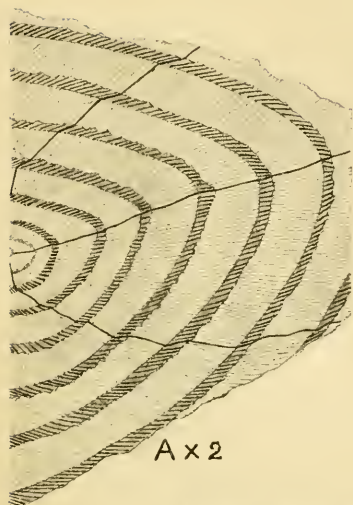
Considerable differences occur in the manner of fossilization. In silicification the first process seems to be the infiltration of silica in solution into the actual substance of the walls of the

#### TEXT-FIG. 2.

Examples of contortion in specimens of fossil wood of *Dadoxylon* (A, B, C) and *Eugenia* (D).

- A.—× 2. Transverse section of *Dadoxylon* sp., Damhauser, Natal, Mus. No. 160, showing black compression bands arising from simple downward pressure. The course of three medullary rays is especially indicated.
- B.—× 3. Transverse section of *Dadoxylon* (probably *D. australe*), Togaat, Natal, Mus. No. 217, showing effects of pressure exerted in at least two directions.
- C.—× 20. Transverse section of *Dadoxylon* (probably *D. australe*), Mus. No. 169, showing the effects of pressure exerted from various directions.
- D.—× 4. Transverse section of *Eugenia*, Port Durnford, Mns. No. 232, showing the remarkable contortion of the tissue with little actual rupture of the elements.

TEXT-FIG. 2.



D x 4

lignified tracheides and medullary cells, and both previously and subsequently to this infiltration the tissue of the wood may undergo through pressure great contortion and differential movement. Most of the lignified substance ultimately disappears and is entirely replaced by silica. Later the cavities may be partially or almost completely filled with silica in the form of chalcedony.

The tissue of the wood forms a definite map whereby the differential movement caused by pressure may be accurately traced, the medullary rays being particularly useful in this respect.

Sheering movement mostly occurs along the lines of the widest tracheides (spring-wood), that is in the region of relative weakness. Very frequently a special infiltration of black oxide of iron occurs along these sheering lines and this may produce a very conspicuous ringing to the wood (text-fig. 2, A). A slight difference in the texture of the original lignified wall of the spring tracheides and a more ready circulation of water through them have probably caused this curious differential staining with iron oxide. The inner edge of the black ring, which is generally close to (text-fig. 3), or actually in contact with (text-fig. 2, A), the autumn-wood of the previous year, tends to be sharply defined; while the outer edge, where the spring-wood is gradually passing over into autumn-wood, is more irregular. Great pressure acting from different directions may produce remarkable faults and sheering phenomena analogous on a microscopic scale to the great faults and contortions seen in geological strata, the structure of the wood exhibiting very clearly all the movements which have occurred (text-fig. 2, A, B, C).

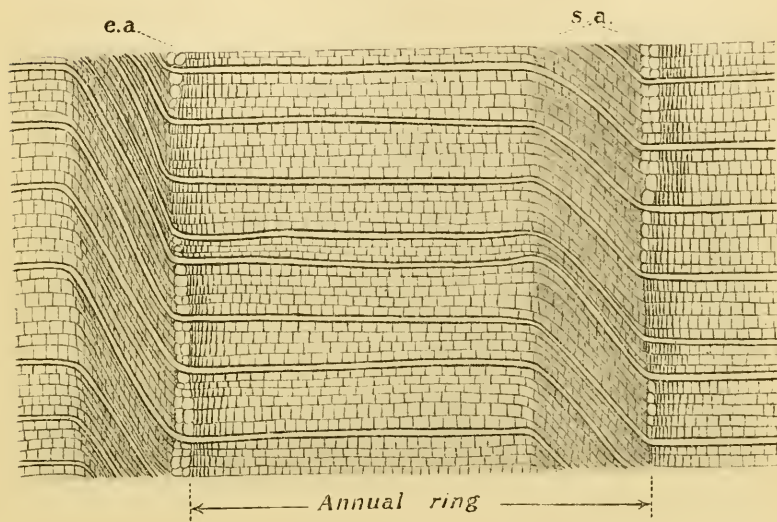
In fig. A the specimen experienced a great flattening pressure, and sheering took place along the six shaded bands. The course of three medullary rays has been strongly indicated for the purpose of showing the result of the differential movement. The bands are black through iron staining.

In fig. B the wood has been subjected to enormous pressure which has been applied in different directions at different

times, and consequently the course of the medullary rays is remarkable. Fig. C shows a more unusual case where great pressure from the sides and also from above occurred.

These sheering movements may occur before, during or subsequently to complete silicification. If they occur before

TEXT-FIG. 3.



*Dadoxylon* sp.— $\times 35$ . Transverse section showing sheering areas (*s. a.*) running through early spring-wood near to, but not necessarily quite in contact with, the edge (*e. a.*) of the autumn-wood of the previous year.

fossilization the outlines of the flattened cells would tend to be more or less observable, if during fossilization the outlines would be less clear, and if subsequently the silicified walls would be shattered, especially if the cavities of the elements had not been completely filled, and the organic structure would tend to be completely lost.

The silica which impregnates and ultimately replaces the walls of the tracheides and cells may contain dark granules which have the appearance of being oxide of iron (Pl. XXV, fig. 1, *b. s. t. w.*). Sometimes this blackened silica occurs over

only a portion of a tracheide wall, as shown in one of the upper tracheides of the figure. The silica which subsequently fills the cavities of the tracheide may in a similar way be either colourless or blackened.

It is particularly observable that in the sheering bands (Pl. XXV, fig. 2) the silica is generally blackened.

In these bands it may be very usually seen that the medullary rays (fig. 2, *m.r.*), although of course bent, do not in themselves exhibit so much flattening and distortion as the surrounding tracheides. This appears to be only explicable by supposing that the sheering took place after partial silicification, the walls of the tracheides being only partially impregnated while the medullary cell cavities were already filled and supported by solid silica. Subsequently, on pressure being applied, the surrounding incompletely silicified tracheides would be flattened and contorted, while the medullary rays supported by silica would be less affected.

It is, indeed, quite likely that, owing to the difference in the tissue of the medullary rays and wood proper, the rays might become filled with silica before the tracheides, and the cracks that would necessarily arise in the silica through differential movement of the solid mass would be re-cemented together by silica.

An examination of the specimens of calcified wood demonstrates that calcium salts are far less satisfactory than silica as fossilizing agents.

In the case of the phosphatized wood from the beds at Weenen the chief mineral constituent is calcium phosphate. This substance does not appear to be able to actually enter the lignified substance of the tracheides like silica, since in section (Pl. XXV, fig. 3) remains of the lignified walls can be seen in an apparently little altered condition (*o.t.w.*) between the mineral walls. It would clearly appear that the mineral salts are laid down on the inner side of the lignified walls to form a kind of cast of the cavities, and that it is gradually added on to from the outside as the lignified walls slowly disappear. A secondary deposition of mineral matter

is frequently seen forming a more or less complete inner layer to the cast. In some cases this mineral appears to be silica. Sometimes the whole tracheide cast is solid and homogeneous throughout as at *s.c.c.*, fig. 3. At other times a perfectly opaque black mass (*o*) occupies the cavity. This is probably iron oxide. The casts frequently exhibit cracks which were subsequently filled in by secondary deposition of mineral matter (fig. 3, *p.f.*).

A comparison of figs. 5 and 6 is of much interest in showing that sheering took place at two different times during fossilisation. At fig. 6 the tracheides were bent out of shape before the cavities were filled with the mineral substance, and at fig. 5 the sheering took place subsequently, and the mineral casts (*s.S.t.*) of the tracheide cavities were shattered.

With crossed prisms of polarizing apparatus a dark reticulum is seen. In fig. 4 this dark portion includes any of the original tracheide wall that persists, and also the outer portion of the mineral cast. The remainder of the wall of the cast exhibits irregular radial dark and light bands or patches. The inner secondary layer is generally brighter than the primary cast. It is suggested that the different optical reaction of the mineral substance of the outer portion of the cast may be due to slight impregnation with organic matter from the decomposing lignified walls of the tracheides.

In the case of the calcified wood from Ingwavuma, which is possibly of Cretaceous origin, the main mineral substance is calcium carbonate (see table of analyses, p. 356). This appears to be a very poor fossilizing agent for the woody tissue. The structure of the wood is badly preserved; but a careful examination of transverse and longitudinal sections proved that the wood was undoubtedly coniferous, similar in character to the silicified specimens; but as the pits were not distinguishable a reliable determination could not be made.

Pl. XXV, fig. 7 represents a transverse section. On the left-hand side the elements of the wood, consisting of tracheides (*r.t.t.w.*) and medullary rays (*t.m.r.*), are visible in the shadowest outline only. In the middle of the section the tissue is clearly seen (*o.t.w.*). The walls are of the

normal thickness and are of a yellow colour. The section is viewed with crossed prisms. On the right of the section the tissue is obliterated and a radiating spherulitic structure is observable.

The calcium carbonate can apparently pass with difficulty into the substance of the walls of the woody tissue, but with much less thoroughness than with silica. It appears to partially impregnate and embed the organic structure, rather than to actually replace it as in the case of silica. According to the tangential section in Pl. XXV, fig. 9, a partial decomposition of the wall of the tracheides (*r.t.t.w.*) was taking place at the time of the penetration of the mineral substance. The outer swollen portion is diffusely yellowish, due probably to the impregnation of the mineral substance with decomposing organic matter, while the central layer of a deeper colour would appear to represent the less decomposed portion of the wall. In fig. 8 is seen the shadowy, decomposed walls of tracheides, but on the right-hand side a few less swollen walls are observable.

The whole fossil is very solid, and there are practically no spaces left. A newly clipped off piece was carefully weighed and then immersed in water for a short time. On removal, and after being wiped, there was no difference in the weight, thus showing that the water was unable to enter the fossil. In the case of the phosphatized specimens and with some of the silicified woods, a very marked difference in weight was at once observable (see table, p. 358).

## DICOTYLEDONOUS WOOD.

### (1) MODE OF OCCURRENCE AND GEOLOGICAL HORIZON.

Specimens of a black, somewhat friable, fossilized wood have been received from various sources from different parts of the coast of Zululand. Subsequently some specimens collected by the Natal Geological Survey were obtained.

Mr. William Anderson,<sup>1</sup> with respect to these, writes:

“At Port Durnford, Zululand, there is a cliff section containing a bed of impure lignite, overlaid by a series of false-bedded sands, which can be quite easily identified with sections higher up the coast, which undoubtedly overlie beds of Tertiary age containing marine fossils. . . . The lignite bed consists almost entirely of vegetable matter with large masses of timber, and probably having an origin under marshy boggy conditions.

“The upper false-bedded sands outcrop very commonly in sections of the sand-hills on the immediate shore-line, and may yet prove to be of later date than Tertiary.

“The division between the sand beds and the fossiliferous marine strata below is usually a more or less sandy lignitic bed (carbonaceous) containing large pieces of timber comparatively well preserved. This lignitic bed is not always present, and then the sandy beds rest immediately on the fossiliferous marine shales. The lower layers of the sand then contain enormous numbers of fossil spores and spore-cases.”<sup>2</sup>

Immediately above the mammalian bearing shales and below the lignitic bed is a thin layer with enormous numbers of Foraminifera, which, according to G. T. Hinde, were identified as more likely to be of Tertiary than Cretaceous age.

According to R. Ethridge, of Sydney Museum, the mollusca in the mammalian beds are Tertiary and possibly Eocene.

The general arrangement of the strata above described has been confirmed by Mr. A. Hammar, Government Surveyor, who informs me that further north in the St. Lucia district he observed the following section:

(1) at the top a reddish, loose sandstone about 10 ft. in thickness;

(2) a seam of sandstone with much limonite about 5 ft. in thickness;

<sup>1</sup> William Anderson, ‘Third Report of the Geological Survey of Natal and Zululand,’ pp. 54, 122, 123, 124. London, 1907.

<sup>2</sup> I regret that it has not been possible to obtain specimens of these “spores.”

(3) white friable calcareous sandstone about 50 ft. in thickness;

(4) lignite bed about 2 ft. 6 in. in thickness;

(5) at the base running into the sea a greenish-grey, soft, sandy shale.

The largest piece of timber observed was a trunk about 20 in. in diameter.

## (2) LIST OF SPECIMENS WITH LOCALITIES.

Mus. No. 232.—Inyazan Junction, Zululand. Collected by A. Cowley, 1909. Some of these specimens consist of compressed layers of a material having a peat-like appearance.

Mus. No. 230.—Lignite seam. Port Durnford, Zululand. Collected by Natal Geological Survey, 1905. The specimens are obviously woody in nature and are considerably silicified.

Mus. No. 234.—Lignite seam. Port Durnford. Collected by A. Cowley, 1910. Similar to Mus. No. 230, but some of the specimens exhibit stages in the transformation into a jet-like substance.

Mus. No. 233.—St. Lucia, Zululand. Collected by A. Hammar, 1910. Specimen exhibits one of the stages in the transformation.

Mus. No. 229.—“Wood Bed.” North Point, False Bay, Zululand. Collected by Natal Geological Survey, 1905. Some of the specimens exhibit stages in the transformation into jet.

Mus. No. 228.—Same locality as Mus. No. 229. The specimens consist entirely of the jet-like substance.

## (3) DESCRIPTION OF THE FOSSIL WOOD.

The specimens are black or dark grey in colour, and are sometimes friable and exceedingly difficult to cut into section; but the firm of Dr. Krautz succeeded in making some good preparations.

Some of the samples do not exhibit the structure of wood in the hand specimen. They have a shining pitch-like aspect, and are singularly tough and cloggy to saw. The hardness, as tested by the mineral scale, is about 3·25 for the firmer samples of the wood. The pitch-like substance is somewhat softer, having a hardness of about 2·75.

A glance at a section of the fossilized wood at once demonstrates its dicotyledonous nature, since pitted vessels are conspicuously present.

At first it was thought to be almost impossible to identify the wood; but accidentally it was noticed that the general texture of the fossil wood recalled that of the Water Boom (*Eugenia cordata* Laws). A section of this wood revealed the fact that the fossil wood certainly belonged to this genus, and almost certainly to this species.

The following is the description of the wood of the Water Boom given by Stone<sup>1</sup> as far as it concerns the fossil wood.

“Natural order—Myrtaceæ. Dry weight 60 lb. per cubic foot (sp. gr. 0·962). Hardness like that of English elm. Very fine compact grain, dense and even. Surface dull. Pores variable, about the size of those of the beech or apple, nearly all single, pairs very rare; 11–20 per sq. mm. Rays thick in the middle, tapering above and below to fine ends, size comparable to those of Blue Gum; ‘middles’ and ‘ends’ 18–26 per mm.; direct, not avoiding the pores. Annual rings apparently clear; boundary? a zone of poreless wood at intervals. Wood parenchyma very abundant, occupying half the transverse surface; independent of the pores.”

This description agrees with a sample of Water Boom wood in the Museum with the exception that there is no really poreless wood, and the wood parenchyma is by no means very abundant. This parenchyma consists of irregular clusters of comparatively thin-walled cells of about twice the diameter of a wood fibre.

<sup>1</sup> Stone, Herbert, ‘The Timbers of Commerce,’ p. 134. London, 1905.

The fossil wood has a specific gravity of 1.43, the increase being doubtless due to the infiltration of mineral matter. Fine compact grain with dull surface. Pores variable in size and distribution. A narrow area poor in vessels occurs as a kind of boundary between the somewhat faintly defined annual rings.

The pitted vessels with a variable diameter of 0.050–0.156 mm. are frequently solitary, sometimes in pairs. There may be small nests consisting of one or more pitted vessels with a number of smaller vessels; these latter are scalariform (Pl. XXVI, fig. 16, *sc.*), and have a diameter of about 0.025 mm. The number of pitted vessels is variable over different areas; the average of a number of counts gave 12 to a square millimetre.

Medullary rays exceedingly numerous, and in an uncontrorted portion of the wood they are straight. They are swollen in the middle where they consist of three or four cells in thickness, and taper above and below into long ends. The middle portion consists of 15–25 cells in vertical height, and they are there smaller than in the ends. In transverse section, including both “ends” and “middles,” there are 20–26 per millimetre. Radial length of medullary cells 0.042–0.073 mm. Vertical height of end cells about 0.046 mm.

The wood fibres have a diameter of about 0.0182 mm.

Communicating with the pitted vessel there are occasional groups of several parenchymatous cells with walls having large pits (fig. 16, *p.c.*).

The pitted vessels are frequently blocked up with masses of large irregularly rounded cells which constitute the thyloses (fig. 16, *th.*). Neither in the recent wood nor in the fossil wood are annual rings clearly marked, although zones of more or less poreless wood do occur.

The wood parenchyma in longitudinal section is seen to consist of somewhat elongated cells arranged in vertical rows. They do not appear to be definitely related to the vessels (fig. 16, *w.p.*).

On the whole the structure of the fossil wood may be said

to agree perfectly with that of the sample of Water Boom wood in the Museum, and very approximately with the sample described by Stone.

(4) CHEMICAL COMPOSITION AND PHYSICAL PROPERTIES.

At St. Lucia, False Bay and Port Durnford some of the specimens from the lignite seam exhibited the transformation of the wood into a jet-like substance. The various stages of the transformation could be traced. The elements of the wood are gradually converted under pressure into a compact more or less homogeneous substance which is translucent and brownish-yellow in section.

Analyses of a typical piece of the lignite (Pl. XXVI, fig. 10) and of the jet-like substance (Pl. XXVII, fig. 23) were made in the Government Laboratory, Durban, with the results shown in the following table :

Substance.	Fossil wood. Port Durnford. Mus. No. 232.		Impure jet. Port Durnford. Mus. No. 228.		
	Including the moisture.	Excluding the 4.61 per cent. moisture.	Including the moisture.	Excluding the 12.88 per cent. moisture.	
	Per cent.	Per cent.	Per cent.	Per cent.	
Organic and volatile matter.	Water expelled at 100° C. . . . .	4.61		12.88	
	Carbon . . . . .	24.12 { 9.09	9.53	33.80 { 43.95	50.48
	Hydrogen . . . . .	2.16	2.26	6.79	7.80
	Oxygen } . . . . .	8.26	8.66	30.18	34.67
	Nitrogen }				
	Silica . . . . .	73.02	76.57	1.63	1.87
	Oxide of iron . . . . .	1.15	1.21	0.52	0.60
	Oxide of alumina . . . . .	0.30	0.31	1.01	1.16
	Oxide of lime . . . . .	0.52	0.55	1.03	1.18
	Oxide of magnesia . . . . .	0.12	0.13	0.24	0.28
	Phosphoric anhydride . . . . .	0.19	0.20	0.15	0.17
Sulphuric anhydride . . . . .	trace	trace	1.14	1.31	
	99.42	99.42	99.52	99.52	

Physical character.	Fossil wood. Port Durnford. Mus. No. 232.	Impure jet. Port Durnford. Mus. No. 228.
Specific gravity . . . . .	1.43	1.25
Hardness (mineral scale) . . . . .	3.25	2.75

From this table it can be seen that the amount of water held hygroscopically is considerable, being 4.61 per cent. of the total weight in the case of the fossil wood, and 12.88 per cent. in that of the jet. Small pieces of the substances were pounded and carefully weighed, and then heated to 105° C. for two hours. On being weighed again the difference gave the amount of water expelled. After the lapse of twenty-four hours of dry hot weather the powder in both cases had absorbed water from the air, and was of exactly the same weight as before heating.

The large amount of silica (73.02 per cent.) contained in this lignite, which has a quite typical appearance, was unexpected. With crossed prisms the section is seen to be for most part isotropic. The silica is clearly in the form of amorphous opal, which must penetrate the actual substance of the tracheide and vessel-walls, since from the comparatively low specific gravity and porous nature of the specimen it is quite obvious that a considerable portion of the cavities of the elements remains empty.

The analysis shows that the wood has undergone a far more profound change than would have been anticipated from the appearance under the microscope.

As in the case of the much older fossil coniferous woods in the Coal Measures and higher series much differential movement of the woody tissues due to pressure and strains can be observed in the majority of the specimens (text-fig. 2, *D.*). We have already seen that the annual rings are not very clearly marked in this wood, and there are consequently no very definite lines of weakness along which compression bands could be formed as in the conifer. The whole mass of the

wood exhibits the effects of the pressure, and the medullary rays generally show a remarkably zig-zag course. This mostly occurs without any obvious fracture of the walls of the tissue elements of the wood. It is probable that partial impregnation of the walls of the elements with silica would not necessitate fracture under differential movement, but it is extraordinary to note the amount of such movement which is possible without any great dislocation of the tissue. In all probability most of the contortion occurred before the process of fossilization had proceeded very far.

(5) FOSSILIZATION AND ALTERATION OF THE WOOD.

The least altered wood is shown in transverse section in Pl. XXVI, fig. 10.

There appear to be two different directions in which changes took place in the lignite seam :

(1) ordinary fossilization or silicification of the tissues, comparable to that which produced the well-silicified coniferous woods described above ;

(2) changes in the direction of bituminous coal formation.

According to Dr. Aitken,<sup>1</sup> bituminous coal consists of :

(a) an opaque black substance which is insoluble in acids, and may be free carbon (?) ;

(b) a yellow or reddish resin-like substance which is translucent or transparent, volatile by heat, and insoluble in naphtha and acids, and possibly referable to the Succinite group ;

(c) earthy matter.

In the specimens which exhibit the structure of wood in the least altered condition, the formation of a yellowish-red substance had begun. The cavities of the wood fibres had become filled, and the medullary cells were also partially occupied. The outlines of the wood fibres in many parts of the section had become lost ; while in some parts this substance formed a thin layer in between the fibres, thus marking them out with great clearness (fig. 11,  $y_1$ ).

<sup>1</sup> Dana, Dwight James, 'A System of Mineralogy,' p. 756. New York, 1889.

These changes probably took place under shallow boggy conditions with plenty of free oxygen from the air, so that a large part of the oxygen of the original wood remained. In some places the original lignified walls of the wood fibres had so far been altered that the yellowish-red substance had extruded out of the cavity of the wood fibre to form flake-like pieces.

At this stage in the transformation the condition became fixed by the infiltration of silica, and a fossil of the slightly altered wood resulted. By reference to the analysis given on page 369 it will be seen that 76.57 per cent. of silica occurs. Of the 50 per cent. of carbon in ordinary wood only 9.53 per cent. remains. Silicification of some of the wood fibres is much more complete than in the others, and such fibres (figs. 10 and 11, *d.f.*) with crossed prisms stand out conspicuously with a central core of the yellow material.

In fig. 12 the transformation has proceeded further, and the cavities of the pitted vessels have mostly become filled with the yellow substance, also the cells of the medullary rays are much more completely filled.

In fig. 13 the outlines of many of the medullary cells have disappeared, and the yellow substance has extruded so as to form in some cases continuous sheets appearing as thick lines in the cross-section. The bituminous material in the medullary rays gradually becomes dispersed through the general matrix (*m.*) which is itself being changed into a similar substance (fig. 14). Some especially silicified wood fibres (*d.f.*) can be observed scattered through the matrix.

The final result of these changes is seen in fig. 15,  $\Delta$  in transverse section. Traces of the large medullary rays can be seen, which are much contorted owing to the great pressure that the material has experienced. The general matrix appears more or less homogeneous with a faintly granular or reticular appearance. The substance exhibits a marked vertical striation, which is readily seen in longitudinal section (Pl. XXVII, fig. 23), and the reticular appearance in trans-

verse section seems to be caused by the cross-sections of the longitudinal fibrous elements.

With crossed prisms (fig. 15, B.) the section remains fairly bright. In many parts it is traversed by narrow light and dark bands which run across the remains of the medullary rays, but not necessarily at right angles to them. The direction, however, tends to be more or less radial.

We will now trace these changes in the tangential section.

Pl. XXVI, fig. 16 represents the least altered wood, where the cavities of the wood fibres are seen to be more or less occupied by the yellow resin-like substance which appears in the form of yellowish brown streaks (*y*). The outlines of the wood fibres are indistinct, except in the case of the especially silicified fibres, as at *d.f.* The thylose cells (*th.*) and the wood parenchyma (*w.p.*) are little altered. The cavities of the medullary cells are partially filled. In fig. 17 the condition is shown under greater magnification. Here the outlines of the wood fibres are distinct, and an especially silicified fibre (*d.f.*) is shown. In fig. 18 the medullary cells have become completely filled, and the outlines of the wood fibres have almost completely disappeared. These changes have continued further in fig. 19, where the yellow matter has extruded out of the original cavities into the general matrix (*m.*) formed by the coalescence of the fibre walls. A well-defined gland is shown in the medullary ray at *g.* The condition is seen under greater magnification at fig. 20. A tendency for a vertical striation is now observable in the general matrix. In fig. 21 the yellow substance is becoming dispersed in the general matrix which as a whole is now becoming yellower and less distinct from the yellowish brown matter which originally filled the cavities of the elements. The vertical striation is more marked than before, but occasional silicified fibres can be seen.

In fig. 22 the medullary rays (*r.m.r.*) are becoming less distinct, and the final result of the transformation is shown in fig. 23, A. Here the vertical striation is very evident. Microscopic cracks (*m.c.*) and narrow lenticular cavities (*l.c.*) are present. With crossed prisms (fig. 23, B) the vertical stria-

tion becomes more evident, and, in addition to this, alternating dark and light squarish areas are conspicuous. This section is a longitudinal tangential one, and the dark and light areas appear to be the cross-sections of the dark and light bands which tend to run radially in the transverse sections.

In a longitudinal more or less radial section (fig. 24) the appearance in ordinary transmitted light remains much the same. The trace of what was apparently a vessel showing a cross-striation is seen at *v*. At *m.r*<sub>1</sub>, the medullary ray has been less altered than usual. With crossed prisms (fig. 25), long dark and light bands running horizontally are conspicuous. In certain places coarse cross-hatched structures are observable, and it is thought that these indicate the position of former medullary rays.

It appears that sometimes the medullary rays became less changed than usual, and the cellular structure remained distinct, while the surrounding tissue of wood fibres had been converted into the jet-like substance. These less altered areas weather out more readily than the surrounding substance, and constitute places of weakness whereby the whole mass may become riddled by spaces which are lenticular in tangential section. Such a condition is seen in Pl. XXV, fig. 26, A, where a medullary ray is shown which has not yet been weathered out. With crossed prisms (fig. 26, B) the cellular structure is seen extending into the jet-like substance. A weathered out medullary ray with the jet-like substance flaking off around the space is represented at *w.sp*.

Less altered tissue (*l.a.m.r.*, *m.r*<sub>1</sub>) in the midst of the jet-substance is shown in Pl. XXV, fig. 27.

In some of the sections a good deal of perfectly opaque black substance, especially in the medullary rays, occurs. At first this was thought to be simply iron oxide; but it is quite possible that a considerable portion is carbon, since there appears to be more of this opaque substance present than the percentages of iron oxide (1.21 per cent. in fossil wood, and 0.60 per cent. in the jet) shown in the analyses would account for.

The description above given deals with the structural

changes which the wood undergoes as it is being transformed into the remarkable jet-like substance. The chemical changes which take place require a detailed investigation by a qualified chemist.

In the following table the percentages of carbon, hydrogen and oxygen in a number of different substances and minerals are given :

	Material. <sup>1</sup>	Carbon.	Hydrogen.	Oxygen. <sup>2</sup>
		Per cent.	Per cent.	Per cent.
Oxygenated hydrocarbons.	{ Cellulose . . . . .	44.45	6.17	49.38
	{ Wood . . . . .	51.21	6.24	42.55
	{ Peat . . . . .	60.38	6.08	33.54
	{ Bituminous coal . . . . .	67.92	5.66	26.42
	{ Cannel coal . . . . .	85.88	5.82	8.30
	{ Fossil wood (Mus. No. 232) . . . . .	46.60	11.05	42.35
	{ Jet-like mineral (Mus. No. 228) . . . . .	54.31	8.39	37.30
	{ Succinite . . . . .	78.94	10.53	10.53
	{ Bathvillite . . . . .	78.86	11.46	9.68
	{ Torbanite . . . . .	82.19	11.64	6.17
{ Dopplerite . . . . .	51.09	5.29	43.62	

It will be seen that the composition of the organic and volatile matter of the fossil wood and jet-like mineral compared with that of bituminous and cannel coal is characterised by an excess of hydrogen and oxygen, and compared with that of the oxygenated carbohydrates, Succinite and Torbanite, it shows an excess of oxygen.

The excess of oxygen is probably connected with the conditions under which the transformation proceeded, since the presence of the oxygen of the air would permit a large portion of the oxygen of the original organic matter to remain.

The yellowish-red or brown resin-like substance at first filling the cavities of the wood and ultimately taking the

<sup>1</sup> This table is mostly compiled from Dana's 'Mineralogy.' 1889.

<sup>2</sup> Any small amount of nitrogen that may be present is included in the figures of this column.

<sup>3</sup> Excluding the inorganic matter and moisture.

place of the woody substance burns with a smoky flame without obvious fusion. It is apparently quite insoluble in alcohol, ether, benzole, carbon bisulphide, acids and alkalies. The fossil wood colours a solution of potash deep brown, but the jet-like mineral does not have this effect.

This bituminous substance may probably be regarded as consisting of one or more oxygenated hydrocarbons allied to Bathvillite or Torbanite, but differing from them in having a greater percentage of oxygen.

The above description of the structural changes that the wood undergoes in its transformation would constitute an interesting introduction to the subject of the chemical changes which lead to coal-formation; and an exhaustive investigation with the material at hand would undoubtedly throw much light on the vexed question of the origin of the different kinds of coal.

The genus *Eugenia* is quoted by Schenk<sup>1</sup> as occurring in the Upper Cretaceous rocks of N. Greenland and Westphalia, and it is therefore an ancient genus.

The Water Boom is at present one of the dominant trees on the coast, and there can be little doubt that the fossil wood actually belongs to this species.

The lignite bed of 2 ft. or more in thickness is chiefly composed of the remains of this tree, and it occurs under a thickness of some 60 ft. of soft sandstone.

In number of years, therefore, the bed must be considered as a very ancient deposit, although geologically it is probably on the border line of Tertiary and Recent.

The great contortion and the profound chemical changes which have taken place in the wood also point to its antiquity; and it may be stated that the occurrence of this seam is evidence of a great uniformity of climatic conditions and biological environment on the sea-board of East Africa for a relatively very long period.

<sup>1</sup> Zittel, Karl A., 'Handbuch der Palæontologie.' II. "Palæophytologie." p. 641. 1890.

EXPLANATION OF PLATES XXV AND XXVII,  
 Illustrating Dr. Ernest Warren's paper "On Some Specimens  
 of Fossil Woods in the Natal Museum."

FIG. 1.— $\times 500$ . Mus. No. 174. Harrismith. Small piece of transverse section of *Dadoxylon* completely silicified. The walls of the tracheides are of silica with practically no lignin remaining. The cavities are filled with silica. The silica may be blackened by dark granules of iron oxide or possibly fixed carbon.

FIG. 2.— $\times 500$ . Mus. No. 174. Harrismith. Transverse section of *Dadoxylon* wood. It passes through a compression band or sheering area occurring in the spring-wood. It should be noticed that the bent medullary rays in the band are not much flattened, and there is no distortion as in the tracheides.

FIG. 3.— $\times 750$ . Mus. No. 220. Weenen. Small piece of transverse section of phosphatized *Dadoxylon* wood. The calcium phosphate forms casts of the tracheide cavities. The actual wall of the tracheide has mostly disappeared except at *o.t.w.* This may be either the remains of the original lignin wall or a silicified representation of it.

FIG. 4.— $\times 750$ . Mus. No. 220. Weenen. The same as fig. 3 viewed with crossed prisms. It should be noticed that a dark reticulum is visible, this being due to the fact that the outer portions of the casts have a different optical reaction to the inner portions.

FIG. 5.— $\times 250$ . Mus. No. 220. Weenen. Transverse section of phosphatized wood. A compression band is seen in the spring-wood. This was produced subsequently to fossilization since the calcified structure is observed to be shattered.

FIG. 6.— $\times 500$ . Mus. No. 220. Weenen. Transverse section of phosphatized wood through a compression band. The cells of the band were clearly squeezed out of shape before complete fossilization. The medullary rays in the band are not greatly affected.

FIG. 7.— $\times 200$ . Mus. No. 12. Ingwavuma. Transverse section of calcified *Dadoxylon* wood viewed with crossed prisms. The fossilizing substance is calcium carbonate. The structure of the wood is poorly preserved, probably through the lack of the power on the part of the mineral substance of easily replacing the lignified material of the tracheide walls.

FIG. 8.— $\times 400$ . Mus. No. 12. Small piece of transverse section showing moderately well-preserved tracheide walls on the right, but on the left only shadowy swollen walls are observable.

FIG. 9.— $\times 400$ . Mus. No. 12. Small piece of longitudinal section of the same. The "fixed" decomposing walls of tracheïdes are seen at *r.t.t.w.*

FIG. 10.— $\times 150$ . Mus. No. 232. Inyazan Junction, Zululand. Transverse section of *Eugenia* wood. The tissue is fairly well silicified as it contains over 70 per cent. silica. The preliminary changes (as the filling up of the cavities of the wood fibre with bituminous matter) for the transformation into the jet-like substance had taken place and the condition was then "fixed" by a considerable infiltration of silica.

FIG. 11.— $\times 450$ . Mus. No. 232. Inyazan. Small piece of transverse section showing an especially silicified wood fibre, *d.f.* The cavities of the fibres are filled with bituminous substance which is also seen (*y<sub>1</sub>*) between some of the fibres. At the bottom of the figure the fibre walls have coalesced and the bituminous material has extruded out into flake-like extensions.

FIG. 12.— $\times 150$ . Mus. No. 232. Inyazan. Transverse section of the next stage in transformation. The cells of the medullary rays and most of the pitted vessels have become completely filled with the bituminous matter. The outlines of the fibre walls have completely disappeared.

FIG. 13.— $\times 150$ . Mus. No. 233. St. Lucia, Zululand. Transverse section of a later stage in the transformation. The bituminous masses are breaking down and becoming dispersed through the general matrix (*m.*) which is itself being altered into a similar substance.

FIG. 14.— $\times 150$ . Mus. No. 229. "Wood Bed," False Bay, Zululand. A still later stage in the transformation. The general matrix is becoming more homogeneous; but the course of the thicker medullary rays is still observable (*r.m.r.*)

FIG. 15 A.— $\times 100$ . Mus. No. 228. "Wood Bed," False Bay. A transverse section of the jet-like substance exhibiting the remains of the thicker medullary rays and a fairly homogeneous matrix with a faint, very fine reticular structure.

FIG. 15 B.— $\times 100$ . Mus. No. 228. Transverse section of similar section viewed with crossed prisms. Running obliquely across there is a system of dark and light bands.

FIG. 16.— $\times 150$ . Mus. No. 232. Inyazan. Longitudinal tangential section of wood in the condition described under fig. 11. Pitted vessels (*p.v.*), thylose (*th.*), especially silicified fibres (*d.f.*) where most of the lignified substance has been replaced, wood parenchyma (*w.p.*) and pitted parenchymatous cells (*p.c.*) are shown.

FIG. 17.— $\times 400$ . Mus. No. 234. Port Durnford, Zululand. Small piece of longitudinal tangential section similar to fig. 16. The bitu-

minous matter has partially filled the medullary cells. The walls are partially silicified, while those of the fibre marked *d.f.* are more completely so.

FIG. 18.— $\times 150$ . Mus. No. 234. Port Durnford, Zululand. Longitudinal tangential section in the condition described under fig. 12. The outlines of the wood fibres have mostly disappeared.

FIG. 19.— $\times 150$ . Mus. No. 234. Longitudinal tangential section at about the same stage of change as seen in fig. 12. The bituminous matter at first confined to the cavities of the wood fibres has now extended into elongated flakes or chains. In one of the medullary rays the remains of a gland (resin-gland?) can be seen.

FIG. 20.— $\times 150$ . Mus. No. 234. Port Durnford. A small piece of a longitudinal tangential section in the condition of fig. 19.

FIG. 21.— $\times 150$ . Mus. No. 234. Port Durnford. Longitudinal tangential section in much the same condition as in fig. 13. The bituminous substance is becoming dispersed in the general matrix (*m.*) which is being transformed, but the remains of medullary rays can be seen.

FIG. 22.— $\times 150$ . Mus. No. 232. Inyazan. Longitudinal tangential section in same condition as in fig. 14. *r.m.r.* represents the remnant of a medullary ray. A vertical striation is beginning to be visible.

FIG. 23A.— $\times 100$ . Mus. No. 228. "Wood Bed," False Bay. Longitudinal tangential section of jet-like substance (*cf.* fig. 15) exhibiting a vertical striation, the remains of medullary rays (*r.m.r.*) and microscopic cracks (*m.c.*) and lenticular cavities (*l.c.*).

FIG. 23B.—The same viewed with crossed prisms. A succession of short horizontal dark and light areas becomes conspicuous.

FIG. 24.— $\times 100$ . Mus. No. 228. "Wood Bed," False Bay. A somewhat radial section exhibiting medullary rays; the lowest (*m.r.<sub>1</sub>*) is not completely transformed. The remnant of a vessel (*v.*) can be seen.

FIG. 25.— $\times 100$ . The same viewed with crossed prisms exhibits a succession of long, more or less horizontal, dark and light areas; also patches showing a coarse cross-hatched structure. Towards the bottom there is an indication of a horizontal microscopic fracture (*m.f.*) which is bordered by homogeneous material.

FIG. 26A.— $\times 150$ . Pl. XXV. Mus. No. 228, Y. "Wood Bed," False Bay. Jet-like substance in longitudinal tangential section in which the medullary rays have not been wholly obliterated and transformed.

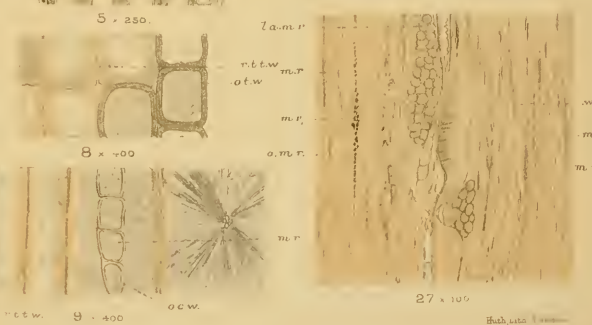
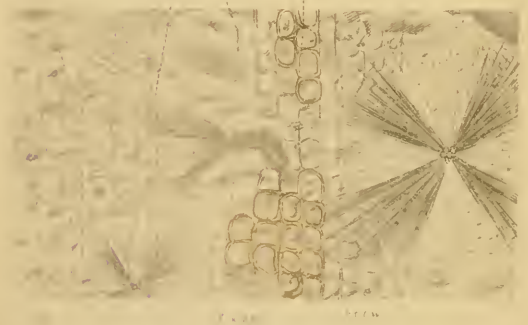
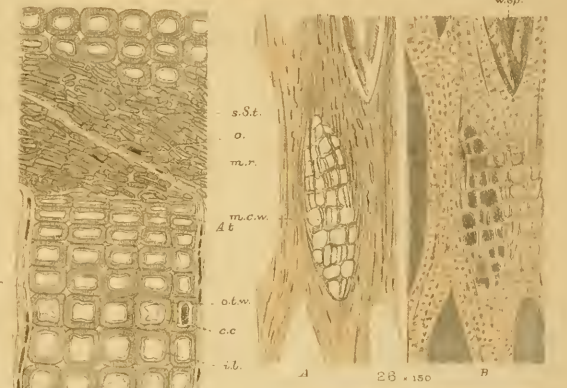
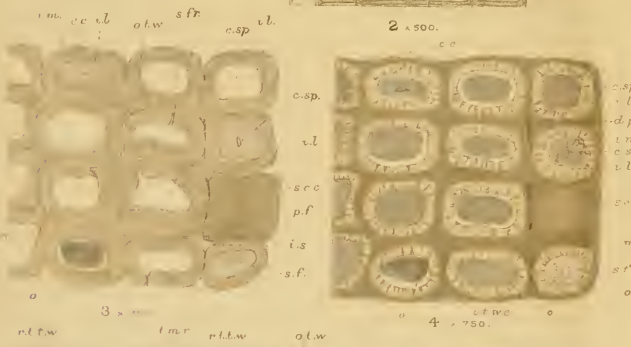
FIG. 26B.—The same viewed with crossed prisms shows on the right-hand side cellular elements in the midst of the jet-like substance. The specimen has undergone some disintegration, and lens-shaped

cavities have been formed by the disappearance of such incompletely transformed areas.

FIG. 27.—× 100. Pl. XXV. Mns. No. 228, Z. "Wood Bed," False Bay. Longitudinal tangential section of jet-like substance showing clearly the outlines of vessels (*w.v.*) and of the cells of medullary rays (*l.a.m.r.*)

#### EXPLANATORY REFERENCES.

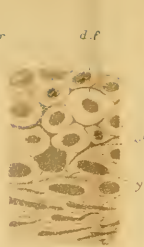
*A.t.* Autumn tracheide. *b.s.* Blackened silica. *b.s.t.w.* Blackened silica in tracheide wall. *c.c.* Calcium phosphate cast. *c.s.* Colourless silica. *c.sp.* Central space. *c.S.t.* Compressed spring tracheide. *d.f.* Depolarizing fibre. *d.p.* Dark portion with crossed prisms. *e.a.* Edge of autumn-wood. *g.* Cavity of medullary ray gland filled with yellow matter. *i.l.* Inner layer of cast. *i.m.* Inner mass. *i.s.* Intertracheide space filled with calcium phosphate. *l.a.m.r.* Less altered medullary ray. *l.e.* Lenticular cavity. *m.* Matrix formed by coalescence of tracheide walls. *m.c.* Microscopic crack. *m.c.w.* Medullary cell wall. *m.f.* Microscopic fracture. *m.r.* Medullary ray. *m.r.<sub>1</sub>* Medullary ray in jet-like substance showing trace of cells. *m.r.c.* Medullary ray cells filled with yellow matter. *m.r.s.* Medullary ray silica. *o.* Oxide of iron or carbon. *o.m.r.* Oxide of iron in medullary ray. *o.c.w.* Original cell wall. *o.t.w.* Original tracheide wall. *o.t.w.c.* Original tracheide wall and outer portion of cast. *p.c.* Parenchymatous cell communicating with pitted vessel. *p.f.* Primary fracture filled with secondary deposit. *p.v.* Pitted vessel. *p.v.y.* Pitted vessel filled with yellow matter. *r.m.c.* Remains of medullary cell. *r.m.r.* Remains of medullary ray. *r.t.* Rent tracheide. *r.t.t.w.* Remaining trace of tracheide wall. *s.c.* Scalariform vessel. *s.c.c.* Solid calcium phosphate cast. *s.f.* Space filled with crystalline calcium phosphate. *s.fr.* Secondary fracture extending through primary cast and inner layer. *s.S.t.* Shattered spring tracheides. *s.t.w.* Silicified tracheide wall. *th.* Thylose. *t.m.r.* Trace of medullary ray. *u.S.t.* Uncompressed spring tracheide. *v.* Trace of vessel in jet-like substance. *w.f.* Wood fibre. *w.p.* Wood parenchyma. *w.sp.* Weathered space. *w.v.* Wood vessel. *y.* Yellowish-red bituminous matter in fibres and medullary cells. *y<sub>1</sub>* Yellowish-red bituminous matter between fibres. *y.p.v.* Bituminous matter in pitted vessels.



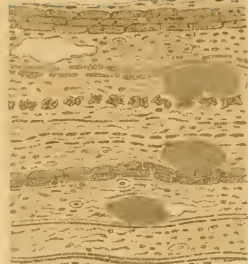




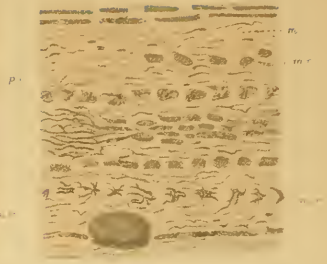
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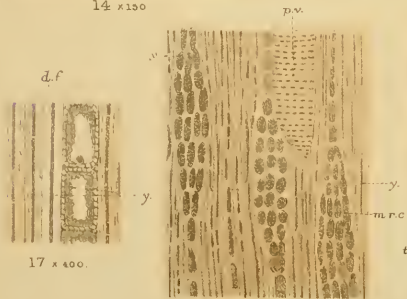
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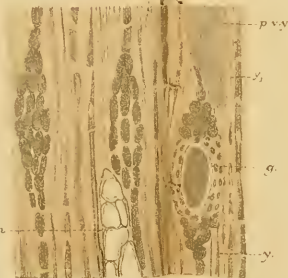


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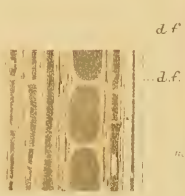


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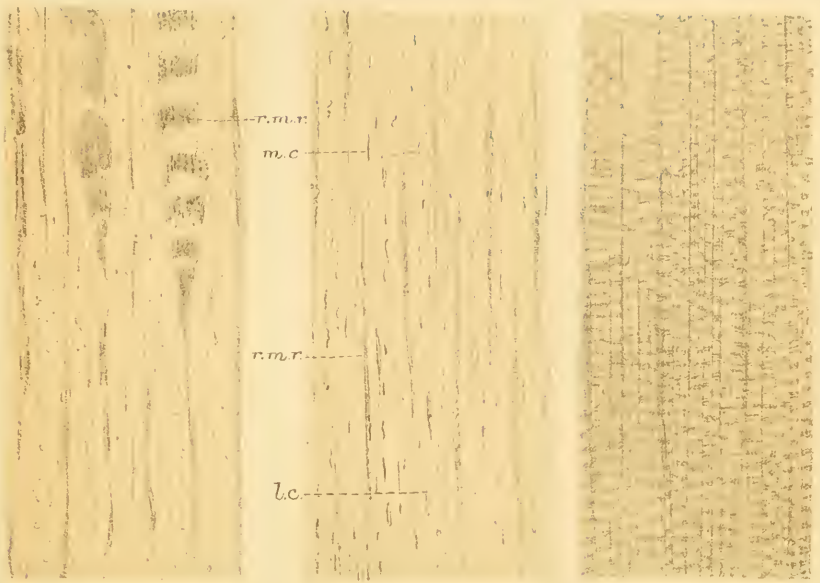


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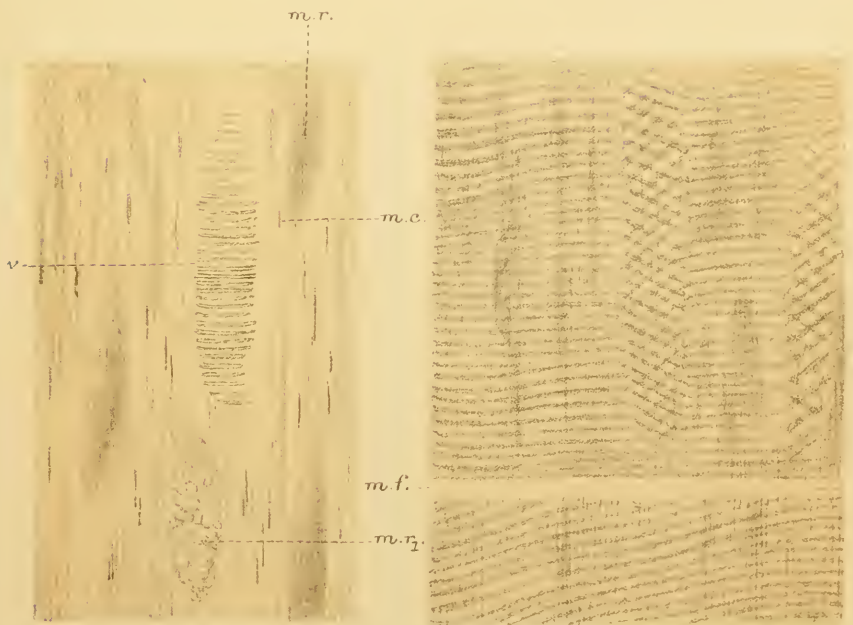
v.s.

A.

B.

22 x 150.

23 x 100.



24 x 100.

25 x 100.



## A Spherulitic Dolerite from Vryheid, Natal.

By

**W. Campbell Smith, B.A., F.G.S.,<sup>1</sup>**

Assistant in the Mineral Department, British Museum.

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With Plates XXVIII—XXX and Text-figure.

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THE rock which forms the subject of this note is remarkable on account of a beautiful radial structure which is shown on weathered surfaces.

Specimens were collected by Mr. A. Cowley and forwarded by him to the Natal Museum at Pietermaritzburg. Two large specimens together with several fragments were sent by Dr. E. Warren to the British Museum, and it is on these that the following description is based. The following particulars of the mode of occurrence of the rock were communicated to Dr. Warren by Mr. Cowley.

The rock occurs on a private farm, Vaalbank, in Hlobane Valley, twenty miles east of Vryheid, Natal. Here it is exposed as two parallel sills intruded in coal-bearing beds belonging to the Karoo system. Numerous large blocks have become detached from the main mass, and it is on these that the beautiful weathering effects are so well seen.

As seen on fresh unweathered surfaces the rock is almost black in colour, and is very compact and fine-grained. The radial structure is only revealed by a peculiar silky lustre which it gives to the broken faces. With the aid of a lens a few minute prismatic crystals can be made out scattered through the fine-grained ground-mass.

The study of thin sections under the microscope shows that

<sup>1</sup> Communicated by permission of the Trustees of the British Museum.

in mineral composition the rock is very similar to the enstatite-dolerites intruded in the Karoo beds of Natal and Zululand, recently described by Dr. Prior.<sup>1</sup>

Small phenocrysts of enstatite and augite with very occasional olivines lie in a ground-mass composed of long lath-shaped feldspars with interstitial augite and magnetite.

The enstatite occurs in well-formed crystals showing the forms  $a$  (100),  $b$  (010) and  $m$  (110). Rectangular sections bounded by the two pinacoids and having their corners truncated by the prism-faces are frequent, but very often prism-faces appear only on one pair of opposite corners and not on all four corners. These cross-sections measure about 1 mm. by 0.4 mm. and the shorter side is invariably parallel to the plane of the optic axes. The prismatic cleavage is well developed. The crystals are colourless in thin section and show the usual optical properties of enstatite.

The augite phenocrysts show a very striking development, exhibiting a strong tendency to form skeletal crystals. They occur as prismatic crystals 3 to 6 mm. long and about 0.2 mm. broad. Longitudinal sections of these crystals have a forked appearance, but where cut nearly normal to their long axes they give square sections with hollow centres, showing that the crystals are not forked but are actually hollow for the greater part of their length. Most crystals are bounded by the prism-faces alone, the clino-pinacoid occurring as a subordinate form. The prismatic cleavage is not always evident, but there is always present an irregular fracture roughly perpendicular to the length of the crystals. Twinning about the ortho-pinacoid is very common. The crystals are quite colourless in thin sections. Longitudinal sections give high interference tints with extinction-angles ranging up to  $40^\circ$ , but, as a rule, averaging about  $32^\circ$ . Square cross-sections give very low interference tints and frequently show one optic axis emerging in the field of view.

<sup>1</sup> G. T. Prior, "Petrographical Notes on the Dolerites and Rhyolites of Natal and Zululand." 'Annals of the Natal Museum,' vol. ii, pt. 2 (1910), p. 141.

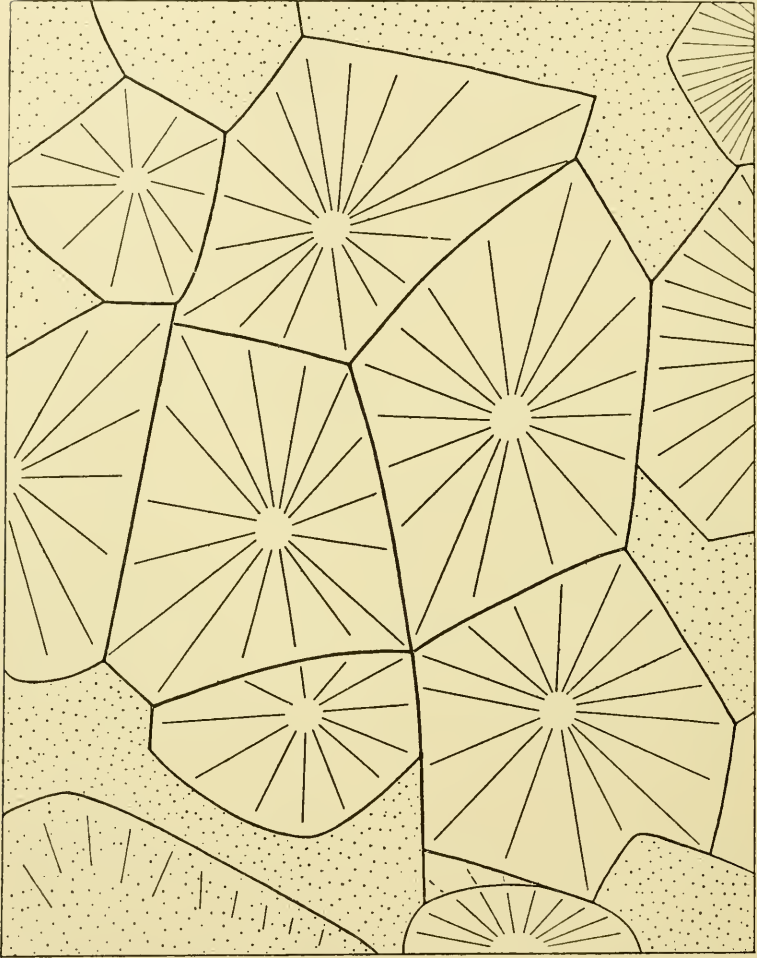
Another interesting phenomenon displayed by these augite phenocrysts is that they are frequently surrounded by a secondary zone of augite. In cross-sections the secondary augite is seen to develop principally at the corners, and whereas the phenocrysts are bounded by four prism-faces alone, the secondary growth usually develops pinacoidal faces, the prism becoming subordinate: this gives rise to a cruciform appearance of the whole crystal. This secondary zone is of quite small dimensions, but there is always a definite boundary between it and the original crystal. In cross-sections the outer zone is much more birefringent than the phenocryst, but the two extinguish simultaneously. In sections giving oblique extinction the difference in double refraction is less marked, but the outer zone has a slightly higher extinction-angle, which usually exceeds that of the phenocryst by  $7^{\circ}$ . Very rarely this secondary growth of augite occurs in parallel position on the enstatite phenocrysts.

Olivine occurs sparingly as phenocrysts, and usually has undergone considerable resorption.

The feldspars occur in long, very thin, lath-shaped crystals. Longitudinal sections occasionally give extinction-angles of  $11^{\circ}$ , but the majority give quite small angles. In certain sections, however, the feldspar appears as small rectangles showing albite- or more probably Carlsbad-twinning, and giving symmetrical extinction-angles up to  $32^{\circ}$ , which correspond to labradorite.

Some of these cross-sections of feldspar show inclusions in the form of negative crystals now occupied by augite and magnetite in minute grains. These cores can also be made out in longitudinal sections running down the centres of the crystals, and often it is almost impossible to distinguish between the material inside the feldspars and that occupying the interspaces between the laths. The latter is composed of crystals of pale yellowish augite, enclosing minute grains and cubes of magnetite, and, as we shall show later, precisely identical with the augite forming a secondary growth round the phenocrysts.

We must now turn to the radial markings brought out on the weathered surfaces. Some idea of the appearance of



Outline sketch of weathered surface of the lower sill. Natural size.

these will be obtained from the photograph of a specimen from the upper sill (left-hand side, Pl. XXVIII), and one from the lower sill (right-hand side). The accompanying text-figure

is a diagrammatic sketch, to actual size, of a portion of the weathered surface of the lower sill, shown in Pl. XXVIII.

It will be observed that groups of radial lines start from numerous centres distributed over the surface, and that in general the different groups are bounded by lines which are sensibly straight, so that the whole surface is divided up into a number of polygonal areas. The average diameter of these areas is 4 cm., but in some places they are as much as 8 cm. across. The several centres are by no means equidistant from one another, but, wherever two groups of radial lines meet in a straight line, this line is midway between the centres of the groups. The irregular distribution of the centres thus gives rise to a great variety of shape in the polygonal areas. On the specimen from the lower sill some of these bounding lines are seen to be curved: such lines are always nearer to one of the centres than to the other, and are concave towards the nearer centre. The radial structure is developed on all weathered surfaces of the specimens, and is not confined to any one plane. Patches apparently free from radial structure (represented by the dotted areas in the figure), are still bounded by sharp lines, and can be shown to be cross-sections of rays starting from centres in the body of the rock.

The structure is shown equally well on pieces of both sills, but in the upper one the centres tend to be farther apart. In one case two centres are as much as 10 cm. apart, and here the line dividing the two areas is very indistinct; the rays seem to diminish in strength as they recede from the centre and at 3.5 cm. from it they are only faintly marked.

In addition to the radial lines brought out by weathering, incipient cracks are often seen starting from the centres. These are usually three in number, and are equally inclined to each other, but they rarely extend for more than 0.5 cm. from the centre. These cracks were well shown in a piece of the rock which Dr. Warren had cut through and polished; they evidently occur throughout the rock, and are intimately connected with the radial arrangement.

Several sections were cut parallel to a weathered surface, so that their positions with regard to the centres and edges of groups of rays could be determined; another was cut in a plane at right angles to these, and two others were cut from the body of the rock about one inch from the nearest weathered surface. An examination of these sections quickly revealed the cause of the macroscopic effects.

The first section, cut so that one of the centres appears on the edge of the slide, shows the labradorite as long thin laths diverging from points grouped around the centre. As the rays are traced outward from the centre fresh groups of feldspars are seen to start from various points along the line, each group spreading out like a fan, so that the result is a roughly radial structure (Pl. XXIX, fig. 1). No section could be obtained showing that there was any definite nucleus at the centre of a group.

In a section cut to show one of the boundaries between two groups a sharp line can be seen with the naked eye corresponding to the straight line on the weathered surface. Under the microscope this line is clearly shown to be caused by the confluence of two streams of feldspar-laths diverging from the opposite centres. The line is not perfectly straight but is slightly undulating (Pl. XXIX, fig. 2); the feldspars from one centre tend to push in between those coming in the opposite direction, which explains why the cracks formed on cooling run parallel to the rays rather than along these lines of junction.

Sections showing part of a space apparently free from radial structure reveal a rather confused mass of short feldspar crystals arranged in little bundles with here and there a few almost square sections. Such sections are cut almost at right angles to one of the radial groups of feldspars, which, fanning out from numerous points, produce a curiously confused appearance.

Similar structures to those described above were shown by sections taken in different planes and in different parts of the rock.

There appears to be no marked relation between the positions of the enstatite and augite phenocrysts and the general radial structure. Here and there a crystal of enstatite is seen to be broken across, and the several parts are separated by a small interval as though pushed apart by the outgrowing felspars. In places the augites appear to have concentrated in the eddies between two streams of felspars, and very occasionally the crystals lie with their long axes parallel to the laths; in nearly every case, however, the position of the augite is quite independent of the radial structure.

All the above phenomena can be readily made out with a 2-inch objective, but the application of a higher power brings to light further interesting facts.

The interspaces between the felspars are, as above mentioned, occupied by a pale yellow augite and minute crystals of magnetite. This augite is not in granules but in more or less continuous crystals, which appear to be very closely intergrown with the felspar, even at the centres from which the latter starts (Pl. XXX, fig. 1). The secondary zone of augite at the edges of the phenocrysts frequently presents a serrated edge, indentations being formed to receive the ends of the felspar crystals which abut against the augite phenocrysts; consequently, in the neighbourhood of these phenocrysts the felspars are wrapped about by minute ophitic plates. It is impossible to make any distinction between the augite of these secondary zones and that filling the interspaces between the felspar (Pl. XXX, fig. 2).

We undoubtedly have in this rock an example of the pseudo-spherulites of Rosenbusch, and these spherulites are of a truly remarkable size for so basic a rock. Nearly all spherulitic (or variolitic) structures hitherto described in basic rocks are contact phenomena produced in the glassy, or devitrified glassy, facies of andesites or basalts. The spherulites are usually of very small dimensions, and have often suffered considerable alteration.

However, an occurrence of "a coarsely spherulitic ('vario-

litic<sup>1</sup>) basalt from Skye," described in 1899 by Messrs. Clough and Harker<sup>1</sup> affords a very close parallel to some of the phenomena mentioned above. This rock occurs as a sill of Tertiary age at Camas Daraich, Point of Sleat, Skye. The spherulites vary in diameter from  $1\frac{1}{2}$  to 3 inches, and occur throughout the entire sheet. Sections show that some parts of the rock contain some residual glass, but this is usually absent, and then, but for the presence of olivine in place of the augite phenocrysts, the two rocks are wonderfully similar in structure. The similarity is also evinced by the presence of minute ophitic plates of augite and by small extinction-angles in the feldspars, the latter phenomenon being attributed to overlapping of the fibres.

Another somewhat similar case of spherulitic structure in dolerite has been described by Schwantke<sup>2</sup> in a rock from Ofleiden, Tannus Mts., where it is associated with typical variolites. It is interesting to note that in parts of this rock there is a micrographic intergrowth of augite and feldspar.

A very interesting occurrence is also described by E. B. Bailey<sup>3</sup> from Ardmuchnish, Argyllshire. The spherulites are small and lie in a ground-mass which is to a large extent glassy, but their structure is very similar to that of the Vryheid rock. Among other interesting points he records the presence of negative crystals in the feldspars filled with glass and iron oxides, and he shows that the augite and feldspar crystallised almost simultaneously, though the feldspar seems to have commenced first.

This intimacy of growth between the augite and feldspar is very striking, as it is observed in every one of these four cases. It is no doubt an expression of the fact that in each case the spherulites have crystallised out of a magma which approximated to the eutectic composition. In acid rocks

<sup>1</sup> Clough and Harker, 'Trans. Edinburgh Geol. Soc.,' vii (1898), p. 381.

<sup>2</sup> A. Schwantke, 'Neues Jahrb. f. Min., etc.,' Beil.-Band xviii, (1903), p. 503.

<sup>3</sup> E. B. Bailey, 'Trans. Edinburgh Geol. Soc.,' viii, (1904), p. 363.

spherulites are frequently formed of a micropegmatitic inter-growth of quartz and felspar.<sup>1</sup> Teall<sup>2</sup> has pointed out that in alloys of eutectic composition spherulitic structures are developed by rapid cooling. Indeed, just as a magma of eutectic composition seems to lend itself to the formation of glass,<sup>3</sup> so, under other conditions, it seems to favour the production of spherulites. In this connection the occurrence of small spherulites in glassy rocks may be not without significance.

A study of the order of crystallisation in the Vryheid dolerite leads to some further conclusions on the conditions favourable to the growth of spherulites. From the extreme regularity of their development it appears that the enstatite crystals grew comparatively slowly, and were among the first products of crystallisation. The angites, on the other hand, must have crystallised out with extraordinary rapidity, as their skeletal and long-prismatic habit suggests. These phenocrysts represent the excess of angite in the original magma above the eutectic composition. The next mineral to commence separating out was the labradorite. We have seen that it is closely bound up with the interstitial augite, but the way in which its crystals control the radial structure clearly shows that it started to crystallise just before the augite. The shape of the curved boundaries between spherulites of unequal size shows that the growth of the radius—that is, of the felspar crystals—was uniform,<sup>4</sup> so that the fact that most of the boundaries lie midway between two centres is evidence that crystallisation of the felspar commenced simultaneously at a great number of points. The frequent inclusions of ground-mass in negative crystals and the lath-shaped habit show that the growth of the labradorite took place with great rapidity, while the small extent to

<sup>1</sup> Whitman Cross, 'Bull. Phil. Soc. Washington,' xi (1891), p. 430.

<sup>2</sup> J. J. H. Teall, 'Quart. Journ. Geol. Soc.,' lvii (1901), p. lxxv.

<sup>3</sup> Harker, 'Natural History of Igneous Rocks,' 1909, p. 224.

<sup>4</sup> Popoff, "Eine neue Untersuchungsweise sphärolitischer Bildungen," 'Min. Petr. Mitt. Wein,' xxiii (1904), p. 153.

which phenocrysts have been pushed aside by the outgrowing feldspars shows that, at the time of their crystallisation, the viscosity of the magma was already considerable.

Now this development at one moment of crowds of crystals with a long-prismatic habit has been shown by Miers<sup>1</sup> to take place when a solution is brought into the labile state by reason of a fall in temperature or increase in concentration. It appears that the rapid crystallisation of the augite phenocrysts carried the composition past the eutectic point and made the magma supersaturated with respect to labradorite. If the cooling were fairly rapid the supersolubility curve for labradorite would be reached before any feldspar crystallised out. There would then be a sudden development of long thin crystals of labradorite, the fall in temperature would be checked, and, the composition of the magma returning towards the eutectic, the remainder of the augite would commence to crystallise out, filling up the spaces between the feldspars while these were still growing.

It is not known whether any parts of the Vryheid dolerite show a glassy development; but it will be observed that in all other cases of spherulitic basic rocks they are always associated with rocks which were once glassy.

In many spherulitic tachylytes the spherulites have been developed in a zone lying between the pure glass and the completely crystallised rock. The temperature conditions favourable to spherulitic growth are evidently intermediate between those obtaining for the glass and for the holocrystalline rock.

It seems that a magma approaching to a eutectic composition will give an ophitic or even micrographic structure if enabled to crystallise from the metastable state. If it reaches the labile state there will be a sudden development of spherulitic structure. Finally, if the temperature falls so rapidly that the magma becomes too viscous to allow of rapid crystallisation a glassy rock will result; the very small dimensions of spherulites in many glasses is no doubt due to

<sup>1</sup> H. A. Miers, 'Science Progress,' ii (1907), pp. 121-134.

this prevention of crystallisation by the increasing viscosity of a rapidly cooling magma.

It is very difficult to say how far one is justified in drawing an analogy between the aqueous solutions studied by Miers and Miss Isaacs and the complex solutions represented in a rock magma. However, the facts recorded above seem to show that supersolubility curves and "hypertectics" may be of much more importance in controlling crystallisation than has been supposed.

In conclusion I wish to acknowledge my indebtedness to both Dr. G. T. Prior and Mr. L. J. Spencer for much kind help in the preparation of this paper.

#### EXPLANATION OF PLATES XXVIII-XXX,

Illustrating Mr. W. Campbell Smith's paper, "On a Spherulitic Dolerite from Vryheid, Natal."

#### PLATE XXVIII.

$\times \frac{3}{5}$ . Weathered spherulitic dolerite from the upper sill (left hand side) and lower sill (right hand side).

#### PLATE XXIX.

FIG. 1.— $\times 26$ . Section near the centre of a spherulite, showing the arrangement of the feldspars.

FIG. 2.— $\times 26$ . Section across the plane of contact of two spherulites.

These two figures also show the characteristic habit of the augite phenocrysts and their secondary zones. A large crystal of enstatite, broken in two, is seen in fig. 1.

#### PLATE XXX.

FIG. 1.— $\times 140$ . Cross-sections of feldspar crystals showing the way in which they enclose cores of augite which can hardly be distinguished from the augite growing between separate feldspar crystals.

FIG. 2.— $\times 140$ . A long thin crystal of augite stretching right across the field shows its secondary zone and the peculiar manner in which this zone grows in between the feldspars.





*Seel, Fryhettl.*

WEATHERED SPHERULITIC DOLERITE FROM NATAL.  $\times \frac{3}{5}$ .

*Allard & Son, Impr.*





Fig 1.(x 26.)

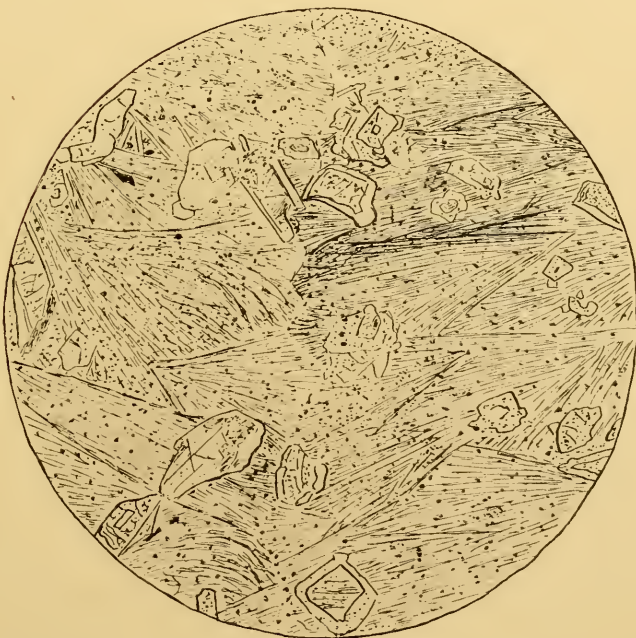


Fig 2.(x 26.)

Campbell Smith.

London Stereoscopic Co. inc.

SPHERULITIC DOLERITE FROM NATAL.

1. Near centre of Spherulite.

2. Across contact plane



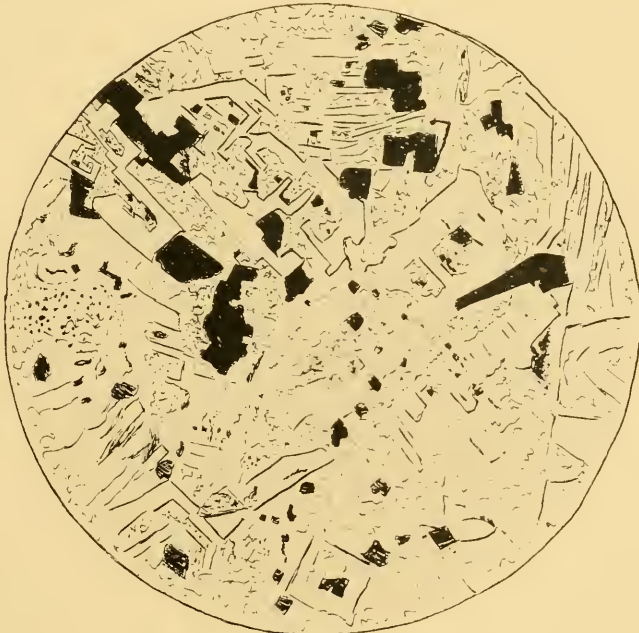


Fig. 1. (x140)

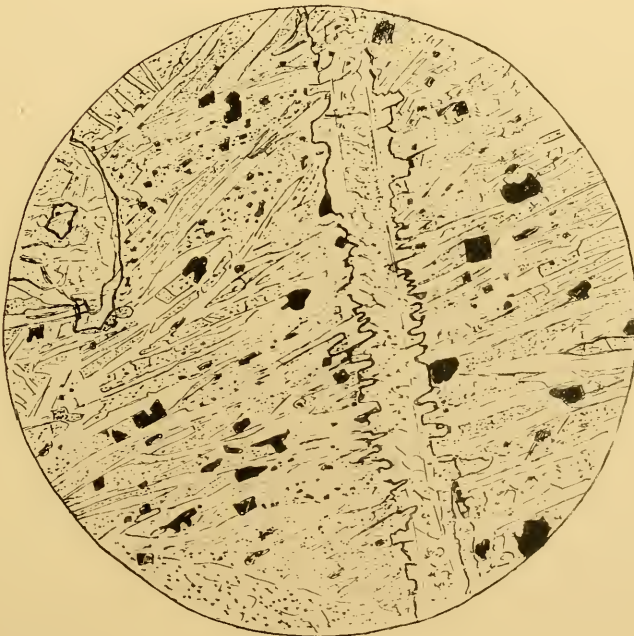


Fig. 2. (x140)

Campbell Smith.

London Stereoscopic Co. imp

SPHERULITIC DOLERITE FROM NATAL.

1. Feldspar crystals with cores of Augite

2. Augite crystal with Secondary zone.



**Note on an Interesting Contact of Dolerite with Sandstone from the Ecca Beds of Elandslaagte, Natal.**

By

**F. H. Hatch, Ph.D., F.G.S. M.Inst.C.E.,**

Vice-President of the Institution of Mining and Metallurgy, and Past-President of the Geological Society of South Africa.

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With Plate XXXI.

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THE specimens showing the contact here to be described were handed by Dr. Warren, of the Natal Museum, to the author during his visit to Natal in 1909. They are pieces of the core from a bore-hole at Elandslaagte, Natal, which intersected a sill of compact dolerite, eleven feet thick, traversing Ecca Beds, the upper junction being at 109 feet from the surface, the lower at 120. Thin sections of both junctions were made, and these, in both cases, show unmistakable evidence of the thermal changes due to contact, so that it is clearly evident that this is an intrusive sill and not a flow.

THE SANDSTONE.

A hand specimen of this rock shows it to be particularly fine-grained and compact, the component particles being scarcely discernible without the aid of a lens. Under the microscope it is found to consist mainly of sub-angular grains of quartz with subordinate striated felspar, flakes of biotite and isolated particles of garnet, all embedded in a carbonate cement, which, judging by its appearance and faint brown colour, probably consists of carbonates of lime, iron, and magnesia.

## THE SILL.

The sill consists of a very compact, aphanitic olivine dolerite. It is dark-coloured and has a sub-vitreous appearance which almost recalls the characters of Lydian-stone. Under the microscope the rock is seen to be porphyritic, slender, lath-shaped feldspars (plagioclase) being embedded in a dark-coloured glassy groundmass, which has undergone only slight devitrification. Occasionally the feldspar phenocrysts are aggregated in glomero-porphyritic fashion. In most cases the crystals have the form only of feldspar, their feldspathic material being replaced by a pseudomorphous mixture of calcite and chlorite.

The olivine also is only represented by serpentine pseudomorphs. Some of the grains, however, have preserved their original form, which is quite characteristically that of olivine crystals.

No original augite could be found, but there are many chlorite pseudomorphs, which probably represent scattered granules of augite.

## THE CONTACT ZONES.

Towards the actual contact of the two rocks the colour of the groundmass of the dolerite takes on a deeper hue, becoming finally almost opaque and with no signs of devitrification. It carries, however, just as many feldspar phenocrysts and microlites as before. This darkened zone extends for a distance of five millimetres from the contact, and no doubt represents a "chilled margin."

Between the actual edge of the dolerite and the unaltered sandstone there is a layer 1 mm. thick, which shows clearly the results of the thermal metamorphism of the dolerite on the sandstone. In this layer the quartz grains appear unchanged both as regards size and position; but the matrix in which the grains lie is completely modified, the pale car-

bonate cement having been replaced by a dark-coloured mass which consists partly of brown mica and partly of an indeterminate black opaque material. Although the quartz grains have not appreciably diminished in size, examination under a high power shows that each grain is surrounded by a thin shell of secondary crystalline material produced by the fusion of the outer portion of the quartz grains and a combination of the fused silica with some of the components of the cement in which they originally lay.

It is evident from the above description that the dolerite sill was intruded at a high temperature, but that it was very quickly cooled on being brought in contact with the large mass of cold sandstone. Hence, although in the contact selvage the thermal effects are quite pronounced, the width of the selvage is extremely limited. On the other hand, the cooling effect of the sandstone on the sill itself is very marked, for besides the production of actual selvages, the rapid abstraction of heat appears to have caused the groundmass throughout the whole thickness of the sill to solidify as glass, the feldspar and olivine phenocrysts and the isolated feldspar micro-lites being evidently of earlier origin.

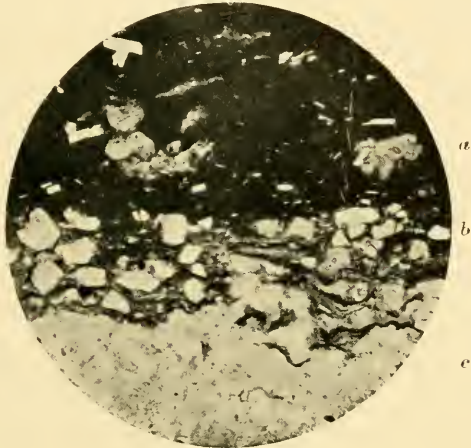
#### EXPLANATION OF PLATE XXXI,

Illustrating Dr. F. H. Hatch's paper, "Note on an Interesting Contact of Dolerite with Sandstone."

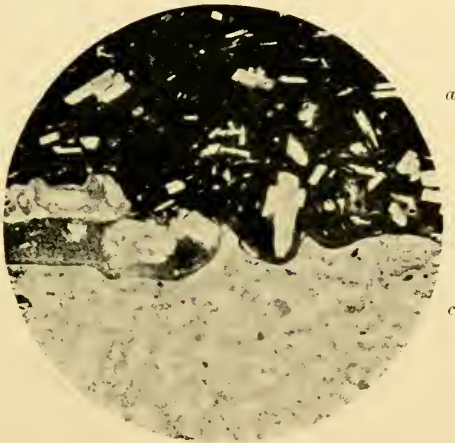
FIG. 1.— $\times 8$ . Micro-photograph of junction of dolerite with sandstone. *a*. The dolerite "chilled edge." *b*. The selvage of partially fused sandstone. *c*. The unaltered sandstone.

FIG. 2.— $\times 8$ . Junction of dolerite with sandstone. *a*. The dolerite "chilled edge." *c*. The sandstone showing no "fusion selvage."





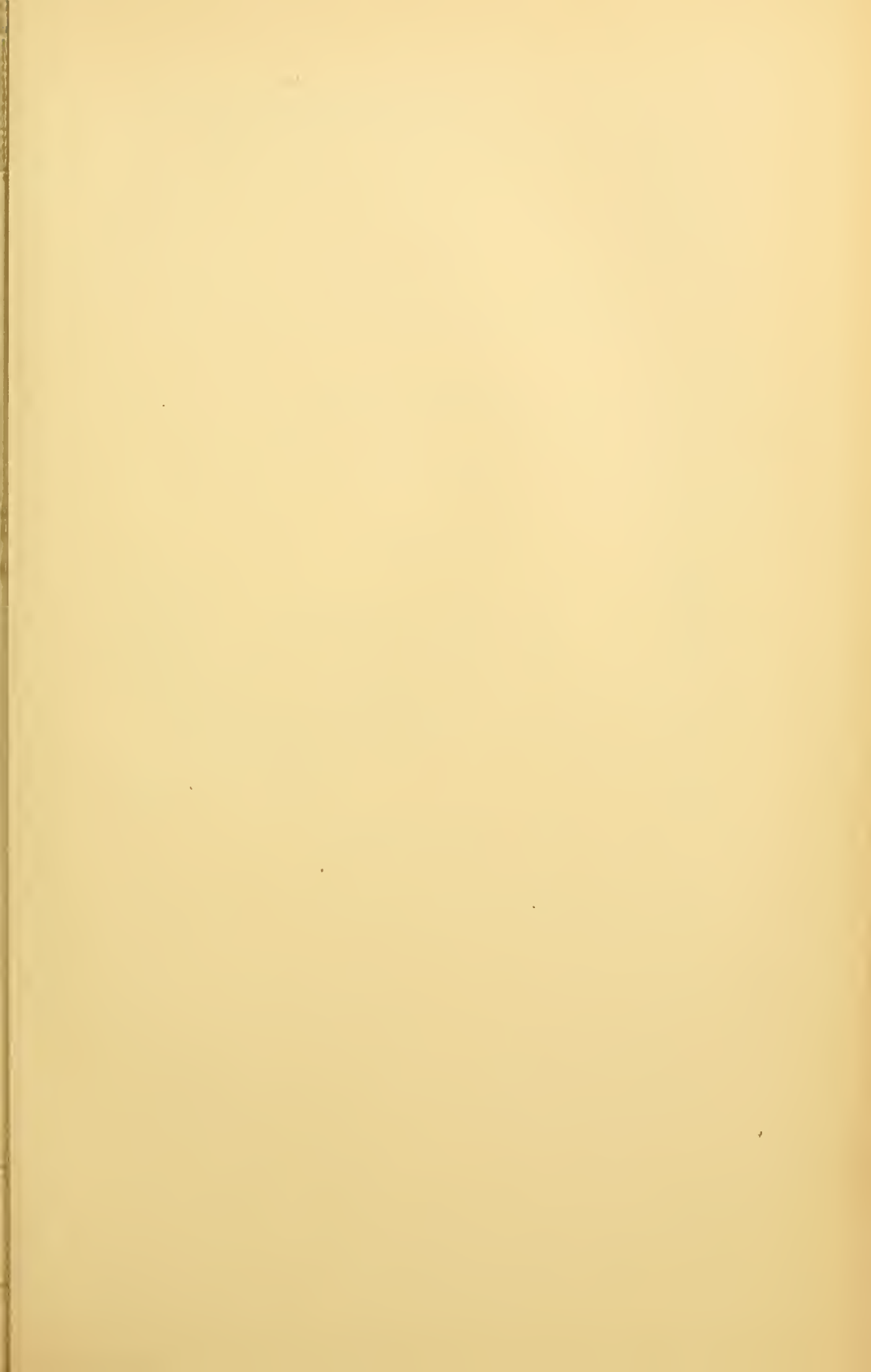
1.  $\times 8$ .



2.  $\times 8$ .

CONTACT OF DOLERITE (*a*) WITH SANDSTONE (*c*).  
1. With fusion selvage (*b*). 2. Without fusion selvage.







## The Oligochæta of Natal and Zululand.

By

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With Plate XXXII.

### CONTENTS.

	PAGE
INTRODUCTION . . . . .	397
HISTORY AND BIBLIOGRAPHY . . . . .	398
GEOGRAPHICAL DISTRIBUTION AND LIST OF SPECIES . . . . .	400
SYSTEMATIC ACCOUNT . . . . .	408
ANALYTICAL KEYS TO THE OLIGOCHÆTA OF NATAL AND ZULULAND . . . . .	448
(A) KEY FOUNDED ON EXTERNAL CHARACTERS . . . . .	448
(B) KEY FOUNDED ON INTERNAL AS WELL AS EXTERNAL CHARACTERS . . . . .	452
EXPLANATION OF PLATE . . . . .	458

### INTRODUCTION.

THIS memoir on the Oligochæta of Natal and Zululand is based largely on an examination of a series of specimens which I collected in Natal during my visit to South Africa, 1911. My collection has been amplified by a considerable amount of material from the Natal Museum, which Dr. E. Warren kindly entrusted to me for examination. I am also indebted to Mr. E. C. Chubb, of the Durban Museum, for certain specimens.

With the material at my disposal it has been found possible to treat the oligochæte fauna in a monograph form. In this undertaking I have received valuable assistance from Dr. R.

Collett, of the Christiania Museum, Dr. Jägerskiöld, of the Gotenborg Museum, and Prof. H. Théel, of the Riks Museum of Stockholm, who have been so good as to allow me to re-examine the types of certain formerly described species of oligochaetes from Natal and Zululand.

### HISTORY AND BIBLIOGRAPHY.

Our knowledge of the earthworms from Natal and Zululand extends back to the year 1866, when J. G. H. Kinberg presented to the Academy of Sciences at Stockholm a preliminary paper on the "Oligochaeta of the Eugenie Expedition." This paper, as well as a few others published in the nineteenth century, give only scanty information with reference to the oligochaetes of Natal. In the present century only two papers dealing with the earthworms of the districts now being considered have been published. These papers, however, are far from giving an even fairly adequate picture of the oligochaete fauna, since the larger of them deals with only six different species.

In the following list of papers there is given all the literature up to the present which contains descriptions or revisions of the Oligochaeta of Natal and Zululand. To the titles of these papers I have added the names of the species described, while the modern synonyms are given in square brackets.


1866. KINBERG, J. G.—"Annulata nova" [Continuatio].  
'Öfv. Vet. Förh.,' nr. 4, 1866.

*Tritogenia sulcata* *n. sp.* [Microchætus sulcatus  
(Kinb.) f. typicus.]

*Geogenia natalensis* *n. sp.* [Microchætus nata-  
lensis (Kinb.).]

*Hegesipyle hanno* *g. e. sp. n.* [Gen. et spec. spur.]

1886. BENHAM, W. B.—"Studies on Earthworms, II," 'Quart.  
Journ. Micr. Sci.' (n.s.), 26, 1886.

*Microchæta*  *beddardi* *n. sp.* [Microchætus bed-  
dardi Benh.]

1892. BENHAM, W. B.—“Description of Three New Species of Earthworms,” ‘Proc. Zool. Soc. Lond.,’ 1892.

*Microchæta papillata* *n. sp.* [*Microchætus papillatus* *Benh.* f. *typicus.*]

*Microchæta beddardi* *Benh.* [*Microchætus beddardi* *Benh.*]

1893. BEDDARD, F. E.—“On some New Species of Earthworms from Various Parts of the World,” ‘Proc. Zool. Soc. Lond.,’ 1892.

*Eudriloides durbanensis* *n. sp.* [*Eu. durbanensis* *Bedd.*]

*Ilyogenia africana* *n. sp.* [*Ocnerodrilus* (*Ilyogenia*) *africanus* (*Bedd.*)]

1899. MICHAELSEN, W.—“Revision der Kinberg’schen Oligochæten-Typen,” ‘Öfv. Vet. Förh.,’ nr. 5, 1899. The same species as in l. c. 1866, J. G. H. Kinberg.

1906. COGNETTI DE MARTIS, L.—“Nuove Specie dei Generi Pheretima e Tritogenia,” ‘Atti. Acc. Torino,’ xli.

*Tritogenia morosa* *n. sp.* [*Microchætus sulcatus* (*Kinb.*) f. *typicus.*]

*Microchætus* *n. sp.* [*Gen. et spec. spur.*]

1907. BEDDARD, F. E.—“On Two New Species of the African Genus *Microchætus* belonging to the Collection in the Museum of Christiania,” ‘Proc. Zool. Soc. Lond.,’ 1907.

*Microchætus colletti* *n. sp.* [*M. colletti* *Bedd.*]

*Microchætus zuluensis* *n. sp.* [*M. zuluensis* *Bedd.*]

1907. MICHAELSEN, W.—“Oligochæten von Natal und dem Zululand,” ‘Ark. Zool.,’ iv, nr. 4.

*Fridericia bulbosa* (*Rosa*) var. [*F. peregrinabunda* *n. sp.*]

*Chilota trægårdhi* *n. sp.* [*Ch. trægårdhi* *Mich.* f. *typicus.*]

*Microchætus papillatus* *Benh.* [*M. papillatus* *Benh.* f. *typicus.*]

*Microchætus zulu* *n. sp.* [*M. zuluensis* *Bedd.*]

*Microchætus gracilis* *n. sp.* [*M. gracilis* *Mich.*]

*Microchætus ivari* *n. sp.* [*M. ivari* *Mich.*]

The above list shows that we were acquainted with only twelve different species of oligochaetes from Natal and Zululand, excluding the doubtful *Hegesipyle hanna* *Kinb.*, which is probably a form with acanthodrilid sexual apparatus and belongs to one of the following genera: *Dichogaster*, *Kerria*, *Chilota*, *Microscolex*, or *Acanthodrilus*.

Considering that Natal and Zululand have been under scientific exploration since about the middle of the nineteenth century, we must regard this as a very poor result; but we shall see in the following that it cannot be laid to the charge of the collectors. It would appear that we have in Natal and Zululand a region with a poor oligochaete fauna, that is to say, poor relatively to that of the Cape Province, which is a rich one.

#### GEOGRAPHICAL DISTRIBUTION.

Before discussing the general character of the oligochaete fauna of Natal and Zululand, I will give a list of all the species found in the large collection at my disposal.

#### LIST OF OLIGOCHÆTA FROM NATAL AND ZULULAND.

(Species known to April, 1913.)

##### FAM. ENCHYTRÆIDÆ.

- Fridericia peregrinabunda* *n. sp.* (peregrine).  
*Fridericia perrieri* (*Vejl.*) (peregrine).

##### FAM. MEGASCOLECIDÆ.

##### Sub-fam. ACANTHODRILINÆ.

- Chilota warreni* *n. sp.* (endemic in Natal).  
*Chilota trågårdhi* *Mich.*, f. *typicus* (endemic in Zululand).  
*Chilota trågårdhi* var. *major* (endemic in Natal).  
*Chilota wahlbergi* *Mich.* f. *typicus* (endemic in Natal and Transvaal).  
*Chilota braunsi* *Mich.* (endemic in Natal and Eastern Cape Province).

Sub-fam. MEGASCOLECINÆ.

*Pontodrilus bermudensis* *Bedd.* f. *typicus* (widely distributed littoral species).

*Pheretima heterochæta* (*Mich.*) (peregrine).

Sub-fam. TRIGASTRINÆ.

*Dichogaster bolau* (*Mich.*) (peregrine).

*Dichogaster crawi* *Eisen.* (peregrine).

Sub-fam. OCNERODRILINÆ.

*Kerria gunningi* *Mich.* (endemic in Natal and South Transvaal).

*Ocnerodrilus* (*Ilyogenia*) *africanus* (*Bedd.*) (endemic in Natal).

Sub-fam. EUDRILINÆ.

*Eudriloides durbanensis* *Bedd.* (endemic in Natal?).

FAM. GLOSSOSCOLECIDÆ.

Sub-fam. GLOSSOSCOLECINÆ.

*Pontoscolex corethrurus* (*Fr. Müll.*) (peregrine).

Sub-fam. MICROCHÆTINÆ.

*Microchætus natalensis* (*Kinb.*) (endemic in Natal).

*Microchætus papillatus* *Benh.* f. *typicus* (endemic in Natal).

*Microchætus papillatus* *Benh.* var. *cæmenterii* *n. var.* (endemic in Natal).

*Microchætus sulcatus* (*Kinb.*) f. *typicus* (endemic in Natal).

*Microchætus sulcatus* (*Kinb.*) var. *howickianus* *n. var.* (endemic in Natal).

*Microchætus zuluensis* *Bedd.* (endemic in Zululand).

*Microchætus colletti* *Bedd.* (endemic in Zululand).

*Microchætus gracilis* *Mich.* (endemic in Natal).

*Microchætus ivari* *Mich.* (endemic in Natal).

*Microchætus parvus* *n. sp.* (endemic in Natal).

*Microchætus beddardi* *Rosa* (endemic in Natal).

FAM. LUMBRICIDÆ.

*Helodrilus caliginosus* (*Sav.*) f. *trapezoides* (*Dug.*) (peregrine).

*Helodrilus constrictus* (*Rosa*) (peregrine).

This list contains twenty-five species and three varieties, which are about twice as many as formerly known in this region. Considering the quantity of material at my disposal, I expected at the beginning of my studies, a larger gain of new species; but I soon perceived that the great majority belonged to known forms. Indeed, there are only three new species and three new varieties of old species in the list; and one of the new species, *Fridericia peregrinabunda*, is but a new nomination for an oligochaete formerly described as a variety of another species. The collection has, however, a considerable value, as it has enabled me to re-examine old species, such as those of Kinberg, which were very imperfectly known.

A reference to the list will show that many of the species are peregrine, or non-indigenous, and were doubtless introduced by man; these have nothing to do with the real oligochaete fauna.

The foreign species are: two species of the genus *Fridericia* of the family *Enchytraeidae*, the widely distributed *Pheretima heterochaeta*, the two species of *Dichogaster*, the cosmopolitan *Pontoscolex corethrurus*, and the two species of the Lumbricid genus *Helodrilus*.

The locality of *Eudriloides durbanensis* *Bedd.* is somewhat doubtful. The headquarters of the genus *Eudriloides* are the coast districts of British East Africa and German East Africa. Beyond this region, *Eu. parvus* *Mich.* was found at Quilimane at the mouth of the Zambezi River. This species has been regarded as an outpost of the genus, and we may perhaps in a like manner regard *Eu. durbanensis* as an outpost of the tropical African fauna continued farther to the south. Similar outposts are known extending as far south, such as *Nemertodrilus kellneri* *Mich.* from the Orange Free State. This is likewise a member of the Ethiopian sub-fam. *Hudrilinae*, and allied to *N. griseus* *Mich.* from Mozambique. The doubt about *Eudriloides durbanensis* is due not so much to the improbability of the locality, as to the manner in which it was found. The species was not collected at Durban, but at Kew Gardens, in England,

from a box containing plants sent from Durban; and there is consequently no real security that the specimens came from Durban. Even if they actually did come from there, the species may have been introduced with foreign plants. Also *Eu. durbanensis* is one of the very few of the older species which has not been found again in Natal. This is a suspicious circumstance, and it would be unwise to base any conclusions with regard to geographical distribution on such an insecure foundation.

In addition to the peregrine species we have to remove the littoral species *Pontodrilus bermudensis* *Bedd.* f. *typicus*. Such littoral species, to which the sea is not an impassable barrier, have a very different kind of distribution to the bulk of the Oligochæta, which avoid salt water, and to which the sea-shore is a strict limit. *Pontodrilus bermudensis* is a species occurring on the sea-shore of all oceans in the warmer zones, and therefore its presence does not assist in characterising the oligochæte fauna of our region.

The remaining species on the list are endemic, and represent the typical, i. e. the primordial, oligochæte fauna of the country. These alone are of use in establishing the geographical relations, which will be found to be in accord with the geological history of the continent. The indigenous oligochæte fauna is composed of three different groups, belonging to different families or sub-families, and exhibiting quite different faunistic relations.

These three groups are: (1) The genus *Chilota* of the section *Chilotacea*, sub-fam. *Acanthodrilinæ*, fam. *Megascolecidæ*; (2) the sub-fam. *Ocnerodrilinæ*, fam. *Megascolecidæ*; (3) the sub-fam. *Microchætinæ*, fam. *Glossoscolecidæ*. To these might be added a questionable fourth group represented by *Eudriloides durbanensis* with doubtful origin.

(1) Section *Chilotacea*.—This group is represented by four species and one variety of the genus *Chilota*.

The distribution of the genus *Chilota* appears to be restricted as follows. In the southern parts of Africa there are

many species in the Cape province, one in the Transvaal, several in Natal and one in Zululand. In the southern parts of South America there are many species in South Patagonia, Fireland, Falkland Islands, and Chile northwards as far as Coquimbo. The only known species which occurs elsewhere is *Chilota exul* (*Rosa*) from the Cape Verde Island, San Antonio; but it is very doubtful if it is an indigenous species there. The South African group of *Chilota* is accompanied by the single species of the genus *Udeina* (*U. kinbergi* (*Mich.*)), from the banks of the river Vaal, whilst that of South America is living together with the allied great genus *Yagansia*.

This group of Chilotacea of Natal and Zululand consequently forms an integral part of the typical South African fauna, and especially exhibits the singular faunistic connection between the southern corners of the two continents of Africa and South America.

(2) Sub-fam. Ocnerodrilinæ.—This group is represented by a single species of the genus *Kerria*, occurring in the meantime as far north as Pretoria, Transvaal, and a single species of *Ocnerodrilus* (*Ilyogenia*).

The sub-family Ocnerodrilinæ is a typical Ethiopian group, and all the known genera are represented in the tropical regions of Africa. But it is not restricted to Africa, and just these two genera found in Natal, viz. *Kerria* and *Ocnerodrilinus*, are also found in the tropical parts of South America, Central America, and West Indies.

In the Cape Province no Ocnerodrilinæ have been found. In the eastern districts Natal appears to be the southern limit of this sub-family. In the more western districts the southern limit is further north; *Pygmæodrilus arausionensis* *Mich.* occurs at Bathville in the north of the Orange Free State, and there are some species in German South-West Africa.

This second group of the oligochæte fauna of Natal thus includes an outpost of the fauna of tropical Africa, which has extended to the south-east of the continent; and it is also related, as we have seen above, to the fauna of South America, Central America and the West Indies.

(3) Sub-fam. *Microchætinae*.—This sub-family, belonging to the family *Glossoscolecidae*, forms with its nine species of the genus *Microchætus* the bulk of the original indigenous oligochæte fauna of Natal and Zululand. The genus *Microchætus* is strictly confined to South Africa, and is distributed throughout the whole of the Cape Province, but it is more prevalent in the eastern (and northern?) districts. It passes northwards as far as the north-west corner of the Cape Province, also to the northern frontier of the Orange Free State and to Zululand.

The nearest terricolous ally of this genus is *Kynotus* of Madagascar; but the relationship is not very close, and intermediate steps are exhibited by certain aquatic forms. The genus *Microchætus* was doubtless derived from the aquatic genus *Glyphidrilus*, whilst the aquatic genus *Callidrilus* must be regarded as the ancestor of *Kynotus*. Both of these aquatic ancestors are living in the eastern parts of tropical Africa. *Glyphidrilus* also occurs in the East Indies and in the Malay Archipelago. In the regions of their presumed descendants these genera have not been found, neither *Callidrilus* in Madagascar nor *Glyphidrilus* in South Africa.

It is doubtful in what region the terricolous genera *Microchætus* and *Kynotus* have arisen. They may have originally developed from their aquatic ancestors in eastern tropical Africa, and have spread from there to the southern regions, becoming extinct in the land of their birth. On the other hand, we might assume that their ancestors in former times had a wider distribution, *Glyphidrilus* extending over South Africa and *Callidrilus* over Madagascar, and that they have become extinct after giving rise to their terricolous descendants.

Be this as it may, the time of the descent of *Microchætus* and its allies from their aquatic ancestors must be placed in a far-distant geological period; and we must regard the genus *Microchætus* as typically South African.

Even if we have to assume that the genus originally

invaded South Africa from the northern regions in past geological time, yet its presence forms the sharpest contrast between the modern oligochaete fauna of South Africa and that of tropical Africa. The latter is dominated by the phyletically much younger groups of the Trigastrine genus *Dichogaster* and the sub-family *Eudrilinæ*. These are living in South Africa with the *Ocnerodrilinæ* and with some other aquatic and amphibial groups. The *Ocnerodrilinæ* have only a portion of their dominion in this region, and they stand somewhat apart owing to their different habitat.

To recapitulate, the endemic fauna of the *Oligochaeta* of Natal and Zululand proves to be an integral portion of the Cape fauna with a small addition of outposts from the tropical African fauna.

But the oligochaete fauna of the Cape region is not homogeneous, the *Microchætinæ* prevail in the eastern districts, whilst the *Chilota* occur especially in the western parts. In this respect Natal and Zululand seem to even surpass the south-eastern districts of the Cape Province.

The faunistic character of the numerical preponderance of *Microchætus* over *Chilota* is accompanied by a peculiarly local distribution. All *Microchætus* species are found in very restricted areas of Natal and Zululand, although they are true endemic species. Somewhat different is the distribution of the *Chilota* species. It is true that *Ch. warreni* has up till now been found only in Natal, but the three other species have a much wider distribution: *Ch. trægårdhi* occurs both in Natal and Zululand, *Ch. wahlbergi* in Natal and the Transvaal, and *Ch. braunsi* in Natal and the Cape. These species may be regarded as peregrine to a certain extent, since probably they invaded Natal and Zululand at a fairly recent geological period; but the *Microchætus* species are the real aborigines of the eastern parts of South Africa.

The eastern fauna of the Cape is distinguished from the western by the non-occurrence of certain genera. The genera in question both belong to the section *Acanthodrilacea* [*Eodrilacea*] of the sub-family *Acanthodrilinæ*.

*Acanthodrilus* [*Eodrilus*] is archaic in character, and in far-distant geological periods was spread presumably over all the continents of the southern hemisphere as well as over the neighbouring portions of the northern hemisphere, such as Cameroon and Central America as far as Mexico. But this wide region of distribution has been much restricted and split up, and in recent times we only find the genus in scattered and widely separated localities. One of these localities is the southernmost corner of the African continent in the vicinity of Cape Town. Here we find a small number of species of *Acanthodrilus*, which give an archaic character to the oligochæte fauna of the Cape region. In other parts of South Africa, including Natal and Zululand, this archaic genus has been exterminated and replaced by phyletically younger oligochætes. In addition to the Cape Town residue we have several different species of *Acanthodrilus* surviving in Madagascar, and a single species in the Cameroons.

In the other genus, *Microscollex*, the distribution is quite different. This genus is represented by a small number of species in the southernmost coastal districts of the Cape Province. These extend eastwards as far as Port Elizabeth. The genus *Microscollex* is phyletically younger than *Acanthodrilus*, and has acquired the power of enduring salt-water, and thus it has the power of spreading widely across the sea. It probably originated in the southern corner of South America, and was distributed by means of the west-wind drift over all the region of the subantarctic seas, Patagonia, Falkland Islands, South Georgia, Crozet Islands and Kerguelen as far as the islands south of New Zealand.<sup>1</sup> In the course of distribution, which has probably occurred in relatively recent times, the southernmost coast of Africa was affected and became colonised with *Microscollex*. It would appear that there has not been time for the genus to spread further north, and so the oligochæte fauna of Natal and Zulu-

<sup>1</sup> Michaelsen, W., "Zur Kenntnis der Eodrilaceen und ihrer Verbreitungsverhältnisse." *Zool. Jahrb. Syst.*, xxx, p. 540 a. f., map p. 436.

land is distinguished from that of the Cape Province by the absence of species of *Microscolex*.

## SYSTEMATIC ACCOUNT.

### FAM. ENCHYTRÆIDÆ.

#### *Fridericia peregrinabunda* n. sp.

*Fridericia* sp. (? *bisetosa* *Levins*); Michaelsen, "Die Oligochaeten der deutschen Südpolar-Expedition 1901-1903," Deutsche Südpol.-Exp. 1901-03, IX, Zool. i, p. 19, 1905; Michaelsen, "Die Oligochaeten Deutsch-Ostafrikas," Zeitschr. wiss. Zool., lxxxii, p. 310.

*Fridericia bulbosa* (*Rosa*) var.; Michaelsen, "Oligochaeten von Natal und Zululand," Arkiv. Zool., iv, nr. 4, p. 2, 1907.

HAB.—Howick, Natal; valley just beneath Shelter Falls in rather dry earth, W. Michaelsen, September 2nd, 1911. Umgeni near Durban; at the roots of carnations, W. Michaelsen, September 7th, 1911.

Pietermaritzburg (teste Michaelsen); Zanzibar (teste Michaelsen); ? St. Paul (teste Michaelsen); ? New Amsterdam (teste Michaelsen); ? St. Helena (teste Michaelsen).

In my material there were many specimens of an Enchytræid which belonged to the group of *Fridericia bulbosa* (*Rosa*), but which differed somewhat from all the species of the group. It is not quite clear whether the small differences which are present really justify a specific separation, or whether such differences should be regarded as characterizing varieties of a somewhat variable species, as I assumed in 1907. Although still inclined to my former view, I here adopt the method of my colleagues, and treat the supposed variety as a true species; but in the future revision of this family it is quite likely that these forms will be re-united in one species.

EXTERNAL CHARACTERS.—Dimensions of mature specimens (the figures in parenthesis refer to stretched specimens from Pietermaritzburg): length 10-12 (15-18) mm., diameter 0.4-0.45 (0.25-0.33) mm. Number of segments 60-70.

Colour light grey, irregularly mottled by the contents of the alimentary canal shining through the body-wall.

The setæ are straight for nearly the whole length, but are bent slightly at the proximal end. They occur regularly in pairs throughout the body.

Dorsal pores are distinct; they begin on the seventh segment and are placed in the middle of the segments.

Clitellum ring-shaped, but ventrally it is flatter. It extends from the beginning of the twelfth segment to the end of the middle third of the thirteenth segment. The pellucid gland-cells of the clitellum are arranged in more or less regular transverse rows or zones.

INTERNAL ANATOMY.—Septa between segments 6 and 7, 7 and 8, 8 and 9 are somewhat thickened.

Alimentary Canal.—There are three pairs of main septal glands situated in the fourth, fifth, and sixth segments, two pairs of smaller intermediary ones in the fifth and the sixth segments and a less distinct pair in the fourth segment. The main septal glands are nearly globular, those of each pair are connected together by a narrow median transverse bridge.

The peptonephridia are provided with an irregular main portion, which is widest at the ends and somewhat narrow in the middle. In the widened fore-part the lumen shows an irregular undulation, and in the widened hind-part the walls show bladder-like projections, some two of which are prolonged into narrow diverticula or branches.

The œsophagus ends and the intestine begins in the middle of the twelfth segment. The front part of the intestine from the middle of the twelfth segment to the end of the fifteenth is provided with a system of "chyle-channels."

Nervous System.—The brain is only a little longer than broad, rather thick and somewhat convex behind; it projects in front in a short convex bow. Commissural bands arise laterally from the underside somewhat behind the frontal curve.

Excretory System.—The nephridia were examined in the segments of the fore-body only as far as the sixteenth

segment. They have a large pre-septal portion which is only a little shorter and somewhat narrower than the post-septal part. The pre-septal and post-septal portions are connected together by a rather narrow neck. The duct arises from the underside of the post-septal part at a small distance from the neck, but as the long axis of the post-septal part mostly runs transversely in the body it often appears that the duct arises from the hinder end of the apparently shortened and much broadened post-septal portion.

Reproductive System. — Spermiducal funnel rather thick, not quite twice as long as broad, with a narrow collar, and pierced excentrically. Sperm-duct very thin, rather long and coiled irregularly.

Spermathecae with a very slender curved duct without glandular appendages, and with a single bulb-shaped ampulla without diverticula. The duct enters the broad pole of the ampulla, and its proximal end projects somewhat into the lumen of the ampulla. Proximally the ampulla narrows into a moderately long prolongation, which enters the œsophagus laterally in the hinder part of the fifth segment in front of the septum between the fifth and sixth segments. In this, *F. peregrinabunda* differs from *F. pulchra*, where the prolongation opens in the sixth segment, in front of the septum between the sixth and seventh segments.

REMARKS.—*Fridericia peregrinabunda* belongs to the group of *F. bulbosa* (*Rosa*), and is particularly related to *F. pulchra* *Friend*.<sup>1</sup> It differs from the latter species in certain minor points, principally in the more complex shape of the pepto-nephridia which are long and quite simple and smooth tubes in *F. pulchra*; also in the shape of the nephridia, and in the normal course of the spermathecae which enter the œsophagus in the fifth segment, whilst in *F. pulchra* they run backwards nearly as far as the septum between the sixth and seventh segments.

*F. peregrinabunda* is doubtless a peregrine species imported by man into Africa. It seems to be rather widely dis-

<sup>1</sup> *Friend*, H., 'Journ. Micr. Sci.,' 1912, p. 21, text-figs. 9, 10.

tributed. It is also densely distributed, since there are no less than three localities in Natal—Howick, Pietermaritzburg, Durban. The worm was doubtless introduced in earlier times and has spread widely. Various statements have been made of a *Fridericia* being found on various islands associated with Africa—Zanzibar, St. Paul, New Amsterdam, St. Helena. In all these cases the worm referred to is a species of the small “bisetose” group of this genus. In my opinion all these worms are *Fridericia peregrinabunda*; but since the specimens from these islands were immature it is not possible to be absolutely sure.

*Fridericia perrieri* (*Vejd.*).

*Fridericia perrieri* (*Vejd.*); Michaelsen, “Oligochaeta,” Tierreich, x, p. 98, 1900. Contains synonymy and bibliography.

Loc.—Howick, Natal; found in detritus near the Umgeni Falls, W. Michaelsen, August 30th, 1911 (2 specimens).

This is a peregrine species spread over most European countries.

FAM. MEGASCOLECIDÆ.

Sub-fam. ACANTHODRILINÆ.

*Chilota warreni* *n. sp.* Pl. XXXII, figs. 1, 2.

HAB.—Howick, Natal; found in detritus near the Umgeni Falls, W. Michaelsen, August 30th, 1911 (many specimens).

Farm “Camin” between Pietermaritzburg and Greytown, Natal; found at the roots of fern, Mrs. Liebermann, November 11th, 1911 (one specimen).

Game Pass, Drakensberg, Natal; H. C. Burnup, June, 1912 (a number of mature specimens).

EXTERNAL CHARACTERS.—Length 42–65 mm., diameter 2.5–3 mm., number of segments 102–114. Many apparently complete specimens are considerably shorter, and they without doubt represent pieces with regenerated hinder ends.



Colour dark violet-grey dorsally. The intensity diminishes on passing backwards from the fore-end, and the colour changes into a reddish-brown. Ventral side yellowish-grey, and laterally somewhat abruptly separated from the dark colour of the dorsal surface.

Setæ rather large, especially at the hinder part of the body; ventrally they are widely paired, dorsally they are separated. Generally the middle lateral distance is equal to the width of the dorsal pairs; it is distinctly larger than the width of the ventral pairs, and a little smaller than the ventral median distance<sup>1</sup> ( $aa : ab : bc : cd = 7 : 4 : 6 : 6$ ). Median dorsal distance rather small; at the fore-end twice as large as the width of the dorsal pairs, at the hind-end even smaller, measuring only once and half times the length ( $dd = 1\frac{1}{2} - 2 cd$ ). The width of the ventral pairs diminishes in the region of the male pores.

Nephridial pores are in the lines of setæ *c*.

Clitellum ring-shaped, ventrally not very conspicuous. It extends over five segments, 13-17. At the thirteenth and at the seventeenth, or at one of them, the clitellum often appears incompletely developed.

Male area: prostate pores are in two pairs on the seventeenth and nineteenth segment in the lines of setæ *b*, each on a transversely ovate papilla which is often provided with a deep transverse furrow. Male pores not seen, probably on the eighteenth segment in the lines of setæ *b*; in most cases there is to be seen a pair of transverse furrows in these places. There are no seminal longitudinal furrows.

The whole ventral surface of the seventeenth and eighteenth segments is often glandular, and this modification sometimes extends a little beyond these segments.

Female pores are in front of setæ *a* in the fourteenth

<sup>1</sup> For the sake of convenience in referring to the various distances the four setæ of the two pairs on each side are lettered respectively *a*, *b*, *c*, *d*, passing from the ventral to the dorsal surface. The letter *a* stands for the whole circumference.

segment, and are reflected slightly towards the middle ventral line.

Spermathecal pores in two pairs are on the furrows between the seventh and eighth segments, and the eighth and ninth segments in the lines of setæ *b*.

INTERNAL ANATOMY.—The septa of the gizzard region are extraordinarily tender. Septa between the ninth and tenth segments, tenth and eleventh segments and the eleventh and twelfth segments are very little thickened, and must still be regarded as thin.

Alimentary Canal.—Gizzard small, hardly broader than the neighbouring part of the œsophagus; occurs in the fifth and sixth segments. Esophagus without calciferous glands. Intestine without typhlosole.

Circulatory System.—Dorsal vessel simple; the last hearts are in the twelfth segment.

Reproductive System.—Male organs: one pair of great sperm-duct funnels occur free in the tenth segment, they are not enclosed in seminal vesicles. There are two pairs of great grape-like sperm-sacs depending from the septa between the ninth and the tenth segments and tenth and eleventh segments. They project into segments 9 and 11.

Prostates are tubular; the glandular part is very long and richly folded in broad and narrow coils, which extend from the segment of the prostate pores into the segment in front. Duct is relatively short, somewhat bent, and much thinner than the glandular part.

Penial setæ are of two kinds; each prostate is accompanied by one of both kinds. (1) Length 1.2 mm., thickness at proximal end about 35  $\mu$ . The seta gradually diminishes towards the tip, close to which the thickness is about 20  $\mu$ . The seta of this kind is distinctly bent, and ends in a very sharp point. With the exception of the terminal pointed portion, the distal third of the seta is ornamented with a somewhat close annulation. The edge of the annulets consists of densely crowded, irregular triangular teeth closely clinging to the surface, and forming irregular zigzag transverse rows.

(2) This kind is somewhat more slender than the first. Length 1.4 mm., thickness of proximal end  $30\mu$ . Seta gradually tapers; at a distance of 0.2 mm. from the tip the thickness is about  $16\mu$ . The seta is only very slightly bent. A distal length of about 0.16 mm. is flattened and somewhat broadened, being  $26\mu$  broad, forming a slender and fine lancet ending in a simple acute-angled often somewhat reflected tip. With the exception of the lancet extremity the distal third is ornamented like the other penial seta, but the ornamentation is somewhat more delicate.

Female organs: a pair of great ovaries project free into the thirteenth segment.

The spermathecae have an ampulla which is broad and irregularly puffed out. Duct short and narrow, coming off abruptly from the ampulla. Into the duct there open two short, broad and rounded diverticula which are scarcely longer than it. The diverticula are nearly opposite to each other, but their bases are confluent on the front side of the duct of the ampulla. The central lumen of the diverticula is small, and the thick walls contain numerous minute cavities filled with sperm.

REMARKS.—*Chilota warreni* is one of the few South African species with two spermathecal diverticula. It comes nearest to *Ch. trögårdhi* Mich. from Zululand; and resembles this species in the lines of setae *a* and *b* converging towards the male pores, but more distinctly so; also in possessing two spermathecal diverticula and two kinds of penial setae and in many other characters. The two species may easily be distinguished from one another by the shape of the penial setae and by other less obvious characters, such as seminal furrows, copulatory papillae, colour, etc.

*Chilota trögårdhi* Mich. f. *typicus*.

*Chilota trögårdhi* Michaelson, "Oligochæten von Natal und dem Zululand," Ark. Zool. iv, nr. 4, p. 3. text-figs. 1, 2. 1907.

HAB.—Lake Sibayi, a freshwater lake near the coast, N. Zululand (teste Michaelson).

*Chilota trågårdhi* Mich. var. *major* n. var. Pl. XXXII, figs. 4, 5.

HAB.—Hilton Road, eleven miles N.W. Pietermaritzburg, Natal; Dr. M. A—, July 28th, 1905 (one nearly mature specimen).

Natal; Miss Blackmore, 1905 (several immature specimens with only two showing the first signs of sexual organs, one nearly mature specimen).

EXTERNAL CHARACTERS.—Largest specimen, length 130 mm., diameter 3·5–4 mm., number of segments 124.

The colour and arrangement of setæ are as in the typical form. The lines of setæ *a* and *b* converge very gradually towards the male pores, and the setæ are distinctly enlarged at the hinder end as in the typical form. In the original description of *typicus* I omitted to record these facts.

INTERNAL ANATOMY.—As far as the sexual development and the state of preservation permitted me to see, the general anatomy resembles that of *typicus* with the exception of the shape of the penial setæ. In *typicus* each prostate is accompanied by two penial setæ of distinctly different shape, while in *major* these setæ closely resemble one another and differ only slightly in size. The penial setæ of *major* are very slender, being 1–1·1 mm. long and 13  $\mu$  thick at the proximal end; the seta tapers very gradually towards the distal end, where the thickness is about 5  $\mu$ . The setæ are only slightly bent, and they are quite smooth and transparent without any ornamentation, while in *typicus* one kind of the penial setæ has an external ornamentation, which, however, is rather faint and irregular, and perhaps has no great systematic value.

In *typicus* the distal tip is simple and sharp-pointed; but in *major* it has a very characteristic shape, and in both of the penial setæ the distal extremity ends in two minute claws, which are connected together by a membrane like that of a webbed foot. In the plane of the membrane the extremity is slightly widened, but in profile there is no broadening.

*Chilota wahlbergi* Mich. f. *typicus*.

*Chilota wahlbergi* *Michaelsen*, "Revision der Kinberg'schen Oligochaeten-Typen," Öfv. Vet. Förh., lvi, p. 441. 1899.

HAB.—Farm between Pietermaritzburg and Greytown, Natal; at the roots of ferns, Mrs. Liebermann, November 11th, 1911 (one specimen). "Kafferlandet" (teste *Michaelsen*).

The form *pulchrior* *n. f.* from Witpoortje in the Middleburg district, Transvaal (teste *Michaelsen*).

When examining the material from the Transvaal I was of the opinion that the main difference between these specimens and the type specimen of *Kinberg* was that the latter had lost its colour through remaining in spirit for nearly fifty years.<sup>1</sup> But recently I obtained a specimen that had been in spirit only for a few hours, and it had the same pale coloration as the type. It may therefore be stated that there does exist a difference between the specimens from the Transvaal and those from other localities, and consequently I distinguish the Transvaal intensively coloured race from the typical form as *f. pulchrior n. f.*

*Chilota braunsi* Mich. Pl. XXXII, fig. 3.

*Chilota braunsi* *Michaelsen*, "Terricolen von verschiedenen Gebieten der Erde," Mt. Mus. Hamburg, xvi, p. 102, fig. 21. 1899.

HAB.—Zwaartkop Valley, three and a half miles west of Pietermaritzburg, Natal (one not quite mature specimen).

Port Elizabeth, Cape Province (teste *Michaelsen*).

The penial setæ of this species are characteristic in being of a light wine-red colour. This was observed both in the type and in the Natal specimen. The scales ornamenting the penial setæ are distributed rather irregularly, and their arrangement is somewhat variable. They are scattered in the type, but in the specimen from Zwaartkop Valley they tend to be grouped so as to form irregular transverse rows.

<sup>1</sup> *Michaelsen*, W., "Oligochaeten vom tropischen und südlich-subtropischen Afrika, I." 'Zoologica,' Heft 67, p. 146.

## Sub-fam. MEGASCOLECINÆ.

*Pontodrilus bermudensis* *Bedd.* f. *typicus*.

*Pontodrilus bermudensis* *Bedd.* f. *typicus*; Michaelsen. "Oligochæten von verschiedenen Gebieten." *Mt. Mus. Hamburg*, xxvii, p. 85. 1910.

HAB.—Kosi Bay, Zululand; collected December, 1905. Distributed along the coasts of the Pacific, Indian, and Atlantic Oceans in the warmer zones.

The specimens were badly preserved. When copulatory papillæ were visible, a single median ventral papilla could be seen at the furrow between the nineteenth and twentieth segments.

*Pheretima heterochæta* (*Mich.*).

*Amyntas heterochætus* (*Mich.*); Beddard, "A Revision of the Earthworms of the genus *Amyntas*," *Proc. Zool. Soc. Lond.*, 1900, p. 615. Contains synonymy and bibliography.

HAB.—Howick, Natal; in detritus near the foot of the Umgeni Falls, and in rather dry earth beneath stones on veld, W. Michaelsen, August 30th, 1911.

Hilton Road, Natal; Dr. M. A—, July 28th, 1905.

Dorp Spruit, Pietermaritzburg, Natal; October 30th, 1904. Zwaartkop Valley, near Pietermaritzburg, Natal.

Scottsville, Pietermaritzburg, Natal; W. G. Rump, December, 1911.

Durban, Natal; J. Clark, 1911.

This is a peregrine species distributed far over the warmer zones, and doubtless introduced by man into Natal.

## Sub-fam. TRIGASTRINÆ.

*Dichogaster bolau* (*Mich.*).

*Dichogaster bolau* (*Mich.*); Michaelsen. "Oligochæta," *Tierreich*, x, p. 340. 1900. Contains synonymy and bibliography.

HAB.—Scottsville, Pietermaritzburg, Natal; W. G. Rump, 1912.

This is a peregrine species of the warmer zones, imported by man into Natal.

The specimen from Scottsville represents the larger form, which was formerly separated from the typical form as the variety *octonephra* (*Rosa*), where in most of the segments there are four micronephridia on each side, but the ventral-most micronephridium is very small. In many segments of the Scottsville specimen the innermost micronephridium is altogether absent, and these segments are in the condition of the typical form. The specimen may be regarded as intermediate.

*Dichogaster crawi* Eisen. Pl. XXXII, figs. 6 and 7.

*Dichogaster crawi* Eisen, "Researches in American Oligochaeta, with especial reference to those of the Pacific Coast and adjacent Islands," Proc. Cal. Ac. (3) ii, p. 228, pl. x, figs. 82-94. 1900.

HAB.—Scottsville, Pietermaritzburg, Natal; W. G. Rump, December, 1911.

Chapel Street, Pietermaritzburg, Natal; H. C. Burnup, December, 1911.

Also San Francisco, California, and Del Monte in conservatories (teste Eisen).

The specimens from San Francisco were said to have been introduced from Honolulu, Hawaii; but I have shown elsewhere<sup>1</sup> why I regard these statements of Mr. Craw as being incorrect, and it is probable that the worms entered the plant receptacles after their arrival at Mr. Craw's nursery. In any case most of the species of this genus, including *D. crawi*, have been widely transported hither and thither by man into numerous localities.

REMARKS.—The specimens from Natal show in general such a striking conformity with Eisen's *Dichogaster crawi* that there is no doubt about the identity of the species; but at the same time there is an apparently very important difference in a certain structural character. If Eisen's statement is correct, it must be assumed that there is great variability in the character in question. According to Eisen the spermatheca

<sup>1</sup> Michaelsen, W., "Die geographische Verbreitung der Oligochäten." Berlin, 1903.

are provided with one simple diverticulum. In the specimen from Natal, carefully examined by myself, each of the four spermathecae was provided with two diverticula, and one of these in three of the four spermathecae was even doubled. Each diverticulum carried a completely separated globular seminal chamber. The diverticula seem to be rather fragile and easily torn off, and perhaps in Eisen's specimen one of the diverticula had been overlooked through being broken away accidentally.

Further, Eisen's statement with regard to the larger of the two penial setae requires modification. Eisen<sup>1</sup> describes it as being "strongly wavy" in outline, "but with no other ornamentation," and it may appear thus in a balsam preparation. Mounted in spirit or in water the waviness is seen to depend on the presence of a number of convex longitudinal ridges, which are sharply truncated distally. The ridges on one side correspond to grooves on the opposite side, and when the seta is viewed in profile a wavy appearance is produced.

In all other points the penial setae of the Natal specimen agree with Eisen's description.

Dimensions: large penial seta, length 0.6 mm., diameter at proximal end  $10\mu$ ; smaller penial seta, length 0.4 mm., diameter at proximal end  $7\mu$ .

Sub-fam. OCNERODRILINÆ.

*Kerria gunningi* Mich.

*Kerria gunningi* Michaelsen, "Oligochäten vom tropischen und südlich-subtropischen Afrika, ii," Zoologica, Heft 68, p. 1. 1912.

HAB.—Howick, Natal; in detritus near the Umgeni Falls, W. Michaelsen, August 30th, 1911.

Umgeni near Durban, Natal; in the mud on the marshy banks of the Umgeni River, W. Michaelsen, November 7th, 1911.

Pretoria, Transvaal (Michaelsen).

<sup>1</sup> Loc. cit., p. 229, and pl. x, fig. 87.

In the original description of this species I stated that the clitellum was saddle-shaped, being interrupted ventrally between the lines of setæ *a*. This statement is not quite correct, or at least it is not in accord with the condition seen in all the specimens of this species. In the Natal specimens the clitellum is ring-shaped; but ventrally, and especially between the lines of setæ *a*, it is less strongly developed. Even in the type-specimens from the Transvaal there are no distinct ventral borders to the clitellum, and it is not easy to be sure that the glandular structure is entirely lacking medio-ventrally. It is obvious, therefore, that such a slight difference in structure does not justify a separation of the Natal specimens from those of the Transvaal.

*Ocnerodrilus (Ilyogenia) africanus (Bedd.)*.

*Ilyogenia africana* *Beddard*, "On some New Species of Earthworms from various parts of the World," *Proc. Zool. Soc. Lond.*, p. 703. 1892.

*Ocnerodrilus africanus* (Bedd.); *Michaelsen*, "Die Regenwürmer Deutsch-Ost-Afrikas." *Deutsch-Ost-Afrika*, iv, p. 43. 1896.

*Ocnerodrilus (Enicmodrilus) africana (Bedd.)*; *Eisen*, "Researches in American Oligochæta, with especial reference to those of the Pacific Coast and adjacent Islands," *Proc. Cal. Ac.* (3), ii, p. 112. 1900.

*Ocnerodrilus (Ilyogenia) africanus (Bedd.)*; *Michaelsen*, "Oligochæta." *Tierreich*, x, p. 380. 1900.

HAB.—Chapel Street, Pietermaritzburg, Natal; H. C. Burnup, December, 1911.

Durban, Natal (teste *Beddard*).

Five rather poorly preserved specimens, two of which are mature, enable me to make some additional statements about this incompletely known species.

EXTERNAL CHARACTERS.—Dimensions of the two mature specimens: length 25 mm. and 35 mm., maximum diameters 1.0 mm. and 1.3 mm., number of segments 78 and 82.

Colour greyish without special pigmentation.

Head epilobous,<sup>1</sup> about  $\frac{1}{2}$ .

Setæ tend to be strictly paired. Median ventral distance about equal to the middle lateral ones. Median dorsal distance a little smaller than half the circumference of the body ( $aa = bc$ ,  $dd < \frac{1}{2}u$ ).

INTERNAL ANATOMY.—The calciferous glands, or chyle-sacs as I think they should be called, are characteristic in this species. Externally they are sac-like and broader than the œsophagus which is very narrow in the ninth segment. Ventrally they extend forward in the longitudinal axis of the body from the hinder part of the ninth segment to the front end. They arise laterally from the œsophagus. The lumen is divided by a number of longitudinal septa which spring from the external wall and meet in the mid-axis of the organ. A transverse section has, therefore, a wheel-like appearance. The number of radiating septa varies somewhat in different parts of the organ. The maximum number is in the middle, where I have found seven. The external walls, as well as the septa of the organ, are rather thick and are provided with a system of very narrow canals ("Chylusgefässe").

For the remainder of the anatomy reference must be made to the original description by Beddard.

#### Sub-fam. EUDRILINÆ.

##### *Eudriloides durbanensis* Bedd.

*Eudriloides durbanensis* Bedd., "On some New Species of Earth-worms from various parts of the World," Proc. Zool. Soc. Lond., 1892, p. 696, pl. xlvi, figs. 11, 14. 1893.

<sup>1</sup> There are certain terms to express the relationship between the prostomium and the peristomial segment: (1) *zygolobous*, where the prostomium is completely fused with the peristomial segment without showing a dorsal furrow; (2) *prolobous*, where the dorsal furrow between them is transverse; (3) *pro-epilobous*, where the furrow is concave in front; (4) *epilobous*, where the furrow is split dorsally to form two longitudinal grooves running backwards, and the extent to which they pass backwards is expressed by a fraction of the length of the peristomium; (5) *tanylobous*, where the two longitudinal grooves reach the transverse furrow between the peristomial segment and the segment behind.

HAB.—Found in Kew Gardens, England, in a box of plants from Durban, Natal (teste Beddard).

In the general part of this paper I showed that there was much doubt about the original home of this species. Even if the specimens actually came from Durban, there is nothing to prove that the species was not introduced by man into Natal.

FAM. GLOSSOSCOLECIDÆ.

Sub-fam. GLOSSOSCOLECINÆ.

*Pontoscolex corethrurus* (*Fr. Müll.*)

*Pontoscolex corethrurus* (*Fr. Müll.*); W. Michaelsen, "Oligochæta," Tierreich, x, p. 425. 1900.

HAB.—Chapel Street, Pietermaritzburg; H. C. Burnup, December, 1911.

Umgeni, Durban; in plantation, W. Michaelsen, September 7th. 1911.

This is a peregrine species of the warmer zones, found wherever there is horticulture.

Sub-fam. MICROCHÆTINÆ.

*Microchætus natalensis* (*Kinb.*). Pl. XXXII, figs. 8, 9.

*Geogenia natalensis* *Kinberg*. "Annulata nova [Continuatio]," Öfv. Ak. Förh., 1866, nr. 4, p. 100. 1867.

*Geogenia* [? *Microchæta* ?] *natalensis* *Kinb.*; Michaelsen, "Revision der Kinberg'schen Oligochæten-Typen," Öfv. Ak. Förh., 1899, nr. 5, p. 428, text-fig. 1.

*Geogenia* [? *Microchætus* ?] *natalensis* Michaelsen, "Oligochæta," Tierreich, x, p. 462. 1900.

HAB.—Scottsville, Pietermaritzburg, Natal; W. G. Rump, December, 1911.

Pietermaritzburg; in a garden, Dr. E. Warren, September 5th, and December, 1911.

Also Natal, Port Natal (teste Kinberg).

I have examined seven specimens in addition to the type-

specimen. I am convinced that the specimens collected by Dr. Warren and W. G. Rump at Pietermaritzburg belong to this species, although they seem to differ considerably from the type. It is probable that these differences depend upon the different state of development, as the type is not quite mature. At any rate the difference in the shape of the sexual setæ is to be so regarded.

Since the type was immature and badly preserved, I now give a complete description founded on mature and better preserved specimens.

EXTERNAL CHARACTERS.—Dimensions of the smallest and largest specimens: length 118 and 170 mm., breadth 4.5 to 7 mm. and 6 to 7 (at clitellum 9) mm., number of segments 232 and 297.

Colour smoke-grey dorsally, and yellowish-grey ventrally.

Head probolous. The prostomium, first, second and fore-half of third segment are longitudinally furrowed. The first and second segments are simple, third segment irregularly biannulated. The furrow of annulation and the furrows between the first and second segments and the second and third segments are not quite regular. The fourth to the ninth segments are divided into two segment-like ringlets. Front ringlet of the fourth segment is slightly biannulated; all the other ringlets, are simple. Fore-ringlets, bearing setæ and nephridial pores, of fourth to the eighth segments are somewhat larger than the hind-ringlets. The tenth and following segments are simple or indistinctly biannulated.

Setæ begin in the third segment; in general they are rather small. One from the sixth segment measured 0.5 mm. in length, and  $45 \mu$  in thickness, and was rather strongly bent into an **S**. The setæ had an indistinct ornamentation, consisting of irregular and broad scales running mainly in a transverse direction. The setæ are strictly paired. The median dorsal distance of the setæ is a little smaller than half the circumference of the body ( $dd = \text{circa}, \frac{1}{3} u$ ). Median ventral distance of setæ about as large as the middle lateral distance ( $aa = \text{circa } bc$ ). Towards the region of the clitellum

the median ventral distance diminishes, while the median dorsal distance is enlarged. The degree of this dislocation of the lines of setæ varies somewhat in different specimens, and may depend on the state of contraction of the body.

The ventral setæ of the fifteenth to twenty-first segments are transformed into sexual setæ and are not as strictly paired as in the case of the normal setæ. In some specimens the median ventral distance of setæ is hardly larger than twice the distance of the setæ of a ventral pair:  $aa = 2\frac{1}{3} - 3 ab$  at segments 15 to 21.

Nephridial pores are in the lines of setæ *c*.

Clitellum is saddle-shaped, and in all specimens extends over ten segments, thirteenth to the twenty-second inclusive.

Copulatory Organs.—At each side there is a very broad and flat copulatory ridge ("Pubertätswall") extending over four segments, fifteenth to eighteenth, and ventrally nearly reaching the line of setæ *b*, while dorsally it reaches the middle lateral line, transgressing considerably the line of the setæ *d* and of the nephridial pores, which line is bent ventrally in the region of the clitellum. The nephridial pores are seen distinctly on the copulatory wall. The fore-part of this copulatory wall belonging to the fifteenth segment is somewhat differentiated, being thicker than the other parts, and, especially laterally, it overhangs the borders of this segment. In two of the specimens it looks like a narrow, laterally rounded shield. From the fifteenth to the twenty-first segment the ventral borders of the clitellum are formed by a more or less distinct undulating white line. Between these lines the body-wall is glandular and bears the sexual setæ. Only a very narrow medio-ventral strip of the body-wall is free from this glandular modification.

The male pores are in the middle of the copulatory walls in the furrows between the sixteenth and seventeenth segments and somewhat beneath the lines of setæ *c* and of the nephridial pores.

Female pores are somewhat medial to the lines of setæ *a* in front of the zone of setæ of the fourteenth segment.

Spermathecal pores are inconspicuous; they are in groups of about ten to thirteen in the furrows between the thirteenth and fourteenth segments and the fourteenth and fifteenth segments. They occur ventro-laterally between the lines of setæ *b* and *c*.

INTERNAL ANATOMY.—The septa between segments 4-5, 7-8 and 8-9 are extraordinarily strong, while those between 5-6 and 6-7 are very tender, if not quite rudimentary or absent. Septum between ninth and tenth segments and all the following septa are tender and thin.

Alimentary Canal.—There is a very large gizzard in the seventh segment. A pair of nearly globular calciferous glands spring laterally from the œsophagus in the ninth and tenth segments. The tender septum between the ninth and tenth segments seemed to be fixed to the middle zone of the calciferous glands.

Circulatory System.—Dorsal blood-vessel simple; the last heart is in the eleventh segment.

Reproductive System.—Male organs: there are two pairs of large glittering spermiducal funnels in the tenth and eleventh segments; each pair is enclosed in a median transverse seminal vesicle. The lateral ends of the seminal vesicles are prolonged into sperm-sacs which project into the eleventh and twelfth segments respectively.

Spermathecae are in four groups of about eleven each, and are totally embedded in the thick body-wall; they may be seen shining through the semi-pellucid wall. The spermathecae are elongated, being 0.3-0.7 mm. in length and 0.09 mm. in diameter; they open to the exterior by a very thin and short duct.

Sexual setæ: the ventral setæ of fifteenth to twenty-first segments are enlarged and transformed into sexual setæ. They are about  $2\frac{1}{2}$ -3 mm. in length, that is, about five or six times longer than the ordinary setæ. At the proximal end they have a thickness of about 60  $\mu$ , which diminishes to about 45  $\mu$  at the middle of the setæ. The sexual setæ are distinctly bent at the proximal end, while distally they are

nearly straight. The distal end is thickened and broadened to a diameter of about  $80 \mu$  just beneath the tip. One side of this broadened portion is strongly convex, the other side is flat or slightly concave or provided with a longitudinal cleft. The seta ends in a simple and rather clumsy tip, or in two tips with a slightly concave edge between them. In the type-specimen all the sexual setæ had only one point. In one of the specimens from Pietermaritzburg about half of the sexual setæ were provided with two tips while the other half had only one. There is a very characteristic external ornamentation consisting of somewhat irregular, rather densely crowded annulations, the distal borders of which are rather prominent and almost scale-like. From the distal border of these annulations a closely set row of very slender teeth, clinging to the surface of the seta, extend distalwards, and nearly reach the distal border of the next annulus. This ornamentation was not very clearly seen, as the sexual setæ were enclosed in a fine cuticular sheath difficult to remove. In the type-specimen the sexual setæ are not fully developed, and hence they differ in shape and structure.

There are no special glands connected with the sexual setæ projecting into the body-cavity as are found in other species of this genus.

The sexual setæ of *M. natalensis* are provided with a very strong mantle of longitudinal muscles, which at one end are fixed to the proximal portion of the setal sac, and at the other to the body-wall in the immediate neighbourhood of the setal pore.

*Microchætus papillatus* *Benham* f. *typicus*. Pl. XXXII, fig. 10.

*Microchæta papillata* *Benham*, "Descriptions of Three New Species of Earthworms," Proc. Zool. Soc. Lond., 1892, p. 141, pl. vii, figs. 5, 7; pl. viii, figs. 9, 10, 11, 13.

*Microchætus papillatus* *Benh.*; Michaelsen, "Oligochæta," Tierreich, x, p. 450. 1900.

*Microchætus papillatus* *Benh.*; Michaelsen, "Oligochæten von Natal und dem Zululand," Arkiv. Zool., iv, n. 4, p. 5. 1907.

HAB.—Durban, Natal; T. H. Bowker, 1898, Dr. Purcell, 1907, E. C. Chubb, 1911.

Pietermaritzburg; W. G. Rump, December, 1911.

Also, Durban (teste Benham) and Stamford Hill, near Durban (teste Michaelsen).

Ten specimens in all were examined, and these I call *Microchætus papillatus* *Benh. f. typicus*.

EXTERNAL CHARACTERS.—The dimensions of the mature specimens vary considerably; length 220–350 mm., diameter 10–16 mm., number of segments 324–490.

Colour yellowish-grey with sometimes a slight violet-grey tint on the upper anterior surface.

Head probolous. Segments 1–3 simple, fourth to the ninth all divided by a furrow into two ringlets of about equal size, but the hinder ringlet, especially of the ninth segment, is often somewhat shorter than the front one. The tenth and following segments are simple or slightly biannulated.

Setæ are rather tender; they begin on the third segment and are strictly paired. The median ventral distance is equal to the middle lateral ( $aa = bc$ ). The median dorsal distance equals about one-half of the circumference of the body ( $dd = \text{circa } \frac{1}{2}u$ ).

The nephridial pores are in the lines of setæ *cd*.

Clitellum is saddle-shaped and extends over the segments 10–29 or 30 = 20 or 21; but it is not always sharply bordered in front and behind.

Copulatory Organs.—A pair of copulatory walls extend laterally over the five segments 16–20, being very prominent in the middle segments 17–19. These walls broaden the body at this region, especially in the nineteenth segment, and here ventrally the body is flattened. There are no copulatory cushions, or at least no distinct ones. There are generally two pairs of large copulatory papillæ with sexual setæ which are always in the lines of the ventral pairs of setæ. The position of these papillæ is rather constant. There is always a pair on the tenth segment, and a second pair either on the twenty-third segment (in seven specimens) or on the twenty-

ninth segment (in four specimens). In one specimen there was found a supernumerary papilla on one side of the twenty-third segment besides two normal pairs on the tenth and twenty-ninth segments. Another specimen possessed a supernumerary pair of papillæ on the eleventh segment besides the normal ones. Often there are to be seen a great number of very much smaller papillæ carrying all the ventral pairs of setæ of the clitellum region extending from the eleventh to the twenty-ninth segment. These, together with the large papillæ, form two continuous longitudinal series in the lines of the ventral pairs of setæ. Generally these smaller papillæ are indistinct or quite inconspicuous.

Male pores were not seen; probably they occur at the same points as in *var. cæmenterii*, i.e. at the furrow between the seventeenth and eighteenth segments, beneath the lines of setæ *c*.

Female pores are just in front of setæ *b* of the fourteenth segment.

Spermathecal pores are in groups of two to twelve in the lateral parts of the furrows between the twelfth and thirteenth segments and thirteenth and fourteenth segments, or between segments 12 and 13, 13 and 14, and 14-15.

INTERNAL ANATOMY.—It has been described by Benham. The following additional statements may be made. The sexual setæ are about 1.75 mm. in length and 75  $\mu$  in thickness in the middle. They are slightly sigmoid. The thickness diminishes towards the distal end, being only about 20  $\mu$  just beneath the distal tip. The tip is not simple and conical, but is sharpened to form a triangular pyramid, the lateral sides of which are deeply excavated. The distal third of the seta, with the exception of the extreme end, is ornamented. This ornamentation in the proximal parts consists of transverse or more or less oblique annulations, the scaly margins of which are irregularly toothed or pronged. Towards the distal end the annulations become interrupted, and ultimately pass into more or less irregular transverse lines which finally disappear.

Setal glands: the pairs of sexual setæ are provided with two or four setal glands. These are sac-like and compressed on the longitudinal axis so as to be much broader than long. Benham describes two glands, one in front and one behind the setæ. I generally found four of these glands forming a square, the centre of which was occupied by the pair of sexual setæ. In one specimen there was a transitional arrangement; here only two glands were obvious, and they were placed laterally; but in front and behind in the middle line the body-wall was distinctly elevated on the inner surface. Doubtless these elevations were due to the formation of two setal glands which did not break through the muscular layer of the body-wall. These specimens with only two setal glands in connection with each pair of sexual setæ come nearer to the variety *cæmenterii* described below. The difference between Benham's type and the specimens that I have examined must be regarded as being due to a casual variation.

*Microchætus papillatus* *Benh.* comes nearest to *M. pentheri* *Rosa* from the Cape Province; the principal difference is that in *M. pentheri* there are two strongly thickened septa in front of the gizzard, whilst in *M. papillatus* the septa in front of the gizzard are very tender.

*Microchætus papillatus* *Benham*. var. *cæmenterii*  
*n. var.* Pl. XXXII, fig. 11.

HAB.—Howick, Natal; in swampy meadows, W. Michaelsen, August 30th, 1911.

St. Peter's Churchyard, Pietermaritzburg, February, 1905.  
Pietermaritzburg; E. Warren, May, 1912.

There were three mature specimens with several half-mature ones.

EXTERNAL CHARACTERS.—Dimension of the largest: length 540 mm., diameter 9–11 mm., body broadened in the region of the copulatory walls into a breadth of 22 mm.; number of segments about 600. Dimension of the smallest mature specimen: length 330 mm., diameter 7–10 mm., body

broadened in the region of the copulatory walls to a breadth of 22 mm. Number of segments about 530.

Clitellum distinctly bordered in front and behind, extends over the segments 12-24 (=13). Copulatory walls form sharp ridges in the lateral lines, extending over segments 16-20, highest at the eighteenth segment. A pair of flat but very distinct copulatory cushions, surrounded by a wall-like rim, extend medially from the ridges of the copulatory walls from the fore-border of the seventeenth segment as far as the hind-border of the twentieth segment. These cushions are broadest at the seventeenth segment, there reaching from the lines of setæ *d* nearly as far as the lines of setæ *b*, but the latter are distinctly outside the cushions, being separated from them by a distance of about 1.5 mm.

Copulatory papillæ are of very large size and bear the sexual setæ at the twelfth, fifteenth and nineteenth segments (in two mature specimens), or at the tenth, eleventh, twelfth, fifteenth and nineteenth segments (in one mature specimen), or at the fifteenth, sixteenth and twenty-eighth segments (in one half-mature specimen). Smaller papillæ occur on all other segments from the tenth to the twenty-eighth segment. All the papillæ, both large and small, occupy the lines of the ventral pairs of setæ, forming a pair of regular longitudinal series.

Spermathecal pores are in groups of 3-5 on each side on the furrows between segments 11-12 and 12-13.

INTERNAL ANATOMY.—The sexual setæ seem to be larger in this variety. The larger seta of a pair was 2.5 mm. in length, and proximally about 90  $\mu$  in thickness; the smaller seta was 1.8 mm. long and 80  $\mu$  wide. The sexual setæ are slightly sigmoid in shape. Distally they diminish in thickness. The tip is generally broadened in the plane of curvature, and ends in two thick and short teeth which are joined by a web-like membrane nearly as thick as the teeth. The tip is thus wedge-shaped. Sometimes, apparently through wear, the typical shape is not visible. The ornamentation of the distal end resembles that seen in the sexual setæ of *tycticus*; but it

extends further towards the distal tip, where it is also more sharply defined.

Setal glands: each pair of sexual setæ is provided with two great glands lying medially, one in front and one behind the setæ. These glands differ in shape considerably from those of *typicus*; they have the shape of a sausage, and are about three times as long as thick and project freely into the body-cavity.

REMARKS.—*Var. cæmenterii* differs from the typical form of *Microchætus papillatus* in the extent of the clitellum, in the possession of distinct copulatory cushions, in the position of the copulatory papillæ and the spermathecal pores, and in the shape of the sexual setæ and of the setal glands; perhaps also in the number of segments, which is larger even in the smallest mature specimen of the variety than in the largest mature specimen of *typicus*.

*Microchætus sulcatus* (*Kinb.*) f. *typicus*.

*Tritogenia sulcata* *Kinberg*, "Annulata nova [Continuatio]," Öfv. Ak. Förh., 1866, nr. 4, p. 98. 1867.

*Tritogenia sulcata* *Kinb.*; *Michaelsen*, "Revision der Kinberg'schen Oligochæten," Öfv. Ak. Förh., 1899, nr. 5, p. 415.

*Tritogenia sulcata* *Kinb.*; *Michaelsen*, "Oligochæta," Tierreich, x, p. 453. 1900.

*Tritogenia morosa* *Cognetti*. "Nuove specie dei Generi, "Pheretima" e "Tritogenia." Atti. Acc. Torino, xli, p. 13, t.f. 14-17. 1906.

*Tritogenia sulcata* *Kinb.* = *T. morosa* *Cogn.*; *Michaelsen*, "Oligochæten aus dem Westlichen Kapland," Denksch. med.-nat. Ges., Jena, xiii, p. 32. 1908.

HAB.—Natal; Port Natal (teste *Kinberg*); Durban (teste *Cognetti*).

Through the kindness of Prof. Théel I have been enabled to re-examine the type and confirm most of my former statements, but the following corrections are to be made.

The median ventral distance of the setæ obviously diminishes towards the segments which bear the copulatory walls, as I stated; but it does not diminish so far as to vanish, as I

erroneously supposed.<sup>1</sup> In the segments with the copulatory walls the setæ are obliterated, and in the neighbouring segments, seventeenth and twenty-second, the median ventral distance has diminished so as to equal the middle lateral distance,  $aa = bc$ , and only the converging lines of setæ, if continued over the segments 18–21, would meet each other in the middle line as stated correctly in my earlier description.<sup>2</sup>

The so-called median-ventral "papillæ" at the hinder part of segments 17 and 21 are not really papillæ, but only flat glandular patches; they are identical with the copulatory cushions at the eighteenth and twenty-second segments of var. *howickianus* (*n. var.*).

A comparison of the type of *f. typicus* with specimens of var. *howickianus* makes it probable that the number of segments of the type should be increased by one. From this there would result a greater conformity of the two forms, and since the type-specimen had been cut into pieces it is quite likely that a segment had been lost.

Var. *howickianus n. var.* Pl. XXXII, figs. 13–15.

HAB.—Howick, Natal; found under large stones in the rather dry clayey soil of a meadow, W. Michaelsen, August 30th, 1911 (two specimens).

EXTERNAL CHARACTERS.—Dimensions: length 80, 85 mm., diameter 6, 6.5 mm., number of segments 90, 91.

Colour of middle parts of body light greyish with a bluish tint, ends of body yellowish. Clitellum white.

At first sight it appears unintelligible how such a clumsy, soft worm could burrow into the rather hard soil in which it was found. But an examination of the internal anatomy showed that the head-portion is provided with a strong burrowing apparatus in the form of a muscular body-wall, thickened septa and strong gizzard.

Head prolobous.

Segments 1–3 simple; the fourth to the ninth are divided

<sup>1</sup> Michaelsen, W., "Oligochaeta," 'Tierreich,' x, p. 453. 1900.

<sup>2</sup> Michaelsen, W., 'Öfv. Ak. Förh.' 1899, nr. 5, p. 417.

into two ringlets, which are equal to one another in the fourth to the seventh segments, but the front ringlet is larger than the hinder in the eighth segment and even more so in the ninth. Segment 10 and the following are simple or indistinctly biannulated.

Setae are absent from the first seven or eight segments. They are very small and simple, being 0.25 mm. long and  $26\ \mu$  thick, quite straight, and have no nodules or ornamentation, strictly paired, and all ventral in position. The two pairs of a side approach one another; generally  $ad = \text{about } \frac{2}{3} u$  and  $aa = 2\frac{1}{2} bc$ . There is no distinct converging of the lines of setae in the region of the copulatory wall as is seen in *f. typicus*. In the specimens of *var. howickianus* the ventral-median distances of setae remain undiminished in the seventeenth and the twenty-third segments, and there are no setae on the eighteenth to the twenty-second segments.

The inconspicuous nephridial pores were not detected in this form.

The clitellum is saddle-shaped, sharply interrupted between the lines of the ventral pairs of setae. It extends over segments 13-22 (= 10).

Copulatory Organs.—There are two broad, pear-shaped copulatory walls extending over three segments, 19-21, and stretching as far as the borders of the clitellum and the lines of setae *a*. They are separated from each other by a very small median longitudinal furrow. In front and behind the walls there is a transverse cushion of glandular tissue which differs a little from the glandular copulatory walls. These two cushions occupy the whole length of the eighteenth and twenty-second segments and reach laterally as far as the borders of the clitellum. Towards the copulatory walls the cushions cling closely to the obtuse angles formed by the fore- and hind-margins of the walls. In the first specimen examined the middle portions of the copulatory walls are constricted and somewhat irregularly wrinkled, and the cushions of the eighteenth and twenty-second segments are flat. In the other specimen the copulatory walls, together with the

cushions, form a large, rounded, roof-shaped projection, and the walls are quite smooth. The cushions of the eighteenth and twenty-second segments form the gable ends, the tops of which are connected with each other by the furrow which separates the two copulatory walls from each other. There are three pairs of copulatory papillæ bearing the ventral setæ of the twelfth and twenty-third segments and the lateral setæ of segment 12. The two papillæ of each side of the twelfth segment are placed upon a common glandular cushion. The lateral setæ of the fifteenth to the seventeenth segment are provided in the type-specimen of *f. typicus* with special glandular papillæ. Even if such glandular specialisations were present in *f. howickianus* they would not be conspicuous, as the space is occupied by the thick layer of the clitellum. I believe that they are absent in *f. howickianus*, just as the corresponding glands are also absent.

The male pores (on twentieth segment near the middle line in *f. typicus*) could not be detected.

The female pores on the top of minute semi-transparent papillæ, which are situated somewhat medially on the inner side of the lines of setæ *a* (not laterally to them as in *f. typicus* according to Cognetti), are placed at the hinder margin of the fourteenth segment, where there are two small convexities.

Spermathecal pores are inconspicuous; there are generally four pairs placed on the furrows between the eleventh and twelfth segments and the twelfth and thirteenth segments in the lines of the ventral and lateral setæ. The external pore of the left front pair was replaced by two in the specimen which was examined in detail.

INTERNAL ANATOMY.—The septa between segments 4–9 are all more or less thickened; septum 4–5 only slightly, 6–7 and 7–8 strongly, 5–6 and 8–9 moderately.

Alimentary Canal.—There is a large gizzard in the seventh segment scarcely reaching into the sixth segment. A pair of large, nearly globular calciferous glands occur dorso-laterally on the œsophagus in the ninth and tenth segments. The hearts of segments 9 and 10 cling closely

to the calciferous glands. The intestine is provided with a large typhlosole.

**Circulatory System.**—The dorsal vessel is single in the middle portion of the body as far as the fore-part of the twelfth segment; it is double in segments 11–9. The doubling of the dorsal vessel is complete, there being no union of the two vessels at the septa. Large moniliform hearts occur in segments 11–9.

**Excretory System.**—Excretory organs consist of small meganephridia.

**Reproductive System.**—Male organs: the male organs of the two sides are entirely separated from each other. There are two pairs of moderately large spermiducal funnels in segments 10 and 11; those of each side are enclosed in a common seminal vesicle which, ventrally to the œsophagus, extends through the tenth and eleventh segments. The vesicles expand laterally and are constricted by the septum between the tenth and eleventh segments. The basal parts of each seminal vesicle are prolonged into a very small fore and a moderately small hind sperm-sac, the former lying in segment 9 and the latter in segment 12. The vasa deferentia are very delicate, and are separate from one another at least as far as the fifteenth segment. I could not trace them to the external apertures.

**Spermathecæ:** there are generally four pairs which project freely into the body-cavity in the form of thin-walled blind sacs. In the specimen which was opened, the outer spermatheca of the left fore pair was replaced by two.

**Sexual setæ:** the ventral and lateral pairs of setæ of the twelfth segment are each replaced by a single sexual seta. These setæ are about 0.68 mm. in length, and at the proximal end  $50\ \mu$  in thickness. They taper towards the distal end to a width of about  $14\ \mu$ . They are quite straight and have no external ornamentation; but at the proximal two-thirds there is a conspicuous internal structure consisting of a rather rough annulation. I suppose that the ventral setæ of the twenty-third segment are also transformed into sexual

setæ, for these pairs, like the setæ of the twelfth segment, are provided with setal glands.

Setal glands.—The sexual setæ of the twelfth segment are closely accompanied by a number of rather large pear-shaped setal glands, seven at each side, forming with the two sexual setæ a closely crowded group on each side. The pairs of ventral setæ of the twenty-third segment, which have not been replaced by a single seta, are provided with a group of four pear-shaped setal glands which are distinctly smaller than the setal glands of the twelfth segment. In the fifteenth to the seventeenth segments there were no setal glands in the specimen which was examined.

REMARKS.—The var. *howickianus* may be distinguished from *f. typicus* of *Microchætus sulcatus* by some external and internal features. In var. *howickianus* the lines of setæ are not converging towards the regions of the copulatory walls as in *f. typicus*. Other differences are to be seen in the position of the female pores, in the thickness of certain septa, and in the number of the setal glands; in *typicus* there are only four on each side of the twelfth segment, and in var. *howickianus* there are seven.

Our knowledge of the *f. typicus* of this species, based upon the study of badly preserved or immature specimens, is far from being complete. For this reason in the foregoing I have given as complete a description as possible of the var. *howickianus*. The main points in the external and internal anatomy of the variety will presumably agree with those of the typical form, and may be regarded as completing our knowledge of the latter.

#### *Microchætus zuluensis* Bedd.

*Microchætus zuluensis* Bedd., "On two new species of *Microchætus*," Proc. Zool. Soc. Lond., 1907, i, p. 279, with figures.

*Microchætus zulu* *Michaelsen*, "Olig. v. Natal u. d. Zululand," Arkiv. Zool. iv, p. 6, fig. 3. 1907.

HAB.—Eastern Zululand; E. Warren, June, 1903 (immature

specimen). Mfongosi, Zululand; T. W. Jones, September, 1911 (several mature specimens).

Zululand (teste Beddard). Umfolozi, Zululand (teste Michaelsen).

Almost at the same time Beddard and myself published descriptions of an earthworm from Zululand which refer to the same species. Owing to Beddard's priority, my name, *Microchaetus zulu*, becomes a synonym.

Professor Collett, of the Christiania Museum, has kindly lent to me for re-examination the type of Beddard's species, and I, consequently, am able to confirm the identity of *M. zuluensis* *Bedd.* and *M. zulu* *Mich.* The figure given by Beddard<sup>1</sup> differs considerably from the diagnosis given by me for *M. zulu*. But the text-figure is incorrect in many points, principally in the arrangement of the setæ and in the annulation. It shows all the segments simple and of equal length, while the type-specimen of *M. zuluensis* exhibits the same difference in the length of the segments of the body in front of the clitellum as the type of *M. zulu*, and also the same biannulation of segments 4-10.

Both descriptions were based upon immature or badly preserved specimens, and I now take the opportunity of giving a fresh description with the aid of well preserved material.

EXTERNAL CHARACTERS.—Dimensions of mature specimens provided with a clitellum: length 90 mm., diameter 8-9 mm. (at the clitellum 11), number of segments 102; length 145 mm., diameter 12-14 mm. (at clitellum 16), number of segments 133; length 185 mm., diameter 9-11 mm., number of segments 135.

Colour grey with a slight greenish tint dorsally, yellowish grey ventrally.

*M. zuluensis* is a rather clumsy, thick and short worm with a relatively very small number of segments. The variation in number is small, fluctuating in general between 131 and 135. But one extraordinarily small specimen shows a considerable variation, being composed of only 102 segments;

<sup>1</sup> *Loc. cit.*, text-fig. 86.

it is probable that the specimen was not full-grown, although it was sexually mature.

Head indistinctly prolobous, if not zygalobous.

Segments 1-3 simple, 4-10 divided into two ringlets which are about equal in length in segments 4-6 or 7, while the hind one is shorter than the front one in segments 7 or 8-10. Segment 11 and the following are simple or slightly biannulated by a rather indistinct furrow in the middle zone.

The setæ begin ventrally on the sixth segment, laterally even further back. The ordinary setæ are extraordinarily delicate, difficult to detect, and very strictly paired. Median ventral distance distinctly larger than the middle lateral,  $aa = 1.5-1.8 bc$ . Dorsal median distance equals about two-thirds of the whole circumference of the body,  $dd = \text{circa } \frac{2}{3} u$ . The position of the lateral pairs of setæ is somewhat irregular, and often distinctly different in two neighbouring segments.

Clitellum saddle-shaped; in Beddard's specimen it extends from the fourteenth (?) or fifteenth segment to the hinder border of the twenty-eighth segment, but at the fourteenth segment it is only vaguely developed. In the specimens from Mfongosi the clitellum was not distinctly bordered either in front or behind.

Copulatory organs: a pair of rather thick and rounded copulatory walls extend from the beginning, middle or end of the sixteenth segment to the end of the twenty-second segment. These walls are on the lines of the lateral setæ. They do not extend horizontally, and consequently they do not increase the breadth of the body as in some other species of this group, but they extend down vertically. Besides these copulatory walls there is a variable number of copulatory papillæ, which bear the sexual setæ, and generally occur in the lines of the ventral pairs of setæ. There are two groups of such papillæ. The front group consists of one, two or three pairs on segments 11-13, or on some of them. The most constant is the pair on the twelfth segment; the pair is absent in only one out of ten specimens. This excep-

tion is Beddard's specimen, and it bears only one pair of papillæ on the eleventh segment. Generally there is a pair of papillæ on the eleventh or on the thirteenth segment, if there are not pairs on each of the three segments 11-13. While the papillæ on the twelfth segment are very large and prominent, those of the eleventh and thirteenth are often very small, or at least one is very small, if there are three pairs. The papillæ of the eleventh segment in both specimens examined by Beddard differ from the others by occupying the place of the lateral setæ. In Beddard's figure these papillæ are situated between the ventral and the lateral pairs of setæ, and both of these pairs are shown in the figure in addition to the sexual setæ of the papillæ. A re-examination of Beddard's specimens shows that the sexual setæ of the papillæ on the eleventh segment are really the transformed lateral setæ, and the papillæ lie in the lines of the lateral setæ although somewhat shifted in position. The normal setæ are very small and difficult to detect, and are shown too distinctly in Beddard's figure; also, the lateral setæ are much nearer to the ventral ones than indicated in the figure.

The papillæ of the hind groups are smaller than the large ones of the fore group. They constantly begin at the twenty-third segment, forming a continuous longitudinal series at each side. At the most there are five pairs on segments 23-27; the smallest number, found only on one specimen and on one side, was two papillæ on segments 23-24. There are never less than six papillæ in both series taken together.

Spermathecal pores: in the specimens on which I founded my *M. zulu* the spermathecal pores formed groups of 1-10 at each side on the furrows between segments 11-12 or 12-13 to 15-16. In one of the two recently examined mature specimens I could not see spermathecæ, just as Beddard failed to find them; but in a second mature specimen, after having torn away all septa, I discovered a few very small globular spermathecæ. They were, however, very much fewer than in the original type-specimens.

Male pores: I could not detect the male pores in any

specimen. Beddard does not make any direct statement about them; but, from a certain remark,<sup>1</sup> we may assume that he thought that he had seen them in the furrow between the fourteenth and fifteenth segments. He says: "Assuming, however, that the male pores are upon the border-line of segments 14-15, a very usual position for them to occupy in this genus, . . ." In this I am not in accord with Beddard; the usual position for the pores to occupy in this genus is at the beginning of the copulatory walls, which do not begin before the sixteenth segment in this species. Only in certain species of this genus do the copulatory walls reach as far forward as the fourteenth segment, and in these the male pores may be seen at the furrow between the fourteenth and fifteenth segments; for instance, in *M. modestus Mich. f. typicus*. If Beddard is right, the only exception to this rule, in addition to *M. zuluensis*, would be *M. pentheri Rosa*. But Rosa did not see the male pores in this species, and his statement only depends on the observation that the sperm-ducts enter the body-wall in the fifteenth segment. It is quite likely that the sperm-ducts run backwards in the body-wall, and open to the exterior at the copulatory walls, which begin at the seventeenth segment. Personally, I am convinced that neither *M. pentheri* nor *M. zuluensis* are exceptions to the rule, and I believe that the pores seen by Beddard on the furrow between the fourteenth and fifteenth segments, right in front of the copulatory walls, are not the male pores but the female ones.

Female pores: in some of the specimens, including one of Beddard's type-specimens, which I examined, a pair of rather distinct pores could be seen at the hinder border of the fourteenth segment. They occurred between the lines of the ventral and lateral pairs of setæ—that is, in the same position in which Cognetti found them in *M. sulcatus* (*Tritogenia morosa Cogn.*). Generally they are more obvious by being placed on the top of a circular papilla which slightly presses backwards the border-line of the fourteenth segment. I feel

<sup>1</sup> Loc. cit., p. 279.

no doubt that these are the female pores, even without being able to confirm the opinion by anatomical sections, since the material is scarcely good enough for the purpose.

INTERNAL ANATOMY.—The septa between segments 4-9 are thickened; the one between the fourth and fifth segments is moderately strong, while those between segments 5-9 are very strong. The septum between the ninth and tenth segments is very tender, if not rudimentary or absent.

Alimentary Canal.—A large gizzard occurs in the sixth and seventh segments. The septum between the sixth and seventh segments is fixed in the middle zone of the gizzard. The œsophagus bears in the ninth, or ninth and tenth segments, a pair of calciferous glands which are in the form of lateral globular swellings. Intestine begins in the twelfth segment, and there is a large typhlosole.

Circulatory System.—The dorsal vessel is doubled from the fifth to the tenth segment, confluent intersegmentally. The last pair of hearts is in the eleventh segment.

Reproductive System.—Male organs: one pair of large spermiducal funnels occur in the tenth segment. They are enclosed in a pair of seminal chambers which extend laterally and dorsally, and look like sperm-sacs. A pair of flat, rounded sperm-sacs project from the septum between the tenth and eleventh segments into the eleventh segment.

Spermathecae are globular, they have very tender and short ducts which are hidden in the body-wall.

Sexual setae: the setae, situated in the glandular cushions of the copulatory papillae, are enormously enlarged and are transformed into sexual setae. They are about 2.5-3.4 mm. in length and 85  $\mu$  in thickness at the proximal end; they are nearly straight except at the proximal end, where they are somewhat bent. Towards the distal end the diameter of the seta gradually diminishes to about 36  $\mu$ . The terminal portion is somewhat flattened laterally but broadens in the vertical direction to about 42  $\mu$ ; it is then turned obliquely, or nearly transversely, and ends in an acute point. In profile the distal end is like a bird's head with a short and acute beak. The

fibrous internal structure, which is extremely conspicuous in this part of the seta, follows in its course this oblique bending of the tip, and then converges towards the acute tip. There is a faint annulation on the internal structure of the part of the seta just beneath the modified distal end, and to this annulation is added a more or less distinct external ornamentation consisting of irregular, scale-like projections. These often join to form irregular and bluntly-toothed transverse or oblique lines.

Setal glands: the internal glands surrounding the sexual setæ and corresponding to the external copulatory papillæ are circular in outline, and project more or less into the body-cavity. At most they are hemispherical, and are only indistinctly divided by some narrow furrows.

#### *Microchætus colletti* Bedd.

*Microchætus colletti* Bedd., "On Two New Species of the African Genus *Microchætus* belonging to the collection of *Oligochæta* in the Museum of Christiania." Proc. Zool. Soc. Lond., 1907, i, p. 277, text-fig. 85.

HAB.—Zululand (teste Beddard).

Dr. R. Collett, of the Christiania Museum, has kindly entrusted to me the type-specimen of this species for a re-examination. I am able thereby to complete Beddard's description.

EXTERNAL CHARACTERS.—The number of segments is about 312. The six segments from the fourth to the ninth are all divided into two ringlets. Generally the hind ringlet is scarcely shorter than the front one, but in the ninth the difference in the length of the two ringlets is more obvious. Beddard notes the biannulation of "some" segments, but does not state exactly which segments are biannulated, and in the text-figure there is nothing to be seen of this biannulation, and there is no difference in the length of the first segments.

Setæ: the median ventral distance is somewhat longer than the middle lateral distances ( $aa > bc$ ). The median

dorsal distance is distinctly smaller than half the circumference, at least at the middle and hinder portions of the body. It is difficult to see the condition in the front portion, as the type-specimen is dissected and the body-wall is irregularly stretched ( $dd = \text{circa } \frac{2}{3} u$ ).

Copulatory papillæ: the ventral pairs of setæ of the tenth, eleventh, twelfth and twenty-fourth segments are placed upon the top of copulatory papillæ. The papillæ of the tenth, eleventh and twenty-fourth segments are distinct, but those of the twelfth segment are less obvious.

INTERNAL ANATOMY.—Sexual setæ: I have examined the sexual (ventral) setæ of the twelfth and twenty-fourth segments; those of the twelfth segment have a length of 0.6 mm. and a maximum diameter of  $32 \mu$ , while those of the twenty-fourth segment are nearly twice as large, being about 1.0 mm. in length and  $60 \mu$  in maximum diameter. They are both sigmoid, and are provided with a distinct but not sharply bordered nodulus. They terminate in a simple point. With the exception of the extreme tip the distal third of the seta shows a fine ornamentation consisting of very small, irregularly toothed transverse ridges. The length of the ridges hardly reaches a sixth of the diameter of the seta. They are placed in a somewhat irregular system of two crossing spirals. These sexual setæ have been overlooked by Beddard, but they give to us the best distinguishing character of this species.

REMARKS.—*M. colletti* *Bedd.* is nearly allied to two species from Natal—*M. gracilis* *Mich.* and *M. ivari* *Mich.* We might perhaps be justified in uniting these three species into one, *M. colletti* *Bedd.*, and to consider the examples from Natal as varieties of Beddard's Zululand species, which has the priority. But with the material at hand I think it best to keep them separated provisionally.

#### *Microchætus gracilis* *Mich.*

*Microchætus gracilis* *Michaelsen*, "Oligochæten von Natal und dem Zululand." *Arkiv. Zool.*, iv, nr. 4, p. 8. 1907.

HAB.—Van Reenen's Kloof, Natal (teste *Michaelsen*).

Prof. Jägerskiöld, Director of the Gotenborg Museum, kindly lent to me the type-specimen for re-examination, and I am thereby enabled to make a certain correction to my former description.

In the original description it is said that segments 4-10 are all divided into two ringlets; but this is a slip, only the fourth to the ninth segments are biannulated. To a specialist this was evident from the statement that the hinder ringlet of the ninth segment was very much shorter than the front ringlet. This great difference between the lengths of the ringlets always occurs in the last of the biannulated segments.

The main difference in the anatomy of this species and *M. colletti* *Bedd.* is the shape of the sexual setæ. In *colletti* they are distinctly S-shaped, while in *M. gracilis* they are quite straight for nearly the whole length, and are only very slightly curved at the distal end. They are not provided with a distinct nodulus; also the elements of ornamentation consist of deep longitudinal scars.

The shape of the copulatory walls is also different in *gracilis* and *colletti*.

#### *Microchætus ivari* *Mich.*

*Microchætus ivari* *Michaelsen*, "Oligochæten von Natal dem Zululand." *Arkiv. Zool.* iv. nr. 4. p. 10. Text-fig. 4. 1907.

HAB.—Estcourt, Natal (teste *Michaelsen*).

I examined the type-specimen and found it in a worthless condition, and we must therefore rely on the original description.

This species differs from the nearly allied *M. colletti* *Bedd.* and *M. gracilis* *Mich.* by the shape of the copulatory walls, by the position of the copulatory papillæ (on the twenty-first segment), and chiefly by some points in the internal anatomy.

The sexual setæ resemble generally those of *M. gracilis*, but differ in the character of the ornamentation.

Finally, *M. ivari* differs from both of its allies in the

number of the setal glands; there are four or five of such glands connected with each pair of sexual setæ, while there are only two of them in *M. colletti* and *M. gracilis*.

*Microchætus parvus* *n. sp.* Pl. XXXII, fig. 12.

HAB.—Hilton Road, eleven miles N.W. of Pietermaritzburg, Natal; Dr. M. A.—, July 28th, 1905 (one specimen).

EXTERNAL CHARACTERS.—Dimensions: length 54 mm., diameter 3–4 mm., number of segments 115. Perhaps the hind end was regenerated.

Colour, yellowish-grey. Head probobous.

Segments 1–3 simple; the first and second are very short, the third is as long as the first two together. The fourth to the ninth segments are divided into two ringlets, and the furrows of annulation are quite as strongly marked as the intersegmental furrows. The ringlets of segments 4 and 5 are of equal length, and as long as the whole third segment. In the case of segments 6–9 the front ringlet bears the setæ and the nephridial pores, and is longer than the hind ringlet. In the tenth and following segments biannulation is indistinct or absent.

Setæ are rather small; they occur apparently from the third segment. Distances: *aa* somewhat larger than *bc*; *dd* equals about half the circumference of the body.

Nephridial pores are in the lines of setæ *c*.

The clitellum is indistinct and extends over about ten segments—from the twelfth to the twenty-first. The copulatory walls are broad longitudinal ridges just above the lines of the nephridial pores. They are distinctly prominent on segments 16 and 17, indistinct on segment 18, and hardly perceivable on segment 15.

The male pores occur on the copulatory walls in the furrow between segments 16 and 17 (or 15–16?). The sperm-ducts do not enter the body-wall before the furrow between segments 15–16.

Spermathecal pores are single or double, and occur in the

furrows between segments 13-14 and 14-15, just above the lines of the nephridial pores.

There are glandular cushions present in relation to the ventral setæ of segments 14, 16-18, 23-27, and on segments 13, 22, and 28 they are indistinct, or only occur on one side of the body. The cushions of segments 16-18 differ somewhat from the others in being not circular and small, but in occupying the whole length of the segments, and in being bordered on the inner side by a common longitudinal line.

INTERNAL ANATOMY.—The septum between the sixth and seventh segments is very tender if not absent; in the latter case the septum between the fifth and sixth segments is present and very tender. The septa between segments 7-8 and 8-9 are thickened and very strong, while all the posterior septa are very delicate.

Alimentary Canal.—There is a very large gizzard in the seventh or in the sixth and seventh segments. A single pair of nearly globular calciferous glands occur in the ninth segment as lateral appendages of the œsophagus. The intestine begins in about the thirteenth segment.

Circulatory System.—The dorsal vessel is doubled from the eleventh segment to the middle of the gizzard, that is, to the middle of the seventh segment. The last hearts are in the eleventh segment.

Reproductive System. — Male organs: one pair of sperm-duct funnels occur ventrally in the tenth segment enclosed in an unpaired common seminal vesicle. The lateral posterior corners of the vesicle are prolonged into a pair of somewhat broadened sac-like sperm-sacs which seem to project into the eleventh segment. The sperm-ducts pass backwards in a straight line as far as the end of the fifteenth segment, where they seem to enter the body-wall.

Spermathecal pores are single or in pairs. In the specimen examined they were single on both sides at the intersegmental furrow of segments 13-14, while in the furrow between segments 14-15 they were single on the right side and double on the left side. In this case the additional spermatheca was

placed medially to the normal one, and was smaller than the latter. The spermathecæ are of a stunted pear-shape, shortly and narrowly stalked, and their contents give to them a glittering appearance.

Sexual setæ: the ventral setæ of segments 13, 14, 16 18 and 22-28 or 23-27 are enlarged and transformed into sexual setæ. They are only slightly bent at the distal extremity, and are more or less flattened laterally like a sabre. The maximum dimensions are: length 0·96 mm., breadth 30  $\mu$ ; and another example, length 0·78 mm., breadth 60  $\mu$ . The distal end of the sexual setæ is ornamented in a very characteristic manner, being covered with deep scars or cicatrices irregularly distributed or partly joined into small transverse groups. The proximal border of the scars is sharply marked, and is rounded or straight; they lie parallel to each other and to the border of the seta. The scars are as long as broad, or longer than broad; they flatten out and disappear distally.

Setal glands: a sexual seta is accompanied by two or three setal glands which project freely into the body-cavity. Generally these glands are bluntly pear-shaped, firm and opaque. The glands in segments 16-18 differ a little from the others in that they are mostly much longer, being club-shaped and about four times as long as broad; they are also not quite so firm and they are semi-translucent.

REMARKS.—*M. parvus* is allied to *M. modestus* *Mich.*, and it differs mainly in the arrangement of the setæ, of the tubercula pubertatis, and of the cushions of the sexual setæ, as well as in the thickening of certain septa.

#### *Microchætus beddardi* *Benham*.

*Microchætus beddardi* *Benham*, "Studies on Earthworms II," Quart. Journ. Mic. Sci., (N. S.) xxvi, p. 78, pl. viii, figs. 1-8. 10. 1886.

*Microchætus beddardi* *Benh.*; *Benham*. "Description of Three New Species of Earthworms," Proc. Zool. Soc. Lond., 1892, p. 142, pl. viii, fig. 8.

HAB.—Natal (teste *Benham*).

I have had no opportunity of examining this species.

## FAM. LUMBRICIDÆ.

*Helodrilus* (*Allolobophora*) *caliginosus* (*Sav.*)  
f. *trapezoides* (*Dug.*).

*Helodrilus* (*Allolobophora*) *caliginosus trapezoides* (*Dug.*):  
Michaelsen, "Oligochæta," Tierreich, x, p. 483. 1900.

HAB.—Howick, Natal; in detritus near the foot of the  
Umgeni Falls, W. Michaelsen, August 30th, 1911.

A peregrine species imported by man.

*Helodrilus* (*Bimastus*) *constrictus* (*Rosa*).

*Helodrilus* (*Bimastus*) *constrictus* (*Rosa*); Michaelsen, "Oligo-  
chæta," Tierreich, x, p. 503. 1900.

HAB.—Howick, Natal; in detritus near the foot of the  
Umgeni Falls, W. Michaelsen, August 30th, 1911.

A peregrine species imported by man.

ANALYTICAL KEYS TO THE OLIGOCHÆTA FROM  
NATAL AND ZULULAND.

A. KEY FOUNDED CHIEFLY ON EXTERNAL CHARACTERS.

- 1 *a.* Minute white or dirty grey worms not longer than 20 mm.,  
less than 1 mm. thick. Male papillæ on the twelfth  
segment. Clitellum at the twelfth segment and the  
immediately adjoining parts of the eleventh and  
thirteenth segments. . . . . 2
- 1 *b.* Larger worms, at least 20 mm. long and thicker than 1 mm.  
Male papillæ further back than the twelfth segment.  
Clitellum occupies at least three complete segments  
including the sixteenth segment, if not beginning  
further back. . . . . 3
- 2 *a.* Constantly two setæ in a bundle.  
*Fridericia peregrinabunda* n. sp.
- 2 *b.* More than two setæ in a bundle, viz. 4-6, the middle ones  
being smaller than the outer ones.

*Fridericia perrieri* (*Vejl.*)

- 3 *a*. At each setal segment there are more than eight setæ; they form nearly complete circles round the body. Prostate pores at the eighteenth segment, spermathecal pores four pairs at the intersegmental furrows 5-6 to 8-9.
- Pheretima heterochæta (*Mich.*)
- 3 *b*. Every setal segment has in general eight setæ. . . . . 4
- 4 *a*. Setæ of the hinder end are much enlarged and are not placed in eight longitudinal rows.
- Pontoscolex corethrurus (*Fr. Müll.*)
- 4 *b*. Setæ of the hinder end not, or not much, enlarged, in eight regular longitudinal rows. . . . . 5
- 5 *a*. Six or seven segments of the pre-clitellar part of the body, viz. the fourth to the ninth or tenth segment, divided by a ringlet furrow, quite as sharp as the intersegmental furrows, into two ringlets; the front one bears the lateral nephridial pores and the setæ, if they are present.<sup>1</sup> . . . . . 6
- 5 *b*. All segments are simple or only divided by more or less slight ringlet furrows, which are fainter than the intersegmental furrows, and are not restricted to a small number of segments. . . . . 14
- 6 *a*. Setæ all ventral; median dorsal distance of setæ equals about two thirds of the whole circumference of the body. Copulatory walls on segments 19-21, and they touch each other in the median ventral line.
- Microchætus sulcatus (*Kühb.*)
- α The median ventral distance between the innermost ventral setæ diminishes distinctly towards the copulatory cushions. . . . . f. *typicus*
- β The median ventral distance between the innermost ventral setæ does not distinctly diminish towards the copulatory cushions. . . . . var. *howickianus* n. var.

<sup>1</sup> This biannulation is not always easy to recognise, as often the setæ, which may be completely absent, and the nephridial pores are difficult to detect. But the biannulation may be distinguished by the fact that on front of the clitellum a certain segment-like part (really the hind ringlet of the hindermost biannulated segment) is somewhat shorter than the segment behind, while the next segment-like part (really the front ring of the hindermost biannulated segment) is distinctly longer than the posterior normal segments. When enumerating the segments of *Microchætus* species it must be borne in mind that often the first and second segments are retracted into the mouth, and are consequently invisible.

- 6 b. Outermost pairs of setæ in the lateral middle lines or even above them; median dorsal distance of setæ equals one-half of the whole circumference of the body or even smaller. . . . . 7
- 7 a. The median ventral distance between the innermost ventral setæ diminishes distinctly towards the copulatory walls, which occur on the fifteenth to eighteenth segments. . . . .  
*Microchætus natalensis* (Kinb.)
- 7 b. The median ventral distance between the innermost ventral setæ does not diminish distinctly towards the copulatory walls. . . . . 8
- 8 a. Copulatory walls extend over the whole length of the clitellum, twelfth to twenty-third or twenty-fourth segments. . . . . *Microchætus beddardi* Beuh.
- 8 b. Copulatory walls occupy only a part of the length of the clitellum, less than half of it. . . . . 9
- 9 a. Copulatory walls occupy more than four segments. . . . . 10
- 9 b. Copulatory walls occupy four segments or fewer. . . . . 11
- 10 a. Number of segments in mature specimens larger than 300. Copulatory walls stretch over segments 16-20, and are prominent laterally. . . . . *Microchætus papillatus* Beuh.
- a Clitellum extends from the tenth to the twenty-ninth or thirtieth segment; copulatory cushions indistinct. . . . . f. *typicus*
- β Clitellum extends from the twelfth to the twenty-fourth segment; distinct copulatory cushions stretch over segments 17-20. . . . . var. *caementerii* n. var.
- 10 b. The number of segments in mature specimens is smaller than 150. Copulatory walls extend over the sixteenth (or part of it) to the end of the twenty-second segment, not prominent laterally. . . . . *Microchætus zuluensis* Bedd.
- 11 a. Copulatory walls occupy the three segments from the seventeenth to the nineteenth. . . . . 12
- 11 b. Copulatory walls are prominent on the sixteenth and seventeenth segments, indistinct on the eighteenth segment, and hardly recognisable on the fifteenth segment. . . . . *Microchætus parvus* n. sp.
- 12 a. Copulatory walls are upon the median slope of a lateral projection occupying segments 17-19, or they may extend over the neighbouring segments 16 and 20. . . . . 13
- 12 b. Copulatory walls are on the flat ventral side of the body, there being no lateral projections. . . . . *Microchætus colletti* Bedd.

- 13 a. A pair of large setal papillæ on the twelfth segment.  
*Microchætus gracilis Mich.*
- 13 b. A pair of large setal papillæ on the tenth and twenty-first segments, and smaller ones on the eleventh and twelfth segments<sup>1</sup>.  
*Microchætus ivari Mich.*
- 14 a. Clitellum begins far back, at least behind the twenty-fourth segment. . . . . 15
- 14 b. Clitellum includes segments 14-16. . . . . 16
- 15 a. Setæ strictly paired. Clitellum begins on the twenty-seventh or twenty-eighth segment, and reaches as far as the thirty-fourth or thirty-fifth. Distinct copulatory walls on segments 31-33.  
*Helodrilus caliginosus (Sav.) f. trapezoides (Dug.)*
- 15 b. Setæ widely paired. Clitellum extends from twenty-sixth to thirty-first or thirty-second segment. Copulatory walls indistinct or absent. . . . . *Helodrilus constrictus (Rosa)*
- 16 a. Two pairs of prostate pores on seventeenth and nineteenth segments, those of each side united by a longitudinal seminal furrow. . . . . 17
- 16 b. One pair of prostate pores or a single median one . . . . . 22
- 17 a. Setæ ventrally widely paired; dorsally separated (*dl* = *cd*) . . . . . 18
- 17 b. Setæ strictly paired. . . . . 21
- 18 a. Head tanylobous; the dorsal appendix of the prostomium reaches as far as the furrow between the first and second segments. Clitellum extends from the thirteenth to the eighteenth segment; it may not begin until the middle of the thirteenth. . . . . *Chilota braunsi Mich.*
- 18 b. Head epilobous, the dorsal appendix of the prostomium does not reach as far as the furrow between the first and second segments. . . . . 19
- 19 a. Clitellum extends from the fourteenth to the sixteenth segment, ring-shaped, but ventrally somewhat lower.  
*Chilota wahlbergi Mich. f. typicus*
- 19 b. Clitellum occupies at least a portion of the seventeenth segment. . . . . 20
- 20 a. Clitellum extends from the middle of the twelfth segment to the middle of the seventeenth segment.  
*Chilota trågårdhi Mich.*  
 $\alpha$  Length, 80-105 mm.; diameter,  $1\frac{2}{3}$ - $2\frac{1}{3}$  mm. f. *typicus*  
 $\beta$  Length at least 130 mm., diameter  $3\frac{1}{2}$ -4 mm  
 var. *major n. var.*

<sup>1</sup> The constancy of these characters is questionable, and it is advisable to examine the internal anatomy for distinguishing these species.

- 20 *b*. Clitellum extends from the thirteenth to the seventeenth segment, but often incomplete on the thirteenth and seventeenth segments, or on one of them.  
*Chilota warreni* *n. sp.*
- 21 *a*. Setæ all ventral in position, median dorsal distance distinctly larger than half the circumference of the body.  
*Dichogaster bolau* *Mich.*
- 21 *b*. Outer pairs of setæ lateral in position; median dorsal distance equal to half the circumference of the body.  
*Kerria gunningi* *Mich.*
- 22 *a*. Setæ separated  $ab < bc < cd$ . Prostate pores paired at the eighteenth segment.  
*Pontodrilus bermudensis* *Bedd. f. typicus*
- 22 *b*. Setæ strictly paired. . . . . 23
- 23 *a*. Prostate pores paired at the seventeenth segment. Spermathecal pores paired at the furrows between the seventh and eighth segments and the eighth and ninth segments, or at one of them. . . . . 24
- 23 *b*. Prostate pore and spermathecal pore single and median at the seventeenth and thirteenth segments respectively. Paired copulatory papillæ at the eleventh, thirteenth, and fifteenth segments. *Eudriloides durbanensis* *Bedd.*
- 24 *a*. Setæ are all ventral in position; median dorsal distance distinctly larger than half the circumference of the body. Two pairs of spermathecal pores.  
*Dichogaster crawi* *Eisen.*
- 24 *b*. Outermost pairs of setæ lateral in position; one pair of spermathecal pores at the furrow between the eighth and ninth segments. *Ocnodrilus africanus* (*Bedd.*)

B. KEY FOUNDED ON INTERNAL ANATOMY AS WELL AS EXTERNAL CHARACTERS.

- 1 *a*. Minute white or dirty grey worms, not longer than 20 mm., less than 1 mm. in diameter. Male papillæ at the twelfth segment, clitellum extending from the twelfth segment into the neighbouring eleventh and thirteenth segments. No muscular gizzard. (Fam. Enchytraëidæ, gen. *Fridericia*). . . . . 2
- 1 *b*. Larger worms at least 20 mm. long, and thicker than 1 mm. Male papillæ further back than the twelfth segment. Clitellum occupies at least three complete segments, including the sixteenth segment, if not beginning further back (real earthworms). . . . . 3

- 2 a. Constantly two setæ in a bundle. Spermathecae without diverticula. . . . . *Fridericia peregrinabunda n. sp.*
- 2 b. More than two setæ in a bundle. 4-6; the middle ones being smaller than the outer ones. Spermathecae with two diverticula. . . . . *Fridericia perrieri (Vejd.)*
- 3 a. Clitellum includes the fourteenth to the sixteenth segments. Gizzard, if present, is placed before the region of the sperm-sacs. . . . . 4
- 3 b. Clitellum begins behind the twenty-fifth segment. A muscular gizzard in the seventeenth and eighteenth segments. (Fam. Lumbricidæ). . . . . 24
- 4 a. One or two pairs of prostates open at the male pores, or near them, at the seventeenth or eighteenth segment, or at the seventeenth and nineteenth segments. (Fam. Megascolecidæ, with the exception of some scarce species). . . . . 5
- 4 b. Prostates absent. (Fam. Glossoscolecidæ and some scarce species of Megascolecidæ such as *Ocnodrilus africanus*). . . . . 14
- 5 a. One pair of prostates open at the eighteenth segment. (Sub-fam. Megascolecinae). . . . . 6
- 5 b. One pair of prostates open at the seventeenth segment, or two pairs open at the seventeenth and nineteenth segments. . . . . 7
- 6 a. At each setal segment there are eight widely paired setæ. Two pairs of spermathecae open in the furrows between segments 7-8 and 8-9. No gizzard.  
*Pontodrilus bermudensis Bedd. f. typicus*
- 6 b. At each setal segment there are many more than eight setæ; they form nearly complete circles round the body. Four pairs of spermathecae open at the inter-segmental furrows of segments 5-9. A large gizzard. Prostate with racemose glandular portion.  
*Pheretima heterochata (Mich.)*
- 7 a. In each post-clitellar segment six to twelve small sac-like micronephridia occur. Setæ all ventral in position. Two muscular gizzards present. (Sub-fam. Trigastriinæ, gen. *Dichogaster*). . . . . 8
- 7 b. In each post-clitellar segment there is one pair of large meganephridia. . . . . 9
- 8 a. One pair of prostate pores at the seventeenth segment.  
*Dichogaster crawi Eisen*



- 8 *b*. Two pairs of prostate pores at the seventeenth and nineteenth segments, those of each side united by a longitudinal seminal furrow. . . . *Dichogaster bolani* (*Mich.*)
- 9 *a*. Setæ ventrally more or less widely paired, dorsally separated. Œsophagus without glandular or other appendages. One pair of spermiducal funnels in the tenth segment. Two pairs of spermathecal openings at the furrows between segments 7-8 and 8-9. (Sect. Chilota-cea of sub-fam. Acanthodrilinæ). . . . 10
- 9 *b*. Setæ strictly paired. . . . . 13
- 10 *a*. Spermathecae with two diverticula. . . . . 11
- 10 *b*. Spermathecae with one diverticulum. . . . . 12
- 11 *a*. Distal part of the penial setæ with exception of the outermost end ornamented by closely spaced toothed ridges encircling the seta. . . . *Chilota warreni* *n. sp.*
- 11 *b*. Distal part of the penial setæ without distinct ornamentation, or with only a few scattered teeth.  
*Chilota trågårdhi* *Mich.*
- a* Penial setæ of two distinctly different kinds, both of which have a simple distal tip, one of them ornamented with scattered teeth. Length 80-105 mm., maximum diameter  $1\frac{2}{3}$ - $2\frac{1}{3}$  mm. . . . . *f. typicus*
- β* Penial setæ not distinctly different, both without ornamentation; one of them, if not both, ends distally in two minute claws joined together by a web-like membrane. Length 130 mm. or more, maximum diameter  $3\frac{1}{2}$ -4 mm. . . . . *var major n. var.*
- 12 *a*. Diverticulum of spermathecae cylindrical, much longer than the sac-like ampulla. Penial setæ smooth.  
*Chilota wahlbergi* *Mich. f. typicus*
- 12 *b*. Diverticulum of spermathecae kidney-shaped, without stalk, much shorter than the ampulla. Penial setæ at the distal part ornamented with triangular teeth grouped together in small transverse rows. . . . *Chilota braunsi* *Mich.*
- 13 *a*. Prostate pore at the seventeenth segment, spermathecal pore at the thirteenth segment, both pores unpaired. Paired copulatory papillæ on the eleventh, thirteenth, and fifteenth segments. Œsophagus with paired, compact, ribbon-like pouches (Sub-fam. Eudrilinæ).  
*Eudriloides durbanensis* *Bedd.*
- 13 *b*. Two pairs of prostate pores at the seventeenth and nineteenth segments. Two pairs of spermathecal pores at the furrows between segments 7-8 and 8-9. Œsopha-

gus with a pair of chyle-pouches in the ninth segment. No muscular gizzard. (Part of sub-fam. Oenerodrilinæ). *Kerria gunningi Mich.*

14 a. One pair of spermathecal pores at the furrow between the eighth and ninth segments. No copulatory wall in the region of the clitellum. A pair of large chyle-pouches proceeding from the œsophagus in the hind part of the ninth segment and stretching freely forward. (Part of sub-fam. Oenerodrilinæ).

*Oenerodrilus africanus (Bedd.)*

14 b. Spermathecal pores more than one pair, either placed further back than the ninth segment, or three pairs at the intersegmental furrows of segments 6-9. Copulatory walls present in the region of the clitellum. A large muscular gizzard. Chyle-pouches, if present, in the ninth segment, not stretching freely forward. (Fam. Glossoscolecidæ). 15

15 a. Three pairs of spermathecal pores at the intersegmental furrows of segments 6-9. Setae at the hinder end of the body distinctly enlarged, not placed in eight regular longitudinal rows. (Sub-fam. Glossoscolecinae).

*Pontoscolex corethrurus (Fr. Müll.)*

15 b. Spermathecal pores further back than the ninth segment. Setae at hinder end of the body not distinctly enlarged, placed in eight regular longitudinal rows. (Sub-fam. Microchætinae). 16

16 a. One pair of spermiducal funnels in the tenth segment. 17

16 b. Two pairs of spermiducal funnels in the tenth and eleventh segments. 22

17 a. Copulatory walls extending over the whole length of the clitellum, viz. over the segments 12-23 or 24.

*Microchætus beddardi Benh.*

17 b. Copulatory walls occupy only a part of the length of the clitellum, less than half of it. 18

18 a. Copulatory walls occupy more than four segments, viz. sixteenth to the twenty-second segment. Sexual setae 2.5-3.4 mm. long, nearly straight, distal end of the shape of a bird's head, distal part with internal annulation and external toothed transverse ridges.

*Microchætus zuluensis Bedd.*

18 b. Copulatory walls occupy four segments or less. 19

19 a. Copulatory walls occupy the three segments 17-19. 20

19 *b*. Copulatory walls are prominent at the two segments 16-17, indistinct at the eighteenth segment, hardly recognisable on the fifteenth segment. Sexual setæ 0.76-0.96 mm. long, 30-60  $\mu$  broad, slightly bent at the distal end, flattened like a sabre, ornamented at the distal end by scattered fine scars.

*Microchætus parvus* *n. sp.*

20 *a*. Copulatory walls at the flat ventral side of the body, no lateral projections in their region. Sexual setæ 0.6-1.0 mm. long and 32-60  $\mu$  thick, bent like an S, provided with a nodulus distal to the middle, ornamented at the distal part by very small, irregular, toothed, transverse ridges arranged in two crossing systems of spirals.

*Microchætus colletti* *Bedd.*

20 *b*. Copulatory walls on the medial slope of lateral projections which occupy segments 17-19 in addition to a part of 16 and 20. Sexual setæ without nodules. . . . . 21

21 *a*. Sexual setæ about 0.75 mm. long and 30  $\mu$  thick, nearly straight, bent very slightly only at the distal end, ornamented at the distal part by longitudinal scars arranged in two crossing spiral lines. *Microchætus gracilis* *Mich.*

21 *b*. Sexual setæ about 1.0 mm. long and 40  $\mu$  thick, nearly straight, bent very slightly only at the distal end, ornamented at the distal part by irregularly scattered scale-like projections. . . . . *Microchætus ivari* *Mich.*

22 *a*. Setæ all ventral in position; median dorsal distance of setæ equals about two-thirds of the whole circumference of the body. Copulatory walls extend from the nineteenth to the twenty-first segment, touching each other in the median ventral line. Sexual setæ 0.68-0.75 mm. long, and at the proximal end about 50  $\mu$  thick, quite straight, no external ornamentation

*Microchætus sulcatus* (*Kimb.*)

*a*. The median ventral distance between the innermost ventral setæ diminishes distinctly towards the copulatory cushions. . . . . f. *typicus*

$\beta$ . The median ventral distance between the innermost ventral setæ does not distinctly diminish towards the copulatory cushions.

var. *howickianus* *n. var.*

22 *b*. Outermost pairs of setæ in the lateral middle lines, or even above them. Median dorsal distance of setæ equals one-half of the whole circumference of the body. . . . . 23

23 a. The median ventral distance between the innermost ventral setæ diminishes distinctly towards the copulatory walls. Copulatory walls extend from the fifteenth to the eighteenth segment. Sexual setæ about  $2\frac{1}{2}$ -3 mm. long, and at the proximal end about  $60\ \mu$  thick, distinctly bent at the thinner proximal end, the remainder nearly straight except at the distal end, where it is slightly bent, thickened and broadened to a breadth of about  $80\ \mu$ . One of the broad sides convex, the other hardly convex. Tip rather blunt, or two tips with a concave edge between them; external ornamentation consists of somewhat irregular, rather densely crowded annulations, the distal borders of which are a little prominent; they are scale-like and covered by dense rows of very minute teeth.

*Microchætus natalensis* (Kimb.)

23 b. The median ventral distance between the innermost ventral setæ does not diminish distinctly towards the copulatory walls. Copulatory walls stretch over segments 16-20, and are prominent laterally. Sexual setæ 1.75-2.5 mm. long, and proximally  $80$ - $90\ \mu$  thick, slightly bent into the form of an S; external ornamentation consists of more or less oblique annulations, the scaly distal margins of which are irregularly toothed or pronged.

*Microchætus papillatus* Benh.

a. Clitellum extends from the tenth to the twenty-ninth or thirtieth segment. Copulatory cushions indistinct; distal tip of the sexual setæ sharpened to form a triangular pyramid with deeply carved sides.

f. *typicus*

β. Clitellum extends from the twelfth to the twenty-fourth segment. Distinct copulatory cushions stretch over segments 17-20. Distal part of sexual setæ generally end in two thick, short teeth, which are joined by a web-like membrane nearly as thick as the teeth.

var. *cæmenterii* n. var.

24 a. Setæ strictly paired. Clitellum begins at the twenty-seventh or twenty-eighth segment, and reaches as far as the thirty-fourth or thirty-fifth. Distinct copulatory wall at segments 31-33. Four pairs of sperm-sacs in segments 9-12. Spermathecæ present.

*Helodrilus caliginosus* (Sav.) f. *trapezoides* (Dug.)

24 b. Setæ widely paired. Clitellum extends from the twenty-sixth to the thirty-second segment. Copulatory walls

indistinct or absent. Two pairs of sperm-sacs in the eleventh and twelfth segments. No spermatheca.

*Helodrilus constrictus* (*Rosa*)

### EXPLANATION OF PLATE XXXII,

Illustrating Professor W. Michaelsen's paper, "The Oligochæta of Natal and Zululand."

FIG. 1.—× 100. *Chilota warreni* *n. sp.* Distal end of a penial seta of the first form.

FIG. 2.—× 100. *Chilota warreni* *n. sp.* Distal end of a penial seta of the second form.

FIG. 3.—× 100. *Chilota braunsi* *Mich.* Distal end of a penial seta.

FIG. 4.—× 1000. *Chilota trægårdhi* *Mich. var. major n. var.* Distal end of a penial seta.

FIG. 5.—× 100. *Chilota trægårdhi* *Mich. var. major n. var.* Distal half of a penial seta.

FIG. 6.—× 1000. *Dichogaster crawi* *Eisen.* Part of a penial seta.

FIG. 7.—× 30. *Dichogaster crawi* *Eisen.* Spermatheca.

FIG. 8.—× 100. *Microchætus natalensis* (*Kinb.*). Distal end of a sexual seta.

FIG. 9.—× 15. *Microchætus natalensis* (*Kinb.*). Clitellar region from the ventral side.

FIG. 10.—× 1000. *Microchætus papillatus* *Benh. f. typicus.* Distal end of a sexual seta.

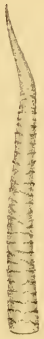
FIG. 11.—× 1000. *Microchætus papillatus* *Benh. var. cæmenterii n. var.* Distal end of a sexual seta.

FIG. 12.—× 100. *Microchætus parvus* *n. sp.* Sexual seta.

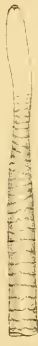
FIG. 13.—× 35. *Microchætus sulcatus* (*Kinb.*) *var. howickianus n. var.* Clitellar region from the ventral side.

FIG. 14.—× 35. *Microchætus sulcatus* (*Kinb.*) *var. howickianus n. var.* The clitellar region from the ventral surface of another individual.

FIG. 15.—× 100. *Microchætus sulcatus* (*Kinb.*) *var. howickianus n. var.* Sexual seta.



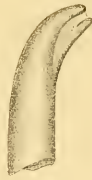
1 x 100.



2 x 100.



3 x 100.



4 x 1000.



5 x 100.



6 x 1000.



7 x 30.



8 x 100.



9 x 15.



10 x 1000.



11 x 1000.



12 x 100.



13 x 35.



14 x 35.



15 x 100.

Michaelsen del.

Huth Lith London.



## On Freshwater Entomostraca from Various Parts of South Africa.

By

**G. Stewardson Brady, M.D., LL.D., D.Sc., F.R.S.**

With Plates XXXIII—XXXVIII.

THE present paper is the result of an examination of a considerable amount of material collected from different places in South Africa by Dr. E. Warren, Director of the Natal Museum, and by Mr. James Gibson, of Durban, Natal.

On a visit to the Victoria Falls, Rhodesia, in May, 1908, Dr. Warren took the opportunity of making a few gatherings from the still pools in the immediate neighbourhood of the Falls. The pools were situated on the north bank, about fifteen yards from the edge of the Zambezi River and a quarter of a mile above the Falls.

At the end of January, 1908, Dr. Warren took numerous nettings from cattle pools, vleis and pans in the neighbourhood of Mont-aux-Sources, Drakensberg Mountains. These were taken at various altitudes on the side of the Orange Free State near to Witzies Hoek. A pan not far from Harrismith was also examined.

It was desired to ascertain whether the Entomostracan fauna of the high altitudes of S.E. Africa resembled the flora in exhibiting a special relationship with the fauna of Australasia, but there appears to be no marked connection.

In January, 1912, several gatherings were made at Port St. John, Pondoland, in a vlei close to the local prison.

My friend, Mr. James Gibson, has sent to me new species

of *Streptocephalus* and *Diaptomus* from a pan near Mahlabatini, Zululand.

The specimens were mostly preserved in 5 per cent. formalin, but some of the gatherings had been fixed in hot corrosive sublimate solution and then placed in alcohol.

The species will be dealt with in systematic order.

## OSTRACODA.

### Genus *CYPRIS* Müller.

#### *Cypris inermis* Brady.

*Cypris inermis* Brady, Proc. Zool. Soc. London, 1904, pp. 121-128.

Found in small pool of clear water formed from the drippings of a spring a quarter of a mile below the rock with Bushman Paintings, near "Rydal Mount," Witzies Hoek, Orange Free State (E. Warren).

### Genus *CYPRIA* Zenker.

#### *Cypria castanea* Brady.

*Cypria castanea* Brady, Proc. Zool. Soc. Lond., 1904, p. 125, Pl. VII, figs. 40-42, Pl. VIII, fig. 43.

Found in drinking-water pool close to "Rydal Mount," Witzies Hoek, O.F.S. (E. Warren).

Large shallow pond overgrown with much aquatic vegetation close to the prison, Port St. John, Pondoland (E. Warren).

### Genus *STENOCYPRIS* G. O. Sars.

#### *Stenocypris aldabræ* G. W. Müller.

*Stenocypris aldabræ* Müller, Die Ostracoden, Voeltzkow Reissergebnisse, p. 288, Pl. I, figs. 1-18; Brady, Annals of the Natal Museum, vol. i, p. 178, pl. xxxi, figs. 1-6, 1907.

Found in large pond by prison, Port St. John, Pondoland (E. Warren).

Genus *HYALOCYPRIS* *gen. nov.*

Shell oblong, compressed, slender and translucent. Antennæ as in *Cypris*. Mandible-palp bears a small 6-setose branchial plate; mouth, labrum and œsophageal opening without serratures or teeth; first maxillar palp complex, profusely setiferous, and bearing also a large bulb-shaped tapering appendage which terminates in a long seta (Pl. XXXIII, fig. 4); the feet of the second pair have a very long terminal claw, and at the distal end of the basal joint a large spherical vesicle which bears a small lateral denticle.

The marked peculiarities of the mouth-organs, together with the characteristic vesiculiform appendages of the second pair of feet, seem to separate the following species very distinctly from those of any hitherto described genus.

*Hyalocypris africana* *sp. nov.* Pl. XXXIII, figs. 1-6.

Shell, seen laterally, oblong-ovate (fig. 1), somewhat narrower in front than behind; greatest height situated in the middle and equal to about half the length, anterior extremity evenly rounded, posterior wider and more flattened, dorsal margin forming a gently arcuate curve, ventral almost straight; seen from above (fig. 2) the outline is compressed, oblong, almost lozenge-shaped, widest in the middle, the width equal to one-third of the length, tapering to the extremities, the posterior rather obtuse, anterior more pointed; shell very thin and delicate, hyaline, surface smooth, very finely hairy towards the margins. Length 1.1 mm. The antennules and antennæ are normal in structure, the fascicle of swimming setæ extending well beyond the apices of the antennal claws; mandibles stout, mandibular palp short and stout, the last joint very small; branchial plate small, bearing six setæ; first and second pairs of maxillæ as usual except that the first pair (fig. 4) bear a larger pyriform marginal plate which ends in a rigid seta; mouth aperture and œsophagus very feebly developed; labrum devoid of serratures, but produced at each side into a stout bifid process (fig. 3); first pair of feet (fig. 5) bearing an extremely

long and slender apical claw, and on the basal joint a large spherical vesicle, which seems to be lined internally with muscular fibre; caudal rami stout (fig. 6), bearing at the apex two strong ungues and one short seta; seta of the dorsal margin situated not far from the terminal claws.

This interesting species occurred at an elevation of 5000 feet at Witzies Hoek, Orange Free State. About half-a-dozen specimens were all that could be detected in the gathering.

Genus *CYCLOCYPRIS* *Brady & Norman.*

*Cyclocypris castanea* *sp. nov.* Pl. XXXIII, figs. 7-10.

Shell seen laterally subcircular; greatest height in the middle (figs. 7, 8) equal to about four-fifths of the length; extremities broadly rounded, dorsal margin boldly arched, ventral almost straight in the middle; seen from above (fig. 9) the shell is broadly ovate, not twice as long as broad, the lateral margins strongly convex; anterior extremity produced in the middle, which is broadly mucronate; posterior not produced, subrotund. Valves of the two sides unequal; that of the right side deeply incurved ventrally forming a broad flange throughout its entire course (fig. 7); margins of the left valve (fig. 8) scarcely at all incurved except for a short space in the middle of the dorsal and ventral margins; shell beset sparingly with short hairs; colour brown. Length 0.57 mm.

Caudal rami extremely slender (fig. 10), having two long apical setæ; seta of the dorsal margin situated almost close to the terminal setæ.

Not more than three or four examples of this species were obtained in the neighbourhood of the Victoria Falls, Rhodesia.

The species might possibly be assigned to the genus *Eurycypris*, *G. W. Müller*; but I think that the characters assigned to *Eurycypris* are scarcely sufficient to form a valid generic separation.

## COPEPODA.

Genus *CYCLOPS* Müller.*Cyclops gibsoni* Brady.*Cyclops gibsoni* Brady, Proc. Zool. Soc. Lond., 1904, p. 123,  
Pl. VI, figs. 1-10.

Found in small pool near Bushman Paintings, "Rydal Mount," Witzies Hoek, O.F.S. (E. Warren). Drinking-water pool close to "Rydal Mount" (E. Warren).

Genus *ATTHEYELLA* Brady.*Attheyella warreni* sp. nov. Pl. XXXVI, figs. 1-9.

Female.—Body slender; abdomen (in spirit specimens) strongly flexed upon the thorax (fig. 1), head well rounded in front; last abdominal segment produced dorsally into a short, sharp spine; caudal laminae scarcely longer than broad, distinct one from the other, the interval distinctly cleft and destitute of spines or serratures, bearing two terminal setae, one of them long, the other short; posterior angles of the abdominal segments bearing one or more spine-like setae (fig. 9). Anterior antennae (fig. 2) very slender, eight-jointed, sparingly setiferous, posterior bearing a very small one-jointed secondary branch. First and second pairs of maxillae (figs. 3, 4) of the usual form, the hand of the second pair ovate-oblong, simple. First pair of swimming feet (fig. 5) shorter than the following pairs, having both branches three-jointed, the outer branch shorter than the inner; the outer branches of the second, third (fig. 6) and fourth (fig. 7) pairs three-jointed and much longer than the inner branches, which are obscurely two-jointed, the basal joints very minute; fifth pair foliaceous (fig. 8), the basal joint wide, bearing four stout terminal setae and one much longer seta on its outer angle, apical joint small, subovate, and bearing three terminal setae. Length 0.6 mm.

This species was taken in fresh water in the neighbourhood of the Victoria Falls. Only about half-a-dozen specimens were seen, all of them females.

Genus *DIAPTOMUS* *Westwood*.

*Diaptomus pictus* *sp. nov.* Pl. XXXIV, figs. 1-6.

Female.—Body rather robust. Seen dorsally, the anterior division is about three times as long as broad, nearly equal in width throughout, rounded in front, the last segment produced into two very conspicuous lateral flaps which are doubly acuminate at the distal angle. Urosome biarticulate, the anterior (genital) segment dilated basally, distal segment longer; caudal rami short, not much longer than broad, terminal setæ stout and strongly plumose. Anterior antennæ short, extending scarcely beyond the posterior extremity of the cephalothorax. Basal joint of last pair of legs simple, without any angular prominence; inner branch simple, unarticulate, claviform, slightly shorter than the first joint of the outer branch, bearing two short apical spines; terminal joint of the outer branch stoutly dilated at the base, distally produced into a long, slightly pectinated spine and bearing two stout marginal spines.

Length 2.10 mm.

Male.—Body rather shorter and more slender than that of the female; cephalothorax rounded off behind, without prominent angles; urosome slender, five-jointed, its second joint produced ventrally into an acute papilliform process. Right anterior antenna very tumid in the middle, its outer margin in front of the swollen portion bearing four strong curved spines; the three terminal joints slender and of nearly equal length, destitute of spines or marginal processes. Fifth pair of feet very unequal in size; outer branch of the right foot much elongated and bearing a long, slender, terminal claw; inner branch small, simple, biarticulate; foot of the left side short and stout, its basal joint with a minute papilliform prolongation; distal joint bifurcate at the apex, forming two unequal curved claws. Lateral spines of the swimming feet finely spinulose in both sexes.

Length of the male 1.90 mm.

Colour generally pale, but the anterior antennæ and caudal stylets of the male deeply coloured with carmine or rosy purple. In the living condition this coloration is much more extensive, and is more or less evident in both sexes.

The species was taken by Mr. J. Gibson in a pan on the summit of the Inkenjeni Mountain near the Mahlabatini Magistracy, Zululand.

*Diaptomus fuscatus*, *sp. nov.* Pl. XXXIV, figs. 7-10;  
Pl. XXXV, fig. 1.

Female.—Body robust; seen dorsally, the anterior portion is more than twice as long as broad, broadly rounded in front; the posterior segment truncated, produced laterally into two sharply acuminate angles; urosome three-jointed, genital segment somewhat dilated, last segment and caudal rami very short and nearly equal in length, terminal setæ very feebly plumose. Anterior antennæ extending when reflexed beyond the posterior extremity of the cephalothorax. Basal joint of the fifth pair of legs simply quadrate; inner branch simple, uniaarticulate, digitiform, bearing a single terminal seta and one or two minute hairs; distal joint of the outer branch stout, awl-shaped, sharply pointed; the distal half of its inner margin finely pectinated, a single stout seta attached near the middle of its outer surface.

Length 1.95 mm. Colour deep brown.

Male.—Anterior antenna bearing a very strong awl-shaped spine immediately in front of the tumid part of the limb, and two very small spines on the preceding joints; the antepenultimate joint exerted at its distal end into a long, slightly curved, projected extremity, as long as the penultimate joint. Last pair of feet (fig. 9) extremely asymmetrical; basal joint of the right foot bearing a minute papilliform process at the end of its inner edge; terminal joint shorter, subquadrate, with a long and slender, flexuous claw and a shorter spine at its outer angle; the foot of the left side is about as long as the first joint of the right foot, simple, club-shaped, tapered to the distal end, which is slightly flexed and

constricted. The lateral spines of the outer branches of the swimming feet are perfectly smooth, without spinules or denticles.

The only available specimens of the male of this species were imperfectly preserved. It approaches rather closely to some of those described by Professor Sars from the Tanganyika expedition, notably to *D. simplex* and *D. cunningtoni*.

The specimens here referred to were taken by Dr. Warren at Equeefa, Natal.

*Diaptomus masculus*, *sp. n.* Pl. XXXV, figs. 2-6.

Female.—Body moderately stout. Seen dorsally, the anterior division is of nearly equal width throughout; the head somewhat narrowed and evenly rounded off; posterior segment truncated, its lateral angles not much produced; urosome four-jointed, the second joint much the longest; caudal laminae scarcely longer than broad, about equal in length to each of the two preceding joints; terminal setae slender, not basally dilated, very feebly plumose; anterior antennae reaching when reflexed to the middle of the urosome. Basal joint of the last pair of legs simple; inner branch claviform, simple, uniaarticulate, with two short apical hairs; first joint of the outer branch rather exceeding the inner branch in length; second joint produced distally into a slender spine which is marginally pectinated beyond the middle; to its basal portion is attached a small spine with a papilliform base, which may perhaps be considered as a rudimentary third joint. The lateral spines of the swimming feet are minutely spinulose.

Length about 2.10 mm.; of male 1.4 mm. Colour reddish-brown.

Male.—Body of the adult very slender, about two-thirds as long as that of the female, narrowly rounded in front, somewhat narrowed and subtruncate behind, rounded off laterally; urosome slender, five-jointed; caudal laminae short,

about as broad as long. The anterior antennæ are very markedly constricted, not only at the hinge-joint, but likewise between the penultimate and antepenultimate joints; there is no spinous prolongation of either of these joints, but the terminal joint has a small digitiform process at its apex.

This is remarkable among the African species of Diaptomidæ in respect of the great disparity in size between the two sexes, in the non-reduction of the number of joints in the female urosome, and, lastly, in the rather peculiar form of the distal portion of the male anterior antenna.

The species occurred plentifully in a gathering made by Dr. Warren in a "pond between Witzies Hoek and Harrismith, ten miles from Harrismith, February 10th, 1908."

Genus PARADIPTOMUS *G. O. Sars*,<sup>1</sup>

(= BROTEAS *Lovén*<sup>2</sup> = LOVENULA *Schmeil*<sup>3</sup>).

The generic name *Protodiaptomus* was proposed by Professor Sars in 1895 to receive a South African species described by him (*P. lamellatus*). This species was evidently congeneric with and very closely allied to that previously described by Lovén as *Broteas falcifer*. Lovén's generic term *Broteas* had been already used by C. L. Koch for a genus of Arachnida (1839). The name *Paradiaptomus* given by Sars must therefore be adopted, if the species is to be considered generically distinct. *Lovenula*, as proposed by Schmeil, is of later date. It would seem, however, that Professor Sars has himself doubted the expediency of a separate name, inasmuch as he includes under *Diaptomus* the five species described by him in his report on the 'Copepoda of the Third Tanganyika Expedition.' These seem to be in no respect generically different from *Paradiaptomus*.

<sup>1</sup> Sars. G. O.. 'On some South African Entomostraca,' 1895.

<sup>2</sup> Lovén. L.. 'Fyra nya arter af Sötvattens-Crustacéer från Södra Afrika.' 1846.

<sup>3</sup> Schmeil. O.. 'Das Tierreich, Copepoder, 1 Gymnoplea,' 1898.

*Paradiaptomus falcifer* (*Lovén*). Pl. XXXV, figs. 7-10.

This interesting species originally described and figured by Lovén (*loc. cit.*) has been recently found by Dr. Warren, who has kindly sent me specimens which were taken in a "pond between Witzies Hoek and Harrismith." Dr. Warren describes the colouring of these specimens as being—"the body milky white, the antennæ deep purple, the furcæ bright red round the base and purple terminally, the setæ purple." I give drawings of some of the characteristic parts—in all respects similar to those of Lovén and to those of more recent authors.

#### PHYLLOPODA.

Genus *CERIODAPHNIA* *Dana*.

*Ceriodaphnia natalis* *Brady*.

*Ceriodaphnia natalis* *Brady*, *Annals of the Natal Museum*, vol. i, p. 180. Pl. XXXII, figs. 3-7, 1907.

Found in drinking-water pool close to "Rydal Mount," Witzies Hoek, Orange Free State (E. Warren).

Genus *LEYDIGIA* *Kurz*.

*Leydigia quadridentata* sp. nov. Pl. XXXVI, fig. 10.

This species, of which three individuals only were found, has little to distinguish it from other members of the genus excepting the presence of four minute but very distinct teeth on the posterior margin of the valves. The valves are faintly striated, and the caudal laminae have the spinous armature which is characteristic of the genus. The length is 0.5 mm.

Obtained near to Victoria Falls (E. Warren).

Genus *CAMPTOCERCUS* *Baird*.

*Camptocercus aloniceps* *Ekman*. Pl. XXXVIII, fig. 1.

*Camptocercus aloniceps* *Ekman*, *Cladoceren aus Patagonien gesammelt von der schwedischen Expedition nach Patagonien*, 1899. *Zool. Jahrb.*, 1900.

Three specimens found in a gathering from near Victoria Falls are indistinguishable from a Patagonian species described by Dr. Ekman, the only apparent difference consisting in the want of marginal cilia in the case of the African specimens. Length of the African specimens 0·85 mm., of the Patagonian specimens 0·75 mm.

Genus *EULIMNADIA* Packard.

*Eulimnadia victoriæ* sp. nov. Pl. XXXVII, figs. 1-7.

Females.—The shell seen laterally is almost circular, diameter 4·5 mm. (fig. 1), very thin and membranous, colourless and translucent, marked with three or four concentric lines of growth, and, seen with a high microscopic power, very minutely and closely reticulated (fig. 7); seen dorsally the outline is ovate, widest in the middle (fig. 2), twice as long as broad, extremities broadly rounded. The front of the head is broadly rounded and is sharply denticulated, the antennules (fig. 3) long and filiform, jointed in the middle, slightly dilated at the extremities which bear a few fine, sensory (?) hairs; antennæ (fig. 4) strongly developed, biramose, basal portion very stout, indistinctly jointed and bearing several setiferous processes; branches seven-jointed, each joint bearing a strong spine and one or more long setæ; the last joint has also four apical setæ. Mandibles (fig. 5) stout, deeply pigmented, the apices rounded and beset with numerous minute setæ; caudal laminae (fig. 6) bearing a series of about eight curved denticulated spines of gradually increasing lengths, the two distal pairs extremely long and slender; in front of these spines arises a pair of very long setæ, and in front of these again a series of about six short digitiform processes, each of which is profusely fringed with long setæ.

The genus, as defined by Packard, differs from *Limnadia* chiefly in the shape of the shell (which is in *Eulimnadia* narrower in lateral view), in the smaller number of lines

of growth, and in the greater number of feet, which in *Eulimnadia* number eighteen pairs. In the shape of the shell, however, the present species departs conspicuously from the type, to which in other respects it seems to conform closely.

Several specimens were collected in the neighbourhood of the Victoria Falls—all of them females.

Genus *STREPTOCEPHALUS* *Baird*.

*Streptocephalus propinquus* *sp. nov.* Pl. XXXVIII,  
figs. 2-6.

Female (fig. 5).—Length to the end of the caudal rami about 8.5 mm., the posterior (tail) division of the body rather longer than the anterior. Head rounded in front and bearing the antennules, antennæ, a pair of deeply coloured eyes and an inconspicuous central ocellus. Behind the head is a cervical region containing the mouth-organs, mandibular hump, and behind these the shell-glands. Following these are eleven segments of the mesosome, each bearing a pair of branchial legs. The genital region consists of two imperfectly separated segments, from which arise the two ovigerous pouches. The tail consists of seven well-defined segments, and ends in two stout caudal prolongations which are plumosely fringed with stout setæ.

The antennules (fig. 6*b*) are simple, very slender and inarticulate; the antennæ (fig. 6*c*) are simple, foliaceous and finely hispid; the ocellus (fig. 6*a*) is small, faintly rubescent; the eyes (fig. 6*d*) are very large, clavate in outline, composed of numerous small lenses, jet-black at their circumference and covered with a transparent, hyaline cornea; the mandibular hump forms a conspicuous bulbous prominence just behind the eye (fig. 6*e*), and behind this, again, is the sphenoidal shell-gland (fig. 6*f*). The first and last pairs of feet are somewhat smaller and of rather different structure from the rest; the marsupial pouch is about as long as two conjoined tail-segments and is slightly bifid at the apex.

Male.—The male (fig. 2) is somewhat smaller than the female, but except in the structure of the antennæ does not present any very marked differences. The antennæ, however, are very strongly geniculated (fig. 3), stout and muscular, and about one-fourth as long as the animal itself, not distinctly jointed; the anterior margin of the median portion produced so as to form a very large and wide three-spined lamina; the apical portion strongly angulated and terminating in a tapering, finger-like extremity. Segments of the tail marked by distinctly prominent ridges at their lines of contact; caudal stylets knotted in appearance, indistinctly divided into numerous short joints and fringed with long, delicate cilia (fig. 4).

Several specimens of both sexes were taken by Mr. Gibson in a pan on the summit of the Inkenjeni Mountain near the Mahlabatini Magistracy, Zululand; but no ovigerous females were seen, and it seems extremely doubtful if any of the specimens, either male or female, were really mature.

The most nearly allied of described species appears to be *Streptocephalus papillatus* G. O. Sars.<sup>1</sup>

## EXPLANATION OF PLATES XXXIII-XXXVIII,

Illustrating Dr. G. S. Brady's paper "On Fresh-water Entomostraca from various parts of South Africa."

### PLATE XXXIII.

*Hyalocypris africana* g. e. sp. n.

- FIG. 1.—× 40. Shell seen from right side.  
 FIG. 2.—× 40. Shell seen from above.  
 FIG. 3.—× 210. Labrum and mouth-aperture.  
 FIG. 4.—× 210. Maxilla of first pair.  
 FIG. 5.—× 120. Foot of first pair.  
 FIG. 6.—× 120. Caudal ramus.

<sup>1</sup> Sars, G. O., "On Two Apparently New Phyllopora from South Africa," Arch. f. Math. Naturv., Bd. xxvii, Nr. 4, 1905.

*Cycloocypris castanea* sp. n.

- FIG. 7.—× 84. Right valve seen from inside.  
 FIG. 8.—× 84. Left valve seen from inside.  
 FIG. 9.—× 84. Shell seen from above.  
 FIG. 10.—× 210. Caudal ramus.

## PLATE XXXIV.

*Diaptomus pictus* sp. n.

## Female.

- FIG. 1.—× 40. Dorsal view.  
 FIG. 2.—× 40. Last thoracic segment and urosome seen laterally.  
 FIG. 3.—× 140. Foot of fifth pair.

## Male.

- FIG. 4.—× 40. Urosome and last thoracic segment seen laterally.  
 FIG. 5.—× 84. Right anterior antenna.  
 FIG. 6.—× 84. Fifth pair of feet.

*Diaptomus fuscatus* sp. n.

## Male.

- FIG. 7.—× 50. Urosome seen laterally.  
 FIG. 8.—× 100. Anterior antenna.  
 FIG. 9.—× 84. Fifth pair of feet.

## Female.

- FIG. 10.—× 140. Foot of fifth pair.

## PLATE XXXV.

*Diaptomus fuscatus* sp. n.

- FIG. 1.—× 50. Female. Dorsal view.

*Diaptomus masculus* sp. n.

## Female.

- FIG. 2.—× 53. Dorsal view.  
 FIG. 3.—× 140. Foot of fifth pair.

## Male.

- FIG. 4.—× 53. Dorsal view.  
 FIG. 5.—× 140. Distal joints of right anterior antenna.  
 FIG. 6.—× 140. Fifth pair of feet.

*Paradiaptomus falcifer* (Lovén).

Female.

FIG. 7.—× 14. Dorsal view.

FIG. 8.—× 33. Foot of fifth pair.

Male.

FIG. 9.—× 30. Anterior antenna.

FIG. 10.—× 33. Fifth pair of feet.

PLATE XXXVI.

*Attheyella warreni* *sp. n.*

Female.

FIG. 1.—× 140. Seen from left side.

FIG. 2.—× 210. Anterior antenna.

FIG. 3.—× 440. Anterior foot-jaw.

FIG. 4.—× 440. Posterior foot-jaw.

FIG. 5.—× 210. Foot of first pair.

FIG. 6.—× 210. Foot of third pair.

FIG. 7.—× 210. Foot of fourth pair.

FIG. 8.—× 210. Foot of fifth pair.

FIG. 9.—× 210. Posterior segments of abdomen.

*Leydigia quadridentata* *sp. n.*

FIG. 10.—× 100. Female seen from right side.

PLATE XXXVII.

*Eulimnadia victoriæ* *sp. n.*

Female.

FIG. 1.—× 19. Seen from right side.

FIG. 2.—× 19. Shell seen from behind.

FIG. 3.—× 63. Antennules and front of head.

FIG. 4.—× 63. One of the antennæ.

FIG. 5.—× 63. Apical portion of mandible.

FIG. 6.—× 63. Post-abdomen with caudal laminae.

FIG. 7.—× 158. Portion of shell showing minute structure.

## PLATE XXXVIII.

*Camptocercus aloniceps* *Ekman*.

FIG. 1.—× 84. Female seen from right side.

*Streptocephalus propinquus* *sp. n.*

## Male.

FIG. 2.—× 16. View from left side.

FIG. 3.—× 40. Left antenna.

FIG. 4.—× 55. Portion of plumose tail-seta

## Female.

FIG. 5.—× 16. View from left side

FIG. 6.—× 40. Mouth organs.

*a.* ocellus.

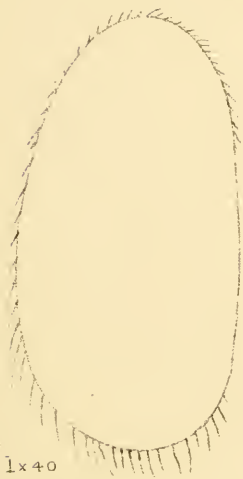
*b.* antennule.

*c.* antenna.

*d.* eye.

*e.* mandibular bulb.

*f.* shell-gland.



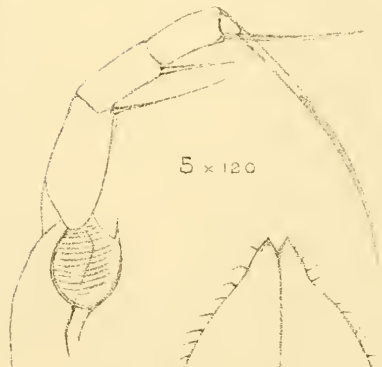
1 x 40.



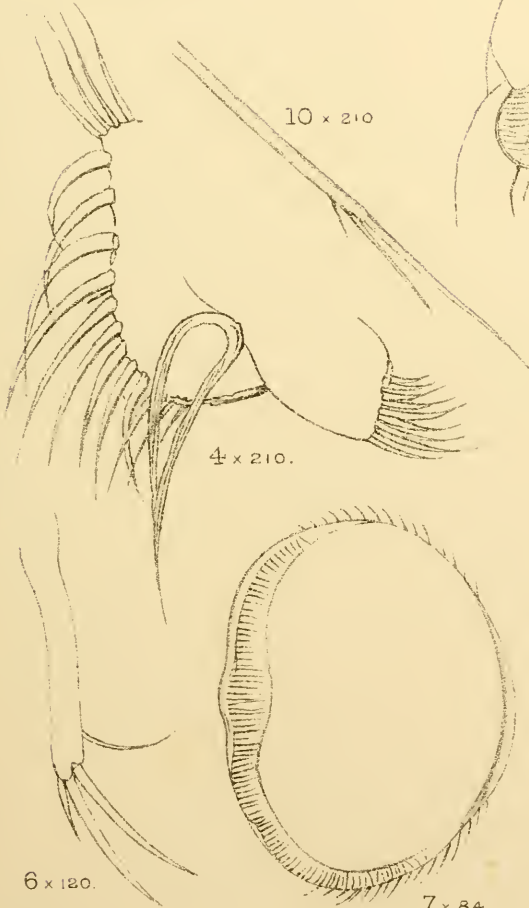
2 x 40.



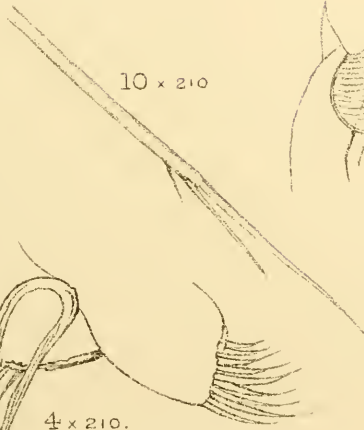
3 x 210.



5 x 120.

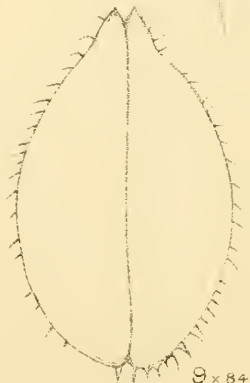


6 x 120.

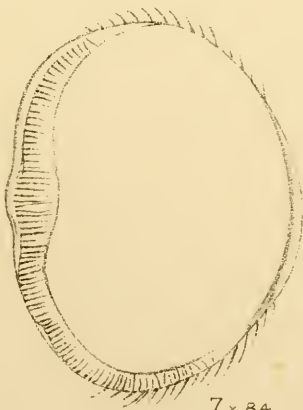


10 x 210.

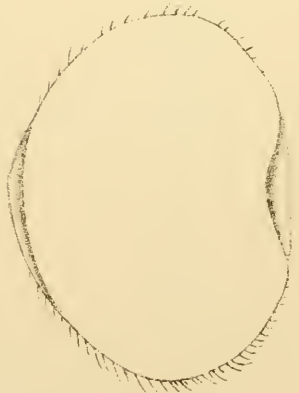
4 x 210.



8 x 84.



7 x 84.



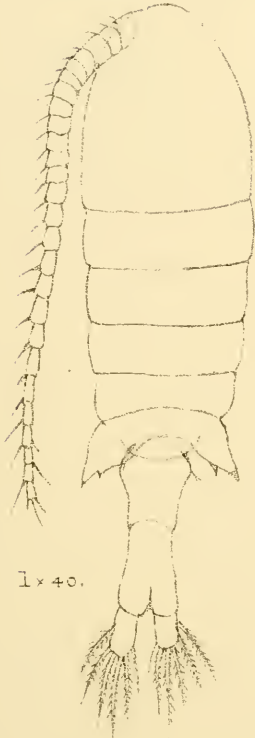
8 x 84.

Brady, del.

Huth, Lith<sup>r</sup> London

HYALOCYPRIS AFRICANA g.e. sp.n. Fig<sup>s</sup> 1-6  
CYCLOCYPRIS CASTANEA sp.n. Fig<sup>s</sup> 7-10.





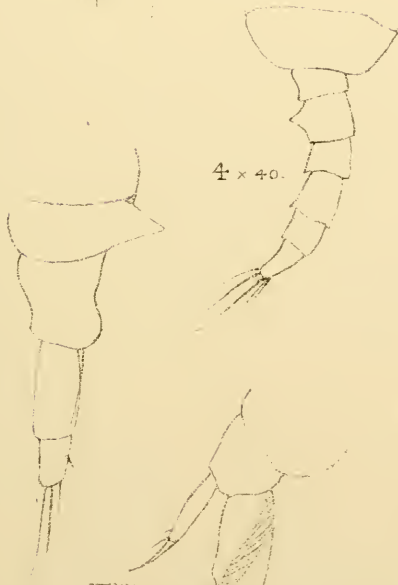
1 x 40.



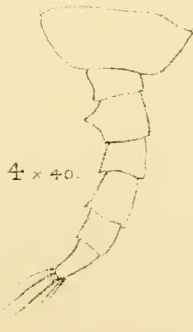
5 x 84.



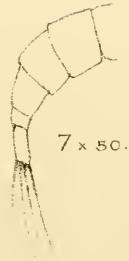
6 x 84.



2 x 40. ♀



4 x 40.



7 x 50.



10 x 140



9 x 84.



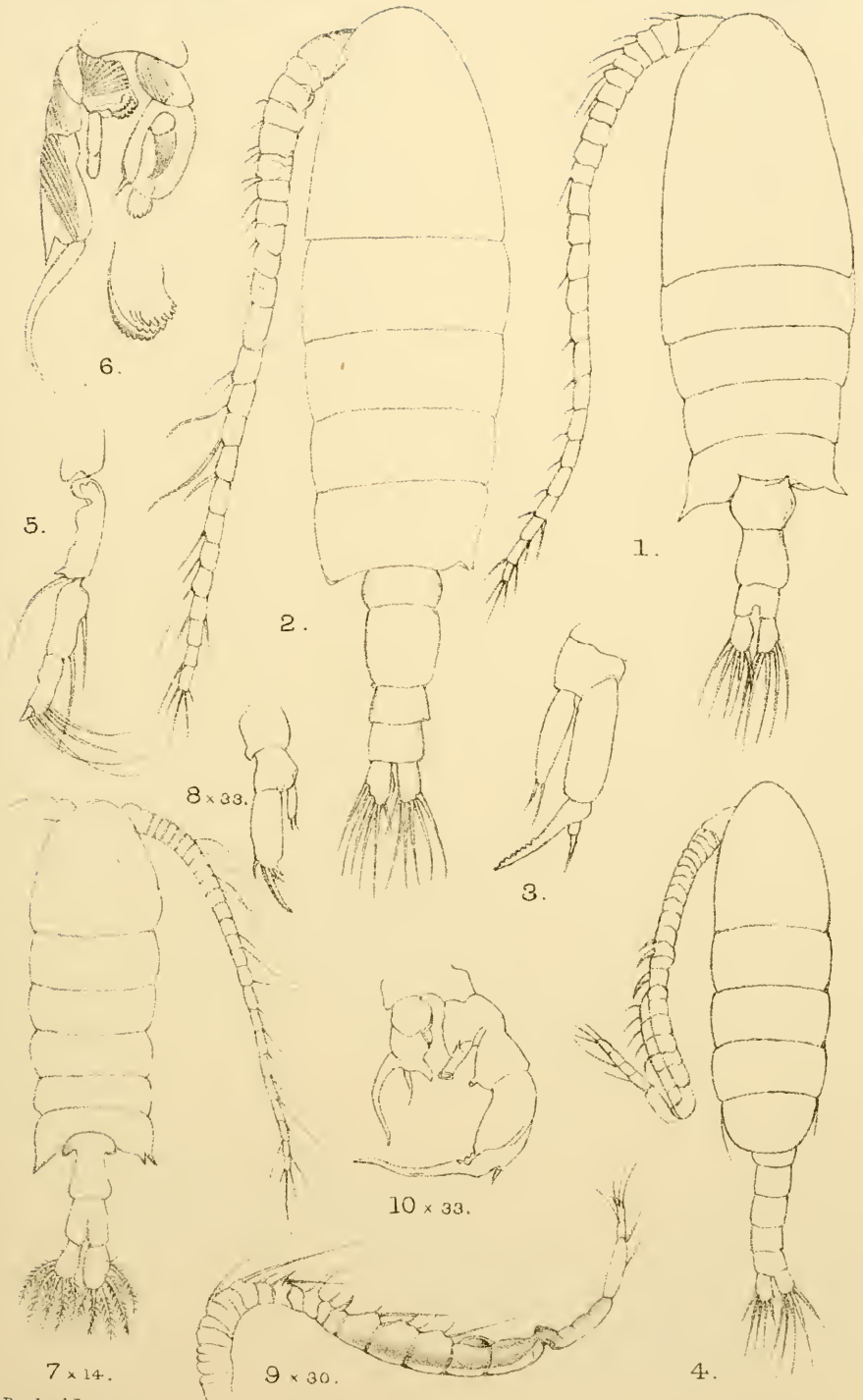
8 x 100.

Brady, del.

Huth, lith London

DIAPTOMUS PICTUS sp n. Fig<sup>s</sup> 1-6.  
DIAPTOMUS FUSCATUS sp n. Fig<sup>s</sup> 7-10.



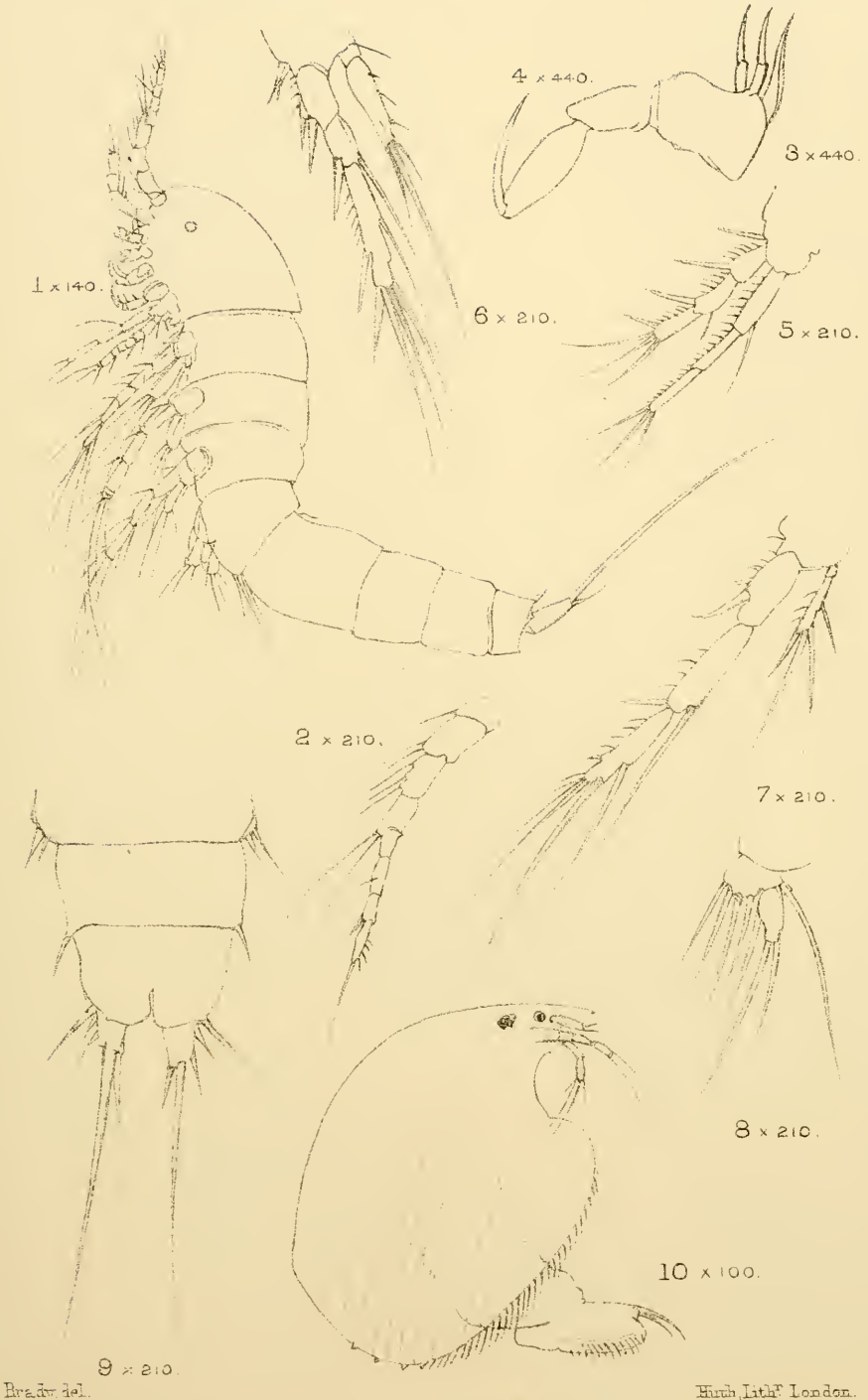


Brady, del.

Huth Lith<sup>r</sup> London.

DIAPTOMUS FUSCATUS sp. n. Fig 1. DIAPTOMUS MASCULUS sp. n. Fig<sup>s</sup> 2-6.  
 PARADIAPTOMUS FALGIFER (Lovén) Fig<sup>s</sup> 7-10.





1 x 140.

4 x 440.

3 x 440.

6 x 210.

5 x 210.

2 x 210.

7 x 210.

8 x 210.

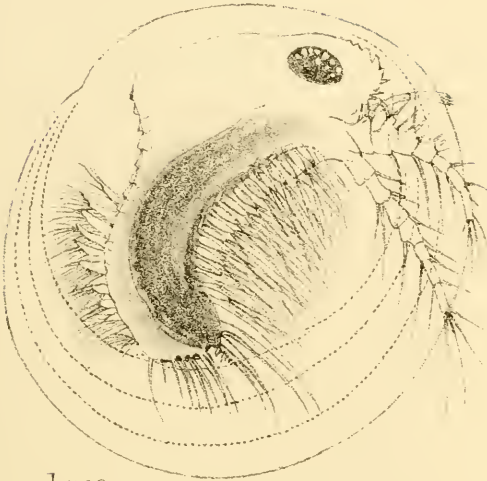
10 x 100.

Brady del.

Hutch, Lith' London.

ATTHEYELLA WARRENI sp.n. Fig<sup>s</sup> 1-9.  
 LEYDIGIA QUADRIDENTATA sp.n. Fig. 10.





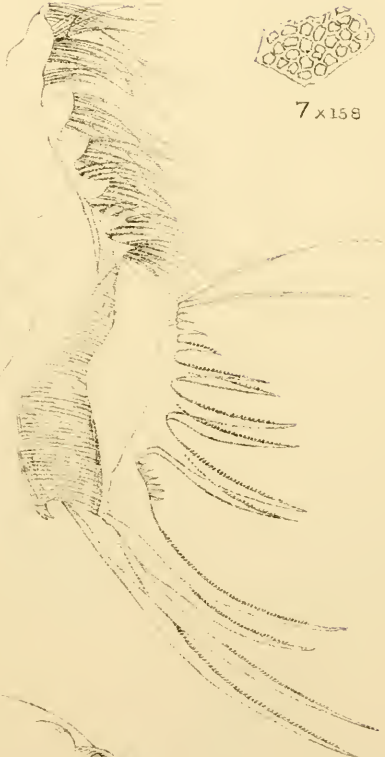
1 x 19.



2 x 19.



3 x 63.



7 x 158



4 x 63.



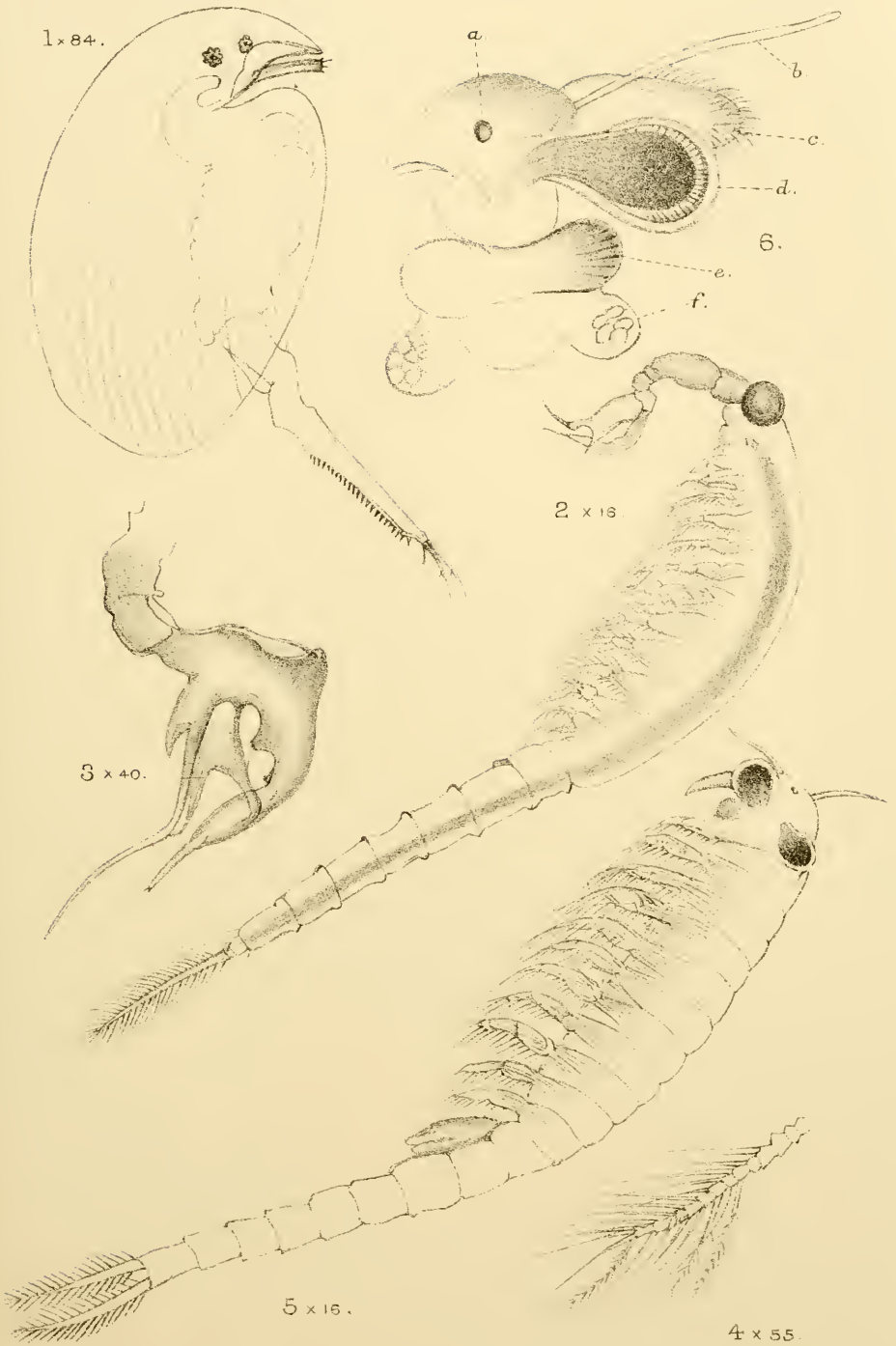
5 x 63.

6 x 63.

Brady, del.

Hatch Lith<sup>r</sup> London.





Brady, del.

Hath, Lith<sup>r</sup> London.

CAMPTOCERCUS ALONICEPS Ekman. Fig. 1.  
STREPTOCEPHALUS PROPINQUUS sp.n Fig<sup>s</sup> 2-6



**Description of *Heleophryne natalensis*, a  
New Batrachian from Natal; and Notes on  
Several South African Batrachians and  
Reptiles.**

By

**John Hewitt, B.A.Camb.,**

Director of the Albany Museum, Grahamstown.

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With Plate XXXIX.

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ON October 22nd, 1912, the Rev. Father P. Boneberg, of Mariannhill Monastery, Pinetown, discovered some remarkable tadpoles at Krantzklouf, Natal, some of which he preserved alive until, about a month afterwards, one of them had become a moderate-sized frog. This he forwarded to me as a species of *Heleophryne*.

On comparing with typical specimens of *H. regis Hewitt* from Knysna I believe it to be a very distinct species, for which I propose the name of *Heleophryne natalensis*. This is the second new species of frog discovered in Natal by Fr. Boneberg within the last year; his first discovery, *Natalobatrachus bonebergi Hewitt* and *Methuen*,<sup>1</sup> representing a hitherto undescribed genus.

It is worthy of remark that these two Natal frogs, though members of different families, share a peculiarity not found in any other S. African frog, viz. the possession of triangular or sub-triangular discs at the tips of the fingers.

The present record is interesting as it considerably extends the known range of this isolated genus, which is the only *Cystignathid* known to occur in Africa, and hitherto has

<sup>1</sup> Hewitt, J., and Methuen, P. A., 'Trans. Roy. Soc. South Africa,' vol. iii, p. 107, pl. vii, 1912.

been recorded only from Knysna and the Stellenbosch neighbourhood.

It may be added that eighteen months ago I ventured to predict that "the genus will be found to occur in the forest region of the whole coastal strip of Cape Province at least."<sup>1</sup>

The Rev. Fr. Boneberg has kindly supplied me with the following interesting notes on his discovery of these tadpoles, which are characterised by possessing a well-developed oral sucker :

"Five specimens were taken at an altitude of 1500 feet in a tributary of the Krantz Kloof River on October 22nd, 1912; three of them were without legs, the other two had each four legs.

"In life they are greyish, becoming darker on the back, where, however, there are some small pale dots; on the sides of the body, and especially of the tail, are some large rust-coloured spots, which in older specimens become almost golden, particularly round the head; the legs are marked with distinct blackish cross-bands.

"They were found only in one spot, a pool of little depth and small dimensions; the tributary flows through virgin forest along a valley of the Krantz Kloof, and has in its course several falls and cascades, the bed of the stream being largely covered with boulders. The tadpoles were observed hanging on rocks beneath the water, others being at the bottom of the river; when disturbed they hid under the rocks.

"One of the four-legged specimens was kept alive in a glass jar; in about ten days the whole tail was absorbed and the little frog began to take flies.

"More examples were secured on November 11th, but no adult frogs could be found though they were searched for. The tadpoles were seen hanging on rocks as before, and they appeared to prefer the neighbourhood of running water. The food probably consists chiefly of the lower forms of plant-life found growing on the submerged rocks. Most of the specimens taken on this occasion died during the journey to

<sup>1</sup> Hewitt, J., 'Annals of the Transvaal Museum,' vol. iii, p. 33, 1911.

Mariannahill, and the survivors did not thrive in the confinement of a glass jar. They could attach themselves so firmly to the glass by means of their oral sucker that it was most difficult to remove them."

With the material at hand, which consists of only one young frog and several tadpoles, it is not possible to give as complete a diagnosis of the species as is desired; but there are certain well-marked differences between this species and *H. regis* Hewitt.<sup>1</sup>

*Heleophryne natalensis* sp. n.

YOUNG FROG.—Ventral surface is smooth, while in *regis* it is granular.

The tibio-tarsal articulation of the adpressed hind limb reaches the eye, while in *regis* it reaches the tip of the snout, or between the eye and the tip of the snout.

The fourth finger is considerably longer than the second, the latter not extending as far as the last phalangeal articulation of the fourth finger, while in *regis* the fourth finger is only a little longer than the second, which extends a little beyond the last phalangeal articulation of the fourth finger. The discs at the tips of the fingers are a little smaller than those of *regis*.

Tympanum is hidden in a strong sigmoidly curved fold passing from the eye to the shoulder.

Fingers free. Toes a trifle more than half webbed.

A light streak occurs between the eyes, bordered behind by a black band; the back has numerous rounded, blackish spots with white centres; upper lip on its anterior half bears whitish spots more or less vertically arranged; two or three white spots are present at the angle of the jaw; limbs have indistinct dark cross-bars; belly is pale in the centre, throat and under surface of limbs are dark.

Total length from snout to vent 32 mm., but the species probably reaches a much greater size.

<sup>1</sup> Hewitt, J., 'Annals of the Transvaal Museum,' vol. ii, p. 45: description of *H. regis*.



The type is in the Museum of the Monastery at Mariannahill.

The characters which separate this species from *H. regis* will also serve to distinguish it from *H. purcelli* *Sclater*.<sup>1</sup> I may here mention that the specific validity of *regis* is not absolutely certain; *H. purcelli*, on which the genus was founded by Mr. W. L. Sclater, is expressly stated both in the generic and specific descriptions to have the toes completely webbed, yet in the figure accompanying the description the toes are not thus represented, being apparently about three-fourths webbed; in *regis* they are scarcely more than half webbed.

**TADPOLE.**—The most striking feature of the tadpole is the presence of a large circular oral disc ventrally situated; this is strongly suctional in function. In a specimen in which the hind-limbs are just commencing to push through the skin this disc is 10 mm. in diameter.

The mouth itself is widely open and subquadrangular in shape. The upper half of the beak is absent; the lower half is black but not strongly developed. The labial teeth are disposed in a single row in each series; there are four upper continuous series, the two outer of which are weakly developed; the first lower series next to the beak is narrowly interrupted in the middle, but all the others are continuous, four strongly developed rows being followed by ten more weakly developed series. The lips are entirely bordered with small fleshy papillæ.

The nostril is nearer to the eye than to the end of the snout, which is large, broad and rounded. The spiracle is sinistral, directed backwards and slightly upwards, its opening being nearer to the vent than to the tip of the snout. The vent seems to be median; this cannot be positively affirmed owing to the appearance of hind-limbs in the specimen.

The tail is fairly long and obtusely pointed; its crests are

<sup>1</sup> Sclater, W. L., 'Annals of the South African Museum,' vol. i, p. 111.

not very well developed, neither of them at this stage extending as far forwards as the vent. In older specimens a feebly developed adipose extension of the dorsal crest reaches anteriorly to a point just above the vent. The caudal crests are without a pigmentary network, but the upper one has a few black lines; the end of the tail is blackish, but elsewhere it is not strongly pigmented.

Measurements: from tip of snout to vent, 27 mm.; from vent to tip of tail, 33 mm.; greatest depth of tail, including crests, 9 mm.

At a very late stage of the metamorphosis, when both fore- and hind-limbs are well developed, the oral disc is still large and conspicuous though the teeth series are absent.

No such tadpole as that just described has hitherto been recorded from South Africa. The sucker-like oral disc has long been known to occur in tadpoles of Ranids inhabiting the mountain streams of Borneo, Java and Burma; but in most cases the greater part of the disc seems to be derived from the sub-buccal adhesive organ of the young larva, which is evidently not the case in *Heleophryne*. The caudal crests in those tadpoles, as in *Heleophryne*, are only slightly developed anteriorly.

## ANURA.

### *Megalixalus fornasinii* *Bianc.*

*Megalixalus fornasinii* *Bianc.*; Boulenger, Brit. Mus. Cat. Batr. Sal., p. 130. 1882.

With this species I now include *M. spinifrons* *Cope*. A single specimen taken by Fr. Boneberg at Mariannahill in May, 1911, has no trace of tubercles dorsally; but along the pale dorso-lateral bands there are some dark spots which possibly represent the tubercles of other specimens. The Natal Museum has an example from Knysna in which the tubercles of the dorsal surface are sparsely scattered and not concentrated on the snout.

*Hemisus marmoratum Pet.*

*Hemisus marmoratum Pet.*; Boulenger, Brit. Mus. Cat. Batr. Sal., p. 178. 1882.

Taken at Tsessebe Siding, Francistown (E. C. Wilmot); the first record of this species from S. Africa.

*Rana natalensis Smith.*

*Rana natalensis Smith*; Boulenger, Brit. Mus. Cat. Batr. Sal., p. 30. 1882.

Taken at Pirie, November, 1912 (Miss F. Ross); the most western record for this species.

## OPHIDIA.

*Calamelaps polylepis Boc.*

*Calamelaps polylepis Boc.*; Boulenger, Brit. Mus. Cat. Snakes, III, p. 246. 1896.

? *Calamelaps warreni Boul.*; Annals Natal Mus., I, p. 234. 1908.

This species has not previously been recorded as such from S. Africa. It was first known to me from Hectorspruit (F. Streeter), the specimen having 194 ventrals; more recently Mr. G. Arnold, of the Rhodesia Museum, sent me the specimen from Empandene (Rev. J. O'Neil), which was recorded by Mr. Chubb<sup>1</sup> under the name of *C. concolor Smith*, but which now proves to be a very fine example of *C. polylepis*, having twenty-one rows of body scales, 200 ventral scales and a total length of 690 mm. A year ago I recorded *C. warreni Boul.* from Empandene, basing the determination on a specimen only 350 mm. long and having nineteen rows of body-scales and 172 ventrals<sup>2</sup>; this in all probability is merely the young of the same species as the former specimen. Now, the type of *C. warreni* is recorded as only 235 mm. long, and is almost certainly a very young specimen. Judging from his recently published key to the S. African Ophidia, Mr. Boulenger<sup>3</sup> is

<sup>1</sup> Chubb, E. C., 'Annual Report Rhodesia Museum,' 1909.

<sup>2</sup> Hewitt, J., 'Records Albany Museum,' ii, p. 276.

<sup>3</sup> Boulenger, G. A., 'Ann. S. African Mus.,' v, p. 516.

satisfied that the chief distinguishing feature of *C. warreni* is the nineteen rows of body-scales and a comparatively small number of ventrals (161-174); but if these are, as I believe, merely juvenile characters, *C. warreni* will probably have to be dropped. Apart from these characters the only claim to specific distinction that can be accorded thereto lies in the fact that the second upper labial is in contact with the pre-ocular, whereas in *polylepis* the second upper labial is in contact with the nasal; it is hardly likely that these characters will prove to be of specific value.

*Amplorhinus nototania Günth.*

*Amplorhinus nototania Günth.*; Boulenger, Brit. Mus. Cat. Snakes, iii, p. 125. 1896.

The Rhodesia Museum has this species from Matetsi (a locality between Bulawayo and Victoria Falls); not previously recorded from S. Africa.

*Psammophis jallæ Peracca.*

*Psammophis jallæ Peracca*; Boll. Mus. Torin., no. 255. 1896.

The Rhodesia Museum has this species from Springvale near the Matoppos. Peracca's original description and figure do not clearly indicate the position of this species within its genus, and Mr. Boulenger in his key ranges it next to *crucifer*, to which it is not closely allied; it really belongs to the *furcatus* and *notostictus* section with regard to the nasal character, and, indeed, it may have to be regarded only as a 15-scaled variety of *furcatus*.<sup>1</sup>

The colour characters of the specimen are as follows: in the mid-dorsal region a broad, brown, longitudinal band with dark brown margin, then on each side a thin yellow streak half a scale thick, below which comes a reddish-brown band 2-2½ scales thick, the ventral surface and the lower half of the outermost row of scales being pale yellow.

<sup>1</sup> Hewitt, J., 'Records of the Albany Museum,' ii, p. 275.

## LACERTILIA.

*Eremias burchelli* *Smith*.

*Eremias burchelli* *Smith*; Boulenger, Brit. Mus. Cat. Lizards, iii, p. 95. 1887.

Maclear (Miss F. Ross): the most eastern record known. Apparently it may occur in the same locality as its near ally, *E. capensis*, for the late Mr. P. D. Morris sent me both species from Victoria West, where *capensis* is common.

*Ichnotropis capensis* *Smith*.

*Ichnotropis capensis* *Smith*; Boulenger, Brit. Mus. Cat. Lizards, iii, p. 78. 1887.

Mariannahill (Fr. P. Boneberg): the first record of this species from Natal.

*I. longipes* *Boul.*<sup>1</sup> seems to me only a variety of *capensis*, and in all probability the two forms will be found to merge completely. According to Mr. Boulenger's key, *longipes* may be distinguished by the greater length of the hind-limb, which, when adpressed to the body, reaches as far as the ear or beyond; this seems to hold good for the males; but in female examples from Marandellas, which is near the type locality of *longipes*, the adpressed hind-limb only reaches to the axil. In any case the name *longipes*, even as a variety, is probably inadmissible, seeing that this form was apparently the one described by Peters<sup>2</sup> under the name of *I. macrolepidota*. It is clearly stated in the description that the claw of the fourth toe reaches up to the ear opening. In the British Museum Catalogue, *macrolepidota* was reduced to a synonym of *capensis*.

*Mabuia occidentalis* *Peters*.

*Mabuia occidentalis* *Peters*; Boulenger, Brit. Mus. Cat. Lizards, iii, p. 200. 1887.

Beaufort West (P. Whatis): the most eastern record in Cape Colony.

<sup>1</sup> Boulenger, G. A., Proc. Zool. Soc., 1902, II, p. 17.

<sup>2</sup> Peters, W. C. H., 'Reise nach Mossambique,' iii, p. 46, 1882.

*Pachydactylus punctatus Peters.*

*Pachydactylus punctatus Peters*; Boulenger, Brit. Mus. Cat. Lizards, i, p. 206. 1885.

So many species of the *punctatus-ocellatus* section of *Pachydactylus* have been described within recent years that it is highly desirable to have better knowledge of the characters of *punctatus* itself. A series from Serowe presents the following characters.

Head rather depressed but not strongly so. Mr. Boulenger,<sup>1</sup> who identifies the Serowe species as *punctatus*, places that species in the group characterised by "head very convex." Snout rather long, about  $1\frac{2}{3}$  as long as the eye, the scales thereon several times as large as those on the back of the head; naso-rostrals in contact; rostral  $1\frac{1}{2}$  to 2 times broader than deep, not entering the nostril; seven, rarely eight, upper labials, and six, rarely seven, lower labials, the first upper labial only very slightly separated from the nostril; ventral body-scales somewhat larger than the dorsal; ear opening rounded; four subdigital lamellæ; brownish above, with small dark spots and vermiculations.

*P. pardus Sternf.*,<sup>2</sup> from Warmbad, G.S.W.A., is said to agree with *purcelli* in respect to the rostral, which is twice as broad as deep and bounds the nostril, but differs in the rounded ear opening and the longer snout, which is  $1\frac{2}{3}$  times the diameter of the eye; it differs from *serval* in the larger eye and broader rostral; in *serval* this scute is a little broader than deep and does not enter the nostril.

<sup>1</sup> Boulenger, G. A., 'Ann. S. African Mus.,' v, p. 463.

<sup>2</sup> Sternf., 'Mit. a. d. Zool. Mus. Berlin,' 1911, p. 398.

## EXPLANATION OF PLATE XXXIX,

Illustrating Mr. John Hewitt's paper, "Description of *Heleophryne natalensis*, a New Batrachian from Natal; and Notes on Several South African Batrachians and Reptiles."

FIG. 1.— $\times 2$ . *Heleophryne natalensis* *sp. n.* Young frog.

A. Ventral view, smooth surface.

B. Dorsal view; *e.* eye; *n.* nostril; *s. f.* sigmoidly curved fold hiding tympanum.

FIG. 2.— $\times 15$ . *Heleophryne regis* *Hewitt.* Ventral view, granulated surface.

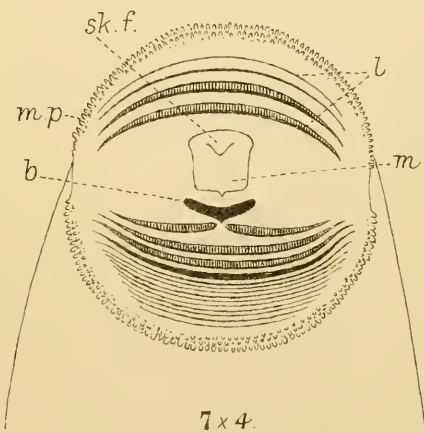
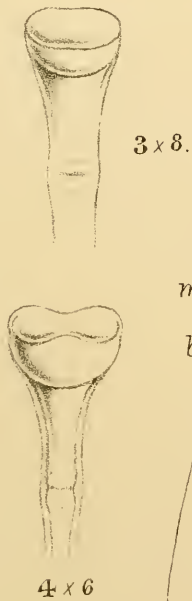
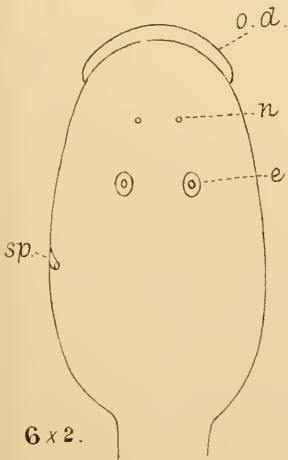
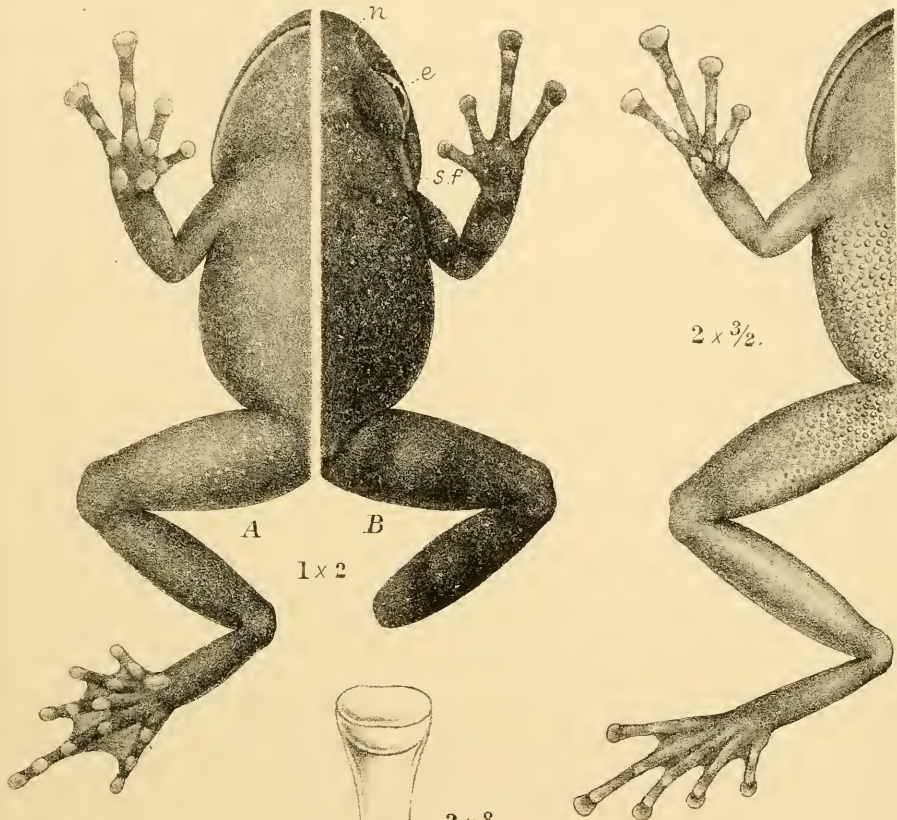
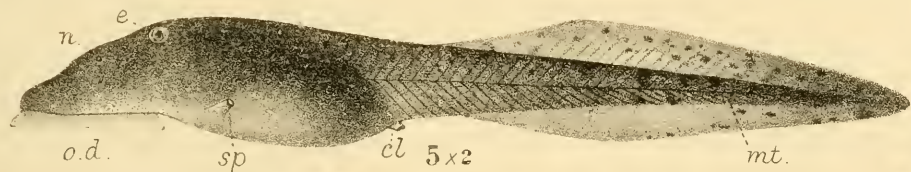
FIG. 3.— $\times 8$ . *Heleophryne natalensis.* Ventral view of distal end of third finger.

FIG. 4.— $\times 6$ . *H. regis.* Ventral view of distal end of third finger.

FIG. 5.— $\times 2$ . *H. natalensis.* Side view of tadpole; *cl.* cloacal aperture; *e.* eye; *mt.* myotomes of tail; *n.* nostril; *o. d.* oral sucker; *sp.* spiracle.

FIG. 6.— $\times 2$ . *H. natalensis.* Dorsal view of front portion of tadpole.

FIG. 7.— $\times 4$ . *H. natalensis.* Oral sucker of tadpole viewed ventrally; *b.* beak; *l.* labial rows of teeth; *m.* mouth; *m. p.* marginal papillæ; *sk. f.* skin-fold projecting downwards within the oral cavity.



Hewitt & Green del.

J.Green lith.

HELEOPHYRNE NATALENSIS sp.n. Figs.1, 3, 5-7.

H. REGIS Hewitt, Figs. 2, 4.



**An Ecological Survey of the Midlands of Natal,  
with Special Reference to the Pietermaritz-  
burg District.**

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With Plates XL-XLVI and Map.

CONTENTS.

	PAGE
INTRODUCTION . . . . .	485
I. REGIONAL FACTORS:	
1. EDAPHIC FACTORS . . . . .	489
2. CLIMATIC FACTORS . . . . .	494
3. INFLUENCE OF MAN . . . . .	495
II. PLANT FORMATIONS AND ASSOCIATIONS:	
1. VELD FORMATION . . . . .	502
2. BUSH FORMATION . . . . .	516
3. THORN VELD FORMATION . . . . .	523
4. ROCKY HILLSIDE FORMATION . . . . .	526
5. ALPINE FORMATION . . . . .	529
6. VLEI FORMATION . . . . .	532
7. PLANT FORMATIONS OF THE STREAMS AND RIVERS . . . . .	535
8. PLANTATIONS . . . . .	537
GENERAL SUMMARY . . . . .	539
EXPLANATION OF MAP AND PLATES . . . . .	543

INTRODUCTION.

IN the year 1912 the author<sup>1</sup> wrote a general account of the vegetation of Natal, and that paper is introductory to the

<sup>1</sup> Bews, J. W., "The Vegetation of Natal," 'Annals of the Natal Museum,' vol. ii, p. 233, 1912.

present one, in which a more detailed œcological survey of this Province is commenced.

In the first part of the former paper the various factors that influence plant life in Natal—geological structure, soil conditions, rainfall, mists, temperature, light, winds, fire, and animals—were described and discussed. Even in the comparatively small area especially dealt with in the present paper most of the types of plant formation determined by these factors are found. In a general paper which deals with the vegetation of a whole country, most attention is naturally paid to the climatic factors, but when a detailed analysis of the various plant associations in a limited area is the object in view, the edaphic factors are of most importance. Consequently in this paper more attention has been paid to the latter. At the same time it is well to keep in mind how greatly the edaphic factors are themselves influenced by the climatic factors, and nowhere can this be better seen than in Natal.

The new industry of wattle growing has of late years led to very extensive interference with the natural vegetation. Stock farmers are also finding that certain foreign grasses are very well suited to conditions in Natal, remaining green and succulent when the natural veld grasses are dry and withered. It is extremely probable that in a few years comparatively little of the original veld will be left. It is therefore all the more important that an œcological survey should be completed with as little delay as possible. The area described in this paper is representative of the large midland section of Natal. The writer hopes in the near future to survey the coast belt, and the mountainous region of the Drakensberg.

The aspects of plant œcology that constitute a prominent feature of the work of H. C. Cowles and F. E. Clements in America, and C. B. Crampton in Scotland, namely the study of the influence of topography and physiography on the vegetation, have influenced to a certain extent the direction which the present work has taken. The conception of

stability and instability in the habitats, and in the plant formations, has been found useful for obtaining a broad grasp of the essential features of the vegetation in any defined area.

At first the grass associations of the veld, varying and changing as they sometimes do every few yards, appeared hopelessly confusing. Nevertheless, where definite plant associations were found to cover an area of any size, and the conditions were carefully examined, it was always found that they were more or less uniform over that area, and this uniformity was the result of a comparatively stable topography. Also, where great variation in the plant associations occurred, it was always seen that there was an equally great variation in the soil conditions, brought about by the fact that soil transportation and denudation were going on with greater rapidity. To put it briefly, the more definite types of plant formation occupy the geologically stable and more or less even ground, while the more variable types are found on the broken ground. It is therefore possible to distinguish in the veld formation (using the nomenclature adopted by the ecologists mentioned above) a subformation of relative stability—in natural veld it mostly consists of a single, almost pure association of *Anthistiria imberbis*—and a subformation of relative instability made up of a variety of associations. It is well to keep in mind, however, the fact that these terms are purely relative. In Natal, where surface changes are proceeding everywhere with extreme rapidity, what has been called stable formation might be regarded as unstable if compared with similar formations in other countries.

It must, of course, be admitted that though these terms are useful for stating certain facts in a concise form, yet as far as real explanation goes they do not take us very far. Geological changes only lead to alterations in the vegetation in so far as they change the physical and chemical characters of the soil, or the environment of the plant as a whole. Further advance in the study of plant ecology is only likely to be made as a fuller knowledge of the environmental factors—

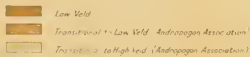
and in particular of the physical properties of the soil—is gained, together with an experimental knowledge of the reaction of plants to these factors.

The writer has been fortunate in being stationed in a country where no previous ecological work has been done, and where the extremely varied natural conditions have led to an equally varied vegetation. Though there is in Natal abundance of opportunity for ecological work, yet there are many corresponding difficulties. The only available systematic work dealing with the flora in Natal is the 'Flora Capensis,' which is not yet completed, and the earlier parts dealing with the natural orders Ranunculaceæ-Campanulaceæ were published by Sonder and Harvey in 1859-1865. Since that time a large number of species have been described in various botanical journals and publications, to which it is difficult for anyone working in South Africa to have access. The greatest difficulty has therefore been the preliminary floristic work. It has been thought better always to omit any doubtfully determined species, so that most of the lists of "associated plants," etc., might be extended, though, it is hoped, not to any very great extent.

A further difficulty was the fact that no topographic maps of Natal are published. For the map which accompanies this paper the "Farm Survey" map (scale 1 in. to a mile) was used as a basis; but no altitudes were given, and it was often extremely difficult to fix the proper limits of certain formations.

In connection with the map which accompanies this paper the writer is greatly indebted to Mr. A. Hammer, Government Surveyor, Natal, who has a very thorough acquaintance with the topography of this Province, and has kindly caused the map to be re-drawn in his office, and has supplied the necessary information with respect to altitudes and other details.

# VEGETATION MAP OF THE PIETERMARITZBURG DISTRICT



Scale 1/4 inch to a mile



## I. THE REGIONAL FACTORS.

## 1. EDAPHIC FACTORS.

The area dealt with in this survey includes roughly about 450 square miles, and may be taken as typical of the Midlands of Natal.

The rising ground to the west of Pietermaritzburg is composed of Coal Measure Sandstones and arenaceous shales (high veld). On the lower ground to the east, Ecca Shales are exposed and mostly lie very near to the surface (low veld). Below these is the Dwyka Conglomerate exposed at various places near Pietermaritzburg (low veld). To the extreme east of the area surveyed Table Mountain Sandstone appears (high veld or transitional).

The whole area is cut through everywhere by dolerite dykes and sills, and the weathering of these adds greatly to the fertility of the soil.

While it is not difficult to find plants that are characteristic of each of these geological formations, yet any attempt to base any Œcological classification on them must necessarily fail, since the other factors—which in Natal are especially important—must be taken into account. It is well also to keep in mind the fact that the soil may bear little or no relationship to the rocks immediately underneath. This is particularly the case in the low veld.

Of course the general topography of a country is determined ultimately by the geological structure, and it is hoped that throughout this paper due attention has been given to the influence of topography in determining the plant formations.

The general positions of the various geological strata have been marked on the vegetation map. The detailed explanation of the map is given at the end of this paper.

The area is drained by the Umgeni river and its main tributary, the Umsindusi. As in all other parts of Natal, denudation is going on with extreme rapidity. The area forms a portion of the second main terrace, but the Zwaartkop

mountain rises to the level of the third, and, on the other hand, the Umgeni and Umsindusi rivers have cut down through the terrace. They and their numerous tributaries have produced a system of hills and ridges with valleys between, giving as a result the very broken type of topography that is characteristic of Natal as a whole. Parts that are at a higher level are under conditions that differ widely from those which obtain at a lower level.

#### (1) High Veld Region.

If we select any of the broader ridges or more rounded hills where the ground is flat as compared with the rest of the region, we find that a considerable depth of soil has accumulated, and it is not being very rapidly transported to lower levels. It is the natural product of the disintegration of the rocks underneath. It is loose and well aërated, and the iron (which is so abundant in all Natal soils) exists in the form of the higher oxides, giving a red colour to the soil. Its mechanical properties are distinctly good. It is either loose or medium in texture, and not too dry, except for a short time during the dry season, when it often forms a fine dust, which is blown down into the valleys. This high veld region receives a much higher rainfall than the low veld; the soil is consequently leached and the soluble salts are dissolved out of it. It is a poor soil chemically, since analyses show a scarcity of lime and phosphates. The grass here grows tall with *Anthistiria imberbis* dominant. Much of this type of soil in the area under consideration has now been planted with wattle. This first type is the most stable of the high veld region.

On steeper slopes there is, as is to be expected, much less uniformity in the soil conditions. In some places the bare rock may be exposed, while in others a great depth of soil may have accumulated more or less temporarily. Some of the slopes are much more rocky than others. If a dolerite sill is exposed the slope may be covered by large blocks of dolerite, and the soil accumulates behind them. There are all

gradations between smooth slopes and those where the ground is very broken. The vegetation varies accordingly. On all the slopes soil transportation is going on rapidly, and the plant associations are very mixed.<sup>1</sup> There is a much greater variety of veld grasses (*Andropogon* associations mostly) as well as associated plants. But the types of plant formation on these slopes do not depend entirely or even mainly on edaphic factors. The climatic factors are equally important. The south-eastern slopes, since they face the rain-bearing clouds and are sheltered from the hot dry winds of the north-west, are often covered with bush, and when this is the case soil transportation is checked, and we get a distinctly stable type. On the other hand, the northern slopes, being fully exposed to the hot winds, are often bare and rocky, and so much so that the grasses cease to be dominant and we find instead various xerophytic trees and shrubs (rocky hillside formation). The two sides of the hill, therefore, are found to differ markedly in soil conditions and in plant formations. These differences are brought about by the large rainfall, the fact that climatic factors are unfavourable to the close type of bush formation on the northern side, and the consequent greater amount of soil transportation on that side.

At the upper end of the valleys of the streams and smaller tributaries we often find bush (close type) if the exposure is towards the south or south-east. In many such valleys, however, the bush has been destroyed and other plant associations replace it. In stream-valleys that have not the proper exposure for bush, the sides of the valley are grassland (*Andropogon* association), while the stream-channel is bare and rocky. When a stream reaches more level ground it frequently spreads itself out so as to form a marsh or vlei, and we may find a series of them along its course.

At the foot of the slopes where drainage is checked there is frequently an iron-pan formation. Iron salts carried down in solution (in the form of the bicarbonate probably) are deposited as oxide of iron when the water dries up, as it does

<sup>1</sup> *Loc. cit.*, p. 258.

during the dry season. Iron salts may also be precipitated by coming into contact with other salts, but this process does not seem so likely in the case of the iron-pan formation in Natal. The soil becomes cemented together by the precipitated iron oxide (limonite). The iron-pan thus formed is known as "oud klip" or "ou klip" in South Africa. The limonite is formed below the surface, but it is frequently exposed if subsequently washed bare of surface soil, and then the ground is covered by masses of the ironstone gravel. The soil drainage is interfered with by this hard layer of limonite. Water cannot rise through it from below nor sink through it from above. Sometimes, however, it is porous and this result does not follow.

The characteristic vegetation of such iron-pans may be described in this place instead of later. They may be recognised from a long distance by the white covering of *Helichrysum aureo-nitens*. It is a very xerophytic plant with a white woolly covering of hairs. *Lobelia decipiens* is another characteristic species, and *Drosera burkeana* is often present.

## (2) Low Veld Region.

In the main valleys of the Umgeni and Umsindusi the conditions are markedly different from those of the high veld region. In some places the rivers have cut down very steeply, leaving rocky slopes, and even cliffs (see Pl. XLII); in other places broad alluvial flats are formed (see Pl. XL). The valleys as a whole are only a degree less rugged than the higher regions.

The alluvial soil of the river flats is a hard, dry, compact clay, much richer chemically than the soil of the high veld, but badly aerated. The iron it contains exists as the protoxide ( $\text{FeO}$ ). There is a certain amount of organic matter mixed with the clay, and the soil is dark in colour. Nodules of precipitated limonite are abundant in places. Lime is also re-deposited in the same way, but in Natal (at least in the

area being considered) we do not get lime-pans such as occur in other parts of South Africa. The lime forms nodules of impure limestone. Sometimes, as was shown by a few rough analyses, magnesium is mixed with it, and the nodules are impure magnesian-limestone.

Above the river flats the sloping ground is covered by a shallow layer of soil, hard, dry and baked, yet at the same time chemically rich owing to the constituents derived from the dolerite rocks above it. This type extends up to the belt which is transitional to the high veld—the higher slopes where soil transportation is most rapid.

Over the whole of this low veld, *Anthistiria imberbis* is again the dominant grass, though its form differs from the high veld variety.

In the parts of the low veld region where the rivers or their tributaries have cut through steeply, the broken character of the ground produces again much greater variation and unstable types. On the steepest slopes the grasses cease to be dominant, and we get the most xerophytic of all the plant formations in this area, or, indeed, in the whole of Natal—Euphorbias, aloes and succulent plants—the rocky hillside formations of the low veld region. There are gradations between this and the grassland areas. *Andropogon* species again form the grassland associations on the stony slopes.

The most striking character of the low veld region is the entire absence of the close type of bush found higher up. It is replaced by thorn trees. These grow isolated or in small clumps dotted over the veld, giving a characteristic park-like appearance, especially on the alluvial flats. Their growth forms are, as we shall see, well adapted to the conditions under which they grow.

So far prominence has been given to the influence of topography on the vegetation. The soil is being washed and blown down from the higher to the lower levels, and this process is taking place faster on the slopes, the rate depending on the steepness of the slopes. On the more level ground, both in the high veld and in the low veld region, the

conditions are more stable and the plant formations are consequently more definite.

## 2. CLIMATIC FACTORS.

In the case of the climatic factors there is an equally great variation, and they are equally important. These have been more fully dealt with in the preliminary paper already published, so in this place the following summary will suffice.

The high veld region receives much more deposition of moisture, both in the form of rain and mist; its southern and south-eastern slopes are sheltered from the dry, hot winds which always blow from the north or north-west; it does not have such extremes of temperature, being cooler during the day and warmer during the night, cooler in summer and warmer in winter; it suffers comparatively little from frosts, especially inside the bush.

The low veld region is very dry, for the rain-bearing clouds tend to pass over it without depositing much of their moisture until they strike the hills. During the winter—when there is usually a still atmosphere—the cold air sinks into the valleys, and the temperature is therefore lower than on the hills; a cold frosty mist forms at night over the low veld.

These climatic factors not only affect the vegetation directly, but they also influence the edaphic factors. Since the higher regions receive more rain, the soils are more leached, and transportation of soil is greater. At the higher regions the soil water dissolves salts from the soils. At the lower levels accumulation of alluvium takes place, and there is also chemical precipitation. As a result the high veld soil is poorer chemically, but richer mechanically than the low veld soil.

In the end of winter, when everything is very dry, the hot dry winds blow down the fine dust from the higher regions to the lower. After the grass is burned the ashes are also blown down in the same way, and this must lead to a further impoverishing of the high veld soil and a corresponding enriching of the low veld.

## 3. INFLUENCE OF MAN.

The high veld is the wattle region. The loose well-aërated soil, with its high percentage of the higher oxides of iron, the high rainfall and the frequent presence of mist-clouds, is well suited for the growth of this tree (*Acacia mollissima*). It is a tree which demands a great deal of water, and the drainage is modified in the neighbourhood of wattle plantations. Vleis are often completely dried up.

The low veld is the mealie country. The mealie (maize) demands a richer soil than that of the high veld, but when the low veld soil is ploughed up and aërated it is found to be very good for the growing of maize. Some farmers can raise crops on the same soil every year, and get a good yield. Others find that their soil requires artificial manures to obtain an annual crop. Still others pursue successfully the following method. After one crop is obtained the soil is ploughed up and allowed to remain fallow for either one or in some cases two years, and it is then again cropped. This practice is continued indefinitely. It is unnecessary in this place to enter into the question of whether this is a case of "soil exhaustion" or "soil sickness." At any rate there is, as is to be expected, a good deal of variation in respect to richness in chemical salts in the low veld soil.

Of course the cultivation of the land leads to a complete change in the vegetation, but there is much interest in observing the various weeds (many of them exotic) which come into such cultivated land, as well as the way in which, if left alone, it reverts to veld.

Though the direct influence of man is very great and can be most easily seen, his indirect influence has been even greater.

During the last year or two, owing to East Coast fever, few cattle have been kept in this district, but when great herds of cattle roamed over the veld they affected both vegetation and soil. The manner in which they influenced the vegetation is of course obvious, but the effect on the soil

requires more explanation. When water, as is usually the case, was only obtainable at some particular place or places, cattle tracks were formed to those spots. These, in course of time, became water channels, and very quickly formed ravines or dongas. Farmers are now more careful not to allow the cattle to form such tracks.

Sheep and goats, where allowed to graze indiscriminately, nibble young trees, and thus affect the bush also.

But it is through the agency of fire that man's indirect influence has been greatest. The veld is being changed and the bush is being destroyed. A considerable amount of attention has been given by the writer to tracing out the various stages of retrogression in the bush—a question of great economic importance.

Fires rarely originate inside the bush, except by deliberate intention. The natives formerly burned down much of the bush to form mealie patches. For a year or two such patches, enriched by the ashes, would yield good crops, but the soil is not a rich one naturally, and so very soon the process had to be repeated. This is a very primitive (probably the most primitive) method of agriculture. It explains why the native kraals and mealie patches cluster round the large forests. This procedure has continued until many of the large forests in South Africa have entirely disappeared. Were it not for the fact that the present native races have not occupied Natal for very long, and the more primitive races were not agricultural, nor very numerous, the destruction would have been still greater than it has been.

The bush was often set fire to by the natives, and also by the early white settlers, in order to drive out game.

A native method of felling trees is to light a fire round the base and allow it to smoulder until the tree comes down. Such fires might sometimes spread and destroy portions of the bush.

However, all this has probably not led to such extensive destruction of the bush as the grass fires outside the bush. When the grass is very dry, as it always is at the end of the

dry season, and a strong wind is blowing, a grass fire will sweep into the bush and destroy the trees around the margin. Next year the dry and half-burnt trees burn still more readily, and scorch another belt. This goes on, and the grass fires gradually eat into the bush. After a time all that remains is a number of patches in the ravines and on the steeper slopes, where the conditions are such that the fires have less effect.

The grass fires also affect the thorn veld, where the trees grow isolated in a park-like manner. The young thorn trees are destroyed by the fire, and only a few manage to survive, until they grow tall enough to be able to offer a successful resistance. It is this chiefly that leads to their growing so far apart. The very thick bark of certain trees in the thorn veld helps them to withstand fire.

The effect of grass-burning on the veld itself will be described more in detail later when the separate grass associations are dealt with, but here it may be pointed out that when the grass is burned early before it has properly withered, it leads to direct changes in the composition of the grass associations, since certain species are less able to withstand it than others. On the other hand when the grass is burned in late winter after it is withered the ground is left bare, and when the first heavy rains come the soil is more affected. It is washed away more readily because it is unprotected by any covering of vegetation. This fact is of importance as helping to explain the extremely rapid rate of denudation, and the formation of those numerous ravines or dongas on the hillsides.

The practice of burning the grass has been carried on for many hundreds of years by the native. When Vasco de Gama landed in 1497 he gave the name Terra de fume to South Africa.

Apart from fires there has been much reckless destruction of the bush by the white man cutting out the more valuable timber trees. The native is still more responsible. In forming the framework of his huts he has used millions of young

trees, always carefully selecting the more valuable kinds. He has also cut down and carried away much of the bush for firewood.

The complete destruction of such large areas of forest and the continuous burning of the grass are probably not without an effect on the climate of South Africa. There are certain facts that seem to point to a slow change in the direction of greater dryness. The Karroo formation is extending eastward and gaining on the veld. There seems to be a general opinion that the rivers of South Africa do not now carry so much water as they did within the memory of man, though such vague testimony is, of course, of little scientific value. Actual figures for rainfall have not been recorded long enough or with sufficient regularity to afford any basis for a very definite conclusion on the matter.

In Natal the rain-bearing clouds coming in from the Indian Ocean, after they have passed over the coast-belt, deposit moisture chiefly on the south-eastern slopes of the high veld region on each terrace. The natural vegetation of these slopes is bush, though since so much of it has been destroyed, it occurs now only in places. A slope that is covered with bush receives more rain than the same slope when the bush has been replaced by veld, because bush is always cooler and therefore precipitates more of the moisture. In the same way to a less extent a slope that is covered with tall grass will receive more deposition of moisture in the form of mist and dew than after the grass has been burned, leaving the ground bare.

The general effect therefore of the destruction of bush and burning of veld in Natal is to lessen the rainfall. It may be assumed that the rain-bearing winds tend to carry more of their moisture over Natal and on to the inland plateau, but it does not follow that the rainfall there is increased, for after the Drakensberg is crossed the remaining moisture may easily be retained and carried right across the heated interior.

The planting of wattle to replace the natural bush has not quite the same result as if the bush had been preserved, for

*Acacia mollissima* is a tree of very rapid growth, and it uses more water from the soil than it aids in precipitating. At the same time it does lead to precipitation, and the air, having lost its moisture, naturally rises, so that more moisture-laden air comes in from the sea to take its place. The large wattle plantations, therefore, though they do lead to a very noticeable drying up of the soil, ought at the same time to increase the rainfall, and have a good effect on the climate generally.

The change in the climate—its increasing aridity—doubtless brought about largely through the influence of man in interfering with the natural vegetation (though of course other causes may be at work), may well in turn have a direct effect on the vegetation. The destruction of forest may in the first instance have led to lessened rainfall, and now the lessened rainfall may cause a progressive decay of forest, as well as to the more xerophytic formations gaining on the mesophytic.

It is interesting therefore to note how all these factors interact and affect one another, as well as react on the vegetation.

The climate affects the vegetation; interference with the vegetation affects the climate; the climate affects the soil; the soil affects the vegetation; interference with the vegetation affects the soil; and the more one studies plant œcology the more one is convinced that man is the disturbing factor affecting them all.

## II. THE PLANT FORMATIONS AND ASSOCIATIONS.

At first it seemed possible to adopt a strictly regional system of classification, dividing the area into a high veld region and a low veld region. In the grassland there is a very distinct difference between the two regions, and in the close bush type of the high veld region and the isolated thorn tree type of the low veld region the difference is even greater.

In other formations, however, the distinction breaks down. In the case of the vleis there is no marked division into high veld type and low veld type. The *Andropogon* associations, which are characteristic of the broken ground, occur in both regions, as well as being typical of the transitional belt between the two.

Marshes and aquatic formations *ceteris paribus* show this feature everywhere, e. g. in Scotland; so does broken ground, i. e. collections of unstable formations. Mere altitude, though it has often been adopted, is always a weak basis of classification, and cannot be rigidly adhered to. A topographical system—plateaux, slopes, upper and lower stream valleys, rocky hillsides, etc.—is much better, and this has been largely used. The “plant communities” themselves have been made the primary basis of classification.

The plant formations and associations will be dealt with in the following order:

## 1. THE VELD FORMATION.

### (1) HIGH VELD.

- (a) *Anthistiria imberbis* dominant.
- (b) *Anthistiria imberbis* dominant. *Andropogon ceresiæformis* sub-dominant.
- (c) Associated plants of the high veld.
- (d) *Andropogon* associations (unstable habitat, transitional to low veld, bush and vlei).

### (2) CHANGED HIGH VELD.

- (a) *Aristida junceiformis* dominant.
- (b) *Eragrostis curvula* dominant.
- (c) *Cynodon dactylon* dominant.

### (3) LOW VELD.

- (a) *Anthistiria imberbis* dominant.
- (b) *Andropogon hirtus* dominant.
- (c) *Andropogon schœnanthus* dominant.
- (d) *Andropogon pertusus* dominant.
- (e) Grass associations on stony hillsides.
- (f) Associated plants of the low veld.

- (4) CHANGED LOW VELD.
  - (a) *Sporobolus indicus* dominant.
  - (5) WEEDS OF CULTIVATED LAND (unstable habitat).
2. THE BUSH FORMATION.
  - (1) CLOSE BUSH (MIDLAND TYPE).
  - (2) SMALLER SCATTERED BUSHES (ROCKY STREAM BUSH).
  - (3) BUSH CLEARING.
3. THE THORN VELD FORMATION.
4. THE ROCKY HILLSIDE FORMATION.
  - (1) HIGH VELD REGION.
  - (2) LOW VELD REGION.
5. ALPINE FORMATION.
6. THE VLEI FORMATION.
  - (a) *Andropogon* associations.
  - (b) *Setaria aurea* dominant.
  - (c) *Eragrostis nebulosa* dominant.
  - (d) *Phragmites communis* dominant.
  - (e) *Leersia hexandra* dominant.
  - (f) *Erianthus capensis* dominant.
  - (g) *Cyperus* associations.
  - (h) *Typha capensis* dominant.
  - (i) *Marsilia macrocarpa* dominant.
  - (k) Mixed associations.
7. PLANT FORMATIONS OF THE STREAMS AND RIVERS.
  - (1) HIGH VELD REGION.
    - (a) Rocky stream bush.
    - (b) Bush-clearing.
    - (c) *Andropogon* associations.
    - (d) Plant formation of stream valleys not facing south.
    - (e) Vleis.
    - (f) Plants of the moist fringing zone.

## (2) LOW VELD REGION.

- (a) *Pennisetum unisetum* dominant.
- (b) *Phragmites communis* dominant.
- (c) *Cyperus* spp. dominant.
- (d) Vlei grasses dominant.
- (e) Trees and shrubs of the river side.

## 8. PLANTATIONS.

- (1) WATTLE (*Acacia mollissima*).
- (2) BLUE GUMS (*Eucalyptus globulus*).
- (3) PINES (*Pinus insignis*, *P. pinaster*).

## 1. THE VELD FORMATION.

## (1) HIGH VELD.

(a) *Anthistiria imberbis* is the most important grass in both types of veld (high and low), though its general habit is very different in each. In the high veld it always flowers, and its flowering culms are two or three feet high, so that in autumn the growth of grass on the high veld is much more rank than on the low veld. Its reddish-brown spathes give a characteristic colour to the landscape, and the type is known to the farmers as red veld. The high veld is also sometimes spoken of as sour veld, not from any acidity in the soil, since analyses show that practically all Natal soils are neutral, but apparently because, when the grass grows rank and tall, the cattle do not care to eat it, and also in contra-distinction to the low veld, which is known as sweet veld.

The habitat has already been described. The soil is of the loose, well-aërated type, but poor in chemical properties. Where it is fairly uniform and of sufficient depth, *Anthistiria imberbis* alone is dominant. Other grasses and associated plants occur very sparsely mixed with it. As a general rule the purer the *Anthistiria* association, the more stable the topography. This association covers all the more level ground and gentle slopes in the high veld region.

(b) *Anthistiria imberbis* dominant and *Andropogon ceresiæformis* subdominant occur frequently over fairly large areas. In such cases the soil is not so deep, and the *Andropogon ceresiæformis* grows on the poorer patches. Its reddish spathes are even more conspicuous than those of the *Anthistiria*. Sometimes there is a complete intermingling of the two species.

As the ground becomes more uneven, and consequently the soil conditions less uniform, the other grasses, which occur sparsely scattered through these two associations, become more abundant, and the stable types pass into the *Andropogon* associations which occur on the slopes. Early in spring, when the grass of the previous year has been burned off, the following grasses appear :

*Tristachya leucothrix*, *Axonopus semialatus*, *Eragrostis brizoides*, *Kœleria cristata*, *Panicum ecklonii*, *P. serratum*.

Later on, growing and flowering with the dominant species, we get the following :

Numerous species of *Andropogon* (to be described later), *Aristida junciformis*, *Eragrostis curvula*, *E. chalcantha*, *Harpechloa capensis*, *Digitaria eriantha*, *D. diagonalis*, *D. ternata*, *Setaria nigrirostris*, *Setaria imberbis*, *Microchloa caffra*, *Panicum lævifolium*, *Pollinia villosa*, *Paspalum distichum*, *Eleusine indica*, *Elionurus argenteus*, *Tricholœna rosea*, *T. setifolia*, *Chloris pycnothrix*.

All the above are fairly common.

The following are rather rare :

*Rottbœllia compressa*, *Sporobolus centrifugus*, *Festuca scabra*, *Panicum natalense*, *Eragrostis chloromelas*.

The Cyperaceæ as a whole are found mostly in the vleis, but the following are veld species :

*Ascolepis capensis*, *Mariscus capensis*, *Bulbostylis cinnamome*, *Cyperus compactus*, *Carex dregeana*.

(c) Associated Plants of the High Veld.—Of the other associated plants the following list may be taken as typical of the area under consideration. They grow here and there scattered through the grass. A few of them flower immediately after the grass is burned, often in the middle of the dry season. The burning of the grass seems to act as a stimulus to them, and a day or two after the grass has been burned they may be found dotted over the surface of the blackened ground. In this class are the following:

*Gazanea longiscapa*, *Gerbera* spp., *Moræa spathacea*, *Scilla* spp., *Cyrtanthus angustifolius*, *Senecio pterophyllus* var. *apteris*, *Senecio* spp., *Hydrocotyle centella*.

The others may be divided into spring-flowering plants and autumn-flowering plants. The former class includes many of the bulbous plants. Their flowering is over before the grass grows tall enough to shade them. The autumn-flowering are the taller forms that rise above the grass. The distinction, of course, is not a very rigid one, for the late-flowering spring plants mix more or less with the early-flowering autumn plants, and some species flower throughout the summer (rainy) season. There is, however, a definite falling off in the number of species found in flower towards midsummer.

The following list, though of considerable length, is probably not nearly complete even for this area; but it will give a good idea of the great variety of associated plants occurring in the veld. As far as possible the months of flowering are indicated after each.

The relative abundance of the various species cannot be readily ascertained, and a special investigation into this subject would be necessary. It was thought, however, that it would be of interest to indicate by an asterisk the more abundant species.

*Heliophila virgata* (10), *Ionidium capense* (10-12), *Polygala hottentota* (2-6), *Muraltia pilosa*\*, *Mahernia erodioides* (1-4), *M. saccifera*\* (4), *Linum thun-*

*bergii* (11-1), *Pelargonium aconitifolium*\* (1-4), *Oxalis pulchella*\* (8-10), *O. semiloba* (1-4), *Rhus discolor* (7-8), *Lotononis corymbosa*\* (12), *L. eriantha* (12), *L. prostrata* (10), *Crotalaria globifera* (8-2), *C. lanceolata*, *C. natalitia*, *C. capensis*\*, *Argyrobium stipulaceum* (10), *A. uniflorum*, *A. rupestre*, *A. sp.* (sp. nov. ?), *Psoralea pinnata* (12) (in wet places), *P. caffra*\*, *Indigofera arrecta*\* (3-5), *I. dimidiata* (11), *I. fastigiata*, *I. rostrata* (12), *I. tristis* (3), *I. spp.*, *Tephrosia longipes* (12-2), *T. macropoda* (2), *T. polystachya* (10-4), *Desmodium hirtum*, *Cassia mimosoides*\* (10-4), *Eriosema kraussiana*\* (10-5), *E. distinctum*\*, *Hoffmanseggia sandersoni* (3-4), *Cliffortia spp.*\*, *Crasula spp.*\*, *Kalanchoe thyrsiflora* (8), *Drosera burkeana* (in moist spots), *Eugenia albanensis* (8), *Hydrocotyle centella*\* (8-3), *Alepidia amatymbica* (7-9), *Spermacoce natalensis*\* (3), *Pentanisia variabilis*\* (8-4), *Oldenlandia amatymbica* (10), *Vangueria pygmaea*\* (8), *V. sp.*, *Scabiosa columbaria* var. *dissecta*\* (10), *Ethulia conysoides* (8-10), *Vernonia kraussii*\* (9), *V. natalensis*, *V. hirsuta*, *V. dregiana* (in moist places)\*, *V. corymbosa* (2-5), *Aster asper*\* (4), *Nidorella auriculata*\* (4), *Conyza pinnatilobata*\* (11), *Gnaphalium luteo-album*\* (7), *Amphidoxa gnaphaloides* (11), *Helichrysum adenocarpum*\* (4), *H. appendiculatum*\*, *H. argyrolepis*, *H. fœtidum*\*, *H. fulgidum*\*, *H. knebsianum*, *H. latifolium*\*, *H. aureonitens*\*, and several other species\*, *Athanasia acerosa*\* (4), *Artemesia afra* (5), *Cineraria sp.* (8), *Senecio juniperinus*\* (4), *S. bupleuroides* var. *latifolius*\*, and spp.\*, *Cryptostemma calendulaceum*\* (8), *Gazanea longiscapa*\* (5-10), *Berkheya setifera* (11), *B. sp.* (*Stobæa*) *echinopoda*\* (2), *B. sp.* (*Stobæa platyptera*)\* (2), *Lactuca capensis*\* (10-4), *Gerbera kraussii*\*, *G. aurantiaca* (4), *Lobelia erinus*\* (6), *Wahlenbergia zeyheri*\* (5), *W. sp.*, *Royena sp.*\* (7-8), *Jasminum multipartitum*\* (10-1), *Sebæa sedoides* (1), *S. crassulæfolia*\* (1),

*Cynoglossum* sp. (9), *Ipomæa simplex* (11-12), *Convolvulus* sp.\* (8-4), *Solanum capense*\* (8-4), *Withania somnifera*\* (2-3), *Nemesia* sp.\* (8-4), *Striga lutea*\* (3), *S. spp.*, *Sopubia cana* (in moist places) (4), *Bopusia scabra* (4), *Diclis reptans*\* (8-6), *Cyrenium adonense*\* (8), *C. racemosum*\* (10), *Ceratotheca triloba* (4), *Thunbergia hirtistylis* (4), *T. atriplicifolia* (4), *Blepharis* sp.\* (8-12), *Justicia* spp.\* (8-4), *Hebenstreitia* spp.\* (8-4), *Selago* spp.\* (8-12), *Lantana* sp.\* (11-12), *Lippia asperifolia*\* (2-4), *Ocimum obovatum*\* (6-8), *Plectranthus* spp.\* (12-4), *Hyptis pectinata*\* (3-5), *Stachys* spp.\* (8-12), *Leonotis leonurus*\* (2-6), *Salvia* spp.\* (8-12), *Ajuga ophrylis*\* (4), *Amarantus painculatus* (2), *A. thunbergii* (2), *Phytolacca stricta*\* (12), *Oxygonum dregeanum* (9), *Rumex ecklonianus* (2-3), *Lasiosiphon kraussii*\* (9), *L. sp.*, *Gnidia* spp.\* (10-4), *Thesium* spp.\* (8-3), *Euphorbia helioscopia*\* (8-10), *E. natalensis*\* (2), *Dalechampia capensis*\* (2), *Cluytia pulchella*\* (7), *Adenocline serrata*\* (10), *Jatropha hirsuta*\* (10), *Raphionacme divaricata*\* (8), *Schizoglossum flavum*\* (10-12), *S. ciliatum* (8-10), *S. stenoglossum* (8), *Sisyranchus trichostomum*, *Asclepias album* (9), *Eulophia* spp.\* (8-10), *Habenaria* spp.\* (10-12), *Disa* spp.\* (10-12), *Corycium* spp.\* (12), *Brownleea* spp. (1-2), *Brachycorythis* sp. (1-2), *Disperis* sp. (2), *Satyrium* spp.\* (10-2), *Morea spathacea*\* (12), *Dierama pendula* (8), *D. pulcherrima* (4), *Watsonia densiflora*\* (2), *W. meriana*\* (8), *Hesperantha bifolia* (10-1), *Gladiolus eckloni*\* (1-2), *G. woodii* (10), *G. pubescens* (10-12), *G. papilio*\* (1-2), *Acidanthera platypetala*\* (9), *Hypoxis baurii* (8-12), *H. spp.*\* (8-12), *Baphæne disticha*\* (9), *Crinum longifolium*\* (12), *Apodolirion buchanani* (6), *Anoiganthus brevifolius* (6) (moist places), *Nerine* spp. (10-12), *Hæmanthus natalensis*\* (9), *Brunsvigia* sp.\* (9), *B. sp.*\* (1-2), *Asparagus* sp.\* (9-12), *Kniphofia* spp.\* (8-12), *Aloe cooperi* (2), *A. ferox*, *A. saponaria*\* (8), *Eriospermum* spp.\* (8),

*Dipcadi viride* (10-1), *Galtonia candicans* (11), *Tulbagia natalensis* (1), *T. violacea* (10), *T. alliacea* (8), *Albuca pachychlamys*\*, *Eucomis undulata*\* (1), *E. punctata*\* (1), *Scilla lanceæfolia*\* (8-10) and several other species (early flowering)\*, *Ornithogallum* spp. (early flowering)\*, *Androcymbium natalense*\* (9), *Sander-sonia aurantiaca* (11-2), *Commelina* sp.\*, *Richardia albomaculata* (8).

All these numerous associated plants (including the associated grasses) are not at all abundant when *Anthistiria imberbis* is the dominant grass. On the more level ground a pure *Anthistiria* association occurs, but as the topography becomes more and more unstable the associated plants grow more abundantly, till at length on the steeper slopes, where the ground is uneven, but not bare and rocky except in places, the various *Andropogon* species become dominant.

(d) *Andropogon* Associations.—A tambootie association with *Andropogon nardus* var. *marginatus* dominant occurs in the moister spots. Such places are naturally more characteristic of uneven ground. As these patches of tambootie grass become larger the veld passes into vlei.

Other species of *Andropogon* found on the slopes are the following:

*Andropogon dregeanus*, *A. filipendulus*, *A. auctus*, *A. cymbarius*, *A. schœnanthus* var. *versicolor*, *A. appendiculatus*, *A. hirtus*, *A. schirensis*, *A. amplectens*, *A. filifolius*, *A. nardus* var. *validus*, *A. plurinodis*, *A. dichroos*, *A. pertusus*.

Pure associations of these rarely occur, and when they do the clumps and patches are never very large. Usually three or four of the species are found mixed together. They are all more or less similar in habit—coarse grasses, which vary greatly in form according to soil conditions, and grow from one foot up to seven or eight in height. They seem able to adapt themselves to widely varying conditions as regards soil.

The other associated veld grasses very seldom become

dominant, but small clumps of *Panicum*, *Digitaria*, or *Chloris* are found. They are, however, more abundant in the *Andropogon* associations than in the *Anthistiria*. This is still more the case with the other associated plants. They are much more abundant on the slopes. In certain places they oust the grasses altogether, and become dominant themselves. In such cases, however, there is every indication that the natural vegetation is bush, and the bush has been destroyed.

The *Andropogon* associations, occupying the more uneven ground, are sometimes surrounded by the *Anthistiria* associations; but frequently they are transitional to other formations. As already pointed out they are transitional to the vleis, in fact the tambootie association is itself the driest type of vlei.

The *Andropogon* associations are also transitional to the bush. The actual succession will be described later under that heading.

Finally, the *Andropogon* associations are intermediate between high veld and low veld. As one passes down from the *Anthistiria* association of the high veld, the associated plants increase, and the *Anthistiria* association becomes more and more mixed, until the *Andropogon* species are dominant. At the foot of the slopes, transitional to the low veld, the species of *Andropogon* which are found in the low veld become the most abundant (*Andropogon hirtus*, *Andropogon pertusus*, *Andropogon schœnanthus* var. *versicolor*). As soon as the low veld itself is reached, *Anthistiria imberbis* (low veld variety) is again the dominant grass.

## (2) CHANGED HIGH VELD.

As a result of man's interference we find certain changes, which must be noticed next.

(a) *Aristida junciformis* dominant. Over wide stretches, both on the more level ground and on the slopes,

*Aristida junciformis* has almost entirely replaced the other grasses of *Anthistiria* and *Andropogon* species. The change can be seen in progress, and there are all stages between natural veld, with *Anthistiria* etc. dominant, and changed veld with *Aristida* dominant.

Early burning of the grass is the chief cause of the change. If the grass is burned before it is completely withered the *Anthistiria* is more affected than the coarse wiry *Aristida*. The reason why farmers do burn early is to get young shoots next year as soon as possible.

If the grass is burned, as it often is, before the end of the rainy season, a new growth may be obtained even before the winter (dry season) sets in, and the young shoots suffer more than the older ones from the winter frosts and drought. In this connection also *Aristida* is stronger than *Anthistiria*.

The soil, however, as was pointed out, is more affected when the grass is burned late.

The effects of early burning are best seen along the railway. Here the grass is always burned as early as possible, lest sparks from the engine should ignite it later when all the veld grass is withered, and cause disastrous grass fires which, not being controlled, might destroy the wattle plantations. *Aristida junciformis* nearly always lines the railway on either side except in the moister spots, where tambootie association holds the field.

The same *Aristida* association also lines the numerous Kafir paths across the veld, where the *Anthistiria* has been killed by being trodden under foot.

This change from natural veld to *Aristida* association is progressive. Farmers everywhere speak of the consequent deterioration in the veld, for *Aristida* is a worthless grass when compared with *Anthistiria*. To counteract this deterioration *Paspalum dilatatum* (doubtfully native of Natal) is being introduced. It is an excellent grass from the farmers' standpoint, and can hold its own against the natural veld grasses. It also remains more green and succulent

during the dry season. Already wide areas have thus been cultivated, and were it not for the fact that during the last few years the East Coast fever has killed nearly all the cattle in this district, the change would probably have been much greater. With no cattle to eat it, the veld grass has been allowed to grow as it would, and the botanical analysis of it has been all the easier, seeing that it has always been allowed to flower. Now that the regular dipping of the cattle seems likely to stamp out this East Coast or tick fever, the herds will soon increase, and the vegetation will be more and more interfered with and changed.

(b) *Eragrostis curvula* is another coarse wiry species similar to *Aristida* in its habitat. It is not abundant as a pure association, but to a certain extent the same remarks apply to it as to *Aristida*. It is most common along the Kafir paths, and it rarely replaces very large areas of the veld.

(c) *Cynodon dactylon*—a grass largely used for making lawns in Natal—is frequently dominant, or forms practically a pure association over patches of changed veld. It is usually found where a Kafir hut has been, or in places where cattle have been kept and the ground has consequently been manured (“Lair-flora”).

### (3) LOW VELD.

(a) *Anthistiria imberbis* is again the dominant grass over the alluvial flats, and the gently sloping ground above them. The soil is of the dry, hard-baked, clayey type already described. It is compact and badly aerated but richer in chemical salts. The low veld variety of *Anthistiria* is very different in general habit from the same species as it grows on the high veld. In the low veld it is loosely tufted and seldom flowers. When it does so it flowers earlier in the year than the high veld variety. Seeing that flowering culms are not formed except sporadically here and there the grass of the low veld does not grow so tall as that of the high veld.

It has, until it withers, a characteristic bluish colour, hence the name "blue grass veld." The low veld is also known as "sweet veld." These terms, however, are very loosely applied. Any veld where the grass makes a good hay, or where cattle do well, is apt to be termed "sweet veld," and the blue colour of the grass is not quite constant. When it begins to wither the leaves become reddish.

As in the high veld the purer the *Anthistiria* association the more stable the soil conditions. Other grasses occur sparsely mixed with it. Of these associated grasses the following are the commonest:

*Andropogon hirtus*, *A. schœnanthus* var. *versicolor*, *A. amplectens*, *A. pertusus*, *A. auctus*, *A. dregeanus*, *A. schirensis*, *A. plurinodis*, *A. dichroos*, *A. appendiculatus*, *Aristida angustata*, *A. junci-formis*, *Eragrostis curvula*, *E. chalcantha*, *E. brizoides*, *Cynodon dactylon*, *Tristachya leucothrix*, *Sporobolus indicus*, *Chloris petræa*, *C. pycnothrix*, *Imperata arundinacea*, *Panicum* spp., *Digitaria diagonalis*, *D. eriantha*, *D. ternata*, *Eleusine indica*.

With changing soil conditions certain of these become more abundant, chiefly the *Andropogon* species, as in the case of the high veld.

(b) *Andropogon hirtus* grows on the poorer soil. Sometimes it grows on almost bare shale, with only an inch or so of soil. Unlike *Anthistiria* it always flowers, and in autumn such parts of the veld are covered with grass two or three feet tall. Its stems are rather slender, and the spikelets covered with silvery hairs give a characteristic colour to the association.

(c) *Andropogon schœnanthus* var. *versicolor* is very similar in its habitat. The two species often grow intermingled, forming a mixed *Andropogon* association.

(d) *Andropogon pertusus* is a characteristic low veld species (cf. *A. ceresiæformis* in the high veld). It demands looser soil, and is only found where the soil is better aerated than is usual in the low veld. Consequently it is not

very common in natural veld, but it frequently holds the field where the ground has at some time or other been ploughed or dug up.

(e) Grass Associations on Stony Hillsides.—It has been pointed out that in the low veld region, in addition to the alluvial flats and gently sloping ground, there are places where the river and its tributaries have cut down steeply. Such slopes may be so steep that they cease to be veld, and we get the rocky hillside formation described on p. 528. Between this extreme and the typical low veld we get hillsides where the grasses grow in semi-isolated tufts :

*Aristida angustata*, *A. junciformis*, *Andropogon hirtus*, *A. schœnanthus*, *A. spp.*, *Eragrostis chalcantha*, *Crossotropis grandiglumis* are characteristic of such hillsides.

*Anthistiria imberbis* may occur in patches where a fair depth of soil has accumulated, but such patches ought perhaps to be looked on as outliers from the typical low veld association.

It is in its general appearance more than in its composition that this type differs from the others. It becomes a semi-open formation. As the tufts of grass grow further and further apart, it passes into the rocky hillside formation. This type practically always forms part of the thorn veld, the trees of which are described later.

(f) Associated Plants of the Low Veld.—The various thorn trees which make up the thorn veld might be included here, but it has been thought advisable to devote a separate section to them so as to compare them rather to the trees of the bush. Of the other associated plants, those that occur in the *Andropogon* associations of the transitional belt are included in the list already given (pp. 505-6). The associated plants are much more abundant on such broken ground, and do not occur so frequently in the low veld proper. The following, however, are all common and characteristic of it.

*Crotalaria distans*, *C. spp.*, *Indigofera longipes*, *I. spp.*, *Tephrosia spp.*, *Crassula spp.*, *Hetero-*

*morpha arborescens*, *Oldenlandia amatymbica*, *Aster asper*, *A. spp.*, *Helichrysum spp.*, *Gazanea longiscapa*, *Dicoma argyrophylla*, *Lactuca capensis*, *Ballota africana*, *Abutilon sonneritium*, *Sida longipes*, *Sparmannia palmata*, *Leucas martinicensis*, *Lippia asperifolia*, *Mahernia grandistipula*, *Hermannia sp.*, *Lasiosiphon sp.*, *Amarantus paniculatus*, *Phytolacca stricta*, *Euphorbia spp.*, *Gomphocarpus spp.*, *Aloe saponaria*, *Hypoxis latifolia*, *Gladiolus ecklonii*, *Crinum longifolium*, *Ammocharis falcata*, *Cyanotis nodiflora*.

#### (4) CHANGED LOW VELD.

The low veld variety of *Anthistiria* is, wherever possible, cut for hay, and consequently the grass of the low veld is not so regularly burned. However, a good deal of it is burned so as to obtain the new growth early, and the burning leads to changes similar to those on the high veld.

*Aristida junciformis* is not common on the low veld. *Eragrostis curvula*, however, does occur in positions similar to those on the high veld, usually lining the Kafir paths.

(a) *Sporobolus indicus* forms an association over considerable areas of changed veld, especially in the immediate neighbourhood of Maritzburg. It replaces the *Anthistiria* completely, but rarely forms a pure association, being mixed with the *Andropogon* species of the low veld. It is somewhat similar to *Eragrostis curvula* in appearance, and that species also is mixed with it.

*Cynodon dactylon* forms a secondary association in the low veld in exactly the same way as in the high veld, being found on the site of old Kafir kraals.

#### (5) THE WEEDS OF CULTIVATED LAND.

When the high veld is ploughed at all, it is usually for the purpose of planting wattle, and such plantations will be dealt

with later. The low veld, on the other hand, is the "mealie" country, the mealie (maize) demanding a richer soil than that of the high veld. Ploughing the soil of the low veld changes its most important feature, namely its lack of proper aëration. It becomes much more like the soil of the high veld, but it is richer chemically, having received the valuable decomposition products of the basic igneous rocks that have been dissolved out of the soils of higher altitudes.

On such ploughed land there is a great variety of weeds. At first the annuals are commonest, but there are some perennials.

The following grasses commonly occur:

*Panicum isachne*, *Digitaria sanguinalis*, *D. ternata*, *Panicum proliferum* var. *longijubatum*, *P. lævifolium* (occasionally), *Cynodon dactylon*, *Poa annua*, *Eleusine indica*, *Chloris pycnothrix*, *Eragrostis aspera*.

Of other weeds (many of them exotic) the following are typical:

*Bidens pilosa*, *Amarantus paniculatus*, *Chenopodium ambrosoides*, *Nicandra physaloides*, *Physalis peruviana* (Cape Gooseberry), *Solanum nigrum*, *Gomphocarpus physocarpus*, *Convolvulus major*, *Striga lutea* (Witchweed or Isona, parasitic on the roots of the maize), *Cyathula cylindrica*, *Senecio latifolius*, *S. juniperina*, *Ricinus communis* (Castor Oil), *Zinnia pauciflora*, *Datura stramonium*, *Gnaphalium luteoalbum*, *G. sp.* (*sylvaticum*?), *Rumex acetosella*, *R. sp.*, *Sonchus oleraceus*, *Phytolacca octandra*, *Stellaria media*, *Senebiera didyma*, *Adjuratum sp.*

The berries of the Cape Gooseberry are collected by the natives and sold in the towns. The berries of *Solanum nigrum*, which are considered extremely poisonous in Europe, are certainly not so in Natal. The writer has sampled some excellent jam made from them, and they are commonly collected and eaten. *Ricinus communis* is very abundant, and if native labour were cheaper, or the seeds could

be obtained by some other method than by collecting by hand, the growing of this plant might be made an important industry. A few of the introduced weeds have spread through the veld and along the roadsides.

In veld that has been ploughed and left, the various weeds mentioned come in during the first year. Perhaps the commonest one of them all is *Bidens pilosa*. It very often covers the entire surface of the ground. Next year the grass *Tricholæna rosea* appears, and the annual species begin to give way to the perennial. About the third or fourth year the grasses are dominant. *Paspalum scrobiculatum* sometimes comes in, and also *Sporobolus indicus* and species of *Digitaria*. Then the *Andropogon* species appear and gradually gain the upper hand. After a time *Anthistiria imberbis* may come in again; but as long as the soil remains well aerated *Andropogon* species, and especially *A. pertusus*, usually remain dominant.

#### SUMMARY FOR THE VELD FORMATION.

(1) In the high veld *Anthistiria imberbis* forms practically a pure association over the more level ground. Soil loose and well aerated.

(2) *Andropogon ceresiæformis* is sub-dominant over certain areas where the soil is not so deep.

(3) On the slopes with more varying soil conditions other grasses and associated plants become more abundant until *Andropogon* species become dominant. This type is transitional to low veld, bush, and vlei.

(4) In the low veld a distinct variety of *Anthistiria imberbis* is dominant over the alluvial flats and gentler slopes. Soil hard, dry, and baked, badly aerated.

(5) On very shallow soil or under varying soil conditions *Andropogon* associations occur (*Andropogon hirtus*, *A. schœnanthus*, *A. pertusus*).

(6) On stony hillsides the grasses grow in semi-isolated tufts (transitional to rocky hillside formation).

(7) As a result of man's interference other associations replace the natural veld grasses (*Aristida junciformis*, *Eragrostis curvula*, *Cynodon dactylon*, *Sporobolus indicus*).

(8) When the veld is cultivated a variety of weeds occur, at first mostly annuals. If such ground is allowed to revert to veld, the perennials gradually replace the annuals and the grasses regain dominance.

## 2. THE BUSH FORMATION.

In the tree growth even more than in the grasses there is a marked distinction between the high veld and the low veld regions. In the former we find the close type of bush, in the latter the very xerophytic isolated thorn trees. The high veld type of rocky hillside formation is intermediate between those two.

### (1) THE CLOSE BUSH (MIDLAND TYPE).

This always grows in the situations where there is a maximum deposition of moisture—the south-eastern slopes. It faces the rain-bearing clouds and is sheltered from the hot, dry winds. The fact that the bush is cooler during the day-time than the surrounding veld increases the precipitation, and the colder air will flow outwards from the bush, so that the veld in the neighbourhood also benefits. On the other hand, there is less rapid cooling in the bush at night, so that frosts inside the bush are rare.

The soil is similar to that of the *Andropogon* associations of the veld, and if the trees were absent the topography would be of a much less stable type. Often the bush-covered slopes are rocky and similar to those rocky hillsides which, when they do not face south-east, are covered by the more xerophytic type of plant formation described on p. 526. Much of the type of veld at present made up of *Andropogon* associations with numerous associated plants was at one time bush. The bush is at the present time retrogressive.

**Marginal Zone.**—Surrounding the bush we have the transitional marginal veld. This belongs partly to veld and partly to bush. Occasionally the typical *Anthistiria* grass veld grows close up to the edge of the bush, but that is rare. *Andropogon* associations, and in particular the tambootie association, are usually found surrounding the bush. In this situation these associations differ slightly in composition from those occurring on the slopes. There is a more varied number of associated plants and ferns present, and the broad-leaved grass *Setaria sulcata* is characteristic of the zone.

This belt suffers less from fire than the veld as a whole, and consequently numerous species of the associated flowering plants take refuge there. Taller half shrubby species are common.

*Berkheya* (*Stobœa*) spp., *Athanasia acerosa*, *Vernonia corymbosa*, *Leonotis leonurus*, *Polygala virgata*, *Artemesia afra*, *Helichrysum* spp., *Indigofera* sp., *Plectranthus* spp., *Hyptis pectinata*, *Lasiosiphon* spp., *Guidia ovalifolia*, *Gladiolus* spp., *Mohria kaffrorum*, *Pellæa hastata* are typical and most abundant. They often oust the grasses altogether.

In the moister parts of the marginal belt, grasses that characterise the vleis, e. g. *Erianthus capensis*, *Arundinella ecklonii*, *Setaria aurea*, as well as, occasionally, *Cyperaceæ*, and such plants as *Osbeckia umlaasiana*, *Richardia africana*, made up the type of plant formation.

A very definite plant association of this marginal zone is formed by the Bracken (*Pteris aquilina*). Sometimes it is almost a pure association, at other times mixed with grasses or with *Rubus pinnatus*.

These plant associations described so far belong properly to the veld portion of the transitional zone. The other part of this zone is more irregular and patchy. It consists of shrubs, trees, and lianes that prefer the outside of the bush, where the conditions regarding light and other factors differ from those in the interior of the bush.

*Rhamnus prinoides*, *Burchellia capensis*, *Trimeria alnifolia*, *Celastrus buxifolius*, *C. nemorosus*, *Buddleia salviæfolia*, *Argyrolobium adscendans*, *Grewia lasiocarpa*, *Gardenia globosa*, *Acacia pennata*, *Entada natalensis*, *Dioscorea* spp., *Helinus ovata* are the chief species found in this outside marginal belt of the bush. Sometimes single isolated trees of *Ilex capensis* are found outside the rest of the bush.

Bush Proper.—Coming now to the composition of the bush itself, the Upper Canopy is formed by *Combretum kraussii*, *Calodendron capense*, *Xymalos monospora*.

The last-named always grows in moist spots, and throws such dense shade that nothing else grows underneath.

Associated with these three trees are: *Pygeum africanum*, *Ficus natalensis*, *Celtis kraussiana*, *Rhus longifolia*, *Podocarpus thunbergii*, *Scolopia zeyheri*, *Olea laurifolia*.

The Lower Canopy has: *Toddalia lanceolata*, *Halleria elliptica*, *Grewia occidentalis*, *Schmidelia monophylla*, *Clausena inequalis*, *Rhamnus prinoides*, with the following of less importance: *Burchellia capensis*, *Gardenia rothmannii*, *G. neuberia*, *Trimeria alnifolia*, *Zizyphus mucronata*, *Cryptocarya acuminata*, *Kraussia lanceolata*, *Xanthoxyloides capense*, and several species of *Rhus*.

The under-shrubs include the following:

*Cluytia pulchella*, *Cassinopsis capensis*, *Celastrus buxifolius*, *Calpurnia lasiogyne*, *Ehretia hottentotica*, *Peddiæa africana*, *Rinorea* sp. (*Alsodeia*),

Under-herbs:

*Echinospermum* sp., *Thunbergia natalensis*, *Peristrophe natalensis*, *Justitia* spp., *Disperis fannineæ*, *Chlorophytum* spp., *Streptocarpus* spp., *Excœcaria* spp., *Adenocline* sp., *Hypolepis anthrixifolia*, *Pteris flabellata*, *P. quadriaurita*, *Asplenium erectum*, *A. cuneatum*, *Pellæa hastata*.

Lianes are very numerous, including:

*Vitis capensis*, *V. cuneata*, *V. cirrhosa*, *Scutia commersonii*, *Senecio* spp., *Dalbergia obovata*, *Popowia caffra*, *Cnestis natalensis*, *Strophanthus capensis*, *Acacia pennata*, *Ceratosicyos ecklonii*, *Jasminum* spp., *Ipomœa* sp., *Helinus ovata*, *Asparagus plumosus*, *Cassytha capensis* (parasitic).

Epiphytes are:

*Polystachya* spp. (orchids), *Angræcum* spp. (orchids), *Mystacidium* spp. (orchids), *Psilotum triquetrum*, *Peperomia caffra*, *P.* sp., *Rhipsalis cassytha*, *Ficus natalensis*, *Lycopodium saururus*, *L. verticillatum*, *L. gnidioides*, *Hymenophyllum* spp., *Trichomanes* spp., *Polypodium incanum*, *P. lanceolatum*, *Asplenium rutæfolium*, *Gymnogramme lanceolata*, Mosses and Hepatics.

Bush of this composition clothes the southern slopes of the Zwaartkop mountain. The large Karkloof forest, which was estimated by the Forest Commission of 1880 to cover an area of 80,000 acres, lies outside the district mapped.<sup>1</sup>

To the south of the Zwaartkop bush, at Indeta, there is bush which, though quite similar œcologically, differs slightly in its composition from the type described. It consists of the following:

*Calodendron capense* (dominant), *Celtis kraussiana* (dominant), *Xymalos monospora* (dominant), *Kiggelaria dregeana*, *Toddalea lanceolata*, *Cyclostemon argutus*, *Xanthoxylon capense*, *Ptæroxylon utile*, *Ocotea bullata* (on high ground), *Olea laurifolia* (on high ground), *Trimeria alnifolia*, *Podocarpus thunbergii* (scarce, but probably more abundant formerly), *P. latifolia* (scarce), *Rhamnus prinoides* (around margin), *Celastrus buxifolius* (around margin).

It will be seen, therefore, that this bush, not being so much interfered with, contains more of the valuable timber trees.

<sup>1</sup> Bews, J. W., "The Vegetation of Natal." 'Ann. Natal Mus.' vol. ii, p. 302. See the account of the Yellow Wood bush.

Though there are thus slight differences in the composition of Midland bush as it occurs in different localities, yet its general ecological character is the same, and this will be summed up later.

(2) SMALLER SCATTERED BUSHES AND ROCKY STREAM BUSH.

A glance at the map will show that there are numerous small patches of bush scattered over the high veld region (e. g. on the Town Hill). The larger bushes also are very ragged in appearance. Clearings have been made which penetrate into the very centre of the bush. Scattered patches remain in the neighbourhood of the larger bushes, and isolated stumps of trees may be found between them. These small bushes are also common near the sources of the streams, and frequently fill the higher stream valleys.

Their character may be summed up and described in a sentence. They are similar in every respect to the outer margin of the bush proper. This fact, together with the way in which they occur and are distributed, points to the conclusion that they are the remains of a forest which formerly covered the whole area over which they are now scattered. They are now found in the ravines and less accessible places, because there naturally the influence of man has been less felt.

These bushes are more open and irregular than the larger type. More light penetrates, and the trees found in this kind of bush are all more or less light-demanding. The following make up the type :

*Rauwolfia natalensis*, *Combretum kraussii*, *Ficus capensis*, *F. natalensis*, *Rhamnus prinoides*, *Celtis kraussiana*, *Trema bracteolata*, *Grewia lasiocarpa*, *G. occidentalis*, *G. caffra*, *Buddleia salviaefolia*, *Vitis cuneata* and other species, but not *V. capensis*, *Nuxia floribunda*, *Calodendron capense*, *Cussonia spicata*, *Xymalos monospora* (sometimes).

Seeing that more light penetrates through this type of

bush there is greater variety in the undergrowth. Its character varies directly with the amount of shade and the degree of wetness in the soil. There may be quite open spaces, though unless these are very large, actinometer measurements show that the full amount of sunlight does not penetrate.<sup>1</sup> In such open spaces the veld grasses may be found. *Setaria sulcata* is characteristic. Any of the numerous associated plants may also occur. If the ground is swampy *Richardia africana* is frequently dominant. *Impatiens capensis*, *Justitia campylostemon*, *Streptocarpus* spp., selaginellas, ferns, mosses, and hepatics are also abundant in moist places. Where the canopy is more dense *Clivia miniata* (Bush Lily) is dominant.

Although, therefore, these scattered smaller tracts of bushes may usually be looked on as the remnants of a larger bush, yet their ecological character has been considerably altered. Of course it is not possible to say definitely that all the rocky stream bush was at one time part of a larger bush, and has been reduced to its present limits by the influence of man, but the evidence for this is in many cases at least convincing enough.

### (3) BUSH CLEARING.

The area at present under consideration, being in the immediate vicinity of Pietermaritzburg, has had more direct interference from man than the more remote parts of Natal. In most of the bush the more valuable timber trees have been cut down, except in the less accessible places. In the Town Bush other trees have been planted to replace those taken away, so that now there is a mixture of such exotic trees as *Eucalyptus* and Australian acacias with the indigenous trees.

In many places the bush has been cleared away altogether, the worthless trees and shrubs having been destroyed by fire after the others had been removed. In such places coarse

<sup>1</sup> *Ibid.*, p. 284.

herbs and shrubs grow up with occasionally here and there single trees that have resisted the fire. *Xymalos monospora* often survives where all the other trees have disappeared.

The whole ground becomes covered with a type of plant association similar to the outside transitional belt between bush and veld, such as:

*Rubus pinnatus*, *Chilianthus dyssophyllus* Berkheya spp., *Athanasia acerosa*, *Plectranthus* spp., *Buddleia salviaefolia*, *Asparagus medioloides*, *Pteris aquilina*, with a mixture of veld grasses—*Andropogon* species chiefly—and associated plants of the veld.

If such an area is carefully protected the bush will grow again, but this seldom happens. The annual grass fires sweep through and destroy the young trees, and the bush clearing tends to become grassland.

Retrogression in the Bush.—We can note, therefore, the following stages of retrogression in the bush:

First, we have the larger midland type of bush, which varies slightly in its composition in different localities, but is of the same general œcological character throughout.

Secondly, we have the smaller scattered areas of bush, usually confined to the upper ends of the small stream valleys, the composition of which is similar to the outside margin of the larger bush, from which, however, it slightly differs œcologically, owing to the fact that it is more open and irregular, and more light penetrates.

Thirdly, the bush has often been destroyed by fire, and in place of it we get the bush clearing.

Lastly, by constantly recurring grass fires, renewal of the bush is prevented, and any surviving shrubs and trees are destroyed, and the area becomes veld, though from the nature of the ground it remains of the unstable variety (*Andropogon* associations with large numbers of the associated veld plants).

## SUMMARY FOR BUSH FORMATION.

This midland type of bush differs slightly in its composition from the similar bush on other terraces. The bush nearer the coast is more nearly allied to tropical East African forest. Though many of the species composing the midland bush also extend through the tropics, yet some of them do not, and many that do so extend are confined to the mountains in the tropics.

In its general ecological character the close type of bush in Natal may be taken as intermediate between sclerophyllous woodland, such as occurs on the west of South Africa (where there are winter rains and dry summers) and tropical rain forest. Some of the trees are more xerophytic than others, but they nearly all possess a rather leathery type of leaf. The individual species, however, vary considerably in this respect.

Epiphytes are not very abundant, and the undergrowth is not luxuriant. The great number of lianes, however, make it somewhat difficult to penetrate through the bush. Owing to the activities of the white ant the bush is generally remarkably free from dead and decaying tree trunks.

Though the bush as a whole is evergreen, yet there is a slight tendency towards becoming deciduous. *Calodendron capense* and *Celtis kraussiana* are both deciduous, and *Combretum kraussii* and *Grewia occidentalis* are almost so. Frosts are rare inside the bush, and the temperature of the soil never falls very low. The bush has, therefore, to withstand a dry winter, but not at the same time a very cold one. Consequently it remains evergreen, but it shows an approach to the deciduous woods of temperate regions.

## 3. THE THORN VELD FORMATION.

The grasses of the thorn veld are the same as those of the low veld. A great part of what is now treeless low veld

recently contained thorn trees. Wherever the soil was suitable for mealie growing the trees have been removed, and only a few remain. There is very little of the low veld that does not contain some thorn trees.

In the thorn veld proper the trees grow isolated a few yards apart. Were it not for the grass-fires they would tend to close in and form thorn "thickets." This has been observed to take place in parts of the veld that have been fenced and protected from grass-fires.

All the thorn trees might have been included in the list of associated plants of the low veld, but there are parts of this veld where there are so few that it is never spoken of as thorn veld. Further, though the trees and grasses, since they occupy the same habitat together, constitute one formation—the thorn veld—yet it is better to consider the grasses under the section to which they properly belong—the veld—and to deal with the trees separately, because they naturally compare with the trees that compose the close bush of the high veld region.

There are probably several species of *Acacia* which occur abundantly enough, but which the writer has failed to identify owing to not being able to find either flowers or pods.

The following species are common :

*Acacia horrida*, *A. caffra*, *A. caffra* var. *rupestris*, *A. arabica* var. *kraussiana*, *A. sp.* (*hirtella?*), *Celastrus buxifolius*, *Ehretia hottentotica*, *Zizyphus mucronata*, *Cussonia spicata*, *Hippobromus alata*, *Euclea undulata*, *E. sp.*, *Culturnia sp.*, *Rhus* spp., *Plectronia* spp., *Sclerocarya caffra*, *Harpephyllum caffrum*, *Chilianthus dyssophyllus*, *Erythrina humeana*, *Nuxia floribunda*, *Plumbago capensis*, *Vangueria* spp., and the list given as associated plants of the low veld.

The umbrella-form is typical of these thorn trees. It is the form which seems best adapted to withstand the hot, dry winds to which they are fully exposed. Their extensive root systems extend horizontally along the surface of the soil, and

do not penetrate to any great depth. This is due for the most part to the fact that over most of the thorn veld the hard shales come very near to the surface. Where the soil happens to be deep they do penetrate to considerable depths. The different species, however, vary in this respect. There is also very considerable variation in the degree of spine-development in the different species and in different individuals of the same species. The thorns vary in both size and number. The more thorns the less leaves. There are also indications of a correlation between the nature of the root-system and the degree of spinosity, but the whole subject is one to which the writer hopes to give further attention.

Another question of great interest is how far have the thorn trees been influenced in their growth-forms, etc., by the constantly recurring grass fires. It was pointed out that grass-burning was the usual practice when Vasco de Gama landed in 1497. It has certainly been going on regularly ever since. The thick bark which undoubtedly does help to protect the thorn trees from the fires, may be, at least, partly a direct adaptation to environment. Their seeds are very hard, and under ordinary conditions will lie for a long time in the soil without germinating. After a grass fire, however, the hard seed-coat is burst by the scorching and they germinate immediately. The young trees grow quickly, and a few of them manage to grow tall enough to be able to resist the next grass fire. The bulk of them are killed, and consequently we do not find them growing close enough to form thorn-thickets. The soil is uniformly very dry, and their growing isolated is not a result of any differences in soil moisture. Altogether the thorn veld presents some of the most interesting problems in connection with the plant oecology of Natal.

## 4. THE PLANT FORMATION ON ROCKY HILL-SIDES.

## (1) HIGH VELD REGION.

This formation is found on the steep slopes which face north, where the climatic factors are unfavourable to the growth of the close type of bush. It is fully exposed to the hot, dry winds from the north or north-west. The trees which compose it are more xerophytic than those of the close bush, but less so than those of the thorn veld. Ecologically it may be taken as intermediate between thorn veld and close bush, but here the determining factors are mainly climatic. The topography is very similar to that of the close bush formation, though soil transportation is less checked, and therefore the slope is more rocky, being more denuded.

The trees grow sometimes isolated, sometimes a few together forming small clumps. They suffer less from fires, for they possess a notably thick bark which protects them. The grasses are also not so luxuriant as in either the high veld or the low veld, and when they are burned the fires are not so destructive. In fact in many cases the grasses are so poor that they are not burned. This poorness in grasses leaves the soil still more exposed, and the slope is very often rugged and broken, being cut through by ravines or dongas. The grasses that do occur are the *Andropogon* associations that clothe the other slopes, with a mixture of *Aristida junci-formis*, and the various associated plants.

Though the slope as a whole is very dry, there may be a few springs or wet spots, and there are commonly dry stream-channels which are filled with water only after a rainstorm. Large and small blocks of dolerite are a common feature of such slopes. These check soil transportation, and conserve moisture. If in the driest, hottest weather a stone is raised, the ground underneath will be found to be slightly damp.

This variability in the soil conditions (in particular as regards its moisture) is reflected in the vegetation. While in the thorn veld where the soil is uniformly very dry there

is nothing but a monotonous succession of thorn trees, etc., here we have extremely xerophytic trees and shrubs growing quite close to others which are not nearly so much so. Since they are all to the same extent exposed to the dry hot winds, the variability in their æcological character must be due to the broken rugged nature of the slopes and the consequent differences in soil conditions.

The following species make up the rocky hillside formation in the high veld region :

*Cussonia spicata*, *Erythrina tomentosa*, *Greyia sutherlandi*, *Aloe natalensis*, *A. ferox*, *A. cooperi*, *Buddleia salviæfolia*, *Chilianthus dyssophyllus*, *Heteromorpha arborescens*, *Combretum riparium*, *Osteospermum moniliferum*, *Dombeya rotundifolia*, *Ricinus communis*, *Ficus capensis*, *Zizyphus mucronata*, *Panax gerrardi*, *Mæsa rufescens*, *Vangueria infausta*, *Solanum auriculatum*, *S. giganteum*, *S. sodomæum*, *Vernonia corymbosa*, *Pavetta obovata*, *Burchellia capensis*, *Ehretia hottentotica*, *Artemesia afra*, *Phytolacca stricta*, *Enclea daphnoides*, *Plectronia* spp., *Royena pubescens*, *Celastrus buxifolius*, *C. acuminatus*, *Lippia asperifolia*.

If this list is compared with the others already given it will be seen that there is an interesting admixture of close bush and thorn veld species, as well as many others that do not occur in these formations. The rocky hillside type is, therefore, not only intermediate in its æcological character, but also to a certain extent in its composition between the trees of the high veld and low veld regions. It is sometimes, but not always, intermediate in position also, being found immediately above the low veld.

## (2) THE LOW VELD REGION.

The rocky hillside formation in this region is the most xerophytic of all plant formations in Natal. The rocky slopes in this case usually overhang the rivers. Since these

all flow more or less in an easterly direction from the Drakensberg to the sea, the slopes on the north side have a southerly exposure, and are sheltered from the dry, hot winds. Such portions of the low veld region stand in contrast to the wide alluvial flats.

South Exposure.—The rocky hillside formation with south exposure consists of:

The thorn veld species of *Acacia*, *Celastrus buxifolius*, *Tecoma capensis*, *Zizyphus mucronata*, *Ehretia hottentotica*, *Cussonia spicata*, and any of the other thorn veld species.

As far as its composition goes it differs very slightly from thorn veld; but owing to the steepness of the slope the grasses are not so abundant, the trees do not suffer from grass fires, and since they are also more sheltered they grow closer together, forming thorn thickets. The situation, exposure, etc., in this case are the same as those of the close type of bush, but the factors operating are those of the low veld region. The associated plants are more abundant than in the case of the thorn veld. An admixture of ferns in the moister portions of the underbush is a feature.

North Exposure.—On the slopes which face north, i. e. on the south side of the river, we get the more xerophytic rocky hillside formation of the low veld region made up of:

*Aloe ferox*, *A. spp.*, *Cussonia spicata*, *Euphorbia grandidens*, *E. tirucalli*, *E. spp.*, *Commiphora harveyi*, *C. caryæfolia*, *Encephalartos altenstenei*, *Passerina spp.*, *Scutia commersonii*, *Rhus spp.*, *Hippobromus alata*, *Ptæroxylon utile*, *Acacia caffra* var. *rupestris* (*A. eridinia?*), *Acacia horrida*, *Mesembrianthemum spp.*

Succulent or semi-succulent lianes:

*Sarcostemma viminalis*, *Dregia floribunda*, *Riocreuxia sp.*, *Capparis spp.*, *Secamone sp.*, *Ceropegia sp.*, *Cissampelos sp.*, *Vitis cuneifolia*, *V. sp.*, *Senecio spp.*

This is one of the most extensive and most interesting of

the plant formations in Natal. It is found in all the main river valleys wherever the rivers have cut through so steeply as to leave such rocky slopes. In the area at present under consideration it occurs below Howick, but the best examples of it in the neighbourhood are further down the Umgeni and just outside the area mapped. The valley of the Tugela is richer still in this type. A rubber company has been formed to work the rubber obtained from *Euphorbia tirucalli*, and it has been estimated that there are at least twelve million specimens of that tree in the Tugela valley alone. The estimate is probably a fairly accurate one (see Pl. XLVI).

Although thorn trees also occur in this formation, yet its xerophytism is shown rather in succulence. The euphorbias and aloes may be taken as the typical members. There are few grasses. Those that do occur are of the low veld, stony hillside type already described.

The various plant formations of hillsides might be grouped as follows :

(1) High Veld Region.

(a) South exposure :

Close bush. Bush clearing. Andropogon veld.

(b) North exposure :

Mixed xerophytic trees and shrubs (intermediate between close bush and thorn veld).

(2) Low Veld Region.

(a) South exposure :

Thorn thickets (similar to thorn veld but denser).

(b) North exposure :

Extremely xerophytic trees and shrubs. Succulents. Very few grasses.

## 5. ALPINE PLANT FORMATION.

The Zwaartkop mountain has an altitude of 4758 feet, which is the highest in this area. The higher altitude has brought

about certain changes in the vegetation, both floristically and ecologically. The mountain has the flat top so characteristic of S. African mountain scenery. The rainfall is very high over the top of the mountain, though no exact figures are available. The deposition of moisture is even much greater than any figures would indicate, as so much of it comes in the form of mist. The rain-clouds usually strike the south-east side first, and this side is clothed with the type of bush already described. On the top, as a result of the high rainfall, we find marshy spots in depressions, while the higher portions are often washed completely bare of soil. In other places the soil that is left is a coarse, heavy sand or gravel. The vegetation is, therefore, very mixed, varying from the most extreme xerophytes to marsh plants.

On the sides of the mountain the usual veld grasses pass right up to the top, except on the south side, where there is bush. Being of the unstable type the *Andropogon* species are the natural dominant grasses, but they have been largely replaced by *Aristida junciformis*.

However, the presence of the following grasses gives a distinctive character to this veld of higher altitude:

*Harpechloa capensis*, *Microchloa caffra*, *M. altera* var. *nelsoni*, *Anthoxanthum ecklonii*, *Tristachya leucothrix*, *Eragrostis brizoides*, *E. chalcantha*, *Axonopus semialatus* (early spring).

The following associated plants are also distinctive:

*Crassula* (many species), *Stachys aethiopica* var. *glandulifera*, *Stachys* sp., *Orthosiphon teucrifolius*, *Cynium racemosum*, *C. adonense*, *Sebæa sedoides*, *S. crassulæfolia*, *Helichrysum adenocarpum*, *H.* spp., *Watsonia meriana*.

On the north side there are a few patches of rocky hillside formation consisting of—

*Greyia sutherlandi*, *Aloe natalensis*, *A. cooperi*, *Buddleia salviæfolia*, and the bracken association (*Pteris aquilina*) above these approaching the top.

On the south side along the upper margin of the bush

*Leucosidea sericea* is abundant. This is a typical alpine species of the Drakensberg.

Behind the Zwaartkop, not rising to the same altitude, there is the peak of the Little Zwaartkop. Over the tops of the two the grasses already mentioned are found, but *Anthistiria*, *Aristida* and *Andropogon* are most abundant. *Stiburus alopecuroides* is common in the marshy spots. In addition, the following plants make up the plant formation of the mountain top :

*Protea hirta*, *Alepidea amatymbica*, *Kalanchoe thyrsoflora*, *Gerbera aurantiaca*, *Gazanea longiscapa*, *G. sp.*, *Psammotropha myriantha*, *Sebæa crassulæfolia*, *Tulbaghia acutiloba*, *Wurmbea kraussii*, *Euryops setiloba*, *E. pedunculatus*, *Cycnium adonense*, *C. racemosum*, *Sutera breviflora*, *Erica sp.*, *Hypoxis kraussiana*, *H. angustifolius*, *H. platypetala*, *Scilla lancæfolia*, *S. globosa*, *S. spp.*

On bare rocks with little or no soil the following :

*Aloe natalensis*, several species of *Crassula*, *Selaginella rupestris*, *Hypoxis kraussiana*, *Pellæa consobrina*, *P. calomelanus*.

In the moister spots :

*Sopubia cana*, *Gladiolus ecklonii*, *Satyrium cordifolium*, *S. longicauda*, *S. macrophyllum*, *S. parviflorum*, *S. sphaerocarpum*, *Disa spp.*, *Brachycorythis pubescens*, *Disperis sp.*, *Habenaria bonatea*, *H. spp.*

In fact these moist places on Zwaartkop are among the best of our localities for ground orchids.

The Zwaartkop mountain, though it rises high above the level of its own terrace, is at the same time far below the altitude of the mountains which form the range of the Drakensberg. In the case of Zwaartkop, as a whole, the vegetation is typical high veld and close bush, with a few patches of rocky hillside formation and small vleis. However, at the higher altitudes the presence of many species not found, or if found not abundant, at lower altitudes, gives a distinctive

character to the plant formation. Such plants as *Leucosidea sericea*, *Protea hirta*, *Erica* sp. connect it with the alpine formation of the Drakensberg.

## 6. THE VLEI FORMATION.

The term *vlei* is applied to a marsh in S. Africa. They are formed most frequently along the spruits or streams, where these spread over the level ground. In some cases vleis occupy small circular depressions with no outlet. In such cases they may dry up during the dry season. There are very few examples of actual lakes or ponds, though there are one or two in the low veld region.

The vegetation of the vleis varies according to the degree of wetness and stagnation in the water, and the various plant associations may be graded accordingly as follows :

(a) The *tambootie* and other *Andropogon* associations, found in the moister spots of the veld, form a transitional type to the vlei. In such places the *Andropogon* species grow tall, and there are all gradations between this and ordinary veld. As one passes from pure *Anthistiria* veld the *Andropogon* species become more and more abundant as they do on the slopes, but in the passage to the vlei they also grow taller and taller, until one reaches the type that is usually spoken of as a vlei. It is impossible, however, to draw any definite distinction between this driest type of vlei and the moister parts of the veld.

(b) *Setaria aurea* becomes dominant in wetter vleis. Its golden spikes give a characteristic colour to this type, so that it can be recognised from a distance.

(c) *Eragrostis nebulosa* is dominant in many vleis—some of them are quite dry in the dry season but flooded in the rainy season. Its loose spreading panicles again give a characteristic colour, this time a greyish white.

(d) *Phragmites communis* is dominant in the very wet vleis where the water is draining through fairly rapidly. The

Phragmites association is also the commonest, or one of the commonest, along the rivers.

(e) *Leersia hexandra* often forms practically a pure association in wet vleis. It forms a dense mat in autumn covering the surface of the vlei to the depth of a foot or two, and as it dries up during the dry season it is usually burned off. The leaves as they wither are a dark reddish-brown in colour.

(f) *Erianthus capensis* (umtala) is the tallest of all our Natal grasses, growing up to twelve feet or more. It is only occasionally dominant in the vleis, being on the whole more characteristic of the marginal belt of the bush, but where it does occur in the vleis, mixed with *Cyperus* spp. or other grasses, it is the most conspicuous species on account of its height.

(g) *Cyperus* Vleis.—*Cyperus latifolius*, *C. fastigiatus*, and other *Cyperus* species form vleis which are of a wet type, but they frequently dry up in winter.

(h) *Typha capensis* is dominant in the wettest vleis where the water is stagnant. Such vleis never dry up completely.

(i) *Marsilia macrocarpa* may form a covering in small ponds, in which the water, drying up as winter advances, leaves a bed of mud which hardens from the edge inwards towards the centre. The only examples of this in the selected area occur in the low veld region.

*Marsilia capensis* is similarly found near Fox Hill.

(k) Mixed Associations.—With the exception of the first, these various associations only occur singly in the smaller vleis. In the larger vleis there is a mixture due to the fact that different parts of such vleis vary in their degree of wetness, and in the amount of stagnation in the water.

In the larger vlei *Andropogon* associations grow along the margin, and grade into the veld on the other side. With the tall *Andropogon* species the following grasses are associated :

*Pennisetum sphacelatum*, *P. thunbergii*, *Calamagrostis huttonæ*, *Phalaris arundinacea*, *Arundinella*

ecklonii, *Bromus maximus*, *Setaria imberbis*, *Stiburus alopecuroides*, *Imperata arundinacea*, *Paspalum scrobiculatum*, *Panicum crux-pavonis*, *Andropogon encomus*.

These are all transitional species from veld to vlei. They may occur in places where *Andropogon* species are not dominant, in fact certain of them may in turn become the dominant species of the transitional zone.

Towards the centre of the vlei we find the other associations already described, in the situations, as regards degree of wetness, suitable to each. In the case of those which require more or less similar conditions there is commonly an intermingling. Thus *Eragrostis nebulosa* may mix with *Setaria aurea*, *Setaria aurea* with *Leersia hexandra*, *Phragmites communis* with *Typha capensis*, and any of them with species of *Cyperus*.

The following is a list of associated plants of the vleis:

Cyperaceæ: *Ascolepis capensis*, *Kyllinga elatior*, *K. erecta*, *K. sp.*, *Pycreus angulatus*, *P. oakfortensis*, *P. flavescens*, *P. umbrosus*, *Cyperus spp.*, *C. rupestris*, *Mariscus congestus*, *M. deciduus*, *M. spp.*, *Eliocharis limosa*, *Fimbristylis complanata*, *F. monostachya*, *Scirpus cernuus*, *S. hystrix*, *S. prolifer*, *S. rivularis*, *Fuirena pubescens*, *F. cœrulescens*, *Lipocarpa argentea*, *Rynchospora glauca*, *Carex spp.*

Other plants: *Luzula africana*, *Moræa spathacea*, *Crococoma aurea*, *Hesperantha baurii*, *Anoiganthus breviflorus*, *Chironea purpurascens*, *Scilla globosa*, *Rhamphicarpa tubulosa*, *Kniphofia breviflora*, *K. sp.*, *Encomus sp.*, *Crinum sp.*, *Richardia africana*, *Eriocaulon sp.*, *Aponogeton natalense*, *Sopubia simplex*, *Gunnera perpensa*, *Trifolium sp.*, *Anthericum sp. (elongatum?)*, *Helichrysum aureonitens*, *Danekia capensis*, *Valeriana capensis*, *Osbeckia umlaasiana (Dissotis)*, *Dissotis eximia*, *Polygonum lapathifolium*, *P. sp.*, *Commelina*

*gerrardi*, *Myosotis afra-palustris*, *Mentha aquatica*, *Lythrum* sp., *Alchemilla capensis*, *Geranium caffrum*, *Ranunculus pinnatus*, *Hypericum lalandii*, *H.* sp., *Epilobium capense*, *E. hirsutum*.

## 7. THE PLANT FORMATIONS OF THE STREAMS AND RIVERS.

### (1) HIGH VELD REGION.

In the high veld region, if we begin at the sources of the streams (or spruits as they are called in S. Africa) and follow them downwards, the following is the succession of types of vegetation.

(a) The whole upper part of the stream valley, if it has the southerly aspect, is filled with bush of the type already described—the rocky stream bush (see p. 520).

(b) In many places this bush has been destroyed and we have the bush-clearing also already described.

(c) If the bush clearing has been replaced by veld, the sides of the valley have *Andropogon* associations, while near to the stream the taller species of *Andropogon* and vlei grasses with *Cyperaceæ* dominate.

(d) In the case of streams which do not face south or south-east, and consequently do not possess the proper exposure for bush, the upper parts have often a few of the trees and shrubs which compose the rocky hillside formation, such as :

*Heteromorpha arborescens*, *Panax gerrardi*, *Buddleia salviæfolia*, *Combretum riparium*, *Ficus capensis*, *Mæsa rufescens*, *Burchellia capensis*, *Ehretia hottentotica*, as well as the following :

*Ficus natalensis*, *Erica urceolaria*, *Myrica æthiopica*, *Podocarpus thunbergii*, *P. elongata*, *Ilex capensis*, *Pygæum africanum*, *Scolopia zeyheri*, *S. (ecklonii)*, *Erica cooperi*, *E. cubica*, *Cyathea dregei*, *Lomaria boreana*, *Osmunda regalis*, *Gleichenia umbraculifera*.

These do not form close bush, but grow isolated or in small clumps as in the case of the rocky hillside formation.

(e) Following the streams downwards a succession of vleis occupy the more level parts, while in the steeper parts the veld formation comes close up to the side of the stream. It consists usually of *Andropogon* associations if it is natural veld, or these are frequently replaced by *Aristida junceiformis*.

(f) Between the grassland and the stream there is a narrow moist zone in which at different places such plants as the following are found:

*Luzula africana*, *Juncus* spp., various *Cyperaceæ*, *Myosotis afra-palustris*, *Mentha aquatica*, *Geranium cafferum*, *Drosera burkeana*, *Osbeckia umlaasiana*, *Richardia africana*, *Cyathea dregei*, *Nephrodium bergianum*, *Aspidium felix-mas*, *Mohria kaffrorum*, *Osmunda regalis*, various *Hepaticæ*, various Mosses.

Half submerged or floating:

*Potamogeton* spp., *Juncus* sp., *Lythrum* sp., *Callitriche bolusii*, *Utricularia* spp., *Myriophyllum spicatum*, *Ceratophyllum* sp.

## (2) LOW VELD REGION.

In the low veld region over the alluvial flats the grasses that line the stream sides are the usual species of *Andropogon* (*A. dregeanus* is common), but in places there are other associations.

(a) *Pennisetum unisetum* is dominant for considerable distances and forms often a pure association.

(b) *Phragmites communis* in the same way lines the banks of the Umgeni and Umsindusi for long distances (Pl. XL).

(c) *Cyperus* spp. are not so common, but clumps of *Cyperus* association occur here and there.

(d) Certain of the other vlei grasses, e.g. *Erianthus capensis*, *Setaria aurea*, *Arundinella ecklonii*,<sup>3</sup> are

found occasionally mixed with the *Andropogon* species or with the other associations.

(e) Of trees and shrubs the following are common close to the river side:

*Zizyphus mucronata*, *Trema bracteolata*, *Ficus capensis*, *F. natalensis*, *Rubus rigidus*, *Eugenia cordata*, *Rhus* spp., *Acacia caffra*, *Celastrus buxifolius*, *Lippia asperifolia*, *Royena pallescens*, *Randia rudis*, *Ehretia hottentotica*, *Combretum salicifolium*. They grow closer together than in the rest of the thorn veld (Pls. XL, XLII, XLIII).

In other parts of the low veld region, where the streams and rivers have formed steeper banks and cliffs, we find the rocky hillside formation already described. The streams and rivers, as followed along their courses, show examples therefore of nearly all the types of plant formation found in the area—bush, veld, vlei, and rocky hillside formation. It is only in the aquatic or semi-aquatic plant associations of their margins that they show a distinctive type. Natal is rather poor in purely aquatic plants as distinguished from the marsh plants that are often semi-aquatic.

The fresh-water algæ have not, as far as the writer knows, been much collected or described. *Nitella* sp. is abundant.

## 8. PLANTATIONS.

### (1) WATTLE.

In Natal the culture of the black wattle (*Acacia mollissima*) has become one of the most important industries. Its bark is particularly rich in tannin and it is being more and more used for tanning. The tree is a native of Australia and was first introduced into Natal probably as an ornamental tree. The first bark was sold locally in 1884, and the first consignment was sent to Europe in 1887. At present the annual value of Wattle bark exported has gone up to over £200,000. The timber is also used as mine props. The industry is rapidly growing in importance.

The first essential requirement of this tree is plenty of moisture. The low veld region is too dry for it. It also demands a deep and porous soil. The presence of iron salts and the absence of lime are points that favour it. The climate and soil of the high veld region suit all its requirements. It grows best in the "mist belts," and the deeper the soil the better. Such soils are usually very poor chemically, but their mechanical properties, as already mentioned, are good. They are never entirely dry as in the case of the much richer soils of the "mealie country" in the low veld.

The soil is ploughed and pulverised, and the seeds are specially prepared before being sown. If sown in the ordinary way they may lie for years without germinating. The seeds of the *Acacia* spp. of the thorn veld germinate after being scorched by the grass fires. The seeds of *Acacia mollissima* are made to undergo an equivalent process. They are soaked in boiling water. Usually the method pursued is to pour boiling water over them which is left to cool gradually and soak into the seeds for a day or so. Older seeds may require to be treated a second or even a third time with boiling water. If the seeds are sufficiently soaked they germinate in about two weeks; if they are not, they germinate irregularly for two or three years.

The seeds are sown either broadcast or in lines. Occasionally mealies are sown at the same time, but generally speaking good wattle soil does not carry mealies. At the end of a few months, when about one foot high, they are thinned to single stems.

If unbroken veld has been planted with wattle, there are few weeds, but if soil that has previously been cultivated (Kafir gardens, etc.) is planted there is usually a great variety of weeds. *Bidens pilosa*, *Senecio juniperina* (ukanga), *Physalis peruviana*, *Nicandra physaloides* are most frequent, but any of the other common weeds occur (see above under "Weeds of Cultivated Land"). *Bidens pilosa* is more abundant than all the rest put together.

About the second year the trees are high enough to shade and kill the weeds. Grasses, if the ploughing has been carefully done, should not be present, but very often they are, for a time, completely dominant. In this case there is great danger from fire.

After the third or fourth year the grasses disappear and the whole plantation consists of wattle without any undergrowth. Nothing could be barer of under vegetation than a wattle plantation. As a rule there is not a single plant to be found other than the wattle itself.

In about seven years the trees are cut down and the bark stripped. The timber is removed and the branches and general *débris* that remain scattered over the ground are burned. Mixed with this rubbish are plenty of seeds, and these germinate among the ashes. The plantation thus renews itself and the process is repeated every seven years.

#### (2) BLUE GUMS.

The other plantations are insignificant in extent as compared with wattle. There are plantations of Blue Gum (*Eucalyptus globulus*) and other *Eucalyptus* spp. The seeds are usually sown in boxes or tins, and the seedlings planted out when they are from three to six inches high. The trees are not cut down, as a rule, till they reach a diameter of twelve inches. The time varies greatly, but this stage is rarely reached before the twelfth year.

#### (3) PINES.

There are also small plantations of *Pinus insignis* and *Pinus pinaster*, and a great number of exotic trees are grown around Maritzburg and elsewhere for ornamental purposes.

### GENERAL SUMMARY.

Natal is a country which, owing to its physical configuration and the steep rise from the sea to the Drakensberg, shows

great variety of natural conditions. It rises by a series of terraces, but these have been cut through by the main river valleys, so that in each terrace there are portions at a higher level—the high veld region, and portions at a lower level—the low veld region. Natal, as a whole, is a region of summer rainfall, 77 per cent. of the average annual rainfall coming between October and March. The winters are very dry. Towards the end of winter hot, dry winds blow from the north or north-west.

On each terrace the high veld region receives the greatest proportion of the deposition of moisture both in the form of rain and mist; it does not have great extremes of temperature; the hot winds do not affect it so much, and its southern slopes are sheltered from them. The soil on the more level parts is loose, well aerated and of considerable depth, rich in the higher oxides of iron, but poor in nutritive salts. On the steeper slopes the soil conditions are more variable, and large and small blocks of dolerite are frequent. The slopes with north exposure are often bare and rocky.

The low veld region is much drier, since the rain-clouds tend to pass over it without depositing moisture; it has great extremes of temperature; the hot winds are both hotter and stronger in the valleys, the air being heated by compression as it descends from above. The soil is a dry, hard-baked, compact clay, badly aerated, but rich chemically. Over the river flats the soil is alluvial, growing more shallow on the rising ground till it becomes transitional to the high veld. Where the rivers have cut down deeply rocky slopes or cliffs are formed, often covered with blocks of dolerite.

The soluble salts are dissolved out of the soils of the high veld and re-deposited in the low veld. Here and there iron-pans are formed, and lime is re-deposited as nodules. The soil itself is washed down, and during the dry season blown down, to lower levels. After the grass fires the ashes are also blown down over the low veld.

The vegetation has been, and is being, greatly changed through the influence of man, both direct and indirect. Fire

has had a great effect in changing the plant associations of the veld and in destroying the bush. Since all the factors interact, climate and soil are also affected.

The plant formations in this area, as determined by these factors, are the following.

### (1) The Veld Formation.

The high veld has a tall variety of *Anthistiria imberbis* dominant over the more level ground, *Andropogon cereziæformis* sub-dominant where the soil is not so deep, and *Andropogon* associations on the steeper slopes transitional to bush, vlei and low veld. There are many associated grasses and other flowering plants which are most abundant in the *Andropogon* associations. *Aristida junciformis*, *Eragrostis curvula*, *Cynodon dactylon* form "secondary" associations as a result of man's interference.

The low veld has a loosely tufted, seldom flowering variety of *Anthistiria* dominant over the alluvial flats and gentler slopes. With changing soil conditions *Andropogon hirtus*, *A. schœnanthus*, *A. pertusus* become dominant. On stony hillsides the grasses grow in semi-isolated tufts. *Sporobolus indicus* and other species form secondary associations in "changed veld." In cultivated land there is a great variety of weeds.

### (2) The Bush Formation.

The midland type of close bush occupies the south-eastern slopes of the high veld region where there is large deposition of moisture and shelter from hot winds. It has a definite composition, varying slightly in different localities, and is intermediate ecologically between sclerophyllous woodland and tropical rain forest. It shows a slight tendency towards becoming deciduous.

In smaller patches and commonly in the higher stream valleys there are scattered bushes, which are frequently the

remnants of larger bush. They are similar in composition to the outer margin of the latter, but are more open and irregular, and this leads to differences in the undergrowth.

Bush clearings have numerous coarse herbs and shrubs and associated plants of the veld, as well as occasional trees, such as *Xymalos monospora*, that may have resisted the fire that destroyed the bush. These plants gradually become replaced by *Andropogon* associations.

### (3) The Thorn Veld Formation.

This occurs in the low veld region. The trees grow isolated, and are prevented from growing closer by the constantly recurring grass fires. Their umbrella-form, horizontal root system, variable thorn development, and thick bark are the main features. These are adaptations brought about by their exposure to the hot winds, by the hard, dry soil with shales usually near the surface, and perhaps partly by the annual grass fires.

### (4) The Rocky Hillside Formation.

In the high veld region this occurs on the slopes which do not face south or south-east. It is intermediate ecologically in its composition, and frequently in its position, between close bush and thorn veld. The trees grow sometimes isolated, sometimes in clumps. The variable soil conditions, particularly as regards moisture, lead to considerable variation in this type.

In the low veld region on slopes with south exposure thorn thickets are formed of the same composition as the thorn veld, but denser. On slopes with north exposure very xerophytic trees and shrubs (succulents) make up the formation.

### (5) The Alpine Formation.

On the Zwaartkop mountain the presence of many species not found lower down gives it a distinct character, and

certain species connect it with the alpine formation of the Drakensberg.

(6) The Vlei Formation.

The various associations can be graded according to the wetness of the vlei and the amount of stagnation in the water. In the larger vleis the associations are mixed. There is a great variety of associated plants.

(7) The Plant Formations of Streams and Rivers.

Following these downwards, bush, veld, vlei, and rocky hillside formations occur, with a distinct formation in the moist marginal zone. Various associations along the river-side are characteristic (*Pennisetum*, *Phragmites*, *Cyperus*). The trees and shrubs which line the streams and rivers are distinctive both in the high veld region and in the low veld.

The author desires to thank Mr. T. R. Sim, F.L.S., for much assistance, particularly in connection with the floristic work; and he is also indebted to Mr. J. Fisher, B.Sc., of Cedara, Natal, for specimens collected in that neighbourhood.

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EXPLANATION OF MAP AND OF PLATES  
XL—XLVI,

Illustrating Professor J. W. Bews's paper, "An Ecological Survey of the Midlands of Natal with Special Reference to the Pietermaritzburg District."

MAP.

In the vegetation map as first prepared by the writer the plant formations were represented by different colours. Since the line of demarcation between high and low veld is nowhere clearly defined, but, on the contrary, the unstable *Andropogon* associations occupy

the transitional belt between the two, and these grade into high veld on the one hand, and low veld on the other, it was, of course, impossible to show any clearly marked boundaries. The *Andropogon* associations were represented by mixing the two colours chosen to represent high veld and low veld.

Since, however, nothing is really gained by using two colours, which adds to the expense of reproducing, the high veld has been represented uncoloured, and the transitional belts (*Andropogon* associations) and low veld have been represented by lighter and deeper shades of the same colour. In the case of the other plant formations—bush, thorn veld, vlei, rocky hillside, plantations—instead of separate colours, various conventional signs have been used, superposed on the colours.

The map thus shows at a glance the main division of the area into high veld region and low veld region. The bush formation, it will be seen, is confined to the high veld, the thorn veld to the low veld region; but vleis of identical character occur in both regions.

The altitude of the main points are given in feet, as mentioned on p. 488; also the various geological strata are indicated. Note that the high veld consists chiefly of Coal Measure Sandstones and arenaceous shales with several large dykes and sills of dolerite, the latter by its decomposition giving rise to the more valuable mineral salts, which, however, get leached out of the high veld soil. The low veld consists mostly of thin beds of Ecca Shales, which lie near the surface.

Dwyka Conglomerate (the lowest beds of the Karroo systems) is exposed at the various points in the low veld region which are marked on the map. Table Mountain Sandstone appears on the extreme right on the rising ground across the Umgeni. Dolerite intrusions occur also in the low veld.

#### PLATES.

NOTE.—In examining these landscape views it should be borne in mind that owing to the peculiar atmospheric conditions of Natal distances are very deceptive, and hills that appear quite near may be thirty or forty miles distant.

Pl. XL.—Albert Falls of the Umgeni. A general view of the low veld alluvial flats (cf. Pl. XLII). In the foreground typical low veld variety of *Anthistiria imberbis*. *Phragmites* lines the river side above and below the falls. Trees and shrubs as described on p. 537. In the background high veld (Karkloof range) with wattle plantations and indigenous bush.

The plants actually gathered near the Albert Falls were the following:

*Phragmites communis*, *Cliffortia strobilifera*, *Helichrysum* spp., *Rubus rigidus*, *Zizyphus mucronata*, *Ficus capensis*, *Combretum salicifolium*, *Chiliantuus dyssohyllus*, *Acacia caffra*, *Dalbergia obovata*, *Rhus* sp., *Celastrus buxifolius*, *Heteromorpha arborescens*, *Asparagus* sp., *Lippia asperifolia*, *Jasminum* sp., *Randia rudis*, *Royena pallescens*, *Vitis orientalis*, *Indigofera* sp., *Epilobium hirsutum*, *Athanasia pennata*, *Aloe saponaria*, *Aster* sp., *Scabiosa columbaria* var. *dissecta*, *Ochna atro-purpurea*, *Setaria imberbis*, *Crassula muscoides*.

Pl. XLI.—Henley. Rocky stream type of bush. List of species as given on p. 520. *Combretum kraussii* is the dominant tree. It is easily recognisable from a distance by the colour of its foliage, which is a light green in early spring and reddish in autumn. High veld is shown in the background.

Pl. XLII.—The Umgeni valley, from Table Mountain (Natal). Thorn veld. This photograph gives a good idea of the rugged country in the low veld region, and should be contrasted with the alluvial flats as shown in Pl. XL. Note how the trees grow closer together near to the river. *Watsonia densiflora* in the foreground (high veld).

Pl. XLIII.—Umlaas River. Thorn veld and denser thorn thicket. For list of species see p. 524.

Pl. XLIV.—Edendale. Rocky hillside formation of high veld region. List of species given on p. 527. High veld with *Anthistiria* and *Andropogon* spp. on the left, *Cussonia spicata* in the foreground.

Pl. XLV.—Below Howick Falls. Rocky hillside formation of low veld region. Thorn thicket to the right. Lists of species, p. 528.

Pl. XLVI.—Tugela Valley. Dry river valley with extremely xerophytic plants. See list p. 528. In the foreground *Aloe ferox*, *Euphorbia grandidens* (candelabra form) is conspicuous, and *Euphorbia tirucalli* (more shrubby) is mixed with it.





Beets.

ALBERT FALLS OF UMGENTI. LOW VEGET. ALLUVIAL FLATS.

Adlard & Son, Impri.





*Brews.*

BUSH AT HENLEY. ROCKY STREAM TYPE.

*Atland & Son, Impr.*





*Allerton.*

UMGENI RIVER FROM TABLE MOUNTAIN. THORN VELD.

*Adlard & Son, Impri.*





Atterston.

UMLAAS RIVER, THORN VELD AND THORN THicket.

Atterton & Son, Impr.





*Allerton.*

EDENDALE. ROCKY HILLSIDE AND HIGH VELD.

*Allard & Son, Impr.*





*Allerton.*

BELOW HOWICK FALLS, ROCKY HILLSIDE AND THORN THicket.

*Allard & Son, Inapp.*





*Allerton.*

TUGELA VALLEY. DRY RIVER VALLEY.

*Adlard & Son, Imptr.*

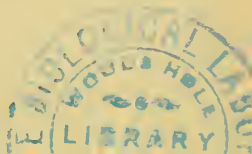


# INDEX OF MOLLUSCA.

(VOL. II.)

Synonyms are indicated by *italics*. New species described in this volume are distinguished by (sp. n.) being placed after the names of the authors.

	PAGE		PAGE
Acanthochites variegatus		<i>Aplysia allochroa</i> Bergh	186
Nierstrasz	211	<i>cirrhifera</i> Quoy &	
Acanthopleura brevispinosa		Gaimard	188
(Sowerby)	211	<i>eusiphonata</i> Bergh	186
granulata		<i>gargantua</i> Bergh	186
(Gmelin)	212	<i>gilchristi</i> Bergh	186
spinigera		<i>lobata</i> Bergh	186
(Sowerby)	211	<i>monochroa</i> Bergh	187
<i>Aclesia cirrhifera</i> (Q. & G.)	188	<i>nigrocincta</i> Martens	187
Afrodonta	333, 334, 335	<i>poikilia</i> Bergh	187
bilamellaris		( <i>Siphonata</i> ) <i>elongata</i>	
(M. & P.)	333, 335	Pease	187
trilamellaris		woodii Bergh	187
(M. & P.)	333, 335	Archidoris capensis Bergh	176
Agriolimax	159, 161	granosa Bergh	176
agrestis (Linn.)	161	scripta Bergh	176
Anatina	214, 219	Argobuccinum (Paralagena)	
Apera	160, 163, 164, 165, 169	clandestinum (Dillwyn)	195
burnupi E. A. Smith	164,	Arion	159, 170
	165, 166, 168, 172, 173	fus cus (Müll.)	170
gibbonsi (W. G. Binn.)	163,	Arionidæ	159, 163, 170
	165, 166, 168	Atopos	169
natalensis Cllge.	164, 165, 167	Aulopoma helicinum (Chemn.)	198
purcelli Cllge.	165, 169		
Aperaidæ Cllge. (fam. nov.)	159, 163	Berthella granulata (Krauss)	189
Aphelodoris brunnea Bergh	179		



	PAGE		PAGE
Calliostoma crossleyæ <i>E. A. Smith</i> (sp. n.)	205, 219	Cleodora acicula ( <i>Rang.</i> )	185
Callochiton dentatus ( <i>Spengler</i> )	210	<i>flexa Pfeiffer</i>	185
planatus ( <i>Spengler</i> )	210	Clio ( <i>Creseis</i> ) acicula ( <i>Rang.</i> )	185
<i>Calyptræa equestris</i> ( <i>Linn.</i> )	201	( <i>Creseis</i> ) virgula ( <i>Rang.</i> )	
Cavolinia inflexa ( <i>Lesueur</i> )	185	var. <i>flexa</i>	185
Ceratoconcha schultzei <i>Simroth</i>	160	Clistoconcha <i>E. A. Smith</i> (g. n.)	217
Cerithiopsis	197	<i>insignis E. A. Smith</i> (sp. n.)	175, 218, 220
<i>peilei E. A. Smith</i> (n. sp.)	196	Cochlogena johnii ( <i>Chemn.</i> )	203
Chætopleura papilio ( <i>Spengler</i> )	210	Colubraria bacillum ( <i>Reeve</i> )	195
Charopa	334	<i>obscura (Reeve)</i>	195
Cheilea	201	Columbella moleculina <i>Duclos</i>	193
Chiton ( <i>Callochiton</i> ) <i>gaimardi Clessin</i>	211	<i>shepstonensis E. A. Smith</i> (sp. n.)	193, 219
<i>dentatus Spengler</i>	210	Cominella	191
<i>fulgetrum Reeve</i>	210	Conus catus <i>Hwass</i>	189
<i>papilio Spengler</i>	210	<i>ceylanensis Hwass</i>	198
<i>planatus Spengler</i>	210	<i>Conus elongatus Reeve</i>	189
<i>watsoni G. B. Sow.</i>	211	Conus gubernator <i>Hwass</i>	190
<i>Chlamydephorus W. G. Binn.</i>	163, 164, 165, 173	<i>moreleti Crosse</i>	189
<i>gibbonsi W. G. Binn.</i>	165	<i>Conus oblitus Reeve</i>	189
Chlamys cuneolus ( <i>Reeve</i> )	212	Conus tulipa <i>Linn.</i>	190
<i>nataleensis Smith</i>	213	Coralliophila coronata <i>H. Adams</i>	194
<i>noduliferus (Sowerby)</i>	212	<i>fragosa E. A. Smith</i> (sp. n.)	194, 219
<i>testudineus (Reeve)</i>	212	<i>Creseis acicula Rang.</i>	185
Chromodoridella mirabilis <i>Eliot</i>	179, 221	<i>virgula Rang.</i>	185
Chromodoris	178, 221	<i>Cuvierina columnella Rang.</i>	186
<i>albolimbata Bergh</i>	178	<i>Cuvierina columnella (Rang.)</i>	186
<i>annulata Eliot</i>	179, 221	Cyclostrema pellucida <i>E. A. Smith</i> (sp. n.)	206, 219
<i>carnea Bergh</i>	179, 225	Cypræa cruenta ( <i>Monstr.</i> )	196
<i>euelpis Bergh</i>	178	<i>Cypræa cruenta var. tortirostris Sowerby</i>	196
<i>lineata (Souleyet)</i>	179, 221	<i>Daphnella casta Hinds</i>	183
<i>porcata Bergh</i>	178, 221, 224, 225	<i>Daphnella minusecula E. A. Smith</i> (sp. n.)	191
<i>runcinata Bergh</i>	178, 221	<i>sulcata</i>	191, 219
Clathurella cardinalis <i>Reeve</i>	191	Diaulula capensis <i>Bergh</i>	177
<i>rava Hinds</i>	191	<i>morosa Bergh</i>	177
<i>westcotti E. A. Smith</i> (sp. n.)	190, 219	Discodoris cœrulescens <i>Bergh</i>	178, 221, 222, 223
<i>zonulata Angus</i>	191		

	PAGE		PAGE
Doridium capense <i>Bergh</i>	185	Geitodoris capensis <i>Bergh</i>	176
<i>Doridopsis</i>	221	<i>Glauconella andersoni</i> <i>G. &amp; H.</i>	
Doriopsisilla capensis <i>Bergh</i>	180	<i>Nevill</i>	183
Doriopsis	180	Glaucaus atlanticus <i>Forster</i>	182
<i>cæsia</i> <i>Bergh</i>	180	Glyphis australis ( <i>Krauss</i> )	208
<i>callosa</i> <i>Bergh</i>	179		
<i>capensis</i> <i>Bergh</i>	179	Haliotis	209
Doris aripona <i>Kelaart</i>	224	<i>emmæ</i> <i>Gray</i>	207
<i>glabella</i> <i>Bergh</i>	177	( <i>Padollus</i> ) parvus <i>Linn.</i>	207
<i>perplexa</i> <i>Bergh</i>	177	( <i>Padollus</i> ) queketti	
<i>pseudida</i> <i>Bergh</i>	177	<i>E. A. Smith</i> (sp. n.)	
<i>setosa</i> <i>Pease</i>	224		206, 219
<i>Doris verrucosa</i> <i>Cuvier</i>	176	<i>Hanleya sykesi</i> <i>Sowerby.</i>	211
		Helenoconcha	333, 334, 335
Emerginula micans <i>A. Adams.</i>	209	Heliacus	200
Endodonta	333, 334, 335	<i>crenellus</i> ( <i>Linn.</i> )	199
<i>bilamellaris</i> ( <i>M. &amp; P.</i> )	335, 337, 338, 340, 343	<i>Helix derbesiana</i> <i>Crosse</i>	340
<i>derbesiana</i> ( <i>Crosse</i> )	340	<i>Helix johnii</i> <i>Chemnitz</i>	205
<i>farquhari</i> <i>Burnup</i>	339,	<i>Helix sealamcllatus</i> ( <i>Pfr.</i> )	340
	340, 341, 343	Hexabranthus adamsii <i>Gray</i>	
<i>inhluzaniensis</i> <i>Bur-</i>			180, 221
<i>nup</i> (sp. n.)	342, 343	<i>Hyalæa inflexa</i> <i>Lesueur.</i>	185
<i>novemlamellaris</i>			
<i>Burnup</i> (sp. n.)	341, 348	Ianthina	202
<i>perfida</i> <i>Burnup</i>		Idalia	222
(n. n.)	337, 339, 343	Idaliella amœnula <i>Bergh</i>	181
<i>quadridens</i> <i>Gude</i>	340	Ischnochiton ( <i>Chondroleura</i> )	
<i>sexlamellata</i> ( <i>Pfr.</i> )	340	<i>simplicissimus</i> <i>Thiele</i>	211
<i>trilamellaris</i>			
( <i>M. &amp; P.</i> )	336, 337, 339,	Janolus capensis <i>Bergh</i>	182
	340		
Epitonium macromphalus <i>E. A.</i>		Kalinga	221
<i>Smith</i> (sp. n.)	203, 219	<i>ornata</i> <i>Alder &amp; Hancock</i>	181
<i>shepstonense</i> <i>E. A.</i>		Kentrodorid labialis <i>C. Eliot</i>	224
<i>Smith</i> (sp. n.)	204, 219		
Eulima leptostoma <i>E. A. Smith</i>		Lamellaria capensis ( <i>Bergh</i> )	202
(sp. n.)	204, 219	<i>leptoconcha</i> ( <i>Bergh</i> )	202
Euplocamus croceus <i>Phil.</i> var.		<i>perspicua</i> ( <i>Linn.</i> )	201
<i>capensis</i> <i>Bergh</i>	180	Lepidopleurus sykesi ( <i>Sowerby</i> )	211
		Leucotina casta <i>A. Ad.</i>	183
<i>Fistulana gregata</i> <i>Lam.</i>	217	<i>Leucotina concinna</i> <i>A. Ad.</i>	183
Fossarus ambiguus ( <i>Linn.</i> )	199	<i>Leucotina elongata</i> ( <i>Sowerby</i> )	183
<i>capensis</i> <i>Pilsbry</i>	199	<i>modesta</i> <i>A. Ad.</i>	183
		<i>natalensis</i> <i>E. A.</i>	
		<i>Smith</i> (sp. n.)	183, 219

	PAGE		PAGE
Limacidae . . . . .	159, 160	Nembrotha . . . . .	221
Limacinae . . . . .	160	<i>capensis</i> Bergh . . . . .	180
Limax . . . . .	159, 160, 163	Neritina <i>souverbiana</i> Mon-	
<i>Limax agrestis</i> Linn. . . . .	161	<i>trouzier</i> . . . . .	204
<i>Limax flavus</i> Linn. . . . .	160	Neritina ( <i>Vitta</i> ) <i>pulcherrima</i>	
<i>Limax fuscus</i> Müller . . . . .	170	<i>Angas</i> . . . . .	204
<i>kraussianus</i> Heynemann . . . . .	163	Notarchus <i>cirrhifer</i> Quoy &	
<i>gagates</i> Drap. . . . .	161	<i>Gaimard</i> . . . . .	188
<i>variegatus</i> Auctt. . . . .	160	Nudibranchia . . . . .	175, 221
Lippistes <i>helicoides</i> ( <i>Gmelin</i> )		Onchidiidae . . . . .	159, 171
	197, 219	Onchidium . . . . .	159, 171
Lucina <i>rosea</i> <i>Angas</i> . . . . .	217	<i>burnupi</i> <i>Cllege</i> . . . . .	171
		<i>peronii</i> <i>Cuv.</i> . . . .	171
<i>Mactra aegyptiaca</i> <i>Chemnitz</i> . . . . .	214	<i>Onchidium peronii</i> <i>Savigny</i> . . . . .	172
<i>Mangila beckeri</i> <i>Sowerby</i> . . . . .	190	<i>savignyi</i> <i>Semper</i> . . . . .	172
<i>elizabethæ</i> <i>E. A. Smith</i>		<i>tonganum</i> <i>Quoy &amp;</i>	
(sp. n.) . . . . .	190, 219	<i>Gaimard</i> . . . . .	171
<i>Marginella ingloria</i> <i>E. A. Smith</i>		Oopelta . . . . .	159, 170
(sp. n.) . . . . .	191, 219	Opisthobranchia . . . . .	176
<i>Marionia arborescens</i> <i>Bergh</i>		Oscaniopsis <i>pleurobranchæana</i>	
	181, 221, 222	<i>Bergh</i> . . . . .	188
<i>Marsenia capensis</i> <i>Bergh</i> . . . . .	202	<i>Ostrea perna</i> <i>Linn.</i> . . . .	213
<i>leptoconcha</i> <i>Bergh</i> . . . . .	202	Oscaniella <i>nigropunctata</i> <i>Bergh</i> . . . . .	189
<i>perspicua</i> ( <i>Linn.</i> ) . . . . .	202	<i>Parmarion flavescens</i> <i>Kefer-</i>	
<i>Martesia falcata</i> "Gray" . . . . .	216	<i>stein</i> . . . . .	162
<i>Martesia striata</i> ( <i>Linn.</i> ) . . . . .	216	Patella <i>barbara</i> . . . . .	209, 210
<i>Melibe</i> . . . . .	222	<i>Patella chinensis</i> <i>Linn.</i> . . . .	201
<i>rosea</i> <i>Rang.</i> . . . .	182	<i>crepidula</i> <i>Linn.</i> . . . .	201
<i>Melina perna</i> ( <i>Linn.</i> ) . . . . .	213	<i>equestris</i> <i>Linn.</i> . . . .	201
<i>Mitra cancellarioides</i> <i>Anton</i> . . . . .	192, 193	<i>fornicata</i> <i>Linn.</i> . . . .	201
<i>nodosa</i> <i>Reeve</i> . . . . .	192	<i>Patella patriarcha</i> <i>Pilsbry</i> . . . . .	209, 210
<i>nodosa</i> <i>Swainson</i> . . . . .	192	<i>Patella plicata</i> <i>Born</i> . . . . .	209
<i>Mitra pinguis</i> <i>Reeve</i> . . . . .	193	<i>porcellana</i> <i>Linn.</i> . . . .	201
(Pusia) <i>tuberculata</i>		<i>Patella rustica</i> <i>Linn.</i> . . . .	209
<i>Kiener</i> . . . . .	192	<i>Pecten rustica</i> <i>Reeve</i> (nec	
(Pusia) <i>tuberculata</i>		<i>Linn.</i> ) . . . . .	209, 210
<i>Kiener</i> var. <i>cancellari-</i>		<i>cuneolus</i> <i>Reeve</i> . . . . .	212
<i>oides</i> <i>Anton</i> . . . . .	193	<i>noduliferus</i> <i>Sowerby</i> . . . . .	212
<i>tuberculata</i> <i>Kiener</i> . . . . .	192	<i>testudineus</i> <i>Reeve</i> . . . . .	212
<i>Mitralaria equestris</i> ( <i>Linn.</i> ) . . . . .	201	Pectinibranchia . . . . .	189
<i>Murex clandestinus</i> ( <i>Chemnitz</i> ) . . . . .	195	Pelecypoda . . . . .	212
<i>Mya vulsella</i> <i>Linn.</i> . . . .	213	<i>Perna</i> ( <i>Isognomon</i> ) <i>samoensis</i>	
		<i>Baird</i> . . . . .	213
<i>Nassa</i> . . . . .	197	<i>sulcata</i> <i>Lamk.</i> . . . .	213

	PAGE		PAGE
<i>Peronia mauritiana</i> Blain . . . . .	171	<i>Scalaria</i> . . . . .	203
<i>Philine aperta</i> (Linn.) . . . . .	184	<i>Schismope carinata</i> (A. Adams)	207, 220
<i>berghi</i> E. A. Smith		<i>insignis</i> E. A. Smith	
(n. n.) . . . . .	184	(sp. n.) . . . . .	208, 220
<i>Philine capensis</i> Bergh . . . . .	184	<i>Schizoglossa</i> . . . . .	169, 173
<i>schæteri</i> Phil. . . . .	184	<i>Scissurella carinata</i> A. Adams . . . . .	207
<i>Pholas cuneiformis</i> Say . . . . .	216	<i>Scissurella juncunda</i> E. A. Smith	
<i>falcata</i> Wood . . . . .	216	(sp. n.) . . . . .	207; 219
<i>Pleurobranchæa capensis</i> (Vays- sière). . . . .	188	<i>Scutibranchia</i> . . . . .	204
<i>melanopus</i>		<i>Separatista chemnitzii</i> A. Ad. . . . .	197
<i>Bergh</i> 188		<i>Sigaretus planulatus</i> Recluz. . . . .	202
<i>Pleurobranchus granulatus</i>		<i>Siphonaria cyaneomaculata</i>	
<i>Krauss.</i> 189		<i>Sowerby</i> . . . . .	176
<i>Pleurophyllidia uchroa</i> Bergh . . . . .	182	<i>Siphonata elongata</i> Pease . . . . .	187
<i>gilchristi</i>		<i>Siphonium</i> ( <i>Dendropoma</i> ) <i>leu-</i>	
<i>Bergh</i> 182		<i>cozonias</i> Morch. . . . .	198
<i>microdonta</i>		<i>Smaragdinella andersoni</i> (G. & H. Nevill) . . . . .	183, 184
<i>Bergh</i> 182		<i>Solarium</i> . . . . .	200
<i>Polyplacophora</i> . . . . .	210	<i>Solarium chemnitzii</i> Kiener . . . . .	199
<i>Prolepis fusca</i> Malm. . . . .	170	<i>cyliindraceum</i> Hanley 199	
<i>Pulmonata</i> . . . . .	176	<i>infundibuliforme</i>	
<i>Pupa johnii</i> (Chemn.) . . . . .	203	(Gmel.) 199	
<i>Rathonisiidæ</i> . . . . .	169	<i>infundibuliforme</i>	
<i>Recluzia hargravesi</i> Cox 202, 203		(Gmel.) var. <i>strigata</i> 199	
<i>Recluzia jehennei</i> Petit 202, 203		<i>Sphenia</i> . . . . .	214
<i>Recluzia johnii</i> (Chemn.) . . . . .	203	<i>natalensis</i> E. A. Smith	
<i>montrouzieri</i> Souvèrbie		(sp. n.) . . . . .	214, 220
202, 203		<i>Standella ægyptiaca</i> (Chem- nitz) . . . . .	214
<i>rollandiana</i> Recluz. 202, 203		<i>Staurodoris verrucosa</i> (Cuvier)	176, 222
<i>Ringicula australis</i> Crosse MS. 184			
<i>australis</i> Hinds . . . . .	184	<i>Terebra filmeræ</i> Sowerby . . . . .	189
<i>Rissoa adjacens</i> E. A. Smith		<i>Teredo clava</i> Gmelin . . . . .	217
(sp. n.) . . . . .	201, 219	<i>gregata</i> Sowerby . . . . .	217
<i>æqua</i> . . . . .	200	( <i>Hyperotus</i> ) <i>gregata</i>	
<i>atomus</i> Smith . . . . .	201	<i>Sowerby</i> . . . . .	217
<i>farquhari</i> E. A. Smith		<i>nucivorus</i> Spengler . . . . .	217
(sp. n.) . . . . .	200, 219	<i>skutschburyi</i> Leach . . . . .	216
<i>vaga</i> . . . . .	200	<i>Teredo stutchburyi</i> Sowerby . . . . .	216
<i>Saxicava arctica</i> . . . . .	215	<i>Testacella</i> . . . . .	164, 169
<i>aronacea</i> E. A. Smith		<i>Testacellidæ</i> . . . . .	164, 169, 172, 173
(sp. n.) . . . . .	215, 220		
<i>lirata</i> E. A. Smith			
(sp. n.) . . . . .	214, 220		

	PAGE		PAGE
Tethys allochroa ( <i>Bergh</i> )	. 186	Tritonidoxa capensis <i>Bergh</i>	. 181
burnupi ( <i>Burne</i> )	. 188	Trochus cariniferus <i>Reeve</i>	. 205
elongata ( <i>Pease</i> )	. 187	( <i>Infundibulops</i> ) cari-	
eusiphonata ( <i>Bergh</i> )	. 186	niferus <i>Reeve</i>	. 205
gargantua ( <i>Bergh</i> )	. 186	Turbo argyrostoma <i>Linn.</i>	. 205
gilechristi ( <i>Bergh</i> )	. 186	Turbo crenellus <i>Linn.</i>	. 199
lobata ( <i>Bergh</i> )	. 186	<i>helicoides</i> <i>Gmelin</i>	. 197
monochroa ( <i>Bergh</i> )	. 187	<i>separatista</i> <i>Chemnitz</i>	. 197
nigrocincta ( <i>Martens</i> )	. 187	Turritella natalensis <i>E. A.</i>	
operta <i>Burne</i>	. 188	<i>Smith</i> (sp. n.)	. 198, 219
poikilia ( <i>Bergh</i> )	. 187	Uperotis clava ( <i>Gmelin</i> )	. 217
woodii ( <i>Bergh</i> )	. 187	Urocyclidæ	. 159, 161
Thaumatodon	333, 334, 335, 343	Urocyclus	. 159, 161
<i>derbesiana</i> <i>Crosse</i>		<i>fasciatus</i> <i>Marts.</i>	. 162
	177, 221, 340	<i>flavescens</i> ( <i>Keferst.</i> )	. 162
Thordisa burnupi <i>Eliot</i> (sp. n.)	223	<i>kirkii</i> <i>Gray</i>	. 161, 162
<i>maculigera</i> <i>Bergh</i>	. 224	<i>kraussianus</i> ( <i>Heyn.</i> )	. 163
<i>maculosa</i> <i>Bergh</i>	. 224	<i>pallescens</i> <i>Ckll.</i>	. 162
<i>punctulifera</i> <i>Bergh</i>		<i>Vaginulus natalensis</i> v. <i>Rapp.</i>	. 170
	177, 224	<i>Vanikoro natalensis</i> <i>Smith</i>	. 201
Torinia	. 199	<i>Veronicella</i>	. 170
<i>Trachycystis rotula</i> <i>M. &amp; P.</i>	. 200,	<i>natalensis</i> (v. <i>Rapp.</i> )	170
	334, 337	<i>saxicola</i> <i>Ckll.</i>	. 171
<i>Trichotropis blainvilleanus</i>		<i>Veronicellidæ</i>	. 159, 170
<i>Petit</i>	. 198	<i>Vulsella lingulata</i> <i>Lam.</i>	. 213
<i>Trifora burnupi</i> <i>E. A. Smith</i>		<i>Vulsella vulsella</i> ( <i>Linn.</i> )	. 213
(sp. n.)	. 196, 219	<i>Xylotrya stutchburyi</i> ( <i>Sower-</i>	
<i>Triopa lucida</i> <i>Stimpson</i>	. 180	<i>by</i> )	. 216, 220
<i>Triton bacillum</i> <i>Reeve</i>	. 195		
<i>clandestinus</i> ( <i>Dillwyn</i> )	. 195		
<i>obscurus</i> <i>Reeve</i>	. 195		
<i>Tritonia indecora</i> ( <i>Bergh</i> )	. 181		
<i>pallida</i> <i>Stimpson</i>	. 181		

# GENERAL INDEX

(EXCLUDING MOLLUSCA).

(VOL II.)



Synonyms are indicated by *italics*. New species described in this volume are distinguished by (sp. n.) being placed after the names of the authors.

	PAGE		PAGE
Aapsekost . . . . .	326	Achyranthes avicularis <i>E. M.</i>	43, 87, 98
Abrus precatorius <i>Linn.</i>	39, 81, 95	Acidanthera platypetala <i>Baker</i>	506
Abutilon sonneratianum <i>Cav.</i>	311, 513	Acokanthera spectabilis <i>Bth.</i>	325
Acacia . . . . .	297, 528, 538	Aceridocarpus . . . . .	305
<i>arabica</i> <i>Willd.</i> var. <i>kraus-</i>		Acrolepis . . . . .	230, 231
<i>siana</i> . . . . .	285, 310, 330, 524	<i>africana</i> <i>R. H. Tra-</i>	
<i>caffra</i> <i>Willd.</i> . . . . .	310, 325, 330,	<i>quair</i>	230
. . . . .	524, 537, 545	<i>digitata</i> <i>A. S. Wood-</i>	
<i>caffra</i> <i>Willd.</i> var. <i>ru-</i>		<i>ward</i>	230
<i>pestris</i> . . . . .	310, 312, 524, 528	<i>molyneuxi</i> <i>A. S. Wood-</i>	
<i>eriadenia</i> <i>Bth.</i> . . . .	528	<i>ward</i> . . . . .	230, 231
<i>hirtella</i> <i>Willd.</i> . . . .	310, 325, 524	Acrostichum aureum <i>Linn.</i>	298, 324
<i>horrida</i> <i>Willd.</i> . . . .	310, 312, 325,	<i>tenuifolium</i> <i>Baker</i>	304
. . . . .	330, 524, 528	Adenocline . . . . .	299, 518
<i>mollissima</i> <i>Willd.</i> . . .	262, 311,	<i>serrata</i> <i>Turcz.</i> . . . .	506
. . . . .	324, 331, 495, 499,	Adjuratum . . . . .	514
. . . . .	502, 537, 538	Agapanthus umbellatus	
<i>natalitia</i> <i>E. M.</i> . . . .	296, 299	<i>L'Herit.</i>	59, 89, 91
<i>pennata</i> <i>Willd.</i> . . . .	518, 519	Agrimonia eupatoria <i>Linn.</i>	22, 81, 97
Acalypha . . . . .	319	Ajuga ophrydis <i>Burch.</i> . .	319, 506
<i>peduncularis</i> <i>Meisn.</i>	41, 88, 101	Albizzia fastigata <i>Oliv.</i> =	
Acanthodrilacea . . . . .	406	<i>Flatcrown</i> . . . . .	13, 66, 67, 80, 101,
Acanthodrilinae 400, 403, 406, 411, 454		. . . . .	299, 300, 325
Acanthodrilus . . . . .	[ 400, 407	Albuca . . . . .	319
		<i>pachychlamys</i> <i>Baker</i> . .	507

- |  | PAGE   |                                      | PAGE   |
|--|--|--------------------------------------|--|
| <i>Alchemilla capensis</i> Thb.              | 535  | <i>Andropogon cymbarius</i> Linn.    | 313, 507   |
| Alcoholism                                   | 75   | <i>dichroos</i> Steud.               | 507  |
| <i>Alepeidea amatymbica</i> E. & Z.          | 505, 531   | <i>dregeanus</i> Nees                | 313,<br>507, 511, 536                                  |
| <i>Aloe cooperi</i> Baker                    | 506, 527, 530  | <i>eucomus</i> Nees                  | 313  |
| <i>ferox</i> Miller                          | 51, 89, 94, 319,<br>506, 527, 528, 545   | <i>filifolius</i> Steud.             | 507  |
| <i>marlothii</i> Berger                      | 312  | <i>flipendulus</i> Hochst.           | 286,<br>300, 306, 313, 315,<br>321, 325, 507           |
| <i>natalensis</i> W. & E.                    | 312, 319,<br>527, 530, 531   | <i>hirtus</i> Linn.                  | 313, 314,<br>317, 500, 507, 508,<br>511, 512, 515, 541 |
| <i>saponaria</i> Harr.                       | 506, 513, 545  | <i>intermedius</i> R. Br.            |  |
| <i>supra-lævis</i> Harr.                     | 295, 296   | var. <i>punctatus</i>                | 313  |
| <i>Alsodeia</i>                              | 518  | <i>marginatus</i> Steud.             | 20, 90, 101  |
| <i>Alysicarpus wallachii</i> Wight &<br>Arn. | 44, 81, 96   | <i>nardus</i> Linn.                  | 286, 300, 321  |
| Amarantaceæ                                  | 87   | <i>nardus</i> Linn. var.             |  |
| <i>Amarantus paniculatus</i> Linn.           | 506,<br>513, 514   | <i>marginatus</i>                    | 306, 313,<br>315, 321, 325, 507                        |
| <i>thunbergii</i> Moq.                       | 506  | <i>nardus</i> Linn. var.             |  |
| Amaryllideæ                                  | 89   | <i>validus</i>                       | 507  |
| <i>Ammocharis falcata</i> Herb.              | 513  | <i>pertusus</i> Willd.               | 313,<br>317, 500, 507, 508,<br>511, 515, 541           |
| Ampelideæ                                    | 80   | <i>plurinodis</i> Stapf.             | 507, 511   |
| <i>Amphidoxa gnaphaloides</i> DC.            | 505  | <i>schirensis</i> Hochst.            | 313, 507   |
| <i>Amphitherium</i>                          | 132, 133, 139  | <i>schœnanthus</i> Linn.             |  |
| <i>Amplorhius nototænia</i> Gunth.           | 481  | var. <i>versicolor</i>               | 313,<br>507, 508, 511                                  |
| <i>Amyntas heterochaetus</i> (Mich.)         | 417  | <i>sorghum</i> Brot. =<br>Kafir corn | 325  |
| Anacardiaceæ                                 | 80   | <i>Aneura</i>                        | 309  |
| <i>Anaphe panda</i> Boisd.                   | 291  | <i>anga</i>                          | 5  |
| <i>Androcymbium natalense</i><br>Baker       | 507  | <i>Angræcum</i>                      | 304, 519   |
| <i>Andropogon</i>                            | 258, 315, 316, 329, 330,<br>491, 493, 500, 501, 503,<br>507, 508, 509, 513, 515,<br>516, 522, 526, 531, 532,<br>533, 535, 537, 542, 543,<br>544, 545 | <i>Animula</i>                       | 291  |
| <i>amplectens</i> Nees                       | 313,<br>317, 507, 511  | <i>Anoiganthus brevifolius</i> Baker | 318,<br>323, 506, 534                                  |
| <i>appendiculatus</i><br>Nees                | 507, 511   | <i>Anomodontia</i>                   | 136  |
| <i>auctus</i> Stapf.                         | 313, 507, 511  |                                      |  |
| <i>ceresiæformis</i> Nees                    | 286,<br>313, 315, 330, 500,<br>503, 511, 515, 541  |                                      |  |
| <i>contortus</i> Linn.                       | 313  |                                      |  |

	PAGE		PAGE
Antarctic Expedition, National	144	Aristida junciformis <i>T. &amp; R.</i>	315, 316,
Anthericum . . . . .	319		317, 500, 503, 508, 509,
<i>elongatum Willd.</i>	534		511, 512, 513, 516, 526,
Anthistiria . . . . .	315, 316, 330,		530, 536, 541
331, 508, 509, 511, 513,		Aroideæ . . . . .	90
517, 531, 532, 541, 545		Artemisia <i>afra Jacq.</i>	45, 83, 94,
<i>imberbis Retz.</i>	286, 311,	306, 325, 505, 517, 527	
313, 315, 316, 325,		Arundinaria <i>tesselata Munro</i>	308
330, 487, 490, 493,		Arundinella <i>ecklonii Nees</i>	306,
500, 502, 503, 507,		322, 517, 533, 536	
508, 510, 512, 515,		Ascarids . . . . .	21
541, 544		Asclepiadaceæ . . . . .	85, 305
Anthoceros . . . . .	309	Asclepias <i>albens Sohl.</i>	506
Antholyza <i>paniculata Klatt.</i>		Ascolepis . . . . .	322
30, 89, 96		<i>capensis Ridl.</i>	503, 534
Anthoxanthum <i>ecklonii Stapf.</i>		Asparagus . . . . .	39, 90, 305, 319, 543
314, 530		<i>medeoloides Thb.</i>	522
Antidesma <i>venosum E. M.</i>		<i>plumosus Baker</i>	
23, 88, 91, 299		301, 303, 519	
Aphodius <i>marginicollis Har.</i>	19	Aspidium <i>flix-mas Sw.</i>	536
Apocynaceæ . . . . .	85	Asplenium <i>conneatum Linn.</i>	518
Apodolirion <i>buchanani Baker</i>		<i>erectum Bory</i>	
318, 506		301, 303, 518	
Apodytes <i>dimidiata E. M.</i>	20, 79,	<i>rutæfolium Kze.</i>	519
92, 296, 302, 303, 304, 325		Assegai tree . . . . .	326
Aponogeton <i>natalense Oliv.</i>	323, 534	Assegaihout . . . . .	326
Apternodus . . . . .	133	Aster . . . . .	545
Aquatic vegetation . . . . .	323	<i>asper Less.</i>	12, 23, 34, 40, 42,
Araliaceæ . . . . .	82	83, 92, 505, 513	
Araucarioxylon <i>latiporosum</i>		<i>eregeroides Harv.</i>	20, 23, 28,
<i>Kraus.</i>	356	83, 101	
Argyrolobium <i>adscendens</i>		Asthma . . . . .	38
<i>Walp.</i>	518	Athanasia <i>acerosa Harv.</i>	
<i>marginatum</i>		505, 517, 522	
<i>Bolus</i>	24, 25,	<i>pinnata Linn. f.</i>	545
80, 102		Attheylla <i>warreni Brady (sp. n.)</i>	
<i>rupestre Walp.</i>	505	463, 473	
<i>stipulaceum</i>		augur = soothsayer . . . . .	5
<i>E. &amp; Z.</i>	505	Avicennia <i>officinalis Linn.</i>	
<i>uniflorum Harv.</i>	505	297, 325, 329	
Aridity, increase in . . . . .	499	Axonopus <i>semialatus Hk.</i>	503, 530
Aristida . . . . .	315, 316, 509, 510, 531	Baakhout . . . . .	326
<i>angustata Stapf.</i>	313,	uBabe (omKulu) = Buffalo-	
317, 511, 512		grass . . . . .	328
<i>barbicollis T. &amp; R.</i>	313, 316		

	PAGE		PAGE
Backache . . . . .	48	imBhulu . . . . .	69, 71
ba-file . . . . .	9	iBhuma = Bulrush . . . . .	53, 56, 90, 91
ba-godukile = "gone home" = died . . . . .	9	iBhungane . . . . .	18
Ballota africana <i>Benth.</i> . . . .	513	uBhusha . . . . .	53, 100
uBani . . . . .	59, 89, 91	Bidens pilosa <i>Linn.</i> = Black- jack . . . . .	25, 83, 100, 311, 514, 515, 538
umBanda . . . . .	30, 91	Bilharzia . . . . .	48
uBangalala . . . . .	50, 53, 91	isiBindi . . . . .	8
isiBangamlotha . . . . .	23, 88, 91	umBindi . . . . .	326
umBangandlala . . . . .	18, 82, 91, 326	umBinza . . . . .	326
Baphia racemosa <i>Hochst.</i> . . . .	299	Bitis arietans <i>Merr.</i> . . . .	71
Barometric pressure in Natal . . .	288	Bitter almond . . . . .	328
Barrenness . . . . .	53, 55	Bitter blaar . . . . .	325
Barringtonia association . . . . .	298	Bituminous coal . . . . .	371, 375
<i>racemosa Roxb.</i> . . . .	298	Bixineæ . . . . .	77
<i>speciosa</i> . . . . .	216, 217	Blackbark . . . . .	328
Bastard ironwood . . . . .	327	Black hairless dog . . . . .	235
Bastard olive . . . . .	325	hairless duiker . . . . .	235
white ironwood . . . . .	326	ironwood . . . . .	327
Bathvillite . . . . .	375, 376	Blackjack . . . . .	25
Bauria . . . . .	136	Black stinkwood . . . . .	327
Beaufort Series . . . . .	228, 255, 349, 350	Blackwood . . . . .	325
Belamcanda . . . . .	25	Blauwbos . . . . .	328
<i>punctata Moench.</i> . . . .	63, 92	Blepharis . . . . .	320, 506
amaBele = Kafir corn . . . . .	2, 54, 325	Blinkblaar . . . . .	328
isiBele = Breast disease . . . . .	37	Blood-cupping . . . . .	13
Belmontia . . . . .	320	Blue grass . . . . .	511
umBengele . . . . .	328	Boetebosje . . . . .	329
Berkheya . . . . .	67, 101, 306, 320, 505, 522	Bogabog . . . . .	329
<i>Berkheya echinopoda DC.</i> . . . .	505	Bogwood . . . . .	327
<i>platyptera Harv.</i> . . . .	505	iBohlololo . . . . .	39, 60, 84, 91
<i>Berkheya setifera DC.</i> . . . .	505	umBomvane . . . . .	33, 79, 91, 326
Bersama lucens <i>Szysz.</i> . . . .	13, 55, 80, 98	umBonemfane . . . . .	327
Beta-umTunzi . . . . .	325	Bopusia scabra <i>Presl.</i> . . . .	23, 33, 46, 65, 86, 96, 506
Beukenhout = Cape Beech . . . . .	327	Bos bubalis <i>Linn.</i> . . . .	241
imBhabazane . . . . .	53, 88, 91	gwarri . . . . .	326
isiBlaha . . . . .	41, 46, 50, 58, 61, 91	Bosch taabosch . . . . .	328
iBheja . . . . .	23, 33, 46, 65, 86, 96	Box wattle . . . . .	327
iBhinini . . . . .	22, 34, 84, 91	iBoza . . . . .	25, 41, 60, 87, 91
imBhiza . . . . .	17	Braambos . . . . .	328
isiBhobo . . . . .	7, 60	Bramble . . . . .	328
imBhozisa . . . . .	34, 91	Brachycorythis . . . . .	319, 506
uBhuhubhu . . . . .	64, 80, 91	<i>vubescens Harv.</i> . . . .	531
iBhucu . . . . .	49, 52, 66, 90, 91		
imBhulelo . . . . .	11		

	PAGE		PAGE
Brachylæna elliptica <i>Less.</i>	296, 303, 325	Calcified wood . . . . .	350, 363
<i>discolor DC.</i>	20, 83,	Calamagrostis huttoniæ <i>Hack.</i>	533
	100, 294, 325	Calamelaps concolor <i>Smith</i>	480
Bracken . . . . .	517, 530	<i>polylepis Boc.</i>	480
Bridelia micrantha <i>Planch.</i>	299	<i>Calamelaps warreni Boul.</i>	480, 481
Broken limbs and sprains	70, 85, 88, 89	Calanthe natalensis <i>Reichb. f.</i>	305
Bromus maximus <i>Desf.</i>	534	Callidrilus . . . . .	405
Broteas falcifer <i>Lovén</i>	467	Callilepis laureola <i>DC.</i>	12, 23, 27,
Brownlea . . . . .	319, 506	83, 100	
Bruguiera gymnorhiza <i>Lam.</i>	297, 325	Callitriche bolusii <i>Sch. &amp; Pax.</i>	323, 536
Brunsvigia . . . . .	506	Callitris cupressoides <i>Schrad.</i>	308
iBuba = syphilis . . . . .	51	Calodendron capense <i>Thb.</i>	52, 299,
Buchnera . . . . .	320	300, 301, 302, 325, 518, 519, 523	
Buddleia salviæfolia <i>Lam.</i>	303, 312,	Calotermes durbanensis	
325, 518, 520, 521, 527, 530, 535		<i>Haviland</i>	114, 116
Buffalo-grass . . . . .	328	<i>flavicollis (Fabr.)</i>	117
Buffalo-thorn . . . . .	329	Calpurnia lasiogyne <i>E. M.</i>	75, 81,
Buffelsbal . . . . .	326	95, 301, 518	
Buffels doorn . . . . .	329	Camdeboo stinkwood . . . . .	325
hoorn . . . . .	325	Camel-thorn . . . . .	325
Bulbine asphodeloides <i>R. &amp; S.</i>	319	Camphorhout . . . . .	328
<i>natalensis Baker</i>	49, 66, 90, 91	Camptocereus aloniceps <i>Ekman.</i>	468, 474
Bulbostylis . . . . .	322	Camptonose . . . . .	149
<i>cinnamonea C. B.</i>		Canavalia . . . . .	305
<i>Clarke</i>	503	<i>bonariensis Ldl.</i>	295
Bull-dog headed calf . . . . .	235	Cancer . . . . .	66
fishes . . . . .	249	Candana = <i>Royena villosa L.</i>	328
uBulungubenyoka* . . . . .	325	Candlewood . . . . .	326
Buphæne disticha <i>Herb.</i>	318, 506	Cannabis sativa <i>Linn.</i>	102
Burchellia capensis <i>R. Br.</i>	299, 301,	Cannel coal . . . . .	375
518, 527, 535		Cape ash . . . . .	326
Burweed . . . . .	329	beech . . . . .	327
Bush, close . . . . .	516	gooseberry . . . . .	514
Bush-fig . . . . .	326	mahogany . . . . .	329
Bush-fires . . . . .	496	plane . . . . .	327
Bush gwarri . . . . .	326	teak . . . . .	328
lily . . . . .	521	Capparidæ . . . . .	78
Bush, retrogression of . . . . .	522	Capparis . . . . .	296, 312, 528
Bush willow . . . . .	325	<i>citrifolia Lam.</i>	325
bw-anga = medicine . . . . .	5	<i>corymbifera E. M.</i>	17, 38,
Cabbage tree . . . . .	326	40, 53, 78, 101	
		<i>gneinzii Sond.</i>	40, 41, 78, 97
		Cardiospermum . . . . .	305

	PAGE		PAGE
Cardiospermum halicacabum		Ceratotheca triloba <i>E. M.</i>	
<i>Linn.</i>	29, 49, 34,		25, 86, 92, 506
	66, 80, 103	Ceriodaphnia natalis <i>Brady</i>	. 468
Carebara vidua <i>F. Smith</i>	. 120	Ceropegia	. 528
Carex	322, 534	<i>umCeya</i>	. 328
<i>dregeana Kth.</i>	. 503	Chætachme aristata <i>Planch.</i>	31, 88,
Carissa arduina <i>Linn.</i>	. 325		95, 299
<i>grandiflora A. DC.</i>	. 294,	<i>meyeri Harv.</i>	31, 69, 88
	295, 325	Charopa	. 334
Cassia mimosoides <i>L.</i>	. 320, 505	Cherrywood	. 328
<i>occidentalis Linn.</i>	74, 81	Chenolea	. 297
Cassine albanensis <i>Sond.</i>	295, 296	<i>diffusa Thb.</i>	297, 329
Cassinopsis capensis <i>Sond.</i>	301, 518	Chenopodium ambrosioides	
Cassipourea verticillata		<i>Linn.</i>	. 514
<i>N. E. B.</i>	299	Chest complaints	. 78, 79, 80,
Castor-oil plant	. 69, 328, 514		81, 82, 83, 84, 87, 88, 89, 90
Cassytha capensis <i>Meisn.</i>	304, 519	Chillingham or Park Cattle	. 240
Catarrh	34, 77, 80, 81, 83,	Chilianthus dysophyllus	
	84, 86, 88, 89	<i>A. DC.</i>	. 313, 522,
Caterpillars	. 291		524, 527, 545
nCathueathu	. 50, 52, 78, 91	<i>oleaceus Burch.</i>	. 325
Cat-thorn	. 325	Chilota	. 400, 403, 404, 406
Cattle-tracks	. 496	<i>braunsi Mich.</i>	400, 406, 416,
Cave Sandstone	. 255		451, 454, 458
Celastrineæ	. 79	<i>exul (Rosa.)</i>	. 404
Celastrus	40, 79, 94, 310	<i>tragardhi Mich.</i>	399, 400,
<i>acuminatus Linn.</i>	325, 527		406, 414, 415, 451, 454, 458
<i>angularis Sond.</i>	295, 303	<i>wahlbergi Mich.</i>	400, 406,
<i>buxifolius Linn.</i>	38, 79, 94,		416, 451, 454
	296, 300, 301, 310, 312,	<i>wahlbergi Mich. f. pul-</i>	
	313, 325, 518, 519, 524,	<i>chrior</i>	. 406
	527, 537, 545, 528	<i>warreni Mich. (n. sp.)</i>	406,
<i>maritima Bolus</i>	. 296		411, 414, 452, 454, 458
<i>nemorosus E. &amp; Z.</i>	. 518	Chilotacea	. 403, 404, 406, 454
<i>peduncularis Sond.</i>	. 325	Chironia baccifera <i>L.</i>	. 295
<i>procumbens Linn.</i>	. 295	<i>purpurascens Bth. &amp;</i>	
Celtis kraussiana <i>Bernh.</i>	. 300,	<i>Hook. f.</i>	. 534
	301, 302, 303, 304, 308,	Chlamydophorous	. 164
	325, 518, 519, 520, 523	Chloris	. 508
Centetes	. 129	<i>gayana Kth.</i>	. 313
Cephalophus grimmi ( <i>Linn.</i> )	. 235	<i>petræa Thb.</i>	313, 317, 511
Cephalanthus natalensis <i>Oliv.</i>	313	<i>pyenothrix Trin.</i>	313, 503, 511
Cerastium dregeanum <i>Fenzl</i>	. 320	<i>virgata Swartz</i>	. 313
Ceratosicyos ecklonii <i>Nees</i>	305, 519	Chlorocodon whitei <i>Hk. f.</i>	24, 85, 88
Ceratophyllum	. 536	Chlorophytum	. 518

	PAGE		PAGE
umChoboko = Scrofula . . . . .	16	Cluytia pulchella <i>Linn.</i> . . . . .	25, 30, 71,
isiChonco = Cold infusion . . . . .	13	88, 99, 299, 300, 301, 303, 325,	506, 518
Christmas bush = Pavetta		Cnestis . . . . .	305
caffra <i>Thb.</i> . . . . .	327	natalensis <i>Pl. &amp; Sond.</i>	296, 519
tree = Pavetta		Coal Measures . . . . .	146, 228, 348, 349,
lanceolata <i>Eck.</i> . . . . .	327	350, 351, 354, 370, 381	
Chronic bronchitis . . . . .	38	Cola natalensis <i>Pl. &amp; Sond.</i> . . . . .	325
coughing . . . . .	78, 83	Colobodus africanus <i>R. H. Tra-</i>	
Chrysochloris . . . . .	129, 130, 133, 134,	quair . . . . .	230
135, 137, 138, 139		Combretum . . . . .	302, 305, 331
asiatica ( <i>Linn.</i> ) . . . . .	130,	kraussii <i>Hochst.</i> . . . . .	300,
131, 132, 135, 138		302, 308, 325, 329, 518,	520, 523, 545
<i>Chrysochloris aurea</i> ( <i>Zimm.</i> ) . . . . .	130	riparium <i>Sond.</i> . . . . .	527, 535
<i>capensis</i> <i>Deam.</i> . . . . .	130	salicifolium <i>E. M.</i>	307, 325, 537, 545
Chrysochloris, dentition of . . . . .	129	Commelina . . . . .	507
<i>granti</i> . . . . .	130	gerrardi <i>C. B. C.</i>	286, 322, 534
<i>hottentota</i>		Commiphora caryæfolia <i>Oliv.</i>	310, 325, 528
<i>A. Smith</i> . . . . .	131, 132,	harveyi <i>Engl.</i>	312, 325, 528
133, 138		Compositæ . . . . .	83, 84, 305
<i>obtusirostris</i>		Consumption . . . . .	38
<i>Peters</i> . . . . .	132, 133	Contact-dolerite . . . . .	156, 157
<i>trevelyani</i> <i>Gunth.</i> . . . . .	130	Contact of dolerite with sand-	
<i>villosa</i> <i>A. Smith</i>		stone . . . . .	393
130, 131, 132, 139		Convolvulaceæ . . . . .	85
Chrysophyllum natalense <i>Sond.</i> . . . . .	325	Convolvulus major = <i>Ipomœa</i>	
Chyle-channels in earthworms . . . . .	409	<i>purpurea</i> <i>Roth.</i> . . . . .	514
-sacs in earthworms . . . . .	421	Conyza incisa <i>Ait.</i> . . . . .	34, 83, 97
iCimamlilo = <i>Pentania varia-</i>		<i>pinnatilobata</i> <i>DC.</i> . . . . .	505
<i>bilis</i> <i>Harv.</i> . . . . .	31, 33, 58, 62, 83, 91	Copepoda . . . . .	463
Cineraria . . . . .	319, 320, 505	Copulatory ridge (Pubertats-	
Cissampelos . . . . .	296, 305, 528	wall) . . . . .	424
<i>torulosa</i> <i>E. M.</i> . . . . .	18, 51,	Cordia caffra <i>Sond.</i> . . . . .	325
69, 77, 102		Corkwood . . . . .	325
Cissus cuneifolia <i>E. &amp; Z.</i> . . . . .	55, 56, 80,	Corycium . . . . .	319, 506
100		Costularia . . . . .	322
Cladium . . . . .	322	Cough . . . . .	40, 84, 89
Clausena inæqualis <i>Bth.</i> . . . . .	20, 22, 78,	Crassula . . . . .	320, 505, 530, 531
99, 299, 301, 325, 518		<i>muscoides</i> <i>Linn.</i> . . . . .	545
Cleft-palate in calf . . . . .	247		
Clerodendron glabrum <i>E. M.</i> . . . . .	20, 22,		
60, 86, 100, 296, 299, 310, 325			
Cliffortia . . . . .	505		
<i>strobilifera</i> <i>Linn.</i> . . . . .	545		
Clivia miniata <i>Regel</i> . . . . .	45, 56, 74, 89,		
98, 308, 521			

	PAGE		PAGE
Crassula rubicunda <i>E. M.</i>	30, 81, 95	Cyrenium	319, 320
Crassulaceæ	81	<i>adonense E. M.</i>	506, 530, 531
Cretaceous Series	153, 346, 349, 350, 363, 365	<i>racemosum Bth.</i>	506, 530, 531
Crinum	89, 93, 534	Cynanchum capense <i>Thunb.</i>	295
<i>longifolium Thb.</i>	318, 323, 506, 513	<i>crassifolium L.</i>	295, 296
Crocasmia aurea <i>Planch.</i>	534	<i>natalitium Schltr.</i>	294
Crossotropis grandiglumis	<i>Rendle</i> 512	<i>obtusifolium L.f.</i>	294
Crotalaria	41, 81, 98, 320, 512	Cynoglossum	506
<i>capensis Jacq.</i>	505	Cynodontia	136
<i>distans Bth.</i>	512	Cynodon dactylon <i>Pers.</i>	314, 316, 500, 510, 511, 513, 514, 516, 541
<i>globifera E. M.</i>	319, 505	Cyperaceæ	308, 322, 503, 517, 534, 535, 536
<i>lanceolata E. M.</i>	505	Cypereæ	90
<i>natalitia Meisn.</i>	505	Cyperus	293, 322, 331, 501, 502, 534, 536, 543
Croton gratissimum <i>Burch.</i>	13, 26, 39, 52, 61, 88, 97	<i>compactus Lam.</i>	503
<i>sylvaticum Hochst.</i>	13, 26, 39, 52, 60, 61, 88, 97, 103	<i>esculentus Linn.</i>	24, 54, 90, 92
Crucifereæ	77	<i>fastigiatus L.</i>	322, 533
Cryptocarya acuminata <i>Schinz.</i>	518	<i>immensus C. B. Clarke</i>	322
Cryptostemma calendulaceum	<i>R. Br.</i> 320, 505	<i>latifolius Poir.</i>	286, 321, 322, 331, 533
<i>niveum Nichols</i>	294	<i>natalensis Hochst.</i>	293
Ctenium concinnum <i>Nees</i>	313	<i>rupestris Kth.</i>	534
Cucumis hirsutus <i>Sond.</i>	13, 40, 82, 102	<i>sexangularis Nees</i>	322
Cucurbitaceæ	82, 305	Cyperus-vlei	330, 533
Culturnia	524	Cypria castanea <i>Brady</i>	460
Cunonia capensis <i>Linn.</i>	308, 326	Cyprinus carpio <i>Linn.</i>	249
Cussonia spicata <i>Thb.</i>	82, 101, 313, 326, 520, 524, 527, 528, 545	Cypris inermis <i>Brady</i>	460
<i>umbellifera Sond.</i>	326	Cyrtanthus angustifolius <i>Ait.</i>	318, 504
Curtisia faginea <i>Ait.</i>	302, 303, 326	<i>lutescens Herb.</i>	318
umCwili = <i>Leonotis ovata Spr.</i>	72, 87, 91	<i>obliquus Ait.</i>	17, 35, 40, 42, 71, 89
Cyanotis nodiflora <i>Kth.</i>	513	Cystignathidæ	475
Cyathea dregei <i>Kze.</i>	308, 313, 535, 536	umDabu	59, 81, 92
Cyathula cylindrica <i>Mog.</i>	514	inDabulalualo	59
Cycloeypris castanea <i>Brady</i>	462, 474	Dactyloctenium ægyptiacum	<i>Willd.</i> 326
(sp. n.)	462, 474	Dadoxylon	233, 346, 347, 352, 355, 358, 361, 377
Cyclops gibsoni <i>Brady</i>	463	<i>australe Arber.</i>	233, 345, 347, 352, 356, 358
Cyclostemon argutus <i>Müll. Arg.</i>	326, 519		

	PAGE		PAGE
umDakane = Apodytes dimi-		Dichogaster . . . . .	400, 402, 406, 453
diata <i>E. M.</i>	20, 79, 92, 325	bolau ( <i>Mich.</i> )	401, 417,
isiDakwa . . . . .	75		452, 454
Dalbergia . . . . .	305	crawi <i>Eisen</i>	401, 418,
obovata <i>E. M.</i>	299, 301,		452, 453, 458
	303, 326, 330, 519, 545	octonephra ( <i>Rosa</i> )	. 418
Dalechampia capensis <i>Spreng.</i>	506	Dichrostachys nutans <i>Bth.</i>	. 310
inDalu = Greyia sutherlandi		Dielis reptans <i>Bth.</i>	. 319, 506
<i>H. &amp; H.</i>	. 326	Dicomma argyrophylla <i>Oliv.</i>	
Dasyurus . . . . .	133, 134, 135, 138, 139		320, 330, 513
viverrinus ( <i>Shaw</i> )	. 139	Diocynodon . . . . .	. 137
Datura stramonium <i>Linn.</i>	66, 86,	Dierama pendula <i>Baker</i>	318, 506
	103, 514	pulcherrima <i>Baker</i>	. 506
Daudebardia rufa <i>Fér.</i>	173, 174	Digitaria . . . . .	314, 315, 317,
inDawo = Cyperus esculentus			508, 515
<i>Linn.</i>	24, 25, 54, 90, 92	diagonalis <i>Stapp.</i>	503, 511
inDawolucwatha . . . . .	71, 92	eriantha <i>Steud.</i>	
inDawoluthi . . . . .	35, 92		313, 503, 511
inDawoluthi emhlope = <i>Belam-</i>		horizontalis <i>Willd.</i>	
<i>canda</i> sp. . . . .	25, 92		313, 314
inDawoluthi emnyama . . . . .	92	sanguinalis <i>Scop.</i>	313, 314,
Delechampia . . . . .	305		514
Delphinognathus . . . . .	136	tenuifolia <i>Beaur.</i>	. 313
Deltatherium . . . . .	139	ternata <i>Stapp.</i>	313, 314, 503,
inDembu = <i>Viscum</i> sp. . . . .	329		511, 514
Denekia capensis <i>Thb.</i>	. 534	isiDikili . . . . .	46, 67, 74, 87, 92, 327
Dendraspis angusticeps <i>Smith</i>	71	iDilophu . . . . .	. 51
Dermatobotrys saundersonii		Dimorphotheca fruticosa <i>Less.</i>	294
<i>Bolus</i>	. 304	Dinocephalia . . . . .	. 136
Desmodium hirtum <i>Guill. &amp; Per.</i>	505	Dioscoraceæ . . . . .	. 89
umDhlesa = <i>Kraussia lanceo-</i>		Dioscorea . . . . .	. 518
<i>lata</i> <i>Sond.</i>	. 327	rupicola <i>Kth.</i>	12, 89, 96
inDhlondhlo . . . . .	59	Dipcadi viride <i>Moench.</i>	319, 507
Diallage-norites . . . . .	148	Disa . . . . .	319, 506, 531
Dianthus . . . . .	320	Disperis . . . . .	319, 531
Diaptomus . . . . .	460, 464, 467	fanniniæ <i>Harv.</i>	. 518
cunningtoni <i>Sars.</i>	. 466	Dissotis incana <i>Naud.</i>	. 30, 82, 93
fuscatus <i>Brady</i>		eximia <i>Harv.</i>	. 534
(sp. n.)	465, 472	isiDla . . . . .	. 66
masculus <i>Brady</i>		umDlandlasi . . . . .	12, 25
(sp. n.)	466, 472	umDlavuza . . . . .	30, 92
pictus <i>Brady</i>		umDlebe = <i>Synadenium arbo-</i>	
(sp. n.)	464, 472	rescens <i>Hk. f.</i>	12, 34, 88, 92
simplex <i>Sars</i>	. 466	iDlebelendlovu = <i>Trimeria al-</i>	
Diarrhoea . . . . .	28	nifolia <i>Planch.</i>	. 23, 77, 92

	PAGE		PAGE
iDliso = <i>Pentania variabilis</i>		iDumbhi lika'ntloyile = <i>Hæm-</i>	
<i>Harv.</i> . . . . .	327	<i>anthus natalensis</i> <i>Pappe</i> 41, 42,	89, 92
inDlolothi . . . . .	12, 92	iDungamuzi = <i>Euclea lanceo-</i>	
umDlonzo = <i>Mikania capensis</i>		<i>lata</i> <i>E. M.</i> 12, 17, 23, 27, 38, 61,	84, 85, 92, 93, 103, 326
<i>DC.</i> . . . . .	49, 51, 61, 84, 92	umDuze = Natal lily 17, 50, 58, 89, 93	
iDlozi . . . . .	64	isiDwa = <i>Gladiolus ludwigii</i>	
uDlutshana = <i>Aster asper</i> <i>Less.</i>		<i>Pappe</i> . . . . .	54, 55, 57, 89, 93
12, 23, 34, 40, 42, 83, 92		Dwaba = <i>Popowia caffra</i> <i>H. &amp; S.</i> 328	
inDodemnyama = <i>Royena vil-</i>		Dwa-dwa = <i>Leucosidea sericea</i>	
<i>losa</i> <i>Linn.</i> . . . . .	28, 71, 99	<i>E. &amp; Z.</i> . . . . .	327
inDola encâne = <i>Triumfetta</i>		Dwyka Conglomerate 142, 151, 228,	489, 544
<i>rhomboidea</i> <i>Jacq.</i> . . . . .	56, 78, 99	Dysentery and Diarrhœa 28, 80, 81,	82, 83, 84, 88, 89
Dolerites 141, 142, 390, 391, 393			
mineral composition . 143		Earache . . . . .	68, 81, 88, 90
Dolichos . . . . .	305	Earthworms . . . . .	290
iDololenkonyane = <i>Rumex eck-</i>		Ebenaceæ . . . . .	84, 85
<i>lonianus</i> <i>Meisn.</i> . . . . .	22, 87, 92	Ecce Series 156, 227, 229, 255, 256,	258, 345, 348, 349, 355
Dombeya . . . . .	299	Shales 146, 227, 228, 229, 231,	489, 544
<i>rotundifolia</i> <i>Harv.</i> . . . . .	527	Echinospermum . . . . .	301, 518
Dog plum . . . . .	326	Edaphic factors . . . . .	489
umDoni = <i>Eugenia cordata</i> <i>Laws</i> 326		Eocene . . . . .	132
Doorn boom . . . . .	325	Eczema . . . . .	66, 80, 90
peer . . . . .	328	Ehretia hottentotica <i>Burch.</i> 301, 303,	310, 326, 518, 524, 527, 528, 535,
uDonqabathwa = <i>Ceratotheca</i>		537	
<i>triloba</i> <i>E. M.</i> . . . . .	25, 86, 92	Ekebergia capensis <i>DC.</i> 41, 100, 326	
Dopplerite . . . . .	375	<i>meyeri</i> <i>Presl.</i> 20, 24, 41,	79, 100
uDosi . . . . .	37, 42	Elæodendron capense <i>E. &amp; Z.</i> 296, 299	
Dovyalis rhamnoides <i>B. &amp; H.</i>		<i>corceum</i> <i>DC.</i> 302, 326	
58, 77, 100		<i>volutinum</i> <i>Harv.</i> 99	
<i>rotundifolia</i> <i>Thb.</i> . . . . .	296	Eleocharis . . . . .	322
Dracæna hookeriana <i>K. Koch</i> . 296		<i>limosa</i> <i>Schultes</i> . . . . .	534
Drach-mijn-keel . . . . .	328	Elephantorhiza . . . . .	92
Dregea . . . . .	305	<i>burchellii</i> <i>Bth.</i>	29, 45, 102
<i>floribunda</i> <i>E. M.</i> 296, 312, 528		Eleusine coracana <i>Gærtn.</i> . . . . .	2
Drimiopsis . . . . .	319	<i>indica</i> <i>Gærtn.</i> 313, 314, 326,	503, 511, 514
Dropsy . . . . .	57, 59, 84, 85, 86, 88		
Drosera burkeana <i>Planch.</i> 323, 492,			
505, 536			
umDubu = <i>Combretum salici-</i>			
<i>folium</i> <i>E. M.</i> . . . . .	325		
isiDuli = <i>Brachylæna elliptica</i>			
<i>Less.</i> . . . . .	325		
uDulamuthwa = <i>Vangueria</i>			
<i>lasiantha</i> <i>Sond.</i> . . . . .	30, 83, 92		
Dumartiera . . . . .	309		

	PAGE		PAGE
<i>Elionurus argenteus</i> Nees . . .	503	<i>Erica urceolaris</i> Berg. . .	535
<i>Embelia kraussii</i> Harv. 22, 34, 84, 91		<i>Eriocaulon</i> . . .	298, 322, 534
Emetic . . . . .	42	<i>Eriosema cordatum</i> E. M. 53, 81, 100	
<i>Emex spinosa</i> Campd. . . . .	26, 87, 96	<i>distinctum</i> N. E. B. . . . .	505
um <i>Embhesa</i> . . . . .	35, 67, 74, 93	<i>kraussianum</i> Meisn. . . . .	505
<i>Encephalartos altensteinii</i> Lehm. 528		<i>salignum</i> E. M. . . . .	53, 100
Enchytraidæ . . . . .	400, 402, 408, 452	<i>Eriospermum</i> . . . . .	319, 506
<i>Endothiodon</i> . . . . .	136	<i>Erythrina caffra</i> Thb. 49, 51, 68, 81,	
<i>Enstatite-dolerites</i> . . . . .	147, 157	101, 296, 299, 310, 326	
<i>Entada natalensis</i> Bth. 296, 299, 518		<i>humcana</i> E. & Z. . . . .	524
Enteric fever . . . . .	46	<i>tomentosa</i>	
Entomostraca . . . . .	459	<i>Buch-Ham.</i> . . . .	527
Eodrilacea . . . . .	406	Essenhout . . . . .	326, 329
Eodrilus . . . . .	407	<i>Ethulia conyzoides</i> Linn. 20, 25, 83,	
Epilepsy . . . . .	62, 64	101, 319, 330, 505	
<i>Epilobium capense</i> Burch. . . . .	535	<i>Eucalyptus</i> . . . . .	331, 521, 539
<i>hirsutum</i> Linn. 535, 545		<i>globulus</i> . . . . .	502, 527, 539
<i>Epilobous</i> . . . . .	421	<i>Euclea</i> . . . . .	524
<i>Epiphytes</i> . . . . .	519	<i>lanceolata</i> E. M. 27, 61, 85, 92,	
<i>Eragrostis</i> . . . . .	315	13, 101, 326	
<i>aspera</i> Nees . . . . .	514	<i>natalensis</i> A. DC. 93, 17, 23,	
<i>brizoides</i> Nees 313, 503,		27, 38, 84, 93, 103, 296, 326	
511, 530		<i>undulata</i> Thb. . . . .	524
<i>chalcantha</i> Trin.		<i>Eucomis</i> . . . . .	534
313, 503, 511, 512, 530		<i>punctata</i> L'Herit . . . . .	507
<i>chloromelas</i> Steud. . . . .	503	<i>undulata</i> Ait. 47, 90, 97,	
<i>ciliaris</i> Linn. . . . .	313	286, 507	
<i>curvula</i> Nees 313, 316,		<i>Eudrilinæ</i> 401, 402, 406, 421, 454	
326, 500, 503, 510, 511,		<i>Eudriloides durbanensis</i> Bedd. 399,	
513, 516, 541		401, 402, 403, 421, 452,	
<i>nebulosa</i> Stapf. 313, 321,		454	
532, 534		<i>parvus</i> Mich. . . . .	402
<i>plana</i> Nees 54, 90, 102, 313		<i>Eugenia</i> . . . . .	358, 376, 378
<i>superba</i> Peyr. . . . .	313	<i>albanensis</i> Sond. . . . .	505
<i>Eremias burchelli</i> Smith . . . . .	482	<i>capensis</i> Harv. . . . .	296
<i>capensis</i> Smith . . . . .	482	<i>cordata</i> Laws. 298, 299, 307,	
<i>Erianthus</i> . . . . .	331	326, 367, 537	
<i>capensis</i> Nees 286, 300,		<i>zeyheri</i> Harv. . . . .	303, 326
301, 306, 322, 326, 331,		<i>Eulimmadia</i> . . . . .	469, 470
501, 517, 533, 536		<i>victoriæ</i> Brady	
<i>capensis</i> Nees var.		(sp. n.) 469, 473	
<i>villosa</i> . . . . .	321	<i>Eulophia</i> . . . . .	319, 506
<i>Erica</i> . . . . .	259, 308, 532, 535	<i>arenaria</i> Bolus 54, 88, 98	
<i>cooperi</i> Bolus . . . . .	535	<i>Euphorbia</i> . . . . .	513
<i>cubica</i> Linn. . . . .	535	<i>bupleurifolia</i> Jacq. . . . .	60

	PAGE		PAGE
Euphorbia grandidens Harv.	66, 312, 326, 528, 545	umFiyo = Cluytia pulchella Linn.	325
helioscopia Linn.	506	Flagellaria guiniensis Sch.	296
natalensis Bernh.	506	Flat-crown	13, 325
puguiformis Boiss.	60	Foraminifera	365
tirucalli L.	312, 326, 528, 529, 545	Fossil coniferous wood	346
Euphorbiaceæ	88	dicotyledonous wood	364
Eurycypris	462	fish-remains	227
Euryops pedunculatus N. E.		wood, chemical composi- tion and physical pro- perties of	356, 369
Brown	531	woods	345
setiloba N. E. Brown	531	Fossilisation	358
Everlastings	326	Fridericia	402, 411, 452
Excæcaria	518	bisetosa Levins	408
africana Müll. Arg.	326	Fridericia bulbosa (Rosa.)	399, 408, 410
caffra Sim	303	Fridericia peregrinabunda Mich. (sp. n.)	399, 402, 408, 410, 411, 453
reticulata Müll. Arg.	299	perrieri (Vejd.)	400, 411, 448, 453
umFana-ka'sihlanjana	68, 90, 93	pulchra Friend	410
Febrile complaints	43, 77, 81, 82, 83, 84, 85, 87, 89	isiFuba, uFuba	38
Felsite	146	somoja	42
Ferrar Glacier	142, 152	iuFudumezolo	13
Festuca scabra Vahl.	503	Fuirena	322
imFeyenkala = Dissotis incana		cœrulescens Steud.	534
Naud.	30, 82, 93	pubescens Desf.	534
imFeyesele = Dissotis incana		uFukuzela = Ocimum obova- tum E. M.	76, 86, 93
Naud.	30, 82, 93	imFulwa = Ophiocaulon gum- mifera Hk. f.	12, 45, 93
imFezi	71	umFusamvu = Pittosporum viridiflorum Sims	44, 77, 93
Ficinia	322	imFuzane	18, 27, 48, 93
Ficoideæ	82	ga	5
Ficus capensis Thb.	299, 305, 307, 308, 326, 520, 527, 535, 537, 545	n-gaka = doctor	5
natalensis Hochst.	299, 300, 304, 307, 308, 326, 518, 519, 520, 535, 537	Gala-gala = Notobuxus natal- ensis Oliver	327
Fimbriaria	309	Galtonia candicans Dene	319, 330, 507
Fimbristylis	322	in-ganga = doctor	6
complanata Linn.	534	on-ganga = doctor	5
monostachya Hassk.	534		
umFinca = Leonotis leonurus			
Brown	327		

	PAGE		PAGE
un-ganga = doctor . . . . .	6	Gladiolus woodii Baker . . . . .	506
Gangrenous rectitis . . . . .	31, 79, 80, 83, 86	Gleichenia umbraculifera Moore . . . . .	535
umGanu = Sclerocarya cafra Sond. . . . .	32, 33, 80, 93	polypodioides Sm. . . . .	308
Garcinia gerrardi Harv. . . . .	326	umGlindi = Rhamnus prin- oides L'Herit . . . . .	328
Gardenia globosa Hochst. . . . .	326, 518	Globe-fish . . . . .	60
neuberia E. & Z. . . . .	301, 326, 518	Gloriosa virescens Ldl. . . . .	55, 57, 90, 94, 319
rothmannia L. f. . . . .	301, 326, 518	Glossopteris flora . . . . .	345
thunbergia L. f. . . . .	326	Glossoscolecidae . . . . .	401, 403, 405, 422, 453, 455
gar-rire . . . . .	5	Glossoscolecinae . . . . .	401, 422, 455
Gazania . . . . .	320, 531	Glycine . . . . .	305
longiscapa DC. . . . .	318, 504, 505, 513, 531	Glycyrrhiza glabra . . . . .	39
uniflora Sims . . . . .	294	Glyphidrilus . . . . .	405
inGeino = Scilla rigidifolia Kth. . . . .	12, 58, 90, 93	Gnaphalium . . . . .	319, 320 luteo-album Linn. 505, 514
inGcolo = Scilla rigidifolia Kth. . . . .	12, 65, 90, 93	sylvaticum Linn. . . . .	414
uGeusulu . . . . .	51, 93	Gnidia . . . . .	506
umGeba = Chilianthus oleaceus Burch. . . . .	325	ovalifolia Meisn. . . . .	517
Geraniaceae . . . . .	78	uGobandhlovu = Secamone gerrardi Harv. . . . .	13, 61, 85, 93
Geranium cafrum E. & Z. . . . .	535, 536	isiGobo . . . . .	39, 90, 93
Gerbera . . . . .	504	uGobo = Gunnera perpensa Linn. . . . .	50, 56, 57, 58, 82, 93
aurantiaca Sch. Bip. . . . .	505, 531	uGodide = Jatropha hirsuta Hoch. . . . .	70, 94
kraussii Sch. Bip. . . . .	22, 25, 83, 94, 505	uGola . . . . .	51
Gerbillus afer Gray . . . . .	292	iGololenkawu . . . . .	30, 80, 94
Geelhout . . . . .	328	n-goma . . . . .	7
Geogenia natalensis Kinberg . . . . .	398, 422	iGomonqo = Fruit-bat . . . . .	61
Georychus hottentotus (Lesson) . . . . .	292	Gomphocarpus . . . . .	12, 85, 98, 320, 326, 513
gi . . . . .	5	physocarpus E. M. . . . .	514
Gift boom . . . . .	325	Gondwanaland . . . . .	345
gir . . . . .	5	Gono-gono = Psychotria ca- pensis Vatke. . . . .	328
Gladiolus . . . . .	517	Gonorrhœa . . . . .	51
eckloni Lehm. . . . .	319, 513, 531	inGowangane = Celastrus buxifolius Lin. . . . .	79
ludwigii Pappé . . . . .	54, 57, 89, 93	inGozi . . . . .	35
papilio Hook. f. . . . .	319, 506	izinGozi . . . . .	70
pubescens Baker . . . . .	318, 506		

	PAGE		PAGE
Gramineæ . . . . .	90	umGwenya-uizinja = Ekeber-	
Granophyre . . . . .	157	gia capensis DC. . . . .	326
Granophytic rocks . . . . .	151	umGxamu = Schotia brachy-	
Grass-burning . . . . .	285, 497	petala Sond. . . . .	30, 81, 94
Grass-fires . . . . .	289	umGxina = Curtisia faginea	
Grewia caffra Meisn. . . . .	296, 520	Ait. . . . .	326
lasiocarpa E. M.		Gymnogramme lanceolata Hk.	
. . . . .	296, 518, 520		304, 519
occidentalis Linn. . . . .	56, 96,	Habenaria . . . . .	319, 506, 531
. . . . .	299, 301, 303, 304,	bonatea Reichb. f. . . . .	531
. . . . .	326, 518, 520, 523	amaHabiya . . . . .	63
Greyia sutherlandi H. & H. . . . .	312,	iHabiya . . . . .	63
. . . . .	326, 527, 530	Hæmanthus albomaculatus	
umGubhane . . . . .	31	Baker . . . . .	296
inGubivumile = Phytolacca		natalensis Pappe. . . . .	41,
abyssinica Hoffm. . . . .	47, 87, 97	. . . . .	42, 89, 92, 319, 506
inGuduza . . . . .	28, 94	Hæmodoraceæ . . . . .	88
Guu, Blue . . . . .	502, 539	Hairless horses and dogs . . . . .	243
inGumbhane . . . . .	31, 33, 65	Hair-restorer . . . . .	75, 87
Gunnera perpensa Linn. . . . .	50, 56, 58,	Halleria elliptica Thumb. . . . .	301, 303,
. . . . .	82, 93, 322, 326, 534	. . . . .	307, 326, 518
umGunya = Celastrus buxi-		lucida Linn. . . . .	305
folius Linn. . . . .	58, 94	Haloragææ . . . . .	82
umGugudo = Celastrus buxi-		Halophilous plant-associations . . . . .	293
folius Linn. . . . .	26, 94	Hard pear . . . . .	328
inGqaqabulani = Smilax kraus-		Harde peer . . . . .	328
siana Meisn. . . . .	68, 90, 94	Harpechloa capensis Kth. . . . .	213, 315,
gqei . . . . .	5	. . . . .	503, 530
gqei-di . . . . .	5	Harpephyllum caffrum Bernh.	
gqeira . . . . .	5	. . . . .	310, 326
i-gqira . . . . .	5	Head-lice . . . . .	67
izinGqunda . . . . .	11	Heart complaints . . . . .	57, 79, 81, 82, 89
inGqwangane = Celastrus		Hebenstreitia . . . . .	317, 319, 506
buxifolius Linn. . . . .	38, 94	Hegesipyle hanno Kim. (g. e. sp.	
umGwali = Euclea lanceolata		spur.) . . . . .	398, 400
E. M. . . . .	326	Heleophryne natalensis Hewitt	
isiGwane = Myrsine melano-		. . . . .	475, 477, 484
phleos R. Br. . . . .	327	purcelli Sclater . . . . .	478
Gwangi = Buddleia salviaefolia		regis Hewitt . . . . .	475, 477,
Lam. . . . .	325	. . . . .	478, 484
isiGwebedla . . . . .	31, 51, 65	Helichrysum . . . . .	286, 306, 319, 513, 515
uGweje = Bopusia scabra		adenocarpum DC.	
Presl. . . . .	33, 86, 96	. . . . .	505, 530
umGwenye = Harpephyllum			
caffrum Bernh. . . . .	326		

	PAGE		PAGE
<i>Helichrysum appendiculatum</i>		umHlagella = <i>Cyclostemon ar-</i>	
<i>Less.</i>	505	<i>gutus Müll. Arg.</i>	326
<i>argyrolepis Mac-</i>		uHlakabla	56
<i>Owan</i>	505	umHlakoti = <i>Rhus lævigata</i>	
<i>aureonitens Sch.</i>		<i>Linn.</i>	328
<i>Bip.</i>	492, 505, 534	umHlakuva = <i>Ricinus com-</i>	
<i>fœtidum Cass.</i>	505	<i>munis Linn.</i>	28, 68, 69, 94
<i>fulgidum Willd.</i>	505	umHlala = <i>Strychnos spinosa</i>	
<i>krebsianum Less.</i>	505	<i>Lam.</i>	73, 74, 85, 94, 328
<i>latifolium Less.</i>	505	umHlambhamanzi = <i>Rauwolfia</i>	
<i>teretifolium Less.</i>	294	<i>natalensis Sond.</i>	17, 46, 85, 94
<i>Helinus</i>	305	uHlambhishoshane = <i>Gerbera</i>	
<i>ovata E. M.</i>	64, 80, 91,	<i>kraussii Sch. Bip.</i>	22, 25, 83, 94
	296, 326, 518, 519	iHlamvu = <i>Gloriosa virescens</i>	
<i>Heliophila</i>	319	<i>Ldl.</i>	53, 55, 90, 94
<i>virgata Burch.</i>	504	<i>lomfana neuntombha-</i>	
<i>Helodrilus</i>	402	<i>zana</i>	90, 94
<i>caliginosus (Sav.)</i>	401	umHlandoti = <i>Albizzia fasti-</i>	
( <i>Allobophora</i> ) <i>cali-</i>		<i>giata Oliv.</i>	325
<i>ginosus (Sav.) f.</i>		uHlanya	64
<i>trapezoides (Dug.)</i>	401,	weHlati	325, 326, 327
	448, 451, 457	umHlatholana = <i>Turraea ob-</i>	
( <i>Bimastus</i> ) <i>con-</i>		<i>tusifolia Hochst.</i>	13, 23, 27, 29,
<i>strictus (Rosa.)</i>	401,		79, 94
	448, 451, 480	isiHlazi	46, 94
<i>Hemius marmoratum Pet.</i>	480	umHlebe = <i>Olea laurifolia Lam.</i>	327
<i>Hepaticæ</i>	536	umHleli = <i>Ehretia hottentotica</i>	
<i>Hermannia</i>	513	<i>Burch.</i>	326
Herring-bone structure	144, 148	iHlinzanyoka	40, 79, 94
<i>Hesperantha haurii Baker</i>	534	umHlonhlo = <i>Euphorbia gran-</i>	
<i>bifolia Baker</i>	506	<i>didens Harv.</i>	66, 326
<i>Heteromorpha arborescens Ch.</i>		umHlonishwa = <i>Psoralea pin-</i>	
& <i>Sch.</i>	18, 82, 91, 303, 326, 512,	<i>nata Linn.</i>	64, 81, 94
	527, 535, 545	uHlonyane = <i>Vernonia woodii</i>	
<i>Hibiscus æthiopicus Linn.</i>	320	<i>Hoffm.</i>	25, 34, 44, 45, 74, 83, 84
<i>pedunculatus Cav.</i>	299		94, 100, 325
<i>surattensis Linn.</i>	50, 52,	isiHlosa	67, 94
	78, 91	iHlule	30, 95
<i>tiliaceus Linn.</i>	298, 327	iHlulelemambha	13, 28, 95
Hiccough	25	umHluma = <i>Rhizophora mucro-</i>	
<i>Hippobromus alatus E. &amp; Z.</i>	13, 34,	<i>nata Lam.</i>	328
	80, 100, 524, 528	isiHlungu	74, 76
iHlaba	38, 51, 89, 94	uHlunguhlungu = <i>Vernonia</i>	
umHlabelo	76	<i>corymbosa Less.</i>	38, 56, 84, 95
uHlabo	38, 39	Hlunguti	325

	PAGE		PAGE
ubuHlungwana = <i>Wedelia</i>		<i>Ichnotropis capensis</i> <i>Smith</i>	482
<i>natalensis</i> <i>Sond.</i>	24, 25, 29, 44, 69, 70, 84, 95	<i>longipes</i> <i>Boul.</i>	482
iHluze . . . . .	30, 81, 326	<i>Ichnotropis macrolepidota</i>	
umHlwazi . . . . .	24, 95	<i>Peters</i>	482
umHlwazimambha . . . . .	53, 95	Igqwanxe = <i>Olea capensis</i>	
Hodotermes . . . . .	128	<i>Linn.</i>	327
<i>havilandi</i> <i>Sharp</i>		<i>Ilex capensis</i> <i>Harv. &amp; Sond.</i>	
. . . . .	114, 115, 290	. . . . .	308, 327, 518, 535
Hoffmanseggia <i>sandersoni</i>		<i>Ilyogenia</i> . . . . .	404
<i>Wood</i>	505	<i>Ilyogenia africana</i> <i>Beddard</i>	399, 420
umHlonyane = <i>Artemisia afra</i>		<i>Impatiens capensis</i> <i>Thb.</i>	521
<i>Jacq.</i> . . . . .	94	<i>Imperata arundinacea</i> <i>Cyr.</i>	24, 90, 102, 313, 511, 534
Hot-air treatment . . . . .	62	Impotency . . . . .	53
Hottentot fig . . . . .	327	isInane = <i>Dactyloctenium</i>	
Hot winds, origin of . . . . .	289	<i>ægyptiacum</i> <i>Willd.</i>	326
ukuHuda, uHudo . . . . .	28	Indigestion . . . . .	22, 85, 90
<i>Hyalocypris africana</i> <i>Brady</i>		Indigofera . . . . .	517, 545
(sp. n.) . . . . .	461, 471	<i>arrecta</i> , <i>Hochst.</i>	505
Hybrid rock . . . . .	157	<i>dimidiata</i> <i>Vogel</i>	505
<i>Hydrocotyle centella</i> <i>Cham. &amp;</i>		<i>fastigiata</i> <i>E. M.</i>	505
<i>Sch.</i> . . . . .	318, 327, 504, 505	<i>longipes</i> <i>N. E. B.</i>	512
<i>Hydrophylax carnosa</i> <i>Sond.</i>	294	<i>rostrata</i> <i>Bolus</i>	505
<i>Hydrostachys natalensis</i> <i>Wedd.</i>	323	<i>tristis</i> <i>E. M.</i>	505
<i>Hymenophyllum</i> . . . . .	304, 519	Injection . . . . .	25
<i>Hypericineæ</i> . . . . .	78	Insanity . . . . .	64, 89
<i>Hypericum</i> . . . . .	535	Intestinal beetles . . . . .	18
<i>æthiopicum</i> <i>Thumb.</i>		complaints . . . . .	84, 85
. . . . .	13, 48, 78, 101	parasites . . . . .	18, 78, 79, 83, 89, 90
<i>lalandii</i> <i>Choisy</i>	535	Ionidium . . . . .	319
<i>Hyphæne crinita</i> <i>Gærtn.</i>	296	<i>capense</i> <i>R. &amp; S.</i>	504
<i>Hypnum</i> . . . . .	304	<i>Ipomœa</i> . . . . .	294, 298, 305, 329, 519
<i>Hypolepis anthriscifolia</i> <i>Presl.</i>		<i>biloba</i> <i>Forsk.</i>	293, 329
. . . . .	301, 518	<i>ficifolia</i> <i>Ldl.</i>	26, 74, 85
<i>Hypoxis angustifolia</i> <i>Lam.</i>	531	<i>palmata</i> <i>Forsk.</i>	46, 85, 97
<i>baurii</i> <i>Baker</i>	318, 506	<i>Ipomœa pes-capræ</i> <i>Roth.</i>	293
<i>kraussiana</i> <i>Burch.</i>	531	<i>Ipomœa purpurea</i> <i>Roth.</i>	26, 44, 85, 95
<i>latifolia</i> <i>Hook.</i>	56, 59, 65, 75, 89, 96, 513	<i>simplex</i> <i>Thb.</i>	506
<i>oligotricha</i> <i>Baker</i>	319	<i>Iridæ</i> . . . . .	506
<i>Hypoxis platypetala</i> <i>Baker</i>	531	<i>Ischænum fasciculatum</i> <i>Brogn.</i>	
<i>Hyptis pectinata</i> <i>Poit.</i>	506, 517	var. <i>arctuatatum</i>	321
<i>Hyacotherium</i> . . . . .	134	Iron-pan . . . . .	491, 492, 540
<i>Hysteria</i> . . . . .	63, 80, 81, 85	Ironwood . . . . .	327
<i>Hystrix africæ-australis</i> <i>Peters</i>	292		

	PAGE
Iteh . . . . .	66
iJalambhu = <i>Ipomœa purpurea</i>	
<i>Roth.</i> . . . . .	26, 44, 85, 95
iJalamu = <i>Ipomœa purpurea</i>	
<i>Roth.</i> . . . . .	26, 85, 95
Jalap . . . . .	26
Jasminum . . . . .	305, 519, 545
<i>multipartitum</i>	
<i>Hochst.</i> . . . . .	296, 505
Jatropha <i>hirsuta Hoch.</i> . . . . .	70, 88, 94, 506
umJela = <i>Rauwolfia natalensis</i>	
<i>Sond.</i> . . . . .	328
Jet . . . . .	370, 375, 378, 379
uJiba . . . . .	30, 95
iJingijola = <i>Rubus rigidus</i>	
<i>Smith</i> . . . . .	30, 81, 95
inJobo . . . . .	21, 95
uJovela . . . . .	47, 51
umJuluka . . . . .	52, 95
Juncellus . . . . .	322
Juncus . . . . .	536
Jungermannia . . . . .	305
Justicia . . . . .	320, 518
<i>campylostemon T. And.</i>	330, 521
Kaarshout . . . . .	326
Kafir boom . . . . .	326
cherry . . . . .	326
constitutional traits . . . . .	14
corn . . . . .	325
foot-paths . . . . .	509
orange . . . . .	328
<i>pharmacopœia</i> . . . . .	12
plum . . . . .	326
Kaffer pruim . . . . .	326
Kajatehout . . . . .	328
Kalanchoe <i>thyrsiflora Harv.</i> . . . . .	505, 531
mKanga = <i>Senecio juniperus</i>	
<i>Lin.</i> . . . . .	538
umKangaza . . . . .	326
Kareehout . . . . .	328
Karoo System . . . . .	141, 142, 255, 544

	PAGE
umKasa . . . . .	328
Kat-doorn . . . . .	325, 329
uKathwa . . . . .	63
isiKelekehlane . . . . .	30, 81, 95
Kenytes . . . . .	156
Kerria . . . . .	400, 404
<i>gunningi Mich.</i> . . . . .	401, 419, 452, 455
Kersehout . . . . .	328
uKhalimele . . . . .	35, 81, 95
amaKhambhi . . . . .	11, 19, 21, 76
iKhambhi . . . . .	18
<i>lamabulawo.</i> . . . . .	59, 82, 95
<i>lesipatsholo.</i> . . . . .	53, 99
<i>leziduli.</i> . . . . .	29, 34, 49, 51, 80, 103
imiKhando . . . . .	11
uKathwa . . . . .	95
Kheper . . . . .	21
umKhiphampethu = <i>Calpurnia</i>	
<i>lasiogyne E. N.</i> . . . . .	75, 81, 95
umKhokha = <i>Abrus precatorius</i>	
<i>Linn.</i> . . . . .	39, 81, 95
<i>wehlathi = Ipomœa</i>	
<i>ficifolia Ldl.</i> . . . . .	26, 85, 95
isiKholokotha = <i>Sansevieria</i>	
<i>thyrsifolia Thb.</i> . . . . .	68, 88, 95
umKhovothi . . . . .	31, 69, 88
isiKhubabende . . . . .	30, 81, 95
amaKhubalo . . . . .	11
umKhuhlane . . . . .	9, 15, 34, 38, 43, 44, 45
<i>omkhulu.</i> . . . . .	37
umKhuhlu . . . . .	13, 23, 28, 79, 95, 103
isiKhulhukhu . . . . .	59
isiKhumukela . . . . .	69, 95
iKhunkulo . . . . .	59
isiKhwa . . . . .	30, 31, 95
umKhwangu . . . . .	35, 95
<i>was'entabeni.</i> . . . . .	20, 96
ukuKhwehlela . . . . .	38
Kiggelaria <i>africana Linn.</i> . . . . .	327
<i>dregeana Turcz.</i> . . . . .	302, 519
Kinderbesje = <i>Halleria elliptica</i>	
<i>Thunb.</i> . . . . .	326
Kinkelboschjes . . . . .	327

	PAGE		PAGE
umKisiso = <i>Cussonia umbellifera Sond.</i>	326	umKwenkwe = <i>Pittosporum viridiflorum Sims.</i>	327
uKlenya = <i>Gunnera perpensa Linn.</i>	56, 93	Kyllinga . . . . .	322, 534
iKlilabhu . . . . .	51	<i>elatior Kth.</i>	534
iKlolo . . . . .	56, 78, 96	Kynotus . . . . .	405
Kniphofia . . . . .	319, 506, 534	iLabatheka = <i>Hypoxis latifolia Hook.</i>	12, 56, 59, 65, 75, 89, 96
<i>breviflora Harv.</i>	534	Labiata . . . . .	87
Knobwood . . . . .	17, 329	Labyrinthodont . . . . .	227, 231
umKoba = <i>Podocarpus elongatus L'Herit.</i>	328	Lactuca capensis <i>Thb.</i>	319, 505, 513
umKobess = <i>Nuxia congesta R. Br.</i>	327	Lafœa dispolians <i>Warren (sp. n.)</i>	105, 109, 110, 111
Kœleria cristata <i>Pers.</i>	314, 503	umLahleni . . . . .	50, 96
inKokhane . . . . .	46, 73, 96	Lair-flora . . . . .	510
inKomankoma . . . . .	70, 96	iLalanyathi = <i>Grewia occidentalis Linn.</i>	56, 78, 96
inKomfe . . . . .	12, 89, 96	<i>enkola</i>	20, 89, 96
<i>enkula</i>	20, 89, 96	iziLalo . . . . .	70
inKominophondo . . . . .	35, 96	Landolphia . . . . .	297
Kommetjes . . . . .	292	Lantana . . . . .	506
inKonazana . . . . .	44, 81, 96	Lasiosiphon 46, 67, 74, 87, 92, 319, 320, 327, 506, 513, 517	
amaKonulu = <i>Rubus pinnatus Willd.</i>	328	<i>kraussii Meisn.</i>	506
Kraussia lanceolata <i>Sond.</i>	296, 327, 518	Lastrea inæquale <i>Hk.</i>	99
Kruisbesje = <i>Grewia occidentalis Linn.</i>	326	Laurel . . . . .	327
umKuana = <i>Tricholœna rosea Nees</i>	329	Laurineæ . . . . .	87
umKuhlu = <i>Trichilia emetica Vahl.</i>	329	Leersia hexandra <i>Sw.</i>	501, 533, 534
Kukuma . . . . .	327	Leguminosæ . . . . .	80, 81, 305
uKumbuqwekwe = <i>Helinus ovata E. M.</i>	326	Lejeunia . . . . .	305
inKunzana = <i>Emex spinosa Campd.</i>	25, 87, 96	Lemna minor <i>Linn.</i>	323
inKunzi = <i>Bopusia scabra Presl.</i>	23, 33, 46, 65, 86, 96	Lemonwood . . . . .	329
inKuphulana = <i>Osteospermum nervatum DC.</i>	43, 97	Leonotis leonurus <i>Brown</i>	34, 72, 73, 87, 98, 306, 319, 320, 327, 330, 506, 517
inKuzwa . . . . .	20, 96	<i>ovata Spreng.</i>	72, 87, 91
inKwa = <i>Dioscorea rupicola Kth.</i>	12, 89, 96	Lepidium capense <i>Thb.</i>	34, 77, 98
mKwane = <i>Ficus capensis Thb.</i>	326	Leprosy . . . . .	15
uKwaphuka . . . . .	71	Leskia . . . . .	304
		uLethi . . . . .	35, 96
		Leucas . . . . .	311
		<i>martiniensis R. Br.</i>	513
		Leucosidea sericea <i>E. &amp; Z.</i>	308, 327, 531, 532
		Leydigia quadridentata <i>Brady (sp. n.)</i>	468, 473

	PAGE		PAGE
Lianes . . . . .	296, 308, 519	isiLumo . . . . .	54
ubuLibazi . . . . .	35, 96	umLunge = <i>Antholyza paniculata Klatt.</i> . . . . .	30, 89, 96
Lichtensteinia interrupta <i>E. M.</i> . . . . .	40, 82, 102	Luxwego = <i>Notobuxus natalensis Oliver</i> . . . . .	327
Light intensity . . . . .	283	Luzula africana <i>Drege</i> . . . . .	534, 536
Lignite . . . . .	346, 366, 369, 376	Lycopodium gnidioides <i>Linn.</i> . . . . .	304, 519
Liliacæ . . . . .	159, 160	saururus <i>Lam.</i> . . . . .	304, 519
uLimilwenkomo . . . . .	49, 67, 83, 96	verticillatum <i>Linn.</i> . . . . .	304, 519
uLimilwenyathi . . . . .	49, 67, 68, 83, 90, 94, 96	Lythrum . . . . .	535, 536
Limnadia . . . . .	469	Maba natalensis <i>Harv.</i> . . . . .	296, 327
Limoenhout . . . . .	329	iMabele yongosi . . . . .	54, 88, 98
Linum thunbergii <i>E. &amp; Z.</i> . . . . .	504	uMabilwana . . . . .	28, 96
Liparis bowkeri <i>Harv.</i> . . . . .	305	Mabuia occidentalis <i>Peters</i> . . . . .	482
Liparite pitchstone . . . . .	153	uMabusana . . . . .	40, 41, 78, 97
Liparose . . . . .	154	uMachakazi . . . . .	34, 97
Lippia asperifolia <i>Rich.</i> . . . . .	34, 46, 86, 102, 506, 513, 527, 537, 545	uMadintsana . . . . .	44, 84, 97
Lipocarpha . . . . .	322	uMadlozana . . . . .	40, 97
argentea <i>R. Br.</i> . . . . .	534	Mæsa rufescens <i>A. DC.</i> . . . . .	527, 535
Liquorice . . . . .	39	uMafumbhuka . . . . .	30, 61, 97
Lobelia decipiens <i>Sond.</i> . . . . .	492	Maggots in cattle sores . . . . .	81
erinus <i>Linn.</i> . . . . .	505	uMaguqu . . . . .	22, 84, 97
Locusts . . . . .	291	uMagwanyana . . . . .	58, 97
Loganiacæ . . . . .	85	uMahedeni . . . . .	12, 45, 47, 87, 97
umLolwa = <i>Hibiscus tiliaceus Linn.</i> . . . . .	327	Mahernia erodioides <i>Burch.</i> . . . . .	505
Lomaria boryana <i>Willd.</i> . . . . .	535	grandistipula <i>Burch.</i> . . . . .	513
umLomoinnandi . . . . .	45, 96	<i>Mahernia saccifera Turcz.</i> . . . . .	504
Loranthus . . . . .	305	uMahlabathi . . . . .	22, 97
Lotononis corymbosa <i>Bth.</i> . . . . .	505	uMahlabekufeni = <i>Croton grattissimum Burch.</i> . . . . .	13, 26, 39, 50, 52, 60, 61, 88, 97
eriantha <i>Bth.</i> . . . . .	505	uMahlokoloza . . . . .	48, 53, 61, 97
prostrata <i>Bth.</i> . . . . .	505	uMaholwana = <i>Ipomœa palmata Forsk.</i> . . . . .	46, 85, 97
Lovenula . . . . .	467	Maize . . . . .	495
amaLovula . . . . .	66	uMakhanda ka'ntsele = <i>Eucomis undulata Ait.</i> . . . . .	47, 90, 97
Lovu-lovu = <i>Kiggelaria africana Linn.</i> . . . . .	325, 327	uMakhuthula = <i>Agrimonia eupatoria Linn.</i> . . . . .	22, 81, 97
uLovwane . . . . .	12, 96	Malaria fever . . . . .	45
iLozane . . . . .	12, 46, 65, 74, 81, 101	uMaluleka . . . . .	35, 97
umLozikazana . . . . .	64		
Ludwigia . . . . .	323		
Luffa sphaerica <i>Sond.</i> . . . . .	25, 82, 101		
umLulama = <i>Turraea heterophylla Sm.</i> . . . . .	58, 96		
Lumbricidæ . . . . .	401, 448		

	PAGE		PAGE
uMalusi . . . . .	12, 28, 97	Menstruation . . . . .	54
Malvaceæ . . . . .	78	Mentha aquatica <i>Linn.</i>	535, 536
iMambha . . . . .	71	Mesembryanthemum . . . . .	59, 295
uMampeshana = Oldenlandia		edule <i>Linn.</i>	294
decumbens <i>Hiern.</i>	42, 59, 82, 97	Metalisia muricata <i>Less.</i>	330
Mangrove . . . . .	297, 325, 329	Microchætinae 401, 403, 405, 406,	
uMankeketha . . . . .	28, 97	422, 455	
uMankunkuku . . . . .	59	Microchætus . . . . .	405, 406, 449
Manson, Sir Patrick . . . . .	31	beddardi <i>Benh.</i>	398,
uMaphipha . . . . .	29, 97	399, 401, 447, 450, 455	
uMaqandalingophi . . . . .	71	colletti <i>Bedd.</i>	401, 442,
Mariscus . . . . .	322, 534	444, 445, 450, 456	
capensis <i>Schrad.</i>	503	gracilis <i>Mich.</i>	399, 401,
congestus <i>C. B. Clarke</i>	534	443, 444, 445, 451,	
deciduus <i>C. B. Clarke</i>	534	456	
Marsilia capensis <i>A. Br.</i>	501, 534	ivari <i>Mich.</i>	399, 401,
macrocarpa <i>Pres.</i>	501, 533	443, 444, 451, 456	
uMasigcolo = Osteospermum		modestus <i>Mich.</i>	440, 447
24, 43, 84, 97		natalensis ( <i>Kinb.</i> )	398,
uMathanjana . . . . .	17, 18, 85, 98	401, 422, 426, 450,	
uMathoyisa . . . . .	34, 77, 98	457, 458	
uMathunga = Cyrtanthus ob-		papillatus <i>Benh.</i>	399,
liquus <i>Ait.</i>	17, 18, 35, 40, 42, 70,	401, 426, 427, 429, 431,	
71, 89, 98		450, 457, 458	
uMayehlezana . . . . .	41, 81, 98	papillatus <i>Benh.</i>	
uMayime = Clivia miniata <i>Regel</i>		var. <i>cæmenterii</i>	
45, 56, 74, 89, 98		<i>Mich.</i>	401, 429, 450,
umMbhezi . . . . .	26, 63, 98	458	
umMbhila . . . . .	36	parvus <i>Mich.</i> (sp.	
iMbho . . . . .	45	n.)	401, 445, 447, 450,
Measles . . . . .	46	456, 458	
Medical treatment, native	16	pentheri <i>Rosa</i>	429, 440
Medicine-men, native . . . . .	1	sulcatus ( <i>Kinb.</i> )	
Medicines, preparation of . . . . .	2	398, 399, 401, 431,	
Megalixalus fornasinii <i>Bianc.</i>	479	434, 436, 440, 449, 456	
spinifrons <i>Cope</i>	479	sulcatus ( <i>Kinb.</i> )	
Megaseolecidae . . . . .	400, 403, 411, 453	var. <i>howickianus</i>	
Megaseolecinae . . . . .	401, 417, 453	<i>Mich.</i> (var. n.)	401,
Melasma . . . . .	320	432, 434, 436, 449,	
Melastomaceæ . . . . .	82	456, 458	
Meliaceæ . . . . .	79	<i>Microchætus zulu Mich.</i>	399, 436,
Melinis minutiflora <i>Beauv.</i>	313	437, 439	
Menacodon . . . . .	136	<i>Microchætus zuluensis Bedd.</i>	399,
Menispermaceæ . . . . .	77	401, 436, 437, 440,	
Menstrua cynocephali . . . . .	54	450, 455	

	PAGE		PAGE
Microchloa altera <i>Stapf.</i> var.		isaMuyisane = Spermacoe	
nelsoni . . . . .	530	natalensis <i>Hochst.</i>	33, 46, 82, 98
caffra <i>Nees</i>	313, 315,	Mygale . . . . .	135
	503, 530	Myosotis afra-palustris <i>C. H.</i>	
Micropternodus . . . . .	133	<i>Wright</i>	535, 536
Microscolex . . . . .	400, 407, 408	Myrica aethiopica <i>Linn.</i>	307, 308,
Mikania . . . . .	305		327, 535
capensis <i>DC.</i>	49, 51, 84,	Myriophyllum spicatum <i>Linn.</i>	
	92, 296		323, 536
Milletica caffra <i>Msn.</i>	. . . . . 327	Myrsineæ . . . . .	84
Mimusops caffra <i>E. M.</i>	295, 296, 327,	Myrsine melanophleas <i>R. Br.</i>	. . . . . 296,
	329		302, 327
obovata <i>Sond.</i>	. . . . . 327	Mystacidium . . . . .	304, 519
uMinya = Croton sylvaticum			
<i>Hochst.</i>	. . . . . 12, 60, 103	umuNa . . . . .	66
Mispel . . . . .	326, 329	iNama = Strychnos atherstoni	
Mistletoe . . . . .	329	<i>Harv.</i>	. . . . . 328
Modecca digitata <i>Harv.</i>	. . . . . 305	isiNama . . . . .	24, 43, 66, 68, 86, 87, 98
Mohria caffrorum <i>Desv.</i>	301, 517,	umNama = Celastrus acumina-	
	536	tus <i>Linn.</i>	. . . . . 325
Molteno Beds . . . . .	255	isiNama esibomvu sehlathi	55, 87, 98
Momordica foetida <i>Schum.</i>	25, 82, 102	Natal geology . . . . .	255
involuta <i>E. M.</i>	25, 82,	lily . . . . .	17, 50, 58
	103	mahogany . . . . .	327
uMondi = Chlorocodon whitei		plum . . . . .	67, 325
<i>Hk. f.</i>	. . . . . 24, 85, 98	rainfall . . . . .	260
Monitor niloticus ( <i>Linn.</i> )	. . . . . 59	temperature . . . . .	272
Monkey ropes . . . . .	328, 329	vegetation . . . . .	253
Monotremes . . . . .	248	winds . . . . .	286
Moræa spathacea <i>Ker.</i>	318, 504, 506	Natalobatrachus bonebergi	
	534	<i>Hewitt &amp; Methuen</i>	. . . . . 475
tenuis <i>Ker.</i>	. . . . . 318	Native ointments . . . . .	13
Moschosma riparia <i>Hochst.</i>	25, 41, 60,	poultices . . . . .	13
	87, 91	steam-baths . . . . .	14
Moya . . . . .	31	Na-touw = Ficus natalensis	
uMoyawovungu . . . . .	59, 98	<i>Hochst.</i>	. . . . . 326
uMpondonde . . . . .	56, 67, 89, 98	iNcamu = Othonna natalensis	
Mtyntyambani . . . . .	: 29	<i>Sch. Bip.</i>	. . . . . 22, 24, 84, 98
iMunyane = Leonotis leonurus		iNcohiba . . . . .	12, 85, 98
<i>Brown</i>	. . . . . 34, 72, 73, 87, 98	iNdiki . . . . .	64
Munyankomo = Eleusine in-		isiNdiyandiya = Bersama lucens	
dica <i>Gærtn.</i>	. . . . . 326	<i>Szysz</i>	. . . . . 13, 55, 80, 98
Muraltia pilosa <i>DC.</i>	. . . . . 504	uNdwendweni = Eulophia aren-	
Mus musculus <i>Lin.</i>	. . . . . 243	aria <i>Bohn.</i>	. . . . . 53, 88, 98
rattus <i>Lin.</i>	. . . . . 292		

	PAGE		PAGE
Nebelele = <i>Albizzia fastigiata</i>		umNqandane wezimpisi = <i>Roy-</i>	
<i>Oliv.</i> . . . . .	325	<i>ena villosa Linn.</i> 28, 61, 71, 85,	99
iNembhe . . . . .	56	iNqayi = <i>Elæodendron voluti-</i>	
Nemertodrillus <i>griseus Mich.</i> . . . . .	402	<i>nun Harv.</i> . . . . .	30, 80, 99, 325
<i>kellneri Mich.</i> . . . . .	402	uNtlangothi . . . . .	12, 61, 99
Nemesia . . . . .	320, 506	uNtliziyonkulu . . . . .	59, 99
Nephrodium <i>athamanticum Hk.</i>		Nudaurelia <i>belina Westw.</i> . . . . .	291
. . . . .	22, 292	umNukambhile = <i>Clausena in-</i>	
<i>bergianum Baker</i> . . . . .	536	<i>æqualis Bth.</i> 20, 22, 78, 99, 325	
<i>felix-mas Rich.</i> 22, 79,		uNukani . . . . .	50, 52, 87, 99
. . . . .	99	nukisa . . . . .	7
<i>thelypteris Desv.</i> . . . . .	308	isiNungu = <i>Oxalis semiloba</i>	
Nerine . . . . .	319, 506	<i>Sond.</i> . . . . .	66, 78, 102
Nervous system, diseases of . . . . .	61	umNungumabele = <i>Xanthoxy-</i>	
umNga = <i>Acacia horrida Willd.</i> 325		<i>lon capense Harv.</i> . . . . .	329
- <i>manzi</i> = <i>Acacia caffra</i>		umNungwane = <i>Xanthoxylon</i>	
<i>Willd.</i> . . . . .	325	<i>capense Harv.</i> 17, 20, 23, 25, 40,	
- <i>punzi</i> = <i>Acacia hirtella</i>		58, 61, 65, 69, 74, 78, 79, 99	
<i>Willd.</i> . . . . .	325	nusa . . . . .	7
uNgazi . . . . .	29, 61, 98, 99	isa-Nusi . . . . .	7
Nge-lambila = <i>Plectronia mund-</i>		Nutseng . . . . .	326
<i>tiana Pappe</i> . . . . .	327	Nuxia <i>congesta R. Br.</i> . . . . .	327
uNgibonisele . . . . .	53, 56, 99	<i>floribunda Bth.</i> 327, 520, 524	
um-ngoma . . . . .	6	isiNwazi = <i>Cissus cuneifolia</i>	
uNgwaleni = <i>Cluytia pulchella</i>		<i>E. &amp; Z.</i> . . . . .	55, 56, 80, 100
<i>Linn.</i> . . . . .	25, 30, 71, 88, 99	umNweba = <i>Mimusops caffra</i>	
amaNgwe . . . . .	12, 60, 99	<i>E. M.</i> . . . . .	327
Niata cattle . . . . .	248	amaNxeba . . . . .	60
Nicandra <i>physaloides Gærtn.</i>		umNyamathi . . . . .	20, 24, 41, 79, 100
. . . . .	514, 538	iziNyamazane . . . . .	47
Nidorella <i>auriculata DC.</i> . . . . .	505	i-Nyanga = <i>medicine man</i> . . . . .	5, 6
Nieshout = <i>Pteroxylon utile</i>		<i>yokubhula</i> . . . . .	6
<i>E. &amp; Z.</i> . . . . .	328	<i>yokuelapha</i> . . . . .	6
Nitella . . . . .	537	i-Nyangi . . . . .	5
uNjalwana . . . . .	51, 53, 99	iNyathelo = <i>Vernonia woodii</i>	
iNkomankoma = <i>Nephrodium</i>		<i>Hoffm.</i> 25, 34, 44, 74, 94, 100	
<i>felix-mas Rich.</i> . . . . .	22, 99	uNyawothi . . . . .	2, 69, 100
Nooiensboom = <i>Cussonia</i> . . . . .	326	uNyanya = <i>Rhamnus prinoides</i>	
umNono . . . . .	25, 99	<i>L'Herit.</i> . . . . .	71, 80, 100
Norites . . . . .	147	umNyezane = <i>Dovyalis rham-</i>	
iNothwane = <i>Triumfetta rhom-</i>		<i>noides B. &amp; H.</i> . . . . .	58, 77, 100
<i>boidea Jacq.</i> . . . . .	56, 78, 99	<i>Nymphæa capensis Thb.</i> . . . . .	323
Notobuxus <i>natalensis Oliver</i> . . . . .	327	<i>stellata Willd.</i> 323, 327	
umNovu-novu = <i>Cordia caffra</i>		iNyongo . . . . .	14, 43
<i>Sond.</i> . . . . .	325		

	PAGE		PAGE
isiNywane = <i>Royena lucida</i> L.	55, 85, 102	<i>Opisthoctenodon</i>	136
		Orchideæ	88
Ochnaceæ	79	<i>Ornithogalum</i>	319, 507
<i>Ochna arborea</i> Burch.	327	<i>Orthosiphon teueriifolius</i> N. E.	
<i>atropurpurea</i> DC.	33, 79, 91, 299, 545	<i>Br.</i>	530
Ocimum	320	<i>Orthotrichum</i>	304
<i>obovatum</i> E. M.	76, 87, 93, 506	<i>Orycteropus afer</i> (Pallas)	292
Ocnerodrilinæ	401, 403, 404, 406, 419, 455	<i>Osbeckia umlaasiana</i> Hochst.	323, 517, 534, 536
<i>Ocnerodrillus</i>	404	<i>Osmunda regalis</i> Linn.	535, 536
<i>africanus</i> (Bedd.)	420, 452, 453, 455	<i>Osteospermum moniliferum</i> Linn.	
(Enicodrillus)		<i>nervatum</i> DC.	294, 527 24, 43, 84, 97
<i>africana</i> Bedd.	420	Ostracoda	460
(Ilyogenia) africa- nus (Bedd.)	399, 401, 420	<i>Othonna natalensis</i> Sch. Bip.	22, 24, 84, 98
<i>Ocotea bullata</i> E. M.	50, 52, 87, 99, 519	Oudehout	325, 327
Olatineæ	79	<i>Oxalis semiloba</i> Sond.	66, 78, 102, 505
<i>Oldenlandia amatymbica</i> Kuntze	319, 505, 513	<i>pulchella</i> Jacq.	505
<i>decumbens</i> Hiern.	42, 59, 82, 97	<i>Oxygonum dregeanum</i> Meisn.	506
<i>Olea capensis</i> Linn.	327	<i>Paaredepram</i>	329
<i>foveolata</i> E. M.	302, 327	<i>Pachydactylus pardus</i> Sternf.	483
<i>laurifolia</i> Lam.	302, 327, 518, 519	<i>punctatus</i>	
<i>verrucosa</i> Link.	327	<i>Peters.</i>	483
<i>Oligochæta</i>	397, 403, 406	<i>serval</i> Werner	483
<i>Oljijenhout</i>	327	umPafa = <i>Zizyphus mucronata</i>	
<i>Olinia cymosa</i> Thb.	327	<i>Willd.</i>	329
<i>Olivine-norite</i>	157	iPahla = <i>Brachylæna discolor</i>	
<i>Oncinotis</i>	305	DC.	325
<i>inandensis</i> Wood & Evans	226	imPakatha	4
<i>Oncoba kraussiana</i> Planch.	299	Palæoniscid fish-scales	229
<i>Opheities</i>	326	Palæonictis	133
<i>Ophiocaulon gummifera</i> Hk. f.	12, 45, 82, 93, 305	Palæosinopa	133
<i>Ophthalmia</i>	66, 68, 79, 80, 83, 86, 87, 89, 90	Palmae	90
		<i>Panax gerrardi</i> Harv.	527, 535
		<i>Panicum</i>	303, 315, 317, 508, 511
		<i>crus-pavonis</i> Nees	322, 534
		<i>curvatum</i> Linn.	313
		<i>dregeanum</i> Nees	313
		<i>ecklonii</i> Nees	503
		<i>isachne</i> Roth.	514
		<i>lævifolium</i> Hack.	313, 503, 514

	PAGE		
Panicum natalense Hochst.	313, 503	Pentanisia variabilis Harv.	31, 33
proliferum Lam.	. 313	58, 83, 91, 319, 320, 327, 505	
proliferum Lam. var.		Peperomia . . . . .	304, 519
longijubatum . . . . .	514	caffra E. M. . . . .	304, 519
serratum Spreng.	313, 503	imPepho . . . . .	67
Pappe . . . . .	326, 328	Perameles . . . . .	133, 135
Paradiaptomus . . . . .	467	nasuta Geoff. . . . .	139
falcifer (Loven)		Peripatus . . . . .	165
. . . . .	468, 473	Peristrophe natalensis T. And.	299,
Paralysis . . . . .	61, 62, 79	. . . . .	301, 518
Pareiasauria . . . . .	136	Persgras . . . . .	327
Paspalum . . . . .	317	Pes-capræ association	293, 295, 329
dilatatum Poir.	324, 509	umPhafa = Zizyphus mucronata	
distichum Linn.	. 503	Willd. . . . .	41, 80, 100
scrobiculatum Linn.	313,	iPhahla = Brachylæna discolor	
. . . . .	515, 534	DC. . . . .	20, 83, 100
Passerina . . . . .	295, 528	Phalaris arundinacea Linn.	. 533
ericoides L. . . . .	294	Phaseolus . . . . .	305
Passifloræ . . . . .	82, 305	Phascolestes . . . . .	133
isiPatshola . . . . .	51, 100	uPhepha . . . . .	38
Pavetta caffra Thb. . . . .	327	Pheretima heterochæta (Mich.)	401,
lanceolata Eck. . . . .	327	402, 417, 449, 453	
obovata E.M. . . . .	527	uPhico . . . . .	35, 100
Peat . . . . .	375	iPhimpi . . . . .	71
Pedalineæ . . . . .	86	Phœnix reclinata Jacq.	38, 99, 101
Peddiæa africana Hurr.	299, 301,	amaPhofu . . . . .	63, 100
. . . . .	303, 327, 518	iPhombhane . . . . .	74, 100
Pedetes caffer (Pallas).	. 292	Phosive . . . . .	63
imPeko . . . . .	13	Phosphatic nodules . . . . .	228
Pelargonium aconitophyllum		Phosphatised wood . . . . .	362
E. & Z. . . . .	320, 505	Phragmites . . . . .	331, 543, 544
peltatum Ait. . . . .	312	communis Trin. . . . .	286,
Pellæa calomelanus Link.	. 531	322, 324, 501, 502, 532,	
consobrina Hook. . . . .	531	534, 536, 545	
hastata Link. . . . .	300, 517, 518	isiPhungo . . . . .	76
umPembetu = Plectronia		iPhungulo . . . . .	57
spinosa Klotzsch. . . . .	327	umPhuphutho . . . . .	33, 100
Penicillaria spicata Willd.	2, 69, 100	Phyllopora . . . . .	468
Pennisetum . . . . .	543	Phyllanthus . . . . .	319, 320
natalense Stapf. . . . .	313	Physalis peruviana Linn.	514, 538
sphacelatum Dur.		Phytolacca abyssinica Hoffm.	12,
& Schinz. . . . .	313, 533	45, 47, 87, 97	
thunbergii Kunth. . . . .	533	octandra Linn. . . . .	514
unisetum Bth. . . . .	313,	stricta Hoffm.	
. . . . .	317, 502, 536	. . . . .	506, 513, 527

	PAGE		PAGE
Phytolaccaceæ . . . . .	87	Polygala oppositifolia Linn. . . . .	17,
Pigeon wood . . . . .	328		78, 102
Pigmented skin . . . . .	329	virgata Thb. . . . .	306, 517
imPila = Callilepis laureola		Polygalea . . . . .	78
<i>DC.</i> . . . .	12, 23, 27, 100	Polygonaceæ . . . . .	87
Piles . . . . .	31, 88	Polygonum . . . . .	534
Pimpinella anisum Linn. . . . .	40	lapathifolium Linn. . . . .	322, 534
imPindisa = Rubia cordifolia		serrulatum Lag. . . . .	66, 87
<i>Linn.</i> . . . .	53, 54, 83, 100	Polypodium africanum Mett. . . . .	304
isiPinga = Scutia commer-		incanum Sw. . . . .	304, 519
sonii Brogn. . . . .	328	lanceolatum L. . . . .	304, 519
Pinus insignis Dougl. . . . .	331, 502, 539	lycoperidioides	
pinaster Soland. . . . .	502, 539	<i>Linn.</i> . . . .	304
Piper capense Linn. f. . . . .	330	phymatodes Linn. . . . .	296
imPisikayihlangulwa . . . . .	47, 100	Polystachya . . . . .	304, 519
Pistia stratiotes Linn. . . . .	323	Pontodrilus bermudensis Bedd. . . . .	401,
Pittosporæ . . . . .	77	403, 417, 452, 453	
Pittosporum viridiflorum Sims . . . . .	44,	Pontoscolex corethrurus (Fr.	
	77, 93, 308	<i>Müll.</i> ) . . . . .	401, 402, 422, 449, 455
Plant-communities . . . . .	500	Popowia . . . . .	305
Plant ecology of Natal . . . . .	485	caffra H. & S. . . . .	296, 328, 519
Plectranthus . . . . .	299, 303, 306, 307,	Portulacaria afra Jacq. . . . .	328
	330, 506, 517, 522	Potamogale . . . . .	135
Electronia . . . . .	305, 524	Potamogeton . . . . .	323, 536
mundtiana Pappe . . . . .	327	Potamophila prehensilis Bth. . . . .	299
obovata Klotzsch . . . . .	327	Pristerodon . . . . .	136
spinosa Klotzsch . . . . .	299, 327	Priva leptostachya Juss. . . . .	66, 67, 86, 98
ventosa L. . . . .	23, 29, 103, 328	Pro-epilobous . . . . .	421
Pleurisy . . . . .	38	Prolobous . . . . .	421
Pleurodynia . . . . .	38	Proscalops . . . . .	135
Plumbago capensis Thb. . . . .	524	Protea . . . . .	259
Poa annua Linn. . . . .	514	abyssinica Willd. . . . .	313
Podocarpus elongata L'Herit. . . . .	302,	hirta Klotzsch . . . . .	313, 531, 532
	328, 535	subvestita N. E. Br. . . . .	313
latifolia Wall. . . . .	519	Protodiaptomus . . . . .	467
thunbergii Hook. . . . .	300,	lamellatus Sars . . . . .	467
	302, 308, 328, 518,	Psammophilous bush . . . . .	258, 293, 297,
	519, 535		329
Pœcilogale albinucha (Gray) . . . . .	57	Psammophis crucifer Daud. . . . .	481
Poison bush . . . . .	325	furcatus Ptrs. . . . .	481
uPoko = Eleusine coracana		jallæ Peracca . . . . .	481
<i>Gærtn.</i> . . . .	2	notostictus Ptrs. . . . .	481
Pollinia villosa Spreng. . . . .	503	Psammotropha myriantha Sond. . . . .	531
Polygala senega Linn. . . . .	18		
hottentotta Presl. . . . .	319, 504		

	PAGE		PAGE
Pseudo-spherulites of Rosen- busch . . . . .	387	umQaqongo = Clerodendron glabrum <i>E. M.</i> . . . . .	20, 22, 60, 74, 86, 100
Psilotum triquetrum <i>Sw.</i> . . . .	304, 519	amaQate . . . . .	53, 100
Psoralea caffra <i>E. &amp; Z.</i> . . . .	505	iQhotho . . . . .	18
pinnata <i>Linn.</i> . . . .	64, 81, 94, 320, 505	uQhume = Hippobromus alatus <i>E. &amp; Z.</i> . . . . .	13, 34, 80, 100
Psychotria capensis <i>Vatke.</i> . . .	328	umQhuqhu . . . . .	45, 75
Ptæroxylon utile <i>E. &amp; Z.</i> . . . .	328, 519, 528	iQondo . . . . .	48, 49, 51
Pteris aquilina <i>Lin.</i> . . . .	301, 329, 517, 522, 530	uQontsi = Eriosema corda- tum <i>E. M.</i> . . . . .	53, 81, 100
flabellata <i>Thb.</i> . . . .	301, 303, 518	isiQuane = Sugar bush . . . . .	328
quadriaurita <i>Retz.</i> . . . .	301, 518	umQuaqu = Nuxia floribunda <i>Bth.</i> . . . . .	327
Pterocelastrus rostratus <i>Walp.</i> . .	61, 80, 101	umQuaquane = Clerodendron glabrum <i>E. M.</i> . . . . .	325
variabilis <i>Sond.</i> . . . .	296, 328	nQudu = Olinia cymosa <i>Thb.</i> . . .	327
Puerperal fever . . . . .	56	uQuengu = Tephrosia macro- poda <i>E. M.</i> . . . . .	12, 46, 65, 74, 81, 101
izimPundu . . . . .	11	Quinine tree . . . . .	328
Pupalia . . . . .	56, 87, 98	umQuma = Olea verrucosa <i>Link.</i> . . . . .	327
Purgatives . . . . .	28, 44	umQumaswele = Olea foveolata <i>E. M.</i> . . . . .	327
iPuzi-lomlambo = Gunnera perpensa <i>Linn.</i> . . . .	326	iQumza elinameva = Scolopia zeyheri <i>Harv.</i> . . . . .	328
Pyreus . . . . .	322	isiQunga = Andropogon mar- ginatus <i>Steud.</i> . . . . .	20, 90, 101
angulatus <i>Nees</i> . . . . .	534	umQuoquongo = Clerodendron glabrum <i>E. M.</i> . . . . .	325
flavescens <i>Reichb.</i> . . . .	534	umQuqoba = Celastrus buxi- folius <i>Linn.</i> . . . . .	325
oakfortensis <i>C. B.</i> <i>Clarke</i> . . . . .	534	iQwangingi = Capparis corymbi- fera <i>E. M.</i> . . . . .	17, 38, 40, 53, 78, 101
umbrosus <i>Nees</i> . . . . .	534	umQwashu = Sideroxylon in- erme <i>Linn.</i> . . . . .	328
Pygæum africanum <i>Hk. f.</i> . . . .	300, 302, 308, 328, 518, 535	umQwashube = Cunonia capen- sis <i>Linn.</i> . . . . .	326
Pygmaedrillus arausionensis <i>Mich.</i> . . . . .	404	Rana natalensis <i>Smith</i> . . . . .	480
Pyrenacantha scandens <i>Planch.</i> . .	56, 79, 101	Randia rudis <i>E. M.</i> . . . . .	299, 300, 328, 537, 545
Pyroxenites . . . . .	147	Ranunculaceæ . . . . .	77
umnQabaza = Grewia occi- dentalis <i>Linn.</i> . . . .	326	Ranunculus pinnatus <i>Poir.</i> . . . .	34, 49, 51, 77, 103, 535
uQadolo = Bidens pilosa <i>Linn.</i> . .	25, 83, 100		
isiQalaba . . . . .	328		
umQalothi = Strychnos hen- ningsii <i>Gilg.</i> . . . .	22, 24, 58, 85, 100		

	PAGE		PAGE
Raphionacme . . . . .	17, 85, 98, 319	Rinorea . . . . .	518
<i>divaricata</i> <i>Harv.</i>	506	<i>ardisiaeflora</i> <i>Welw</i>	303
Rauwolfia natalensis <i>Sond.</i>	17, 46,	Riocreuxia . . . . .	528
85, 94, 308, 309, 328, 330, 520		Rock alder . . . . .	327
Rawsonia lucida <i>Harv.</i> . . . .	305	Roodebesje . . . . .	327
Real yellow-wood . . . . .	328	Roode els . . . . .	326
Rechte geelhout . . . . .	328	Roodehout . . . . .	327
Red alder . . . . .	326	Roode melkhout . . . . .	327
Beds . . . . .	255	peer . . . . .	328
currant . . . . .	328	stinkwood . . . . .	328
dagga . . . . .	327	zaadgras . . . . .	329
mangrove . . . . .	328	Rosaceæ . . . . .	81
milkwood . . . . .	327	Rottbœlia compressa <i>Linn. f.</i> . . . .	503
pear . . . . .	328	Round-worms . . . . .	21
stinkwood . . . . .	328	Royena . . . . .	505
Redwood . . . . .	327	<i>lucida</i> <i>L.</i> 55, 85, 102, 303, 328	
Rhamneæ . . . . .	80	<i>pallens</i> <i>Thb.</i> 328, 537, 545	
Rhamnus prinoides <i>L'Herit</i> . . . . .	71, 80,	<i>pubescens</i> <i>Sim</i> . . . . .	527
100, 301, 303, 308, 328, 518, 519,		<i>villosa</i> <i>Linn.</i> 28, 61, 71, 85,	
520		99, 328	
Rhamphicarpa fistulosa <i>Bth.</i> . . . .	320	Rubia cordifolia <i>Linn.</i> 53, 54, 83, 100	
<i>tubulosa</i> <i>Bth.</i> . . . .	534	Rubiaceæ . . . . .	82
Rheumatic fever . . . . .	58	Rubus . . . . .	305
Rheumatism 57, 77, 82, 83, 85, 90		<i>pinnatus</i> <i>Willd.</i> 296, 300, 328,	
Rhinotermes . . . . .	114	517, 522	
Rhipsalis cassytha <i>Gærtn.</i> 304, 519		<i>rigidus</i> <i>Smith</i> 30, 81, 95, 537,	
Rhizophora mucronata <i>Lam.</i> 297, 328		545	
Rhus 295, 296, 301, 303, 524, 528,		iRubuxa = Pentanisia varia-	
537, 545		<i>bilis</i> <i>Harv.</i> . . . . .	327
<i>discolor</i> <i>E. M.</i> . . . . .	505	Rumex acetosella <i>Linn.</i> . . . .	514
<i>lævigata</i> <i>Linn.</i> 302, 304, 328		<i>ecklonianus</i> <i>Meisn.</i> 87, 92, 506	
<i>longifolia</i> <i>Sond.</i>		Rutaceæ . . . . .	78
299, 300, 302, 518		Saffraan hout . . . . .	326
Rhynchosia . . . . .	35, 81, 95	Saffron wood . . . . .	326
Rhynchospora . . . . .	322	Sagewood . . . . .	325
<i>glauca</i> <i>Vahl.</i> . . . .	534	uSahlulamanye . . . . .	61, 80, 101
Rhyolites . . . . .	141, 152	Sakoone . . . . .	329
Riccia . . . . .	309	Salicornia—Chenolea associa-	
Richardia albomaculata <i>Hook.</i>		tion . . . . .	297, 329
330, 507		<i>herbacea</i> <i>Linn.</i> 294, 297, 329	
<i>africana</i> <i>Kunth.</i> 308, 323,		Saliehout . . . . .	325
517, 521, 534, 536		Salix woodii <i>Seem.</i> . . . .	323
Ricinus communis <i>Linn.</i> 88, 94, 328,		Salvia . . . . .	311, 320, 506
514, 527		Samolus porosus <i>Thb</i> . . . . .	294
Ringicula australis <i>Hinds</i> . . . . .	185		

	PAGE		PAGE
Sandalwood	326	Sclerocarya caffra <i>Sond.</i>	32, 80, 93, 299, 310, 534
Sandersonia aurantiaca <i>Hook.</i>	319, 507	Scelopora ecklonii <i>Szys.</i>	535
Sandulane	327	zeyheri <i>Harv.</i>	292, 328, 518, 535
Sansevieria thyrsofolia <i>Tub.</i>	68, 88	Serofula	16, 77, 78, 82, 84, 85, 89
Sapindaceæ	80	Serofulons cough	89
Sapindus oblongifolius <i>Sond.</i>	30, 96, 296	Serophulariaceæ	86, 320
Sarcophaga	20	Seutia commersonii <i>Brogn.</i>	296, 301, 303, 328, 519, 528
Sarcostemma viminalis <i>R. Br.</i>	312, 528	Sebæa crassulæfolia <i>E. &amp; Schl.</i>	505, 530, 531
Satyrium	506	sedoides <i>Gilg.</i>	505, 530
cordifolium <i>Ldl.</i>	531	Secamone gerrardi <i>Harv.</i>	13, 61, 85, 93, 528
longicauda <i>Ldl.</i>	531	isiSefox	30, 101
macrophyllum <i>Ldl.</i>	531	umSekelo = <i>Pyrenacantha scan-</i>	
parviflorum <i>Sw.</i>	531	dens <i>Planch.</i>	56, 79, 101
sphærocarpum <i>Ldl.</i>	531	Selaginella rupestris <i>Sprengel.</i>	531
Scabiosa columbaria <i>Linn.</i> var.		Selago	320, 506
dissecta	319, 505, 545	uSelwa = <i>Luffa sphaerica Sond.</i>	25, 82, 101
Scævola lobelia <i>Linn.</i>	293	Senebiera didyma <i>Pers.</i>	514
plant-association	293	Senecio	296, 299, 301, 305, 306, 317, 318, 319, 320, 504, 505
Scarabeus sacer <i>Linn.</i>	21	buplenroides <i>DC.</i> var.	
Scarlatina	15	latifolius	505
Schapedrolletjes	328	juniperinus <i>Linn.</i>	505
Schizoglossum ciliatum <i>Schltr.</i>	506	latifolius <i>DC.</i>	514
flavum <i>Schltr.</i>	506	macroglossus <i>DC.</i>	303
stenoglossum	506	pterophyllus <i>DC.</i> var.	
<i>Schltr.</i>	506	apterus	318, 504
Schmidelia erosa <i>Arn.</i>	296	speciosus <i>Willd.</i>	39, 60, 84, 91
monophylla <i>Prest.</i>	299, 301, 518	umSenge = <i>Cussonia spicata</i>	
Schœnoxiphium	322	<i>Thb.</i>	44, 82, 101, 326
Schottia brachypetala <i>Sond.</i>	30, 81, 94, 312	umSengu-mzani = <i>Toddalia</i>	
Scilla	504	natalensis <i>Sond.</i>	328
globosa <i>Baker</i>	531, 534	Septee	325
lanœfolia <i>Baker</i>	507, 531	Sertularia bidens <i>Bale</i>	105, 108, 111
rigidifolia <i>Kth.</i>	12, 58, 90, 93	Setaria	314, 315, 331
Scirpus	322	aurea <i>A. Brown</i>	313, 321, 501, 517, 532, 534, 536
cernuus <i>Vahl.</i>	534	imberbis <i>R. &amp; S.</i>	313, 314, 503, 534, 545
hystrix <i>Thb.</i>	534	nigrirostis <i>Dur. &amp; Sch.</i>	503
prolifer <i>Rotth.</i>	534		
rivularis <i>Bœckl.</i>	534		
Scleria	322		
Sclerocarya	300		

	PAGE		PAGE
Setaria sulcata <i>Raddi</i>	313, 314, 328,	Solanum nigrescens <i>Mart. &amp; Gal.</i>	311
	517	nigrum <i>Linn.</i>	514
verticillata <i>Beauv.</i>	313, 314	sodomæum <i>Linn.</i>	56, 86, 102, 527
uShaqa	58, 65, 83, 101	uSolo = <i>Albizzia fastigiata Oliv.</i>	13, 66, 67, 80, 101
umShekishane = <i>Euclea lanceo-</i>		iSona = <i>Striga lutea Lour.</i>	514
lata <i>E. M.</i>	27, 85, 101	<i>Sonchus oleraceus Linn.</i>	514
Shearing movement in fossil		umSongi	58, 101
wood	360	<i>Sopubia cana Harv.</i>	506, 531
isiShimeyana = treacle-mead	75	simplex <i>Hochst.</i>	534
isiShoshokazana	35, 77, 101	Sores	79, 80, 81, 83
uShwawu	65, 101	Sorex	135, 243
uSi	38, 41, 81, 98	<i>Sorghum caffrorum Beauv.</i>	2
Sibuzana = <i>Andropogon fili-</i>		Soshangane	45
pendulus <i>Hochst.</i>	325	<i>Spalacotherium</i>	136
<i>Sida longipes E. M.</i>	513	<i>Sparmannia palmata E. M.</i>	303, 308, 513
<i>Sideroxylon inerme Linn.</i>	328	Spekboom	328
Silk bark	325	Spekhout	327
inSinda = <i>Anthistiria imberbis</i>		<i>Spermacoe natalensis Hochst.</i>	33, 46, 83, 98, 320, 505
<i>Retz.</i>	325	<i>Sphærothylax algiformis Bisch.</i>	323
nSinde = <i>Randia rudis E. M.</i>	328	Spherulitic dolerite	381
isiSinini	69, 101	Spinal disease	80, 85
umaSintsi = <i>Erythrina caffra</i>		Sporobolus	317
<i>Thb.</i>	49, 51, 61, 68, 81, 101, 326	centrifugus <i>Nees</i>	503
Sirichout	328	indicus <i>R. Br.</i>	314, 317, 330, 331, 501, 511, 513, 515, 516, 541
<i>Sisyranthus trichostomum</i>	<i>Schltr.</i> 506	Sports	235
umSizi	47	Sprains	80
Skin diseases	65, 78, 79, 80, 81, 83, 86	Stachys	319, 320, 506, 530
Slugs	159	æthiopica <i>Linn.</i> var.	
Smalblad	327	glandulifera	530
Smallpox	46	Stamper wood	326
Smilax	305	<i>Stapelia gigantea N. E. B.</i>	64, 85, 103
kraussiana <i>Meisn.</i>	68, 90, 94	Steam bath	57
Snake-bite	71, 79, 85, 86, 87, 89	<i>Stellaria media Villars.</i>	514
Sneeze-wood	328	<i>Stenocypris aldabræ G. M.</i>	460
Soil analysis	259	<i>Müller</i>	305
umSokosoko = <i>Ethulia cony-</i>		<i>Stenoglottis fimbriata Ldl.</i>	305
zoides <i>Linn.</i>	20, 25, 83, 101	<i>Stiburus alopecuroides Stapf.</i>	531, 534
Solanaceæ	86		
Solanum	305, 320		
auriculatum <i>Ait.</i>	331, 527		
capense <i>L. F.</i>	49, 52, 67, 69, 73, 86, 102, 319, 506		
giganteum <i>Jacq.</i>	527		
melongena <i>Linn.</i>	51, 86, 102		



	PAGE		PAGE
Stiff-neck . . . . .	58	Sutera breviflora <i>Hiern.</i> . . . .	531
Stinkhout . . . . .	327	Sutherlandia frutescens <i>R. Br.</i> . . . .	66
Stobæa . . . . .	505, 517	umSuzwane = <i>Lippia asperi-</i>	
<i>Stobæa platyptera</i> <i>Harv.</i> . . . .	505	<i>folia Rich.</i> . . . .	34, 46, 86, 102
Stomach-ache . . . . .	83, 88	Swaziland System . . . . .	255
Stomach complaints 23, 79, 82, 83		Synadenium arborescens <i>Ilk.f.</i>	
	84, 87		35, 88, 92
Stormberg Series . . . . .	255	Syphilis . . . . .	51, 80, 81, 86
Stramonium . . . . .	18, 28, 42		
Strelitzia angusta <i>Thb.</i> . . . .	296, 300	Table Mountain Sandstone . . . . .	
— Osteospermum asso-			255, 489, 544
ciation . . . . .	296	umTala = <i>Erianthus capensis</i>	
Streptocarpus . . . . .	309, 518, 521	<i>Nees</i> . . . . .	326
Streptocephalus . . . . .	460	Talpa . . . . .	135
<i>papillatus G. O.</i>		Tambootic grass . . . . .	20, 325, 532
<i>Sars.</i> . . . .	471	Tanylobous . . . . .	421
<i>propinquus</i>		Tape-worm 21, 78, 81, 83, 84, 85, 87	
<i>Brady</i> (sp.		Tarchonanthus camphoratus	
n.) 470, 474		<i>Linn.</i> . . . .	296, 328
Striga lutea <i>Lour.</i> . . . .	320, 506, 514	umTati = <i>Pteroxyylon utile</i>	
Strophanthus . . . . .	305	<i>E. f. Z.</i> . . . .	328
<i>capensis DC.</i> . . . .	519	Tecoma capensis <i>Lindl.</i> . . . .	528
Strychnos atherstonei <i>Harv.</i> . . . .	328	Teeth, decayed . . . . .	65
<i>gerardii N. E. Brown</i> . . . . .	299	inTelezi . . . . .	10
<i>henningsii Gilg.</i> . . . .	24, 58,	izinTelezi . . . . .	11
85, 100, 328		inTelo . . . . .	66
<i>spinosa Lam.</i> . . . .	73, 85, 94,	umTenenenda = <i>Cola natal-</i>	
296, 328		<i>ensis Oliv.</i> . . . .	325
Stylochiton . . . . .	68, 90, 93	umTensema = <i>Ochna arborea</i>	
Succinite . . . . .	371, 375	<i>Burch.</i> . . . .	27
Sugar bushes . . . . .	328	Tephrosia . . . . .	512
umSugusi = <i>Gardenia globosa</i>		<i>canescens E. M.</i> . . . .	294
<i>Hochst.</i> . . . .	326	<i>diffusa E. M.</i> 12, 74, 84, 101	
Suiker boschjes . . . . .	328	<i>kraussiana Meisn.</i>	
uSukumbhili = <i>Hypericum</i>			40, 81, 102
<i>æthiopicum Thunb.</i>		<i>longipes Meisn.</i> . . . .	505
	13, 48, 78, 101	<i>macropoda E. M.</i> 12, 46,	
umSuhulu = <i>Euphorbia tiru-</i>		65, 74, 81, 101, 505	
<i>calli Lin.</i> . . . .	326	<i>polystachya E. M.</i> . . . .	505
iSandu = <i>Phoenix reclinata</i>		Termes bellicosus <i>Smeath.</i> . . . .	118
<i>Jacq.</i> . . . .	38, 90, 101	Termes bilobatus <i>Haviland</i> . . . . .	114, 118,
uSumunundu = <i>Acalypha pe-</i>			126, 127
<i>duncularis Meisn.</i> . . . .	48, 81, 101	Termes gestroi <i>Wasm.</i> . . . .	128
Supree = <i>Tarchonanthus cam-</i>		<i>incertus Hagen.</i> . . . .	114, 118,
<i>phoratus Lin.</i> . . . .	328		124, 125

- | PAGE  | PAGE   |
|---|--|
| Termes latericius <i>Haviland</i> 114, 118,<br>121, 123, 125, 290                 | isiThumana = <i>Solanum</i> ca-<br>pense <i>L. f.</i> . . . 49, 50, 52, 67, 69,<br>73, 86, 102 |
| nasutus <i>Hagen</i> . . . 115  | Thunbergia atriplicifolia <i>E. M.</i> 506   |
| natalensis <i>Haviland</i> 113, 117<br>118, 120, 127, 290                         | hirtistylis <i>C. B.</i><br><i>Clarke</i> . . . 506  |
| <i>Termes parvus</i> <i>Haviland</i> 114, 118, 125                                | natalensis <i>Hook.</i><br>301, 518  |
| <i>trinervis</i> <i>Rambur</i> 114, 118,<br>124, 127, 128, 290                    | umThunduluka = <i>Ximenia</i><br>caffra <i>Sond.</i> . . . 67, 79, 102                         |
| <i>Termes vulgaris</i> <i>Haviland</i><br>114, 118, 122                           | Thymeleaceæ . . . 87   |
| Termites . . . 113, 289   | Tiliaceæ . . . 78  |
| Tertiary Beds . . . 365   | umTimatane = <i>Royena lucida</i><br><i>L.</i> . . . 55, 85, 102                               |
| Tetrodon inermis <i>Temm.</i> †<br><i>Schleg.</i> . . . 60                        | Titanosuchus . . . 136   |
| stellatus ( <i>Bleek</i> ) . . . 60   | inTlashane = <i>Lichtensteinia</i><br>interrupta <i>E. M.</i> . . . 40, 82, 102                |
| Tenerium . . . 320  | inTlumbha . . . 23   |
| umThakathi . . . 9, 10, 11, 35, 37, 66  | inTlungunyembhe = <i>Toxicophlæa thunbergii</i> <i>Harv.</i> 12, 325                           |
| uThangazana = <i>Cucumis hirsutus</i> <i>Sond.</i> 13, 40, 82, 102                | Tobankoue = <i>Burchellia capensis</i> <i>R. Br.</i> . . . 325                                 |
| isiThathe = <i>Oxalis semiloba</i><br><i>Sond.</i> . . . 66, 78, 102              | Toddalia lanceolata <i>Lam.</i> 301, 302,<br>303, 328, 518, 519                                |
| isiThlelo = <i>Aster erigeroides</i><br><i>Harv.</i> . . . 20, 23, 28, 83, 102    | natalensis <i>Sond.</i> . . . 328  |
| umThente = <i>Imperata arundinacea</i> <i>Cyr.</i> . . . 24, 90, 102              | inTolwane = <i>Elephantorhiza burchellii</i> <i>Bth.</i> 29, 45, 81, 102                       |
| iThebe = <i>Polygala oppositifolia</i> <i>Linn.</i> 17, 18, 78, 102               | umTombe = <i>Ficus natalensis</i><br><i>Hochst.</i> . . . 326                                  |
| Thesium . . . 320, 506  | umTomboti = <i>Excæcaria africana</i> <i>Müll. Arg.</i> . . . 326                              |
| imiThi emblophe = white<br>medicines . . . 11                                     | inTondo = <i>Argyrolobium marginatum</i> <i>Bolus</i> 24, 25, 80, 102                          |
| imiThi emnyama = black<br>medicines . . . 11                                      | Tongoti = <i>Gardenia nuberia</i><br><i>E. &amp; Z.</i> . . . 326                              |
| umThombho = <i>Cissampelos torulosa</i> <i>E. M.</i> . . . 18, 51, 69,<br>77, 102 | Toothache . . . 68, 77, 79, 86, 88   |
| iThondo . . . 18, 102   | Topographic map of Natal . . . 488   |
| Thorns, extraction of . . . 69  | Torbanite . . . 375, 376   |
| Thorn pear . . . 328  | Toscanite . . . 152  |
| tree . . . 325  | Toscanose . . . 156  |
| trees, umbrella-form of 524   | <i>Toxicophlæa thunbergii</i> <i>Harv.</i> . . . 12  |
| veld . . . 309  | inTozane = <i>Peddiea africana</i><br><i>Harv.</i> . . . 327                                   |
| Thrush of infants . . . 66  | Trachypogon polymorphus<br><i>Hack.</i> 313, 31  |
| Thryonomya swinderianus<br>( <i>Temm.</i> ) . . . 292                             |  |
| umThuma . . . 51, 56, 86, 102   |  |

	PAGE		PAGE
<i>Trapa bispinosa</i> Roxb. . . . .	323	<i>Tulbaghia acutiloba</i> Harr. . . . .	531
<i>Trema bracteolata</i> Blume . . . . .	307, 308, 328, 520, 537	<i>alliacea</i> Linn. . . . .	319, 507
<i>Trichilia emetica</i> Vahl. . . . .	13, 23, 28, 79, 95, 103, 299, 329	<i>natalensis</i> Baker . . . . .	507
<i>Tricholena rosea</i> Nees . . . . .	313, 317, 329, 503, 515	<i>violacea</i> Harr. . . . .	507
<i>setifolia</i> Stapf. . . . .	503	<i>amaTungula</i> = <i>Carissa grandi-</i> <i>flora</i> A. DC. . . . .	325
<i>Trichomanes</i> . . . . .	304, 519	<i>Tungwane</i> = <i>Chrysophyllum</i> <i>natalense</i> Sond. . . . .	325
<i>Trichopteryx simplex</i> Hack. . . . .	313	<i>umTunzi</i> = <i>Mumunops obovata</i> Sond. . . . .	327
<i>Triconodont</i> . . . . .	136, 139	<i>Turkey berry</i> . . . . .	328
<i>Trifolium</i> . . . . .	534	<i>Turraea floribunda</i> Hochst. . . . . .	59, 79, 103
<i>Trigastriae</i> . . . . .	401, 417, 453	<i>heterophylla</i> Sm. . . . .	58, 96
<i>Triglochin</i> . . . . .	298, 323, 324	<i>obtusifolia</i> Hochst. . . . . .	13, 23, 27, 94
<i>Trimeria alnifolia</i> Planch. . . . .	23, 77, 92, 299, 301, 303, 329, 518, 519	<i>uTwayi</i> = <i>itch</i> . . . . .	66
<i>Tripteris natalensis</i> Harv. . . . .	84, 97	<i>iTwyina</i> = <i>Pterocelastrus</i> <i>variabilis</i> Sond. . . . .	328
<i>Tristachya leucothrix</i> Trin. . . . . .	313, 315, 329, 503, 511, 530	<i>Typha</i> . . . . .	331
<i>Tritogenia morosa</i> Cogn. de Mart. . . . . .	399, 431, 410	<i>association</i> . . . . .	323
<i>sulcata</i> Kinberg . . . . .	431	<i>capensis</i> Rohrb. . . . .	322, 323, 501, 533, 534
<i>Tritonea rosea</i> Klatt. . . . .	319	<i>Udeina kinbergi</i> (Mich.) . . . . .	404
<i>Tritubercular</i> theory . . . . .	129, 136	<i>Umbaba</i> = <i>Calodendron capense</i> <i>Thb.</i> . . . . .	325
<i>Triunfetta rhomboidea</i> Jacq. . . . . .	56, 78, 99	<i>Umbelliferae</i> . . . . .	82
<i>inTsangu</i> = <i>Cannabis sativa</i> <i>Linn.</i> . . . . .	41, 102	<i>Urinary complaints</i> . . . . .	47, 77, 78, 80, 81, 82, 83, 84, 86, 87, 88, 89, 90
<i>inTsangwana</i> = <i>Tephrosia</i> <i>kraussiana</i> Meisn. . . . .	40, 81, 102	<i>Ursinia tenuiloba</i> DC. . . . .	40, 84
<i>inTsema</i> = <i>Euphorbia pugni-</i> <i>formis</i> Boiss. . . . .	60	<i>Urtica urens</i> Linn. . . . .	88, 91
<i>umTshiki</i> = <i>Eragrostis plana</i> <i>Nees</i> . . . . .	54, 90, 102	<i>Urticaceae</i> . . . . .	88
<i>inTshunga</i> = <i>Momordica</i> <i>foetida</i> Schum. . . . .	25, 82, 102	<i>Urticaria</i> . . . . .	46
<i>inTshungwana yehlathi</i> = <i>Mo-</i> <i>mordica involucrata</i> E. M. . . . . .	25, 82, 103	<i>Uterine disorders</i> . . . . .	88
<i>inTshilo</i> = <i>Capparis citrifolia</i> <i>Lam.</i> . . . . .	325	<i>Utricularia</i> . . . . .	323, 536
<i>inTsinde</i> = <i>Randia rudis</i> E. M. . . . .	328	<i>Vanderlands roodehout</i> . . . . .	327
<i>inTsulwa</i> . . . . .	29, 103	<i>Valeriana capensis</i> Thb. . . . .	534
		<i>uValo</i> . . . . .	59, 75
		<i>umVangazi</i> = <i>Trema bracteo-</i> <i>lata</i> Blume . . . . .	328

	PAGE		PAGE
Vangueria	524	Vleis	320, 532
infausta <i>Burch.</i>	329, 527	Vlier	327
lasiantha <i>Sond.</i>	30, 83, 92	Vocanga thouarsii <i>R. &amp; S.</i>	298, 299,
pygmæa <i>Schl.</i>	505		307
Varanus albigularis ( <i>Daud.</i> )	69	umVuna = <i>Turraea floribunda</i>	
Vasco de Gama	497	<i>Hochst.</i>	59, 79, 103, 325
Vegetation, effect of animals on	289	umVumvu = <i>Celtis kraussiana</i>	
Veld, High	490, 500, 501	<i>Bernh.</i>	325
Low	492, 500, 501	umVuthwamini = <i>Plectronia</i>	
Sour and Sweet	314	<i>ventosa L.</i>	23, 29, 83, 103, 328
Venereal complaints	15, 50, 77, 78,		
	80, 81, 84, 86	Wagen boom	328
Verbenaceæ	86	Wagon trees	328
Vermín-killers	74, 81, 84	Wahlenbergia	319, 320, 505
Vernonia	305	<i>zeyheri E. &amp; Z.</i>	505
<i>corymbosa Less.</i>	38, 56, 84,	umuWane	59, 99
95, 505, 517, 527		wu-wanga	5
<i>dregeana Sch. Bip.</i>	320, 505	Water boom	326, 327, 367, 376
<i>hirsuta Sch. Bip.</i>	505	lily	327
<i>kraussii Sch. Bip.</i>	505	tree	326, 327
<i>natalensis Sch. Bip.</i>	505	Watsonia densiflora <i>Baker</i>	319, 506,
<i>woodii Hoffm.</i>	25, 34, 44,		545
	74, 84, 94, 100	<i>meriana Miller</i>	319, 506,
uVeti = <i>Kiggelaria africana</i>			530
<i>Linn.</i>	327	Wattle, black	262, 301, 324, 502, 537
= <i>Xymalos monospora</i>		Waxberry	327
<i>Baill.</i>	329	Weather plant	39
Vigna	305	Wedelia natalensis <i>Sond.</i>	24, 25, 29,
umVilo = <i>Vangueria infausta</i>			44, 69, 70, 84, 95
<i>Burch.</i>	329	Weeds	513
ubuVimbha = <i>Withania somni-</i>		umWelela	30, 95
<i>fera Don.</i>	33, 51, 65, 86, 103	White ironwood	328
Viscum	305, 329	mangrove	325
Vitex mooliensis <i>Pearson</i>	329	milkwood	328
nViti = <i>Eragrostis curvula</i>		pear	325
<i>Nees</i>	326, 327	Whooping-cough	15
<i>Finceloxicum</i>	305	Wild chestnut	325
Vitis	305	coffee	327
<i>Vitis capensis Willd.</i>	296, 299, 301,	cotton	326
	303, 519, 520	elder	327
<i>cirrhosa Pers.</i>	301, 519	fig	326
<i>cuneifolia E. &amp; Z.</i>	296, 300, 312,	fuchsia	326
	519, 520, 528	grape	329
<i>orientalis Lam.</i>	545	jambos	326
		lemon	320

	PAGE		PAGE
Wild medlar . . . . .	329	Yellow wood, common or bastard	328
mulberry . . . . .	329	iYoli = <i>Datura stramonium</i>	
olive . . . . .	327	<i>Linn.</i> 18, 28, 42, 63, 86, 103	
peach . . . . .	327	Yum-yum . . . . .	325
pomegranate . . . . .	325	Yzerhout . . . . .	327
Wilde kastanje . . . . .	325		
mørbei . . . . .	329	n-Zanga = doctor . . . . .	5
katjepiering . . . . .	326	umZani = <i>Toddalia natalensis</i>	
vijg . . . . .	326	<i>Sond.</i> . . . . .	328
vlier . . . . .	325	iZembhe . . . . .	47, 48
Witch-doctors . . . . .	64	Zenglodon . . . . .	136
Witchweed . . . . .	514	Zevenjaartjes . . . . .	326
Withania somnifera <i>Don.</i> 33, 51, 65,	86, 103, 506	Zijdebast . . . . .	325
Witte peer . . . . .	325	umZilanyoni = <i>Croton sylvati-</i>	
salie . . . . .	327	<i>cum Hochst.</i> 12, 13, 26, 39, 60,	61, 103
yzerhout . . . . .	328	uZililo = <i>Stapelia gigantea</i>	
Wormwood . . . . .	45, 325	<i>N. E. B.</i> . . . . .	64, 85, 103
Wounds . . . . .	70, 84, 88	isiZimane = <i>Euclea natalensis</i>	
Wurnbea kraussii <i>Baker</i> 319, 531		<i>A. DC.</i> 13, 17, 18, 23, 27, 28, 38,	84, 93, 103
uXamu = <i>Monitor niloticus</i>		umZimbeet = <i>Millettia caffra</i>	
( <i>Linn.</i> ) . . . . .	59	<i>Meisn.</i> . . . . .	327
Xanthoxylon capense <i>Harv.</i> 17, 20,	23, 25, 40, 58, 61, 65,	umZimbh'omubi . . . . .	16
69, 78, 79, 99, 302,	303, 329, 518	Zinnia pauciflora . . . . .	514
<i>fraxineum Willd.</i>	61, 69	uZipho = <i>Cardiospermum heli-</i>	
uXaphozi = <i>Ranunculus pin-</i>		<i>cacabum Linn.</i> 29, 34, 49, 51, 61,	66, 80, 103
<i>natus Poir.</i> 34, 49, 51, 61, 77, 103		Zizyphus . . . . .	310
iXhwala . . . . .	35, 36, 37	<i>mucronata Willd.</i> 41, 80,	
Ximenia caffra <i>Sond.</i> . . . . .	67, 79, 102	100, 301, 310, 329, 518,	
iXolo = <i>Trichilia emetica Vahl.</i>	23, 28, 48, 79, 103	524, 527, 528, 537, 545	
Xululembile = <i>Plectronia obo-</i>		Zostera nana <i>Roth.</i> . . . . .	323
<i>vata Klotzsch.</i> . . . . .	327	Zulu charms . . . . .	9
Xymalos monospora <i>B.</i> 284, 300, 302,	304, 329, 518, 519, 520, 522, 542	<i>medicine.</i> . . . . .	1
Xyris . . . . .	322	<i>medicine-men.</i> . . . . .	1
Xysmalobium . . . . .	320	umZungulu = <i>Dalbergia ob-</i>	
Yagansia . . . . .	404	<i>ovata E. M.</i> . . . . .	326
iYali = <i>Smilax kraussiana Meisn.</i>	68, 90, 94	umZuzo! . . . . .	75
Yellow wood bush . . . . .	284, 304, 314	inZwabuhlungu = <i>Senecio spe-</i>	
		<i>ciosus Willd.</i> . . . . .	60, 91
		Zwart yzerhout . . . . .	327
		Zwartbast . . . . .	328
		Zwarthout . . . . .	325
		Zyglobous . . . . .	421

## ERRATA.

- P. 12, 4th line from bottom, for "*Acocanthera thunbergii*" read *Toxicophlœa thunbergii* Harv.
- P. 69, 8th line from bottom, for "*Veranus*" read *Varanus*.
- P. 294, 14th line from top, for "*Cynanchium*" read *Cynanchum*.
- P. 295, 15th line from top, for "*Cynanchium*" read *Cynanchum*.
- P. 296, 15th line from bottom, for "*Cynanchium*" read *Cynanchum*.
- P. 300, 4th line from top, for "*cuneata*" read *cuneifolia*.
- P. 301, 14th line from top, for "*anthrifolia*" read *anthriscifolia*.
- P. 305, 15th line from bottom, for "*Canavallia*" read *Canavalia*.
- P. 311, 5th line from bottom, for "*sonneritianum*" read *sonneratianum*.
- P. 312, 17th line from bottom, for "*Dregia*" read *Dregea*.
- P. 319, 4th line from top, for "*Ornithogallum*" read *Ornithogalum*.
- P. 320, 3rd line from top, for "*aconitifolium*" read *aconitophyllum*.
- P. 320, 5th line from top, for "*mimosioides*" read *mimosoides*.
- P. 326, 6th line from top, for "*Dactylotenium*" read *Dactyloctenium*.
- P. 327, 12th line from top, for "*Melletica*" read *Milletica*.
- P. 327, 3rd line from bottom, for "*mundtii*" read *mundtiana*.
- P. 503, 2nd line from bottom, for "*cinnamone*" read *cinnamonea*.
- P. 505, 16th line from top, for "*Alepidia*" read *Alepidea*.
- P. 505, 11th line from bottom, for "*knebsianum*" read *krebsianum*.
- P. 505, top line, for "*aconitifolium*" read *aconitophyllum*.
- P. 506, 13th line from top, for "*ophrylis*" read *ophrydis*.
- P. 506, 7th line from bottom, for "*Baphæne*" read *Buphæne*.
- P. 507, 5th line from top, for "*Ornithogallum*" read *Ornithogalum*.
- P. 507, 3rd line from top, for "*Eucomus*" read *Eucomis*.
- P. 514, 17th line from bottom, for "*ambrosoides*" read *ambrosioides*.
- P. 518, 3rd line from top, for "*adscendans*" read *adscendens*.
- P. 518, 2nd line from bottom, for "*anthrifolia*" read *anthriscifolia*.
- P. 519, 2nd line from top, for "*cuneata*" read *cuneifolia*.
- P. 520, 4th line from bottom, for "*cuneata*" read *cuneifolia*.
- P. 524, 10th line from bottom, for "*alata*" read *alatus*.
- P. 528, 5th line from bottom, for "*Dregia*" read *Dregea*.
- P. 528, 9th line from bottom, for "*alata*" read *alatus*.
- P. 530, 10th line from top, for "*teucrifolius*" read *teucrifolius*.

- P. 531, 16th line from top, *for* "angustifolius" *read* angustifolia.  
P. 534, 9th line from bottom, *for* "Chironea" *read* Chironia.  
P. 534, 10th line from bottom, *for* "Crocosma" *read* Crocosmia.  
P. 534, 3rd line from bottom, *for* "Danekia" *read* Denekia.  
P. 534, 7th line from bottom, *for* "Eucomis" *read* Eucomis.  
P. 535, 6th line from bottom, *for* "urceolaria" *read* urceolaris.  
P. 535, 2nd line from bottom, *for* "boreana" *read* boryana.  
P. 537, 8th line from top, *for* "pallescens" *read* pallens.  
P. 545, 8th line from top, *for* "pennata" *read* pinnata.  
P. 545, 7th line from top, *for* "pallescens" *read* pallens.

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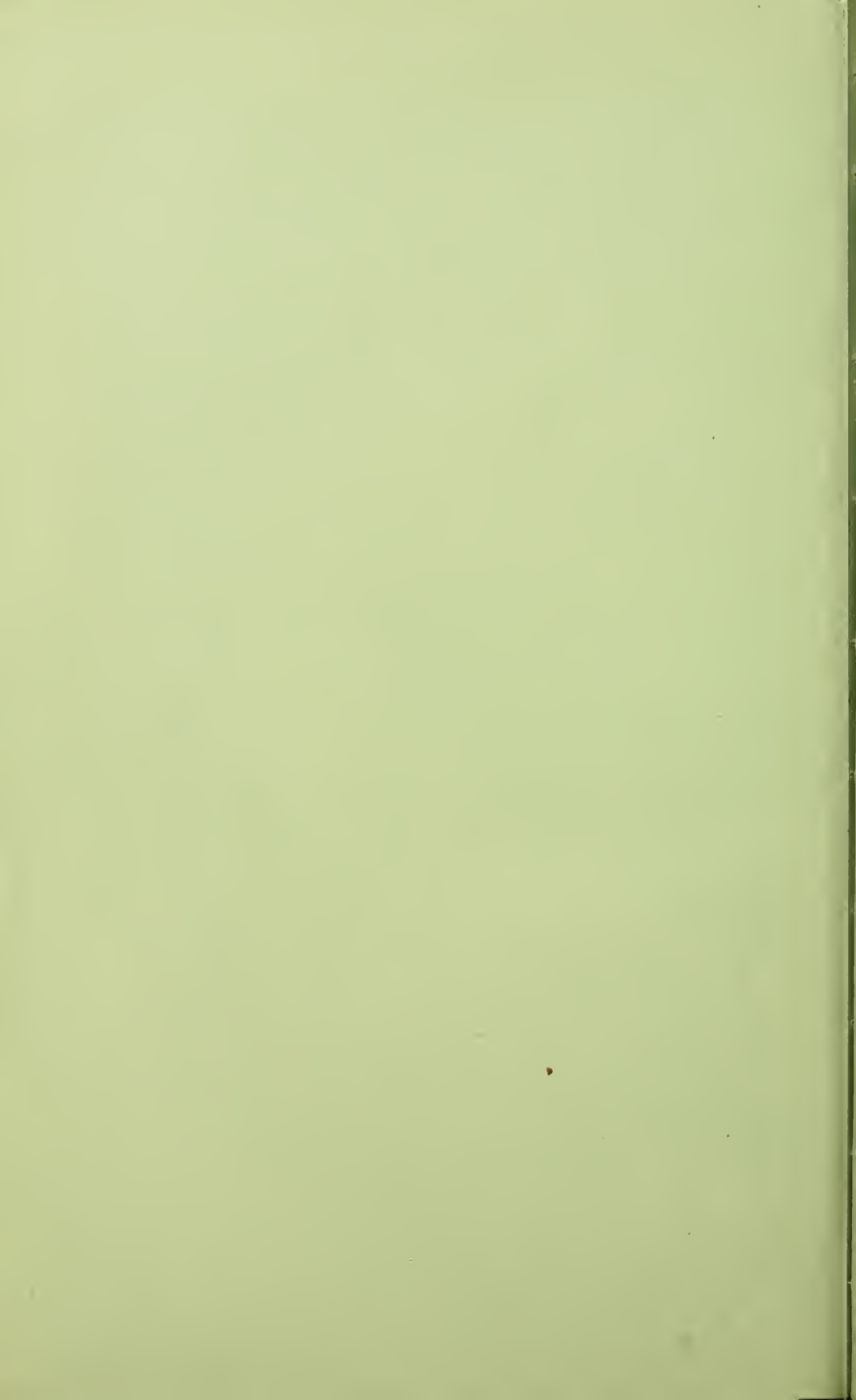
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## CONTENTS.

	PAGE
Zulu Medicine and Medicine-men. By Rev. ALFRED T. BRYANT, Natal . . . . .	1
On <i>Lafœa dispolians</i> sp. n., a Hydroid parasitic on <i>Sertularia bidens</i> Bale. By ERNEST WARREN, D.Sc.Lond. (With Plate I and 2 Text-figs.) . . . . .	105
Notes on the Life Histories of Natal Termites, based on the Observations of the late Mr. G. D. Haviland. By ERNEST WARREN, D.Sc.Lond. . . . .	113
Some Observations on the Dentition of <i>Chrysochloris</i> , and on the Tritubercular Theory. By R. BROOM, D.Sc., M.D., C.M.Z.S., Victoria College, Stellenbosch. (With Plate II.) . . . . .	129

VOL. II.

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## CONTENTS.

	PAGE
Petrographical Notes on the Dolerites and Rhyolites of Natal and Zululand. By G. T. PRIOR, M.A., D.Sc., F.G.S., Keeper of Minerals in the British Museum. (With Plates III-VI.) . . . . .	141
The Slugs of Natal. By WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S., Birmingham . . . . .	159
On South African Marine Mollusca, with Descriptions of New Species. By EDGAR A. SMITH, I.S.O., F.Z.S. (With Plates VII, VIII.) . . . . .	175
On Some Nudibranchs from the Coast of Natal. By Sir CHARLES ELIOT, K.C.M.G. . . . .	221
The Discovery of Fish-Remains in the Ecca Shales, near Ladysmith. By F. H. HATCH, Ph.D., F.G.S. . . . .	227
Notes on Palæoniscid Fish-scales from the Ecca Shales, near Ladysmith. By A. SMITH WOODWARD, LL.D., F.R.S., of the British Museum. (With Plate IX.) . . . . .	229
A Note on a Fossil Wood from Intombi Camp, Ladysmith. By E. A. NEWELL ARBER, M.A., F.L.S., F.G.S. . . . .	233
On a Black, Hairless Duiker and Dog, and a Bulldog-headed Calf. By ERNEST WARREN, D.Sc.Lond. (With Plates X-XIII, and Text-fig.) . . . . .	235

VOL. II.

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MAY, 1912

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## CONTENTS.

	PAGE
The Vegetation of Natal. By J. W. BEWS, M.A., Professor of Botany, Natal University College. (With Plates XIV—XXIII and Map.) . . . . .	253
On Afrodonta Melv. and Pons., with Descriptions of New Species. By HENRY CLIFDEN BURNUP, Keeper of the Conchological Collections, Natal Museum. (With Plate XXIV.) . . . . .	333
On Some Specimens of Fossil Woods in the Natal Museum. By ERNEST WARREN, D.Sc.Lond. (With Plates XXV—XXVII and Text-figs.) . . . . .	345
A Spherulitic Dolerite from Vryheid, Natal. By W. CAMPBELL SMITH, B.A., F.G.S., Assistant in the Mineral Department, British Museum. (With Plates XXVIII—XXX and Text-fig.) . . . . .	381
Note on an Interesting Contact of Dolerite with Sandstone from the Ecca Beds of Elandslaagte, Natal. By F. H. HATCH, Ph.D., F.G.S., M.Inst.C.E. (With Plate XXXI.) . . . . .	393

VOL. II.

PART 4.

AUGUST, 1913

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## CONTENTS.

	PAGE
The Oligochæta of Natal and Zululand. By WILHELM MICHAELSEN. (With Pl. XXXII) . . . . .	397
On Freshwater Entomostraca from Various Parts of South Africa: By G. STEWARDSON BRADY, M.D., LL.D., D.Sc., F.R.S. (With Plates XXXIII-XXXVIII) . . . . .	459
Description of <i>Heleophryne natalensis</i> , a new Batrachian from Natal; and Notes on Several South African Batrachians and Reptiles. By JOHN HEWITT, B.A.Camb. (With Plate XXXIX) . . . . .	475
An Ecological Survey of the Midlands of Natal, with Special Reference to the Pietermaritzburg District. By J. W. BEWS, M.A., D.Sc.(Edin.). (With Plates XL-XLVI and Map) . . . . .	485

VOL. II.

NOVEMBER, 1916.

INDEX.

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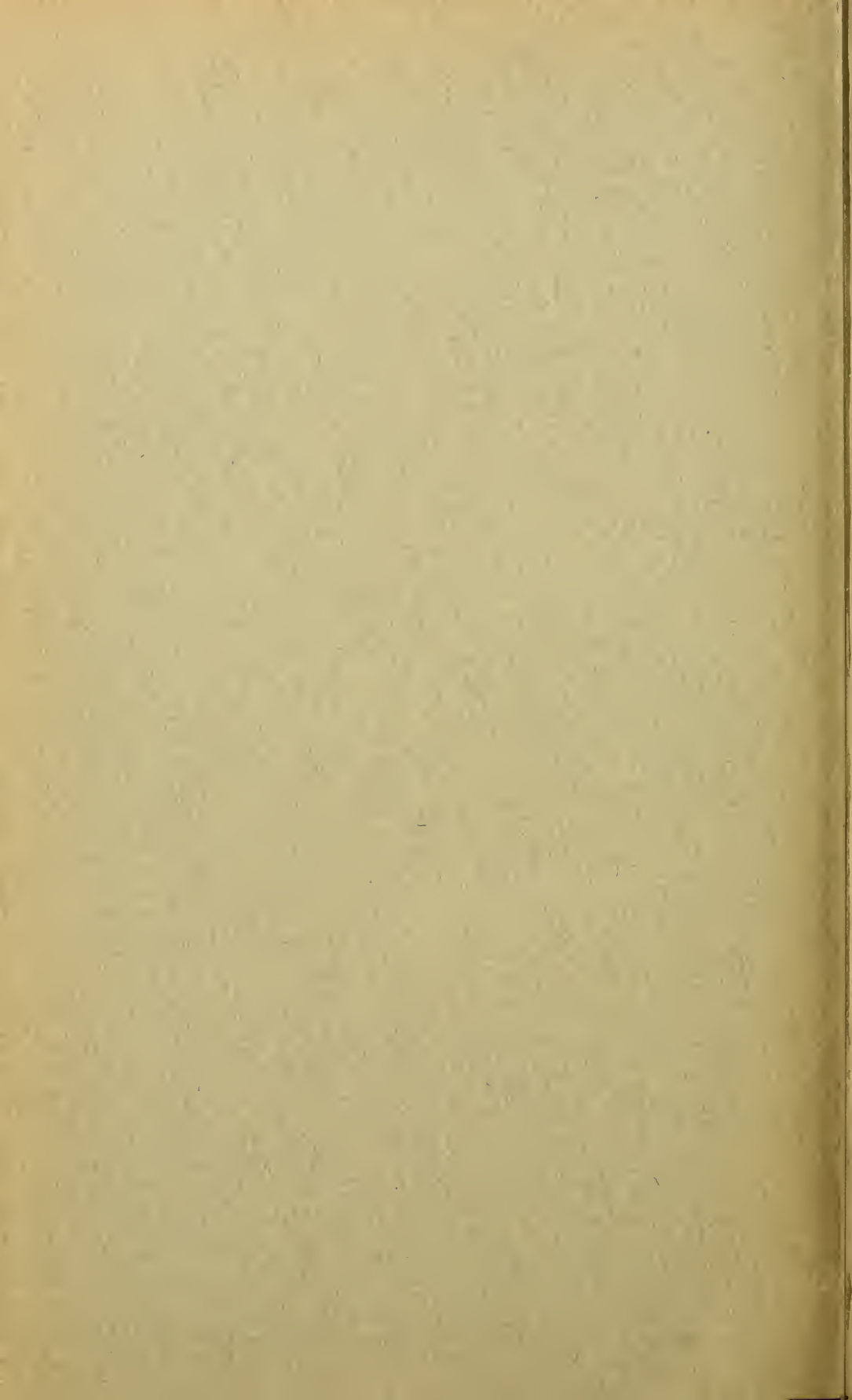
# CONTENTS.

	PAGE
TITLE PAGE OF VOL. II . . . . .	i
CONTENTS OF VOL. II . . . . .	iii
INDEX OF MOLLUSCA . . . . .	547
GENERAL INDEX . . . . .	553
ERRATA . . . . .	587

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