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ZAFAR FUTEHALLY,
J. C. DANIEL & P. V. BOLE

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Taxonomic categories below the level of Genus: Theoretical and Practical Aspects

BY

DEAN AMADON

The American Museum of Natural History

Below the genus, only three systematic categories are in general use and provided for in the International Rules of Zoological Nomenclature. These are the subgenus, the species, and the subspecies. The first of these, the subgenus, is not regarded as very important by most systematists. Furthermore, it is best discussed in connection with the genus. Hence I shall give it no further mention here.

This leaves the species and the subspecies. I also wish to include a category known as the superspecies, although it does not yet have the usage it deserves (Amadon 1966b).

The species is the only taxonomic category that can be defined in precise restrictive terms, rather than in general relative ones. The definition reads about as follows: " A species is a freely interbreeding population whose members do not interbreed with those of other populations". In other words, it is an intrinsically reproductively isolated population. The few individuals of the Whooping Crane and the several hundred orang-utans are examples of species. They don't interbreed with other cranes or apes, and if they did, would probably produce no offspring, or only sterile hybrids.

The so-called higher categories, genus and above, are, on the other hand, subjective and must be defined in relative terms. It is a fact that there is a group of trees known as oaks, whose relationship is evident and which may conveniently be grouped in a genus *Quercus*. Hence we may define the genus as a group of related species. But some species, e.g., the ghinko tree, seem to have no close living relatives. We have to leave this species in a genus of its own, a monotypic genus, and even in a monotypic family and perhaps order. There are many such monotypic genera; scores or even hundreds are recognized among birds alone, and there are only 9000$\pm$ species of birds. Furthermore, there is great difference of opinion as to how closely a group of species must be related if they are to be included in the same genus. Linnaeus used more inclusive genera than is customary today. On the other hand, some " genus splitters " approach the point of having a genus for every species, which destroys the value of this category.

This subjective quality applies to all higher categories. There is as much or more difference of opinion as regards the limits of families, orders, and classes.

To return to the species, in most cases there is no difficulty about recognizing one, at least as long as we stay in one place and consider only the present time. To be sure, we do find some puzzlers. This is sometimes due to the fact that two perfectly good species are difficult to tell apart by comparing them. Species thus similar are infrequent among birds, though they occur, but are commoner in insects. A classic case is *Drosophila pseudoobscura* and *D. persimilis*, two inter-sterile species, so similar they can be separated morphologically only by slight statistical differences in measurements. Such extremely similar sympatric species are known as " sibling species." This is not a very good name because it implies that, like human siblings, they are more closely related to each other than they are to other species. This is not necessarily the case. Two sibling species may be less closely related genetically, or phylogenetically, than are ones superficially less alike. Conversely, genetic differences much below the species level may be as visible as day and night, for example, colour phases or other morphs.

We encounter other difficulties in discriminating between species. They stem from the fact, first convincingly demonstrated by Darwin, that species are not fixed, immutable creations, but rather dynamic, evolving populations that inevitably change with time and which often split into two or more daughter species in somewhat the same way that an amoeba divides into two. Even when a species does not subdivide, it changes with the passage of millennia. If we could follow any species back far enough in time, eventually the gap between ancestor and descendant would be greater than that existing within the limits of any species today. Just how long " back far enough " may be varies tremendously. Many species have evolved, we believe, in less than one million years, yet, judging from fossils, some types have changed little in tens or hundreds of millions of years. Just where to draw the species lines in fossil genealogies is an arbitrary decision. In most instances the geological record is so interrupted and fragmentary that the question is an academic one; in fact, the paleontologist often must work with genera more than with species. It is hardly necessary to add that many species became extinct, leaving no close relatives.

Taxonomy seems to be somewhat like theoretical physics—there are a few constants and many relatives. We may mention one other constant. If we could reconstruct every living individual organism all the way back to the primordial ooze, we would have a complete history of life and its evolution on earth. But this will never be done. G. G. Simpson (1953: 109) estimates that there were 15,000,000 *generations* in the ancestry of the horse back to the Eocene "dawn-horse," and 500,000 or 1,000,000 individuals per generation might be a modest estimate. It is worthwhile bearing in mind, however, that phyletic taxonomy does represent the attempt to trace an evolutionary genealogy that has been enacted down to the last species, subspecies, and individual.

Viewed in this chronological or geological way, the species as a category may seem to disappear—it merges imperceptibly with what went before. Perhaps, however, this is to look at matters the wrong way. A species, as we have seen, is a population of interbreeding living organisms. From this point of view there are at any moment of time a certain number of species. But of *Tyrannosaurus rex* or the extinct Passenger Pigeon we should assert not that they *are* but that they *were* species. We may then conclude that of the species occurring 100 years ago or 100,000 years ago, such and such were ancestors of (or identical with) such and such species of the present moment. Further, we need not go.

The taxonomist who works with present-day forms must often infer species status from morphology. The paleontologist must always do so, and usually from very fragmentary material. So fragmentary, in fact, that he frequently cannot be sure whether he has before him remains of a single species or of several allied ones. But since the paleontologist presents the only direct evidence that we have of the course of evolution during 99.99 per cent of its duration, he is heard with respect, however scanty his evidence. And if he is obliged often to speak in terms of genera rather than species, we may be sure that it was individual organisms grouped into species that enacted the history he relates to us.

Species not only change in time, they may subdivide into one or more daughter species. This process, which usually involves *space* as well as *time*, is responsible for the existing proliferation of species, and is best studied in contemporary forms. As noted above, we have little difficulty with most species so long as we restrict ourselves to one locality here and now. If we begin to trace species spatially, we sometimes run into problems. The common Song Sparrow is a rather different looking bird by the time we reach the coast of Alaska. The population on the Aleutians is made up of birds perhaps three times the weight of the eastern Song Sparrows, and of a duskier hue of plumage. Are they the same species? In general, the answer is "yes" if a more or less continuous series of intermediate interbreeding populations exist, as they do in this case. Gene interchange can then occur, and a favourable mutation arising in one area can spread throughout the range of the species. In a few cases it has been shown in the laboratory that the geographical extremes in such complexes are genetically incompatible. This is one criterion of the species, but if gene interchange throughout a continuous intervening population is possible, it is customary, though in some respects arbitrary, to say that only one species is involved. So long as such genetic communication exists it is even possible that the extremes might again become genetically compatible. If the range were cut in the middle, as so often happens because of geological or climatological changes, the two terminal populations would soon, no doubt, become completely self-contained species incapable of exchanging genes with any others.

With such rare exceptions, however, if individuals of two populations fail to produce hybrids or produce only sterile ones, we may be sure that they belong to different species. The horse and the donkey are species; they will mate but a sterile mule is the result. In nature, we may be sure, there would be strong selection for horses that prefer horses and donkeys that prefer donkeys! Those that could not tell kith and kin would leave no fertile offspring and, further, would produce strong, healthy, long-lived mules to compete with their parents for food.

But though sterility (almost) always proves specific status, the reverse is not true. Many perfectly good species are interfertile. The answer to this conundrum is that if two populations do not interbreed *under normal conditions in nature*, they are separate species. They have reached the level of distinctness that insures that each will go its own separate evolutionary way from that time forth, forever, or until extinction. One oft-mentioned case is that of the Mallard and Pintail Duck. They are species because they occur together in hundreds of thousands over the entire northern hemisphere and hybrids are almost unknown in nature. But if we place a mixed pair of these ducks in a zoo, they will mate, produce young, and the young are more or less fertile. In the wild these two species, and many others like them, are kept apart by certain *isolating mechanisms* peculiar to each, in this case certain calls and courtship patterns. In the absence of a mate of the same species in captivity these isolating mechanisms sometimes break down. The isolating mechanisms themselves in many cases, however, reflect selection resulting from partial (or complete) sterility of the sort suggested above for the horse and mule.

The kinds of isolating mechanisms that evolve are attuned to the sensory equipment of the species concerned. A moth, for example, may recognize its mate by odor; a mosquito by a precise response to the hum produced by the wings, not merely of its own species, but of the opposite sex of its species. In other cases, isolating mechanisms may be at least in part more mechanical, one species of salmon spawning in the spring, another in the fall, and so forth. In plants isolating mechanisms must all be of this nature rather than behavioral. Either plants are cross-sterile or they flower at different seasons; or the pollination is so achieved that there is little or no chance for cross-pollination between related species.

It is easy to see how isolating mechanisms can be improved by selection between interacting species, as suggested above for the donkey and the horse. But it is very difficult to see how isolated populations can arise within a freely interbreeding population, for their incipient differences will be swamped out. One concludes that species in sexually reproducing organisms must usually evolve in physical isolation. I mentioned the orang-utan above as an unquestionable example of a species. In one sense it is a poor example, for there are two completely isolated populations; one on Borneo, the other on Sumatra. These populations have been kept apart for as long as these two islands have been apart from each other and from the mainland, where the orang once occurred also, as known from sub-fossil remains.

Although the orangs of Borneo and Sumatra are very similar, we may be sure that if they could be bred in captivity as readily and rapidly as fruit flies, it would be possible to demonstrate various genetic differences between the two populations. We may go further and say that if these two populations are isolated long enough, they will become specifically and eventually generically distinct.

The rate at which such isolated populations differentiate reflects the selective milieu, and this in turn the constancy or inconstancy of the environment: both the physical and the biotic environment. So far as we can tell from fossil remains, some prolific insects have remained almost the same for millions of years. On the other hand, the proboscideans—the elephants and their allies—evolved rapidly, notwithstanding their long generations and low birth rates.

A species may be broken up into isolated populations in two ways: (1) either the physical environment " moves," as in the case of the orang-utan, because of changes in sea-level, spread of deserts, etc., (2) or individuals of the species itself move; they straggle, fly, swim, walk, or are blown to isolated habitats. Such events may be rare, but there is an eternity of time.

Once isolated, the rate at which a population diverges depends on many factors. Perhaps most important, as noted above, is the extent to which the new environment is unlike the old, just so long as it is not so strange that the species cannot live there at all. Size of population, genetic constitution of the first colonists, especially when few in number, and other factors also play a part.

As a result of this process of geographical speciation, many isolated populations that appear to have formerly belonged to the same species are now so distinct as to be, beyond much doubt, species. Such assemblages of once conspecific allopatric species were called superspecies by Mayr and by Rensch, and the species that comprise them may be called allospecies. The concept is a very useful one in evolutionary and biogeographical studies. I have suggested (Amadon 1966*b*) the use of brackets to designate such superspecies in nomenclature.

The frequent occurrence in the same area, that is, sympatrically, of related species shows that even if, as we believe, species evolve as geographical isolates, they later do in hundreds of cases acquire overlapping ranges. So far as the mechanics of this are concerned, it is the reverse of the original isolating process. Either the environment changes, for example, Sumatra and Borneo again become joined, or the creatures themselves cross distributional barriers. Once two closely related former isolates do come together, two things are necessary if they are to survive and become sympatric species:

1. They must, while separated, have acquired isolating mechanisms which keep them from interbreeding, at least to an extent that will immediately swamp out their differences.

2. They must have acquired sufficiently different life requirements to enable them to live together. As Gause argued and demonstrated, two species with identical requirements cannot coexist. This is true in practice even though one might quibble about it philosophically. Actually two species will never be identical in requirements and in reproductive potential (as would, for example, two colour phases of a single species). Nevertheless, if two species are too similar in their requirements, one will exclude or eliminate the other.

An isolated population cannot, of course, acquire isolating mechanisms or ecological requirements that are directly adapted to enable it to coexist later with species with which it is not then in contact. Hence speciation occurs *in vacuo* and is, to that extent, an " accidental " process; but, as we have seen, such accidents are inevitable in populations isolated for a sufficient time.

When two forms do come together for the first time, they may still compete to an extent that threatens their survival or interbreed to an extent that weakens their genetic integrity. Strong selection will then be set up, tending to increase the gap in their requirements and to make their isolating mechanisms more effective. To emphasize the radically different conditions that exist before and after two isolated populations become sympatric, one might offer the following tabulation:

I. Allopatric (Isolated) Populations: Chance Evolution of
   A. Potential Isolating Mechanisms
   B. Potential Ecological Distinctions

II. Sympatric (Overlapping) Species: Selective Perfection of
   A. Operative Isolating Mechanisms (Reinforcement)
   B. Operative Ecological Distinctions (Morphological divergence or " character displacement ")

One may add the following points:

1. Some populations will have been isolated so long that even when the resultant species first come together, they will be completely isolated reproductively and so distinct ecologically as not to compete seriously.

2. While we are here concerned with the type of adaptive differentiation that enables closely allied species to become sympatric, it must be remembered that distantly allied forms may also compete, e.g., rabbits and antelopes.

3. The opposite side of the coin "isolating mechanisms" is "species recognition mechanisms." Even in a species living among distantly related ones, there will be very precise adaptations to insure reproduction, which in animals involves recognition of other individuals of the same species by one sensory mechanism or another.

These questions of how isolated populations acquire differences and how they interact following overlap of range are at the very root not only of a speciation but also of efforts to understand the dynamics of the ecological community. Such problems must be studied in the field, though with assistance from the cages of the population geneticist.

The Subspecies question—About the turn of the century it began to be evident to students of the better known groups of animals that hundreds of taxa which were described as species have not really achieved that status. For many of them it was shown that where their ranges meet, free interbreeding and intergradation take place. Such forms are not reproductively isolated, and even with the essentially morphological definition of the species then in vogue, it was obvious to biologically oriented systematists that they could not be species. In other cases, taxa not in contact were nevertheless so similar that it was all but certain that they are not species, even though many of them had been described as such in the early enthusiasm of naming and classifying. For example, the lions inhabiting India have, in isolation, become a little different from those of Africa. But are they a different species ? Surely most would agree in saying "no."

A solution to this dilemma that embodied both practical and theoretical advantages was to formalize the category known as the subspecies. Taxa which have acquired recognizable characters, but which nevertheless can be demonstrated or are assumed to be below specific status are called subspecies, and names are applied to them under provisions introduced into the International Code of Nomenclature. For example, the Indian lion might first have been described as a species *Felis persica*, then later regarded as a subspecies of the African lion, *Felis leo*, and thereafter called *Felis leo persica.*

In subsequent years this concept of polytypic species as comprised of subspecies gained wide acceptance, and is now almost universally used in the better known groups, such as birds and mammals. In others, such as insects, knowledge is just reaching the point where this concept can be usefully applied. This polytypic species concept represented an immense step forward. For example, one highly variable South Pacific bird, *Pachycephala pectoralis*, which occurs on many islands, is now treated as having eighty-odd subspecies. Only after we had associated all of them in a single species, could we study this assemblage properly, especially in relation to other true, genetically isolated, species of the same genus.

The polytypic species concept also had a very salutary influence on the genus concept. There is far less excuse for undue genus-splitting after we have reduced our taxa, so far as possible, to bona fide units fitting a "biological" species concept. Furthermore, the polytypic species concept, as Mayr expounded in his 1942 book SYSTEMATICS AND THE ORIGIN OF SPECIES, presented us with a variety of demonstrations that speciation in sexually reproducing organisms ordinarily if not invariably takes place as a result of spatial (=geographical) isolation of subpopulations of a former species.

It is often true in science that concepts of great value are later modified or even discarded. At the present time there is considerable criticism of the subspecies concept. With a practical aspect of this criticism one must express a certain amount of sympathy. The purely nomenclatorial aspect of classification have never achieved the acceptance and stability once hoped for. This is partly because nomenclature to some extent "got off on the wrong foot," particularly as regards the so-called Law of Priority. We are certainly all willing and indeed eager to give due credit to pioneers in our science. But I think the day is past when we should change a well known name bestowed on a species or subspecies by John Doe in 1810, merely because someone shows that Fred Doe described the same species under a different name a few days earlier. I have suggested (1966a), as have others before me, that all names of valid species and even subspecies should be determined by committees of specialists and then listed as Nomina Conservanda, thenceforth to be exempt from the vagaries of purely nomenclatorial change. Of course, there would still be occasional changes, e.g., if somone proves that the Luna Moth is only a morph of the Cecropia Moth, we would lose one species. Further, there is no reason why subspecies names should continue to have nomenclatorial equality with species names. That they should not was first proposed by I. Moore (1954) and later by me (op. cit.). By such a step a vast amount of name changing could at once be eliminated.

Why there is so much opposition to such measures is puzzling. I wonder whether those in opposition to the Fifty Year Rule which implements Nomina Conservanda have really considered the fact that other biologists may in desperation adopt really retrogressive alternatives, e.g., by using common or vernacular names for species, as some plant ecologists and amateur or semi-amateur ornithologists are already doing.

There are, unfortunately, scientific as well as practical aspects to the problem of achieving stability in the names of genera, species, and subspecies. Genera, which I have discussed elsewhere (op. cit.) are not within the scope of this discussion. As regards species and subspecies, it is, in literally hundreds and thousands of cases, impossible to know whether a particular taxon is a species or a subspecies. The Indian lion may, after all, be a species. Even if we find that it interbreeds with the African lion in a zoo, this does not prove that the two taxa are conspecific. We need to know if there are isolating mechanisms in nature and that we shall never know in this or thousands of other cases involving more or less completely isolated taxa. Even dumping out a few African lions in the range of the Indian one would not do, it would be an artificial situation, in some ways analogous to that in a zoo. The only effective answer would be a change in climate and a halting of human abuse of the land in the Middle East that would enable the two populations to meet again naturally. Then we could see what happens. Fortunately there are easier cases to study.

Hence it is necessary to be arbitrary. It would not do to treat all completely isolated taxa as species. This was tried long ago and failed. Even with forms whose ranges do meet, there is every stage of interaction from smooth clines in one character (e.g., Bald Eagles gradually get a little larger as one goes north from the southern United States to Alaska) to ones that hybridize only rarely and are almost surely past the point of no return on the path to becoming separate species.

Also, we now realize that almost all isolated or semi-isolated populations are different. Usually if we examine them carefully enough, we can find at least slight average morphological distinctions; or if not, in those amenable to laboratory analysis one can demonstrate genetic and cytological differences (see, e.g., Dobzhansky's work on various western U.S. populations of *Drosophila*).

Surely one cannot name every such slight population as a subspecies; attempts to do just that have led to a reaction and to suggestions that the entire subspecies concept in the formal sense of naming them be abandoned. Some have suggested that variation should simply be described in geographical terms without employing subspecific names. However, in a species with great variation, especially on many islands, to describe the variation each time is out of the question; merely to list the subspecies and their ranges does call attention to its extent. Further, under an informal system we lose the international currency represented by Latinized scientific names.

I am not enough of a prophet to know the ultimate fate of subspecies and their terminology. I suspect, however, that the advantages outweigh the disadvantages, but that only well differentiated populations will be admitted, that is, ones so distinct that they must be recognized in one way or another—either as races or as species. As Selander & Giller (1963 : 234) have stated, to list such forms as subspecies (or species) represents a considered taxonomic opinion as to their rank, and as such is useful. It may or may not in the long run prove useful to indicate in some other manner less well differentiated populations, as done by Vaurie (1959, 1965), for example, by the use of symbols.

So long, however, as we continue to name geographical isolates of very uneven degrees of distinctness, it is of some value to indicate ones that seem to be approaching specific status. One way of doing this is by the use of parentheses. For example, *Circus* (*cyaneus*) *hudsonius* would mean that we think the form *hudsonius* (which happens to be the American Marsh Hawk) to be a race of *cyaneus* (a related Eurasian hawk), but wish to indicate that the two seem to be approaching the specific level of distinctness.

When a form is judged to be a species, though still capable of some hybridization, it may be called a "semispecies"; the latter is one kind of allospecies or unit of a superspecies. Short (1969) has clarified the significance and taxonomic treatment of the various kinds and degrees of hybridization.

Quantitative Methods—From the above it is evident that species are biological and (in animals) behavioral entities—self-contained, interbreeding populations that do not cross significantly with other populations (species). Furthermore, that there is little correlation between attainment of species status and degree of morphological distinctness. Some perfectly good species are virtually identical morphologically; other very distinct populations are not species. One may also call attention to the tremendous morphological differences that are often found between different sex and age stages of the same species, e.g., the larva and the imago of a butterfly.

It follows that there is no such thing as a "species character" in any general sense of the term. In this respect species are like the abstractions we know as "higher categories." After we have concluded that a population is a species, we can then tell how it differs from other species, but with no assurance that similar characters will define other species, though ofcourse related species will be to varying degrees comparable.

These properties of the "biological species" as Mayr called it are worth emphasizing, even though in practice the taxonomist often must work with morphological characters. He often knows nothing about the reproductive potential of the organisms he is studying except what can be inferred but concludes that if, after eliminating characters seemingly associated with sex, age, season, etc., a series of specimens appear to be like one another and unlike others, they probably comprise a species (or, in some cases, subspecies). The "art" of the taxonomist consists in his skill in using what he has learned about some species to help evaluate less well known or new species.

To do this he uses, so far as possible, quantitative methods. As with so many other fields of science, decisions are a matter of probability. Probability involves statistics. One of the new aids of the statistician is the computer. Some taxonomists, enamored of this new tool, have concluded that they are ushering in a new era of "numerical taxonomy."

But the *only* species we can be sure of are living species that we can demonstrate to be self-contained genetic entities. From this point on everything is inference. The computer can help us make inferences, but no more than that. We have to learn by some other means that caterpillars are young moths, that a lioness is a female lion, or that fish are ancestors of men. The taxonomist at all levels, but especially the species level, must evaluate the significance of similarities and differences. Key features do exist, and perhaps only one or two points in a series of behaviour patterns will be critical in determining whether or not two taxa interbreed. Others, even some aspects of reproductive behaviour, may be less important.

The Species in relation to the total Biological Spectrum—Great and spectacular advances have been made in biology in the past ten or fifteen years. The genetic code has been cracked; the nature and function of DNA and RNA discovered. Molecular biology is quite understandably the order of the day, and it does not much matter whether the molecules come from a horse or a horse chestnut, for one triumph of molecular biology is the demonstration that the genetic code is pretty much the same in all living things.

This does not mean, as some would seem to conclude, that activity should slow down or halt in all other branches of biology. The complexity of the protein molecule is so great as to permit endless variation and evolution. Not only do species differ but even individuals, as made familiar by the problems involved in tissue and organ transplants, blood transfusions, and so forth.

The structure, behaviour, and ecology of the hundreds of thousands of species now living represent the end products of millions of years of interaction and adaptation. The molecular biologist can tell us what makes this possible, but he could never predict from his laboratory that the biochemical processes he has discovered would, after a couple of billion years, produce a man, a redwood tree, or a seventeen-year cicada.

" At the species level, more than any other, the general systematist need not leave the final decision to either numerical (computer) taxonomists or molecular biologists. Specialists in these fields may be able to corroborate but never to either refute or to precisely predict population interactions as observed in nature". (L. L. Short).

A comparison with the physical sciences is possibly worthwhile. Today perhaps the most active branch of research is nuclear physics and particularly investigation of the kinds and properties of ultimate particles. States from coast to coast vie for the privilege of having a new half billion dollar particle accelerator. But could a nuclear physicist reared in isolation and neither shown nor told about the "starry firmament" predict the actual universe as known to the astronomer and cosmologist, even in roughest outline, from his knowledge of nuclear physics ? Assuredly not. It is doubtful, in fact, if he could predict that particles united in a certain way will produce a gas known as oxygen, in another way as hydrogen;

and that when combined in a certain manner, these two gases will form a liquid that is good to drink !

I think we may conclude that those concerned with the evolution, activities, and significance of species, including *Homo sapiens*, need have no inferiority complex. They may turn to the molecular biologist to learn what makes their subjects tick, and hope that he will turn to them to learn what wonders DNA has wrought after two and a half billion years of natural selection in a changing world.

I am indebted to Dr. Lester L. Short for numerous, valuable suggestions.

This paper is based on a lecture given at the Summer Institute in Systematics at the Smithsonian Institution, 1967.

References

Amadon, Dean (1966a.) : Another suggestion for stabilizing nomenclature. *Syst. Zool.* **15** : 54-58.

__________ (1966b.) : The superspecies concept. *Syst. Zool.* **15** : 245-249.

__________ (1968) : Further remarks on the superspecies concept. *Syst. Zool.* **17** : 345-346.

Mayr, Ernst (1942) : Systematics and the origin of species. New York, Columbia Univ. Press.

__________ (1963) : Animal species and evolution. Cambridge, Mass., Belknap Press (Harvard Univ.).

Moore, Ian M. (1954); Nomenclatorial treatment of specific and infraspecific categories. *Syst. Zool.* **3** : 90-91.

Selander, Robert K., & Donald R. Giller (1963) Species limits in the woodpecker genus *Centurus* (Aves). *Bull. Amer. Mus. Nat. Hist.* **124** : 213-274.

Short, Lester L. (1969) : Taxonomic aspects of avian hybridization. *Auk* **86** : 84-105.

Simpson, George G. (1951) : Horses. New York, Oxford Univ. Press.

Vaurie Charles (1959) : Birds of the Palearctic fauna. London, Witherby, 2 vols. 1959, 1965.

Breeding Biology of the Himalayan Rubythroat, *Erithacus pectoralis* (Gould) in the Tien Shan[1]

BY

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(*With two plates*)

The Himalayan Rubythroat [*Erithacus pectoralis* (Gould)] is a characteristic species of the subalpine belt of the Tien Shan. Its biology has not been satisfactorily studied hitherto. The section on the Rubythroat ecology in BIRDS OF THE SOVIET UNION (Gladkov 1954) contains the laconic phrase " Information is wanting " and the first nests were found only in 1957 (Vinokurov 1961). Fragmentary data on the Himalayan Rubythroat biology can be found in some faunistic works (Yanushevich *et al.* 1960; Leonovich 1962; Kovshar 1964, 1966)[2]. For this reason we consider it useful to publish some information on the mode of life of this bird based on observations made in Tien Shan (Zailyisky, Talassky and Kungay Alatau ranges), and available published data.

The Himalayan Rubythroat is widespread in the Tien Shan, being absent only in the western ranges of the Tien Shan—in Pskem and Ugam ranges (Korelov 1956a). It is scarce in Talassky Alatau where it occurs very sporadically, though in individual localities it is quite common : five nests being found and nests of two or three pairs could not be located in an area of 20 hectares in the upper course of the Kshi Aksu River. Rubythroat may occur in Chatkal range (Yanushevich *et al.* 1960). In Kirgizsky Alatau it is rare, seen approximately once in 10 days (Kuznetsov 1962a). It is uncommon in Sonkul, Moldotoo, Atbushi, Narym, Sary

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1 These observations refer in particular to the subspecies *bailloni* (Severtzov) of Russian and Chinese Turkestan, and northern Afghanistan. The race *bailloni* differs from our nominate West-Himalayan *pectoralis* (Gould) clinally only in colour saturation—the male averaging paler and less slaty above, the female more olive, less brown. But the species is migratory and the winter quarters of *bailloni* imperfectly known; it may well enter Indian limits. The breeding biology of the Rubythroat as a species is also imperfectly known, and this paper makes a useful contribution to the subject.—SA.

2 See also Baker, E.C.S., 1933. NIDIFICATION OF BIRDS OF THE INDIAN EMPIRE, 2:81-2. Eds.

Dzhaz, Terskay and Kungay Alatoo ranges, however, in individual regions there are quite a few. In the Burgan-Su ravine (Narym range) for example seven males were seen during one day in end June, 1954 (Yanushevich *et al.* 1960), and in the ravines of the Chon-kysyl-Su (Terskay Alatoo) at least five or six birds (mainly males) during a day trip (Stepanyan 1959). In Zailyisky Alatau, the Himalayan Rubythroat is not more numerous than one to two pairs per kilometre. In individual regions it is common and in some cases it can even be considered numerous taking into account the general scarcity of birds in the mountains. In the ravine of the Bolshaya Almatinka River, for instance, four pairs of the Rubythroat were found living in an area of about 10 hectares in 1967; this apparently being the maximum density in these regions. The species is not numerous in the upper course of the Tekes River (Vinokurov 1961) and very rare in Ketmen range : during two months only one singing male was seen in this locality (Korelov 1956b). It has been found in a number of places in Dzungarsky Alatau : on the southern slopes of the central part of the Altyn-Emel range and in the upper part of the Usek basin where it is common; also in the upper part of the Kok-Su and Bolshoi Baskan basins and in the northern part of the Myn-Chukur range. The Bolshoi Baskan basin is the most northern nesting place of this species hitherto known (Koreyev & Zarudny 1906; Kuzmina, in press). Thus the Himalayan Rubythroat is found in the western half of Tien Shan everywhere; lack of information on its nesting in individual ranges can be explained by the fact that the regions have not been explored properly.

In Tien Shan the Rubythroat lives mainly in thickets of Juniper-elfin. In Talassky Alatau range it lives at altitudes of 2500-2700 m. in the luxuriant thickets of creeping juniper with admixture of honeysuckle shrubs on comparatively gentle slopes covered with meadow herbage, most frequently in the upper courses of rivers. In Kirgizsky Alatau individual pairs nest even in mixed spruce forest in thick shrubs of barberry, dog rose, honeysuckle and juniper, at an altitude of 2100 m. and higher (Kuznetsov 1962b). In other ranges of Kirghizia it nests at altitudes of 3000-3500 m. in intermittent thick brushwood of creeping juniper and glades of subalpine meadows, leafy shrubs and individual spruce trees (Stepanyan 1959; Yanushevich *et al.* 1960). In Zailyisky Alatau, on the northern slopes of the range, the Rubythroat nests at altitudes of 2500-3000 m., sometimes even up to 3100 m. It lives here chiefly on the intermittent juniper stands and subalpine meadows or steppe-like grass-covered plots. Near the lower boundary of the nesting range (2500-2700 m.) it affects juniper and spruce open woodland where individual spruce groups alternate with luxuriant juniper thickets. In the central Tien Shan the species chiefly inhabits the thickets of creeping juniper and caragana, but in valleys having rock outcrops and covered with brushwood the birds can be found as low as the upper[1] boundary of the spruce forest; nests have been found here at altitudes of 2900-3300 m. (Vinokurov 1961). In Dzungarsky Alatau range the birds live in the thickets of creeping juniper at altitudes of 1800-2400 m. (Koreyev & Zarudny 1906).

Thus in the Tien Shan the Himalayan Rubythroat lives chiefly in the thickets of high-mountain brushwoods, mainly of juniper, and is found only in small numbers in the upper part of the forest belt. It never nests beyond the upper boundary of the juniper stand. Its altitude range is 1800-3500 m., but in each discrete locality its vertical distribution is not wider than 500 m. The wide vertical range in the Tien Shan in general (1700 m.) is conditioned by climatic and floristic peculiarities of the individual mountain ranges and depends mainly on their geographic position and their exposure relative to the four cardinal points. To the south in the Pamiro-Alai the Rubythroat also lives above the upper boundary of the juniper-elfin wood, on luxuriant shrubless alpine meadows and is not found in the forest belt (Ivanov 1940; Leonovich 1962; Popov 1959).

The Himalayan Rubythroat is a migratory bird. It appears in the nesting sites after the snow has already melted on a substantial part of the slopes. It ascends the mountains and is then very rarely met with in the submontane regions and the plains. Only one occurrence of this kind is known: a male found in the young strip of forest near the Chokpar village of the Dzambul region on May 10, 1960. The birds do not concentrate during migration and are likely to fly by night.

Information on spring migration of the Himalayan Rubythroat is lacking because of the bird's unobtrusive behaviour during this period.

In the Kirgizsky Alatau range the species appears in late April or early May (Kuznetsov 1962b). The first birds were observed in the Zailyisky Alatau on May 17, 1964, and on May 6, 1965. No further information is available on the time of arrival of the Rubythroat on its breeding grounds.

Immediately on arrival the males begin singing, choosing for this the tops of juniper shrubs, the apices of small and big fir-trees, more rarely stones or roofs of buildings; sometimes the male sings on the wing. The song is loud and clear and cannot be drowned even by the sound of mountain streams. When singing he drops his wings slightly, raises (sometimes almost vertically) and spreads his tail or keeps it folded. The bird turns his head in different directions resulting in the observer

1 There must be a misprint in the work cited; for " the lower boundary of the spruce forest " read " the upper boundary . . . ". One can hardly believe that Himalayan Rubythroat populate the whole spruce forest belt.

hearing sounds of varying intensities. The biological significance of the song lies not only in informing the female that the male is ready to breed, but in "marking" individual territory as well. Usually the male chooses some favourite situation at which he appears from time to time and sings, proclaiming his ownership of the territory. One of the males whose female was already laying eggs was observed singing during two hours (from 10 to 12 a.m.) from 19 points, and moving irregularly over this territory (an area of about one hectare). Most often he was singing from one point at a distance of 50-60 m. from the nest. If any other male entered the occupied site, the owner drove away the rival immediately. One day when we were inspecting a nest containing nestlings, the male drove off at once a neighbouring male that had come to investigate the anxious cries of the owners though the birds themselves were greatly excited by our intrusion.

Duration of singing from one point and its intensity vary, depending apparently on a number of factors. At the beginning of the nesting cycle (before hatching the young), in good weather, the males sing for as long as 10 minutes from one place, and at short intervals. When feeding the young, the males sing more seldom and the duration of the songs gets shorter (one to three minutes). During rain or snowfall the singing ceases but is resumed when the precipitation stops. Sometimes they sing when it is drizzling. The duration of the song is shorter in the middle of the day. The Rubythroat sings from early in the morning till dark; on June 29, 1967, the last song was heard at 21.05 hours in the twilight. No singing was heard at night. The calendar duration of the singing period is also long : in the Zailyisky Alatau the latest singing was heard on July 12, 1965, and on July 13, 1967 (apparently it was not the last song), and in the Talassky Alatau on August 4, 1960. This means that the vocal activity of the males continues for 2.5-3 months.

The Himalayan Rubythroat begins nesting soon after arrival on its breeding grounds. The participation of the sexes in nest-building is not clear; apparently the nest is built by the female alone since we never saw males fetching building material in their bills though we often saw them during this period.

The nests are located on the ground in small hollows. Of the 28 nests known at present in the Tien Shan, none was placed on a juniper shrub. The Himalayan Rubythroat is undoubtedly a ground-nesting species, therefore we consider the information of I. A. Abdusalyamov (1964) of the bird nesting on shrub-branches to be erroneous[1].

[1] Not only the location but the shape of the nest as well as the description of eggs have nothing in common with the nest and eggs of the species in question. One can clearly see from the photo there given that the nest belongs not to *Erithacus pectoralis* but rather to some warbler (*Sylvia* sp. ?).

More frequently the nests are located on the steppe-like slopes near juniper-elfin wood or on small subalpine grass plots in thin juniper stands. They are placed under the cover of tussocks of *Festuca sulcata*, *Carex*, *Cobresia* or other plants, more rarely under the shelter of a stone. Sometimes the Rubythroat nests under thin juniper shrubs growing near thick juniper stands. The nests are placed both in the middle of a juniper shrub and under its outlying branches. We never found nests in large tracts of juniper stands. In the Talassky Alatau one nest was found inside a " hut " made of rough last years stalks of *Polygonum hissaricum*, and another was located on flat (practically horizontal) ground in high, thick, *Agropyrum* sp.; it was fixed to vertical stalks of the grass. Out of 22 nests found in the Talassky, Zailyisky and Kungay Alatau and along the upper course of the Tekes River, six nests were located under juniper shrubs; one under a honeysuckle shrub; three under stones; five under tussocks of *Festuca* sp.; four under tussocks of *Carex*, *Cobresia*, *Poa* and *Geranium*; three under the cover of other grasses. The nests located under the juniper shrubs cannot be seen, and the nests built under the cover of grass are screened by hanging leaves and are not visible. Only one nest (in the Talassky Alatau) could be seen well from above by a horseman riding by at a distance of some metres.

The nests are of two types. The more typical is the covered ball-like nest with the entrance on one side, very similar to a *Phylloscopus* nest. The other type is a normal cup-like nest open at the top. There are many variants intermediate between these two types: some nests have thin covers, covers of others are only half-built; sometimes the back part of the wall facing the slope is somewhat higher than others. Usually the open nests are built in juniper shrubs and under stones, i.e. when an effective roof is available, and the covered nests are built on the terrace slopes under the shelter of grass. There are many exceptions and data are still meagre to establish any correlation between the type of nest and the factors determining it. It is possible that the height above sea-level, the exposure of the slope and the time of building (beginning or middle of the summer) play a definite part in this respect.

The nest is built completely of last year's plants : for the outside part of nest rather rough stalks and leaves are used, sometimes with admixture of moss; the inner part is composed of finer and thinner material. The transition from the outer layer to the inner one is gradual and it is not always possible to separate them. A. A. Ivashchenko, who at our request identified the building materials of seven nests, reported that the birds had used 25 species of plants, the majority of the plants were used as admixtures, *Gramineae* being the most numerous.

The nest is rather massive and loosely built. It is 110-190 mm. in diameter (average of 9 nests 140 mm.), usually somewhat flattened on

Nesting site of the Himalayan Rubythroat

Above: Creeping Juniper, 2500 m. Talassky Alatau; *Below:* Upper boundary of Fir wood with Juniper bushes, 2700 m. Kungay Alatau.

(*Photos: A. Kovshar*)

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(1) Nest on steppe slope; (2) Nest with clutch under Juniper Bush; (3) Male, and (4) Female with food for nestlings.

(Photos: E. Gavrilov)

both sides and with an oval cross-section; it is 66-140 mm. high (average of 7 nests 113 mm.); diameter of nest-cup 55-90 mm. (average of 11 nests 72 mm.); depth 37-59 mm. (average of 7 nests 48 mm.). The entrance is 40-70 mm. wide and 35-60 mm. high.

The eggs are laid everyday. The full clutch consists of 4-6 eggs; of 12 full clutches nine comprised of four eggs, two of five, and one of six eggs. The egg shell is smooth, slightly glossy, of greenish-blue colour. The eggs are unicoloured or have small light rusty dots which form a slightly visible ring on the blunt end. Of seven clutches two contained unicoloured eggs and five of dotted eggs. 34 eggs measured 19.3-22.8 $\times$ 14.5-16.3 mm. (average 21.1 $\times$ 15.3 mm.). 16 slightly incubated eggs weighed 2.0-2.85 g. (average 2.4 g.); hard set eggs weighed 2.3 gm. on the average.

The eggs are incubated apparently only by the female. There are records (Yanushevich *et al.* 1960) of the male also taking part in incubation and possessing a brood patch, but we only observed females incubating when we inspected the nests. The incubation period was not determined.

The hatchlings are blind, covered with light-grey almost white down[1] about 2 mm. long growing in paired bunches on the back ulnar bend, nape (nearly on neck) and on the vertex; the corners of the mouth are white outside and yellow inside; mouth orange inside. Legs and bill flesh-coloured, claws white. On the day of hatching they weigh 2.3 gm. (three nestlings from one nest). The relationship between their growth and other development is similar to that in the majority of song birds : at first rapid increase in weight is observed, then the differentiation of plumage with simultaneous stopping of growth of the body. First the fine plumage of the abdominal part of the body appears, then the rusty ends of the head feathers develop, and after that the tips of the wing and tail quills appear. In nestlings weighing 15, 16.6 and 19.1 gm. the remiges began unfolding only on the second day when they weighed 16.2, 17.3 and 20.1 gm. respectively and had wings 24-30 mm. long. The next three days they did not increase in weight. Five nestlings in another nest weighing approximately the same (18.0, 18.7, 18.9, 19.4 and 21.0 gm.) had considerably larger wings (48-52 mm.) and were almost entirely covered with feathers; when disturbed they jumped out of the nest and scattered about hiding under stones and in thick grass.

The nestlings are fed by both parents. In the mornings on the first few days the female broods them and then brings food equally with the male. The degree of participation of male and female varies in different pairs; thus in one nest (the Talassky Alatau) the male visited the nest

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1 Information of A. A. Vinokurov (1961) that the nestlings of *Erithacus pectoralis bailloni* Sev. are naked is erroneous.

much more frequently than the female (65 times against 40 of 105 total fetchings). In another nest (the Zailyisky Alatau) the food was brought entirely by the female (the male never came to the nest during three hours of observation); in a third nest (Kungay Alatau) out of 37 food trips the male made 21.

The frequency of feeding is as follows. In 18 hours of observation during two days, the parents brought food 105 times to the nest containing three half-feathered nestlings (the Talassky Alatau), during the same period they carried off faecal sacs 30 times. The maximum number of feeding per hour was twelve; the minimum two (average six). The " working " day of this pair was about 16 hours, from dawn till 21.00 hours. During this time the birds brought to the nest about 100 portions of food weighing aggregately about 30 gm. Each of three nestlings weighing, 16-20 gm. thus received about 10 gm. of food a day, i.e. somewhat more than half their weight. In the Kungay Alatau the parents of four feathered nestlings made 37 visits with food in four hours (from 12.00 till 16.00 hrs.) and in the same time they removed seven faecal sacs.

In the Zailyisky Alatau E. V. Gvosdev observed a female fetching food for four one-week old nestlings every three to five minutes (three hours of observation), and in the Kirgizsky Alatau, according to the data of A. A. Kuznetsov (1962b), a pair brought food to the nest every two to five minutes.

They usually brought a single food item at a time, seldom two, and only on one occasion four items were extracted from a nestling's throat; a looping caterpillar, a spider and two little molluscs.

The birds collect the food mostly on the ground, on stones or under shrubs. They look for food within a radius of 150 m. from the nest, but very often much nearer—within three to five metres. They are very vigilant near the nest, especially the female. The arriving bird first alights on top of a neighbouring shrub for a while, peeping anxiously around and then jumps down to the ground and hops to the nest. If there is no danger the male flies directly to the nest without stopping anywhere. When carrying off a faecal sac the bird flies swiftly and without a stop, with short rapid wing strokes it takes the capsule rather far away, not less than 50 m., from the nest. When carrying no faecal sac the bird flies out of the nest and alights on one of the neighbouring bushes or other protruding object, and after looking about flies away as usual. The Rubythroat feeds its young mainly upon caterpillars, often pilose ones. In the Talassky Alatau out of 81 food objects studied visually and according to the method of A. S. Malchevsky and N. P. Kadochnikov[1] (1953) 48

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[1] Neck ligature and subsequent removal of food from the gullet.

represented Liparidae, Noctuidae, Geometridae and other caterpillars (including 30 pilose ones), the remaining items being locusts (15), beetles (6, including 4 Cerambycidae), lizards (*Ablepharus alaicus*, 6), Dermaptera, white butterfly, ants and Diptera (Muscidae and Asilidae : nymphs, pupae and imagines). Small and middle-sized *Ablepharus* lizards were fed entire, like insects, but of the bigger ones only the tails were used.

In the Zailyisky Alatau 35 food objects represented caterpillars (15), butterfly, beetles (5, including a small Tenebrionid), a spider, and the lizard (*Ablepharus alaicus*). In the Kirgizsky Alatau range mostly caterpillars were brought to the nest, once a pilose one (Kuznetsov 1962b). Thus in the different parts of its range in the Tien Shan, the Himalayan Rubythroat feeds its young mainly on large caterpillars, including pilose ones, and on a number of other invertebrates. Among vertebrates only *Ablepharus* lizards are used. After leaving the nest the young birds sometimes eat honeysuckle berries (August, Talassky Alatau).

The food of adult birds during the breeding period differs markedly from that intended for nestlings. In six stomachs examined in the Zailyisky Alatau between May and July were found remains of at least 45 invertebrates including 26 imago beetles (in all stomachs), one beetle larva, three noctuid caterpillars (in one stomach), two bugs of *Lygaeus* sp. (in one stomach), six ants (in three stomachs), one representative of other Hymenoptera, four Asilidae (in one stomach), one spider. The beetles were represented by Bruchidae, Jpidae, four *Aphodius*, six Elateridae, two Tenebrionidae, two Curculionidae and Chrysomelidae. The contents of 14 stomachs of adult Himalayan Rubythroats from the kirgizsky part of the Tien Shan (Peck & Fedyanina 1961) have been analysed. Most frequently they contained ants (64%) and remains of Curculionidae (57%). Less frequently were found remains of other beetles (Tenebrionidae, Lucanidae, Carabidae, Elateridae, Scarabaeidae, Coccinellidae), Heteroptera, Acrididae, caterpillars and molluscs. Seeds of Cruciferae and Polygonaceae were found only in one of the stomachs.

Thus the nestlings are fed mainly on large soft objects, the adult birds themselves living on smaller and coarse objects like beetles, ants and their food is generally more diverse.

How long the nestlings stay in the nest is not definite. On June 16 a nest contained nestlings about two-days old which left on June 30, i.e. when more than 14 days old. Another nest on June 16, contained nestlings with pinfeathers, which left the nest on June 27. Thus the young evidently stay in a nest not less than 15 days. After leaving the nest the young remain for some days in the immediate vicinity, but they do not spend the night in the nest (two broods observed in the Talassky and Zailyisky Alatau). They practically do not change in weight but their plumage develops intensively especially the rectrices and wing-quills. When they leave the nest they can only flop about, but in two-three days they begin flying quite well. Thus one of the young weighing 19.4 gm. on the day of leaving the nest was caught two days later with difficulty at a distance of 20 m. from the nest; it could already fly 20-30 m.

Most probably the broods disperse very soon since we never saw a strongly flying young being fed by its parents. This supposition is confirmed by the observation of a pair of birds in two nests which 14 days after the young had fledged, had laid a fresh clutch of three eggs in a new nest.

There is no information concerning the life of this species after the breeding season is over because of the unobtrusive behaviour of the birds at that time. There is little information on their departure. In the Zailyisky Alatau, in the ravine of the Malaya Almatinka River, Himalayan Rubythroats were met with in a thick aspen forest at an altitude of 1500 m. at the end of August (Shulpin 1939). In the Talassky Alatau the birds were still seen in the nesting sites on September 8 and 9, 1935 (Shulpin 1965). V. V. Shevchenko (1948) recorded that at the end of August, just after the first snowfall, the Himalayan Rubythroat migrated downhill and could be met with in swamp thickets and in juniper stands in ravines. Later, in September and October, especially in foul weather, they could be seen in the submontane orchards. This record, however, had not been confirmed by subsequent observations: during seven years' work in this region one of the present authors has never met with this species below the breeding range. In the Pamir, where the Himalayan Rubythroats do not breed, they are occasionally met with in August (Potapov 1966). Apparently the birds migrate in August, the last of them leaving early in September. In winter the species is not found in Tien Shan. The supposition of V. V. Shevchenko (1948) of their hibernation in warm winters in the Talassky Alatau has not been confirmed by facts.

The studies in the Tien Shan[1] have shown that the great majority of females begin egg-laying in the last third of May. The breeding period of the species is very long: fresh clutches can be found from the middle of May till the middle of July, i.e. during two whole months. This is partly due to the fact that the females do not start breeding simultaneously or synchronously but the chief reason is the repeat clutches, caused by destruction of nests and even second clutches. In 1967 a nest with slightly incubated clutch found on June 25 was destroyed the next day; in 12 days (on July 8) the same pair already had three fresh eggs (including one

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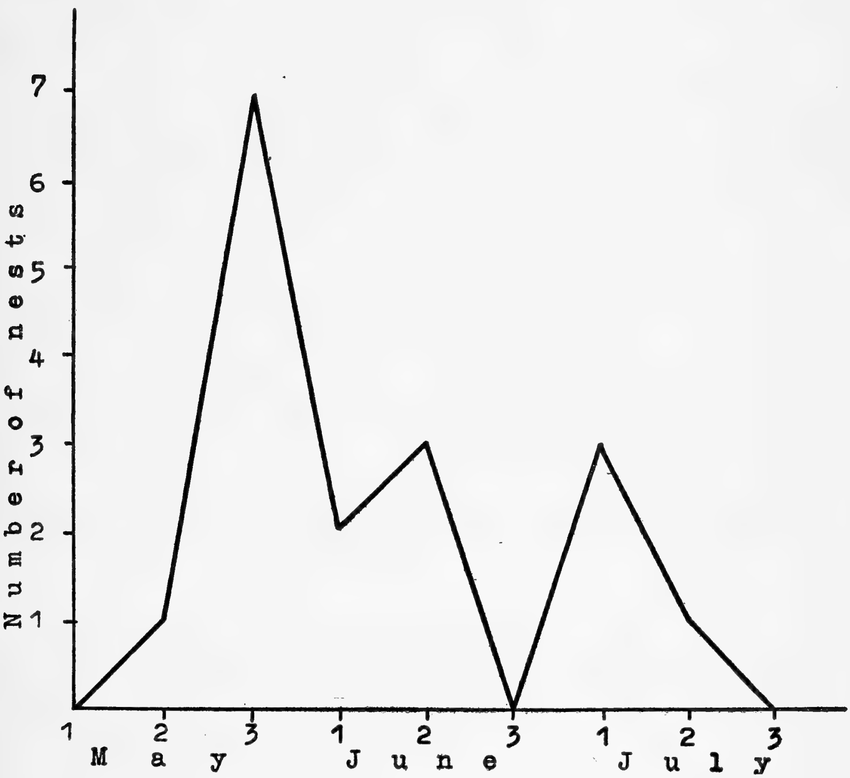
1 The following term were taken into consideration: hatching—12 days, fledgling—15 days. Cases where the fledglings were taken care of by their parents are accounted as the nest (7 cases).

cuckoo egg) in a new nest at a distance of about 70 m. from the old one. On June 16 another nest was found containing nestlings covered with pinfeathers. On June 20 the female and the male were trapped and banded. On June 27 the young left the nest and thereafter we often met the banded male singing intensively in the neighbourhood. On July 11 we found that the banded female had laid three eggs in a new nest built at a distance of 45 to 50 m. from the first one. Thus, there is no doubt that the Himalayan Rubythroat breeds twice a year (i.e. it is double-brooded). In our case the female began the second laying 44 days after the beginning of the first oviposition (on May 26 and July 9). Of course not all pairs bring up the first brood successfully and start breeding again. The destruction of nests results in repeat-nesting and accounts for the fact that some birds bring up only one brood.



The breeding success of the Himalayan Rubythroat is shown by the following data. In the Zailyisky Alatau an average clutch consisted of 4.3 eggs (7 nests) of which 3.7 hatched (4 nests). For the Tien Shan as a whole these data are as follows: a clutch consists of 4.2 eggs (11 nests) of which 4.1 hatched (10 nests) and 3.8 young fledged. Addled eggs and eggs with dead embryos are found very seldom; addled eggs were observed only twice in clutches of four (one addled egg in each nest). Mortality among nestlings is not high; usually all the hatched nestlings leave the nest and only occasionally does one die (the youngest?).

The nests suffer destruction only rarely. Of nine nests under observation only two were destroyed; one containing strongly incubated eggs was abandoned, while the eggs disappeared from the other. Apparently it was a cuckoo's doing in both cases. The first nest was abandoned by the birds after the cuckoo (*Cuculus canorus* L.) had put its egg into their nest removing one of Rubythroat's. The other nest was found by us when we observed a cuckoo thoroughly inspecting the slope near the nest; it flew over from place to place and rested stopping every metre or so to look around. The cuckoo was not searching for food, and the male Rubythroat flew about it crying agitatedly. When the cuckoo flew away we found a nest containing four eggs in this spot, but three of them disappeared the next day. The owners naturally deserted the nest and built a new one at a distance of about 70 m. from it. When we found the second nest it contained two Rubythroat's and one cuckoo's eggs. In the Zailyisky Alatau the cuckoo apparently lays its eggs in the nests of the Himalayan Rubythroat quite often; of 14 nests of this species we found the cuckoo's eggs in three (21%). A nest containing a cuckoo nestling has not yet been found.

The potential enemy of the Himalayan Rubythroat is the musteline family: the marten and the stoat; however, we did not observe any nests destroyed by these animals. One of the Rubythroat nests containing two half-fledged nestlings was highly infected by *Ornithonyssus sylvarum* mites.[1] The next day one of the nestlings was found dead while the other seemed likely to share the same fate.

Thus the rate of destruction of the nests of this species is not high which makes it possible for a part of the population to raise two broods in a year.

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[1] Identified by V. N. Senotrusova.

References

Abdusalyamov, I. A. (1964): Ptitsy gornogo Zeravshana.

Gladkov, N. A. (1954): Semeistvo drozdovykh v knige " Ptitsy Sovetskogo Soyuza ", t. 6.

Ivanov, A. I. (1940): Ptitsy Tadjikistana.

Koreev, B. P. & Zarudny, N. A. (1906): Ornithologicheskaya fauna Semirechenskogo Kraya. Mat. k pozn. fauny i flory Ross. Imperii, otd. zoologich., vyp. YII.

Korelov, M. N. (1956 a): Fauna pozvonochnykh zhyvotnykh Bostandyka. V knige " Priroda i khozyajstvennye usloviya gornoi chasti Bostandyka."

________(1956 b): Materialy k avifaune khrebta Ketmenj (Tien-Shan). Tr. instituta zoologii AN KazSSR, t. YI.

Kovshar, A. F. (1964): Ptitsy vysokogorja zapadnoj chasti Talasskogo Alatau. V knige " Okhotnichi ptitsy Kazakhstana".

________(1966): Ptitsy Talasskogo Alatau.

Kuzmina, M. A. (in press): v pechati. Rod solovej-krasnoshejka. V knige "Ptitsy Kazakhstana ", t. 3.

Kuznetsov, A. A. (1962): K biologii ptits vysokogorja Kirgizskogo khrebta. " Ornithologiya", vyp. 5.

Leonovich, V. V. (1962) K biologii maloizuchennykh ptits Tadjikistana. Byull. MOIP, otd. biologich., t. XYII, n. 2.

Malchevsky, A. S. & Kadochnikov, N. P. (1953): Metodica prizhiznennogo izucheniya pitaniya gnezdovykh ptenzov nasekomoyadnykh ptits. " Zool. zhurnal", t. 32, vyp. 2.

Pek, L. V. & Fedyanina, I. F. (1961): Pishcha ptits Kirgizii. V knige " Ptitsy Kirgizii ", t. 3.

Popov, A. V. (1951): Ptitsy Gissaro-Karategina.

Potapov, R. L. (1966): Ptitsy Pamira. V Knige " Biologiya ptits ".

Shevchenko, V. V. (1948): Ptitsy gosudarstvennogo zapovednika Aksu-Dzhabagly. Tr. zapov. Aksu-Dzhabagly, vyp. 1.

Shulpin, L. M. (1939): Ecologicheski ocherk ornithofauny Alma-Atinskogo zapovednika. Tr. Alma-Atinskogo zapov., vyp. 1.

________(1965): Materialy po faune ptits zapovednika Aksu-Dzhabagly (Talassky Alatau). Tr. zapovedn. Aksu-Dzhabagly, vyp. 2.

Stepanjyan, L. S. (1959): Ptitsy Terskey Alatau, (Tien-Shan). Uchenye sapiski Mosk. obl. pedagogich. instituta im N. A. Krupskoj, t. 71, vyp. 4.

Vinokurov, A. A. (1961): K biologii nekotorykh vorobjinykh ptits Zentrainogo Tien Shanya. V sb. " Materially po nazemnym pozvonochnym Kazakhstana". Tr. inst. zool. AN KazSSR, t. XV.

Yanushevich, A. I., Tyurin, P. S., Yakovleva, L. D., Kydyraliev, A. & Semenova, N. I. (1960): Ptitsy Kirgisii, t. 2.

Notes on *Stellaria saxatilis* Buch.-Ham. ex D.Don, *Stellaria vestita* Kurz and *Stellaria sikkimensis* Hook.f.

BY

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Stellaria saxatilis Buch.-Ham. ex D. Don and *S. vestita* Kurz are considered as conspecific. *S. vestita* Kurz is adopted as the correct name for the resulting taxon. *S. sikkimensis* Hook. f. is re-established as a distinct species.

D. Don (1825) established *Stellaria saxatilis* on the basis of Hamilton's collection from Nepal Himalaya. Later, Kurz (1873) recognised *S. vestita* from China, and indicated its close affinity to the former species. Hooker f. (1874) described *S. sikkimensis* from the Sikkim Himalaya during the treatment of the family Caryophyllaceae for British India and stated its affinity to *S. saxatilis* in the following words—" Nearly allied to *S. saxatilis* but less perigynous, more laxly hairy and cymes much shorter peduncled and terminal."

Very recently Mizushima (1963), while working on the Caryophyllaceae of the Eastern Himalaya collected by the Indo-Japanese Botanical expedition of 1960, considered both *S. saxatilis* and *S. vestita* as conspecific and rightly adopted Kurz's binomial *S. vestita* as the correct name for the resulting taxon, since *S. saxatilis* Buch.-Ham. ex Don must be rejected because of the presence of the earlier homonym *S. saxatilis* Scop. (1772). A little later, the present author, in his paper " On the Indian Alsinoideae—some new names and new combinations " published in 1965, reduced *S. vestita* Kurz to a variety under the new name *S. hamiltoniana* Majumdar, which he proposed to replace the nomenclaturally illegitimate name *S. saxatilis* Buch.-Ham. ex D. Don.

A critical study of the types of *S. saxatilis* and *S. vestita* revealed that the two species are very similar except that the former has shortly petioled leaves with acutely mucronate apex while the latter is characterised by sessile leaves with acuminately mucronate apex (distinctly narrowed upwards). However, the specimens of *S. saxatilis* from Bhutan show both the above characters and form a connecting link between the two species. Therefore the author quite agrees with Mizushima who united the two species and adopted *S. vestita* Kurz as the correct name for this S. E. Asiatic plant.

Following Kuntze (1891), Majumdar (1965) reduced *S. sikkimensis* Hook.f. to a variety of *S. hamiltoniana* Maj. However, a careful study of the types of both *S. vestita* and *S. sikkimensis* reveals that it seems justified to maintain *S. sikkimensis* as a distinct species instead of maintaining it as a variety of *S. vestita.* The distinguishing characters of the two are as follows:

S. vestita	*S. sikkimensis*
1. Plants densely tomentose to wooly with stellate hairs. Often glabrescent.	1. Plants pubescent to villous with simple, long, rigid hairs.
2. Leaves not ciliate.	2. Leaves ciliate with tubercle-based hairs.
3. Flowers in axillary and terminal, long-peduncled cymes.	3. Flowers solitary at each node of the flowering branches forming terminal, leafy, cymose panicle.
4. Bracts scarious.	4. Bracts foliaceous.
5. Sepals usually connate at base into obconic tube. Fruiting sepals 0.50 — 0.55 cm. long.	5. Sepals quite free to the base. Fruiting sepals 0.40 — 0.45 cm. long.
6. Capsule 0.4 — 0.5 cm. long; shorter or equalling the sepals.	6. Capsule 0.5 — 0.6 cm. long; exceeding the sepals.
7. Seeds tuberculate, 1.0 mm. across.	7. Seeds nearly smooth, minutely granulate, 0.6 — 0.7 mm. across.

Stellaria vestita Kurz, in Journ. Bot. 11: 194, 1873; Mizushima in Journ. Jap. Bot. 38: 153, 1963.

S. saxatilis Buch.-Ham. ex D.Don, Prodr. Fl. Nep. 215, 1825 (non Scop. 1772); Wall. Cat. 634; Edgew. & Hook.f. in Fl. Brit. Ind. 1:232, 1874; Gamble, Fl. Presid. Madras 1:62, 1915; Fyson, Fl. South Ind. Hill-Stat. 41, 1932; Mizushima in Faun. Fl. Nep. Himal. 122, 1952.

S. laxa Merr. in Philipp. Govt. Lab. Bur. Bull. 29: 12, 1905 (non *S. laxa* F. Behm. 1887).

S. stellato-pilosa Hayata, Fl. Mont. Formos. 58, pl. 2, 1908; Mater. Fl. Formosa 37 (1911).

S. hamiltoniana Majumdar in Journ. Ind. Bot. Soc. 53: 142, 1965.

S. hamiltoniana Maj. var. *vestita* (Kurz) Majumdar *loc. cit.* 142, 1965.

Type: D. J. Anderson, s.n. (Acc. no. 41131, CAL). Specimens examined: (Herb. Cal.)

INDIA: Assam: Shillong, 1494 m., May 1911, *I. H. Burkill* & *S. C. Banerjee* 15; Shillong, 1768 m., April 1886, *C. B. Clarke* 43447 A (as *S. saxatilis*); Shillong, Jowai Road, March 1892, *D. Prain*, s.n. Acc. no. 41134; Khasi hills 1220-1520 m., May-June, 1876 *Kurz* no. 192; Shillong hill, 1828 m., May 1886, *C. B. Clarke* 43918 B (as *S. saxatilis*); Khasi hills, West gorge at Dum pep, 1828 m., June 1911, *I. H. Burkill* & *S. C. Banerjee* 35186; Khasi hills, Simons, s.n., Acc. no. 41130; Khasi hills, April 1894, *G. A. Gammie* 340.

BHUTAN: Ta Wollaokar, 1828—2134 m., without collector's name, 1770; Nanga valley, *G. Sen Gupta* 744.

NEPAL: Hamilton, Wall. Cat. 634 (as *S. saxatilis*) holotype (K).

CHINA: Yunnan: Momyen, *D. J. Anderson*, s.n., Acc. no. 41131, type (CAL).

Distribution: India, China, Java, Indochina, Philippines. *N.B.* Types of *S. laxa* Merr. and *S. stellato-pilosa* Hayata are not seen by the author, but the synonyms are cited on the authority of Mizushima (1963).

Stellaria sikkimensis Hook.f. in Fl. Brit. Ind. 1:230, 1874.

Stellularia saxatilis (Ham.) O. Kuntze var. *sikkimensis* (Hook.f.) O. Kuntze, Revis. Gen. Pl. 1:55, 1891; Majumdar in J. Ind. Bot. Soc. 44:142, 1965, pro syn.

Stellaria hamiltoniana Majumdar var. *sikkimensis* (Hook. f.) Majumdar, loc. cit. 1965.

Type : Herb. Griffith s.n. (K)

Specimens examined : (Herb. Cal.)

INDIA : West Bengal : Darjeeling, Herb. Griffith, s.n. holotype (K); Kurseong, 1828 m., Oct. 1884, *C. B. Clarke* 36499 C; Sinchul, northern face, *S. Kurz*, s.n., Acc. no. 40979; North of Sinchul, 2194 m., Aug. 1862, *T. Anderson* 961; Darjeeling 2133 m., Sept. 1872, *J. S. Gamble* 3810 A; Darjeeling 2133 m., July 1875, *C. B. Clarke* 26755 D; Phulloot, 3350 m., Oct. 1875, *C. B. Clarke* 25724 A;

BHUTAN : Do chu la, 3175 m., Sept. 1964, *P. K. Hazra* 446;

SIKKIM : Without precise locality, *S. Kurz*, s.n., Acc. no. 40981, 40982 and 40983; without precise locality, *G. King* 930; without precise locality, *T. Thomson*, s.n. Acc. no. 40975 (two specimens on the same sheet are *S. vestita*); *G. King*, s.n., Acc. no. 40985; Top of Tonglu, Oct. 1857, *T. Thomson*, s.n., Acc. no. 40973 and 40976; without precise locality, Oct. 1871, *G. King*. 35; above Gangtok, 1980 m., July 1910, *W. W. Smith* 2960; E. Himalayas without precise locality, *G. H. Cave* 6745; without precise locality, *G. King* 2008; La Chung, 2590 m., Aug. 1892, *G. A. Gammie*, s.n., Acc. no. 40878, 40879 and 40880; Padmchen, 2438 m., Aug. 1910, *W. W. Smith* 4490.

Distribution : Eastern Himalaya : West Bengal, Sikkim and Bhutan.

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10th General Assembly and 11th Technical Meeting of the International Union for Conservation of Nature and Natural Resources

BY

ZAFAR FUTEHALLY

The 10th General Assembly and 11th Technical Meeting of the International Union for Conservation of Nature and Natural Resources took place at New Delhi from 24th November to 1st December 1969. It was a memorable Assembly in many ways, particularly for India because it was the first time that the IUCN Conference has been convened in Asia. Between 1948 and 1966, General Assemblies were held in France, Belgium, Venezuela, Denmark, Scotland, Greece, Poland, Kenya and Switzerland.

India's first physical contact with the IUCN was in November 1965, when a strong delegation was on its way to Bangkok for a Regional Conference to study conservation problems of South-east Asia. Information about this is available in IUCN Booklet New Series No. 11. Taking advantage of this occasion Mr. E. P. Gee, India's tireless ambassador of conservation, induced the Government of India to hold a Special Meeting of the Indian Board for Wild Life at New Delhi on 24th November 1965. The Proceedings of this meeting were published in Supplementary Paper No. 17 of the IUCN Publications New Series. After this one-day meeting at New Delhi, the delegates went to Bharatpur, and the always resourceful Peter Scott drew up a short practical plan to enable the full potential of Bharatpur to be realised from the angle of tourism. Peter Scott's paper and the accompanying illustrations were published in this *Journal* (**63**: 206-209). Unfortunately these suggestions have yet to be implemented.

Every General Assembly centres around a principal theme. For instance, the theme of the Lucerne Assembly in June 1966 was " Towards A New Relationship of Man and Nature in Temperate Lands". The discussions in the Technical Sessions were mainly concerned with the damage caused by recreation and tourism in general to natural areas, the ecological effects of introduced plant species and the ecological effects of introduced animal species. The Proceedings of this Assembly are available in IUCN Publications No. 7, 8 and 9, New Series.

The theme of the 10th General Assembly at New Delhi, appropriately, was "The Environmental and Economic Values of the Conservation of Nature". The four Key-Note Addresses were given by Dr. Frank Fraser Darling, Dr. C. D. Deshmukh, Prof. Roger Revelle and Prof. V. A. Kovda. Dr. Fraser Darling, whose Reith Lectures over the BBC in England in December 1969, made such an impression both in that country and abroad, has been a close student of Indian ecology. On an earlier occasion, when the Society was drawing up its Memorandum for submission to the Cow Protection Committee of the Government of India, Dr. Darling had said, " We should realise the wholly justifiable attitude of considering the cow sacred in a situation which India must have represented 2,000-3,000 years ago. She provided milk and dung, made paths and consumed much obtrusive green growth. She was an animal new to India and would need the greatest care in a period of adaptation. Now, populations of men and cows are in totally different relation to the deteriorated environment, and we know to our constant cost that attitudes, rituals and conventions persist far beyond the biological and social situations which brought them forth as erstwhile necessities of living. There is here not so much a cultural lag in time, but a cultural over-run". The Cow Committee of the Government of India unfortunately disintegrated after a few acrimonious meetings, and one does not know whether the views expressed by Dr. Darling will have any impact on its thinking in future years. In his Key-Note Address to the Assembly, Dr. Darling spoke about the ecological implications of nomadism, and pointed to the damage done to the environment by a settled population of human beings and cattle, and the need for constructive conservation measures.

Prof. Kovda was concerned by new technological developments which now have global implications. " Geochemical activity of man has become universal throughout the planet, and technogenesis—a specific peculiarity of the modern face of the earth". He went on to say that " Modern industry not only enriches substantially the biosphere with a number of chemical elements, but transforms the natural geochemical ratios of elements which cannot but tell on the biosphere...."

It was encouraging to learn from him, however, that in the USSR wild life conservation has been making steady progress. As an example he mentioned the Saiga antelope (*Saiga tatarica*). The species was at one stage on the verge of extinction, due to intensive hunting, and in 1920 a few hundreds only were left in remote regions of Kalmikia and Kazakhstan. Today, there are over a million animals and thousands of animals can be safely shot every year for food and sport on a sustained yield basis.

Dr. C. D. Deshmukh gave a forthright account of the failure of the Government of India to protect its forests and vegetation, and to give due importance to conservation policies in general. He said that " the failure to conserve may be partly due to ignorance. In this politician-ridden society of ours (all over the world) it is, however, largely due to the triumph of the short-term over the long-term. The politician pacifies his more ignorant voter at the cost of all the unborn".

Dr. Deshmukh felt that measures necessary for economic development could be reconciled with conservation in developing countries, provided we try to solve our problems in an intelligent and creative way without copying the attitudes of the West blindly. Starting, for instance, with the premise that within the tropics where there is abundant sunshine, and where human labour is plentiful and cheap, large-scale plantation of trees is a logical way of meeting our fuel and other construction requirements, " the labour component of housing can be increased considerably (i) by using bricks instead of cement concrete for both floor and roof; (ii) by deferred payment of wages to the labour in respect of the difference between rates for skilled and unskilled labour, i.e., by borrowing part of the value of the labour directly from the worker; (iii) by supporting a large-scale housing programme for urban areas by the systematic growing of fuel for brick-making (as well as for domestic use), on waste and unproductive land." I quote from Stein: "Assuming that trees grow $2\frac{1}{2}$ times faster in the tropics than in northern Europe and that fossil fuel costs say 25 per cent more and labour costs only 1/5 as much (the figure is more likely 1/10), then the advantages are of an order of $2.5 \times 1.25 \times 4 = 15$ times ! " By linking housing construction—brick-making and the growing of fuel for brick-burning into a mutually supporting economic arrangement it becomes possible to envision a profitable basis for both urban housing and large-scale reforestation on a commercial basis. Moreover, the ready availability of alternative domestic fuel will release animal manure for our fertilizer-hungry land. Leaves could also be harvested as fodder. Thus, under tropical conditions, a tree would be a cheap and efficient device for converting solar energy into fuel". The trouble in India, of course, has been that we have been living not on our income but on our capital as far as trees are concerned.

The papers presented in the Technical Meetings of the Assembly were divided into the following headings :

(1) " Conservation of habitats, soil and water resources with special reference to Montane regions and Nature Conservation as a supplementary objective of productive and protective forestry". In this group of papers, two struck the writer as particularly important. Dr. K. P. Mirinian of the USSR pointed out that once a forested region was denuded

to a level below about 60 per cent, its capacity to prevent soil erosion was almost negligible. In other words, we in India must recognise that many of our areas which are included in the category of ' forest ' are not really performing their protective functions because their density is not good enough. Another paper by R. S. Ambasht of Banaras Hindu University provided valuable guidelines on the way erosion damage can be measured, and suggested the importance of local vegetation for protective purposes.

The second set of papers dealt with the effects of " Pollution on Natural Ecosystems " and the third on " Management and Breeding of Wild Life Species, the Role of Zoos, and the Role of Birds in an Agriculture economy". In his paper on Birds in India's Agriculture Economy, Dr. Sálim Ali pointed out that although weaver birds, house sparrows, etc. consumed substantial amounts of rice crops and cereals, this aspect has been over-emphasised in the Indian scientific world, and it is forgotten that they feed their young entirely on insects and worms, thus destroying a great number of pests. Other beneficial roles are also ignored, e.g. their pollinating, to a large degree, the Red Silk Cotton (which mainly provides the wood for our safety matches). His remedy, in order to determine the true status of birds in national economy, is " Comprehensive life-history studies of the individual species involved—their ecology, food . . . habits, migrations. Analysis of stomach contents by itself is not enough".

The Second Session of the Technical Meetings was concerned with Conservation of Terrestrial Communities under the International Biological Programme. Two papers of great practical importance were the 'Ecological impact of domestic stock on the Gir Forest' by K.T.B. Hodd, and 'A Preliminary report on the ecology of domestic cattle in rural West Bengal' by Dr. S. Odend'hal. Hodd, who stayed in the Gir Forest for nearly a year for his doctorate thesis, established a number of exclosures in the Gir to find out how soon and how well the vegetation revived if it was saved from damage for a specific period of time. He found that after only one year, the exclosure showed a high ratio of perennial grasses such as *Dichanthium annulatum*, some recovery of soil porosity and 80 to 100 per cent land cover as compared with only 30 per cent in the grazed areas. At the end of the growing season less than 300 kilos of dry matter per hectare remained. As far as the regeneration of trees were concerned, Hodd found that in the open areas only *Acacia arabica* was able to survive, and, understandably, unpalatable herbs such as *Cassia tora* were particularly abundant.

Everything that Hodd says points to the need for greatly reducing the pressure of buffaloes and cattle from the Gir Sanctuary if it is to become a satisfactory home for wild life, and regain its normal productivity.

Odend'hal studied an area of 5.75 sq. miles in rural West Bengal to determine the position of the cattle within the economy. In this small area there were a total of 16,126 human and 3,759 heads of cattle, which is a high ratio even for India. But the significant point seems to be that there is enough straw produced from the paddy field to feed this large cattle population. What is important of course is to be told what the optimum ratios between humans and cattle and land should be, and when the studies are completed, perhaps some definite information will be available.

The Third Session was organised by the Survival Service Commission and dealt with problems of threatened species. In a way this was the most interesting part of the conference for the Indian audience for it dealt with such live subjects as the future of the Asiatic Lion, the Indian Tiger, the Great Indian Bustard, and other endangered species in India. Dr. Sálim Ali's paper on the Great Indian Bustard suggests. " In the absence of a network of reliable local observers, most of this basic information (on the Bustard) would have to be self-collected by mobile teams of investigators. . . . In spite of being totally protected by law, the Great Indian Bustard continues to decline. To stay the rot there is a proposal to create a Bustard sanctuary in the extensive grasslands of Gujarat where a few birds still survive. But the practicability of this project will need a thoroughgoing ecological investigation".

Fr. H. Santapau, in his paper on 'Endangered Plant Species and their Habitats' referred to the fact that forests near villages are constantly being cut down, and many forests are threatened. Father Santapau made a special plea for Indian orchids, which are exploited without any thought being given to their perpetuation.

J. C. Daniel, submitted a review of the present status of endangered species of Indian Reptiles. " Lack of precise information makes the assessment of the status of Indian reptiles difficult. However, on the basis of data available on commercial exploitation of reptiles it appears that the crocodiles, marine turtles, lizards of the genus *Varanus* and many species of snakes need protection. Endemic reptiles restricted to certain habitats are also in danger of extinction".

The 4th Session of the General Assembly was conducted by the International Commission on National Parks, and was concerned with the National Park situation in South-east Asia with special reference to the role, management and economic functions of National Parks in densely populated non-industrial areas. One valuable Resolution which emerged from the discussions dealt with the definition of National Parks. There have often been rather unconstructive debates at the meetings of the Indian Board for Wild Life on this question, and it is to be hoped that this Resolution of the IUCN will help in determining which areas should be given National Park status and what should be the principles underlying their management. The Resolution reads : " *Considering* the importance given by the United Nations to the national park concept, as a sensible use of natural resources, *and considering* the increasing use which has been made during these last few years in some countries of the term "National Park" to designate areas with increasingly different status and objectives, *the* 10*th General Assembly of IUCN meeting in New Delhi in November* 1969 *recommends* that all governments agree to reserve the term "National Park" to areas answering the following characteristics and to ensure that their local authorities and private organisations wishing to set aside nature reserves do the same:

A National Park is a relatively large area 1) where one or several ecosystems are not materially altered by human exploitation and occupation, where plant and animal species, geomorphological sites and habitats are of special scientific, educative and recreative interest or which contains a natural landscape of great beauty and 2) where the central authority of the country has taken steps to prevent or to eliminate as soon as possible exploitation or occupation in the whole area and to enforce effectively the respect for ecological, geomorphological or aesthetical features which have led to its establishment and 3) where visitors are allowed to enter under special conditions, for inspirational, educative, cultural and recreative purposes.

Governments are accordingly *requested not* to designate as "national park";

1) a scientific reserve which can be entered only by special permission (strict nature reserve)

2) a natural reserve managed by a private institution or a lower authority (Provincial Park, etc.) without some type of recognition and control by the central authority

3) a "special reserve" as defined in the Algiers Convention of 1968 — (fauna or flora reserve, game reserve, bird sanctuary, geological or forest reserve, etc.)

4) an inhabited and exploited area where landscape planning and measures taken for the development of tourism have led to the setting up of "recreation areas" where industrialization and urbanization are controlled and where public outdoor recreation takes priority over the conservation of ecosystems (parc natural regional, nature park, Naturpark, etc.). Areas of this description which have

been established as " National Parks " should be redesignated in due course."

The next Session of the Assembly, dealing with the reports and discussions of the Pre-Assembly Tours, was disappointing only for the reason that the time devoted to it was so short. The Pre-Assembly Study Tours related to the Periyar Wild Life Sanctuary, Sariska Wild Life Sanctuary, Guindy National Park, Dachigam Sanctuary, the proposed Bird Sanctuary-cum-Recreation area in the Salt Lake areas of Calcutta, and the position of the Swamp Deer in the Kanha National Park. It is to be hoped that all these reports will be quickly processed by the Centre and the States, and that implementation will not be delayed, because in these matters where the physical environment keeps changing so rapidly, delay is often tantamount to rejection.

One Session of the Assembly was devoted to Conservation Education. A Pre-Conference Working Party of the Education Commission of the IUCN had met at Dehra Dun earlier, and the problems of Conservation Education at school and college levels were discussed in a broad manner. It is to be hoped that this will help in the production of suitable text-books for use in our own country, for there is a serious shortcoming of such material and without this conservation cannot become 'popular,' or be supported by the people at large.

The Tenth General Assembly passed as usual many resolutions. All these are important, but we would like to draw attention to the following ones, which deal with our specific problems. All of them are self-explanatory, and are quoted without comment.

Periyar Wild Life Sanctuary : The resolution "urges the responsible authorities to integrate the various interests involved and place them under the control of one senior administrator and to manage the sanctuary on a planned basis".

Grazing in Wild Life Reserves and National Parks : The Assembly recognises that the penetration of domestic cattle into wild life reserves is a major factor in the deterioration of wild life habitats. It resolved that the Indian Government should take immediate steps to prohibit the grazing of all domestic livestock within the boundaries of all wild life reserves".

The Asiatic Lion : It has been recognised that agricultural intrusion and the general decline in the numbers of wild life is a major cause of the reduction in the number of the Asiatic Lion, now restricted only to the Gir. The General Assembly "requests the Government authorities concerned to prevent any further encroachment into the sanctuary, and recommends that measures be taken to recover the land where cultivations have already intruded........"

The Tiger: The assembly was generally alarmed by the position of the tiger in India, and generally in other countries. It decided quite rightly that "in view of the grave threat to the tiger populations in the countries where the animal occurs, due to direct and indirect methods of destruction ... the Governments of these countries (declare) a moratorium on killing of this animal until such time as censuses and ecological studies ... reveal the correct position as regards population trends ...." Only five States in India have completely banned the killing of tigers, and others should follow suit immediately.

Calcutta Salt Lake Area: The assembly was greatly impressed with the report of the study group on the Calcutta Salt Lake area, and it strongly recommended to the Government of India "that early steps should be taken to implement the conclusions of this report to establish a bird sanctuary within a wider protected zone and to integrate it within a regional plan".

Specialised Wild Life Department: In almost every meeting of the Indian Board for Wild Life there has been discussion about the need for a separate wild life department within the forest service to look after the interests of wild animals and their habitats. This is a problem peculiar not only to India but concerns almost every country of the world. The assembly therefore passed an appropriate general resolution which said, "having noticed that in many countries no specialised department exists to conserve wild life...recommends to the various Governments ... (to) consider the possibility of organising separate departments of wild life...."

The Final Session of the Assembly was organised by the Landscape Planning Commission of the IUCN.

Looking back on the Conference in the light of the experience of those held in other countries it must be acknowledged that the organisation by and the hospitality of the Government of India left little to be desired. The presence of the Prime Minister, Dr. Karan Singh, the Minister of Tourism, and the Chairman of the Indian Board for Wild Life, and other senior Ministers and Members of the Planning Commission at several Sessions, both formal and informal, left the delegates with the quite justifiable impression that conservation will in future form an important item in the deliberations of the Government of India. It will, however, be left to institutions like the Bombay Natural History Society, the Wild Life Preservation Society of India, the World Wild Life Fund — Indian National Appeal and others, to see to it that the resolutions which were passed and which engaged the attention of the leading conservationists of the world are implemented as quickly as possible. It has become customary for the General Assembly to issue a Declaration or a Manifesto on conservation, relevant for the time and for the occasion. At New Delhi the following Declaration was passed on 29-11-1969.

Realising that the splendour of this earth derives from its sunlight, its beautiful green cover, its inter-dependent fauna and flora, and from the diversity of its landscapes and *Realising* that since the beginning of its existence, the people of the earth, even when poor in material possessions, have found life richly worth living because of these natural assets; and *Realising* that man, himself a product of the evolutionary system, is dependent on the stability and self-renewing properties of his environment; *Realising* too, that the world's population is growing at an alarming rate; *that* economic development depends entirely on the utilization of natural resources, that this utilization is carried out often with little attention to the needs of renewal, *that* because of this, much of the earth, once well watered and productive, is now impoverished and degraded *that* once abundant plant, animal and scenic resources, have been ravaged *that* therefore the attainment of a high quality of living for all mankind now depends upon the conservation and restoration of these dwindling resources, and *finally that* the natural resources of the world are a heritage on which the survival of future generations must depend.

We the members of the International Union for Conservation of Nature and Natural Resources assembled at New Delhi in November 1969

Now declare again our fundamental purpose as an international union of concerned States, Organization and individuals

To urge on all governments and people the adoption, as a basic principle of development, the conservation and protection of long-term values rather than exploitation for short-term gains

To foster sound environmental policies and to promote protection of ecosystems, human environments and habitats of wild creatures from abuse and damage

To encourage and assist in the making of co-ordinated legislation and international conventions to govern the utilization and treatment of soil, water, air, flora and fauna, to minimize pollution, and to protect the landscape in general and ecosystems of special interest in particular and, finally to urge upon all nations, action and support of those values which make life possible and worthwhile.

An event which greatly pleased the Assembly, and the Bombay Natural History Society in particular, was the award of the John C. Phillips Medal to Dr. Sálim Ali. The citation reads :

" Senior Statesman of conservation and distinguished scientist, whose influence on conservation in his own continent has been great and whose work and accomplishments are known and respected throughout the world;

Most distinguished ornithologist and field naturalist in his own country, whose published works have long been the basic and authoritative references on the birds of his country and have established him in the foreground of world ornithologists;

Internationally recognized and respected leader in conservation, whose efforts over the years have been a major factor in creating the climate of acceptance in conservation matters and preservation of wild life which exists in his own country today".

Growth Potential of Red Hairy Caterpillar, *Amsacta moorei* Butler, in relation to certain Food Plants

BY

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The larvæ of *A. moorei* were reared on eight natural food plants and the growth response of the insect recorded. On the basis of survival percentage of larvæ, percentage of adult emergence, pupal weight, size and fecundity of moths, *bajra* was the most preferred food for *A. moorei*, closely followed by *urd*. Castor was found to have a distinct retarding effect on the normal rate of growth of *A. moorei*, resulting in a prolonged larval period and also a relatively longer pupal period than in the case of the other food plants. The larvæ failed to survive when reared on paddy, sannhemp and *arhar*.

Introduction

The red hairy caterpillar, *Amsacta moorei* Butler, is polyphagous. Fletcher (1914) recorded it on *jowar*, *bajra*, groundnut, castor, cotton and pulses. It is also reported to attack cow pea, soyabean, maize, sannhemp and sorghum by Pruthi (1938) and Bindra & Kittur (1958). In view of the wide range of host plants of this pest, it is important to know how far the growth and development of the insect are influenced by the various food plants. This paper is a report on the relative food value of some of the important food plants of *A. moorei* which is an important and widely distributed pest of crops in Uttar Pradesh.

Material and Methods

A gravid female moth of *A. moorei* was collected from the field on 27th July, 1964. It was kept in a glass jar and fed on 5 per cent sugar solution soaked in cotton wool. The next day the moth laid eggs freely on the glass jar. Four days after egg-laying the eggs hatched satisfactorily. Immediately after hatching the tiny larvæ were carefully collected with the help of a camel hair brush and 20 larvæ were transferred to each of the eight sets of 10.0 cm. petridishes containing clean and tender leaves of the following food plants :

Maize (*Zea mays*), *jowar* (*Sorghum vulgare*), *bajra* (*Pennisetum typhoideum*), castor (*Ricinus communis*), *urd* (*Phaseolus mungo*), *arhar* (*Cajanus cajan*), paddy (*Oryza sativa*) and sannhemp (*Crotalaria juncea*).

The food was changed once in the morning every day. As the larvæ grew older, they were transferred to bigger petridishes (15.0 cm. diameter). The number of larvæ becoming pupæ, the time taken to complete the larval development and the larval weight at two intervals, viz., 6 and 12 days after hatching, were recorded.

After pupation, the pupæ were transferred to separate glass jars and their mouths covered with muslin cloth. Data on pupal period, pupal weight after 4 days of pupation, percentage of adult emergence, size and sex-ratio of the adults resulting from the larvæ reared on different food plants were also recorded.

The emerging moths were separated into another set of glass jars and fed on 5 per cent sugar solution. The data on the longevity and fecundity of the moths and the incubation period of the eggs were recorded for each set.

Twenty newly hatched larvæ of the same date of hatching were kept in 10.0 cm. petridishes in identical sets, as before, and the leaves of the same food plants were fed to them and the data recorded in the same manner as described earlier. In this way the growth and development of the insect on the different food plants were studied through two consecutive generations.

All tests were performed at room temperature prevailing at Kanpur during July to September (Max. 86-102° F, Min. 83-88° F and Relative humidity 50-92 per cent).

Results and Discussion

The effect of different food plants on the percentage survival of the larvæ and the range of larval period is shown in Table 1. The growth index figures obtained by dividing the percentage(n) of the larvæ becoming pupæ by the average time (Av) taken to complete the development are also given in the table.

Table 1

The survival percentage, range of larval period and growth index of *A. moorei* in relation to the type of food supplied

Food plant	Number of larvæ kept for observation	Number of larvæ pupated	Percentage of larvæ pupated (n)	Range of larval period in days	Average larval period in days (Av)	Growth index n Av
Maize ..	40	8	20.0	15-16	15.5	1.29
Jowar ..	40	10	25.0	15	15	1.66
Bajra ..	40	20	50.0	16	16	3.12
Castor ..	40	9	22.5	23-30	26.5	0.84
Urd ..	40	16	40.0	17-19	18	2.22

The Chi-square test for association of the type of food given and the number of larvæ pupated showed that the value of chi-square(x^2), which is 12.408, is significant at 5 per cent level. The results, therefore, suggest that the type of food has differential response to the survival percentage of *A. moorei* larvæ. *Bajra* is the most preferred and maize the least. On the basis of the growth index values also the development of larvæ was best on *bajra*, followed by *urd, jowar,* maize and castor in the descending order. It would be seen, however, that while the percentage of larvæ pupated was lowest on maize, castor resulted in the lowest growth index value apparently because the larval period was considerably prolonged on this food plant. The results also showed that the larvæ completely failed to survive when reared on paddy, sannhemp and *arhar*.

Table 2 shows the effect of different food plants in inducing variation in the larval weights. It will be seen from the table that the larval weights on the sixth day after hatching although slightly less in the case of *urd* and maize are practically identical in the case of *jowar*, *bajra* and castor. But differences are observable among them on the twelfth day after hatching. The results, therefore, suggest that the type of food has differential response to the gain in weight of larvæ from six days onwards. During this period the gain in weight in the case of *bajra* is highest and significantly different from all others except castor; while it is lowest with maize and *urd* which do not differ significantly from each other. However, no definite correlation can be established between the gain in weight of larvæ on different food plants and their growth index values.

TABLE 2

VARIATION IN LARVAL WEIGHT IN RELATION TO TYPE OF FOOD

Food plant	Mean larval weight in gm.		Gain in weight between the two intervals in gm.
	6 days after hatching	12 days after hatching	
Maize	0.0128	0.1360	0.1232
Jowar	0.0165	0.1685	0.1520
Bajra	0.0160	0.1915	0.1755
Castor	0.0160	0.1785	0.1625
Urd	0.0140	0.1505	0.1365

f = highly significant. C. D. at 5% =0.015

Table 3 shows the duration of the pupal period and the variations in the pupal weights when the larvæ were fed on different food plants. It would be seen from the table that the duration of the pupal life, though only slightly variable, was shortest with *bajra* and longest with castor, while *jowar*, maize and *urd* are found intermediate. The pupal period was thus affected in much the same way as the larval period by the respective food plants. Further, the highest pupal weight is obtained with larvæ fed on *bajra* and next in order came *urd*, castor, *jowar* and maize. The pupal weight is thus apparently correlated with the growth index value of the plant except in the case of castor.

TABLE 3

DURATION OF PUPAL PERIOD AND PUPAL WEIGHTS OF *A. moorei* IN RELATION TO THE TYPE OF LARVAL FOOD SUPPLIED

Food plant	Range of pupal period (in days)	Average pupal period (in days)	Average pupal weight after 4 days of pupation in gm.
Maize	5-7	6.25	0.089
Jowar	6	6.00	0.097
Bajra	5-6	5.75	0.172
Castor	6-8	7.00	0.010
Urd	6-7	6.70	0.160

The effect of different foods in inducing variation in percentage emergence, size and sex-ratio of the adult moths is given in Table 4. This table shows that the percentage of adult emergence is highest when the larvæ are reared on *bajra* and lowest on *jowar*, while the remaining can be arranged in the following descending order : *Urd* > castor > maize. The percentage of adult emergence is thus affected by the respective food plants in much the same way as the survival percentage of larvæ. It is also seen from the results that the largest size is obtained if reared on *bajra* and *urd*, followed by those fed on castor, *jowar* and maize. These results show that the size of the moths as well as the pupal weight are affected by the different food plants in the same way and that the heaviest pupæ are the producers of large-sized moths. The females outnumber the males in the case of *jowar*, *bajra* and maize, but are equal in number if reared on castor and *urd*.

TABLE 4

PERCENTAGE EMERGENCE, SIZE AND SEX-RATIO OF ADULT MOTHS OF *A. moorei* IN RELATION TO THE TYPE OF LARVAL FOOD SUPPLIED

Food plant	Percentage of adult emergence	Mean size of male in cm.		Mean size of female in cm.		Sex-ratio male : female
		Body length	Wing expanse	Body length	Wing expanse	
Maize ..	62.5	1.4	2.25	1.43	2.66	1:1.50
Jowar ..	60.0	1.0	2.25	1.5	2.7	1:2.00
Bajra ..	80.0	1.5	2.5	1.6	2.85	1:1.66
Castor ..	66.6	1.2	2.5	1.3	2.7	1:1.00
Urd ..	75.0	1.5	2.5	1.5	2.85	1:1.00

Table 5 shows the longevity and fecundity of the moths bred from larvæ reared on different food plants, as also the incubation period of the eggs laid by them. It will be seen that the female moths, when fed on 5 per cent sugar solution, lived slightly longer than the males in all cases. They lived longest when bred from larvæ reared on *bajra* and shortest on castor. Marked differences are seen in regard to the number of eggs laid by the females, the largest numbers of eggs being laid by the moths raised on *bajra*, followed by *urd*, maize, castor, and *jowar* in the descending order. The incubation period of eggs varied only slightly, being longest in the case of moths raised on *urd* and shortest on castor.

TABLE 5

LONGEVITY, FECUNDITY AND INCUBATION PERIOD RECORDS OF *A. moorei* IN RELATION TO THE TYPE OF LARVAL FOOD SUPPLIED

Food plant	Average longevity in days		Average number of eggs laid per female	Average incubation period in days
	♂	♀		
Maize	3 0	5.0	349	3.0
Jowar	4.0	5.0	250	3.0
Bajra	4.0	6.0	512	3.0
Castor	4.0	4.5	324	2.8
Urd	3.0	5.0	448	3.5

Finally with regard to time for completing the life cycle, i.e., the period from egg-laying to the emergence of moths, it will be seen that it was 24.75 days with maize and *bajra*, 24.0 days with *jowar*, 28.25 days with *urd*, and 36.3 days with castor.

REFERENCES

BINDRA, O. S., & KITTUR, S.U., (1958): On the biology and control of the red hairy caterpillar, *Amsacta moorei* Butler (Arctuidæ-Lepidoptera) in Madhya Pradesh. *Vikram* (*Sci.*) **5**:62-72.

FLETCHER, T. B., (1914): Some South Indian Insects and other animals of importance. Supdt. Govt. Press Madras, pp. 369.

PRUTHI, H. S., (1938): Report of the Imperial Entomologist. *Sci. Rep. Agri. Res. Inst.* New Delhi. pp. 113-128.

Cause and effects of a heavy rainfall in Darjeeling and in the Sikkim Himalayas

BY

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(*With two text-figures*)

During his stay in Darjeeling in November and December 1968 the author collected data relating to the catastrophic rainfall, which occurred in this region between the 2nd and 5th October 1968, and amounted to 1091 mm. (fig. 1) at Kurseong. The present report is chiefly concerned with the causes of this rainfall. Its effects will be dealt with more fully in a separate paper.

In the monsoon climate of India the rainy season covers 4 to 6 months, and usually lasts from May to September. The heaviest precipitation is noted on the southern slopes of mountains (the monthly rainfall in the Assam hills amounts to 2800 mm.). On the border of the Sikkim Himalayas and in the neighbouring parts of Nepal and Bhutan, not screened by hills, the annual rainfall is also abundant—of the order of 2500 - 5000 mm. In Darjeeling the summer half of the year receives 2852 mm. and in the winter half only 241 mm. From June to September it rains almost every day (each month with 20-27 rainy days) and 5 to 20 days with a rainfall exceeding 50 mm. During the 2-3 winter months, there is rarely rain. According to data for the years 1949 - 1968, the rainfall ranged from 2100 to 3900 mm. in this period (fig. 1). Precipitation of catastrophic type occurs rarely, the heaviest rainfall in a day was noted in Darjeeling in 1899 (493 mm.) and 1950 (454 mm.). Every 20 - 30 years in the course of a continuous 3 - 5 day's precipitation the amount of rainfall goes up to 1000 mm.

Precipitation is differentiated spatially. In the monsoon climate a rain shadow is distinctly marked, for example, in the Assam-uplands, Cherapunji receives 10869 mm., whereas Shillong lying immediately behind the interfluve, only 2253 mm. On the border of the Himalayas there occurs an inversion of precipitation. While the stations at the foot of mountains record 2000 - 3500 mm., Kurseong at an altitude of 1400 m.- 4052 mm., and Darjeeling lying on the ridge at an altitude of 2150 m., only 3092 mm. In deep valleys the contrasts are still greater. During the showers which occurred in 1950 between the 9th and 14th June, the amount of rainfall varied from 275 to 1150 mm.

Changes in the discharge of rivers are the result of differences in the annual course of precipitation and of the occurrence of heavy rainfall. G. N. Dutt reports that the discharges of the River Gish, south of Kalimpong, with a drainage area of 62 square miles wooded in 42 per cent, varied in 1952 from 3 $m.^3$/sec. to 22270 $m.^3$/sec. the maximum specific run-off amounting therefore to 133 $m.^3$/sec./$km.^2$

The information obtained by the author concerns part of the terrain stricken with flood. The main ridge of the Himalayas in this part is the Sikkim Himalayas culminating in the mighty Kanchenjunga massif (8586 m.). In front lie the Darjeeling Hills with ridges ranging from 2000 to 3000 m. above sea-level, cut by valleys 1000 to 2000 m. deep. The largest River Tista with a catchment basin of about 7500 sq. km. drains the whole of Sikkim and is a tributary of Brahmaputra (in the last century it flowed to the Ganges).

The lower step of the Himalayas is chiefly built of strongly folded gneisses and mica schists of the Darjeeling series of medium resistance. Along the edges of the mountains and in deep valleys the underlying, weak, shales of the Daling series as well as sandstones, quartzites, and shales of the Gondwana series are exposed on the surface, whereas on the border of the lowland poorly cemented sandstones and shales of the Siwalik series occur. The structure of the substratum and the considerable unevened slopes of rivers deepening their channels cause the ridges of the Lower Himalayas to be generally narrow and rounded, the slopes steep, inclined at 20 - 50°, straight or convex (undercut at the foot), less frequently convex-concave. They are dissected by numerous steep-walled ravines and shallow gullies with bottoms covered with debris scree, and diversified by old and new landslide channels. Despite their steepness there developed on the slopes a waste cover of sandy loam on gneiss 0.5 - 5 m. thick, absorbing large quantities of water, not readily subject to wash-out but susceptible to mass movements. This area was covered in the past by the jungle. Up to the height of 500 m. it was a tropical forest, from 500 to 2000 m. — a subtropical forest composed of many species of trees, and from 2000 to 3600 m. above sea-level — various vertical zones of temperate forest, higher with *Rhododendron*. In the past century the forests were largely destroyed and their species

Darjeeling District

1. Peaks; 2. rivers; 3. main roads; 4. boundaries; 5. pass; 6. rainfall; 7. automatic recorders.

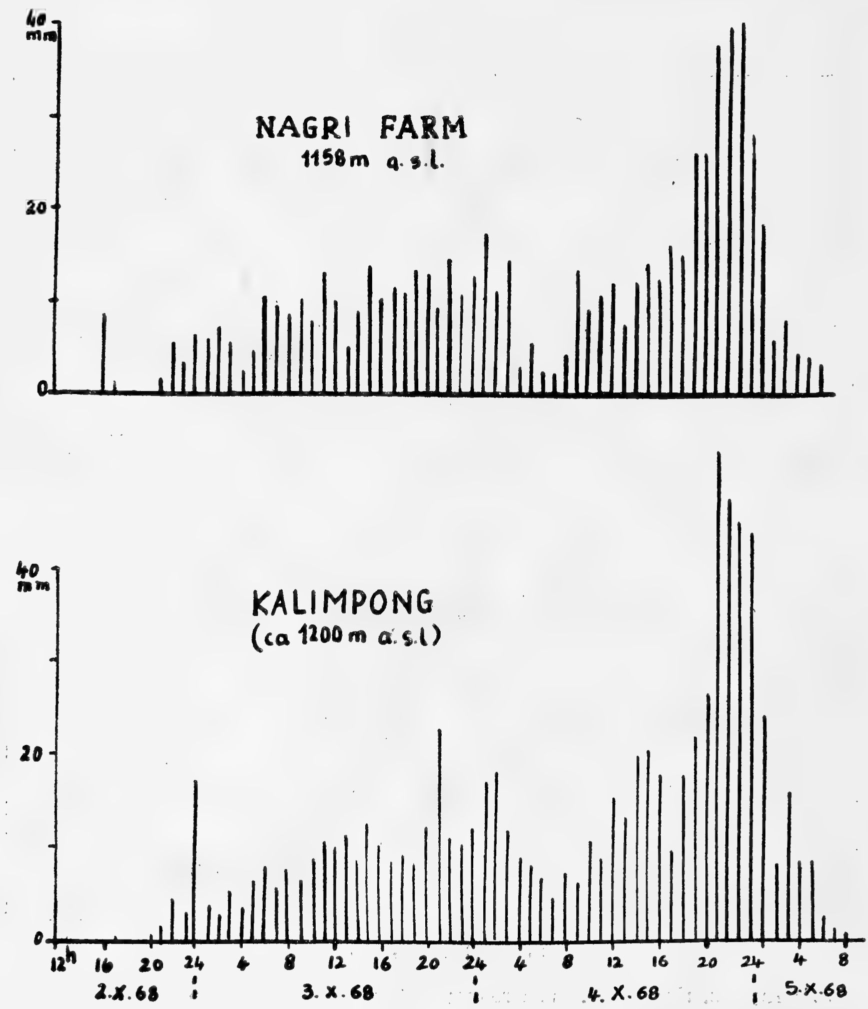

Fig. 2—Rainfall between 2 and 5 October according to automatic recorders, Nagri Farm (From Dr. F. Rahman), Kalimpong (from Meteorological Office)

composition underwent changes. It is only above the altitude of 2200 m. that dense forest complexes have been preserved. Below 1800 m. about 30 - 50 per cent of the area is occupied by tea gardens established in the nineteenth century.

Similarly as in the three preceding years the summer monsoon in 1968 was poor in precipitation (fig. 1), amounting only to 2000 mm., and the daily rainfall exceeded 50 mm. only 6 times. Towards the end of September a storm front developed over the Bay of Bengal and after becoming transformed into a deep depression it reclined on the Himalayas. On the 2nd October 1968, after a local afternoon rainfall, an uninterrupted rain began to fall at about 8 p.m. It covered eastern Nepal, Darjeeling Hills, Sikkim, and western Bhutan. Its intensity increased during 3rd October, rising to 15 - 20 mm. per hour on the night from the 3rd to the 4th. Then it weakened but became stronger again in the afternoon of the 4th October. Between 8 and 12 p.m. it reached its peak, amounting to 40 - 60 mm./hr. on the average. At daybreak the rain stopped altogether. The automatic rainfall stations (fig. 2) give a clear picture of the course of the intensity of the rainfall, while the other stations show the spatial differentiation of its amount (Table). The largest amount of rainfall was noted

TABLE

RAINFALL BETWEEN 2—5 OCTOBER 1968 IN DARJEELING REGION

Station	For year 68	2.x.68	3.x.68	4.x.68	2-5.x.68
Jalpaiguri		120.0	113.0	..	233.0
Nagri Farm		91.4	260.1	382.8	734.3
Nagri Farm/automatic rec.		87.6	241.6	368.9	698.1
Kurseong St. Mary's College	4878.5	152.0	301.0	638.0	1091.0
Rangtong T. E.	3197.8	151.1	209.5	241.0	601.6
Poobong T. E.	3975.1	110.0	255.0	400.0	765.0
Darjeeling Planters Club ..	2651.2	93.5	210.3	303.3	607.1
Darjeeling Meteorol. Obs.		85.0	215.0	275.0	575.0
Bannockburn T. E. ..	2689.6	83.3	207.0	356.1	646.4
Chongtong T. E.					above 650.0
Kalimpong Meteorol. Obs.		73.4	257.8	465.1	796.3
Kalimpong automatic rec. .		71.1	261.3	456.1	788.5

on slopes of mountains exposed to the south at an altitude of 1000 - 1500 m. Kurseong recorded 1091 mm., and Kalimpong 796 mm. A smaller amount of rainfall was noted by stations in deep valleys on the southern slope (Nagri Farm 734 mm., Poobong 765 mm.), the lowest being recorded on ridges (Darjeeling 575 mm., and 607 mm.) and in valleys in the rain shadow (Bannockburn 646 mm.). The 60 hours' rainfall was the last of the summer monsoon, when the soil was already saturated with moisture [in contrast to the rainfall of June 1950 — cf. (fig. 1)]. However, the immediate cause of the sudden run-off of waters was the last accent of heavy rain, when within 4 hours there fell 200 mm., and locally probably still more. This occurred on 4th October and according to eye-witness accounts at about 11 p.m. slopes began to slide down, while the swollen rivers carried away bridges.

First of all the equilibrium of the circulation of water on slopes was disturbed. The water infiltrating into the sandy soil could not penetrate deeper into the unweathered rock and began to flow under pressure grooving channels in the soil and gushing in the form of springs, giving rise to mud and rubble sliding tongues denuding whole patches of slopes of the weathering crust. Where the water infiltrated deeper along joints, large rock slides 1 km. long and 20 - 30 m. deep were formed, being also encountered in forests. The waters flowing in the bottoms of overgrown ravines began to deepen them with the boulders they were carrying and to undercut valley sides.

The waters gathered in the stream beds, which often were deepened up to 8 m. in solid rock, or else were filled up in sections with alluvia (the author observed thickness amounting to 12 m.). These beds had frequently become three to five times wider. The force of the water was evidenced by its carrying heaps of boulders 2 - 5 m. in diameter, some of them even exceeding 10 m. The violent rise of waters included also the large rivers. The level of the Tista was up to 24 m. higher than the average (at Tista Bazar the author noted a high water mark 18 m. above its level at the end of November). The observed velocity of the flood water amounting to 20 km./hr., the mean transversal cross-section of the river channel being 5,000 m^2., permitted the calculation that at Tista Bazar there flowed about 27,500 $m.^3$/sec., which equals a specific run-off of 3.6 $m.^3$/sec./$km.^2$. According to hydrological data published in the Calcutta press (Statesman), the River Kosi, draining eastern Nepal, carried in the morning of the 5th October 1968, 91, 300 $m.^3$/sec., which corresponds to a specific run-off of 14.7 $m.^3$/sec./$km.^2$. The waters of rivers flowing out on to the plains flooded vast areas, bringing about the formation of new river channels and submerging fields and settlements, or covering them with gravel and sand.

The result of these heavy rains were geomorphological changes of slopes and valley bottoms, as well as economic loss.

In the region of Darjeeling about 20 per cent of deforested slopes became transformed through the degradation of the upper soil layer and often of the whole waste cover, e.g. in the Poobong tea gardens out of the 200.5 ha. of tea fields 26 per cent were destroyed and out of the 520 ha. of the total area of the settlement—18.2 per cent. The damage in the forests was 10 times lesser. Thus, one can estimate (the aforestation of the catchment basin amounting to 30 - 50 per cent) that on the average a l-metre thick layer of substratum was removed from 10 per cent of the area, which equals a lowering of the whole terrain by 10 cm. in the course of the considered heavy rain (degradation of the order of 100,000 $m.^3$ per 1 $km.^2$). Only an insignificant part of the material held on at the base of slopes, while most of it was carried away by the swollen rivers. The high undercuttings and deepening in the solid rock indicate that the transport power of the rivers exceeded the usual supply from the slopes. This is a characteristic trait of rivers of humid regions with uneven slopes and of young mountains lifted by tectonic movements. The comparison with other catastrophes, especially with those of the years 1899 and 1950, permits the assumption that the deepening of valleys and retreating of mountain slopes takes place above all during periods of catastrophic rainfall, occurring once in 20 - 30 years and being sometimes connected in this region with earthquakes. The periods dividing them are phases of carrying down the material to channels during normal monsoon precipitation, and of intense chemical weathering preparing the waste material which will be removed from the slopes during the subsequent catastrophic rainfall. Worthy of note is that landslides formed in 1950 did not generally undergo rejuvenation by 1968. The period of 18 years was too short for the development of a new soil layer.

The catastrophic rainfall caused great damage to the economy. Apart from the fact that about 1,500 people had been killed (excluding Nepal and Bhutan), hundreds of houses were destroyed, settlements buried (e.g. Pul Bazar), scores of bridges carried away, including the main bridge on the Tista on the road leading to Tibet, and in about 200 sections the high road and railway line from Siliguri to Darjeeling was cut. Agriculture suffered losses difficult to retrieve. In the mountains 20 - 30 per cent of cultivated land (chiefly tea gardens) was destroyed, and in the lowland, apart from the buried fields, irrigation appliances were ruined.

The catastrophic rains recurring roughly every 20 years require a regulation of the water circulation, chiefly by means of a skilful draining of the waste cover on mountain slopes, which would preclude the development of newly formed landslides and prevent future catastrophes, as well as the construction of storage reservoirs at the outlet of all the Himalayan valleys.

Acknowledgements

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Dr. N. R. Kar of the Government College of the West Bengal University was kind enough to give me the first introduction to the area in November 1968 at a symposium organised by the Int. Geographical Congress at Darjeeling.

A Catalogue of the Birds in the Collection of the Bombay Natural History Society-6

Scolopacinae (part)

BY

HUMAYUN ABDULALI

[*Continued from Vol.* **66**(3): 559]

This part deals with 218 specimens of 19 species and subspecies up to No. 403 in IND. HANDBOOK (**2**: 297), up to Register No. 23299. Miss Shanta Nair, Research Assistant, attended to measurements and other routine work, and I am grateful for her assistance.

385 **Numenius phaeopus phaeopus** (Linnaeus) (Sweden) Whimbrel **6**: 203

18: 10♂♂ 7♀♀ 1o?

1 *Bushire, Persian Gulf;* 1 Baluchistan; 1 Kandla, Kutch; 1 Thana Creek, 1 Thana District, 1 Bhyander, 1 Versova, 1 Bombay, 2 Panvel, Kolaba; 1 Pulicat, Chingleput, Madras; 3 Long Island, Middle Andamans, 2 Car Nicobar, 1 Camorta, 1 Great Nicobar.

Five of the seven from the Andaman and Nicobar Islands are females, while eight of the ten males are from the west coast down to about Bombay.

With the literature available I have been unable to decide if any of them is *variegatus* (Scopoli).

386 **Numenius phaeopus variegatus** (Scopoli) (Luzon) Eastern Whimbrel **6**: 204

nil.

387 **Numenius arquata arquata** (Linnaeus) (Sweden) Curlew **6**: 200

nil.

388 **Numenius arquata orientalis** C.L.Brehm (East Indies) **6**: 202

11: 3♂♂ 5♀♀ 3o?

1 *Amara, Iraq;* 2 Bharatpur, Rajasthan; 3 Kutch; 3 Kolaba District, Maharashtra; 1 *Peking, China;* 1 *col.* C.M. Inglis (=Bihar?).

All the specimens have almost unmarked axillaries and from the literature available appear to be of this race.

	Wing	Bill	Tail
♂♂	280, 295, 295 (280-297)	141, 142, 142 (137-139)	104-107
♀♀	290-307 av. 300 (300-314)	135-190 av. 161 (135-194)	107-110

The measurements include those of two females obtained near Bombay in October (and not in the Society's collection) which have very short bills (135, 143).

389 **Limosa limosa limosa** (Linnaeus) (Sweden) Blacktailed Godwit

11: 3♂♂ 3♀♀ 5o?

3 *Baghdad;* 1 *Rohtak, Persian Baluchistan;* 1 Risalpur, N.W.F.P.; 1 Kharaghoda, Gujarat; 2 Nasik, 1 Panvel; 1 *col.* C.M. Inglis (=Bihar?); 1 Manipur, Assam.

The females of this species are larger than the males, and this race (wing 205-240; bill 88-126; tarsus 75-82) is accepted (FAUNA and IND. HANDBOOK) as larger than *melanuroides* (wing 176-207, bill 77-95, tarsus 66-73).

The five birds from Iraq and the north-west (1♀ 4o?) are larger than the four from the rest of India (1♂ 3♀♀).

Wing	221, 222, 224, 230, 234	cf.	198, 211, 212, 215
Bill	102, 114, 116, 122, 127	cf.	103, 103, 104, 106
Tarsus	84, 85, 88, 90, 91	cf.	72, 75(2), 78

In the dry stage the former also have their bills more yellow, less dusky.

The female from Nasik (No. 20147) measuring 198, 104, and 75 may well be of the next form. A larger series of correctly sexed specimens from peninsular India is necessary[1].

390 **Limosa limosa melanuroides** Gould (Port Essington, Australia) Eastern Blacktailed Godwit **6**: 207

2 o? *Tientsin, China.*

Wing 194, 209 (LaTouche in BIRDS OF EASTERN CHINA measures 3 females; 192, 211, and 228); bill (one only) 106 (LaTouche: 72.5, 78.5, 112); tarsus 62, 75.

391 **Limosa lapponica lapponica** (Linnaeus) (Lapland) Bartailed Godwit **6**: 252

4: 1 ♂ 2♀♀ 1o?

1 Kandla, Kutch; 1 Bhyander, 1 Thana, Bombay, 1* Rewas, Kolaba.

The female obtained on 8 December* is much greyer above than the others (August-September).

[1] After this was completed a ♂ and a ♀ shot out of a flock at Rewas, Kolaba District, on 19 October 1969, were measured: wings 217 and 245, and bills 112 and 124 respectively.

392 **Tringa erythropus** (Pallas) (Holland) Spotted or Dusky Redshank **6**: 223

10: 2♂♂ 5♀♀ 3o? (3 in summer plumage)

1 *Aliabad*, 12 *m. SE. of Shiraz, Iran;* 1 Khushdil Lake, Quetta; 1 Dodi, Malwa Plateau, Bhopal; 1 Bogna, Shahjehanpur, U.P.; 3 Darbhanga, Bihar; 2 no data, *col.* F.J.R. Field; 1 *Tientsin, China.*

Wing	Bill	Tarsus	Tail
♂♂ 166, 168	57, 58	57, 57	66, 70
(158-168)	(53-59)	(53-59)	(60-68)
♀♀ 164-169 av. 166.4	55, 56, 59	53-60 av. 56.6	63-68 av. 65.6
(166-177)	(57-64)	—	—

393 **Tringa totanus totanus** (Linnaeus) (Sweden) Common Redshank **6**: 221

394 **Tringa totanus eurhinus** (Oberholser) (Tso Moriri Lake' 15,000′, Ladakh) Eastern Redshank **6**: 222

37: 10♂♂ 25♀♀ 2o?

2 *Hawi Plain*, 1 *Samarrah, Iraq;* 1 *Turbat*, 1 *Shiraz*, 1 *Kuh-e-Khwaja, Hamun Lake, Iran;* 1 *Rohtak R., near Sib, Persian Baluchistan;* 1 Hajarganji, Baluchistan; 3 Bahawalpur, Punjab; 2 Kandla, Kutch; 1 Bassein, 2 Bhyander, 1 Hog Island, Bombay, 5 Belapur, Thana, 3 Panvel, 2 Rewas, Kolaba, 1 Rajapur, Ratnagiri; 1 Karwar; 1 Point Calimere; 1 Chilka Lake; 3 Calcutta Market; 2 Andamans; 1 Car Nicobar.

There have been continued and considerable differences of opinion regarding the races of the Redshank occuring in India. Oberholser described *eurhinus* as larger than nominate *totanus.* Meinertzhagen said that they were not separable, but described *terrignotae* from Koko Nor, both races being said to winter in India. Stuart Baker (**6**: 220) accepted this, but later authors synonymised *terrignotae* with *eurhinus*! BIRDS OF SOVIET UNION (3: 230) does not accept either *eurhinus* or *terrignotae*, synonymising both with nominate *totanus.* In SYNOPSIS, both *totanus* and *eurhinus* were said to occur all over India, but in IND. HANDBOOK (2: 257) the occurrence of the nominate race in India is doubted.

The specimens available measure:—

Wing	Bill	Tarsus	Tail
9♂♂153-166 av. 158 (ex Vaurie 152-165 av. 157.5)	43-45 av. 44.2 (from skull 45-51)	47-52 av. 49.5 (49-51)	61-66 av. 64 (63-72)
25♀♀152-171 av. 160.4 (2♀♀ 162, 165)	42-50 av. 45 (from skull 51-54)	47-53 av. 49.9 —	59-71 av. 64.5 (67)

All the specimens are in winter plumage and it is evident that the grey sheen on freshly obtained specimens fades into the pale brown of the older skins in a few years.

The measurements of the bill from feathers, 39-42, for *Tringa t. totanus* as in BR. HANDBOOK (4: 330) are sufficient to separate them from the present specimens, but as the measurements are not repeated by subsequent authors I presume they are not correct. A male obtained at Point Calimere on 18th October 1969 has its wing 150, bill 37 (tip broken), tail 63, and tarsus 44. The upper parts are darker and many of the feathers tipped with pale rufous indicating that this is a juvenile.

Without material from Europe, it is not possible to offer any remarks except to reiterate that (1) the birds from Mesopotamia do not differ from the others in size or colour, (2) the half-dozen specimens identified by Whistler and/or Ticehurst are all marked *eurhinus*, and (3) the others do not appear to be different.

395 **Tringa stagnatilis** (Bechstein) (Germany) Marsh Sandpiper or Little Greenshank **6**: 216

8: 5♂♂ 3♀♀

1 Kandla, Kutch; 2 Panvel, 1 Dharamtar Creek, Kolaba; 1 Balugaon, Chilka Lake; 3 Calcutta Market.

	Wing	Bill
♂♂	145 (132-139)	40, 40, 41, 43 (37-40)
♀♀	137, 140, 142 (133-143)	39, 40 (40-50)

The measurements in IND. HANDBOOK (2: 261) are from BRITISH HANDBOOK and show some differences from those available.

396 **Tringa nebularia** (Gunnerus) (District of Trondhjem, Norway) Greenshank **6**: 225

23: 12♂♂ 10♀♀ 1o?

1 *Samara*, 1 *Azuzali, R. Tigris, Iraq;* 1 *Hamun Lake, Seistan*, 1 *Bampur R., near Pahran, Persian Baluchistan;* 1 Jaipur; 2 Vaghjipur, Mehsana; 1 Ahmedabad; 1 Ghoti, Nasik; 2 Thana; 3 Bhyander, Bombay; 1 Chilka Lake; 1 Baghowni, 1 Banhar, Darbhanga, Bihar; 1 Kheri, Oudh; 3 Calcutta Market; 1 Bhugwada, Nepal; 1 *Meping R., Paknampo, Siam.*

	Wing	Bill	Tarsus	Tail
♂♂	177-205 av. 190	53-59 av. 55.6	58-67 av. 60	80-89 av. 82.3
	(184-194)	(50-56)	(55-61)	(68-80)
♀♀	183-201 av. 190.5	54-60 av. 56.7	59-63 av. 61.5	75-86 av. 79
	(184-200)	(53-59)	—	—

397 **Tringa ochropus** Linnaeus (Sweden) Green Sandpiper **6**: 215

39: 13♂♂ 21♀♀ 5o?

1 *Sulaimaniyah, Iraq;* 1 *Duzdap, E. Persia;* 1 *Sib*, 1 *Geh, Persian Baluchistan*; 2 Wana, Baluchistan; 2 Chitral; 1 Kalsi, 1 Muglib, Ladakh; 1 Banyar, Kashmir; 1 Kashmor, Upper Sind Frontier; 1 Punjab; 4 Delhi, 1 Keonthal; 1 Patan, Jaipur; 3 Bombay; 1 Karwar; 1 Kumbum Valley, Kurnool Dist.; 1 Gondia, Balaghat; 1 Baghowni, Tirhut; 2 Cawnpore, 2 Meerut, 1 Kheri Dist.; 1 Karunprayog, Garhwal; 1 Calcutta Market; 1 Imphal, Manipur; 1 *Prome*, 1 *Thayetmyo, Burma;* 3 *Peking, China.*

	Wing	Bill	Tarsus	Tail
♂♂	136-152 av. 142.7	31-37 av. 34	31-39 av. 34-3	52-61 av. 57
	(136-148)	(33-35)	(32-34)	(52-61)
♀♀	138-148 av. 143	33-36 av. 34.7	33-37 av. 34	55-62 av. 58
	(142-153)	(33-36)		

398 **Tringa glareola** Linnaeus (Sweden) Spotted Sandpiper **6**: 219

36: 13♂♂ 20♀♀ 3o?

2 *Baghdad, Iraq;* 1 *Kajjarak near Shiraz, Iran;* 2 *Sib, Persian Baluchistan;* 2 Harbuz, *c.* 55 m. east of Panjgur, Kalat, Baluchistan; 1 Chitral, N.W.F.P.; 1 Ladak, Kashmir; 1 Delhi; 1 Kutch; 1 Bardoli, Baroda, Gujarat; 1 Ghoti, Nasik, 4 Thana, 3 Kolaba; 2 Palnis; 2 Travancore; 1 Chilka, Orissa; 3 Calcutta Market; 1 Meerut, 1 Nahrosa, Pilibhit, U.P.; 1 Margherita, Assam; 1 Andamans; 3 *Burma,* 1 *Peking, China.*

	♂♂	♀♀
Wing	122-134 av. 124.6 (IH 120-128)	122-132 av. 129 (IH 125-130)
Bill	28-32 (IH 25-29 ex BR. HANDBOOK)	27-31 (IH ex BR. HANDBOOK 25-31)

Sp. No. 19756 from Thana District, Bombay, is in abberrant plumage being washed with greyish all over.

Two *T. ochropus* were listed under this species.

399 **Tringa guttifer** (Nordmann) (Okhotsk) Spotted Greenshank

nil. **6**; 226

400 **Tringa terek** (Latham) (Shores of the Caspian Sea about the mouth of the Terek River) Terek or Avocet Sandpiper **6**: 212

9: 2♂♂ 3♀♀ 4o?

1 *Kashgar, Chinese Turkestan;* 1 Karachi; 1 Bhyander, Bombay; 2 Rewas, Kolaba Dist.; 1 Cannanore, Malabar; 1 Point Calimere; 1 Calcutta Bazar; 1 Betapur, Middle Andamans.

The specimen from Cannanore is no doubt one of the two obtained at this place on 12 December 1931, and noted in the Eastern Ghats Survey (*JBNHS* **39**: 255). It was later received on 6 December 1938 from Major Phythian-Adams, then resident in the Nilgiris, and the entries on the labels and in the Register were changed to read " Cannanore, Nilgiris, S.I., 6th Dec. 1938".

Wing	Bill	Tarsus	Tail
125-135 av. 130	43-52 av. 47	26-28 av. 27	47-52 av. 50
(126-141)	(♂♂43-49, ♀♀44-52)	(25-28)	(47-56)

401 **Tringa hypoleucos** Linnaeus (Sweden) Common Sandpiper **6**: 217

28: 10♂♂ 11♀♀ 7o?

1 *Feluja, R. Euphrates, Iraq;* 2 *Chaharbar* (*Chah Bahar ?*), *Persian Gulf,* 1 *Fao,* 1 *Karun River, Persia;* 2 Ashni R., 1 Chitral; 2 Chini, Simla Hills; 1 Chandigarh, Punjab; 1 Karachi; 1 Bodeli, Gujarat; 1 Bhyander, 1 Kurla, 1 Andheri, 1 Ghodbunder, 2 Bombay, 1 Rewas, Kolaba; 1 Karwar; 1 Edanad, Kerala; 1 Ceylon; 1 Rajora, 1 Bastar; 1 Baghowni, Bihar; 1 Rangpo, Sikkim; 1 Katchal, Nicobars.

	♂♂	♀♀
Wing	104-113 av. 109 (106-114)	103-114 av. 108.4 (111-119)
Bill	23-27 av. 24.1 (23-25)	23-27 av. 25.2 (24-26)
Tail	51-60 av. 54.8 (50-59)	53-61 av. 55.7 (50-59)

402 **Arenaria interpres interpres** (Linnaeus) (Gotland, Sweden) Turnstone **6**: 154

19: 6♂♂ 8♀♀ 5o?

2 *Tanb Island, Persian Gulf;* 1 Karachi; 1 Mandvi, 1 Kandla, Kutch; 1 Bandra, 1 Gorai, Bombay; 1 Rewas, Kolaba; 2 Cape Comorin (1 missing); 2 Chilka Lake, Orissa; 1 Manipur, Assam; 1 Choldhari, 2 S. Sentinel Island, Andamans; 1 *Papun, Burma;* 2 *Tientsin, China.*

Wing ♂♂ 144-163 av. 151.6 (IH ex BR.HANDBOOK 147-157)

♀♀ 142-159 av. 150 (IH. ex BR. HANDBOOK 146-162)

403 **Limnodromus semipalmatus** (Blyth) (Calcutta Bazar) Snipe-billed Godwit **6**: 210

2 o? (1, head only) Chilka Lake, Orissa.
Wing 181 (177-181); bill 81, 84 (77-87)

The statement in IND. HANDBOOK (2: 276) that it can be separated in the field from a godwit by its conspicuously slenderer, longer bill is no doubt in error, for the bill is appreciably *shorter* than that of the Blacktailed (102-127) and no longer than in the Bartailed (♂71, ♀♀ 91, 99, 1 unsexed 82).

I may also draw attention to the fact that I have changed the type locality from " Madras " to " Calcutta Bazar". Jerdon first obtained a specimen in the Madras Market and sent it to Blyth at the Indian Museum at Calcutta, and it is in the first place misleading to indicate the type locality as Madras. Some time later (1848), Blyth described the species *Macrorhamphus semipalmatus* with Jerdon's name as author. At the same time he stated that the description was based on a fresh specimen from the Calcutta Bazar. The authorship is correctly attributed to Blyth, and the bird which formed the basis of the description, i.e. the bird from the Calcutta Bazar, would be the type.

(to be continued)

Nomenclatural Notes on some Flowering Plants—II

BY

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During general studies on Indian flora, particularly of Bhutan and Jowai areas in Assam, and also during his work at the Hartley Botanical Laboratories, University of Liverpool (U.K.) in 1966-67, the author noticed that names of many plants needed change if the rules in the International Code of Botanical Nomenclature (1966) were strictly applied. These notes mainly involve the rules of priority, invalid publication, later homonyms and also the recent altered taxonomic concepts of some genera.

BRASSICACEAE

Sisymbrium bhutanicum Balak. nom. nov. *S. lasiocarpum* Hook f. & Thoms. in J. Linn. Soc. 5 : 163, 1861 (non F. Muell. 1858) et in Hook. f. Fl. Brit. Ind. 1 : 148, 1872.

FLACOURTIACEAE

Taraktogenos macrocarpa (Bedd.) Balak. comb. nov. *Asteriastigma macrocarpa* Bedd. Fl. Sylv. 2: t. 266, 1872 et Ic. t. 242, 1874; Gamble, Fl. Pres. Madras 52, 1915. *Hydnocarpus macrocarpa* (Bedd.) Warb. in Engler & Prantl, Pflanzenfam. 3 (6a) : 21, 1893; Gilg in Engler, Pflanzenfam. 21 : 409, 1925.

MELIACEAE

Aglaia exstipulata (Griff.) Balak. comb. nov. *Euphora exstipulatis* Griff. Notul. 4 : 547, 1851. *A. polyantha* Bedd. Ic. Pl. Ind. Or. 1 : 44, 1874. *A. minutiflora* Bedd. l. c. t. 193, 1874; Hiern in Hook. f. Fl. Brit. Ind. 1 : 557, 1875.

Dysoxylum alliarum (Buch.-Ham.) Balak. comb. nov. *Guarea alliaria* Buch.-Ham. in Edinb. Mem. Wern. Soc. 6 : 305, 1832. *Hartighsea alliaria* (Buch.-Ham.) Voigt, Hort. Sub. calc. 136, 1845. *D. hamiltonii* Hiern in Hook. f. Fl. Brit. Ind. 1 : 548, 1875.

Dysoxylum gobara (Buch.-Ham.) Merr. in J. Arn. Arb. 23: 173, 1942, *Guarea gobara* Buch.-Ham. in Edinb. Mem. Wern. Soc. 6 : 306, 1832. *Hartighsea gobara* (Buch.-Ham.) Voigt, Hort. Sub. Calc. 136, 1845.

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[1] Part I in *J. Bombay nat. Hist. Soc.* 63: 327-331, 1967.

Guarea disyphonia Griff. Notul. 4 : 503, 1851, *D. procerum* Hiern in Hook. f. Fl. Brit. Ind. 1 : 547, 1875.

RHAMNACEAE

Sageretia parviflora (Roem. & Schult.) G. Don, Gen. Syst. 2 : 29, 1832. *Rhamnus parviflorus* Roem. & Schult. Syst. 5 : 295, 1820. *Rhamnus filiformis* Roth, Nov. Sp. Pl. 153, 1821. *Sageretia oppositifolia* Brogn. in Ann. Nat. Sc. sér. 1, 10 : 360, 1827; Lawson in Hook. f. Fl. Brit. Ind. 1 : 641, 1875. *Sageretia filiformis* (Roth) G. Don, Gen. Syst. 2: 29, 1832; Raizada in Indian For. 94 : 450, 1968.

Zizyphus mauritiana Lamk. var. **fruticosa** (Haines) Seb. & Balak. in Indian For. 89 : 525, 1963. *Z. jujuba* Lamk. var. *fruticosa* Haines, For. Fl. Chota Nagpur 270, 1910 et Bot. Bih. Oriss. 195, 1921. *Z. mauritiana* Lamk. var. *fruticosa* (Haines) Raizada & Saxena in Indian For. 92 : 326, 1966, *nom. illeg.*

ROSACEAE

Malus sikkimensis (Wenzig) Balak. comb. nov. *Sorbus sikkimensis* Wenzig in Linnaea 38 : 58, 1874. *Pyrus sikkimensis* Hook. f. Fl. Brit. Ind. 2 : 373, 1878.

As treated by Hutchinson (Gen. Fl. Pl. 1 : 210, 1964) *Malus* differs from *Pyrus* in styles being connate at base and fruits globose, without or with very few grit cells.

Rubus duthieanus Balak. nom. nov. *R. fasciculatus* Duthie in Ann. R. Bot. Gard. Calc. 9 : 39, 1901 (non P. J. Mueller, 1858).

Rubus duthieanus Balak. var. **tomentosus** (Cardot) Balak. comb. nov. *R. fasciculatus* Duthie var. *tomentosus* Cardot in Le Comte, Notul. Syst. 3 : 314, 1917.

Rubus glandulifer Balak. nom. nov. *R. lanatus* Hook. f. Fl. Brit. Ind. 2 : 331, 1878 (non Focke, 1867).

Rubus kumaonensis Balak. nom. nov. *R. reticulatus* Hook. f. Fl. Brit. Ind. 2 : 331, 1878 (non Kerner, 1870).

Rubus kurzii Balak. nom. nov. *R. ferox* Wall. ex Kurz. For. Fl. Brit. Burma 1 : 437, 1877; Hook. f. Fl. Brit. Ind. 2 : 329, 1878 (non Boenn. 1824).

Rubus nutantiflorus Hara in J. Jap. Bot. 40 : 327, 1965. *R. nutans* Wall. ex G. Don, Gen. Syst. 2 : 528, 1832 (non Vest 1824); Hook. f. Fl. Brit. Ind. 2 : 334, 1878.

Rubus nutantiflorus Hara var. **nepalensis** (Hook. f.) Balak. comb. nov. *R. nutans* G. Don var. *nepalensis* Hook. f. Fl. Brit. Ind. 2 : 334, 1878.

Sorbus bhutanica (W. W. Smith) Balak. comb. nov. *Pyrus bhutanica* W. W. Smith in Rec. Bot. Surv. Ind. 4 : 265, 1911.

Sorbus differs from *Pyrus* in corymbose or paniculate flowers and pinnate or 'pinnately lobed leaves, as treated by Hutchinson (Gen. Fl. Pl. 1 : 210, 1964).

Sorbus kachinensis (W. W. Smith) Balak. comb. nov. *Pyrus kachinensis* W. W. Smith in Rec. Bot. Surv. Ind. 6 : 100, 1914.

Sorbus monbeigii (Cardot) Balak. comb. nov. *Pyrus monbeigil* Cardot in Le Comte, Notul. Syst. 3 : 352, 1918.

Sorbus parvifolia (Blatter) Balak. comb. nov. *Pyrus parvifolia* Blatter in J. Indian Bot. Soc. 9 : 207, 1930.

SAXIFRAGACEAE

Saxifraga himalaica Balak. nom. nov. S. *micrantha* Edgew. in Trans. Linn. Soc. 20 : 50, 1846 (non Fisch. ex DC. 1830); Clarke in Hook. f. Fl. Brit. Ind. 2 : 394, 1878.

Saxifraga nigroglandulifer Balak. nom. nov. *S. nutans* Hook. f. & Thoms. in J. Linn. Soc. 2 : 69, 1857 (non D. Don 1822; nec Adams 1834); Clarke in Hook. f. Fl. Brit. Ind. 2 : 393, 1878.

CRASSULACEAE

Sedum hookeri Balak. nom. nov. *S. elongatum* Hook. f. & Thoms. in J. Linn. Soc. 2 : 98, 1858 (non Ledebour 1834); Clarke in Hook. f. Fl. Brit. Ind. 2 : 419, 1878.

MELASTOMACEAE

Sonerila amabilis Kurz in J. As. Soc. Beng. 40 (2) : 53, 1871. *S. kurzii* Clarke in Hook. f. Fl. Brit. Ind. 2 : 539, 1879.

Sonerila trianae Balak. nom. nov. *S. amabilis* Triana (in Trans. Linn. Soc. 28: 76, 1871, nom. nud.) ex Clarke in Hook. f. Fl. Brit. Ind. 2 : 533, 1879 (non Kurz 1871).

S. amabilis Kurz (1871) is the earlier name for *S. kurzii* described by C. B. Clarke in 1879 and hence treated here as the correct name. Clarke's binomial *S. amabilis* published in 1879 is not legitimate being a later homonym of *S. amabilis* Kurz (1871) and hence a new name *S. trianae* is proposed here.

Araliaceae

Euaraliopsis Hutch. Gen. Fl. Pl. 2 : 80, 1967. *Araliopsis* Kurz, Andaman Rep. App. 39, 1870, nom. nud. *Brassaiopsis* Clarke in Hook. f. Fl. Brit. Ind. 2 : 735, 1879, p.p. (non Decne & Planch. 1854).

Hutchinson (1967) separated this genus from *Brassaiopsis* sensu Clarke (1879) on the basis that the leaves of *Euaraliopsis* are digitately lobed or partite and not compound as in *Brassaiopsis* Decne & Planch. The following species also belong to this genus:—

Euaraliopsis alpina (Clarke) Balak. comb. nov. *Brassaiopsis alpina* Clarke in Hook. f. Fl. Brit. Ind. 2 : 736, 1879.

Euaraliopsis griffithii (Clarke) Balak. comb. nov. *Brassaiopsis griffithii* Clarke in Hook. f. Fl. Brit. Ind. 2 : 736, 1879.

Euaraliopsis mitis (Clarke) Balak. comb. nov. *Brassaiopsis mitis* Clarke in Hook. f. Fl. Brit. Ind. 2 : 736, 1879.

Euaraliopsis polyacantha (Wall.) Balak. comb. nov. *Hedera polyacantha* Wall. Pl. As. Rar. 2 : t. 190, 1831. *Panax palmatum* Roxb. (Hort. Beng. 21, 1814, nom. nud.) et Fl. Ind. ed. 2, 2 : 74, 1832. *Araliopsis andamanica* Kurz in Andaman Rep. App. 39, 1870. *Brassaiopsis palmata* (Roxb.) Kurz in J. As. Soc. Beng. 39 (2): 77, 1870; Clarke in Hook. f. Fl. Brit. Ind. 2: 735, 1879. *Euaraliopsis palmata* (Roxb.) Hutch. Gen. Fl. Pl. 2 : 80, 1967.

This is the correct name for the lectotype species of this genus and not *E. palmata* (Roxb.) Hutch.

Euaraliopsis simplicifolia (Clarke) Balak. comb. nov. *Brassaiopsis simplicifolia* Clarke in Hook. f. Fl. Brit. Ind. 2 : 735, 1879.

Schefflera seemannii Balak. nom. nov. *Agalma glaucum* Seem. in J. Bot. 4 : 25, 1866 (non *S. glaucum* Harms, 1894). *Heptapleurum glaucum* (Seem.) Clarke in Hook. f. Fl. Brit. Ind. 2 : 728, 1879 (non Kurz 1877).

Asteraceae

Saussurea pterocaulon Decne in Jacquem. Voy. Bot. 95, t. 103, 1844. *Aplotaxis candolleana* DC. Prodr. 6 : 541, 1837. *Jurinea adenocarpa* Ledeb. Fl. Ross. 2 : 765, 1846. *S. candolleana* (DC.) Hook. f. Fl. Brit. Ind. 3 : 372, 1881 (non Clarke 1876).

J. D. Hooker made the combination *S. candolleana* based on *Aplotaxis candolleana* DC., the earliest name for this species. However, in 1876, C. B. Clarke had already described a species under the name *S. candolleana* and hence Hooker's name is a later homonym and not legitimate. The next in priority is *Saussurea pterocaulon* Decne, which is the correct name for this species.

Saussurea candolleana Clarke, Comp. Ind. 230, 1876 (non Hook. f. 1881). *S. clarkei* Hook. f. Fl. Brit. Ind. 3 : 372, 1881.

J. D. Hooker (1881) described the species *S. clarkei* which happens to be synonymous to the earliest published name, *S. candolleana* Clarke, the latter being treated here as the correct name.

Saussurea conica Clarke, Comp. Ind. 224, 1876. S. *uniflora* Wall. ex Hook. f. Fl. Brit. Ind. 3 : 366, 1881 (non Clarke 1876). *S. uniflora* var. *conica* (Clarke) Hook. f. l. c.

Saussurea conica Clarke var. **conica,** *S. uniflora* Hook. f. var. *conica* (Clarke) Hook. f. Fl. Brit. Ind. 3 : 366, 1881.

Saussurea conica Clarke var. **uniflora** Balak. nom. nov. *S. uniflora* Wall. ex Hook. f. Fl. Brit. Ind. 3: 366, 1881, excl. var. *conica* (non Clarke 1876).

S. uniflora Hook. f. (1881) is a later homonym and hence not legitimate. *S. uniflora* Clarke (1876) is an entirely different species. However, *S. conica* Clarke is an earlier synonym of *S. uniflora* Hook. f. and treated by J. D. Hooker as a variety of his species and here treated as the correct name of *S. uniflora* Hook. f.

Saussurea edgeworthii Kitamura in Acta Phytotax. Geobot. 24:4, 1969. *Aplotaxis foliosa* Edgew. in Trans. Linn. Soc. 20 : 77, 1846. *S. foliosa* (Edgew.) Hook f. Fl. Brit. Ind. 3 : 373, 1881 (non Ledeb. 1829).

Senecio bombayensis Balak. nom. nov. *Doronicum reticulatum* Wight, Calc. J. nat. Hist. 7 : 156, 1847. *S. reticulatus* (Wight) Clarke, Comp. Ind. 199, 1876 (non DC. 1837). *S. grahamii* Hook. f. Fl. Brit. Ind. 3 : 347, 1881 (non Benth. 1857).

Senecio bhutanicus Balak. nom. nov. *Prenanthes quinqueloba* DC. Prodr. 6 : 404, 1838. *S. quinquelobus* (DC.) Hook. f. & Thoms. in Clarke, Comp. Ind. 209, 1876 (non DC. 1837); Hook. f. Fl. Brit. Ind. 3 : 353, 1881.

Senecio connatus Balak. nom. nov. *Ligularia arnicoides* DC. Prodr. 6 : 314, 1837. *S. arnicoides* (DC.) Clarke, Comp. Ind. 207, 1876 (non Hook. & Arn. 1841); Hook. f. Fl. Brit. Ind. 3 : 351, 1881.

Senecio flexuosus Balak. nom. nov. *S. calthaefolius* Hook. f. Fl. Brit. Ind. 3 : 350, 1881 (non Maximov 1871).

Senecio kashmirianus Balak. nom. nov. *S. pedunculatus* Edgew. in Trans. Linn. Soc. 21 : 74, 1846 (non Sch.-Bip. 1844); Hook f. Fl. Brit. Ind. 3 : 342, 1881.

Senecio khasianus Balak. nom. nov. *S. obtusatus* DC. Prodr. 6: 367, 1838 (non Pursh. 1814); Hook. f. Fl. Brit. Ind. 3 : 340, 1881.

Senecio multiceps Balak. nom. nov. *Doronicum arnottii* DC. in Wight, Contr. Bot. 23, 1834; DC. Prodr. 6 : 322, 1838 (non *S. arnottii* Hook. f. 1844). *Madaractis polycephala* DC. Prodr. 6 : 440, 1838. *S. polycephalus* (DC.) Clarke, Comp. Ind. 197, 1876 (non Ledeb. 1830); Hook. f. Fl. Brit. Ind. 3 : 344, 1881.

Senecio stylosus Balak. nom. nov. *Gynura walkeri* Wight, Ic. Pl. Ind. Or. t. 1122, 1846. *S. walkeri* (Wight) Thwaites, Enum. Pl. Zeyl. 167, 1860 (non Arnott 1836). *Notonia walkeri* (Wight) Clarke, Comp. Ind. 176, 1876; Hook. f. Fl. Brit. Ind. 3 : 337, 1881.

Jacobsen (Handb. Sukkulent Pflanzen. 2: 1026, 1954) reduced *Notonia* to *Senecio* on the basis that the succulent nature is common to both genera and that the ovate style tips of *Notonia* as compared to the truncate nature in *Senecio* can hardly be relied upon for generic distinction.

Vernonia ceylanica Balak. nom. nov. *V. scariosa* Arn. in Nov. Act. Nat. Cur. 18 : 346, 1836 (non Poiret 1808); Hook. f. Fl. Brit. Ind. 3: 236, 1881. *Decaneuron scariosum* DC. Prodr. 7 : 264, 1838. *Centratherum scariosum* Clarke, Comp. Ind. 4, 1876.

PRIMULACEAE

Androsace dubyii (Dergnac) Balak. comb. nov. *A. primuloides* Duby in DC. Prodr. 8 : 51, 1844 (non Moench. 1802; nec D. Don. 1825); Pax & Knuth in Engler, Pflanzenr. 22 : 183, 1905. *A. sarmentosa* var. *primuloides* (Duby) Hook. f. in Curtis, Bot. Mag. t. 6210, 1876 et in Fl. Brit. Ind. 3 : 498, 1882. *A. sarmentosa* var. *dubyii* Dergnac in Kneucker, Allg. bot. Zeitsch. 10 : 110, 1904.

Lysimachia knuthiana Balak. nom. nov. *L. glandulosa* Knuth in Engler, Pflanzenr. 22 : 264, 1905 (non Edgew. 1846).

Lysimachia muelleri Balak. nom. nov. *L. salicifolia* F. v. Muell. ex Benth. Fl. Austral. 4 : 269, 1868 (non Miller 1772); Pax & Knuth in Engler, Pflanzenr. 22 : 305, 1905.

Primula asperulata Balak. nom. nov. *P. incisa* Franch. in Bull. Soc. Bot. France 33 : 69, 1886 (non Lamk. 1778); Pax & Knuth, l.c. 66.

Primula flaccida Balak. nom. nov. *P. nutans* Delavay ex Franch. Bull. Soc. Bot. France 33: 69, 1886 (non Georgi 1797); Pax & Knuth, l.c. 94.

Primula klattii Balak. nom. nov. *P. uniflora* Klatt in Linnaea 37: 500, 1872 (non Gmelin 1805); Hook. f. Fl. Brit. Ind. 3: 492, 1882.

Primula roxburghii Balak. nom. nov. *P. rotundifolia* Roxb. Fl. Ind. ed. 2, 2: 18, 1824 (non Pallas 1776); Hook. f. Fl. Brit. Ind. 3: 483, 1882.

Primula rugosa Balak. nom. nov. *Carolinella obovata* Hemsl. in Hook. Icon. Pl. t. 2775, 1903. *P. obovata* (Hemsl.) Pax in Engler, Pflanzenr. 24: 47, 1905 (non Duby 1844; nec Huter 1873).

BORAGINACEAE

Paracaryum uncinatum (Benth.) Balak. comb. nov. *Cynoglossum uncinatum* Benth. in Royle, Illus. 305, 1836. *C. laxum* G. Don, Gen. Syst. 4: 356, 1838. *C. roylei* Wall. ex DC. Prodr. 10: 155, 1846. *Echinoglossum glochidiatum* DC. Prodr. 10: 136, 1846. *Paracaryum glochidiatum* (DC.) Benth. in Benth. & Hook. f. Gen. Pl. 2: 850, 1876; Clarke in Hook. f. Fl. Brit. Ind. 4: 161, 1883.

ACANTHACEAE

Eranthemum L. Sp. Pl. 9, 1753. *Daedalacanthus* T. Anders. in Thw. Enum. Pl. Zeyl. 229, 1864; Clarke in Hook. f. Fl. Brit. Ind. 4: 417, 1884.

Daedalacanthus T. Anders. is strictly synonymous to *Eranthemum* L. as the type species of the former, *D. montanum* T. Anders. is synonymous to the type species of the latter, *E. capense* L.

Eranthemum burmanicum Balak. nom. nov. *Daedalacanthus parishii* Clarke in Hook. f. Fl. Brit. Ind. 4: 421, 1884 (non *E. parishii* Clarke 1884).

Eranthemum macrostachys (T. Anders.) Balak. comb. nov. *Daedalacanthus macrostachys* T. Anders. in J. Linn. Soc. 9: 488, 1867; Clarke in Hook. f. Fl. Brit. Ind. 4: 420, 1884.

Eranthemum pulchellum Andr. Bot. Repos. 2: t. 88, 1800 (non Roxb. 1832). *Justicia nervosa* Vahl, Enum. 1: 164, 1804. *E. nervosum* (Vahl) R. Br. Prodr. 1: 477, 1810; Santapau in Univ. Bombay, Bot. Mem. 2: 35, 1952. *Daedalacanthus nervosus* (Vahl) T. Anders. in J. Linn. Soc. 9: 487, 1867; Clarke in Hook. f. Fl. Brit. Ind. 4: 418, 1884.

Eranthemum wardii (W. W. Smith) Balak. comb. nov. *Daedalacanthus wardii* W. W. Smith in notes R. Bot. Gard. Edinb. 10: 174, 1918.

Synnema Benth. in DC. Prodr. 10: 538, 1846. *Cardanthera* Buch.-Ham. (ex Voigt, Hort. Sub. Calc. 482, 1845, nom. nud.) ex Nees in DC. Prodr. 11: 67, 1847; Clarke in Hook. f. Fl. Brit. Ind. 4: 403, 1884. *Adenosma* Wall. Pl. As. Rar. 3: 75, 1832 (non R. Br. 1810).

The generic name *Cardanthera* taken by Voigt from a manuscript name of Buchanan-Hamilton was not validly published by Voigt in 1845 as such his note does not fulfil any of the conditions set by article 41 of the Code. The genus was validated only in 1847 by Nees von Esenbeck. However, by this time *Cardanthera* Buch.-Ham. ex Nees became antedated by *Synnema* Benth. (1846) and the latter name should be adopted as the correct name.

Recently Raizada (in Indian For. 94: 451, 1968) published notes on this change in generic name. It seems necessary to point out that some of the species names listed by him are in neuter gender, while others are in feminine gender. *Synnema* is a Greek compound word (*syn:* with, together; *-nema:* thread) in the neuter gender and Bentham (1846) attributed the same gender to his genus, as obvious from the ending of the specific epithet of the type species, *S. avanum.* According to article 23, the specific epithet when adjectival in form and not used as substantive should agree gramatically with the generic name. Hence all adjectival specific epithets belonging to *Synnema* should be in neuter gender, ending in-*um.* It may also be pointed out that Greek adjectives used as specific epithets show a disconcerting array of nominative endings and hence it is usual practice to give them the Latin endings,—*a* (f.), — *us* (m.) and *um*—(n.).

The following are the correct names of Indian species of *Synnema:*

Synnema anomalum (Blatter) Raizada in Indian For. 94: 451, 1968. *Cardanthera anomala* Blatter in J. As. Soc. Beng. 26: 350, 1930.

Cardanthera anomala Blatter described from Bombay differs from all species of *Synnema* in having only one fertile stamen with one staminode and just 10—12 seeds supported on curved retinacula, whereas *Synnema* is characterised by 4 fertile stamens and many seeds on straight retinacula. The type specimens, *Hallberg* 9766 and 9767 were collected from Vihar Lake, Salsette Island and Tardeo in Bombay. Santapau (Univ. Bombay, Bot. Mem. 2: 14, 1951) states that none of these specimens are present in Blatter Herbarium. As authentic material of this species is not available, it is not possible to decide now, whether it belongs to *Synnema* or another genus.

Synnema balsamicum (L. f.) O. Ktze in Rev. Gen. Pl. 2: 500, 1891. *Ruellia balsamica* L. f. Suppl. 289, 1781. *Adenosma balsamea* Spreng. Syst. 2: 829, 1825. *Cardanthera balsamica* (L. f.) Clarke in Hook. f. Fl. Brit. Ind. 4: 404, 1884. *S. barbigera* O. Ktze, l.c. 500; Raizada, l.c. 451.

Synnema balsamicum (L. f.) O. Ktze var. **thymus** (Nees) Balak. comb. nov. *Adenosma thymus* Nees in Wall. Pl. As. Rar. 3: 79, 1832. *Cardanthera balsamica* (L. f.) Benth. var. *thymus* (Nees) Clarke in Hook. f. Fl. Brit. Ind. 4: 404, 1884.

Synnema biplicatum (Nees) Imlay in Kew Bull. 1939: 111, 1939. *Adenosma biplicata* Nees in Wall. Pl. As. Rar. 3: 79, 1832, *Pedicularis avana* Wall. ex Benth. Scroph. Ind. 52, 1835. *Synnema avanum* Benth. in DC. Prodr. 10: 538, 1846; Raizada, l.c. 451. *Cardanthera avana* Benth. ex Clarke in Hook. f. Fl. Brit. Ind. 4: 405, 1884. *Synnema avanum* Benth. var. *biplicatum* (Nees) O. Ktze, Rev. Gen. Pl. 2: 500, 1891.

Synnema griffithii (T. Anders.) O. Ktze, Rev. Gen. Pl. 2: 500, 1891. *Adenosma griffithii* T. Anders in J. Linn. Soc. 11: 454, 1870. *Cardanthera griffithii* Clarke in Hook. f. Fl. Brit. Ind. 4: 404, 1884.

Synnema pinnatifidum (Dalz.) O. Ktze, Rev. Gen. Pl. 2: 500, 1891. *Nomaphila pinnatifida* Dalz. in Kew J. Bot. 3: 38, 1851. *Adenosma pinnatifidum* (Dalz.) T. Anders. in J. Linn. Soc. 9: 455, 1867. *Cardanthera pinnatifida* (Dalz.) Clarke in Hook. f. Fl. Brit. Ind. 4: 405, 1884.

Synnema triflorum (Roxb.) O. Ktze, Rev. Gen. Pl. 2: 500, 1891. *Ruellia triflora* Roxb. (Hort. Beng. 46, 1814, *n.n.*) Fl. Ind. 3: 52, 1832. *Adenosma triflora* Nees in Wall. Pl. As. Rar. 3: 79, 1832. *Cardanthera triflora* (Roxb.) Clarke in Hook. f. Fl. Brit. Ind. 4: 405, 1884.

The combination, *Cardanthera difformis* (L. f.) Druce in Rep. Bot. Exch. Cl. Brit. Isles 1916, Suppl. 2: 612, 1917 based on *Ruellia difformis* L. f., made for this species is not correct as it is not a *Synnema* at all. The description and the synonym, '*Nir—Schulli*' Rheede (Hort. Malab. 2: 89, t. 46, 1679) given by Linnaeus f. indicate this to be *Hygrophila erecta* (Burm. f.) Hochr. and not *Synnema triflorum.*

Synnema uliginosum (L. f.) O. Ktze, Rev. Gen. Pl. 2: 500, 1891. *Ruellia uliginosa* L. f. Suppl. 290, 1781. *Adenosma uliginosa* (L. f.) R. Br. in Verm. Schrift. 3:298 1867. *Cardanthera uliginosa* Clarke in Hook. f. Fl. Brit. Ind. 4: 403, 1884.

Synnema verticillatum (Nees) O. Ktze, Rev. Gen. Pl. 2: 500, 1891. *Adenosma verticillata* Nees in Wall. Pl. As. Rar. 3 : 79, 1832. *Cardanthera verticillata* (Nees) Clarke in Hook. f. Fl. Brit. Ind. 4: 404, 1884.

NEPENTHACEAE

Nepenthes chapmannii Balak. nom. nov. *N. zeylanica* Chapm. in Ceylon J. Sci. Sect. A, Bot. 12: 221, 1947 (non Rafinesque 1836).

ORCHIDACEAE

Bulbophyllum devangiriensis Balak. nom. nov. *B. uniflorum* Griff. Notul. 3. 293, 1851 (non Hassk. 1844); Hook f. Fl. Brit. Ind. 5: 755, 1890. *Sarcopodium uniflorum* (Griff.) Lindl. Fol. Orch. 16, 1853.

Bulbophyllum guttulatum (Hook. f.) Balak. comb. nov. *Cirrhopetalum guttulatum* Hook. f. Fl. Brit. Ind.5: 776, 1890. *Bulbophyllum umbellatum* Lindl. in Edw. Bot. Reg. 30: t. 44, 1844 (non Lindley 1830).

Chiloschista Lindl. Fischer (in Gamble, Fl. Pres. Madras 1440, 1928) gives the spelling of this genus as *Chilochista*, but the original spelling given by Lindley is *Chiloschista.*

Additional knowledge on the morphology of the genus *Sarcochilus* (*sensu* Hook. f. Fl. Brit. Ind. 6: 33, 1890) indicates this genus to be heterogenous composed of at least four distinct genera, *Chiloschista, Micropera, Thrixspermum* and *Sarcochilus* (*sensu stricto*). Most recent authors including Pfitzer (in Engler & Prantl, Pflanzenfam. 2(6): 216, 1889), J. J. Smith (in Fl. Buitenz. 6: 533, 1905 et in Fedde, Repert. 32: 350, 1933) and Santapau & Kapadia (Orch. Bombay 209, 1966) have accepted and followed this division.

Chiloschista minimifolia (Hook. f.) Balak. comb. nov. *Sarcochilus minimifolius* Hook. f. Fl. Brit. Ind. 6: 37, 1890.

Dendrobium perpusillum Balak. nom. nov. *D. pumilum* Roxb. Fl. Ind. 3: 479, 1832 (non Swartz 1805); Hook. f. Fl. Brit. Ind. 5: 713, 1890.

Dendrobium wightii Balak. nom. nov. *D. graminifolium* Wight, Ic. Pl. Ind. Or. t. 1649, 1851 (non Willd. 1805); Hook. f. Fl. Brit. Ind. 5: 718, 1890.

Eulophia dabia (D. Don) Balak. comb. nov. *Bletia dabia* D. Don, Prodr. Fl. Nep. 30, 1825. *Limodorum ramentaceum* Roxb. Fl. Ind. 3: 467, 1832. *E. campestris* Lindl. Gen. Sp. Orch. 185, 1833; Hook. f. Fl. Brit. Ind. 6: 4, 1890. *E. ramentacea* (Roxb.) Lindl. Gen. Sp. Orch. 185, 1833.

Micropera rostratum (Roxb.) Balak. comb. nov. *Aerides rostratum* Roxb. Fl. Ind. 3: 474, 1832. *Camarotis purpurea* Lindl. Gen. Sp. Orch. 219, 1833. *Sarcochilus purpureus* (Lindl.) Benth. ex Hook. f. Fl. Brit. Ind. 6: 36, 1890.

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The Behaviour of the Lesser Bandicoot Rat, *Bandicota bengalensis* (Gray & Hardwicke)

BY

DWAIN W. PARRACK AND JACOB THOMAS

(*With eleven text-figures*)

A study of the behaviour of 4 adult Lesser Bandicoot Rats, *Bandicota bengalensis*, was conducted by observing their activity for 50 minutes per hour, 24 hours per day for 28 days. The animals were studied in a pen in which they could burrow freely. The amount of food removed from the food containers was measured and the amount of food hoarded was calculated. Measurements were also made of the amount of time spent above ground, the number of trips to the food platform, the timing of activity, and the number and types of social interactions.

INTRODUCTION

The lesser bandicoot rat, *Bandicota bengalensis*, is distributed throughout most of India, East Pakistan, and parts of Burma (Biswas & Tiwari; in press) and occupies both rural and urban environments. In rural areas it is an agricultural pest, burrowing into bunds separating farm plots and attacking standing crops. In cities this animal destroys large amounts of stored food and seems to be replacing *Rattus rattus* as the main urban rat. Records from the Plague Control Laboratory in Calcutta show that between 1936 and 1965, *B. bengalensis* increased from about 27 per cent to about 90 per cent of the rats captured in Calcutta and Howrah (Seal & Banerji; in press). This displacement of *R. rattus* represents a potential health hazard, as *B. bengalensis* has been reported to be more susceptible to the plague bacillus than *R. rattus* (Nimbkar & Deoras; in press).

The success of this species in replacing *R. rattus* is coupled with its high reproductive capacity. Southwick (in press) has compared the reproductive patterns of several murid rodents and using Spillett's study of the bandicoots of warehouses in Calcutta and Howrah, showed an annual production of 69.6 young per year per female in *B. bengalensis*, as compared with 35.7 for *R. norvegicus* and 31.3 for *R. rattus*. Spillett (1968) in his warehouse studies found that the average population density for all 12 months of the year was .77 rats/square metre of warehouse floor space. However, the captures greatly decreased during the rainy months of July and August and when these two months are excluded, the average density jumps to 8.5 rats/square metre of floor space (personal communication).

There are few estimates of the amount of food lost to this bandicoot; Deoras (1966) and Spillett (1968) reported on the daily consumption of caged animals. Patnaik (in press) has reviewed the estimates of daily consumptions for Indian rats in general and reports estimates of 20, 25, 30 and 60 g./day, but it is not possible to know if any of these figures are for *B. bengalensis*, or if they represent hoarding as well as actual consumption. Pingale *et al.* have gathered somewhat more detailed information for several species of murid rodents.

Little is known of the behaviour of this species. Deoras (1967) has gathered information about their burrows, and Parrack (1966) reported on the activity cycle of animals in activity cages, but almost nothing is known of other aspects of the behaviour of this animal.

As Kavanau (1967) and others have pointed out, the relatively sterile environment to which captive animals are often submitted tends to distort their behaviour. Zoo animals, for instance, often develop highly stereotyped behaviour which is completely foreign to their behaviour in the wild. To avoid the distortion of the behaviour of the bandicoots used in these studies, we have used a pen which, because of its dirt floor, allows for burrowing (apparently a strong psychological " need " in these animals) and which allows considerable freedom for running about. Six groups of bandicoots, usually 4 adults (2 males and 2 females) have been studied. The number of periods of observation (50 minutes) varied from 6 to 24 in a 24 hour period. The present study, using 24 periods/day, is intended as a base-line for other studies.

Materials and Methods

Two adult males (No. 33, weighing 245.8 gm.; No. 34, 211.4 gm.) and two adult females (No. 35, 190.0 gm.; No. 36, 165.5 gm.) were used in this study. All 4 animals had been trapped in a grain warehouse in Calcutta and housed in individual cages for 3 days before the study began. The animals were individually marked by clipping the hair in different parts of the body. All were apparently healthy and neither of the females showed signs of pregnancy. The animals were introduced into the study pen simultaneously in order to avoid the effects of prior occupancy. Detailed recording of the behaviour was begun at 17.00 hours, a few hours after introduction.

The pen was constructed of bricks, mortar, and plaster and measured 4 by 6 m. (fig. 1). The walls were sunk 2 feet beneath the surface of the surrounding ground and 3 feet of additional dirt was put into the pen, thus reducing the chances of the animals digging out. The floor of the pen was laid off in 24, 1-metre squares with rows of half-buried bricks. and the squares were identified by combinations of letters and numbers,

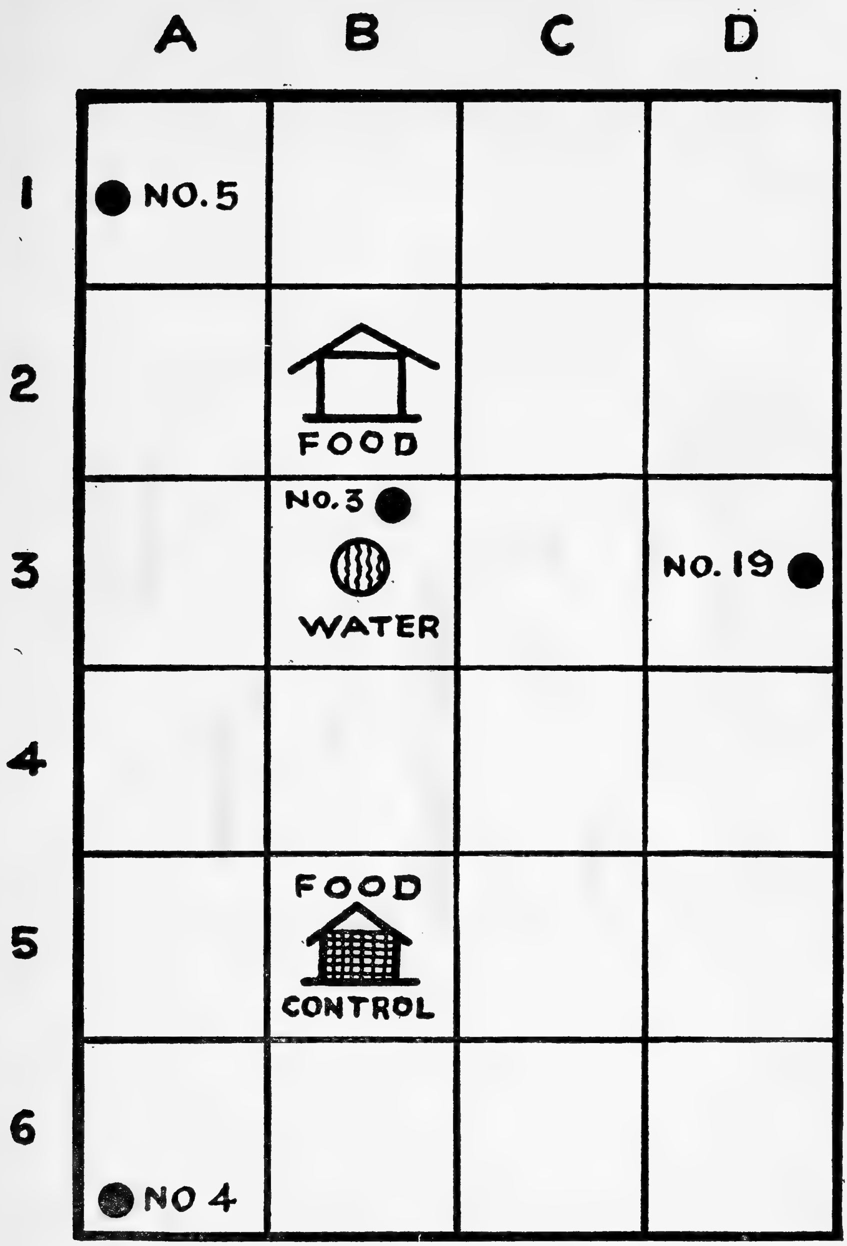


Fig. 1.

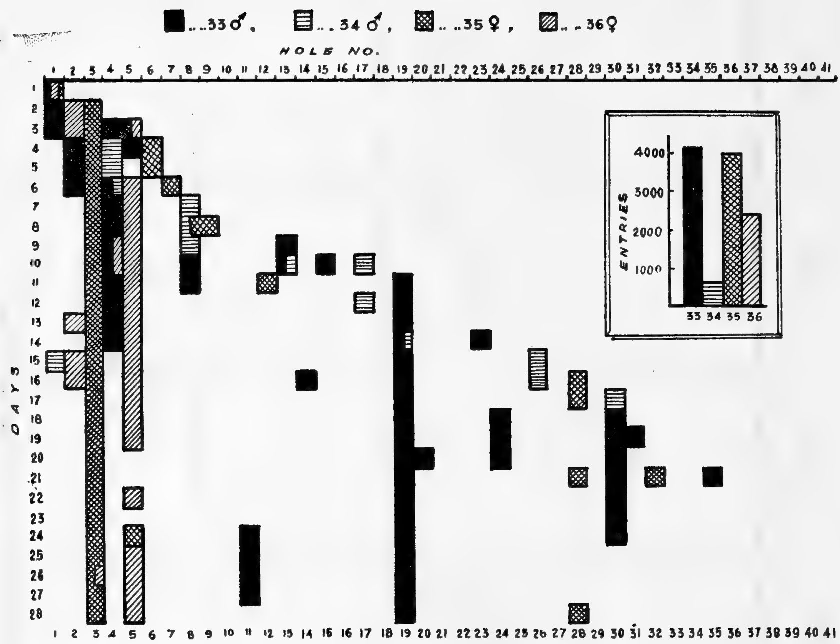


Fig. 2

The pen was roofed with wire mesh to prevent the entry of birds and predators. At night the pen was lighted with 4, 60-watt, clear light bulbs. A covered feeding platform was placed in square B-2 which had been bricked-in to prevent holes being dug directly beneath the platform. A large mirror was hung on the wall behind the feeding platform so that the observers could see the animals which were hidden by the platform. A water dish was placed in square B-3 and in square B-4 there were caged food dishes (inaccessible to the rats) which were used as controls for changes in the weight of food due to relative humidity. Each burrow was marked with a stake bearing a number.

Supplies of rice, wheat, and dal (*Lens culinaris*) were put into the food dishes and weighed at 17.00 hours and at 06.00 hours each day.

The observational " day " began at 18.00 hours and ended 24 hours later. In the present study observations were made 50 minutes/hour, 24 hours/day for 28 days. The study was conducted during the winter (13 January to 10 February, 1968) during which time there was almost no rain and the average daily maximum and minimum temperatures were 78.8°F and 58.0°F respectively.

Observations were made from a shed at one end of the pen, one observer recording the activity of one male and one female, a second observer recording the behaviour of the other 2 animals. The observers " traded " rats several times per day and the working hours of the observers were shifted to prevent individual bias in recording.

Collective food consumption was recorded twice per day and the following data were recorded for each rat: number of squares entered, number of trips to food and water, number of entries into and exits from each burrow, time above ground, time spent in digging and grooming, and the number and type of social interactions. The data were transferred to punched cards and tabulated on an IBM 407 tabulator.

Results and Discussion

Social Rank

In this study, as well as in others yet to be completely analysed, the animals began a series of fights within 5 minutes after being introduced into the pen. The fighting often was associated with the digging of holes. One animal would begin digging only to have another attempt to displace him, or her, from the hole. Within 15 or 20 minutes the dominant animal was identifiable by the observers because of his aggressiveness and the number of times the others moved away from him.

The larger male, No. 33, very quickly established himself as the dominant and the smaller male, No. 34, was clearly the subordinate. Aspects of the dominance and subordinance of the males will be considered later. It is difficult to assign a rank to the females, as they had much less social interaction than male. The fact that 35 ♀ outweighed 36 ♀ by almost 25 g. suggests that she had a physical advantage over the latter. Further, she occupied the most favourable hole (under the food platform) and visited the food more often than did 36 ♀. Also, she was much more inclined to fight, initiating some 15 fights (as compared to 17 initiated by 33♂ and 1 by 36). Her weight, the location of her burrow, the number of her visits to food, and her aggressiveness might be indications that she out-ranked the other female.

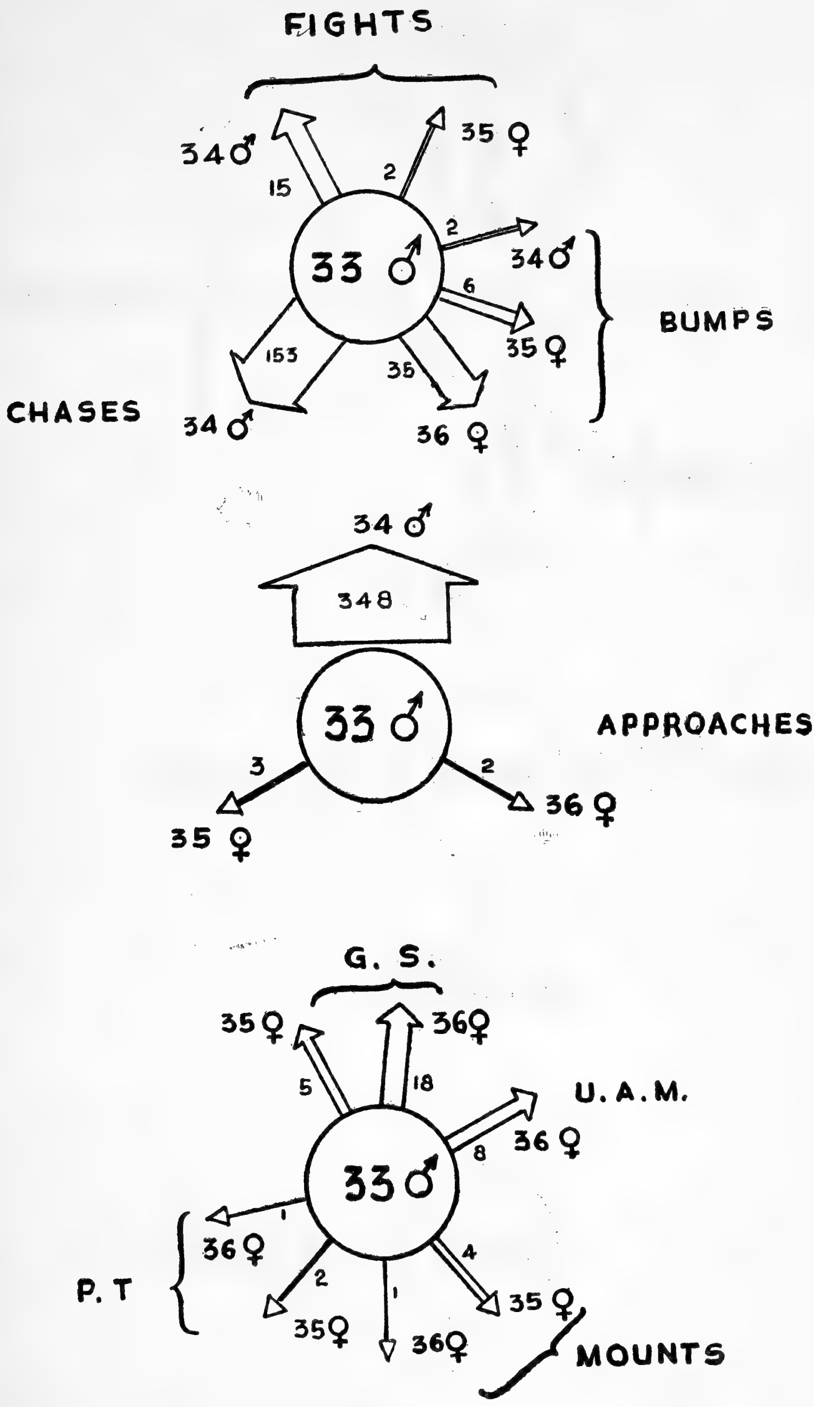
Barnett (1958) distinguished three ranks of males in laboratory colonies of wild *Rattus norvegicus:* (1) "alpha" males, which were larger than the others, were aggressive, displayed no hesitation in moving in the cage, and always gained weight; (2) "beta" males, which ranked below the "alpha" but above the "omegas," had been defeated by the "alphas" in combat but did not develop "shock" and always gained weight; (3) "omega" males, which were continuously persecuted, moved about more slowly, had poor condition of the fur, lost weight, and often died of "shock."

In the present study the two males showed mixtures of characteristics of all three ranks. The dominant male (33) was like Barnett's "alphas" in that he was larger, more aggressive, and moved freely about the pen. However, he lost weight (20.3 gm.). The subordinate male (34) resembled Barnett's "omegas" in being continuously harassed by the dominant, moving more slowly (Table 2) and in losing weight (15.4 gm.). However, the fact that he survived the 28 days of persecution would seem to classify him as a "beta".

Food Consumption

The animals used in this study almost always emptied the food dishes after each of the two daily fillings. The food supply, therefore, was not unlimited, but it was more than adequate, since excavation of the burrows at the end of the study revealed a considerable amount of rotting food. During the 28 days of the study, a total of 4,398 gm. of food was removed, a daily average of 162.9 gm. of 40.7/gm./rat/day. These figures lie somewhere between the minimal requirements and the amount they would remove given an unlimited supply.

Grain warehouses often have, what to the rats, are limitless supplies of food. In a study of 8 penned bandicoots Parrack (in press) found


FIGHTS
34♂
15
2
35♀
2
33♂
34♂
6
35♀
BUMPS
153
35
CHASES
34♂
36♀
34♂
348
33♂
APPROACHES
3
2
35♀
36♀
G. S.
35♀
36♀
5
18
U. A. M.
36♀
8
33♂
1
36♀
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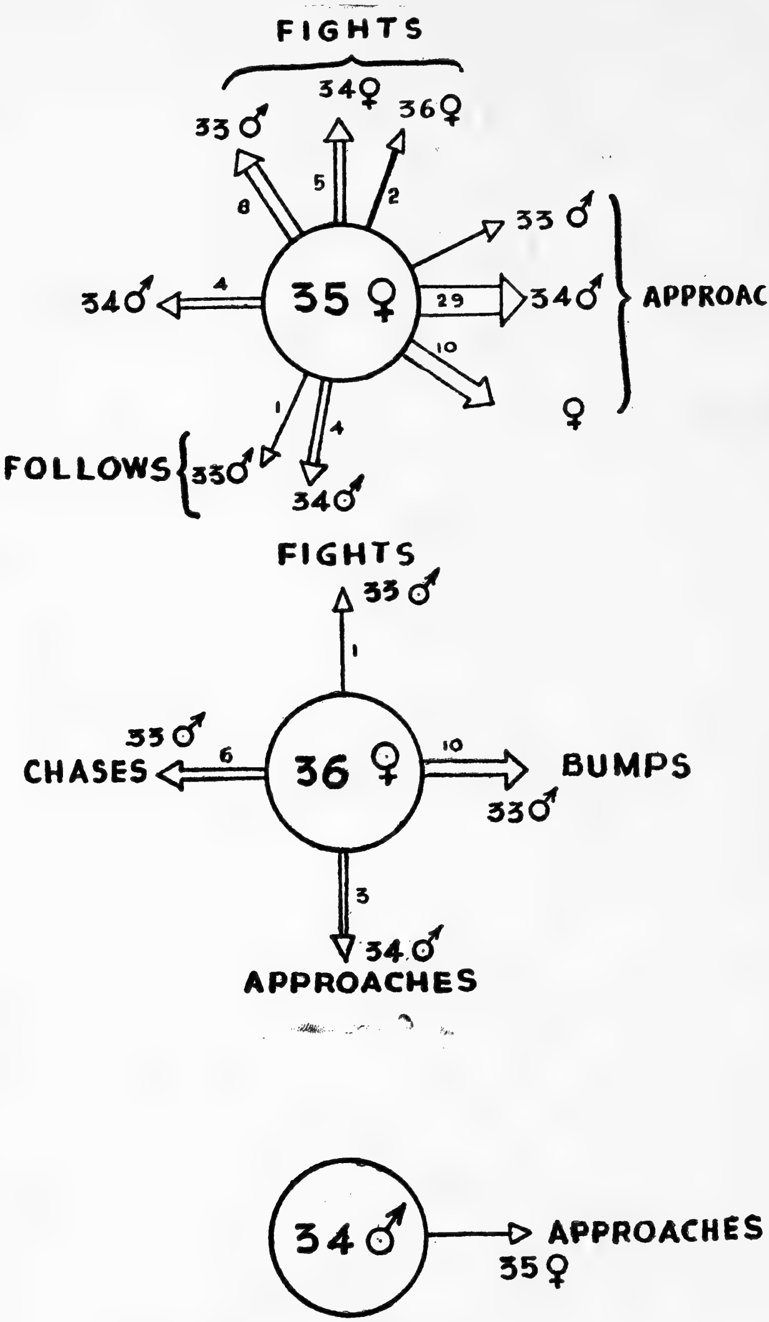
P. T
2
1
35♀
35♀
36♀
MOUNTS

Fig. 3.


FIGHTS
33♂
34♀
36♀
8
5
2
33♂
35♀
4
34♂
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34♂
APPROACHES
10
♀
1
4
FOLLOWS
33♂
34♂
FIGHTS
33♂
1
33♂
CHASES
6
36♀
10
BUMPS
33♂
3
34♂
APPROACHES
34♂
APPROACHES
35♀

Fig. 4

that given an unlimited supply the rats removed a daily average of 67.4 gm./rat and calculated that this amount was about 5 times the amount actually consumed.

Deoras (1967) reported a daily consumption of 12.8 gm./rat/day and Spillett (1968) reported about 11 gm./rat/day. These figures are for the amount actually eaten and do not include hoarding. Our own studies (in press) of adults in individual cages which allowed no hoarding showed an average consumption of 14.9 gm./rat/day (34 rats; $\bar{x}$ body wt. =216.7 gm.). The discrepancies in these three reports are probably due to individual variations in the physiology of the rats, the body size of the rats, the season of the year, and the duration of captivity.

If the average of the three reports (12.9 gm. rat/day) is taken to be fairly reliable estimate of actual food consumption, the animals in the present study were probably consuming 32 per cent and hoarding 68 per cent of the total amount removed from the food containers.

General Comparison of Individuals

During the course of the study the males lost weight and the females gained. Table 2 summarizes several types of activity for the entire study period. In most of these activities there is a strong difference between the sexes. In terms of the total number of squares entered, the males were much more active than the females, with the dominant male (No. 33) entering almost 7 times as many squares as the least active female. The number of squares entered is also associated with the initial weight of the animals, the heaviest animal (33♂) being the most active, the lightest (36♀), the least active.

TABLE 1

CHANGES IN BODY WEIGHT DURING THE 28 DAYS OF THE STUDY

Rat No.	Initial wt. (gm.)	Final wt. (gm.)	Change (gm.)
33♂	245.8	225.5	— 20.3
34♂	211.4	196.0	— 15.4
35♀	190.0	229.5	+ 39.5
36♀	165.5	195.3	+ 29.8
Overall average body wt.=207.4 gm.			

The subordinate male spent more than twice as much time above ground than did the dominant male. It seems likely that he was prevented from entering the burrows by the dominant. Not only did the subordinate male spend more time above ground, he moved about less rapidly than the other 3 animals, entering only 1.7 squares/minute above ground, as compared with 5.4 for the dominant and 7.6 for 35 ♀. Female 35 and the dominant male made frequent trips to the food platform (both more than 3000 times), while 34 ♂ and 36 ♀ went much less often. The subordinate male did much more wandering per trip to food (21.6 squares/trip) than did the others. The 2 females had taken up residence in burrows near the food platform and confined most of their movement to food gathering, hence they entered only 2.2 (35 ♀) and 3.1 (36 ♀) squares per trip. Female 35, who occupied a hole under the food platform, visited the food dishes on an average of every 17 seconds (.3 min./trip) when she was above ground, while female 36, occupying a hole slightly further away, returned to the platform every 38 seconds (.6 min./trip). The subordinate male returned to platform on an average of every 12.5 minutes in contrast to the dominant male who returned after average intervalsof 1.6 minutes.

Grooming : Neither of the females was observed grooming. Male 33 groomed for a total of 9 minutes and male 34 for 20 minutes. Grooming as a displacement activity has been reported for several rodents and Barnett (1958) describes it in *R. rattus.* Displacement activities occur when the expression of a drive is blocked or frustrated. That the males, rather than the females, groomed in this study and that the subordinate male groomed much more than the dominant, suggests that at least some of the grooming observed here was a displacement.

Digging : The amount of time of observed digging was not related to sex or rank. It is known that most, if not all, of the burrows were interconnected, and as the burrows were extensive, much of the digging must have been done when the animals were invisible to the observers.

Trips to water : The timing of the trips to the water container reflected the general pattern of activity, that is, during those hours when the animals entered many squares, there was an increase in the number of trips to water. Most of the trips fell between 18.00-24.00 hours and 06.00-09.00 hours, the times in which the food platform was visited more frequently. There was, however, no correlation between the daily total of squares entered and the daily total of trips to water.

Diurnal activity : Although bandicoots are generally nocturnal, they, like *R. norvegicus* (Calhoun 1962), will become active during the day time under undisturbed conditions. Of the total time spent above ground by all 4 animals about 35 per cent was during the day time and about 48 per cent of the trips to the food platform took place during the day-light hours.

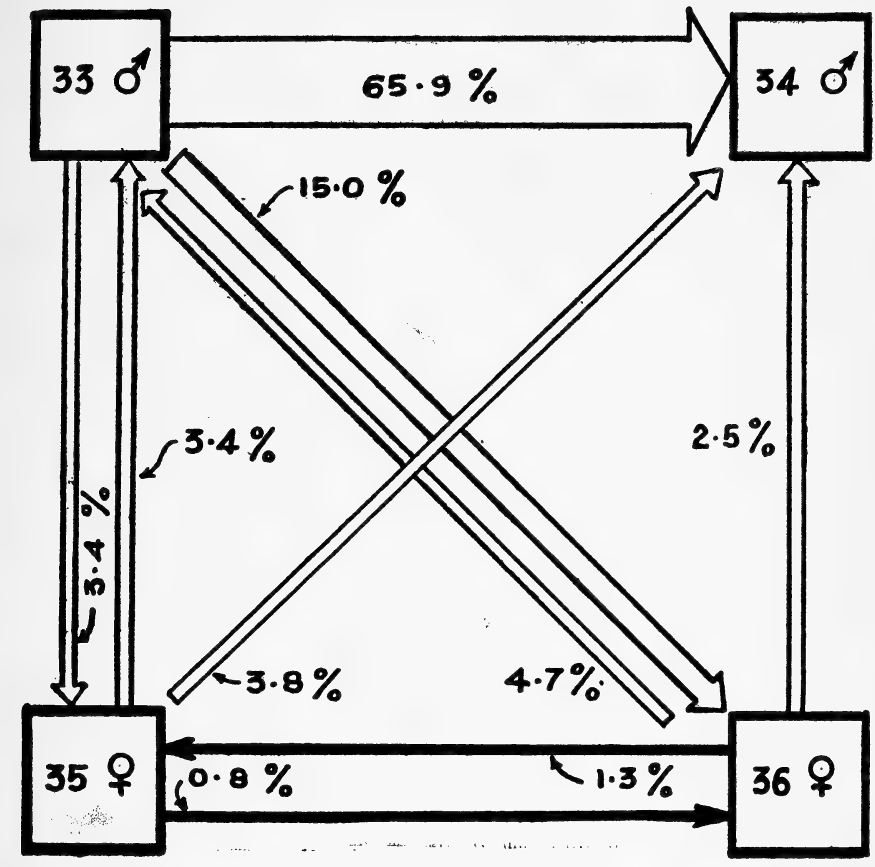
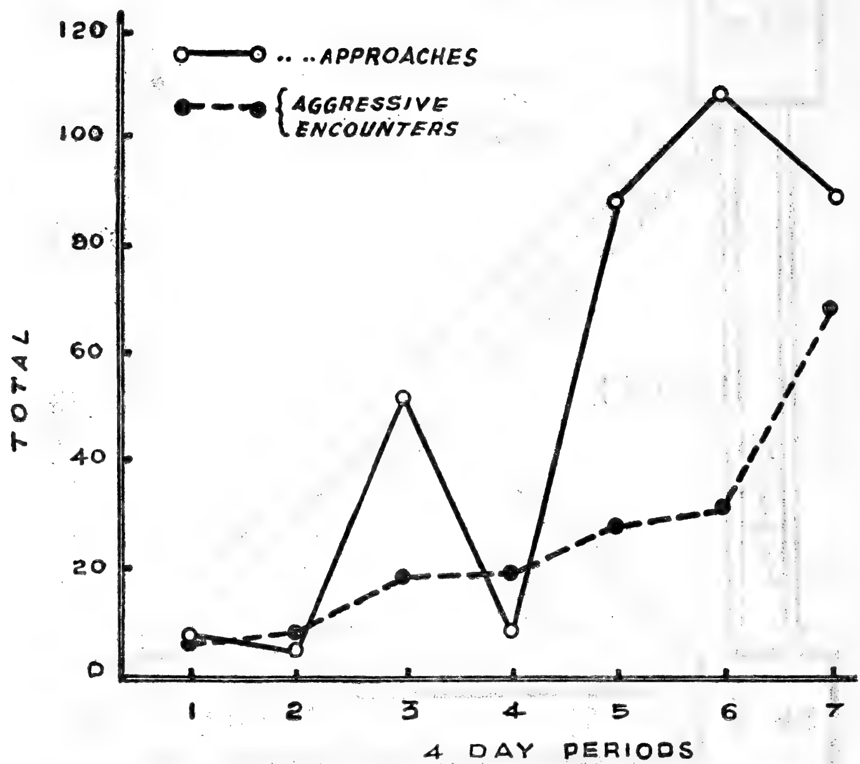


Fig. 5



APPROACHES
AGGRESSIVE ENCOUNTERS
120
100
80
60
40
20
0
TOTAL
1
2
3
4
5
6
7
4 DAY PERIODS

Fig. 6

Use of Burrows

Forty-one holes were dug by the rats during the 28 days of the study. The usage of these holes (as indicated by the number of times the animals entered or left them) was far from uniform. No entries were recorded for 2 of the holes after they had been dug. On the other hand, some of the holes were entered well over a thousand times. Fig. 2 gives a history of the occupancy of the holes which has been simplified by considering only those holes which were entered 10 or more times in a day by an individual rat. The records of entries and exits were so nearly identical that only the entries will be considered.

The most striking characteristic illustrated by fig. 2 is that the females tend to settle down very quickly to occupying one hole, while the males are more inclined to change burrows. On day 2, female 35 began frequenting hole No. 3 (under the food platform, fig. 1) which she occupied throughout the remainder of the study. In the 26 days of her occupancy she made a total of 3,983 entries of which 3,310 (83 per cent) were into that hole. The other female (36) established herself in hole No. 5 on day 6 and used it as a residence for the rest of the 28 days even though on days 19, 20, and 23 she was generally inactive and entered the hole less than 10 times. She was somewhat less active than 35 making a grand total of 2,348 entries; 1,943 (82 per cent) of which were into hole number 5. The dominant male occupied several holes. On day 6 he began frequenting No. 4 and deserted it on day 14. His second major hole was No. 19 which he occupied from day 11 through day 28. Twenty per cent of his 4,060 entries was to hole No. 4 and 44 per cent was to hole No. 19. Hole No. 30 was less often visited by him and accounted for only 5 per cent of his total entries. The subordinate male never established a permanent residence. His longest residence was for 3 days (hole No. 8) after which he was displaced by 33 ♂. He was likewise displaced from holes No. 4 and 30. The difference in the males' total number of entries is striking, with 4,060 for 33 ♂ and only 616 for 34 ♂ .

Social Interactions

The following social behaviour were recorded : fighting, chasing, bumping, genital sniffing, mounting, pelvic thrusting, and approaching and following. Chasing differed from following in that the former was slower than the latter. Approaching is defined as an interaction in which one animal comes toward another and in which no other type of interaction (fighting, mating, etc.) results. Bumping is used to describe the striking of one animal with the hip of another. The other terms are self-explanatory. No occasion of what Barnett (1958) called "amicable" behaviour in *R. rattus* were seen in this study.

Categorizing of most of these behaviours into headings such as Aggressive and Sexual is straight forward; Aggressive behaviour involving fighting and bumping and Sexual involving genital sniffing, mounting and pelvic thrusting. Some behaviours, however, are less easily categorized. Chasing, for instance, could conceivably be aggressive or sexual in motivation and it seemed logical to consider all chasing as aggressive except for the questionable case of a male chasing a female. As it turned out, there were no cases of a male chasing a female. Approaching, like chasing, could conceivably be of sexual or non-aggressive motive. However, it seems likely that most of the cases of approaching were aggressive. This will be discussed later.

In this analysis attention is focused on the number and type of interactions initiated (so far as the observers could determine) by the individual rat. The number of interactions initiated by each rat varied a great deal : 33 ♂ initiated a total of 597, while the next most active animal, 35 ♀, initiated only 66. Female 36 was still less active with 20 interactions, and the subordinate male throughout the 28 days of the study was seen initiating only one action, a single approach to 35 ♀.

Figures 3 and 4 summarize the interactions of the 4 animals. Of the 597 interactions of 33 ♂ the majority (81 per cent) were either chasing or approaching the subordinate male. It seems likely that approaching in this case was aggressive, since the timing of the approaches and of the clearly recognisable forms of aggression (fighting, chasing) were almost mutually exclusive (fig. 2). Incidents of clearly recognizable aggression by 33♂ against 34 ♂ tended to occur on a 24 hour cycle, in the morning between 06.00 and 09.00 hours when the subordinate male made most of his trips to the food. This is taken to mean that during most of the "day" 34♂'s trips to food could be intimidated by a mere approach by 33 ♂, but that when hunger drove him to the food platform, more violent forms of aggression resulted (figs. 9, 11).

Relatively little actual fighting occurred. Of the 33 fights recorded 17 were started by 33 ♂, 15 by 35 ♀, and 1 by 36 ♀. Twenty of the 33 fights involved 34 ♂ who, therefore, did somewhat more fighting than any of the other 3 animals. The females chased only the males, not each other, and 36 ♀ bumped 33 ♂ 10 times.

The subordinate male was not seen in any sexual activity. Similar observations were made by Calhoun (1962) on penned Norway rats (*R. norvegicus*) in which some low ranking males showed no sexual behaviour and in which highly dominant males sometimes held territories containing several females.

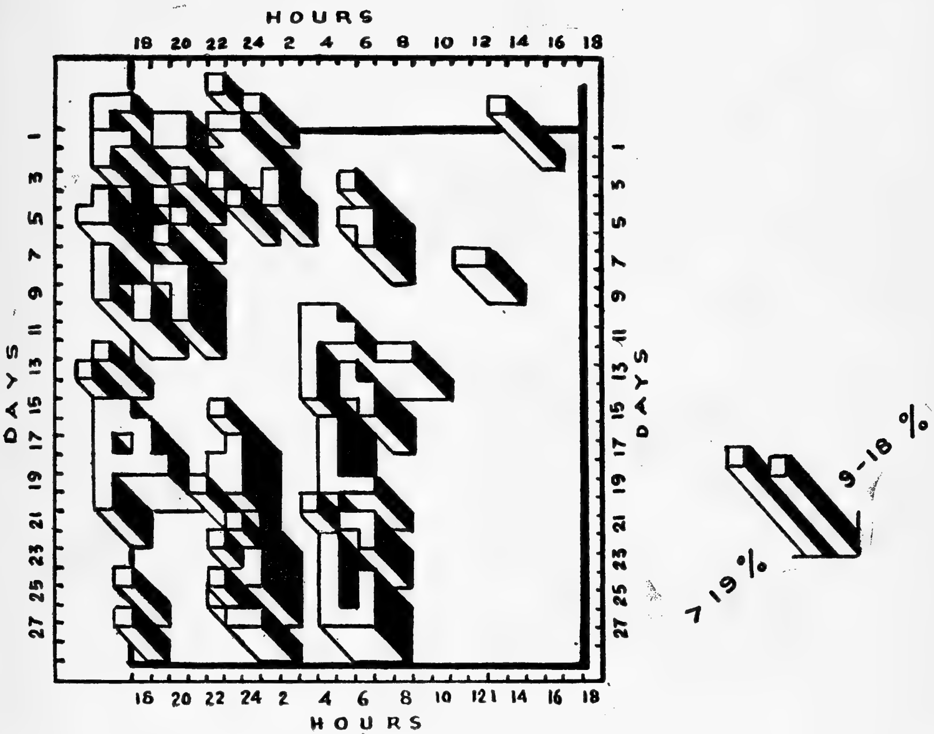

HOURS
18 20 22 24 2 4 6 8 10 12 14 16 18
DAYS
1 3 5 7 9 11 13 15 17 19 21 23 25 27
7-19 %
9-18 %

Fig. 7

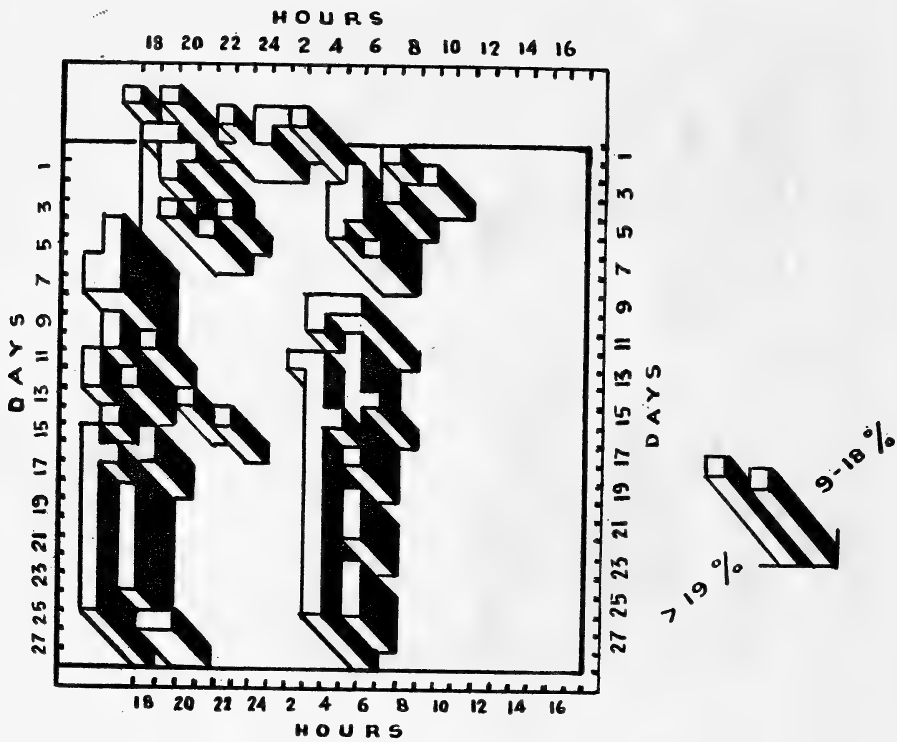

HOURS
18 20 22 24 2 4 6 8 10 12 14 16
DAYS
1 3 5 7 9 11 13 15 17 19 21 23 25 27
> 19 %
9-18 %

Fig. 8

The dominant male sniffed the genital region of 36 ♀ 18 times and attempted to mount 9 times, but in 8 of these the female either kicked him off or moved away. Only once was successful mounting and pelvic thrusting observed (day 6) in the case of this female. Female 35 was somewhat more receptive. He sniffed her genital region 5 times, succeeded in positioning his feet on her back 4 times and displayed pelvic thrusting twice (both on day 25). Neither of the females was obviously pregnant at the end of the study.

The relationship of social rank of males, and the number of offspring sired is one which should be considered in campaigns of chemosterilization of rats. Calhoun (1962) showed in *R. norvegicus* high ranking males were more sexually active and the present study indicates that the same is true in bandicoots. If dominant males were shown to be more easily given the chemosterelant (either by their being more easily trapped or more willing to take bait), the task of chemosterilization might be made easier. If, on the other hand, low ranking and sexually inactive individuals were more easily trapped or more willing to take the bait, the task would be made more difficult.

The interactions of the females were, for the most part restricted to a few squares, chiefly the squares in which their burrows or the food platform were located. The males, on the other hand, had interactions scattered over a much larger area of the pen. Of the 330 approaches by 33 ♂ to 34 ♂ for which the location was noted, the majority occurred in squares B-2 (food platform), B-4, A-6 (hole No. 4), C-6, D-6 (fig. 1). Chases were less common, with 115 of known location. These most frequently occurred in B-2 (food platform), A-3 and A-6 (hole No. 4). The locations of 11 fights are known: 5 took place in B-2 (food platform), 3 in B-4, and the remaining were scattered with single fights in 3 different squares.

Cycles of Activity

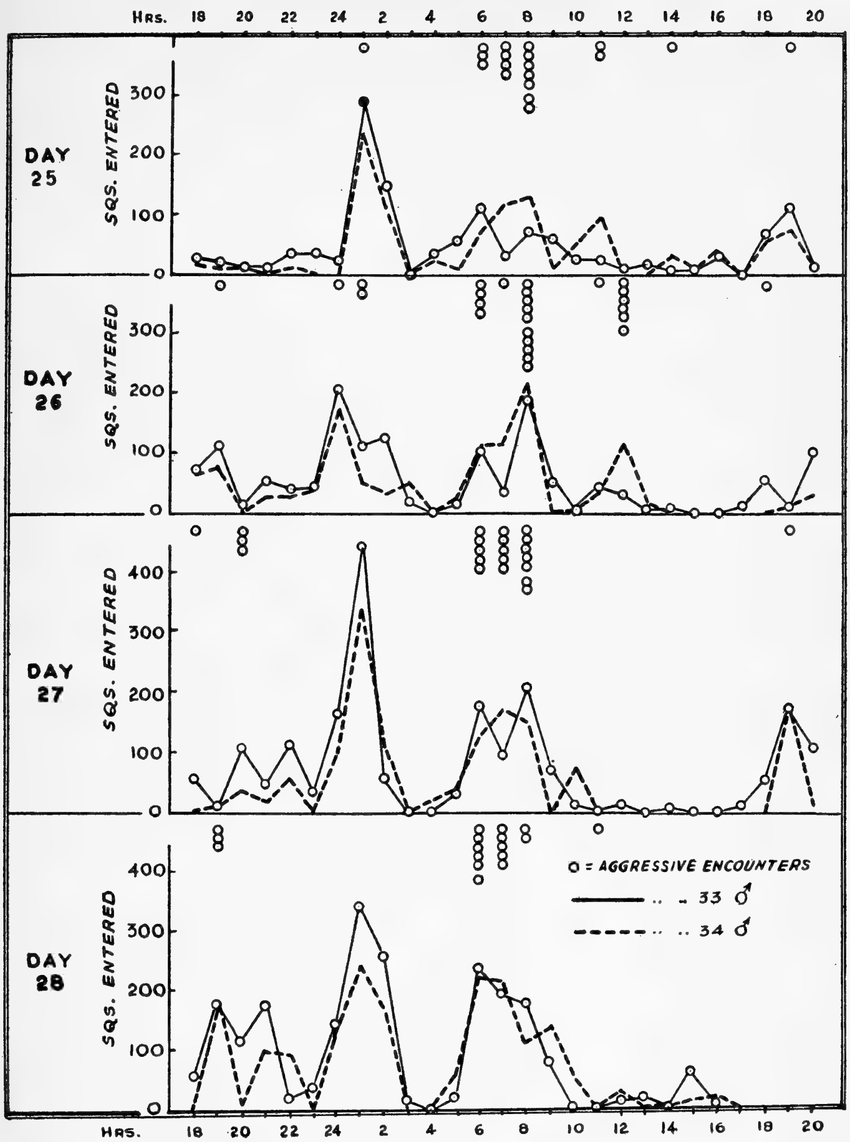
G. H. Wang (cited in Richter, 1965) showed that *R. norvegicus* females in activity cages have a 4-day cycle of wheel-running and that this cycle is associated with the oestrus cycle, ovulation occurring just before the peak of wheel-running. One of the female bandicoots used in the present study (35) displayed a rather well developed 3-day cycle in the number of squares entered (Table 3), which possibly reflects the oestrus cycle of this species. In her record there are five 3-day periods and one period of 6 days. The other female (36) was much less consistent with peaks of activity being separated by 2 to 6 days. The males showed peaks separated by 2 to 5 days, the most common being 4 days.

During the first 10 days of the study there were 4 occasions when the peak of activity of one of the females coincided with the peak of one of the males, but during the remaining 18 days the peak of activity of the males were synchronized with each other. If the 3-day cycles shown by 36 ♀ were actually reflections of her oestrus cycle, a degree of synchrony between her and the males might be expected. This, however, was rarely the case. Calhoun (1962) reported an increase of fighting among male *R. rattus* when females were in heat, but in the present study fighting showed no pattern comparable to the 3-day cycle of 35 ♀. The cause of her cycle is unknown.

Changes in Behaviour

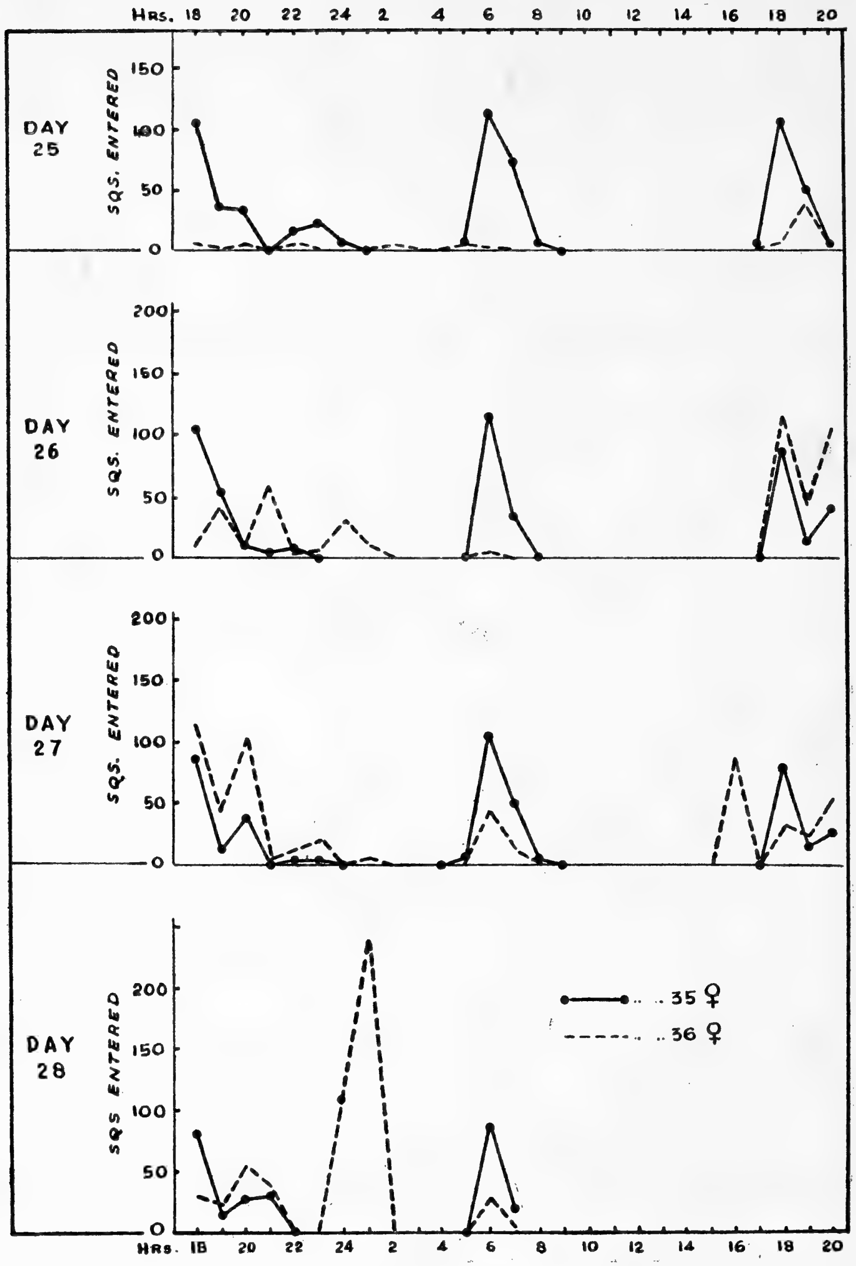
During the course of the study several aspects of behaviour changed considerably. While the amount of time above ground for the females remained low and constant throughout the 28 days, the males spent increasing amounts of time above ground (fig. 6). The subordinate male during the last two 4-day periods remained above ground about 80 per cent of the time and was often seen sleeping in the food platform when the dominant male was underground. Although the increase in the dominant's time above ground could have been caused by a number of factors, it is difficult to avoid the impression that he was remaining above ground in response to the subordinate. The subordinate could not escape from the area, as he might have done in a warehouse or field, and he was physically and behaviourally capable of surviving the persecution by the dominant. This seems to have lead to increasing amounts of time above ground and to an increase in the amount of harassment. As shown in fig. 6, the amount of aggression (here defined as fighting and chasing) increased 11-fold from the first to the last 4-day period. As mentioned earlier, approaches seem to be of aggressive motivation. If fighting, chasing, and approaching are considered as one, the total amount of aggression increased 13-fold during the study.

In addition to changes in the amount of time spent above ground and the amount of aggression there were changes in the daily patterns of activity. Figs. 7 and 8 summarize in a simplified fashion the daily activity (number of squares entered) of male 33 and female 35 for 28 days. These two animals were more regular in the timing of their activity than were the other two; however, the patterns of the two males were very similar to each other, and the same is true for the females. The females throughout most of the study displayed two peaks of activity, the first during the early hours of the night, 18.00-20.00 hours, the second in the morning, 06.00-07.00 hours. These peaks are associated with the weighing of the food at 17.00 and 06.00 hours. Female 35 lived in a burrow under the food platform and seems to have become active in response to the disturbance. The other female, living a short distance away, was not so



HRS.
18
20
22
24
2
4
6
8
10
12
14
16
18
20
DAY 25
DAY 26
DAY 27
DAY 28
SQS. ENTERED
O = AGGRESSIVE ENCOUNTERS
.. .. 33 ♂
.. .. 34 ♂

Fig. 9



Hrs. 18 20 22 24 2 4 6 8 10 12 14 16 18 20
DAY 25
SQS. ENTERED
150
100
50
0
DAY 26
200
150
100
50
0
DAY 27
200
150
100
50
0
DAY 28
200
150
100
50
0
..35 ♀
..36 ♀

Fig. 10

regular in her response. The males also showed an early evening peak, but this declined during the last week of the study. Their morning peak was well developed, although not as uniform as that of the females. During the last half of the study the males had a third peak which occurred in the middle of the night, 24.00-03.00 hours.

Summary

1. The amount of food removed from the food dishes by the 4 bandicoots far exceeded the amount they consumed. Roughly 68 per cent of the food removed was hoarded in the burrows.

2. The females spent much less time above ground than did the males.

3. Each female occupied a single burrow throughout most of the 28 days of the study, while the males tended to change burrows and to use none as intensively as did the females.

4. The subordinate male, unable to leave the pen, spent more time above ground than did the dominant male.

5. The great majority of social interactions were initiated by the dominant male, and most of his interactions were aggressive and were directed toward the subordinate male.

6. The amount of aggression increased with the passage of time.

7. Most of the aggression occurred near the food platform.

8. The subordinate male was in no sexual activity at all.

9. The females had two daily peaks of activity, one in the early evening, one in the morning, both probably associated with the disturbance of weighing the food.

10. The males had a peak of activity in the middle of the night in addition to peaks in the early evening and morning.

Acknowledgement

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References

Barnett, S. A. (1958): An analysis of social behaviour in wild rats. *Proc. Zool. Soc. Lond.* **130**(1): 107-152.

Calhoun, J. B. (1962): The ecology and sociology of the Norway rat. U. S. Public Health Service Pub. No. 1008. 288 pp., Washington.

Deoras, P. J. (1966): Some observations on the probable damage caused by rats in Bombay. *Indian J. Ent.* **28**(4): 543-547.

Kavanau, J. L. (1967): Behaviour of captive white-footed mice. *Sci.* **155** (3770): 1623-1639.

Nimbkar, Y. S. & Deoras P. J. (in press).

Parrack, D. W. (1966): The activity cycle of the lesser bandicoot rat, *Bandicota bengalensis*. *Curr. Sci.* **35**(21): 544-545.

Pingale, S. V., Krishnamurthy K. & Ramasivan T. (1967): Rats. Foodgrain Technologists' Research Association of India, Hapur. 91 pp.

Richter, C. P. (1965): Biological clocks in medicine and psychiatry. Charles C. Thomas, Springfield, Illinois. 108 pp.

Spillett, J. J. (1968): The ecology of the lesser Bandicoot-Rat in Calcutta. Bombay Natural History Society and Johns Hopkins University.

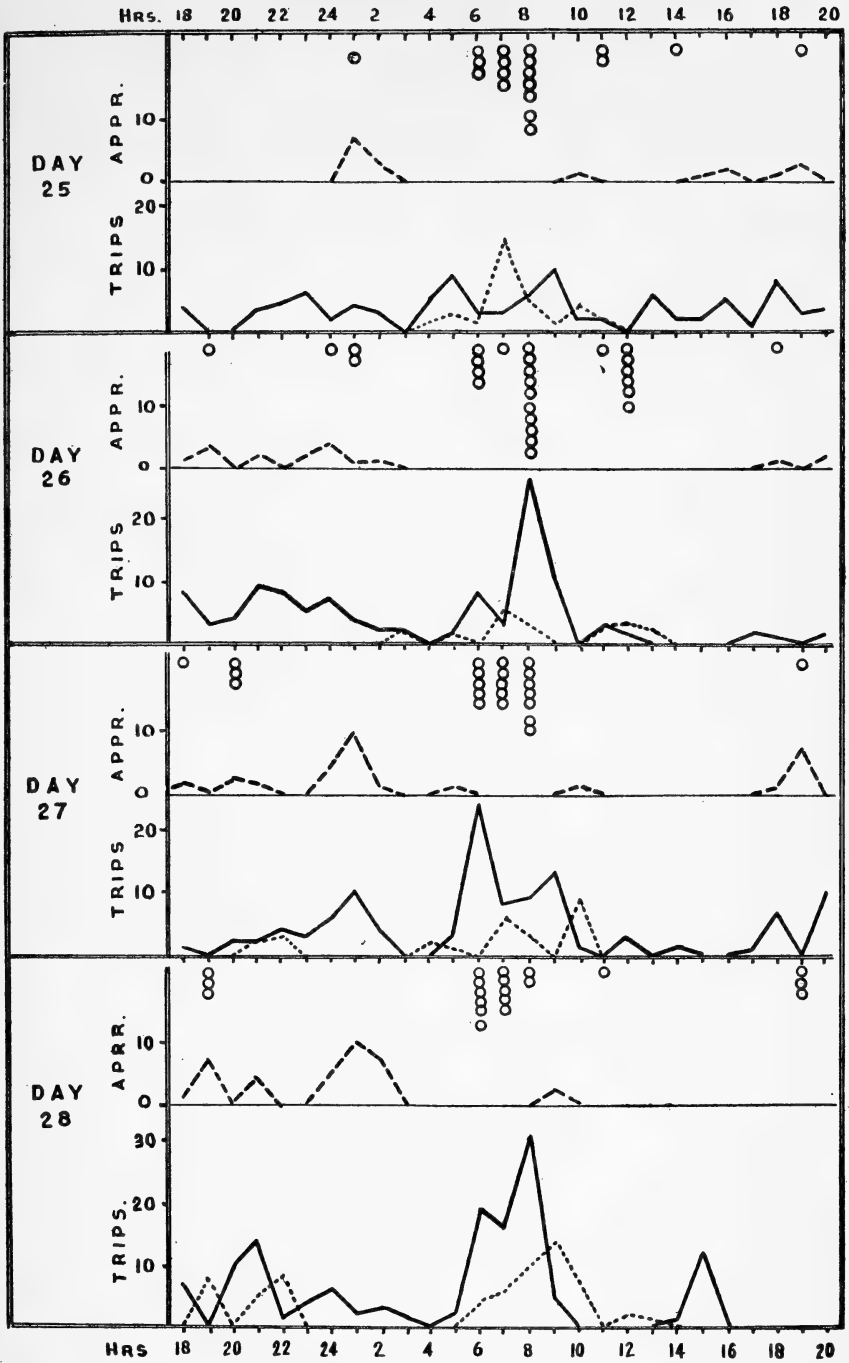
HRS. 18 20 22 24 2 4 6 8 10 12 14 16 18 20
DAY 25
DAY 26
DAY 27
DAY 28
APPR.
TRIPS
0
10
20
30
HRS 18 20 22 24 2 4 6 8 10 12 14 16 18 20

Fig. 11

TABLE 2

COMPARISON OF SEVERAL ACTIVITIES BY INDIVIDUAL *B. BENGALENSIS* DURING 28 DAYS

Rat No.	Total squares entered	Minutes above ground	Squares/ minute above ground	% time above ground	No. of trips to food	Squares/ trip to food	Minutes above ground/ trips to food	Minutes digging	Trips to Water
33 ♂	33,384	6,200	5.4	18.4	3,702	9.0	1.6	68	232
34 ♂	23,928	14,244	1.7	42.3	1,106	21.6	12.5	42	135
35 ♀	7,533	993	7.6	3.0	3,438	2.2	.3	99	153
36 ♀	5,848	1,200	4.9	3.6	1,914	3.1	.6	10	97

7

TABLE 3

COMPARISON OF PEAK DAYS OF ACTIVITY (NO. SQUARES ENTERED) OF 4 *B. BENGALENSIS*

Rat No.	Day No.																											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
33♂			x				x		x					x				x		x				x				
34♂					x					x				x				x		x				x				
35♀				x			x			x			x						x			x			x			
36♀			x			x			x		x						x				x						x	

Notes on some peculiar cases of Phytogeographic distributions

BY

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(*With two plates*)

INTRODUCTION

The flora of a place is above all the result of phylogenesis which has bestowed to the area a certain number of species through the evolutionary history. The prevailing climate acts as a sieve of big dimension permitting only those species of the allotted stock to thrive whose tolerance range fall within the limits imposed by the climate. Soil factors act as a sieve of finer dimension operating further selection in the fraction passed on by the climate. Biotic factors, mainly man and his domesticated animals introduce a further check on the vegetation. Man's action has been on the destructive side mostly, but even when protective like the silvicultural treatments, it is at the expense of a large number of species that a couple of economic ones are favoured. He and his cattle have degraded the optimum stages of the natural vegetation which are as a rule forests to thickets or savannas. He also plays an important role in extending the areas of species, intentionally or accidentally.

BIOTIC FACTORS

Anthropogenic

The accidental introduction may be illustrated at least with reference to three species.

(1) **Capparis decidua** (Forsk.) Pax—The distribution of *Capparis decidua* is discontinuous. It is spread over Northern Tropical Africa, Egypt, Arabia, Persia and West Pakistan; in India it covers Rajasthan, Northern Gujarat and the Deccan from Julwania up to Bijapur. After a considerable discontinuity it reappears in the extreme south-east part of the Peninsula. Its introduction in this south-east corner via the ship route from Africa may be a possibility as is also suggested by the distribution pattern of *Acacia planifrons*.

(2) **Acacia planifrons** W. & A. (Plate 1) The Umbrella Thorn Tree is distributed mainly over the semi-arid area of south-east corner

of India near Tuticorin and Pamban in Tirunelveli and Ramanathapuram districts and at a few localities in Madurai and Coimbatore districts. It is found also in Bellary but is planted there. After a long discontinuity in the Peninsular India, the species is encountered near Porbandar (Kathiawar) which is and which was a port of some importance in the past like Tuticorin. Morphologically the species is closely allied to *A. spirocarpa* Hochst. ex A. Rich. of North-East Africa and Arabia (Fyson 1919; Viart 1963). The Map shows the distribution of *A. planifrons*.

Marco Polo during his return from China (1291-1295), visited a part of India. One of his observations was concerning the flourishing horse trade between the ports of south Arabia (notably Aden) and Cail, a port of south India which has presently disappeared but which was at the mouth of the Tambraparani River in Tirunelveli District (Hambis 1955; Viart 1963).

Annually about 10,000 horses were imported. A good number of these perished due to lack of care and had to be replaced. Marco Polo notes that the Sultans of the Arabian and the Persian Gulf ports received considerable revenues because of this commerce. This trade continued for a long time even in the hands of Portugese after the Arabs. Panikkar (1958) also reports that the Portugese supplied persian horses to the Vijayanagar Empire.

This important trade route between Arabia, Africa and the above mentioned ports of India may be responsible for the accidental introduction of the species in India where over centuries it has emerged as a species only slightly distinct from the African-Arabian member.

(3) **Hyphaene indica** Becc. The Indian Doum Palm has been reported from the sandy coast of Daman, Diu and near Bombay (Seshagiri Rao 1963, 1964; Abraham 1969). Hence the endemic occurrence of the species in the erstwhile Portugese territories is a noteworthy feature. Besides, *H. indica* has close morphological affinities with *H. thebaica* (L.) Mart. of Africa.

This peculiar genus of branched palm is concentrated in Africa, Madagascar, and Arabia with as many as 30 species (Willis 1967). *H. indica* seems to be a case of early introduction on the west Coast of India.

Anamalous Distribution

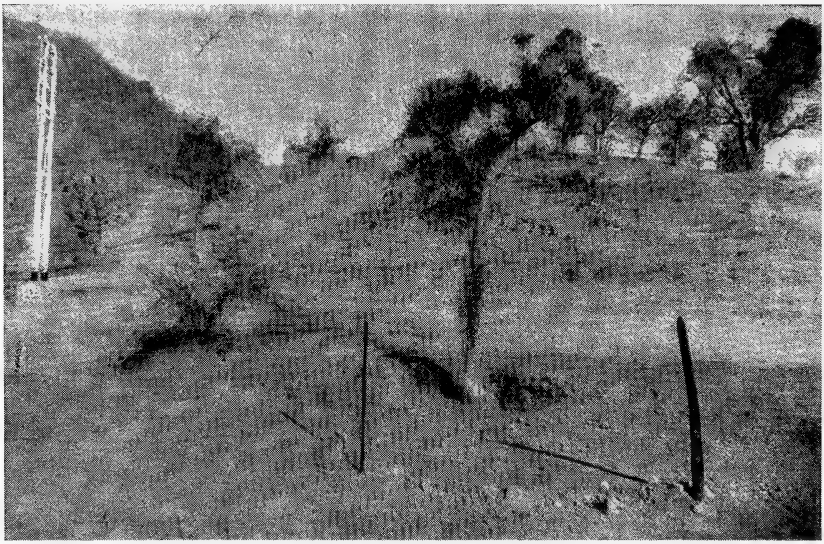
The discontinuous patchy distribution of *Hardwickia binata* Roxb. in peninsular India is a puzzle.

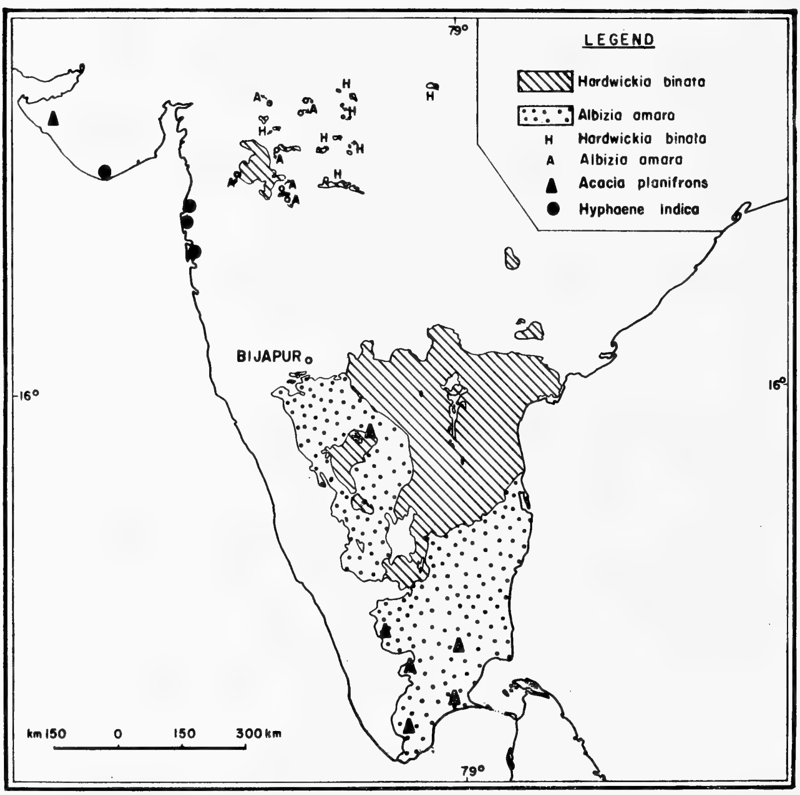
Hardwickia binata is encountered on acid parent rock, genissic complex, sandstone or quartz in the plateau region of Andhra Pradesh,

Acacia planifrons with its characteristic umbrella-shaped canopy.

Hardwickia binata in open forest. Note the normal appearance of the tree when not lopped.

(*Photos: Author*)





Above: *Hardwickia binata* (foreground) in tree-savanna. Note its deformed shape due to lopping and hacking. *Below:* Distribution of *Acacia planifrons, Hyphaene indica, Hardwickia binata and Albizia amara*

Mysore State and Salem District of Tamil Nadu. After a long discontinuity it reappears in the Malegaon Desh, the Satmala and the Satpura ranges of the Deccan trap country and in a few parts of the Vindhya and Mahadeo ranges (Map).

Another remarkable feature of its distribution is its complete absence in the Western Ghats. It occurs on the east-west oriented Satmala, Satpura, Mahadeo and Vindhya ranges but is conspicuous by its absence in the north-south oriented Sahyadris. It is found in discontinuous patches in NE-SW oriented hills of Eastern Ghats (in Andhra Pradesh and Tamil Nadu) and near Haveri, Harihar, Chitradurga, Hiriyur and Tumkur (Mysore State) just to the east of the Western Ghats.

Rainfall range is 500 to 1200 mm. spread over a period of 4 to 6 months in the areas of *Hardwickia* but the distribution of the species has not been satisfactorily correlated with climatic and soil conditions. It is not uncommon to come across statements like " the distribution of *Hardwickia* is curious and not readily explicable," " distribution of *Hardwickia* cannot be logically explained " in the Working Plans.

Brandis (1911) noted that *Hardwickia binata* most commonly grows on sandstone, and if found on trap, as in south Berar, the rock is rich in veins of quartz.

According to Champion (1936) this species is the most characteristic of shallow hard gravelly soils over trap but occurs on a variety of other rocks though then more mixed with other trees.

In Satpura division of Chhindwara district *Hardwickia* occurs on sandstone with underlying marl,—a reddish, soft and crumbling material intermediate between rock and soil (Working Plan).

Mahabale & Karnik (1958) considered *Hardwickia* forests of the Satpura range in Maharashtra to be edaphic climax because they are found only in a few definite localities on recent alluvial formations. They further reported that calciferous soils inhibit its good growth whereas black soils with higher percentage of silica favours better growth.

Pataskar & Seshagiri Rao (1965-66) are of the opinion that in the Dhulia District *Hardwickia* is conspicuous on the leached out soils.

Bhatia (1959) on the other hand states that *Hardwickia* occurs on the calcareous soil in Madhya Pradesh and that it grows well on the black cotton soil. He describes a *Tectona-Hardwickia* forest on limestone in the Nimar division.

Karnik (1955) observes that the belt of *Hardwickia* in the Satpura range of Khandesh is associated with cherty or gritty soil. Pebbles of white, yellow or red quartz and scanty and stunted nature of the grass growth are enumerated as the special features of the *Hardwickia* soil.

In the Working Plan of North and East Khandesh Division (1958) it is stated that the soil carrying *Hardwickia* forest is hard, gravelly or gritty with admixture of pebbles of quartz crunching under feet.

Because of its general association with skeletal soil, *Hardwickia* forests have been called as an edaphic type; however, we have observed this species on deep black soil in Andhra Pradesh.

From the foregoing it may be seen that contrasting views have been expressed as to the edaphic requirements of the species; this is because every study has been on a local scale and not covering the entire distribution range of *Hardwickia.*

Mall (1968) comparing the forest of Daultapur (in Dewas division at a distance of 113 km. from Bhopal) with that of Kalakund (in Mhow range about 40 km. from Indore) finds that *Hardwickia* is totally absent in the former. He attributes this difference to historical factor asserting that there is no significant difference in soil characters of the two forests.

We would like to emphasise here the role of human interference and grazing.

In the Working Plan of the Buldana sub-division (W. Berar Dn.) it is stated that there has been no reproduction in *Hardwickia* forests for at least 20 years. Seeding may not be good each year but it has been abundant every 3 to 5 years. After each seeding, a number of seedlings come up but they are all destroyed in the summer. It may also be added that *Hardwickia* does not coppice like other trees of the deciduous forest.

Grazed areas show indications of reproduction having been killed back by browsing or badly hacked about by graziers. Burning and grazing are quoted as the devastating biotic factors in the *Hardwickia* forests by Champion & Seth (1965). Cattle and goats are fond of *Hardwickia* leaves and the trees in the vicinity of villages are badly lopped and hacked for fodder (Plate I and II). Great is the utility of the tree in dry years like 1966 when it was chiefly responsible for feeding the herds in absence of grasses, in some drought-stricken parts of Madhya Pradesh (Pers. Comm., D.N. Pateria, D.F.O., Khargon). In short, unassisted *Hardwickia* reproduces itself extremely slowly.

There is some natural regeneration of this species by seeds in E. and N. Khandesh divisions as also in Satpura division, Chhindwara District where the site factors are favourable. *Hardwickia* resists fire but the growth for the first few years is very slow. (Working Plan for the Satpura forests of East and North Khandesh Divisions, 1958).

Natural regeneration is again very poor in Dewas division. There is also a dearth of younger age classes due to past selective working, though *Hardwickia* represents over 50 per cent of the trees in the overwood.

We too have observed that the seedlings of *Hardwickia* are practically lacking in many of the open forests and tree-savannas where there are big old trees of the species. Does this lack of natural regeneration mean that the areas where *Hardwickia* exists to-day will in course of time be replaced by other species when the old trees will have completed their life span? The gradual disappearance in patches may explain the discontinuous distribution of the species.

Working Plan of Buldana division makes a note that in the folds of hills and along many *nalas* teak reproduction is plentiful and it is probable that teak may one day replace *Hardwickia* over greater part of this type.

In the open forests of the Satpura and Satmala, *Hardwickia* is generally gregarious towards the borders of the forests but not so in the interior. Because of its very hard wood it is not so easy to fell. Whereas the other species become the victim of axe at the forest margin, *Hardwickia* escapes the maltreatment. In the interior where the forests are better protected not being easily accessible, other species have a fair chance of survival and the abundance of *Hardwickia* is not so striking.

Role of edaphic factor

That the soil factor can bring about discontinuous distribution is shown by the range of **Albizzia amara** Boiv.

This species which is so common in the southern part of the Peninsula disappears from Bijapur northwards over the black soils of the Deccan trap zone. In this tract geology changes from gneissic complex, quartzite, slate and sandstone to the Deccan trap.

It reappears in the Nasik, Dhulia, Jalgaon and West Nimar districts (Map). In these areas it is associated with alluvial soils or with red ferruginous soils derived from the trap on the hills but not with black clayey calcimorph soils. Its acidophilous nature seems to explain its discontinuous distribution.

Summary

The role of biotic, especially anthropogenic factor, has been emphasised to explain the discontinuous distribution patterns of *Capparis decidua, Acacia planifrons, Hyphaene indica* and *Hardwickia binata*.

The discontinuity in the range of *Albizzia amara* may be correlated to its acidophilous nature, eliminating it over the black calcimorph soils of the Deccan trap.

Acknowledgement

I am thankful to Dr. P. Legris for having extended to me the facility to tour the mapped area and to consult the forest working plans.

References

Abraham, V. (1969): A preliminary survey on the flora of Trombay. *Proc. 56th Indian Sci. Congr.* Abstr. Pt. III: 326-327.

Bhatia, K. K. (1959): Teak bearing forests of Old Madhya Pradesh. *Indian For.* **85**: 710-722.

Brandis, D. (1911): Indian trees.

Champion, H. G. (1936): A preliminary survey of the forest types of India and Burma. *Indian For. Rec.* **1**: 286

Champion, H. G. & Seth, S. K.: (1965): A revised survey of the forest types of India. Dehra Dun.

Fyson, P. F. (1919): *Acacia planifrons* W. & A. *Bot. Bull. Presidency College, Madras.* pp. 4-5.

Hambis, L. (1955): La description du monde par Marco Polo. Paris 433.

Karnik, C. R. (1955): A contribution to biogeographical studies of Khandesh with special reference to the Satpura range. *Bombay Geogr. Mag.* **1**: 65-72.

Mahabale, T. S. & Karnik C. R. (1958): Ecology of Satpura forests, Bombay State, India. *J. Univ. Bombay* **26** (pt. 5): 33-49.

Mall, L. P. (1968): Ecology of Daultapur and Kalakund forests of Madhya Pradesh. *Proc. Symp. Recent Adv. Trop. Ecol.* **2**: 398-406. ISTE. Varanasi.

Panikkar, K. M. (1956): Histoire de l'Inde. Paris 396 p.

Pataskar, R. D. & Seshagiri Rao, R. (1965-66): Studies on the vegetation of Toranmal ranges and surrounding areas of Dhulia District, Maharashtra State. *Proc. 53rd Indian Sci. Congr.* Pt. IV: 267-268.

Seshagiri Rao, R. (1963): *Hyphaene indica* Becc. along the West Coast of India. *J. Bombay nat. Hist. Soc.* **60**(3): 761-763.

——————— (1964): The Doum palms in India. *Principes J. Palm Soc.* **8**(2): 49-54.

Viart, M. (1963): Contribution a l'étude de l'action de l'homme sur la végétation dans le Sud de l'Inde. *Thése Sci.*, Toulouse.

Willis, J. C. (1966): A dictionary of the flowering plants and ferns. Cambridge Univ. Press. 7th ed. revised by H. K. Airy Shaw.

A Synopsis of the Genus *Eisocreochiton* Quisumb. & Merr. (Melastomataceae)

BY

M. P. Nayar

(*With two plates*)

A new species *Eisocreochiton furfuracea* Nayar, is described from Borneo with illustrations. *Anplectrum monticola* Ridl. is transferred to the present genus as *Eisocreochiton monticola* (Ridl.) Nayar. *Creochiton kinabaluense* Heine is found to be conspecific with *E. monticola* (Ridl.) Nayar. A key to the species so far known is also presented.

Introduction

The author has carried out a taxonomic study of several genera in the family Melastomataceae at the Central National Herbarium, Calcutta, the Herbarium, Royal Botanic Gardens, Kew, U.K. and the Rijksherbarium, Leiden, Netherlands from 1960-68. The present paper deals with the genus Dissochaeteae Quisumb. & Merr. belonging to the tribe Dissochaeteae Triana.

Quisumbing & Merrill (in Philipp. Journ. Sc. 37: 177, 1928) established the genus *Eisocreochiton* on the basis of specimen *Ramos & Edano* Bur. Sc. No. 45610 from Luzon, Philippines. While describing the type species *Eisocreochiton bracteata*, they observed that the inflorescence and vegetative characters agree with that of *Creochiton* Bl. However, since the "floral characters are totally different" they assigned the genus *Eisocreochiton* to the tribe Oxysporeae near *Blastus* Lour. The genus *Eisocreochiton* is closely allied to *Creochiton*, but differs in having dorsally spurred and ventrally biappendiculate connective; whereas in the genus *Creochiton* Bl. the connective is dorsally spurred and ventrally inappendiculate. Quisumbing & Merrill (l.c. supra) wrongly assigned the genus *Eisocreochiton* to the tribe Oxysporeae. Since the genus *Eisocreochiton* has baccate fruits, it belongs to the tribe *Dissochaeteae;* while the tribe Oxysporerae has capsular fruits.

The name *Eisocreochiton* is derived from Greek, '*Eiso*'=alike, equal; '*creo*'=fleshy; '*chiton*'=an outer covering, in allusion to the thick bracteoles covering the flowers. *Eisocreochiton*=plants alike *Creochiton.*

Of the three species so far known, the type species *E. bracteata* Quisumb. & Merr. is endemic to the Island of Luzon in the Philippines.

The other two species *E. monticola* (Ridl.) Nayar and *E. furfuracea* Nayar are both endemic to Borneo.

KEY TO THE SPECIES OF *Eisocreochiton*

I. Stamens 4:

II. Bracteoles oblong-ovate, 8-11 mm. long, 4-8 mm. wide, pale green, thin; leaves when dry pale green, under surface of leaf when young more or less covered with ferrugineous plumose and stellate hairs, hairs deciduous and leaves glabrescent .... *E. bracteata*

II. Bracteoles obovate, 5-6 mm. long, 3-4 mm. wide, dark brown, thick; leaves when dry brown, under surface of leaf densely covered with ferrugineous plumose and stellate hairs. .... *E. furfuracea*

I. Stamens 8, four large and four small .... *E. monticola*

ENUMERATION OF SPECIES

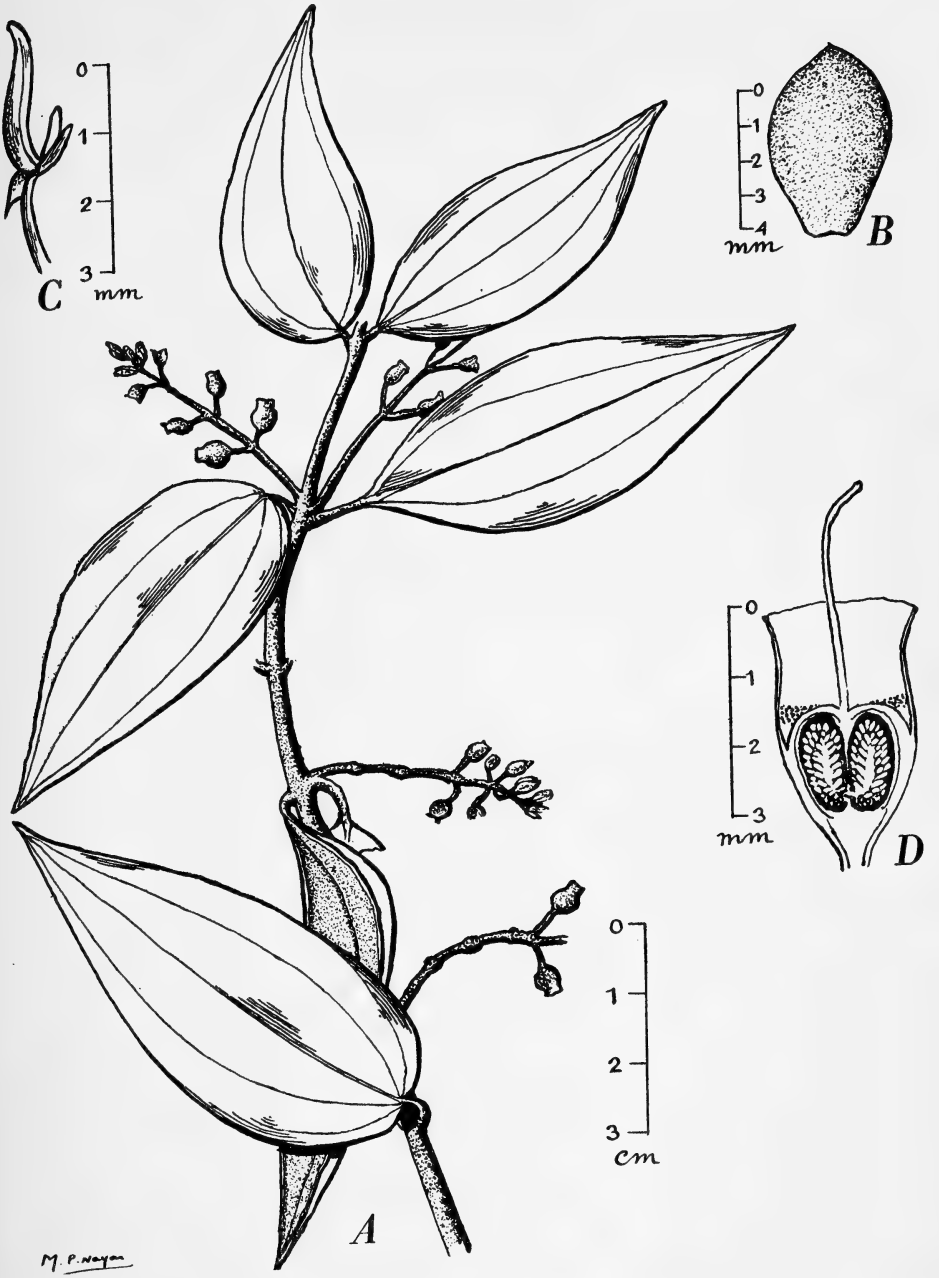
1. **Eisocreochiton bracteata** Quisumb. & Merr. in Philipp. Journn. Sc. 37: 177, 1928.

Distribution: Philippines, Luzon, Nueva Vizcaya Prov., Mt. Alzapan, *Ramos & Edano* Bur. Sc. No. 45610 (Isotypes K, BM)

2. **Eisocreochiton furfuracea** sp. nov. (Plate I)

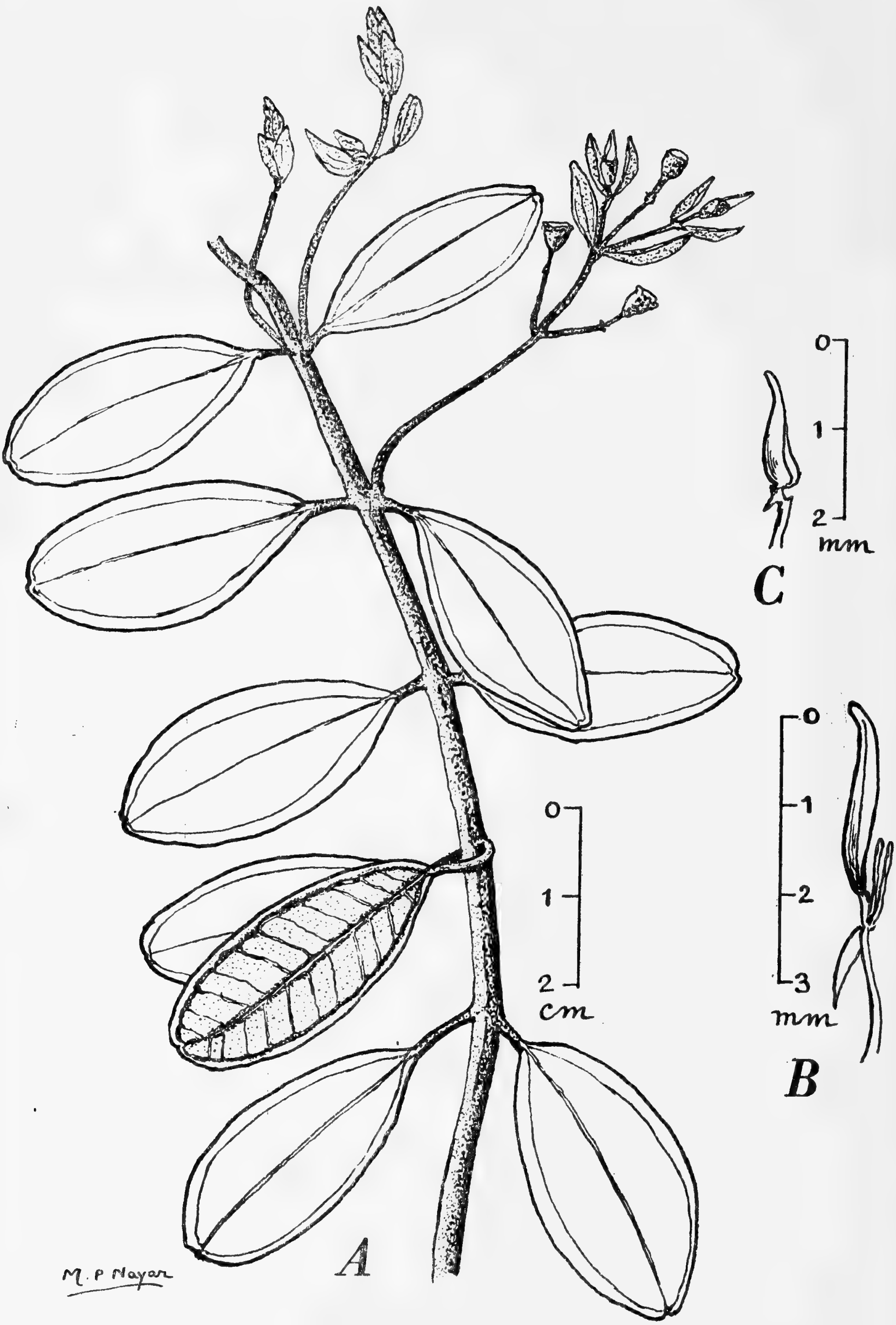
Affinis *E. bracteatae* Quisumb. & Merr., sed bracteolis obovatis, brunneis, minoribus, foliis subtus dense pubescentibus differt.

Frutex scandens. Rami subteretes, dense ferrugineo-plumoso-furfuracei. *Folia* ovato-lanceolata, 4.5-6.5×2.5-3 cm., basi subrotunda vel subobtusa, apice acuminata, margine integra, supra glabra, subtus dense ferrugineo-stellata, coriacea, 3-5 nervia, venulis transversis indistinctis; petiolus 8-11 mm. longus, dense ferrugineo-plumoso-hirsutus. *Inflorescentia* axillaris, racemosa, 3-7 cm. longa; bracteolae obovatae, 5-6×3-4 mm., dense furfuraceae, brunneae; pedicellus 4-5 mm. longus. *Calycis tubus* campanulatus, 2.5-3 mm. longus, stellato-furfuraceus, limbus truncatus. *Petala* 4, 2-2.5×2 mm. glabra. *Stamina* 4, filamentis 1.5 mm. longis, antheris 2 mm. longis, connectivo non producto, dorso in appendicem triangularem 0.8 mm. longam exeunte, in parte ventrali in appendices duas 0.7 mm. longas exeunte. *Ovarium* calycis tubo septis 4 adnatum, ' loculis ' 4, usque ad quartem partem prolongatis; Stylus 2-2.5 mm. longus, glaber, stigmate inconspicuo. *Bacca* globosa, stellato-furfuracea; semina numerosa, cuneata, 0.7-0.8 mm. longa.



Eisocreochiton furfuracea Sp. nov.

A. Habit. B. Bracteole. C. Stamen-side view. D. L. S. of calyx tube



Eisocreochiton monticola (Ridl.) Nayar comb. nov.

A. Habit. B. Large stamen-side view. C. Small stamen-side view.

Typus lectus a Jacobs and locum Rajang, altit. c. 500 m. in dist. Kapit, Sarawak in Borneo die 25 augusti anni 1958, et positus in Herb. kew, Anglia, sub numero *Jacobs* 5293; Isotypus positus in Rijksherbario in urbe Leiden, sub numero *Jacobs* 5293.

Climber. Branches subterete, densely ferrugineous and plumose furfuraceous. *Leaves* ovate-lanceolate, 4.5-6.5×2.5-3 cm., base subrotund or subotuse, apex acuminate, margin entire, upper surface glabrous, under surface densely ferrugineous and stellate, coriaceous, 3-5 nerved, transverse venules indistinct; petiole 8-11 mm. long, densely ferrugineous and plumose hirsute. *Inflorescence* axillary, racemose, 3-7 cm. long; Bracteole obovate, 5-6×3-4 mm., densely furfuraceous and brownish; pedicel 4-5 mm. long. *Calyx tube* campanulate, 2.5-3 mm. long, stellate-furfuraceous, limb truncate. *Petals* 4, 2-2.5×2 mm., glabrous. *Stamens* 4, filament 1.5 mm. long, anther 2 mm. long, connective not produced, dorsally ending in a triangular appendage 0.8 mm. long, ventrally ending in two appendages 0.7 mm. long. *Ovary* concrescent with the calyx tube by 4 septa, extra-ovarial chambers 4, descending to $\frac{1}{4}$ of the ovary; Style 2-2.5 mm. long, glabrous, stigma inconspicuous. *Berry* globose, stellate-furfuraceous; Seeds numerous, cuneate, 0.7-0.8 mm. long.

Distribution: Borneo: Sarawak, Kapit Dist., Rajang, alt. below 500 m., 25 Aug. 1958, *Jacobs* 5293 (Holotype K, isotype L.)

E. furfuracea Nayar is allied to *E. bracteata* Quisumb. & Merr., but differs in the size and shape of bracteoles and in the nature of pubescence on the under surface of the leaf. In *E. furfuracea* the bracteoles are obovate (5-6 mm. long and 3-4 mm. wide), dark brown and coriaceous; whereas in *E. bracteata* the bracteoles are oblong-ovate, (8-11 mm. long, 4-8 mm. wide), pale green and membranaceous.

3. **Eisocreochiton monticola** (Ridl.) Nayar, comb. nov. (Plate II).

Anplectrum monticola Ridley in Kew Bull. 1: 31, 1946. Type: *Brooks* 50 (K).

Creochiton kinabaluense Heine in Mitt. Bot. Staatssamml. Munchen 1. Heft 6: 214, 1953. Type: *J. & M. S. Clemens* 32646 (Isotypes K, BM)—Synon. nov.

Climber, about 13 m. in height. *Branches* subterete, furfuraceous and lepidote, pilose, nodes usually 1-2 cm. apart. *Leaves* elliptic, 1-3.5× 0.7-1.5 cm., base cuneate, apex retuse, upper surface glabrous, under surface sparsely puberulous, hairs deciduous, glabrescent, 3-nerved, cross-venules distinct on the under surface; petiole 3-4 mm. long, furfuraceous. *Inflorescence* axillary, 3-5 cm. long, furfuraceous; bract elliptic or obovate, 5-6 mm. long; bracteole obovate, 4 mm. long, furfuraceous;

pedicel 1-2 mm. long. *Calyx tube* campanulate, 2.5-3 mm. long, furfuraceous, limb sinuate. *Petals* 4, oblong-lanceolate, 2.5-3 mm. long, acuminate. *Stamens* 8, 4 small and 4 large stamens; large stamens: filament 1-1.5 mm. long, anther 2-2.5 mm. long, provided with a short connective, dorsally ending in a triangular appendage, 1 mm. long and ventrally ending in two linear appendages 1 mm. long; small stamens: filament 0.5-0.8 mm. long, anther 1.5 mm. long, dorsally ending in a minute tubercle and ventrally inappendiculate. *Ovary* 4-chambered, apex of the ovary furfuraceous; Style 4-5 mm. long, glabrous, stigma punctiform. *Berry* globose, stellate-furfuraceous; seeds numerous, cuneate 0.5-0.8.mm. long.

Distribution : Borneo: Sarawak, Summit of Benkaran, *Brooks* 50(K); Gunong penrissen, Kuching Dist., 29 Apr. 1962, *Ilias Pa'ie* S. 16371 (K); Sabah, Mt. Kinabalu, alt. 1166 m., *J. & M. S. Clemens* 32646 (K, BM); Colomban basin, alt. 1166 m., 14 Aug. 1933, *J. &. M. S. Clemens* 34455 (K); Tenompok, alt. 1666 m., 25 May 1932, 28616 A. (K); Ibid., *J. & M. S. Clemens* 28616 (K).

While describing the type species *Anplectrum monticola*, Ridley (in Kew Bull. 1:31, 1946) commented as follows: "This very curious plant is quite unlike any other species in its densely set, small coriaceous leaves and short axillary panicles." Heine (in Mitt. Bot. Staatssamml. Munchen 1: heft 6:214, 1953) independently proposed the binomial *Creochiton kinabaluense* for the same taxon on the basis of Clemens gatherings (*J. & M. S. Clemens* 32646, 33951) from Sabah, Borneo. In the original description of *C. kinabaluense* there is no description of the nature of stamens and it is presumed that Heine erected this species basing on the nature of bracteoles enveloping the flower buds and in the presence of axillary panicles. Besides the bracteoles enveloping the flower buds, the main generic character which distinguishes the genus *Creochiton* Bl. is the dorsally spurred and ventrally inappendiculate stamens. In this taxon the stamens are dorsally spurred and ventrally biappendiculate.

Acknowledgement

I wish to express my gratitude to Sir George Taylor, Director, Royal Botanic Gardens, Kew, U. K. for all facilities during my stay at Kew from 1961-67.

Obituary

FR. H. SANTAPAU, S.J.

(1903-1970)

The death of Rev. Fr. H. Santapau, S.J. on 13 January 1970 was a grievous loss to Indian Botany, to the Bombay Natural History Society and to his numerous friends and colleagues at the Society, in the City of Bombay, and throughout the world.

Born at La Galera, Tarragona, Spain on 5 December 1903, Fr. Santapau joined the Society of Jesus at the age of 16 and was educated in Spain and London and took his Ph.D. in Philosophy at Rome in 1927. In 1936 Fr. Santapau joined the London University but his studies were interrupted by the war. He later joined the Imperial College in London and took his Ph.D. in Botany based on his Flora of Khandala, worked out during his two years (1946-48) at Kew Gardens.

Fr. Santapau reached India in 1928 and became one of the Professors of Botany at St. Xavier's in 1940. His botanical exploration of the country of his adoption took him from the deserts of Baluchistan to the rain forests of Assam and from the Darjeeling hills in the Himalayas to the Nilgiri and Palni hills in the south. His vast collection of over 100,000 specimens is mainly housed at the Blatter Herbarium at Bombay. He gave freely of his knowledge of Indian Botany and lectured to students of universities throughout the country and was a recognised postgraduate teacher in many of them. He was a ' Visitor ' to the Universities of Delhi and Poona. His contributions on Indian Botany which number over 350 include authoritative treatises on taxonomy of Indian plants such as his floras of Khandala, Purandhar, Saurashtra and his papers on various families of plants. His ' Orchids of Bombay State ' is another notable contribution. Fr. Santapau had the rare ability to communicate with the scientist as well as the layman with equal facility as is evident from his book COMMON TREES published by the National Book Trust, India.

He was a fellow of the National Institute of Sciences of India and was associated with numerous societies and scientific bodies. He was a member of many committees of the Council of Scientific and Industrial Research and was responsible for re-organising for the Government of India, the Botanical Survey of India and retired as the Director of the Survey in 1968.

Fr. Santapau's association with the Bombay Natural History Society dates back to 1944 when he joined as an ordinary member and was elected to its Executive Committee the same year. He became an editor of the Journal in 1948 (volume 48) and was elected Vice-President in 1954.

Fr. Santapau's services to India and to Indian Botany were recognised by the award of Padma Shri by the Government of India and the Birbal Sahani Medal by the Indian Botanical Society. He was made a member of the Order of Alphonso the Wise by the Spanish Government.

His publications in the Society's *Journal* are listed below:

1944 *Ventilago bombaiensis* Dalz. (*with a plate*). **44**(3): 496-498.
—— The flowering of *Strobilanthes*. **44**(4): 605-606.

1945 New plant records for Bombay Presidency. **45**(3): 445-448.
—— *Curcuma pseudomontana* Grah. **45**(4): 618-623.

1946 An abnormal flower of *Gloriosa superba* Linn. (*with a plate and a text figure*). **46**(1): 202-204.
—— New plant records for the Presidency of Bombay (II) (*with a plate*). **46**(2): 377-381.
—— Abnormal flowering of *Careya arborea* Roxb. in Khandala. **46**(2): 409-410.
—— Variation in the numbers of floral parts in *Jasminum malabaricum* Wt. **46**(3): 563-566.

1947 Notes on the Convolvulaceae of Bombay. **47**(2): 337-355.

1948 Notes on the Solanaceae of Bombay. **47**(4): 652-662.
—— The Genus *Ceropegia*—further comments. **47**(4): 775-777.

1949 Artificial key to the Papilionaceae of Bombay Province. **48**(2): 277-282.
—— Notes on the Gesneriaceae of Bombay. **48**(3): 489-492.
—— The genus *Ceropegia*: still further comments. **48**(3): 613-614.

1950 Notes on the Scrophulariaceae of Bombay. **49**(1): 25-49.
—— Editorial note on the growth of herbarium specimens. **49**(1): 135-136.
—— Notes on the Lentibulariaceae of Bombay. **49**(2): 217-221.
—— The flowering of *Strobilanthes*. **49**(2): 320-321.
—— A plea for the Preservation of Wild Plants. (*with a plate*). **49**(3): 427-429.
—— Further remarks on the flowering of *Strobilanthes*. **49**(3): 575-576.

1951 The genus *Dioscorea* in Bombay State. (*with three plates*). **49**(4): 624-638.
—— New record for *Frerea indica* Dalz. in Bombay Province. **49**(4): 801-802.
—— *Frerea indica* Dalz.—A new record in Bombay. **50**(2): 427.
—— A branched specimen of *Costus speciosus* Smith. **50**(2): 427.
—— Critical notes on the identity and nomenclature of some Bombay plants (*with two plates*). **50**(2): 305-312.
—— A note on *Neuracanthus sphaerostachyus* Dalz. (*with two plates*). **50**(2): 428-430. (Jointly with P. V. Bole).

1952 Contribution to the bibliography of Indian Botany. (Part I). **50**(3): 520-548.

—— On a common species of *Curcuma* of Bombay and Salsette Islands. (*with a plate*). **51**(1): 135-139.

—— Contribution to the bibliography of Indian Botany. (Part II). **51**(1): 205-259.

1953 Notes on the Acanthaceae of Bombay. **51**(2): 349-368.

—— Critical notes on the identity and nomenclature of some Bombay plants II. The genus *Zizyphus* Mill. **51**(4): 801-804.

—— The species of *Crotalaria* in Bombay. **51**(4): 960-962.

1954 Critical notes on the identity and nomenclature of some Bombay plants III. *Murdannia scapiflorum* (Roxb.) Royle. (*with two plates*). **52**(1): 137-141. (Jointly with R. R. Fernandes).

—— The genus *Murdannia* in Bombay State. **52**(2 & 3): 658.

—— New plant records for Bombay. (*with two plates*). **52**(2 & 3): 661-663. (Jointly with A. Randeria and R. R. Fernandes).

1955 A new species of *Chlorophytum* from Salsette Island. (*with a plate*). **52**(4): 897-900. (Jointly with R. R. Fernandes).

—— *Alternanthera polygonoides* R. Br. var. *erecta* Mart.—a new record for Bombay State. (*with a plate*). **52**(4): 957 (Jointly with G. P. Shrivastava).

—— A botanical excursion to North Kanara, Bombay State, in May 1954. **53**(1): 10-28.

—— *Laurentia longiflora* Endl. a new record for Bombay State. (*with a plate*). **53**(1): 156-157.

—— The botanical exploration of Krishnagiri National Park, Borivli, near Bombay. (*with two maps, one coloured and two black-and-white plates*). **53**(2): 185-200. (Jointly with A. Randeria).

—— New plant records for Bombay III. (*with five plates*). **53**(2): 210-213. (Jointly with C. Saldanha).

—— New plant records for Bombay IV. (*with four plates*). **53**(2): 214-216. (Jointly with several students).

1956 Name changes of a few Bombay plants. **53**(3): 499-500. (Jointly with D. Panthaki).

—— Extensive loss of water by forest trees in the Dangs Forest. **53**(3): 501.

—— *Dolichos bracteatus* Baker. **53**(3): 501-502. (Jointly with D. Panthaki).

—— The name *Hoya bendula*. **53**(3): 504.

—— Tobacco without nicotine. **53**(3): 504.

—— The poisonous qualities of *Calotropis gigantea* R. Br. **54**(1): 218.

—— Notes on *Aerides maculosum* Lindl. (*with a text-figure*). **54**(1): 220-221. (Jointly with Z. Kapadia).

—— Some new plants for the Dangs Forest, Bombay State. (*with two plates*). **54**(1): 221-225. (Jointly with D. Panthaki).

1957 *Eclipta prostrata*, *E. erecta* or *E. alba:* Which is the correct name? **54**(2): 475-476.

—— *Alternanthera paronychyoides* St. Hil.—A correction. **54**(2): 476-477.

—— *Habenaria panchganiensis*—New name for a Bombay Orchid. **54**(2): 478. (Jointly with Z. Kapadia).

—— The genus *Cuscuta* in Bombay. (*with a plate*). **54**(3): 707-713. (Jointly with V. Patel).

—— Further notes on the Indian species of *Curcuma* (Zingiberaceae). **54**(4): 966-967.

—— The species of *Lagenandra* of Bombay and Madras. **54**(4): 967-969.

—— *Neuracanthus sphaerostachyus* Dalz.—Further comments. **54**(4): 969-970. (Jointly with G. L. Shah).

1958 The phyllotaxy of *Euphorbia neriifolia* Linn. **55**(1): 186-187. (Jointly with G. L. Shah).

—— The coconut, *Cocos nucifera* Linn. Observations of the first English Jesuit in India. **55**(1): 188-189.

—— New plant records for Bombay-V. (*with five plates*). **55**(3): 481-485. (Jointly with R. R. Fernandes & Z. Kapadia).

—— *Cryptostegia madagascariensis* Boj.—A new record for Bombay. (*with a plate*). **55**(3): 594-595. (Jointly with N. A. Irani).

1959 The leaves of *Alseodaphne semecarpifolia* Nees. **56**(1): 160.

—— Critical notes on the Orchidaceae of Bombay State. I.—The genus *Habenaria* Willd. (*with six plates*). **56**(2): 188-203. (Jointly with Z. Kapadia).

—— Lectotypes of the species and varieties described by Blatter and Hallberg in their 'Flora of the Indian Desert.' **56**(2): 276-281.

—— *Salmalia malabarica* and *S. insignis* in Bombay. **56**(2): 364-365.

—— The Royal Botanic Gardens, Kew. By W. B. Turrill. (A Review). **56**(3): 611-613.

—— The flowering of *Strobilanthes*. (*with a plate*). **56**(3): 677.

—— The leaves of *Alseodaphne semecarpifolia* Nees.—A correction. **56**(3): 678.

1960 Critical notes on the Orchidaceae of Bombay State. II. *Platanthera* L. C. Rich. & *Peristylus* Bl. (*with four plates*). **57**(1): 124-135. (Jointly with Z. Kapadia).

—— The identity of the *Entada* plants from Bombay. **57**(1): 238-240.

—— Critical notes on Orchidaceae of Bombay State. III. The genus *Oberonia* Lindl. (*with five plates*). **57**(2): 252-269. (Jointly with Z. Kapadia).

—— *Artocarpus heterophyllus* Lamk. (*with a plate*). **57**(2): 447-449.

—— Critical notes on the Orchidaceae of Bombay State. IV. The genus *Dendrobium* Sw. (*with ten plates*). **57**(3): 491-510. (Jointly with Z. Kapadia).

—— Black colour in flowers: Is there such a colour in nature? **57**(3): 701-702.

1961 Critical notes on the Orchidaceae of Bombay State. V. *Eulophia* R. Br. and *Aerides* Lour. (*with five plates*). **58**(1): 53-67. (Jointly with Z. Kapadia).

—— Critical notes on the Orchidaceae of Bombay State. VI. *Nervilia* Gaud & *Malaxis* Sw. (*with three plates*). **58**(2): 332-350. (Jointly with Z. Kapadia).

—— New plant record from Bombay, *Physalis longifolia* Nutt. **58**(2); 550-551. [(Jointly with G. L. Shah, Z. Kapadia (née V. Patel)]

—— New plant record from Bombay: *Alternanthera pungens* H.B.K. **58**: 551-553. (Jointly with G. L. Shah).

—— Critical notes on the Orchidaceae of Bombay State. VII. *Eria* Lindl. & *Porpax* Lindl. (*with three plates*) **58**(3): 595-607. (Jointly with Z. Kapadia).

1962 Critical notes on the Orchidaceae of Bombay State. VIII. Some of the smaller genera. (*with six plates*). **59**(1): 154-172. (Jointly with Z. Kapadia).

—— Critical notes on the Orchidaceae of Bombay State. IX. Some of the smaller genera (Continued). (*with eight plates*). **59**(2): 382-404. (Jointly with Z. Kapadia).

—— Gregarious flowering of *Strobilanthes* and Bamboos. (*with a plate*). **59**(2): 688-695.

—— Critical notes on the Orchidaceae of Bombay State. X. Some of the smaller genera (continued). (*with two plates*). **59**(3): 827-842. (Jointly with Z. Kapadia).

1963 Critical notes on the Orchidaceae of Bombay State. XI—Some of the smaller genera (continued). (*with two plates*) **60**(1): 92-103.

—— Additions to the Flora of Bombay State: Grasses from Salsette Island. (Malad-Madh Area). **60**(1): 134-139. (Jointly with G. L. Shah).

1965 Further contribution to the botany of Dangs Forest, Gujarat. **62**(2): 201-210. (Jointly with G. L. Shah).

1969 A contribution to the Flora of Salsette Island, Bombay, (Malad-Madh Area). **66**(3): 430-442. (Jointly with G. L. Shah).

EDITORS

Reviews

1. THE TWILIGHT OF INDIA'S WILD LIFE. By Balakrishna Seshadri. pp. 212 (24 × 16 cm.) with 58 illustrations and 5 maps. London, 1969. John Baker Publishing Ltd. Price 52*s.* net.

There are two important points that Seshadri makes in his book: THE TWILIGHT OF INDIA'S WILD LIFE which if seriously noted by the powers that be, may yet save India's wild life from becoming extinct.

The total area of all existing wild life sanctuaries and national parks in India is approximately 4700 sq. miles. This is an insignificant percentage of the total forest area of the country. Yet, these tiny pockets, the last refuge of India's vanishing wild life are far from inviolate. Grazing is permitted in them. Commercial quality timber is grown and extracted from them. Poaching is common, both by villagers allowed to live within the sanctuaries and permitted to keep 'crop protection' guns and affluent visitors (contractors and sometimes even Government officials). All these not only disturb animal and bird life but also make their habitat unsuitable. If grazing, and commercial exploitation of timber, and poaching are not stopped soon in these wilderness areas they will have nothing left to show except emaciated cattle.

The other point is that there has, sadly, been no effort made by the Government to get the expert advice of conservationists while planning projects (conservationists until very recently have been classified as cranks and eccentrics) so that vast areas at dam sites and irrigation and industrial projects have been thoughtlessly denuded of valuable forest cover resulting not only in the extinction of several species of animals along with their habitat but also in the washing off of the top soil leading to serious erosion.

It is entirely practicable to plan towards control of further despoliation. There are men and women in India who can do valuable work to help this cause. It is their duty to make the Government aware of the urgent need to take corrective action before it is too late.

Once it is accepted that conservation is essential the first step is to provide effective management. Seshadri has listed 48 sanctuaries and national parks. Of these only a handful have any sort of management. The rest are neglected, and if neglected much longer, may cease to exist except on paper.

I did not know that the Tons, or Govind Ballabh Pant Sanctuary, created in 1955, in Tehri Garwal, is 368 sq. miles in area, that the Rishi-ganga or Nanda Devi Sanctuary formed in 1939 in the Himalayas for high elevation fauna is 250 sq. miles or that the Rajaji Sanctuary west of the Corbett Park was 173 sq. miles.

All these are bigger than the Corbett and Kanha National Parks and what wonderful places they would be to visit if only we heard more about them. Obviously, they are not as accessible as the better known sanctuaries; not considered important, and so they languish. Poachers and woodcutters will soon turn these beautiful forests into wasteland.

It is nothing short of criminal that we so callously neglect our most wonderful heritage. Too late, as Seshadri says, will the people of India realise that they have lost what nature took aeons to create.

G. S. RANGANATHAN

2. THE MALAYAN NATURE JOURNAL. RAIN FOREST ISSUE. Vol. 22 (1968-69). Parts 3 & 4. September 1969. pp. i-viii +99-206 (25×16 cm.). Kuala Lumpur, 1969. The Malayan Nature Society, P.O. Box 750, Kuala Lumpur, Malaysia. Price M$ 10.00 (=US $ 3.30/£1-7-6 Sterling).

This special Rain Forest Issue of *The Malayan Nature Journal* carries several papers of interest to botanists, foresters, and naturalists generally. Among others may be mentioned a study by T. C. Whitmore and C. P. Burnham of changes with altitude of forests and soils on granite near Kuala Lumpur, another by J. A. Bullock and Khoo Bin Khong of the formation of litter in tropical rain forest, a preliminary study by J. B. Kenworthy of water balance in tropical rain forest in the Ulu Gombak Forest Reserve, and a discussion by P. F. Burgess of ecological factors in hill and mountain forest in Malaya with a description of the rain forests at different heights. Among the shorter papers are a study by J. L. Harrison of the abundance and population density of mammals in Malayan lowland forests, an estimation by H. Elliott McClure of bird population density in the primary forest of Selangor, and a description by P. F. Burgess of colour changes in the Malayan forests in 1968-69. On the practical side are papers by Paul Wycherley on forests and productivity, and by J. A. Bullock on the productivity of the rain-forest ecosystem.

As is usual with *The Malayan Nature Journal*, the papers are illustrated with numerous well taken and well reproduced photographs.

D. E. R.

3. THE CLUE BOOKS: INSECTS AND OTHER SMALL ANIMALS WITHOUT BONY SKELETONS. By Gwen Allen and Joan Denslow. pp. 61 (22.5×20.5 cm.) with many illustrations by Derek Whiteley. London, 1969. Oxford University Press. Price 15*s*. net.

The Clue Books are a slim, square series for children between the ages of eight and twelve. The other books in the series are ' Birds,' ' Bones,' ' Flowers,' and ' Trees.'

We have become used to a children's natural history literature which is out to charm the child, using lavish photographs and exotic colour. The Clue Books fall in a different category. Most pages are in sober black and white, although there are attractive and accurate colour pictures as well. The book aims to capture the intelligent child by making the whole business of insects an absorbing game, like a jigsaw puzzle, and by showing him that he can win; he can find out what a particular insect, found in the salad, actually is, discover its larvae and pupae, and finally, he can keep it as a pet. It seems a more enduring method than to merely enthrall him for a few moments by enormous shiny pictures. In fact the book could be used to very good purpose by the imaginative school-teacher. Although it is oriented to Britain and Europe, it could be used for India with a little bit of pruning by an adult.

The first pages deal with ' What are Insects ' generally, illustrated by line drawings and diagrams. The next pages deal with what the insect (or ' other small animal without a bony skeleton ') looks like under a magnifying glass. Does it have wings but no waist? If so, turn to page 19. On page 19 you learn something more, with another picture, and then turn to the right page. In the next section, where there are colour pictures dealing with various groups: Butterflies, Ants, Grasshoppers, etc. with short trenchant notes on each such group. The last pages deal with vivaria made out of jam-jars and daddy's shoe-box.

SHAMA FUTEHALLY

4. THE WORLD OF THE POLAR BEAR. By Richard Perry. pp. 195 (21.5×14.5 cm.) with 12 illustrations. London, 1966. Cassell & Company Ltd. Price 30*s*. net.

How many people realise that the polar bear is not far from extinction and that the total number currently is reckoned to be not more than about 8,000 to 12,000. Considering the vast area of the northern polar region which these animals inhabit it is dismal proof that no part of this earth, however, remote from Civilisation, escapes the pernicious influence of man.

Richard Perry (who has also written a book on the Tiger) noting that not much information was available in book form about polar bears set out to rectify the deficiency and he has succeeded in putting between the covers of his book a wealth of information in a systematic manner. Observations about polar bears have been recorded since 890 A.D. and Perry quotes from over fifty sources from the earliest times to the 20th Century.

A polar bear litter consists of one or two cubs, very rarely three. A cub when born is 1 to 2 lbs. in weight and a big adult male is 8 to 9 ft. long and weighs about a thousand pounds (females are smaller). The largest male recorded was 11 ft. long and weighed 1,800 lbs.—about as big as the Alaskan or Kodiak bear. Cubs are cast off after the first spring when they are 15-16 months old although some stay longer even up to the 3rd year. Polar bears are fertile up to 25 years and have a maximum life span of 35-45 years.

The Polar bear is a powerful and indefatigable swimmer capable of doing 120 to 180 yards per minute. About the only creature he fears is the killer whale which may be the reason the polar bear, although an excellent swimmer, avoids water if he can. He is also wary of the Bull Walrus which may attain a length of 15 ft., a weight of $1\frac{1}{2}$ tons and is equipped with 3 ft. long tusks weighing 10 lbs. apiece. The polar bear is no fool.

Seals form the staple diet of Polar bears, mainly blubber, the flesh being mostly left to Arctic foxes and ravens who are hangers on. In addition, along with vegetable matter (during summer) they also eat cast up marine animals, mussels, starfish, shrimps, and other crustacea. They seldom catch fish. 156 lbs. of walrus blubber and meat has been found in the stomach of a polar bear. This is about twice as much as what a hungry tiger or lion can consume at one sitting. In captivity, very much less suffices to feed a polar bear, the menu at one zoo being 10 lbs. of horse flesh, 3 lbs. of butterfish, 3 lbs. mackerel and 4 to 5 lbs. of stale bread.

Polar bears are canny hunters and either when waiting patiently near the blow holes of seals or swimming submerged towards an unsuspecting seal on an ice floe, they exhibit great intelligence. When frustrated, which must be fairly frequently, they vent their rage almost in human fashion. A thwarted bear may jump up and down with fury, smack the water, roar and toss snow. One bear smashed his paws against a rock out-crop severely injuring them as subsequently discovered. Polar bears also gambol and glissade down slopes with keen enjoyment.

The ice pack travels clockwise around the North Pole at about 2 miles per day and Polar bears are usually to be found on this, leaving it for the mainland where they go to hibernate. Before hibernation they eat moss to provide an internal obstruction referred to as 'tappen', then stuff themselves with blubber which must keep them alive for several months.

The dens constructed for hibernation are quite large and show considerable engineering skill. Quite frequently, an entrance tunnel in the snow leading to an ' ante room ' and an inner chamber at a slightly raised level (to retain warmth) with a ledge between.

Estimates of Polar bear population vary between 6,000 to 17,000 and Perry thinks it may be 8,000 to 12,000. The replenishment rate (excess of cubs over mortality) may not be adequate. The species, therefore, is in danger of becoming extinct. The Russians were the first to ban the killing of polar bears (in the late fifties?) and the Canadians and Norwegians followed suit. The U.S. called an international meeting in 1965 to discuss measures to protect the Polar bear.

The Arctic regions have a wealth of animal and bird life and Mr. Perry has provided much interesting information not only about the polar bear but also about the seal, walrus, muskox, arctic fox, wolf, killer-whale, glaucous gull, kittiwake, skua and ptarmigan. It would be wonderful to visit the fascinating world of the Polar bear. The next best thing is to read about it.

G. S. RANGANATHAN

5. THE WEALTH OF INDIA: A DICTIONARY OF INDIAN RAW MATERIALS AND INDUSTRIAL PRODUCTS. Vol. VIII: Ph-Re. pp. xxx+394+XII (27.5×21.5 cm.). 11 plates and 142 text-figures. New Delhi, 1969. Council of Scientific & Industrial Research. Price Rs. 70; 140*s*; $ 21.

Vol. VIII of the Raw Materials portion of THE WEALTH OF INDIA, which follows its predecessor after an interval of two years and more, keeps up the high standard of the series. During the interval the Editorial Committee suffered a serious loss by the death of Dr. Baini Prasad. Since then another eminent member of the Editorial Committee has died, the Rev. Fr. H. Santapau. The reviewer trusts that their absence from the Committee will not slow down the rate at which this valuable encyclopaedia of India's resources makes its appearance.

Several of the genera dealt with in this volume cover products of common use or occurrence and furnish the layman with detailed and helpful information about familiar things, regarding the origin, procuring, and uses of which his knowledge is limited and vague, for instance *Phoenix* (date palms), *Pinus* (pines from which, besides commercial timber, turpentine, and rosin, come the chilgoza seeds that we eat with such relish), *Piper* (betel leaves, black pepper), *Pithecellobium* (Madras Thorn, known among other vernacular names as vilayati imli, the fruit of which to our schoolboy palates was a delicacy), *Plantago* (isubgol), Plumbago (a common garden plant, which besides other uses provides a drug which we are told may be of use in the treatment of leucoderma and baldness of the head), *Prunus* (almonds, apricots, plums, peaches, cherries), *Psidium* (guavas), *Pyrus* (pears), *Punica* (pomegranates), *Raphanus* (radishes), and many more. Deserving of special mention is *Rauvolfia*, the source of a drug for a long time in use in Ayurvedic practice, the value of which was realised by allopaths only in the last decade, leading to a sudden drain on our wild-grown supply and to a hurried search for practicable methods of establishing a cultivated supply. On the zoological side attention may be drawn to articles on Prawns, Shrimps & Lobsters, and on Porpoises & Dolphins, and on the minerals side on Rare Earths, Quartz & Silica, and Phosphates.

One slight mistake has crept in, at page 165. The tree illustrated in text-figure 57 is *Plumeria alba*, not *Plumeria acuminata*.

The index, giving the common English names as well as those in the principal Indian vernaculars and also trade names, makes reference easy for the layman.

D. E. R.

Miscellaneous Notes

1. WILD DOG'S COURAGE RATING

Wild dogs, *Cuon alpinus* (Pallas), have always been presented to the world as intrepid, ruthless and wanton killers. Yesterday, I watched an incident, which together with the encounter between a pack of dogs and a herd of sambar hinds, I had reported earlier, leaves me in doubt as to their courage rating.

A pack of wild dogs was hunting in and around ' Cheetal walk ' our week-end home in the jungle in the low country in the Nilgiris. I followed them unseen by working my way from one hide to another, placed by me along the Sigur River.

From the first machan I could see 9 dogs; six of them were sub-adults and were lolling about waiting for a lead, while 3 older dogs were running up and down the far bank trying to pick up a fresh scent. As the dogs went down stream, beyond sight, I got down from the machan and got into another, which was 150 yards below the first. This machan commands an excellent view of the river for nearly 300 yards. As I was sitting there, I saw about half a dozen dogs at the water's edge 100 yards below, hesitating to get in. The river which usually holds about 6 inches to a foot of water, had about 2 to 3 feet of water in it, after recent rains. Just then a sambar stag carrying 20 in. antlers walked into the stream-bed from my side of the river, almost opposite the spot where the dogs were. Without hesitation it waded into the stream and made, in a leisurely manner, for the section of the bank where the dogs stood. I was so sure that the stag was being driven towards the waiting dogs that I fully expected the rest of the pack to break cover behind the stag at any moment. Instead, to my surprise a larger stag followed. Seeing the stags making their way towards them, the dogs retreated. Shortly afterwards I saw them cross the river 50 yards further down. There were 16 of them and half of them had just grown out of their puppy-hood.

I remained to see if the retreat was designed to be a tactical move. It was not.

The stags had moved up and were almost opposite me, on the far bank. I had them under observation for nearly an hour. They hung about together and were joined by two hinds, who were obviously in the area even when the dogs were operating there. They seemed to be together, just in case.

Only some months previously we came across a very freshly killed young sambar stag with 15 in. horns in the Moyar flume channel, about

5 miles from ' Cheetal walk.' On seeing us the dogs fled. Watching the dogs were a young sambar stag and 3 hinds, some 50 yards away.

This would show that wild dogs in our area do kill adult sambar, but prefer not to if they can help it. It is also possible that sambar around ' Cheetal walk ' have, out of necessity, learnt to gang up to defend themselves, whatever the case, it is apparent that wild dogs have been over-rated, so far as their courage is concerned.

"CANOWIE"
COONOOR-1, E.R.C. DAVIDAR
NILGIRIS,
October 12, 1969.

2. HABITAT OF THE HIMALAYAN TAHR *HEMITRAGUS JEMLAHICUS* (H. SMITH)

The genus *Hemitragus* comprises three forms that are usually each assigned specific rank. The morphological differences between them may not be as great as that reported and subspecific distinction might prove to be a better expression of relationship.

Previous reports on the habitat of the Himalayan tahr imply that it is a forest dwelling species. In New Zealand its preferred habitat is the zone above the tree line and below the permanent snow. A reappraisal of habitat requirements in the Himalaya showed that tahr were observed only above tree line, both in winter and summer. Previous reports therefore appear to be in error. Habitat requirements in New Zealand and the Himalaya are identical within the limits imposed by differing plant communities. The error in previous descriptions of habitat may be due both to confusion of the tahr with the serow (*Capricornis*) and to the finding of male tahr wandering below their normal altitudinal zone.

The Himalayan tahr *Hemitragus jemlahicus* ranges from Kashmir to Sikkim along the Himalaya (Wrenicke 1943, Bailey 1944, Ellerman & Morrison-Scott 1951, Frenchkop 1955 and Das 1966). Prater's (1934) contention that it also occurs in Bhutan has not been confirmed[1].

Pohle (1949) proposed a separate sub-species for the tahr of Sikkim, differentiating this postulated form from that in Nepal on alleged differences in horn spread and pelage. Apparently he was unaware of the marked seasonal changes in pelage colour of tahr because he has compared the winter pelage of Sikkim specimens with descriptions of summer pelage of specimens collected farther west. Pohle does not make a good case for morphological differences between tahr of Sikkim and Nepal. Neither

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[1] See the following note—Eds.

does Schaefer (1950) argue convincingly for geographic and genetic isolation of the two populations. The sub-species is not recognised here.

Charles (1957) proposed that until more material becomes available for detailed comparison, the three forms of *Hemitragus* (*jemlahicus* in the Himalaya, *hylocrius* in southern India, and *jayakari* in eastern Arabia) should be considered provisionally as races of the nominate form *Hemitragus jemlahicus*. On zoogeographic grounds I suspect that sub-specific rather than specific distinction of forms will prove to be the more meaningful expression of their interrelationship.

The habitat of Himalayan tahr has been described as thick forest interspersed with rocky bluffs (Kinloch 1876, Blanford 1888, Ward 1922, Burrard 1925, Prater 1934, Morris 1965) and Burrard (1925) stressed that individuals " never by any circumstances wander above the tree-line".

In contrast, its habitat in New Zealand, where it was introduced in 1904, is restricted almost entirely to the zone above tree-line (Anderson & Henderson 1961, Christie & Andrews 1964, Caughley 1965, 1966). Its altitudinal range of about 3,000-7,000 ft. in that country is ecologically and climatically equivalent to 12,000-16,000 ft. in the Himalayas. Tahr do occasionally descend below 3,000 ft. in New Zealand, but only as a result of males wandering before the rutting season.

From March 1968 I spent a year in Nepal and was able to investigate this apparent paradox. Although all altitudinal zones from tropical to frigid were investigated, tahr were found only in the region above tree line at altitudes between 12,500 ft. and 16,000 ft. The greatest number of observations were made between 13,000 ft. and 15,000 ft. and this range was the same for both summer and winter. These observations suggest that previous statements on the habitat of tahr in the Himalayas are incorrect, and that habitat requirements in New Zealand and Nepal are identical within the limits imposed by different vegetation types.

Two reasons for the confusion come to mind. Firstly, most of the quoted reports on habitat appear not to be based on observation but are repetitions without acknowledgement of observations made by Kinloch (1876) and Burrard (1925). Both these men certainly shot tahr in forest but these animals are likely to be males wandering in winter. No report is available of a female having been shot in forest.

Secondly, some reports of tahr in forest may have originated from mistaken identity. The serow *Capricornis sumatraensis* is called " tahr " by several hill groups in Nepal, the " th " form indicating a hard " t " and not the " th " of English useage. No ethnic group in Nepal uses " thar " for *Hemitragus*: Brahmins and Chetris use " jharal "; Tamang and Gurung use " jharal," " jharal-thar " and sometimes the Tibetan

" yang "; and sherpas use " reiwo." This confusion of names may have resulted in the occasional instance of serow being reported as tahr.

On the basis of observations reported here and those reported from New Zealand, the published descriptions of the habitat of the Himalayan tahr require amendment. In both winter and summer the habitat comprises the zone of grassland between tree line and the permanent snow. In the Himalaya this zone lies between 12,000 ft. and 17,000 ft. Occasionally individuals will be found lower than this but such occurrences are at variance with normal behaviour.

School of Biological Sciences, University of Sydney, Sydney, Australia, GRAEME CAUGHLEY

September 12, 1969.

References

Anderson, J. A. & Henderson, J. B. (1961): Himalayan Thar in New Zealand. New Zeal. Deerstalkers' Assn: Spec. Pub. 2.

Bailey, F. M. (1944): The Himalayan Tahr (*Hemitragus jemlahicus* H. Sim.) [Sic]) in Sikkim. *J. Bombay nat. Hist. Soc.* **45**: 82-83.

Blanford, W. T. (1888): The Fauna of British India including Ceylon and Burma. Mammalia. London.

Burrard, G. (1925): Big Game Hunting in the Himalayas and Tibet. London.

Caughley, G. (1965): Horn Rings and Tooth Eruption as Criteria of Age in the Himalayan Thar, *Hemitragus jemlahicus. New Zeal. Jl Sci.* **8**: 333-351.

———————, (1966): Mortality Patterns in Mammals. *Ecology* **47**: 906-918.

Charles, R.P. (1957): Morphologie Dentaire du Thar et du Bouquetin Espéces Actualles et Subfossiles des Gisements Préhistoriques. *Mammalia* **21**: 136-141.

Christie, A. H. C. & Andrews J. R. H. (1964): Introduced Ungulates in New Zealand. (a) Himalayan Tahr. *Tuatara* **12**: 69-77.

Das, S. M. (1966): Palaearctic Elements in the Fauna of Kashmir. *Nature* **212**: 1327-1330.

Ellerman, J. R. & Morrison-Scott, T. C. S. (1951): Checklist of Palaearctic and Indian Mammals 1758 to 1946. London.

Frenchkop, S. (1955): Sous-ordre des Ruminants ou Sélénadontes, pp. 568-593. *In* P.-p. Grassé (ed.) Traité de Zoology. Paris.

Kinloch, A. (1876): Large Game Hunting in Thibet and the Northwest. London.

Morris, D. (1965): The Mammals. London.

Pohle, H. (1949): *Hemitragus jemlahicus schaeferi* sp. n., dieöstlichste Form des Thars. *Zool. Anz.* **194**: 184-191.

Prater, S. H. (1934): The wild animals of the Indian Empire and the Problems of their Conservation. *J. Bombay nat. Hist. Soc.* **37**: 59-96.

————, (1965): The Book of Indian Animals, second (revised) edition. Bombay.

Schaefer, [E] (1950): über den Schapi (*Hemitragus jemlahicus schaeferi*). *Zool. Anz.* **145**: 247-260.

Ward, A. E. (1922): Game Animals of Kashmir and the adjacent hill Provinces. *J. Bombay nat. Hist. Soc.* **23**: 595-609.

Wrenicke, C. J. T. (1943): Occurrence of the Himalayan Tahr (*Hemitragus jemlahicus*) in Sikkim. *J. Bombay nat. Hist. Soc.* **44**: 114-117.

3. HIMALAYAN TAHR, *HEMITRAGUS JEMLAHICUS* (H. SMITH, 1826) IN BHUTAN

In so far as neither S. H. Prater in his BOOK OF INDIAN ANIMALS nor Ellerman & Morrison-Scott in their CHECKLIST OF INDIAN AND PALAEARCTIC MAMMALS mention the presence of tahr in Bhutan, I wish to record that this animal is present and not uncommon in the Chuka, Gedu, Phutlibr areas of S. W. Bhutan on the Thimphu road, between 5,000 to 7,000 ft. above sea-level.

I had heard of its occurrence at Chuka a year ago, and I was given some ' poached ' tahr meat a few weeks ago. I myself was lucky to see a young animal (sex unknown) with short horns, at Phutlibr on 27 October 1969 at midday in rocky jungle whilst I was watching birds in a favourite haunt. The animal did not see me and approached head-on to within less than ten yards when it stopped and, puzzled by my keeping still, watched me for some ten seconds before taking fright.

My Bhutanese companion also saw the animal and stated its name in Bhutanese to be ' Chara,' similar to the Nepalese name of ' Jharal.'

Its occurrence in Eastern Bhutan will be investigated and the subject of a further letter if any reliable information comes to light.

BANK OF BHUTAN,
PHUNTSHOLING,
BHUTAN,
November 7, 1969.

J. R. S. HOLMES

4. BLACKBUCK, *ANTILOPE CERVICAPRA* (LINNAEUS) SWIMMING

On 16 December 1969, I was walking back to the Rest House at about 5-30 P.M. after watching a large number of Blackbuck around the observation tower at the Point Calimere Sanctuary. As I came near the forest rest house, my way was blocked by a lagoon about 25 yards wide, which was either a backwater fed by the sea or a drainage of the water from the forest. I was looking for a safe place to cross it when a fisherman coming from the opposite direction shouted a warning to me not to cross where I was, as there was apparently a strong current at the junction of the sea and the lagoon. As I crossed further up as he directed, I saw him swimming across. It must have been quite deep. I started walking towards the Rest House when I saw a Blackbuck standing to my left towards the sea. On seeing me he started to gallop along the shore, until he came near the lagoon. He stopped momentarily, when he saw his way cut off, but the next moment jumped into water and with two characteristic leaps he was in the middle of the lagoon and promptly went down. After a couple of seconds I saw his head bob up and he started swimming steadily till he reached the opposite shore. He shrugged and sneezed a few times and bounded off out of sight. I am not aware whether Blackbuck have been observed swimming before.

BOMBAY NATURAL HISTORY SOCIETY'S BIRD MIGRATION STUDY CAMP, POINT CALIMERE SANCTUARY, TAMIL NADU, *January* 4, 1970. S. A. HUSSAIN

5. A RECORD OF THE TIGER BITTERN, *GORSACHIUS MELANOLOPHUS* (RAFFLES) FROM KARAIKUDI, RAMANATHAPURAM DISTRICT, TAMIL NADU

In December, 1968, Prof. J. Samuel Raj, Head of the Department of Zoology, Alagappa College, Karaikudi, brought to the Museum a mounted specimen of a medium-sized bird more or less resembling a Black Bittern. Since the species was not represented in the Museum collection and as we were doubtful about its correct identity, we had it sent to the Bombay Natural History Society, where it was identified as the Tiger Bittern or Malay Bittern, *Gorsachius melanolophus* (Raffles). This is quite an unusual record for this species since it had not been apparently recorded earlier from eastern India, although there was one record from the Nilgiris in the report of the Eastern Ghats Survey by Whistler and Kinnear. The occurrence of this species in Tamil Nadu is therefore quite unique and is worth reporting.

Prof. Samuel Raj who secured the specimen reports that the bird was caught on the Alagappa College campus, Karaikudi, Ramanathapuram District, on 7 November, 1967, which was a rainy day. Due to heavy rains, the bird is reported to have dropped down from a tree. It was kept alive for a week and stuffed and mounted later on and finally brought to the Madras Museum in December, 1968. Prof. Samuel Raj reports that specimens of the Tiger Bittern are seen occasionally in and around Karaikudi during November and December. The distribution of this species is cited in Stuart Baker's (1929) FAUNA OF BRITISH INDIA **6**: 362 as " Ceylon, the Malabar Coast to the Southern Bombay Presidency, Assam, Manipur, Burma, South through the Malay States to Sumatra, Java, Borneo and Formosa."

ACKNOWLEDGEMENT

I am grateful to Prof. J. Samuel Raj for having kindly donated the specimen of this Bittern to the Madras Government Museum, where it

was hitherto unrepresented, and for furnishing the necessary information on its locality, date of collection and the circumstances under which the specimen was collected.

GOVERNMENT MUSEUM,
EGMORE, MADRAS-8,
December 1, 1969.

S. T. SATYAMURTI
Director of Museums, Madras

6. ON THE OCCURRENCE OF SWINHOE'S SNIPE, *CAPELLA MEGALA* (SWINHOE) NEAR BOMBAY, AND A NOTE ON ITS IDENTIFICATION

On 7th December 1947, while shooting with Dr. Sálim Ali on the lower portion (*c*. 300′) of Cathedral Rock, near Kalyan, Bombay, we put up two snipe out of tall rushes on the edge of terrace paddy. In flight they appeared much heavier and darker than either Pintail (*C. stenura*) or Fantail (*C. gallinago*). We preserved the less damaged one, believing it to be Swinhoe's [*C. megala* (Swinhoe)] which has been recorded in eastern and southern India but not so far north-west. It was sent to the British Museum, but was identified by Sir Norman Kinnear as a Pintail (*C. stenura*).

In the course of cataloguing the collection recently, I found this specimen (No. 14938) listed among *C. gallinago*. The notes on the label prompted me to re-compare this with the Pintails and, as the tail (originally noted to have 22 feathers with the central pair in moult, and a part of which is preserved) definitely lacked the more pin-like feathers on the outside, I sent the skin to Dr. Dillon Ripley who agrees that it is Swinhoe's Snipe (*C. megala*).

This extends the accepted winter range of the species north-west of Madras, Mysore, and Kerala.

In 1934, La Personne (*JBNHS* 37 : 734) stated that Swinhoe's Snipe could be distinguished from the Pintail by its bastard wing being 20 mm. or longer as against 17 or less in the latter. Stuart Baker confirmed the difference and suggested diagnostic limits of over 19 mm. for Swinhoe's and under 19 mm. for the Pintail. This is repeated in subsequent literature including IND. HANDBOOK (2 : 285), but the spike-like and longest feather in the bastard wing only measures 15-18 mm. in this and six other specimens in the Society's collection and does not appear to be any longer than in the Pintail.

This species resembles the Pintail in the shape of the bill tip, the barring on the underwing, and the absence of the broad white tips to the secondaries, and the only consistent differences appear to be:

(*a*) the absence of the pinfeathers at the side of the tail, (*b*) a slightly longer wing (135-144, cf. 128-137), and

(*c*) a longer tail (52-60, cf. 44-50).

The last character does not appear to have been noticed before but is very consistent.

75, ABDUL REHMAN STREET, HUMAYUN ABDULALI
BOMBAY-3,

January 9, 1970.

7. OCCURRENCE OF THE GREAT SNIPE, *CAPELLA MEDIA* (LATHAM) IN BURMA AND INDIA

Only three records of the Great Snipe [*Capella media* (Latham)] have been accepted from peninsular India and, though it is said to have been obtained in Ceylon and the Andamans, it has not been recorded from Burma. It may therefore be interesting to note that in the course of cataloguing the Society's collection, we found 9 birds of this species listed as *Capella gallinago* (Linnaeus). Six of them are from Iraq and Persia but, in addition to one from near Bangalore collected by Capt. A. Boxwell on 28th October 1910 (the label now reads: " Capt. A. Boxall, 2 December 1910 ") and which is one of the three records referred to above, there are two more, from Walmer, Nilgiris, and Moulmein, Burma.

The first of these two specimens was collected by Phythian-Adams and is marked as received in November 1933. It was no doubt sent to the Society as it appeared different from the Common Snipe but was apparently marked *C. gallinago* by one of the Society's assistants and the identification not checked upon subsequently. This forms the fourth record from India.

The Burmese bird was collected at Moulmein by W. A. W. Dawn but the label bears no date. This also was marked as the Common Snipe and has been overlooked for many years. Mr. Dawn was elected a member of the Society on 28 February 1899, a fact which gives some indication of the date of collection.

In addition to the longer wing the additional amount of white on three of the outermost tail-feathers is very distinctive. The sketch in IND. HANDBOOK (reproduced from BR. HANDBOOK) represents this correctly but reference is made to the Key in the FAUNA which refers to the black base to the feathers and implies that the distal portion is pure white and without the black bars. The Key in IND. HANDBOOK (2 : 278) perhaps needs another correction, for it specifies a wing under 150 mm. The specimens available have their wings 138 (frayed)—150. The upper limit would be larger in fresh birds. The tarsus is noticeably stouter than in *gallinago*.

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
SHAHID BHAGAT SINGH ROAD,
BOMBAY-1 BR,
October 25, 1969.

HUMAYUN ABDULALI
SHANTA NAIR

8. NOTES ON INDIAN BIRDS-11. ON THE DISTRIBUTION OF *STERNA FUSCATA* LINNAEUS IN INDIAN LIMITS—A CORRECTION

At a monthly meeting of the Bombay Natural History Society held on 4 July 1887 (*JBNHS* **2**:286), reference was made to a Sooty Tern *Sterna fuliginosa*, now *S. fuscata*, said to have been obtained by W. F. Sinclair at Alibag, Kolaba District; this is noted as the only record from the area in " The Birds of Bombay and Salsette " (1939, *JBNHS* **40**:636).

In 1938, Sálim Ali, Charles McCann and I collected numerous remains of terns and their eggs on the Vengurla Rocks, off Malwan, south of Bombay, and among them the smaller wings could be divided into two groups, brown and grey. Sálim Ali who compared our specimens with specimens in the Society's collection (1939, *JBNHS* **43**:448) divided the brown wings into two groups: (a) measuring 237 (2), 240, and 242 mm., which he identified as *Sterna anaethetus*, recorded there by Hume in 1875, and (b) 2 measuring 270 and 294, which he identified as *Sterna fuscata*, making the only nesting record for the area, the next nearest being from the Laccadives. It may be mentioned that the wings found by us have not been preserved.

On 21 October 1947, I obtained 2 terns out of a loose party of 5 or 6 on wooden boxes and similar rubbish floating in a calm patch in the sea, about a mile south of Bombay and 5 miles off the mainland. These were identified as *Sterna fuscata* by Sálim Ali.

When working out my first collection from the Andamans (1968), I was unable to separate the material in Bombay into two species *fuscata* and *anaethetus*, and one of the two just mentioned was sent to the Smithsonian Institution where they identified it as *anaethetus*. Presumably for this reason this record is omitted from the INDIAN HANDBOOK, but a reference is made to Sinclair's specimen.

While cataloguing the collection (1969), the bird from Alibag seemed to me to be no different from the several others accepted as *anaethetus*, and I requested the British Museum (Natural History) to send me representative specimens of both species. With this additional material in hand, Sálim Ali and I are agreed that we have no specimen of *fuscata* in the Society's collection, and that the bird collected by Sinclair is *anaethetus* and not *fuliginosa* (*fuscata*) as originally recorded.

Judging from the material available, *fuscata* is larger (wing over 270) than *anaethetus* and is separable from it by its much darker upper parts and the white eye-stripe not continuing beyond the eye as it does in *anaethetus*. The two wings from Vengurla Rocks, if correctly measured, indicate that *fuscata* breeds there but, in view of the possibility of error in ascertaining the correct measurements from broken wings separated from the body, it is advisable to await a confirmation.

The 16 specimens of *anaethetus* available in Bombay from the Red Sea to the Andamans and the Ceylon specimens obtained from the British Museum cannot be separated into the three races now accepted in the FAUNA and INDIAN HANDBOOK.

75, ABDUL REHMAN STREET, HUMAYUN ABDULALI
BOMBAY-3,
January, 30, 1970.

9. THE FLIGHT SPEED OF THE HOUSE CROW, *CORVUS SPLENDENS* VIEILLOT

On 19 August 1969, I was going from Vellore to Arkonam (North Arcot Dt., Tamil Nadu) in our departmental jeep for field work, when near the village of Vallam, I noticed a pair of house crows flying in the same direction as the jeep. As the trunk road was almost straight and they were flying overhead parallel to the road, we kept pace with them for nearly five kilometres. The speedometer of the jeep showed a constant speed of 35 kilometres per hour. They were flying leisurely quite often calling to each other and it appeared that this was their normal flight speed as against the hurried flight when they are late to return to the roosting place from feeding areas.

Care K. N. PANICKER
VIRUS RESEARCH UNIT,
C. M. C. HOSPITAL,
VELLORE,
December 26, 1969.

10. IS THE CORRECT NAME OF THE MANGROVE WHISTLER, *PACHYCEPHALA CINEREA* (BLYTH) OR *PACHYCEPHALA GRISOLA* (BLYTH)?

Blyth (1842, *J. Asiat. Soc. Beng.* **11**: 799) was confused over the identity of a female specimen supposed to be an example of *Tephrodornis superciliosus* Swainson v. *Lanius keroula* Hardwicke and Gray. It differed considerably from the male. Both specimens were collected together out of a small party (from the neighbourhood of Calcutta). At a later date he shot another female of *T. superciliosus* and found that the male and female were alike. The controversial female specimen could therefore be isolated specifically and it appears that he could not place it with any other species. The description laid down by him was as follows:-

". . . . no white whatever on the tail, which is besides shorter and less rounded and the superciliary streak and dark colour of the ear-coverts are also wanting." He further pointed out ". . . the diversity in the tail is so remarkable that I imagine few would incline to regard them specifically the same." This expression of doubt was cleared by him when a year later (*J. Asiat. Soc. Beng.* **12**: 180) he remarked, "The supposed variety of *Tephrodornis superciliosus*, having no whitish line over the eye, nor white on the exterior tail feathers may be designated *T. grisola*". In the year 1847, Blyth described *Muscitrea cinerea* (*J. Asiat. Soc. Beng.* **16**: 122) from Arakan, Burma. It was later found that *Muscitrea cinerea* was the same as *Tephrodornis grisola.* The species name *grisola* has been subsequently used by Jerdon (1862, BIRDS OF INDIA, **1**: 411) Gadow (1883, CAT. BIRDS BRITISH MUS. **8**: 220), Oates (1890, FAUNA BRITISH INDIA, Birds, **2**: 31), Oberholser (1912, *Smithson. misc. Collns.* **60**: 11), Stresemann (1913, *Novit. Zool.* **20**: 355), Baker (1924, 1930, FAUNA BRITISH INDIA, Birds, **2**: 484; **7**: 190), Robinson (1927, THE BIRDS OF MALAY PENINSULA **1**: 189) Delacour & Jabouille (1931, LES OISEAUX DE L' INDOCHINE FRANCAISE p. 208), Kuroda (1933, THE BIRDS OF THE ISLANDS OF JAVA **1**: 151), Junge (1936, *Temminckia* **1**: 59), Riley (1938, *Bull. U.S. nat. Mus.* **172**: 484-485), Chasen (1939, THE BIRDS OF MALAY PENINSULA **4**: 231), Smythies (1940, THE BIRDS OF BURMA, p. 164). From the literature as far as available to me I find that since 1940, the species name *cinerea* has been used by De Schaueusee (1940, *Proc. Acas nat. Sci. Phil.* **91**: 409), Delacour (1947 BIRDS OF MALAYASIA, p. 298), Glenister (1951, THE BIRDS OF MALAY PENINSULA, SINGAPORE AND PENANG, p. 227), Smythies (1953, THE BIRDS OF BURMA, p. 159), Ripley (1961 A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN, p. 440), Mayr (1967, CHECK-LIST OF THE BIRDS OF THE WORLD **12**: 8), Ali & Ripley (1968, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN **1**: xlvi) and others. Ripley, Mayr, and a few others explained that *Tephrodornis grisola* was unidentifiable, hence the later name *cinerea* should be used.

The genus *Muscitrea* has since been synonymised with *Pachycephala* Vigors (1825, *Trans. Linn. Soc. Lond.* **14**: 444). An examination of the type specimen of Blyth's *Tephrodornis grisola* (♀, Botanical Garden, Sibpur, near Calcutta), present in the Zoological Survey of India, however, leaves one without any doubt as to its correct identity—that it is the same bird currently known as *Pachycephala cinerea* (Blyth). No doubt Blyth's (*J. Asiat. Soc. Beng.* **12**: 180) description of *Tephrodornis grisola* is vague and inadequate, but the species can be identified by referring to the type specimen. Since the species name *grisola* is older than *cinerea* and is identifiable, it should be resurrected. Such an action will not violate Article 23b of the code.

ZOOLOGICAL SURVEY OF INDIA, AJIT KUMAR MUKHERJEE
CALCUTTA-13.
April 10, 1969.

11. SLIGHT REACTION FROM BITES OF THE REAR-FANGED SNAKES *BOIGA CEYLONENSIS* (GUNTHER) AND *DRYOPHIS NASUTUS* (LACÈPÈDE)

While handling a Cat Snake (*Boiga ceylonensis*, 750 mm.) which I had collected from Khandala, it bit and held the middle of my left middle finger, the snake's whole mouth closed over the finger. There was slight bleeding and after a few minutes the bitten area was swollen to the degree of a moderate bee sting, accompanied by itching. These symptoms persisted for about half an hour, the swelling gradually disappeared after about two hours.

In April, while handling a Green Whip Snake (*Dryophis nasutus*, 680 mm.) it made a sudden jab at my face (which is a common habit of this species) and made a quick bite on the tip of my nose. Immediately blood started dripping and this continued for an unusually long time (18 minutes). The nose tip is a very sensitive area and I experienced the itchiness mentioned above, but only slightly noticeable swelling.

Species of *Boiga* and *Dryophis* in India grow to over six feet in length, but the only danger from their bites would be to those rare individuals " hyper-sensitive " to the venom (similar to the more commonly occurring allergy to bee and wasp venoms). The only rearfanged snake considered dangerous to man occurs in Africa, the Boomslang (*Dispholidus typus*).

C/o CHATTOPADHYAYA, ROMULUS WHITAKER
CHATEAU MARINE NO. 6,
MARINE DRIVE,
BOMBAY,
March, 1968.

12. CANNIBALISM IN THE INDIAN RAT SNAKE *PTYAS MUCOSUS* (LINNAEUS)

I am at present keeping a number of rat snakes of various sizes and the water snakes *Cerberus* and *Natrix* together in a large pit with smooth high walls to prevent escape. Periodically I put live frogs, live and dead mice and rats in for the snakes, most of which thrive. Those that refuse to eat I simply release as all these specimens are common. Yesterday I noticed one of the rat snakes (8 feet in length) with a elongate bulge in its body which was obviously a snake. Checking, I noted the absence of a large *Natrix piscator* (44 inches and heavy-bodied). Today as I was looking into the pit I saw a seven foot rat snake seize a four foot snake of the same species and attempt to swallow it. The small snake, however, struggled fiercely and soon escaped. Later in the day I found a *Cerberus rhynchops* nearly bitten in two, evidently by a large *Ptyas*. *Ptyas mucosus* undoubtedly prefers mice, rats, frogs, and toads, but in the absence of sufficient quantities will attack and devour other snakes including its own kind. Deoras in SNAKES OF INDIA (1965) mentions snakes as part of the widely varied diet of the Indian rat snake.

C/o CHATTOPADHYAYA, ROMULUS WHITAKER
CHATEAU MARINE NO. 6,
MARINE DRIVE,
BOMBAY,
January 8, 1968.

13. A REDESCRIPTION OF *SIREMBO JERDONI* (DAY): (PISCES: BROTULIDAE)

(*With a text-figure*)

Five specimens of *Sirembo jerdoni* (Day) measuring 95 mm., 105 mm., 123 mm., 137 mm. and 145 mm. total length were collected during April 1964 from boat seine catches on the Visakhapatnam coast. This species has so far been recorded only from the Madras coast (Day 1888, Menon & Rao 1963). There is one specimen in the collections of the Zoological Survey of India, Indian Museum, Calcutta (Registered No. 13202/1), also collected from Madras (in 1940). Until now this species has not been assigned to its correct genus and the few earlier descriptions are meagre (Day 1888, 1889). Hence, it is redescribed here in detail under the relevant genus.

Day (1888) originally described this species under *Brotula* Cuvier as *B. jerdoni* despite the absence of barbels on both jaws, a characteristic feature of *Brotula*. His description is very brief and the counts for dorsal fin rays (126) and anal fin rays (95) are much too high. No figure is given, but he stated that a coloured figure of this species was amongst Jerdon and Elliot's illustrations. Neither these illustrations nor Day's type specimen are traceable, but the colour pattern of this species is more or less accurately described by Day.

Menon & Rao (1963), while discussing the systematic affinity of this species, stated that a new genus should be erected to accommodate it, since it differs from related brotulid genera in having the ventral fins behind the eyes and the dorsal originating in front of the pectoral. However, no description was given and their specimen is not available for examination. My observations on fresh specimens have shown that the origin of the ventrals is below eyes, well before the posterior margin of the orbit. The position of the origin of the dorsal fin does not seem to have any generic significance in this group. The confusion regarding the origin of the ventrals by Menon & Rao (1963) may be due to the fact that their observations were limited to a single preserved specimen. However, examination of the specimen of *S. jerdoni* in the Indian Museum (text. fig.) also shows that the ventral origin is in front of posterior margin of the orbit.

The absence of barbels on both jaws and the origin of the ventrals below the eyes are characteristic of two genera, *Haplobrotula* Gill (Smith 1961) and *Sirembo* Bleeker (Gunther 1862, Norman 1939); the latter can be distinguished from the former by (1) a single ray in each ventral fin (2 in *Haplobrotula*), (2) the presence of scales all over head and (3) the absence of spines on the preopercle and opercle. The characters of the present species conform to those listed above and hence it is placed in the genus *Sirembo*. The erection of a new genus as suggested by Menon & Rao (1963) is not necessary.

Sirembo jerdoni (Day)

D 89-92; A 61-63; V 1; P 23; C 10; Vert. 48 (13+35)

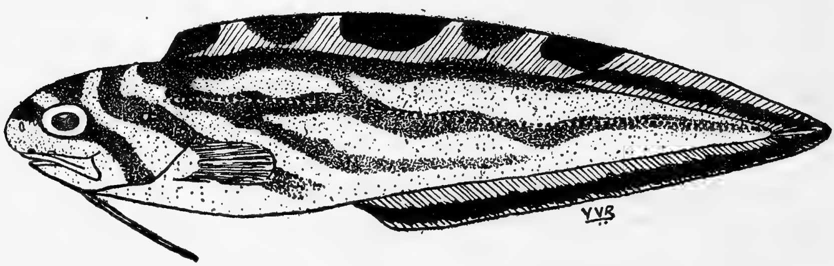
Body elongate, laterally compressed, tapering posteriorly. Greatest body depth 5.6-6.6, length of head 4.2-4.6, distance from snout tip to insertion of dorsal 4.8-5.0, to origin of anal 2.2-2.5, length of pectoral 8.0-9.0, all in total length. Snout 4.8-5.7, eye 3.4-3.8 and interorbital distance 3.8-4.2 in length of head. Snout blunt with three pores on either side; eyes covered by membrane. Mouth inferior, both lips with numerous tubercles. Maxilla reaches to a little behind posterior margin of orbit. Two rows of conical teeth in both jaws, the outer row a little enlarged; villiform teeth on palatine in oblong patches and a single inverted V-shaped patch on vomer.

A blunt spine at the superior corner of opercle. Four gill rakers on lower arm of the first gill arch; five branchiostegals; pseudobranchiae absent.

Lateral line in the upper half of body, single, distinct and complete.

Dorsal, caudal and anal fins continuous; dorsal originates before gill openings; anal originates one-fourth length behind that of dorsal; pectoral fins rounded, situated in the lower half of body; rays of all fins unbranched and embedded in thin membrane; no spines in fins; ventrals situated well before posterior margin of orbit, each a single ray, two-thirds length of head.

Scales cycloid, covered by skin, present all over head and body; base of pectoral scaly; no scales on fins.



Sirembo jerdoni (Day), total length 145 mm., showing the colour pattern.

Vent in advance of mid-point of total length; pyloric caecae 9 to 11; vertebrae 48 (13 prehaemal and 35 haemal). *Colour:* Body light brown; an oblique dark band from above snout across eye to the inferior corner of opercle; one band between eyes dorsally, one transverse band behind eyes which descends vertically on either side to some distance and then runs back obliquely through the superior corner of opercle fading out before anal origin. From nape two dark grey-brown bands run back along the body on either side, the first along the dorsal base to the last fifth of body and the second descending to the lateral line and running along it to the base of caudal; the second band gives off a branch above pectoral tip; this latter runs obliquely to above anal origin from where it runs parallel to the second band and gradually fades away by about middle of anal. In one specimen the two main bands are connected by a short band above anal origin. The bands of the two sides have a common origin dorsally in front of dorsal fin. Pectoral fin base slightly brown. There are five discrete roughly semicircular blotches on the dorsal fin, the first, third and fifth black in colour while the second and fourth are dark grey. The last blotch ends at about two-thirds length of the fin. After the fifth blotch the smaller specimens have one or more blotches but in larger specimens there is a continuous black band in the lower half of the fin up to tip of caudal. The anal fin has a broad black band running all along its lower half to meet that of the dorsal at the tip of caudal fin. The edge of anal fin may sometimes be lighter. The colour fades a little in formalin preserved specimens.

ACKNOWLEDGEMENTS

I am grateful to Dr. S. Dutt and Mr. P. J. P. Whitehead for valuable suggestions. My thanks are also due to Professor P. N. Ganapati for excellent facilities. To Dr. P. K. Talwar I am grateful for kindly examining the specimen of *B. jerdoni* in the Indian Museum for me and furnishing necessary information. I am indebted to the Council of Scientific and Industrial Research for the award of Senior Fellowship, during the tenure of which this work has been carried out.

CENTRAL REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
JABALPUR, (M.P.),
May, 20, 1969.

V. VISWESWARA RAO

REFERENCES

DAY, F. (1888): Fish. India, Suppl. 804.

——— (1889): Fauna of British India, Fishes. **2**: 435.

GÜNTHER, A. (1862): Catalogue of the Acanthopterygian Fishes in the collection of the British Museum. **4**: 371-374.

MENON, A. G. K. & RAMA RAO, K. V. (1963): Notes on three rare fishes from Madras. *Ann. Zool.* **4**(5): 47-48.

NORMAN, J. (1939): John Murray Expedition, Sci. Rept., Fishes. **7**(1): 80.

SMITH, J. L. B. (1961): The Sea Fishes of Southern Africa. 4th ed., Central News Agency Ltd., South Africa. pp. 360-364.

14. JOHNSON GRASS, *SORGHUM HALEPENSE*—A NEW HOST OF SUGARCANE GREEN BORER, *RAPHIMETOPUS ABLUTELLUS* ZELLER (PHYSITIDAE: LEPIDOPTERA)

The green borer, *Raphimetopus ablutellus* Zell. is one of the major pests of sugarcane in Bihar, Uttar Pradesh and Haryana States. It causes dead hearts on young shoots from March to June. Besides sugarcane, it has also been recorded on *Saccharum spontaneum* (Siddiqi & Singh 1959) and *Saccharum munja* (Gupta 1959).

During 1962 and 1963 a survey was made to record its alternate and collateral host plants in and around the Indian Institute of Sugarcane Research Farm, Lucknow (U.P.) from March to June, when this borer is found in serious form on sugarcane crop. Observations were made on various Graminaceous crops and weeds like wheat (*Triticum vulgare*), barley (*Hordeum vulgare*), oats (*Avena sativa*), maize (*Zea mays*), jowar

(*Sorghum vulgare*), kans or kahi (*Saccharum spontaneum*), Johnson grass (*Sorghum halepense*), sarkanda (*Saccharum munja*), kush (*Desmostachya bipinnata*), bharuhi (*Imperata cylindrica*), motha (*Cyperus rotundus*) and some unidentified weeds. In both years, young shoots of Johnson grass were observed to be attacked by two species of sugarcane borers, namely, *Chilotraea infuscatellus* Snellen and *R. ablutellus*, the latter being the first record on this weed. Out of 15 per cent of the total dead hearts found during June, 1963, 11 per cent were caused by *R. ablutellus* alone. During this period, full grown larvae were observed forming waterproof silken covering around their bodies in preparation for diapause. The infestation from March to April was very low in this grass and hardly 1 to 2 per cent shoots were attacked.

DEPARTMENT OF ZOOLOGY-ENTOMOLOGY, PUNJAB AGRICULTURAL UNIVERSITY, LUDHIANA,
May, 29, 1968.

J. P. CHAUDHARY

REFEERNCES

GUPTA, B. D. (1959): Insect pests of sugarcane in India IV. The green borer, *Raphimetopus ablutellus* Zeller. *Indian Sugar*. **9**(5): 269-271.

SIDDIQI, Z. A. & SINGH, O. P. (1959): Biology of *Raphimetopus ablutellus* Zeller (Lepidoptera: Pyralidae), the green borer of sugarcane in Uttar Pradesh. *Indian J. Ent.* **21**(2): 132-136.

15. PECULIAR ACCIDENT TO THE BUTTERFLY, *DELIAS EUCHARIS* DRURY

The Common Jezebel (*Delias eucharis* Drury) is always about in our garden at Andheri, Bombay, and on the morning of 7 September 1968 at 8 a.m. I found several of these alighting on a white Lantana shrub, which was covered with flowers. One butterfly, however, appeared to be struggling to get away from the flower, but its proboscis seemed to be entangled in the blooms, and the antennae thickly covered with pollen. Another of the same species came along, flitted over it for a while, and passed along. I watched this situation for some time and then pulled the butterfly away from the flower and placed it on the ground but it could not fly. I had it examined at the Society and was told that it was not damaged in any way. I wonder if any butterfly enthusiasts have ever come across a similar situation.

32-A, JUHU LANE, ANDHERI, BOMBAY-58,
September 9, 1968.

ZAFAR FUTEHALLY

16. THE FEEDING BEHAVIOUR OF THE LEMON BUTTERFLY *PAPILIO DEMOLEUS* L.

A large number of observations on the feeding visits of *Papilio demoleus* to flowers were recorded in the gardens attached to the Fruit

Experimental Station at Kirkee. The feeding time of these insects is restricted to a few hours in the morning.

The number of such visits on the flowers of different plant families were as follows

Convolvulaceae	549
Geraniaceae	764
Verbenaceae	488
Compositae	434
Caryophyllaceae	323
Scrophulariaceae	107
Nyctaginaceae	13

With the exception of Nyctaginaceae (Apetalae) and Caryophyllaceae (Polypetalae) these families belong to Sympetalae, in which the petals are all united together. The nectaries are situated at the base of the fused petals and are therefore well protected.

A very large number of visits were recorded on blue, violet and purple shades. Next in preference were the purple-eyed and violet-eyed white flowers. Then came the yellow and white flowers. Least preference was shown to scarlet-red, pink, scarlet-red-eyed white and pink-eyed white flowers.

These field observations substantiate the conclusions arrived at by extensive experimentation (followed by statistical analysis) under the controlled conditions of the cage with the help of the standardized Ostwald coloured papers and the Bauman grey papers. They confirm :

(*a*) that these insects tend to prefer flowers with compactly arranged and limited number of parts offering less contour (Vaidya 1958); and

(*b*) that they prefer for feeding blue and purple colours (Ilse & Vaidya 1956).

Department of Zoology,
University of Poona,
Poona-7,
December 20, 1967.

VIDYADHAR G. VAIDYA

References

Ilse, D. & Vaidya. V. G. (1956): Spontaneous feeding response to colours in *Papilio demoleus* L. *Proc. Indian Acad. Sci. XLIII*, 23-31.

Vaidya, V. G. (1958): Visual perception in *Papilio demoleus* L., Ph. D. Thesis submitted to University of Poona.

17. ON A HYMENOPTEROUS EGG-PARASITE OF AQUATIC BUGS INJURIOUS TO PISCICULTURE

Parasitism by hymenopterous egg-parasites has been observed in a few cases of aquatic insects. During our investigations on the biology of aquatic bugs, a number of eggs of *Anisops bouvieri* Kirkaldy and *Plea frontalis* (Fieber) collected from a temporary pond near Central Inland Fisheries Research Institute, Barrackpore, were found to be infested by a hymenopterous parasite, *Prestwichia* sp. (Family Trichogrammatidae). Examination under the microscope of these eggs showed that some of them had exit holes. Such eggs were discarded and only complete eggs were selected for the determination of the number of parasites per host egg. Fifty parasitized eggs of each species were dissected and the number of parasites in each egg were counted. Results of these observations are given in the Table below.

Number of parasites	Number of host eggs	
	Anisops bouvieri	*Plea frontalis*
1	5	50
2	20	..
3	19	..
4	6	..

In the laboratory freshly deposited eggs of *Anisops bouvieri* Kirkaldy and *Plea frontalis* (Fieber), in the stems of aquatic plants, were exposed to the attacks of the female parasite and her behaviour was observed. She walked on the plant twigs, touching them with her antennae until the host egg was located when she raised her body and thrust the needle-shaped ovipositor into the host egg. While ovipositing, she quivered and scratched the plant tissue with her legs. The process of egg-laying took from 4-6 minutes.

The parasite takes about 11 days to complete its life-history at a temperature ranging from 26.6°C to 32.2°C. Further studies on the biology of these parasites would probably lead to evolving a suitable method for the biological control of aquatic bugs preying upon fish fry. It is noteworthy that the genus *Prestwichia* Lubbock is recorded for the first time from India and the eggs of *Anisops bouvieri* Kirkaldy and *Plea frontalis* (Fieber) are new hosts for the parasite.

Acknowledgements

The author is grateful to Dr. B. S. Bhimachar, former Director, Central Inland Fisheries Research Institute, for his guidance. Thanks

are due to Dr. D. S. Hill, Commonwealth Institute of Entomology, London, for confirming the identity of the parasite.

CENTRAL INLAND FISHERIES
RESEARCH INSTITUTE,
BARRACKPORE, WEST BENGAL,
January 29, 1969.

J. M. JULKA[1]

18. HONEY BEES AND WASPS AS PESTS OF GRAPE

Honey bees usually feed on nectar but, the Indian Honey Bee, *Apis indica* F. and Wasps, *Polistes hebraeus* (Fb.) and *Vespa orientalis* Linn. damage the ripening grape berries in Madhya Pradesh. *A. indica* has not so far been reported as a pest of grapes as far as the author is aware.

Exotic varieties of grapes, particularly Perlette, Muscat, and Beauty Seedless are the most promising varieties of economic importance in Madhya Pradesh. They start ripening from the middle of May and the fruiting season is almost over by the end of June. During 1962, 1963 and 1968, at Gwalior a single vine on an average bore 136, 147, and 183 bunches consisting of 2,441, 2,876 and 3,087 berries, respectively. The berries of Perlette and Muscat are light greenish to light yellowish in colour, seedless, sweet, having edible thin skin, tasty and of pleasing texture. The normal sugar content of these fruits is 18 per cent with acid at 0.8 per cent. They are the most preferred by *A. indica* followed by Beauty Seedless that are purplish in colour whereas the seeded varieties with inedible skin are comparatively less favoured and sour varieties are least favoured. Hard inedible skinned varieties almost escape damage. The percentage of damaged berries in Perlette and Muscat varieties varied from 15.6 to 64.8 and 12.7 to 58.6 respectively, during 1962, 17.2 to 63.5 and 10.7 to 54.5 during 1963; and 18.7 to 70.3 and 13.5 to 62.7 during 1968. The infestation attains a peak during the first fortnight of June. No varietal preference has been observed by wasps. The bees and wasps make minute punctures on the ripe and ripening berries only and feed on the pulp by gnawing the epicarp leaving the skin behind. Such infested berries either remain on the bunch or fall to the ground. During 1966 and 1967, the pests of grape vine at Jabalpur in Madhya Pradesh were also surveyed. Thrips caused maximum damage during the blossom and fruiting stage, adversely affecting fruit formation and causing cracking and scab formation on grapes. Bees and wasps were secondary minor pests on these cracked berries at Jabalpur. At Gwalior, honey bees and wasps are major pests of grapes irrespective of thrips infestation, and are a potential menace as well as a great setback to the

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cultivation of grapes in this region. If the ripening bunches are not protected by paper bags, no ripe fruit can be harvested and even the cost of cultivation cannot be realised.

ACKNOWLEDGEMENTS

The author is thankful to Shri R. C. Srivastava, Chairman of Horticulture, for permission to record observations and Director, Zoological Survey of India, Calcutta, for the identifications. Partial use of data collected along with Shri S. U. Kittur during 1962 and 1963 is duly acknowledged. The author is indebted to Dr. R. R. Rawat, Chairman of Entomology, for guidance and encouragement.

DEPARTMENT OF ENTOMOLOGY,
J. N. KRISHI VISHWA VIDYALAYA,
COLLEGE OF AGRICULTURE,
GWALIOR, M.P.,
December 24, 1968.

D. K. SAXENA

19. ANEMOTACTIC RESPONSE IN THE FIREFLY, *LUCIOLA* SP. (COLEOPTERA: LAMPYRIDAE)

Positive response to wind currents by insects has been observed by many workers (Wheeler 1899; Fraenkel 1932; Kennedy 1939). Terms such as anemotropism and anemotaxis have been applied to this behaviour. In some cases, the positive reaction to air currents is closely linked up with visual or olfactory stimuli (Fraenkel & Gunn 1961).

During the second week of May, 1968 fairly large numbers of the firefly, *Luciola* sp. were seen flying around trees at night in the Malabar Christian College compound. At night, around 9 p.m., about ten of them flew into our room, evidently attracted by the electric light. An electric ceiling fan was at that time, revolving at top speed in the room. It was observed that the fireflies flying inside the room were frequently knocked down by the blades of the fan. In order to find out whether the flight orientation was in any way connected with the wind current produced by the fan, the lights in the room were switched off and there was total darkness. The course of flight of the fireflies could be easily followed with the help of the bright flashes of greenish yellow light produced by them. It was found that the insects persistently flew towards the fan, directly against the strong wind current. This is a positive and directional response to the wind current, which is apparently not connected with any other stimuli and it may therefore be termed positive anemotaxis.

This behaviour must be having some adaptive significance in nature under certain conditions.

DEPARTMENT OF ZOOLOGY, A. B. SOANS
MALABAR CHRISTIAN COLLEGE, JOYCE S. SOANS
CALICUT 1, KERALA,
June 8, 1968.

REFERENCES

FRAENKEL, G. (1932): Die Wanderungen der Insecten. *Ergebnisse der Biologie,* **6**: 1-238.

——— & GUNN, D. L. (1961): The Orientation of Animals. Dover Publications, Inc., New York.

KENNEDY, J. S. (1939): The visual orientation of flying mosquitoes in still and in moving air. *Proc. Zool. Soc. Lond.* A. **109**: 221-242.

WHEELER, W. M. (1899): Anemotropism and other tropism in insects. *Arch. EntwMech. Org.* **8**: 373-381.

20. THE RED PUMPKIN BEETLE *RAPHIDOPALPA FOVEICOLLIS* (LUCAS), AS A PEST OF THE JAPANESE MINT

The Red Pumpkin Beetle, *Raphidopalpa foveicollis* (Lucas), is a serious pest of cucurbits and is very widely distributed all over India. Besides cucurbits, it has been reported to damage the leaves of plants such as *Lathyrus odoratus* L., *Pisum sativum* L., *Medicago sativa* L., *Oryza sativa* L., *Zea mays* L., *Cyamopsis psoraloides* DC., *Trifolium resupinatum* L., french beans, *Phaseolus vulgaris* Linn, etc. The beetle is reported here for the first time as causing damage to mint, *Mentha arvensis* L. subsp. *haplocaly* Briq. var. *piperascens* Malinvaud. The menthol in the leaves of this new host plant gives them a strong aroma and bitter taste but does not deter the pest.

The Japanese mint, an important exotic aromatic plant, was initially introduced on the farm of the Northern Zonal Centre of the Central Indian Medicinal Plants Organisation, Haldwani (Nainital) and is now grown as a cash crop in about three thousand acres in the Tarai tract of Uttar Pradesh. Adult red pumpkin beetles, *Raphidopalpa foveicollis* (Lucas) (Coleoptera: Chrysomelidae) were observed in groups of three to six on leaves of Japanese mint in March-April 1967 and 1968 at the farm of CIMPO, Haldwani, situated on Bareilly-Nainital Road about a mile north of Pantnagar Railway Station. They fed on the underside of the leaves and caused fairly severe damage. Initially the damage is mainly to the palisade tissue in between the veins, causing transparent patches on the infested leaves which are progressively holed. Unless large number of such patches appear, the pest escapes detection while feeding on the undersurface of the leaf and continues to damage it. Besides the leaves, young growing apical and auxiliary buds are eaten. This, however, retards growth only temporarily. In severely infested plots, the loss of crop ranges from 15 to 20 per cent.

Even though the beetles were observed feeding on the foliage and also pairing on the plants; it is not yet known as to how far they complete their development on this new host. However, the ease with which they feed on this plant suggest, in addition to the pairing recorded on the host, that the pest might be able to complete its life cycle on the Japanese mint itself. The extent of damage caused afford sufficient justification to classify it as a serious pest.

Control Measures: Spraying 0.02 per cent endrin at the rate of about 1,000 litres per ha. in the early hours of the day effectively control the pest. In this case, the crop should not be harvested within three weeks of the date of spraying. Dusting 5 per cent malathion at the rate of 2 kg. per ha. or spraying 0.1 per cent malathion at the rate of about 1,000 litres per ha. is also effective in reducing infestation.

Acknowledgements

The authors are thankful to Dr. R. L. Paliwal, Director (Research), Experimental Station, and Dr. N. K. Anant Rao, Dean, College of Agriculture, U.P. Agricultural University, Pantnagar and Director & Scientist-in-Charge, Central Indian Medicinal Plants Organisation, Lucknow, for their keen interest in the work. Thanks are also due to Dr. A. P. Kapur, Director, Zoological Survey of India, Calcutta-12, for identifying the beetle.

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RAJENDRA GUPTA

May 11, 1968.

21. THE TAXONOMIC STATUS OF THE SECTION *FISSENDOCARPA* (HAINES) RAVEN OF THE ONAGRACEOUS GENUS *LUDWIGIA* L.

The taxonomy of the genus *Ludwigia* has been worked thoroughly by Baillon (Hist. P1. 6: 463, 1877), Munz (Bull. Torrey Bot. Club 71: 152-165, 1944 & Darwiniana 4: 179-284, 1952), Brenan (Kew Bull. 8: 163-172, 1953), Hara (J. Jap. Bot. 28: 289-294, 1953), and Raven (Reinwardtia 6: 327-427. 1963). Baillon united the genera *Jussiaea* L. and *Isnardia* L. with this. But some authors including Munz did not accept Baillon's treatment in uniting *Jussiaea* with *Ludwigia* and maintained the former as a distinct genus having stamens twice as many as the sepals and the latter having stamens as many as the sepals. Brenan convincingly showed the inconsistency of the above character and followed Baillon in merging *Ludwigia* and *Jussiaea;* but selected the name *Jussiaea,* which was contrary to rules as pointed out by Hara. Raven in his synoptical treatment of the genus *Ludwigia* which includes *Jussiaea, Isnardia* and *Oocarpon* Mich., recognises 17 sections; out of them *Fissendocarpa* stands in an anomalous position without any close relatives on account of its fruit and seed characters and destroys the homogeneity of the genus *Ludwigia.* This is obvious from the following remarks by Haines (J. As. Soc. Bengal n.s. 15: 312-314, 1919) and Raven.

Haines—" The species with these peculiar fruits and dimorphous seeds seem to merit a special section of the genus which I propose to call *Fissendocarpa.*" " . . . on all these characters some botanists would perhaps make a new genus."

Raven—" It has no relatives. . . . The dimorphic seeds of this species are very unusual."

So in order to make the genus *Ludwigia* a homogenous one, the section *Fissendocarpa* is here raised to generic status.

Fissendocarpa	*Ludwigia*
Seeds dimorphous	Seeds not dimorphous
Each locule with uniseriate seeds at the proximal portion of the fruit and pluriseriate seeds at the distal portion.	Each locule with either uniseriate or pluriseriate seeds throughout the length of the fruit.
In fruits uniseriate seeds at the proximal portion are embedded in endocarp and pluriseriate seeds at the distal portion are free.	In fruits all the seeds are free or all embedded in endocarp.

Fissendocarpa (Haines) Bennet stat. nov.

Jussiaea sect. *Fissendocarpa* Haines in J. As. Soc. Bengal n.s. 15: 314, 1919.

Type species: *Jussiaea fissendocarpa* Haines *l.c.* 313=*J. linifolia* Vahl.

Fissendocarpa linifolia (Vahl) Bennet comb. nov.

Jussiaea linifolia Vahl, Ecolog. Am. 2: 32, 1798.

J. fissendocarpa Haines *l.c.* 313.

J. hyssopifolia G. Don, Gen. Syst. 2: 693, 1832.

Ludwigia hyssopifolia (G.Don) Exell, Garcia de Orta 5:471, 1957 Raven *l.c.* 385.

Acknowledgements

The author thanks Dr. K. Subramanyam, Director of the Botanical Survey of India for encouragement and Mr. A. N. Henry, Scientific Officer of the Botanical Survey of India for suggestions.

Botanical Survey of India, S. S. R. BENNET
Calcutta-14,

March 3, 1969.

22. INTERESTING PLANTS FROM MAHARASHTRA STATE

During studies on the flora of Maharashtra State the species noted below were recorded as little known or new to the State. Salient identification characters to their brief notes on distribution are given in this paper.

Apiaceae (=Umbelliferae)

1. **Seseli diffusum** (Roxb. ex Sm.) Sant. & Wagh in Bull. Bot. Surv. Ind. 5: 108, 1963. *Ligusticum diffusum* Roxb. ex Sm. in Rees, Cycl. 21: 11, 1812. *Cnidium diffusum* DC. Prodr. 4: 153, 1830. *Seseli indicum* Wt. & Arn. Prodr. 371, 1834; C. B. Clarke in Fl. Br. Ind. 2: 693, 1879; Gamble, Fl. Madras 1: 561 (reprint).

Herb, annual, sub-erect, 8-20 cm. high, profusely branched from the base; leaves pinnate; umbels compound with linear bracts and bracteoles; corolla whitish pink; fruits subglobose with prominent ridges, densely hairy, tip ending in two divaricating reflexed points.

Fls. & frts.: April-May. *Loc.:* Islapur along Penganga river bed, Nanded District, *Janardhanan* 101320. (Occasional along river bed.)

The density of hairs on the fruit of this species varies considerably. Clarke (*l.c.*) also indicates the occurrence of both glabrous and densely hairy fruits with a wide range of intermediate forms.

The present record from the drier parts of Central Maharashtra is interesting, as it links up the distribution between eastern India including Bengal and southern India covering Andhra Pradesh and Mysore State.

Fabaceae

2. **Eleiotis monophylla** (Burm.f.) DC. Mem. Leg. 7: 350, 1825; Schindl. in Fedde. Repert. 311, 1928. *Glycine monophylla* Burm. f. Fl. Ind. 161, t. 50, f. 2, 1768. *Eleiotis sororia* DC. Mem. Leg. 7: 350, 1825; C. B. Clarke in Fl. Br. Ind. 2: 153, 1876; Cooke, Fl. Bombay 1: 364 (reprint); Gamble, Fl. Madras 1: 333 (reprint).

Annual monsoon herb; stem about 1 m. long, weak, trailing, triquetrous; leaf usually 1-foliate, stipulate, large, orbicular, rarely with a pair of small, oblong-oblanceolate leaflets arising from the joint just above the short petiole; thereby indicating the trifoliate character of leaf; racemes auxillary up to 15 cm. long, fragile, flowers rosy purple; pods small, boat-shaped.

Fls. & frts.: August-November. *Loc.:* Dhulia District; Ranipur, *Pataskar* 926009; Unapdeo near hot springs, *Pataskar* 110115; Ratanpur forest near Kansali, *Pataskar* 110262; Kotbandhani, *Pataskar* 110061.

This species, reported from Madras, Mysore, Andhra Pradesh in the south and Madhya Pradesh and Uttar Pradesh in the north, has so far not been recorded from Maharashtra State. Santapau (Jour. Bomb. Nat. Hist. Soc. 48: 277, 1949) expresses doubts about its availability in Bombay Presidency. It is, therefore, interesting that the present record establishes the continuity of its distribution from south to north of India.

3. **Galactia tenuiflora** (Klein ex Willd.) Wt. & Arn. Prodr. 206, 1834; van Steenis in Reinwardtia 5(4): 431, 1961; Baker in Fl. Br. Ind. 2: 192, 1876; Cooke, Fl. Bombay 1: 393 (reprint); Gamble, Fl. Madras 1: 251 (reprint).

Fls. & frts.: September-October. *Loc.:* Kondhibari ghat near Sakri, Dhulia District, *Pataskar* 117519.

4. **Indigofera colutea** (Burm. f.) Merr. in Phil. Journ. Sci. 19: 355, 1921; Santapau, F1. Saurashtra 131, 1962. *Galega colutes* Burm. f. Fl. Ind. 172, 1768. *Indigofera viscosa* Lamk. Encycl. 3: 247, 1789; Baker in Fl. Br. Ind. 2: 95, 1876; Cooke, Fl. Bombay 1: 337 (reprint).

Fls. & frts.: August-October. *Loc.*: Dhulia District: Ranipur-Nagzari, *Pataskar* 110062; Kansali hill forest, *Pataskar* 110237; Ranipur River, *Pataskar* 11001.

The present record is from Dhulia District of Maharashtra State, where the species is common.

ACKNOWLEDGEMENT

The authors wish to express their grateful thanks to Shri R. S. Rao, Regional Botanist, Botanical Survey of India, Western Circle, Poona-1 for encouragement and guidance in preparing this paper.

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE,
7 KOREGAON ROAD,
POONA-1,
March, 6, 1969.

R. D. PATASKAR
(Miss) K. K. AHUJA

23. A NEW LOCALITY RECORD OF *CORDIA CRENATA* DEL. IN PIRAM ISLAND OFF SOUTH SAURASHTRA COAST

A species of *Cordia* reported from Piram Island off Bhavnagar-Gopnath shores in the gulf of Cambay on identification was found to be *Cordia crenata* Del. Recently this species was reported from Nargoa airport, Diu Island; Duthie reported it from Rajputana in 1911.

In Piram Island this plant was found growing along the margins of the scrubland exposed to sea-influence. In the year 1962 the writer also collected the same species under similar situations from Diu Island. A look at its scattered isolated habitat would reveal that it is a new intruder.

Piram Island: *T. A. Rao* 2061, 4.10.64; Diu Island: *T. A. Rao* 1947(a), 22-11-1963.

ECOLOGY SECTION,
BOTANICAL SURVEY OF INDIA,
76, LOWER CIRCULAR ROAD,
CALCUTTA-14,
May 1, 1969.

T. ANANDA RAO

24. *CLEOME RUTIDOSPERMA* DC. (CAPPARACEAE)—A NEW RECORD FOR ASSAM

C. rutidosperma DC., a native of West Tropical Africa, introduced in Caribbean region, found in Malaysia and Burma, recently recorded for India from West Bengal (vide, Mukherjee in Ind. For. Vol. 95(4): 237.1969.) and, is now recorded here for the first time for Assam.

Cleome rutidosperma DC. Prod. 1: 241.1824; Jacobs in Fl. Males. (Ser. 1) 6: 104. 1960.

An annual, erect to spreading, widely branched herb. Stem, petiole and nerves underneath with sparse prickle-like, softish appendages. Leaves on 2.5-4 cm. long petioles, ovate-elliptic with an acute or cuneate base, subacute, thinly herbaceous, lateral ones 2-2.5×1-1.2-1.8 cm. central leaflet 2.5-3cm. ×1.5-1.8 cm. lateral nerves 6-9 pairs. Flowers solitary, violet-blue; pedicels filiform, 2-2.7 cm. with minute whitish gland-like sticky hairs. Fruits cylindric, tapering towards both ends, 4-5 cm. long, glabrous. Seeds yellowish symmetrical with a blackish tcenre, obtuse concentric ribs and stronger cross-ribs.

Specimen examined: ASSAM. Gauhati, Satri Bari Road, *A. C. Dut* 979 (CAL).

INDIAN BOTANIC GARDEN, R. B. GHOSH
SIBPORE, HOWRAH.

CENTRAL NATIONAL HERBARIUM, R. PRASAD
CALCUTTA,
May 7, 1969.

25. TWO NEW RECORDS OF ARACEAE FROM THE UPPER GANGETIC PLAIN

The following 2 species of *Typhonium* collected from Ramgarh-Khusmi forest of Gorakhpur District of Eastern Uttar Pradesh, do not seem to have been recorded from the Upper Gangetic Plain earlier, and hence they are recorded here as being new to the area. The two species have been grown in the Banaras Hindu University Botanical Garden, where they have flowered and fruited again during the following year.

Typhonium schottii Prain. Tuberous herbs, 25-35 cm. high; tubers 2.5-4 cm., in diam.; leaves 8.5-11.5 cm. long, about as broad or much broader than its length, triangular-hastate, appearing with the inflorescence, 3-partite, each segment with a bulbil at the base; lateral segments unequal sided, 8-9.5 × 2.5-4.4 cm.; middle segment 8.5-10.5 × 6-7.2 cm.; petioles 18-24 cm. long; peduncles 5-6.5 cm. long (in fruit up to 10 cm. long). Spathe slender 12.5-13.5 cm. long, open; spadix 11.5-12.3 cm. long, exerted, with a long barren appendage; appendage oblique at the base; female flowers and male flowers well separated; female flowers at the base on a 3.5-4.5 mm. long portion; neutral flowers above the female flowers, linear, yellow, spreading, 5-6 mm. long; male flowers at a distance of 1.3-1.5 cm. above the neutral ones on a 1 cm. long portion, reddish-purple; anthers sessile; berry ovoid, 7-8 × 4 mm. 1-seeded.

Flowers and fruits: June-July.

Specimens examined: Khusmi Forest, *Reddi* 1055 (BAN), common in ' Sal ' forest undergrowth.

Typhonium roxburghii Schott. Geophytic herbs, 25-30 cm. high; tubers 3-3.5 cm. in diam., with a number of adventitious roots arising from the top; leaves 8-9 cm. long, about as broad or slightly broader than its length, ovate, hastately sagittate, cordate at the base, sub-3-lobed, with bulbils at the base; petioles 17-22 cm. long; peduncles 1.8-2.3 cm. long. Spathe slender, 13.5-14.5 cm. long, 3-4 cm. broad at the base, reddish-purple; apex rounded, somewhat twisted; limb open; spadix 12 cm. long, exerted, with a barren appendage; appendage rounded at the base; female and male flowers well separated; female flowers at the base; neutral flowers above the female flowers, yellow, linear, spreading, 5-7 mm. long; male flowers reddish-purple.

Flowers and fruits: June-July.

Specimens examined: Khusmi Forest, *Reddi* 1056 (BAN), common in ' Sal ' forest undergrowth along with *T. schottii* Prain.

The description of both these taxa has been drawn from fresh living material. The identification of both the specimens has been done at the Central National Herbarium, Calcutta.

ACKNOWLEDGEMENT

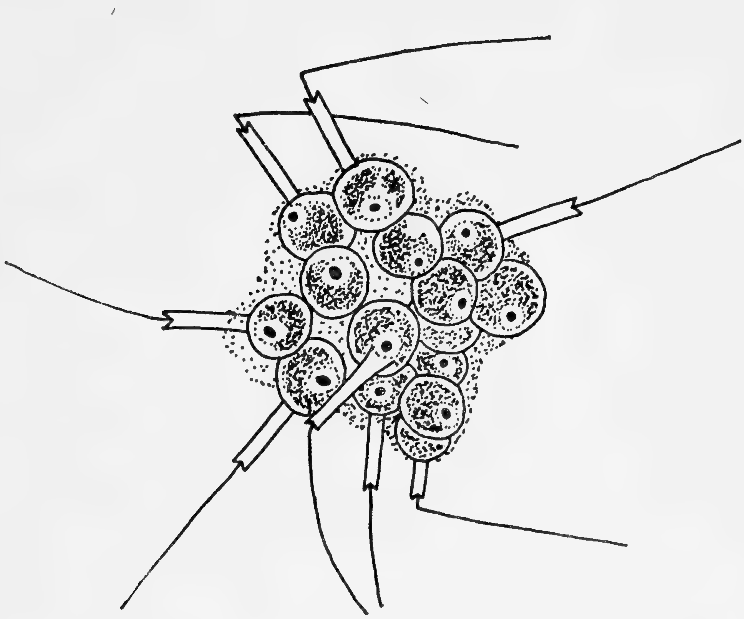
Thanks are due to Dr. A. C. Joshi, Vice-Chancellor, Banaras Hindu University, for guidance and to the Keeper, Central National Herbarium, Calcutta, for his help in the identification work.

DEPARTMENT OF BOTANY, B. VENKATAREDDI
BANARAS HINDU UNIVERSITY,
VARANASI,
June 20, 1969.

26. ON *CHAETOSPHAERIDIUM GLOBOSUM* (NORDST.) KLEBAHN FROM INDIA

(*With a text-figure*)

Out of the five genera of the family Coleochaetaceae, five species only of *Coleochaete* have been described so far from different parts of India. All the five species *Coleochaete nitellarum* Jost., *C. pulvinata* A.Br., *C. soluta* (de Brēb.) Prings., *C. scutata* de Brēb. and *C. orbicularis* Prings. have been reported for the first time from Gujarat by Patel (1966, 1968), except *C. scutata* de Brēb. which was previously recorded from Ahmedabad by Kamat (1962). As far as the author is aware, the taxon *Chaetosphaeridium globosum* (Nordst.) Klebahn is described here for the first time from India.



Chaetosphaeridium globosum (Nordst.) Klebahn, showing the nature of the cells in a cluster (x 690).

The material was collected by the author, in the last week of October, 1955, from a small pond near the railway line at Valavao, Baroda District, Gujarat State. The plant grew as an epiphyte on *Zygnema* sp. The cells are generally spherical, in clusters of irregular shape with mucilaginous envelopes. Clusters with mature cells were also seen as free floating with *Zygnema* filaments. Basal interconnecting tubes in the cells are not apparent. Individual cell bear a long seta, Characteristic of the family Coleochaetaceae. Seta is the axial cytoplasmic filament, the basal portion of which is ensheathed by a short cylindrical gelatinous sheath. The cells are uninucleate with a laminate parietal chloroplast containing a single pyrenoid in it. Clusters are of about 60 μ in width. The cells are 15.0 μ in diameter.

The description and the dimensions of the species described here, generally agree with those of *Chaetosphaeridium globosum* (Nordst.) Klebahn.

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VALLABH VIDYANAGAR,
GUJARAT STATE,
July 15, 1969.

R. J. PATEL

REFERENCES

KAMAT, N. D. (1962): Chlorophyceae of Ahmedabad, India. *Hydrobiologia* **20**: 248-279.

PATEL, R. J. (1966): *Coleochaete Pulvirata* A. Br. from Gujarat. *J. Bombay nat. Hist. Soc.* **63**: 222-224.

——————(1968): On *Coleochaete* from Gujarat (India). *Phykos* **7**(1 & 2): 90-97.

27. A NEW RECORD FOR *CROTALARIA INCANA* LINN. FROM SOUTH INDIA

Crotalaria incana Linn. forming the subject of this note was collected by me in June 1969 from the Museum compound, Trivandrum, Kerala State. The specimen was identified at Kew (ref: H.2412/69) and is preserved in the Herbarium, Sree Narayana College, Quilon. This South American species, hitherto known to occur in India only in the Kumaon hills, is an addition to the south Indian flora. Description given below is based on fresh specimens.

Crotalaria incana Linn. Erect, annual white silky pubescent herbaceous shrub, 95 cm. or so high. Stem terete, white silky pubescent. Leaves alternate, trifoliate, stipulate; stipules linear, subulate, hairy, deciduous, about 4 mm. long; petioles c. 6.8 cm. long, subterete, pulvinate, silky pubescent; petiolule pubescent; blade 7.7 c. 4.4 cm., soft, elliptic to elliptic-obovate with an acute mucronate or obtusely acute mucronate tip and a cuneate base, sparsely pubescent below, puberulous to glabrate above. Flowers up to 30 in a terminal raceme 25 cm. or more long, bracteate, bracteolate and shortly pedicellate; bracts linear subulate, hairy, deciduous, about 6 mm. long; bracteoles narrow, hairy, 5 mm. long; pedicels 3 mm. long. Calyx hairy outside, glabrous within, 1.3 cm. long with a tube 3 mm. long and linear-lanceolate greenish-yellow lobes. Corolla pale yellow, slightly exserted; standard pale yellow, round elliptic 1.6 cm. long and 1.2 cm. broad; wings yellowish hyaline, obliquely linear oblong with a round tip; keel yellowish hyaline with a thick brush of white hairs on the upper margin without. Stamens 10, monadelphous with dimorphous anthers. Ovary subsessile to sessile 5 mm. long, 2 mm. broad, thick, white, silky hairy; style slender, linear, hairy on the inner side; stigma slightly thickened; ovules many. Fruit cylindrical, swollen, deflexed, silky hairy, 3.5 cm. long, 7 mm. wide, sulcate above, up to 40-seeded; seeds angularly reniform, smooth, greenish black with a light brown shade around the groove, 3-2.5 mm.

It is interesting to note that *C. incana* Linn, characteristic of the Kumaon hills (about 5,000 ft. above sea-level), is now found at sea-level. Equally interesting is the fact that the specimen collected by the author is not the typical asiatic form. To quote Kew authorities, " This is clearly referable to *Crotalaria incana* L., although, as you correctly surmise, is not the typical asiatic form. It is in fact an exact match with the forms of this rather variable pan-tropical species which hails from S. America, and your plant may well have been introduced either by accident or design from that continent".

The author wishes to express his sincere thanks to the Director, Royal Botanic Gardens, Kew, who has identified the specimen. The author's thanks are also due to Prof. N. A. Erady, Maharaja's College, Ernakulam, for valuable advice.

SREE NARAYANA COLLEGE, N. RAVI
PUNALUR, KERALA,
September 19, 1969.

28. AN ABNORMAL *PSIDIUM* MUTATION

In 1954 the writer as Senior Technical Assistant, National Botanic Gardens, was in charge of malis engaged in lifting closely packed guava seedlings for transplanting. Among the first batch lifted was one with distinctive foliage, which was potted off; later on three more came to light. They were all about 60 cm. in height. One of the strongest growing was planted in a shrubbery border.

It was impossible to trace the source of these abnormal seedlings as the fruit from which they were raised had been purchased in the open market. There was every likelihood that the fruit responsible for the abnormal seedlings was from a mutating branch in some orchard. Had an entire plant shown the abnormal foliage and poor fruiting quality, there is little doubt that it would have been uprooted.

By 1964 this guava had developed into a tall bush about 3.65 m. in height, and as it bore several fruits was protected with a wire-netting screen. Unfortunately this was not thief proof and the following year some individual stripped the plant of all but a solitary fruit that was hidden under a cluster of leaves. The fruit was artificially ripened, it was only 2.5 cm. in diameter. The flesh was nearly 2 cm. in diameter, of normal guava flavour, not very sweet, and containing about 100 seeds; germination took place in 6 weeks, but during a dry spell, when a tube well failed, these seedlings died.

The height of the abnormal guava plant at the time of making this report is 3.65 m. In *Psidium guajava* two flower buds appear at the lower end of young growth, two to three pairs, of leaves from the base. In the abnormal specimen, however, terminal or side shoots, each bear on the upper nodes 2-4 flowers, which, as a rule, do not fully expand. The growth of the abnormal guava is more or less fastigate. The dry foliage of the mutant normally does not fall but remains attached till removed by the breeze or other mechanical method.

The summer of 1965 was very severe, and the fruits of the mutant fell in large numbers. The first tree-ripened fruit was collected in August, and a note was made of its characteristics: Diameter of fruit 5 cm.; scent very strong; flesh white, thickness of flesh 1.2 cm.; seeds large, but relatively few; colour of skin pale greenish yellow. The following details refer to the plant or its leaves: Bark greyish brown in colour, rough; leaf cordate, apex finely pointed, pigmentation confined to the swollen veins at the base of the leaf; petiole average 17 mm. long; leaf blade 33.5 $\times$ 30 mm.

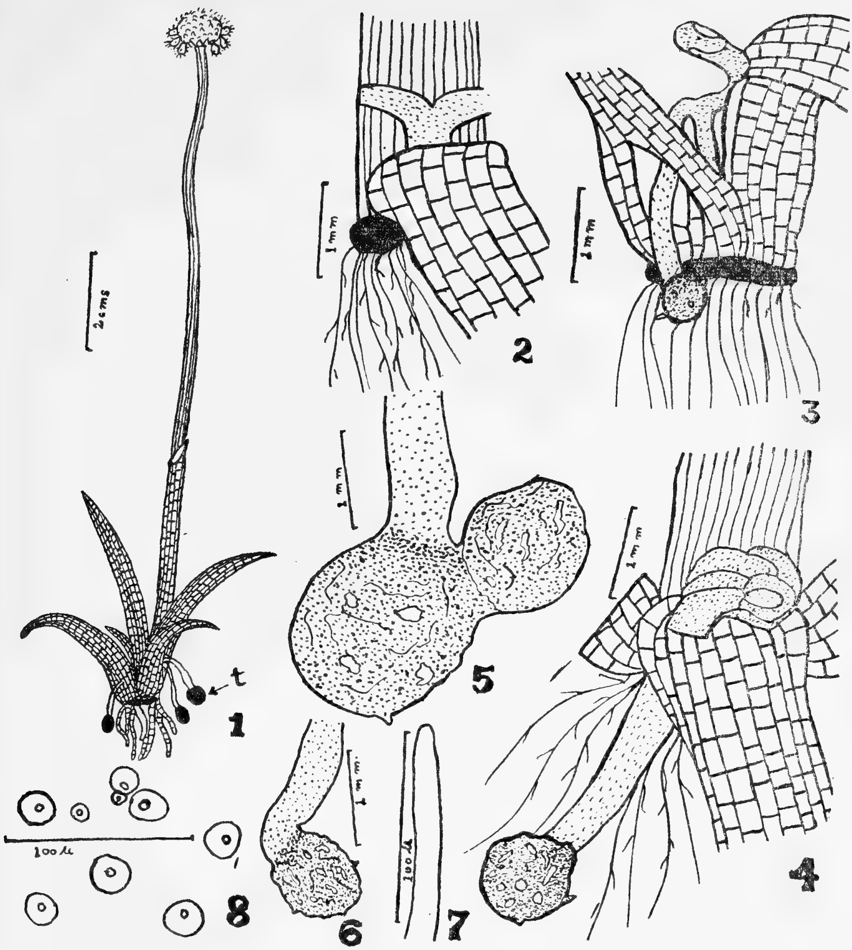
LUCKNOW, S. PERCY-LANCASTER
November 1, 1969.

29. TUBERS IN *ERIOCAULON RITCHIEANUM* RUHL

(*With eight text-figures*)

Tuberiferous habit has not been reported in any member of Eriocaulaceae so far. The plants of *E. ritchieanum* collected from Radhanagari and Pahanala (Kolhapur District, Maharashtra) were found to bear tubers (fig. 1). The tuberiferous habit is a regular feature of all the plants of this species growing in these two localities. The development and morphology of these tubers is described here.

Tuber primordia originate as axillary buds. Each primordium grows vertically up to 5 mm. into a short axillary branch; its tip then branches dichotomously into 2-4 branches (fig. 2); these turn down, pierce through the subtending or adjacent leaf-base and enter into the soil. Each branch tip then swells up to form a tuber (figs. 3, 4). The mature tuber has an average size of 4 $\times$ 2.5 mm.; it is round (fig. 6), or bilobed (fig. 5) in outline; its surface is covered with dense growth of unicellular hairs (fig. 7). One or two buds (eyes) are found on the tubers. Mature tubers are full of simple circular starch grains (fig. 8). Dried tubers germinate readily in a petridish with a thin layer of moist soil. The plants attain maturity within 45 to 60 days.



Tubers in *Eriocaulon ritchieanum* Ruhl.

Fig. 1. Entire plant with tubers (*t*). Figs. 2-4. Development of tuber producing branches and formation of tubers. Figs. 5, 6. Mature tubers. Fig. 7. Unicellular hair on the tuber. Fig. 8. Statch grains.

The authors are thankful to Sir George Taylor, Director, Royal Botanical Gardens, Kew, for confirmation of the specific identity and to Dr. H. N. Moldenke, U.S.A., for his opinion.

BOTANY DEPARTMENT, A. R. KULKARNI
SHIVAJI UNIVERSITY, M. H. DESAI
KOLHAPUR, MAHARASHTRA,
October 31, 1969.

30. FIELD IDENTIFICATION OF *TEPHROSIA* PERS.

In the field it is difficult to identify the species of *Tephrosia* from other plants in vegetative state. For example, the plants of *Indigofera tinctoria* Linn. and *Tephrosia purpurea* Pers. look very similar in vegetative state. To identify one from any other the following method has been tried by us during botanical excursions and found useful. Take a leaflet of any species: hold its apex and base and pull it apart; if it is a leaflet of *Tephrosia*, it will always be cut in V-shaped manner. This is true even if the leaflet is folded transversely and then pulled apart. This technique has been tried by us on all the species of *Tephrosia* available here.

Other taxonomists are requested to try this method.

DEPT. OF BOTANY, P. K. MUKHERJEE
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A new race of the Blackcrested Baza, *Aviceda leuphotes* (Dumont), from the Andaman Islands

BY

HUMAYUN ABDULALI AND ROBERT B. GRUBH

In February 1969 an attempt was made to visit Narcondam Island, 80 miles east of North Andaman Island. A party of three assembled for the purpose at Port Blair, in the Andamans, but the arrangements for the Narcondam trip went awry and H.A. returned a few days later leaving behind Rex Pimento and R.B.G., both of the Bombay Natural History Society, as there was still a chance of the trip to Narcondam coming off. During their wait these two collected some 130 birds in the neighbourhood of Port Blair and on some islands further south, on which H.A. will report later. The present note concerns two specimens of the Blackcrested Baza, *Aviceda leuphotes* (Dumont), a species not previously recorded from the Andamans, obtained by them at Wrightmyo in South Andaman Island.

The specimens of *Aviceda leuphotes* already in the collection of the Bombay Natural History Society are from India and Burma, and have been assigned to the subspecies *A. l. leuphotes* (Dumont) (Type locality : Pondicherry) and *A. l. syama* (Hodgson) (Type locality : Lower region of Nepal) in accordance with their places of origin (1969, *J. Bombay nat. Hist. Soc.* **65** : 697). The present specimens differ strikingly from the India and Burma specimens in :

(*a*) having a thin, and not broad, blackish-rufous bar across the upper breast following the white ;

(*b*) this band being followed in the case of the male by only one chestnut band and in the female by only two chestnut bands, leaving the rest of the underparts unbarred ;

(*c*) the unbarred portion of the lower breast being more intensely rufous than in the specimens from India and Burma, and

(*d*) the wings ♂ 223, ♀ 224 being slightly smaller than in 45 birds at the British Museum (Nat. Hist.) from northern and southern India, Burma, Siam, Cambodia, and Malacca kindly measured for us by Mr. D. J. Freeman of the British Museum (Nat. Hist.) as (excluding one 220 mm. ♂) 224-251 av. 235·8 mm.

As regards (*b*) and (*c*) above, Mr. Freeman states that the material available to him varies greatly in the amount of barring, and 3 of 4 birds from Ceylon, which otherwise agree with *A. l. leuphotes* and have pale breasts, are virtually without barring.

The ♂ had testes 12 mm. and the ♀ 3 mm. ovaries, which fact together with their behaviour suggests a courting pair and leaves little doubt that this species, though so far overlooked, is resident in the Andamans.

On these differences, we separate the Andaman birds as :

Aviceda leuphotes andamanica subsp. nov.

Type and paratype : ♂ No. 23112 and ♀ 23113 in the collection of the Bombay Natural History Society, obtained by Robert B. Grubh and Rex Pimento at Wrightmyo, South Andaman Island, on 9th April 1969.

A list of specimens from the Andaman and Nicobar Islands received from the Zoological Survey of India included specimen No. 23177 obtained in the Andamans and designated as *Baza leuphotes*. The specimen itself was not traceable and no additional data are available thereon.

In view of the limited amount of material available in Bombay, these two specimens were sent to the British Museum (Nat. Hist.) and to the American Museum of Natural History. We are grateful to Messrs I. C. Galbraith and D. J. Freeman of the former institute and Dr. Dean Amadon and Mrs. LeCroy of the latter for their comments and observations which have been of considerable help to us in deciding to describe a new subspecies.

Orchids of Nepal—3

BY

M. L. BANERJI [1] AND B. B. THAPA [2]

(*With nine text-figures*)

[*Continued from Vol.* **66** (3) : 583]

In this paper the species belonging to the genus *Dendrobium* and also those of *Epigeneium* and *Ephemerantha* are accounted. The species of the allied genus *Eria*, collected from Nepal, are also included in this part of the series.

Schlecter estimated the total number of species of *Dendrobium* (in the broad sense) at 900, and of *Eria* at 400, and these two genera to constitute almost the whole of the tribe *Dendrobium*. However, recently there have been some readjustments in the generic limits of *Dendrobium*, and Summerhayes (Kew Bull. 1957) adopted the name *Epigeneium* Gagnep. and discarded *Katherinea* Hawkes, and *Sarcopodium* Lindl. considering that *Epigeneium*, *Sarcopodium* and *Katherinea* are congeneric. Balakrishnan & Chowdhury [Bull. Bot. Surv. Ind. 8 (3 & 4): 312-318, 1966], however, feel that *Epigeneium* and *Katherinea* are two distinct genera with clear differences. We have followed Summerhayes.

The genus *Desmotrichum* was established by Blume in 1825, but Pfitzer (Pflanzfam. II, 6 : 173, 1889) treats it as a section of *Dendrobium*, an arrangement accepted by Schlecter, J. J. Smith and Holttum although Kranzlin in Pfreich. I : 343-358, 1910, had restored the genus. The name *Desmotrichum* has been conserved as a genus of the Phaeophyta, and P. F. Hunt & Summerhayes proposed a new name, *Ephemerantha* for the orchid genus (see Taxon 10 : 102, 1961). This genus is distinguished from *Dendrobium* by vegetative characters and the fugaciousness of the flowers.

The characters of the tribe *Dendrobium* may be broadly given as plants nearly all epiphytic, of sympodial growth, each branch of the sympodium bearing one or more leaves, its stem thin or fleshy throughout or fleshy in part, leaves of various shape, joined at the base ; inflorescence usually lateral of one to many flowers, which sometimes appear singly in succession from a small group of bracts ; lateral sepals

[1] University of Kalyani, Kalyani, W. Bengal.
[2] Horticultural Assistant, Indian Co-operation Mission, Kathmandu.

more or less triangular in shape, their bases joined to the column-foot forming a mentum ; petals either smaller or larger than the sepals, usually thinner, lip more or less 3-lobed, the base often long and narrow, joined to the end of the column-foot and sometimes partly to the sides of the column-foot, often with longitudinal keels, column with distinct feet which is often longer than the column, anthers usually attached at its apex by the filament, pollinia 4 in two pairs, with or without caudicle, rostellum small.

Dendrobium, *Epigeneium* and *Ephemerantha* all have 4 pollinia, without caudicle, while *Eria* has 8 pollinia with short caudicles.

Artificial key to the species of *Dendrobium*

A. Inflorescence terminal or both terminal and lateral—

B. Stem simple or nearly so, often a small pseudobulb, flowers small. Petals not broader than the dorsal sepal; side-lobes of lip strongly inciso-serrate—

C. Racemes elongate, drooping, many flowered. Lip much shorter than the sepals.................................... *denudans*

CC. Racemes many flowered. Lip as long as the sepals.... *eriaeflorum*

CCC. Racemes short, erect, 3-5 flowered. Lip shorter than the sepals.... .... *alpestre*

BB. Stem rather short, tufted, suberect. Flowers solitary or racemose, often large—

C. Mentum as long as the dorsal sepal. Mid-lobe small, orbicular, fringed, disk with 3 wrinkled ridges............... *longicornu*

CC. Mentum half as long as the dorsal sepal. Mid-lobe retuse, apiculate, disk with 2 ridges................................ *formosum*

AA. Inflorescence lateral on the stem or pseudobulb—

B. Stem flattened ; leaves shortly ensiform, distichous, imbricating. Flowers on the leafless extremities of the branches, minute, greenish...... *anceps*

BB. Stem tufted, elongate, stout or slender, distichous. Flowers usually large in lateral pairs, fascicles or racemes—

C. Mentum short, conical or rounded. Lip not calceolar—

D. Petals as narrow as the sepals or narrower. Lip narrower than broad. Flowers 2·5-3·0 cm., fragrant........... *candidum*

DD. Petals as narrow or narrower than the sepals. Lip as broad as long. Flowers *c*. 6 cm. in diam............ *primulinum*

DDD. Petals broad. Lip narrower than broad—

E. Flowers 1-3 on a short peduncle. Lip recurved, base with sides incurved.......................... *heterocarpum*

EE. Flowers in pairs. Lip clawed, base convolute.. *transparens*

EEE. Flowers 2-3 on a short peduncle. Lip clawed, undulate .... *amoenum*

DDDD. Petals much broader than the sepals. Lip as broad as long or broader—

E. Flowers solitary or 2-3 on a short peduncle or simple pedicelled. Margin of lip entire or slightly erose—

Lip orbicular, hairy inside. Flowers *c.* 5 cm. in diam. .... *pierardi*

Lip broadly ovate, pubescent, margin wavy. Flowers 3·5 cm. in diam........................ *crepidatum*

Lip broad, ovate, pubescent, base slightly convolute. Flowers 6-7 cm. in diam.................... *nobile*

EE. Flowers 5-12 in a raceme, large.............. *pulchellum*

CC. Mentum short. Lip not calceolare. Stem often swollen at the very base—

D. Stem terete—

E. Lip orbicular, margin fimbriate, 2 brownish spots.... *gibsonii*

EE. Lip with a small convolute base, pale yellow, disk deep red .... *clavatum*

EEE. Lip clawed, orbicular, margin toothed, with 2 deep red spots .... *chrysanthum*

DD. Stem clavate, flowers crowded on decurved racemes. Lip large, funnel-shaped, very hairy.................... *densiflorum*

CCC. Mentum short. Lip calceolar, fimbriate with 2 purple blotches. Flowers light yellow.............................. *moschatum*

Dendrobium alpestre Royle, Ill. Himal. 370, t.83, 1839 ; F.B.I. 5 : 715, 1890.

Flowers reddish-white ; sepals ovate-lanceolate ; petals oblanceolate, mentum short and obtuse, lip lanceolate, side-lobes serrate, mid-lobe small, crisp, disk with 2 lamellae. Collected from Talmuga at 2300 m.

D. amoenum Wall. ex Lindl. Gen. et Spec. Orch. 78, 1830 ; F.B.I. 5 : 738, 1890 ; *Limnodorum aphyllum* Roxb. Pl. Corom. 1 : 34, t.41, 1795 ; *Dendrobium aphyllum* (Roxb.) C. E. C. Fischer in Gamble, Fl. Madras Pres. 1416, 1929 (Fig. 1).

Flowers white with violet tips and lip purple, scented ; sepals oblong-lanceolate, obtuse ; petals larger, ovate, mentum conic and stout ; lip shortly clawed, ovate, obtuse, undulate, purplish, base yellow. *Flowering* in April and May ; distributed between 900 to 1800 m. Collected from Nagarjung, Godavari, locality unknown (Herklott).

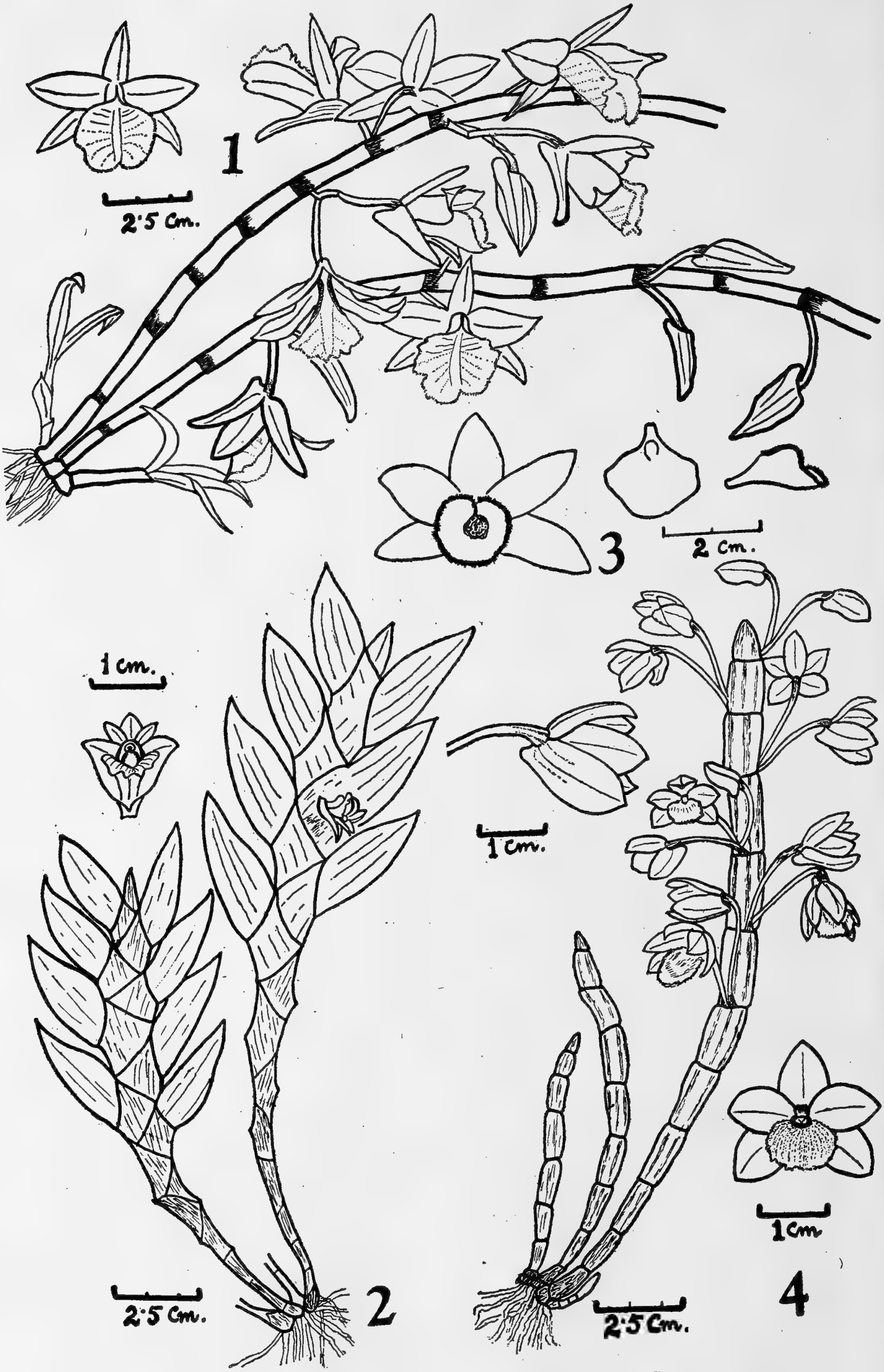

Fig. 1. *Dendrobium amoenum* Wall. ex Lindl.; 2. *D. anceps* Sw.;
3. *D. chrysanthum* Wall. ex Lindl.; 4. *D. crepidatum* Lindl.

D. anceps Swartz in Vet. Acad. Handl. Stockh. 246 : 1800 ; F.B.I.5 : 724, 1890 ; King & Pantl., in Ann. Roy. Bot. Gard. Calc. 8 : 41, t.54, 1898 ; Hara in Fl. Eastern Himal. 431, 1966 (Fig. 2).

Flowers *c.* 1·2 cm. long, greenish ; mentum longer than the sepals ; lip oblong, faintly 3-lobed, membraneous, margins stiff and crisp. *Flowering* during June or earlier ; distributed in the subtropical belt. Collected from Hitaura, locality unknown (Herklott).

D. candidum Wall. ex Lindl. Bot. Reg. 1838, Miscl. 54, 1838 ; F.B.I. 5 : 735, 1890 ; King & Pantl., 49, t.63, 1898 ; Hara, 431, 1966.

Flowers 2·5-3·0 cm., fragrant, whitish or with little purplish shade ; sepals and petals subsimilar, linear-oblong, obtuse, mentum rounded ; lip ovate-lanceolate with cuneate base, side-lobes narrow, mid-lobe ovate, obtuse, disk with a long callus. *Flowering* during March and April, and again in September and October, distributed between 1500 to 2100 m. Collected from Manichur and Daman.

D. chrysanthum Wall. ex Lindl. Gen. et Spec. Orch. 80, 1830 ; F.B.I. 5 : 747, 1890 (Fig. 3).

Flowers about 5 cm. across, fleshy, bright yellow ; sepals broad, petals orbicular, fimbriate, mentum broad, crested ; lip clawed, orbicular, margin toothed with 2 deep red spots (F.B.I. mentions one spot, but our specimens had two spots). *Flowering* during June and mid-September ; distributed at 900 to 1800 m. Collected from Pokhra, Dhankutta.

D. clavatum Wall. ex Lindl. in Paxton Fl. Gard. 2 : 104, 1850 ; F.B.I. 5 : 746, 1890.

Flowers glossy, large, yellow ; sepals linear-oblong, petals much broader, suborbicular, mentum short ; lip with a small convoluted base, pale yellow, disk deep red. *Flowering* during May and June ; distributed between 1500 to 1800 m. Collected from Godavari.

D. crepidatum Lindl. in Paxton Fl. Gard. 1 : 63, t.45, 1850-51 ; F.B.I. 5 : 740, 1890 ; King & Pantl., 48, t.66, 1898 (Fig. 4).

Flowers about 3·5 cm. across, yellow, waxy with purple pedicels ; sepals oblong, obtuse, petals obovate, mentum short, obtuse ; lip clawed, broadly ovate, retuse, pubescent, margin wavy, base deeper yellow. *Flowering* during April and May ; distributed between 300 to 900 m. Collected from Hitaura, locality unknown (Herklott).

D. densiflorum Lindl. ex Wall. Pl. Asiat. Rar. 1 : 43, t. 40, 1830 ; F.B.I. 5 : 748, 1890 ; King & Pantl., 56, t.79, 1898 ; Hara, 432, 1966.

Flowers about 5 cm. across, yellow ; sepals obtuse, petals broader, erose, mentum large, sub-globose ; lip large, funnel-shaped, retuse in front, very hairy inside, edge not fringed, deeper yellow. *Flowering* during April and May ; distributed between 900 to 1500 m. Collected from Bajrabarahi, Pokhra, Dhankutta, locality unknown (Herklott).

D. denudans D. Don, Prodr. Fl. Nep. 34, 1825 ; F.B.I. 5 : 715, 1890.

Flowers white with reddish veins on the lip, rarely yellowish ; sepals long, slender, dorsal sepal with 3 nerves and lateral sepals with 5 nerves ; petals long and slender, 1-nerved ; mentum incurved ; lip much shorter than the sepals, brownish, side-lobes serrate, mid-lobe small, disk with 2 lamellae. *Flowering* during August and September ; distributed between 1500 to 2100 m. Collected from Chandragiri, Sundarijal, Sheopuri, and Suryabinak.

D. eriaeflorum Griff. Notul. 3 : 316, 1851 ; F.B.I. 5 : 715, 1890 ; King & Pantl., 44, t.61, 1898 ; Holttum, Rev. Fl. Malaya 1 : 308, 1953 ; Hara, 432, 1966.

Flowers greenish-yellow : sepals lanceolate ; lip as long as the sepals, side-lobes serrate, mid-lobe undulate, purple veined, mentum incurved, obtuse, disk with longitudinal crest. *Flowering* in March. Collected only once from Lamidanda at 1900 m.

D. formosum Roxb. Fl. Ind. 3 : 485, 1832 ; F.B.I. 5 : 721, 1890.

Flowers large ; sepals oblong-lanceolate, acuminate ; petals much larger, about 4 cm. in diam., sub-orbicular, undulate, mentum half as long as the dorsal sepal, conical ; lip 7 cm. long, broadly obovate, entire, side-lobes rounded, mid-lobe retuse, apiculate, disk yellow, with two ridges from the base to the middle. *Flowering* during May and June : well distributed in the tropical belt. Collected from Trisuli, Hitaura, locality unknown (Herklott).

D. gibsonii Lindl. in Paxton, Mag. Bot. 5 : 169, 1838 ; F.B.I. 5 : 746. 1890.

Flowers small *c.* 3·5 cm. across, orange-yellow ; sepals sub-orbicular, petals broader, entire, mentum short ; lip suborbicular, margin everted and fimbriate, 2 brownish spots, hairy. *Flowering* during April and May ; distributed between 900 to 1050 m. Collected from Dhankutta.

This species has a strong resemblance to *Ephemerantha fimbriata* (Bl.) Hunt & Summerhayes, but differs in having smaller flowers, petals not erose, lip not deeply fimbriate. The flowers are not fugacious.

D. heterocarpum Wall. ex Lindl. Gen, et Spec. Orch. 78, 1830 ; F.B.I. 5 : 737, 1890 ; King & Pantl., 53, t. 74, 1898 ; Holttum, 287, 1953.

Flowers *c.* 6 cm. across, ochraceous-yellow or creamy-yellow, highly fragrant ; sepals linear-oblong, acute, petals ovate-lanceolate, acuminate, mentum large, conical, lip ovate-lanceolate, recurved, base with incurved sides, yellowish, disk with 2 purplish spots. *Flowering* during March and April ; distributed in the tropical belt. Collected from Sundarijal, near Tokha, locality unknown (Herklott).

D. longicornu Lindl. Gen. et Spec. Orch. 80, 1830 ; F.B.I. 5 : 720, 1890 ; King & Pantl., 46, t. 64, 1898 ; Hara, 432, 1966 (Fig. 5).

Flowers faintly yellowish ; sepals lanceolate, acuminate, not keeled, petals narrower, acuminate, mentum slender, funnel-shaped, straight and as long as the dorsal sepal, side-lobes of the lip rounded, mid-lobe small, orbicular, yellow in the middle, fringed disk with 3 wrinkled ridges. *Flowering* during September and October ; distributed from 1200 to 2400 m. Collected from Chandragiri, Sheopuri, Godavari, and locality unknown (Herklott). A few specimens were collected from Shankhoo area *c.* 1350 m. which had the lip densely fimbriate, and probably belonged to var. *hirsuta.*

D. moschatum Sw. in Schrad. Neues. Journ. 1 : 94, 1805 ; *D. calceolaria* Carey ex Hook. Exot Fl. 184, 1828 ; F.B.I. 5 : 744, 1890.

Flowers 6-8 cm. across, light yellow with purplish lines ; sepals elliptic-oblong, petals broader, mentum stout ; lip cup-shaped, margin broad, incurved, fimbriate, 2 large purple blotches. *Flowering* during June and July ; distributed at 900 to 1200 m. Collected from Hitaura, locality unknown (Herklott).

D. nobile Lindl. Gen. et Spec. Orch. 79, 1830 ; F.B.I. 5 : 740, 1890 ; King & Pantl., 51 t. 71, 1898 ; Holttum, 291, 1955 ; Hara, 432, 1966.

Flowers 6-7 cm. across, in groups at the nodes, purple above and white below ; sepals linear-oblong, obtuse, petals much broader ; lip subsessile, broad, ovate, pubescent, margin recurved, base slightly convolute, deep purple at the base. *Flowering* during April and May ; distributed at 1500 m., and collected from Dhankutta. F.B.I. gives the colour of the flower as variable, but as our collection has been from only one locality, we are unable to comment on this.

D. pierardi Roxb. in Hook. f. Exot. Fl. t. 9, 1828; F.B.I. 5 : 738, 1890 ; King & Pantl., 51, t. 72, 1898 ; Holttum, 292, 1953 ; Hara, 433, 1966.

Flowers 5 cm. across, purplish ; sepals oblong-lanceolate, sub-acute, petals broader, oblong, mentum short ; lip orbicular, hairy throughout inside, base purple, light shade of yellow all over. *Flowering* during April to June and even July ; distributed from 600 to 1200 m. Collected from Deorali to Narkata, Dhunibesi, Pokhra, and Chatra.

D. primulinum Lindl. in Gard. Chron. 400, 1858 ; F.B.I. 5 : 735, 1890 ; Holttum, 293, 1953.

Flowers lilac, *c.* 6 cm. in diam. ; sepals and petals subequal, 5-6 mm. wide, linear-oblong, obtuse ; lip 3 cm. in diam., large, pubescent, base

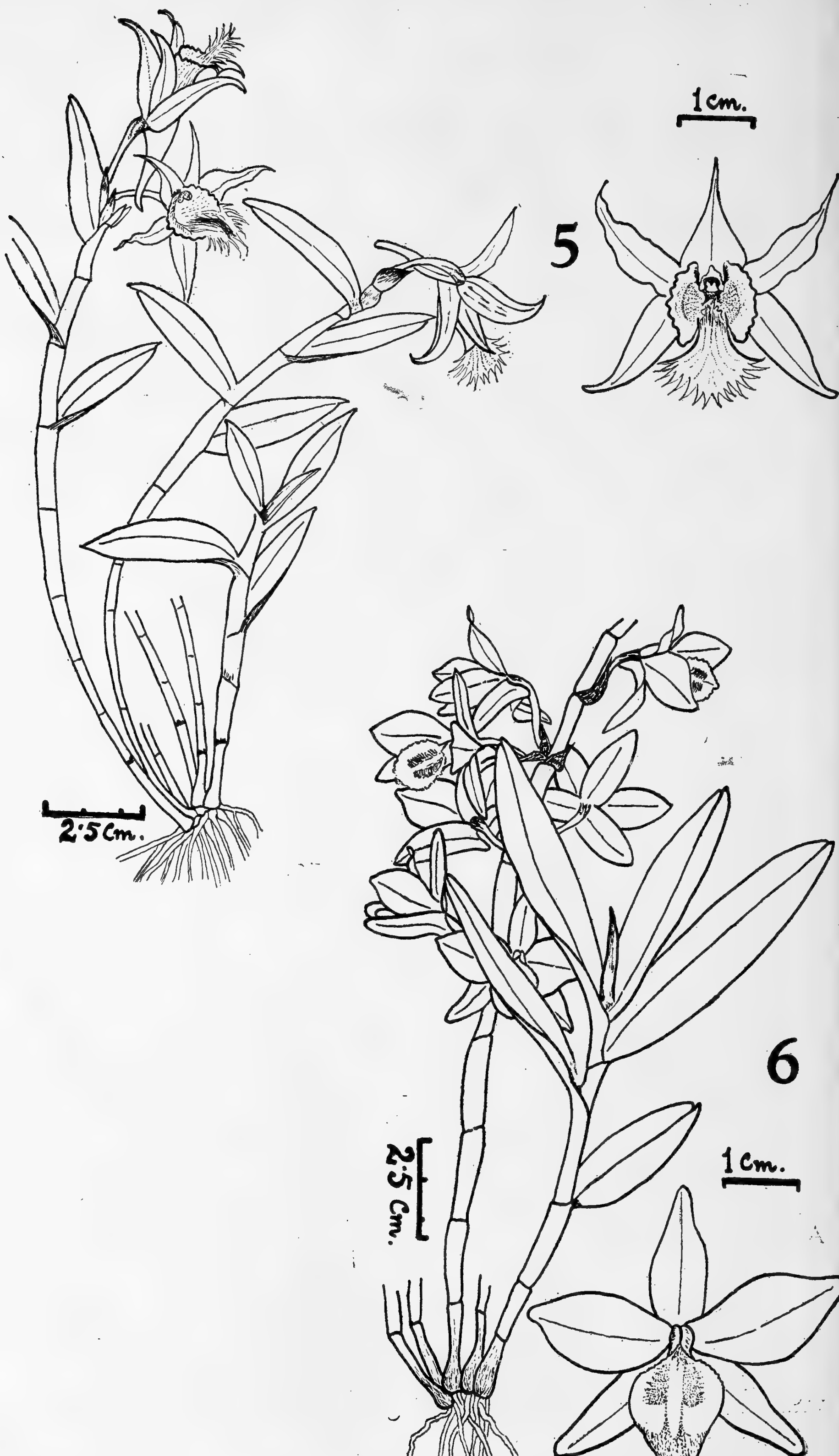

Fig. 5. *Dendrobium longicornu* Lindl.; 6. *D. transparens* Wall. ex Lindl.

short and convolute, margins ciliated, purplish. *Flowering* during April and May ; distributed between 600 to 1200 m. Collected from Hitaura. This species is very similar to *D. pierardi.*

D. pulchellum Roxb. ex Lindl. Gen. et Spec. Orch. 82, 1830 ; Holttum, 293, 1953 ; *D. dalhousieanum* Wall. F.B.I. 5 : 743, 1890.

Flowers large, *c.* 10 cm. in diam., yellowish ; sepals oblong, acute, petals much broader, mentum crimson, tip and sides densely glandular-villous, disk with 2 lamellae which are slightly fringed. *Flowering* during July and August ; distributed from 1200 to 1800 m. Collected from Tarebhir area.

D. transparens Wall. ex Lindl. Gen. et Spec. Orch. 79, 1830 ; F.B.I. 5 : 738 ; 1890 (Fig. 6).

Flowers purplish or whitish with a shade of purple ; sepals lanceolate, acute, petals broader, ovate, mentum conical ; lip clawed, elliptic-oblong, base convolute, lobes obtuse, purple, pubescent, 2 blotches. *Flowering* during April and May, or even June ; distributed from 200 to 1350 m. Collected from Goarigaon to Chanipur, Bhainsa, Dhunibesi, Pokhra, locality unknown (Herklott).

Ephemerantha Hunt & Summerhayes

The genus is distinguished from *Dendrobium* principally in the fugaciousness of the flowers and secondarily on vegetative characters.

Ephemerantha macraei (Lindl.) P. F. Hunt & Summerhayes in Taxon, 10 : 105, 1961 ; *Dendrobium macraei* Lindl. Gen. et Spec. Orch. 75, 1830 ; F.B.I. 5 : 714, 1890 ; King & Pantl., 61, t. 86, 1898 ; Hara, 432, 1966 ; *Callista macraei* (Lindl.) O. Ktz. Rev. Gen. Pl. 655, 1891.

Flowers creamy-white, fugacious ; sepals and petals erecto-patent, linear-lanceolate, acute, mentum short, side-lobes of lip sprinkled with red, oblong, mid-lobe small with 2 lobules, crenulate, disk with 2 crests. *Flowering* during June and July ; distributed between 1650 to 2400 m. Collected from Godavari.

Hunt & Summerhayes consider this species to be quite different from *E. fimbriata* (Bl.) Hunt & Summerhayes, and Narayanaswami (*Journ. Ind. Bot. Soc.* **25** : 215, 1946) has discussed the differences of *macraei* and *fimbriatum.*

Epigeneium Gagnep.

Rhizome elongated, pseudobulbs numerous, moniliform, monophyllous ; inflorescence solitary terminal ; flowers large, sepals subequal, spreading, dorsal sepal adnate to the column, lateral sepals large, attached laterally to the foot ; petals narrower, adnate to the sides of the column ; lip panduriform (fiddle-shaped), oblong, base cuneate, side-lobes erect, mid-lobe obovate to obcordate ; column short, foot long ; pollinia 4 in 2 pairs.

ARTIFICIAL KEY TO THE SPECIES OF *Epigeneium*

Leaves 10-12 cm. long. Flowers with a shade of purple, 7-8 cm. in diam. ; mid-lobe rhomboid and thick..*amplum*

Leaves 5·5-9·0 cm. long. Flowers chestnut-brown, 4·0-4·5 cm. in diam. ; mid-lobe orbicular and thin..*rotundatum*

Epigeneium amplum (Lindl.) Summerhayes in Kew Bull. 1957 (2): 260, 1957 ; *Dendrobium amplum* Lindl. Gen. et Spec. Orch. 74, 1830 ; F.B.I. 5 : 711, 1890 ; Hara, 431, 1966 ; *Bulbophyllum amplum* Reichb. f. in Walp. Ann. 6 : 244, 1861 ; *Katherinea ampala* (Lindl.) Hawkes, Balak. & Chowdhury in Bull. bot. Surv. Ind. 8 (3 & 4) : 312, 1966 (Fig. 7).

Flowers large 7-8 cm. in diam., white to dull green with a shade of purple ; sepals lanceolate, acuminate ; lip sessile, side-lobes short, mid-lobe broad, rhomboid, acute, crenulate, thick, purplish ventrally and purple spotted dorsally, disk with 3 lamellae. *Flowering* during May and again during October and November ; distributed between 1200 to 1800 m. Collected from Sheopuri, Thokha, and Sundarijal area.

E. rotundatum (Lindl.) Summerhayes in Kew Bull. 1957 (2) : 264, 1957 ; *Sarcopodium rotundatum* Lindl. Fol. Orch. Sarcopod, 2. 1853 ; *Bulbophyllum rotundatum* (Lindl.) Reichb. f. in Walp. Ann. 6 : 244, 1861 ; *Dendrobium rotundatum* (Lindl.) Hk. f. in Fl. Brit. Ind. 5 : 712, 1890 ; *Katherinea rotundatum* (Lindl.) Hawkes, Balak. & Chowdhury in Bull. bot. Surv. Ind. 8 (3 & 4) : 312, 1966.

Flowers 4·0-4·5 cm. in diam., pale chestnut-brown ; sepals and petals erect, acute, fleshy ; lip sessile, side-lobes small, mid-lobe large, orbicular and thin, 3 lamellae on the base. *Flowering* during April and May ; distributed at 1800 m. Collected from Mahadeophedi to Katonje.

Eria Lindl.

Long stem-like pseudobulbs. Flowers not large nor showy, flower-structure as in *Dendrobium*, but the base of the lip not forming a spur by uniting with the edges of the column-foot ; pollinia 8 with caudicles.

ARTIFICIAL KEY TO THE SPECIES OF *Eria*

A. Pseudobulbs ovoid or depressed. 2-3 leaved, leaves membraneous. Scape longer than the leaves, filiform. Flowers very small, glabrous ; lip narrow, lanceolate and slightly dilated in the middle........................*muscicola*

AA. Stem tall, terete, leafy. Leaves distichous, long, narrow, having crystalline concretions. Flowers minute, woolly in subterminal spikes, lateral sepals short, broad, mid-lobe of lip bilobed and crenulate............*paniculata*

AAA. Pseudobulbs short or long, 1-noded forming a fleshy stem or crowded on the creeping rhizome. Flowers small or medium sized, glabrous or pubescent, rarely woolly in lateral or subterminal spikes or racemes—

B. Flowers small or minute in dense spikes, sub-globose, pilose.......... ....*convallarioides*

BB. Flowers small or medium-sized, many-flowered spikes—

C. Flowers sessile or subsessile—

D. Mentum rounded, lip short.....................*graminifolia*

DD. Mentum nil; lip short, yellow and pink............*excavata*

DDD. Mentum rounded; lip oblong, yellow and red............*alba*

CC. Flowers pedicelled, bracts large—

D. Side-lobes of lip incurved and with 3 thick ridges. Flowers *c*. 2·5 cm. in diam..................................*confusa*

DD. Side-lobes of lip rounded. Flowers *c*. 1·5 cm. in diam...... ....*bractescens*

DDD. Side-lobes with 2 thick ridges between them. Flowers *c*. 2·5 cm. in diam.................................*coronaria*

AAAA. Pseudobulbs usually large. Leaves one or few, often loaded with crystalline concretions. Flowers in terminal or subterminal spikes, woolly or dense white tomentose, yellow with purplish markings...................*flava*

Eria alba Lindl. Gen. et Spec. Orch. 67, 1830; F.B.I. 5 : 795, 1890.

Flowers white, sepals ovate-lanceolate, 3-5 nerved, glabrescent, petals linear-oblong, 3-nerved, mentum rounded; lip oblong, broadly clawed, side-lobes pointed forwards, obtuse, mid-lobe yellow and red, disk with 2 ridges between the side-lobes. *Flowering* time probably August. Collected from Dana at *c*. 1450 m.

E. bractescens Lindl. Bot. Reg. 27, Miscl. 18, 1841; F.B.I. 5 : 796, 1890; King & Pantl., t. 166, 1898; Holttum, 388, 1953.

Flowers light pink, glabrous, puberulous; lateral sepals ovate-lanceolate, falcate, acuminate, petals linear-oblong, 5-nerved, mentum conical, side-lobes deeper pink, rounded, mid-lobe creamy and papillose. *Flowering* during August and September; distributed between 1500 to 1800 m. Collected from Rhingmo to Jubing and Suryabinak.

E. confusa Hk. f. in Hook. Icon. Pl. 19, t. 1850, 1889 et F.B.I. 5 : 796, 1890.

Flowers whitish; sepals broadly ovate-oblong, obtuse, 5-nerved. pubescent, petals elliptic-lanceolate, 3-5 nerved; lip obovate, side-lobes incurved, 3 thick ridges, mid-lobe orbicular, thick. *Flowering* during April and May; distributed between 1200 to 1800 m. Collected from Bajrabarahi. This species has a strong resemblance to *E. bractescens.*

E. convallarioides Lindl. Gen. et Spec. Orch. 70, 1830 ; F.B.I. 5 : 791, 1890.

Flowers greenish-yellow, subglobose, pilose ; sepals very broad, 5-7 nerved, petals 3-nerved, mentum rounded ; lip cuneate with a broad warted tip. *Flowering* during September and October ; distributed at about 1800 m. Collected from Sheopuri, Godavari, and Sundarijal. F.B.I. gives the colour of the flowers as white or straw-yellow, but in all our material the colour was greenish-yellow.

E. coronaria (Lindl.) Reichb. f. in Walp. Ann. 6 : 272, 1861; King & Pantl., 124, t. 172, 1898, Hara, 433, 1966 ; *Coelogyne coronaria* Lindl. Bot. Reg. Miscl. 83, 1841 ; *Trichosma suavis* Lindl. Bot. Reg. t. 21, 1824 ; F.B.I. 5 : 827, 1890.

Flowers whitish or yellowish, sweet smelling ; sepals ovate-lanceolate, petals oblong, lip sub-sessile, streaked, with purple and yellow in the middle, disk with 2 ridges, slightly deeper yellow between the side-lobes, mid-lobe with 5 clear and 2 faint ridges. *Flowering* during October and November ; distributed between 1500 to 2000 m. Collected from Okhaldunga and Sundarijal areas.

E. excavata Lindl. ex Hk. f. Icon Pl. t. 1846, 1889, et Gen. et Spec., Orch. 67, 1830 (p.p.) ; F.B.I. 5 : 795, 1890 ; King & Pantl., 124, t. 171, 1898 ; Hara, 434, 1966.

Flowers dull yellow ; sepals ovate-lanceolate, falcate, petals 5-nerved, mentum nil ; lip short with 3 central ridges, yellow, side-lobes pink with purple nerves, mid-lobe large, obovate. *Flowering* during June ; collected from Sheopuri *c.* 1800 m.

E. flava Lindl. Gen. et Spec. Orch. 65, 1830 ; F.B.I. 5 : 801, 1890 ; Hara 434, 1966.

Flowers light yellow with purple markings on the lip ; sepals ovate-lanceolate, 9-nerved, obtuse, petals obtuse, 3-nerved, mentum subcylindric ; lip thick, puberulous, side-lobes short. *Flowering* during April and May, but in the orchid-house of the garden it sometimes flowers in December also, probably due to the plants being fully exposed to bright sun and the effect of temperature ; distributed at 450 to 750 m. Collected from Hitaura and Dhunibesi.

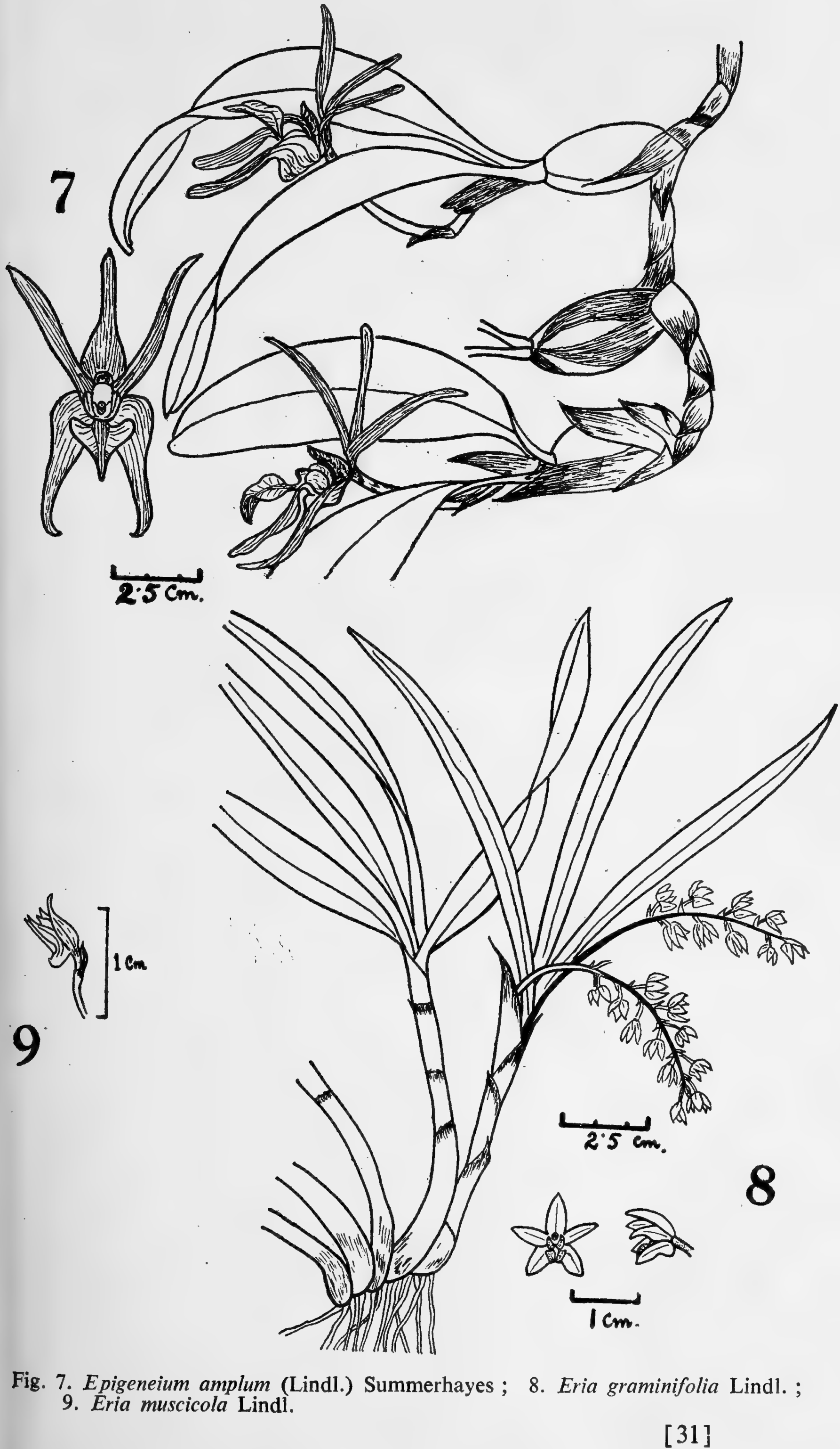

Fig. 7. *Epigeneium amplum* (Lindl.) Summerhayes ; 8. *Eria graminifolia* Lindl. ; 9. *Eria muscicola* Lindl.

E. graminifolia Lindl. in Journ. Linn. Soc. 3 : 54, 1859 ; F.B.I. 5 : 794, 1890 ; King & Pantl., 119, t. 164, 1898 ; Hara, 434, 1966 (Fig. 8).

Flowers white, glabrous ; lateral sepals ovate-lanceolate, 3-5-nerved, petals linear-lanceolate, acute, mentum rounded ; lip short ; side-lobes oblong, recurved and with a short ridge, mid-lobe orbicular. *Flowering* during June and July ; collected from Sheopuri, *c.* 1800 m. The spreading and recurved side-lobes are very characteristic of this species.

E. muscicola Lindl. in Journ. Linn. Soc. 3 : 47, 1857; F.B.I. 5 : 789, 1890 ; Hara, 434, 1966 (Fig. 9).

Flowers very small ; sepals lanceolate, finely acuminate, lateral sepals falcate, petals narrowly lanceolate, mentum rounded ; lip narrow, lanceolate and slightly dilated in the middle. *Flowering* during April and May ; distributed between 1200 to 1500 m. Collected from Lamidanda and Dhankutta.

E. paniculata Lindl. in Wall. Pl. Asiat. Rar. I : 32, t. 36, 1829 ; F.B.I. 5 : 789, 1890.

Petals elliptic, obtuse, mentum rounded ; lip suborbicular, side-lobes oblong, mid-lobe bilobed and crenulate, disk thick. *Flowering* during April and May ; distributed at 750 to 1200 m. Collected from Dhunibesi and Bajrabarahi.

(*to be continued*)

Amphipoda from the East Coast of India—2

Gammaridea and Caprellidea

BY

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(*With six text-figures*)

[*Continued from Vol.* **66** (3) : 576]

Cymadusa sardenta (Oliveira)

(Fig. 13)

Grubia sardenta Oliveira, 1953, p. 365, pls. 25-26.

Material : Hare Island, Tuticorin : 1 male from algae growing on a wooden pole.

Length : 10 mm.

Description : Male : Head less than twice as long as 1st segment. Eyes small, oval, colourless in alcohol (was probably red). Lateral lobes only slightly produced. Body broadly curved, with grey or violet patches and dots all over the body and appendages.

Antenna 1 as long as body, with short setae. Peduncle reaching end of 4th peduncular joint of antenna 2. 1st joint as long as 2nd and thrice that of 3rd, lower margin with a spine at 1/3 its length and another subterminal. Flagellum nearly 4 times as long as peduncle, with 53 joints. Accessory flagellum 2-jointed, 2nd being minute. Antenna 2 less than 2/3 as long as antenna 1. Peduncle as long as flagellum with long, dense, plumose setae on both the margins ; 4th joint a little longer than the 5th. Flagellum with short setae, with 33 joints.

Mandible : Molar well-developed, reniform. Primary cutting plate with 6 teeth and the accessory with 5. Spine row with 8 spines. 3rd joint of palp a little longer than 2nd, thrice as long as 1st, inner margin apically with about 10 long setae. Maxilla 1 : Inner plate very short, with 6 long setae on inner margin. Outer plate with 9 apical spines.

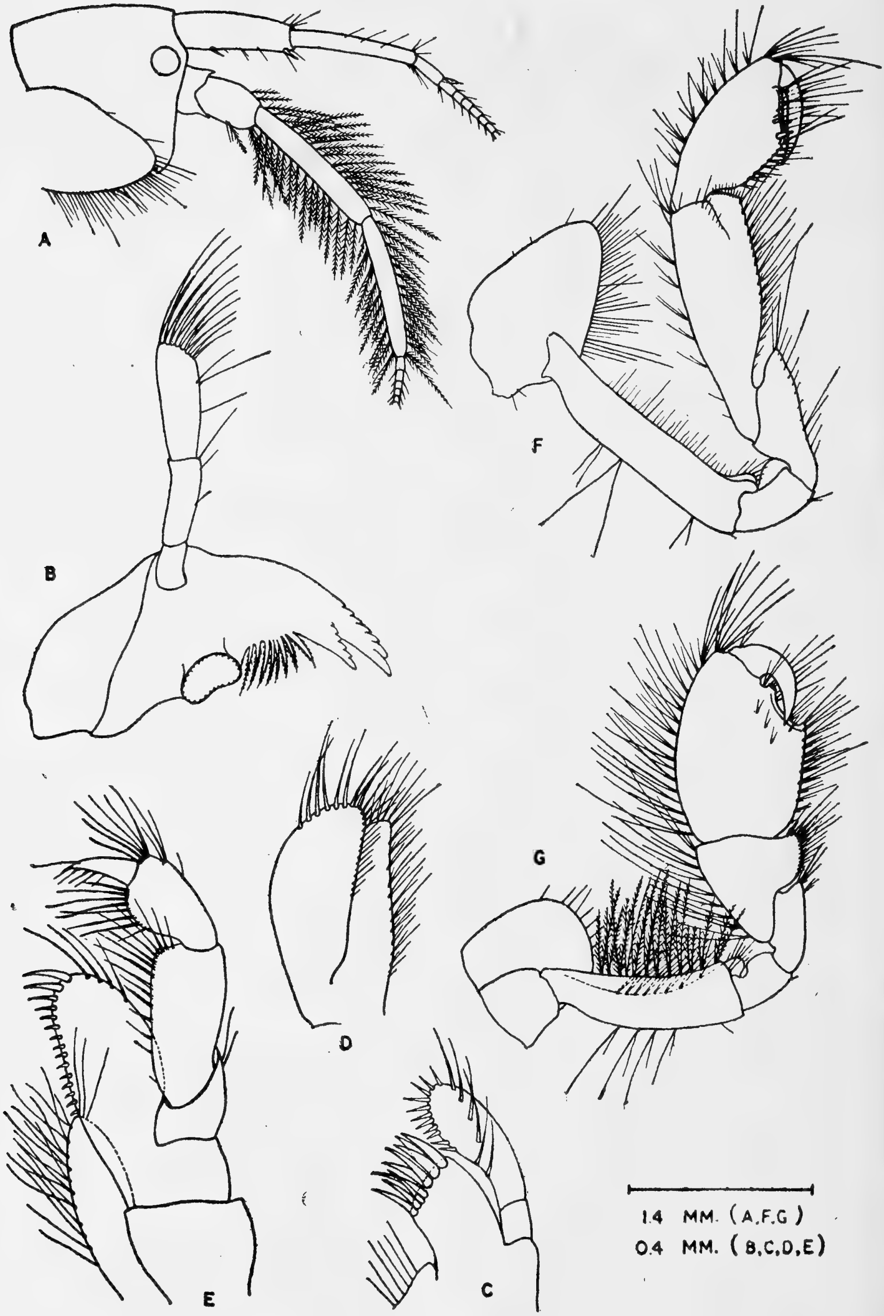

Fig. 13. *Cymadusa sardenta* (Oliveira). *Male* : A, head ; B, mandible ; C, maxilla 1 ; D, maxilla 2 ; E, maxilliped ; F, gnathopod 1 ; G, gnathopod 2.

2nd joint of palp thrice as long as 1st, with 11 spines on apical and inner margins and an oblique row of 6 long setae on lower aspect. Maxilla 2 : Inner plate about half as broad as outer, both with long plumose setae apically and on inner margin. Maxilliped : Inner plate extending beyond base of 1st palpar joint inner margin and apex setose. Outer plate not reaching end of 2nd palpar joint, with 4 long setae at the apex and 16 spines on inner margin decreasing in length from the apex. 2nd palpar joint twice as long as 1st, inner margin with long setae ; 3rd joint narrower distally with long setae on both margins ; terminal joint with 6 stout setae on inner margin.

Gnathopod 1 much longer than gnathopod 2 but slender. Side plate oval, conically produced in front, with a fine row of setae below. 2nd joint narrow, as long as 5th joint, front margin with 2 angular ribs which are distally produced into two small, rounded lobes. 3rd joint half as long as next, front margin elevated into a rounded lobe. 4th joint hind margin distally produced into a conical, pointed lobe. 5th joint unusually long, constricted at the base and widening distally ; hind margin serrate, with dense setae, front margin with 8 sets of setae. 6th joint about 2/3 as long as 5th, densely setose, constricted at the base and widening distally. Palm shorter than hind margin, oblique, slightly concave, defined by a spine at posterior angle. Dactylus narrow, nearly straight, longer than the palm. Gnathopod 2 : Stout, densely setose with plumose setae. Side plate quadrate, rounded below. 2nd joint densely setose, longer than the 6th, front margin 2-ribbed and distally produced slightly. 3rd joint 2/3 as long as next, front margin with a notch near the base. 4th joint only slightly produced distally. 5th joint about half as long as 6th, both margins densely setose. 6th joint large, oval, densely setose. Palm oblique, shorter than hind margin, with a flat-topped tooth near the hinge of dactylus, followed by a concave portion and a pointed tooth defining the palm. Dactylus stout, strongly curved.

Peraeopods, uropods and telson as in *C. microphthalma*.

Remarks : The specimen closely agrees with the description and figures of *C. sardenta* given by Oliveira (1953), the differences being insignificant. The antennae are much longer, the flagella with more joints, otherwise similar. The inner plate of maxilla 2 is much narrower. 2nd palpar joint of maxilliped longer, twice as long as 1st. 6th joint of gnathopod 2 of male is broader, palm with a flat-topped tooth near the hinge of dactylus which is not found in Oliveira's specimen. This structure is, however, not of any systematic value (Schellenberg 1928 : 668). The present material is only half the length of the type which was 20·5 mm. in length.

I believe that *Grubia compta* Pearse (1912, p. 376, fig. 6, *not* Smith) from Florida should be referred to this species, though Barnard (1955) unites it with *Cymadusa filosa.* Pearse's figures are strikingly similar to the present specimen, though the gnathopods are wrongly labelled.

Distribution : Rio de Janeiro, Brazil. This is the first record of this species from India.

Family COROPHIIDAE

Genus *Corophium* Latreille

Corophium acherusicum Costa

(Fig. 14)

Corophium acherusicum Bate, 1862, p. 282 ; Della Valle, 1893, p. 364, pl. 1, fig. 11, pl. 8, figs. 17, 18, 20-41 ; Stebbing, 1906, p. 692 ; Chevreux & Fage, 1925, p. 368, fig. 376 ; Schellenberg, 1925, p. 191 ; 1928, p. 672 ; Shoemaker, 1934, p. 24 ; 1947, p. 53, figs. 2-3 ; 1949, p. 76 ; Crawford, 1937, p. 617, fig. 2 P. (literature) ; Barnard KH, 1940, p. 482 ; Reid, 1951, p. 269 ; Barnard JL, 1955, p. 37 ; Nayar, 1959, p. 43, pl. 15, figs. 14-20.

Material : Visakhapatnam harbour : 4 females from algae growing on wooden rafts.

Length : 2·7 mm.

Remarks : All the specimens studied are females. They have the characteristic features given by Crawford (1937). Antenna 1 : 1st joint of peduncle with 4 spines on the inner margin and 5 on the lower, the basal ones being slightly curved. Antenna 2 : 2nd joint of peduncle with 3 distal spines on the pointed lobe, 3rd joint with 2, 4th joint with 7 spines on lower margin arranged 2, 2, 2, 1 and 5th joint with 2 single spines equidistantly placed on lower margin. Gnathopod 1 : Side plate conically produced, with 3 long, apical setae. Dactylus with a tooth on the inner margin. Gnathopod 2 : Dactylus with one or two teeth on inner margin.

One specimen had the spines on antenna 2, joint 4, arranged as 1, 2, 2, 1 on the right and 1, 3, 2, 1 on the eft. Spines on joint 5 were arranged 2, 1 on both sides.

Distribution : Cosmopolitan in tropical and temperate seas. Previously recorded in India from the Krusadai Island in the Gulf of Mannar and presently from the Andhra coast.

Genus *Grandidierella* Coutière

Grandidierella bonnieri Stebbing

Grandidierella bonnieri Stebbing, 1908, p. 120, pl. 6 ; Barnard KH, 1935, p. 299, figs. 12*d* & 13*b* ; 1951, p. 708 ; 1955, p. 7 ; Schellenberg, 1938(*b*), p. 215 ; Shoemaker, 1948, p. 11, fig. 3 ; Nayar, 1959, p. 38, pl. 14, figs. 1-5.

Grandidierella megnae Chilton, 1921, p. 548, fig. 10 ; Stephensen, 1933(*a*), p. 434.

Unciolella lunata Schellenberg, 1928, p. 669, fig. 207 (*not* Chevreux).

Material : Tuticorin : Several specimens from a saltwater pond in Hare Island. Devipattinam : 2 males and 2 females from algae on the sea shore. Tondi : Several specimens from a brackish water canal. Point Calimere : Several specimens from the Kodiakkarai swamp. Kovelong : Several specimens from the Buckingham Canal. Madras : Several specimens from the Adyar estuary and the Buckingham Canal. Ennore estuary : Several specimens from filamentous algae and oyster shells. Pulicat Lake : Several specimens from the lake, mud pools and salt pans.

Length : 8 mm.

Distribution : India, Philippines, Suez Canal, South Africa, Brazil, Bonaire Island, Caribbean sea, West Indies and Cuba.

Grandidierella gilesi Chilton

Grandidierella gilesi Chilton, 1921, p. 552, fig. 11 ; 1925, p. 537 ; Barnard KH, 1935, p. 300 ; Schellenberg, 1938(*a*), p. 93 ; Nayar, 1959, p. 40, pl. 14, fig. 6.

Material : Pinnakayal : 1 female and 2 males from the tanks of a saltwater pumping station. Tuticorin : 1 male and 1 female from a saltwater pond in the Hare Island.

Length : 7 mm.

Distribution : India, Tale Sap (Thailand) and Philippines.

Genus *Ericthonius* Milne-Edwards

Ericthonius brasiliensis (Dana)

Pyctilus brasiliensis Dana, 1853-55, p. 976, pl. 67, figs. 5 *a-h*.

Ericthonius brasiliensis Stebbing, 1906, p. 671 ; 1910, p. 463 ; Walker, 1909, p. 343 ; Kunkel, 1910, p. 100, fig. 39 ; 1918, p. 163, fig. 49 ; Chilton, 1923, p. 242, figs. 1-5 ; Chevreux & Fage, 1925, p. 353, fig. 360 ; Schellenberg, 1925, p. 187 ; 1926(*b*), p. 384 ; 1928, p. 668 ; 1931, p. 257 ; 1935, p. 233 ; 1938(*a*), p. 90 ; 1938(*b*), p. 217 ; Stephensen, 1927, p. 136 ; 1942, p. 402 ; Barnard KH, 1937, p. 173 ; 1955, p. 8 ; Shoemaker, 1935, p. 249 ; 1941, p. 188 ; 1942, p. 48 ;

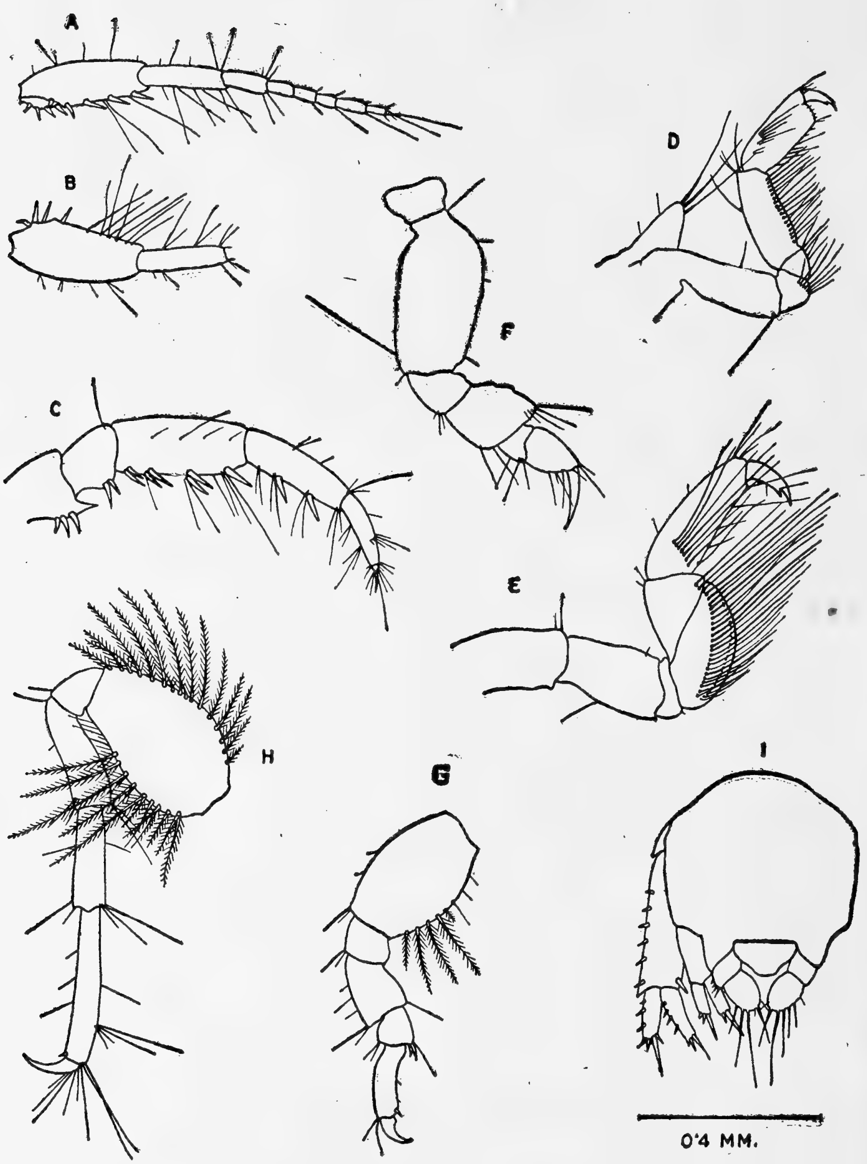

Fig. 14. *Corophium acherusicum* Costa. *Female*: A, antenna 1, side view; B, antenna 1, dorsal view; C, antenna 2; D, gnathopod 1; E, gnathopod 2; F, peraeopod 1; G, peraeopod 4; H, peraeopod 5; I, urus.

Rudwick, 1951, p. 153 ; Reid, 1951, p. 267 ; Barnard JL, 1955, p. 37 ; 1959, p. 39 ; Pillai, 1957, p. 60, figs. 14 (3-7) ; Nayar, 1959, p. 42, pl. 15, figs. 1-13.

Ericthonius brasiliensis Sexton, 1911, p. 218 ; Chevreux, 1911, p. 262 ; 1925, p. 391 ; Chevreux & Fage, 1925, p. 353, fig. 360 ; Pirlot, 1939, p. 68, 77.

Cerapus brasiliensis Bate, 1862, p. 267, pl. 45, fig. 8.

Ericthonius disjunctus Stout, 1913, p. 658.

Material : Pamban : 1 female from seaweeds. Kovelong : 2 females and 3 males from sponges. Madras harbour : Several specimens from ascidians.

Length : 4 mm.

Distribution : Cosmopolitan in tropical and temperate waters.

Family Podoceridae

Genus *Podocerus* Leach

Podocerus brasiliensis (Dana)

Platophium brasiliense Dana, 1853-55, p. 838, pl. 55, fig. 9.

Podocerus brasiliensis Stebbing, 1917, p. 447 ; Barnard KH, 1925, p. 366 ; 1935, p. 305 ; Schellenberg, 1928, p. 674 ; 1938 (*a*), p. 94 ; 1938 (*b*), p. 217 ; Rudwick, 1951, p. 153, fig. 3 ; Barnard JL, 1953, p. 87 ; 1955, p. 39 ; 1959, p. 39 ; Nayar, 1959, p. 45, pl. 15, figs. 21-26.

Podocerus brasiliensis Della Valle, 1893, p. 329 ; Stebbing, 1906, p. 704 ; Reid, 1951, p. 267.

Cyrtophium brasiliense Bate, 1862, p. 274, pl. 46, fig. 6.

Platophium synaptochir Walker, 1904, p. 296, pl. 8, fig. 52.

Podocerus synaptochir Stebbing, 1906, p. 741 ; Walker, 1909, p. 343 ; Barnard KH, 1916, p. 279.

Material : Pamban : 1 male and 1 female from seaweeds. Madras harbour : Several specimens from ascidians, sponges and polyzoans on the concrete blocks.

Length : 4 mm.

Distribution : Cosmopolitan in the tropical and temperate seas.

Genus *Laetmatophilus* Bruzelius

Laetmatophilus sp.

(Fig. 15)

Material : Kovelong : 1 female from the washings of ascidians.

Length : 2 mm.

Description : Female : Head about twice as long as 1st segment. Eyes protruberant, rounded and dark. Body depressed and broad, the short and narrow pleon being folded beneath. Body segments transversely grooved, not markedly keeled. Side plates small.

Antennae long, subpediform and densely setose. Antenna 1 : A little shorter than antenna 2 ; 1st joint of peduncle short and stout, front margin distally ending in a tooth. 2nd joint longer than the 3rd. Flagellum as long as 3rd joint, with 3 joints of which 1st is twice as long as the 2nd, 3rd very short. Antenna 2 robust, 2/3 as long as body. 2nd and 3rd joints of peduncle short, 5th longer than 4th. Flagellum with 2

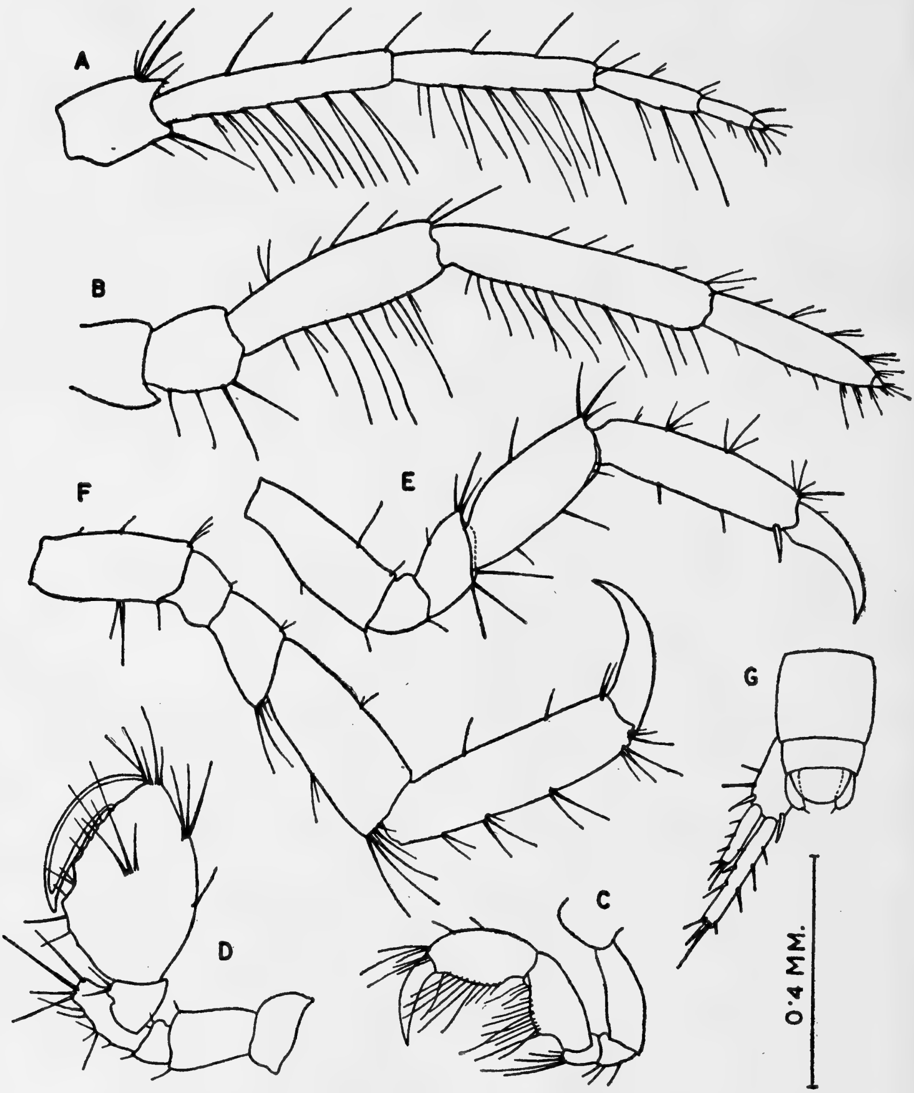

Fig. 15. *Laetmatophilus* sp. *Female :* A, antenna 1 ; B, antenna 2 ; C, gnathopod 1 ; D, gnathopod 2 ; E, peraeopod 1 ; F, peraeopod 5 ; G, urus.

joints, 1st joint 2/3 as long as 5th joint of peduncle, 2nd very short. Mouth parts typical of the genus.

Gnathopod 1 : Side plate very narrow. 5th joint as long as 6th, hind margin produced into a setiferous lamellar lobe. 6th joint widest at the middle, palm undefined. Dactylus stout, with averted point. Gnathopod 2 much longer than the preceding, with stout setae. 4th joint distally produced into an acuminate projection. 6th joint large, oval. Palm oblique, about $1\frac{1}{2}$ times as long as hind margin, defined by a small dentiform projection, followed by a concave space and the rest tubercular. Dactylus stout, longer than palm.

Peraeopods similar in size and structure. 2nd joint shorter than 5th. Joints 5-7 well-developed. Peraeopods 2-4 missing. Pleopods feebly developed. Uropod 1 well-developed and spinous. Outer ramus subequal to peduncle, half as long as inner ramus. Uropod 2 rudimentary, represented by a curved lobe with a short apical seta. Uropod 3 wanting. Telson semi-circular in shape.

Remarks : From a single female it is difficult to fix the identity of this specimen. Of the 7 species of *Laetmatophilus* so far described, the female is not known of *L. tridens* and *L. leptocheir* and among others the present specimen is very near to *L. purus* Stebbing.

Suborder CAPRELLIDEA

Family CAPRELLIDAE

Genus *Paradeutella* Mayer

Paradeutella bidentata Mayer

(Fig. 16)

Paradeutella bidentata Mayer, 1890, p. 29, pl. 1, figs. 35-36; pl. 3, figs. 36-41 ; pl. 5, figs. 34-35 ; pl. 6, figs. 12-25 ; 1903, p. 145 ; 1904, p. 225 ; Raj, 1927, p. 125, pl. 15, figs. 2 a-b.

Material : Pamban : 3 females from seaweeds growing on rocks under the railway bridge.

Length : 4·5 mm.

Remarks : This species seems to be very localised as all the previous records, as well as the present one, refer to material collected from the Gulf of Mannar.

Distribution : Ceylonese and Indian coasts of the Gulf of Mannar.

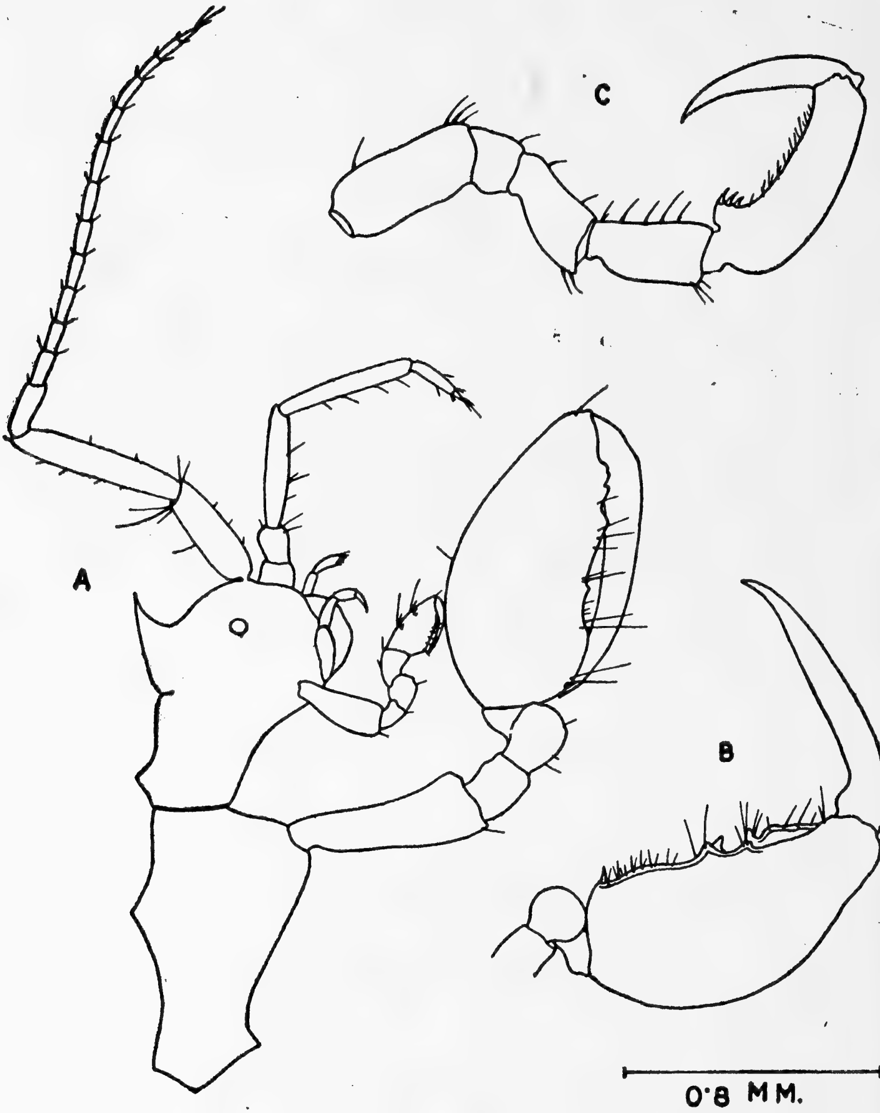

Fig. 16. *Paradeutella bidentata* Mayer. *Female* : A, front part of animal; B, gnathopod 2; C, peraeopod 5.

Genus *Tritella* Mayer

Tritella pilimana Mayer

(Fig. 17)

Tritella pilimana Mayer, 1890, p. 31, pl. 1, fig. 37, pl. 3, figs. 48-50, pl. 5; fig. 50, pl. 6, fig. 9 & pl. 7, fig. 7 ; 1903, p. 48, pl. 2, fig. 6,

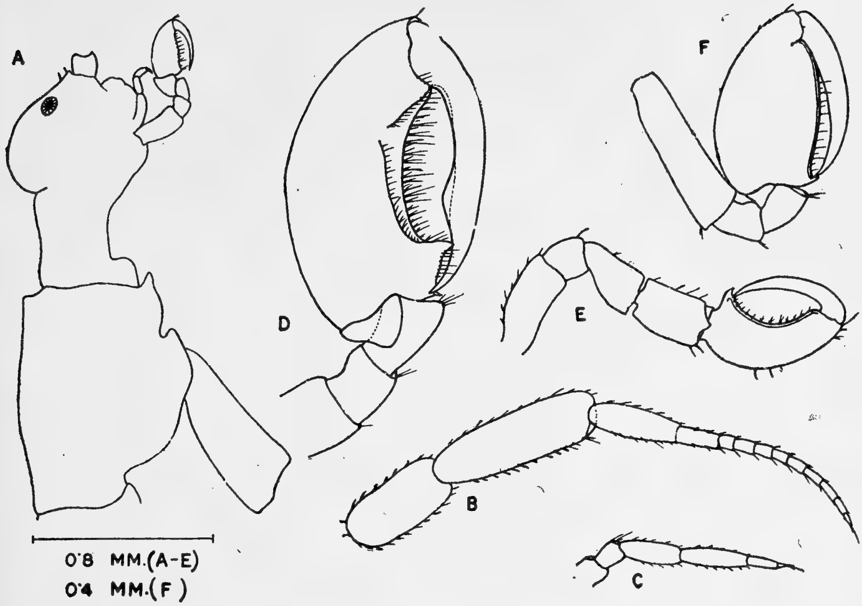

Fig. 17. *Tritella pilimana* Mayer. *Male :* A, front part of animal ; B, antenna 1 ; C, antenna 2 ; D, gnathopod 2 ; E, peraeopod 5. *Female* : F, gnathopod 2.

Material : Kovelong : 34 specimens from the hydroids and polyzoans growing on ascidians. Madras harbour : 3 females from polyzoans growing on concrete blocks.

Length : 6 mm.

Remarks : These specimens closely agree with Mayer's (1890, 1903) figures of this species first described from California. I am, however, doubtful of the identification, considering how these slow-moving animals could be distributed over such a long distance existing between California and India.

Distribution : California. This is the first record of this species from India.

Genus *Paracaprella* Mayer

Paracaprella alata Mayer

(Fig. 18)

Paracaprella alata Mayer, 1903, p. 67, pl. 2, figs. 40-41 & pl. 9, fig. 73.

Material : Madras : 28 specimens from polyzoans growing on sponges washed ashore at Marina beach.

Length : 4·2 mm.

Remarks : The specimens closely agree with the figures and description of this species given by Mayer (1903). I was not able to examine the mouth parts as the specimens were collected in a semi-dried condition. The specimens are also similar to Giles' (1888) *Caprella madrasana*, but his figures are not good. Mayer did not refer to this paper and it is possible that *P. alata* may have to be united with this species.

Distribution : Sydney, Australia. This is the first record of this species from India.

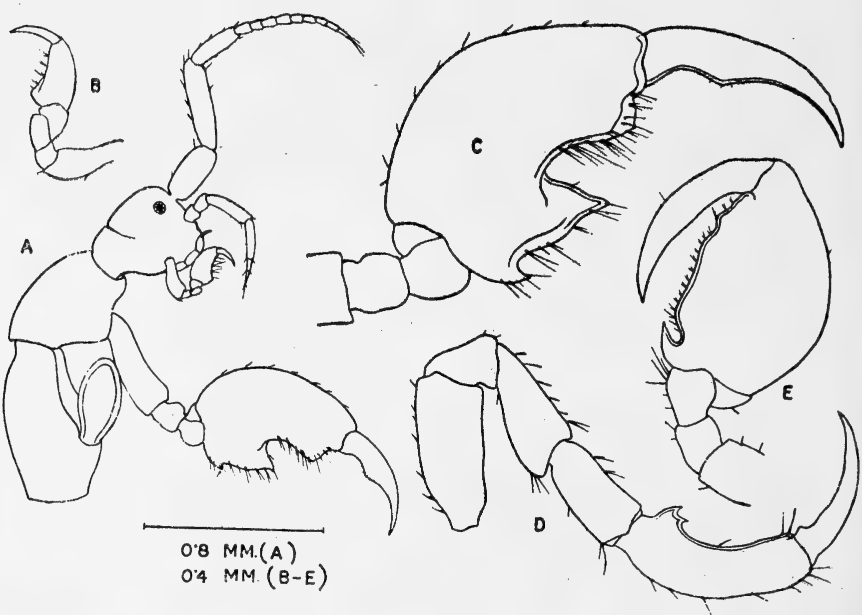

Fig. 18. *Paracaprella alata* Mayer. *Male* : A, front part of animal ; B, gnathopod 1 ; C, gnathopod 2 ; D, peraeopod 5. *Female* : E, gnathopod 2.

Notes on Ecology

The amphipods studied here are mostly littoral, collected from intertidal and shallow waters. Some are estuarine, brackishwater and terrestrial, collected from the sea-shore, estuaries and nearby ponds and canals. The littoral species were found clinging to seaweeds, free or attached to the rocks or washed ashore. Some species were also found in association with other invertebrates. *Orchomenella affinis* was collected from the washings of nudibranchs. *Ampelisca zamboange* was found in the cavities of sponges. *Amphilochus schubarti* was found in the debris formed on compound ascidians. *Leucothoe spinicarpa* lives among algae as well as sponges and holothurians. *Maera quadrimana* was also found on holothurians. *Elasmopus pectenicrus* was found among zoantharian colonies and also among the arms of crinoids. *Lembos kergueleni* and *Cymadusa microphthalma* were found in the cavities of sponges. *Ericthonius brasiliensis* and *Podocerus brasiliensis* were collected from the washings of both sponges and ascidians. The caprellids were found clinging to polyzoan and hydroids growing on sponges and compound ascidians. The association of these amphipods with other invertebrates appears to be purely a chance occurrence and has not developed to the extent of commensal or semiparasitic relationship as they were also collected from seaweeds and the present observations do not indicate such a relationship.

Among the terrestrial amphipods, some talitrid and hyalid amphipods were collected from the sea-shore and on the banks of brackishwater and freshwater canals and ponds, two or three miles away from the sea-shore. Hurley (1959) applied the term 'supralittoral' to the amphipods of the sea-shore zone generally called sandhoppers. These are still dependent on sea-water for their distribution though their feeding and breeding may be performed on land. The term 'terrestrial' was used for those which are entirely independent of sea-water. In the sense of these terms, there are only supralittoral amphipods and no terrestrial ones in the present collection. *Orchestia anomala* was collected from under stones at the high tide mark, around saltwater ponds and also around a freshwater pond about a mile away from the sea-shore. *Talorchestia martensii* was collected from the tidal edge, the sea-shore and the banks of brackishwater and freshwater ponds and canals. *Parhyale inyacka* was collected from the intertidal waters as well as from under stones and jumping about at the tidal edge.

The change from marine to terrestrial environment is one of the important steps in the evolution of the Amphipoda. Carter (1931) says that the majority of terrestrial animals have reached the land by way of freshwater rather than directly from the sea. Pearse (1929) and Edney (1954) believe that the route to land was across the littoral zone rather than by way of estuaries and swamps. I think that both these routes are possible, though there are no truly terrestrial species in the present collection to prove this. *T. martensii* appears to have taken to land through the estuaries, though they are not still independent of water. It occurs in all the zones from the littoral area to the freshwater. *O. anomala* on the contrary, appears to have taken up land life through the sea-shore. It occurs under the stones on the sea-shore and also around freshwater ponds near the sea-shore.

Geographical Distribution

The interpretation of distributional data is an extremely complicated affair. The importance of a group of animals for zoogeographical conclusions depends on the volume of our knowledge of the group, the facilities for their dispersal and the barriers in their way of dispersal (Mahendra 1939). It is also necessary to consider the distribution of as many groups as possible before arriving at conclusions (Nicholls 1933). Our knowledge on the Amphipoda is far from complete. In this paper, distributional data are given for each species based on published information which are not necessarily complete.

The number of amphipod species known from India is not large and a large part of the Indian coasts remains to be explored for their amphipod fauna. Moreover, our knowledge of this group of animals from the rest of the Indo-Pacific area is rather meagre. These animals are also likely to be introduced from one country to another by ships whose bottom with their algal growth is an ideal habitat for them. In view of these points, no definite zoogeographical conclusions can be reached from the present study. However, the amphipod fauna of India has its closest affinity to that of Ceylon and other islands and countries bordering the Indian Ocean. In the present collection of amphipods, there are 9 cosmopolitan species. Apart from these there are 12 species which are nearly cosmopolitan (or are irregularly distributed and hence not of any importance in the present discussion). This is largely due to lack of knowledge of this group in several areas. 18 species are distributed in the Indo-Pacific Ocean. The maximum number of 19 species are restricted to the Indian Ocean. 3 species are known only from India, namely, *Paracalliope indica*, *Parhyalella indica* and *Photis digitata*, but it cannot be said whether they are truly endemic since our knowledge of this group of animals in the rest of the Indo-Pacific area is, as already pointed out, rather scanty.

Summary

The present paper is the second and concluding part of a systematic study of the Amphipod Crustacea of the east coast of India. A total number of 32 species belonging to seven gammaridean families and a caprellidean family are dealt with here, of which 16 species are recorded for the first time from India. The ecology of these amphipods is discussed. A discussion on the geographical distribution shows their close affinity to the Amphipoda of the islands and countries bordering the Indian Ocean.

References

AUDOUIN, V. (1826) : Explication sommaire des planches de Crustaces de Egypt et de la Syrie, Publices par J. C. Savigny, Membre de l'Institut. *Description de la Egypte, Hist. Nat.* **1** (4) : 77-98.

BARNARD, J. L. (1953) : On two new amphipod records from Los Angeles Harbour. *Bull. S. Calif. Acad. Sci.* **52** (3) : 83-87, pl. 15.

———— (1955) : Gammaridean Amphipoda (Crustacea) in the collections of Bishop Museum. *Bull. Bishop Mus. Honolulu* **215** : 1-46, 20 figs.

———— (1958) : Index to the families, genera and species of the Gammaridean Amphipoda (Crustacea). *Occ. Pap. Allan Hancock Fdn.* **19** : 1-145.

———— (1959) : Ecology of Amphipoda and Polychaeta of Newport Bay, California. Part II. Estuarine Amphipoda. ibid. **21** : 13-69, 14 pls.

BARNARD, K. H. (1916) : Contributions to the Crustacean fauna of South Africa. 5. Amphipoda. *Ann. S. Afr. Mus.* **15** (3) : 105-302, pls. 26-28.

———— (1925)—-Do-— 8. Further additions to the list of Amphipoda. ibid. **20** : 319-380, pl. 34.

———— (1935) : Report on some Amphipoda, Isopoda and Tanaidacea in the collection of the Indian Museum. *Rec. Indian Mus.* **37** : 279-319, 21 figs.

———— (1937) : Amphipoda. John Murray Expedition, 1933-34, *Sci. Rep.* **4** (6) : 131-201,

———— (1940) : Contribution to the Crustacean fauna of South Africa. 12. Further additions to the Tanaidacea, Isopoda and Amphipoda together with keys for the identification of hitherto recorded marine and freshwater species. *Ann. S. Afr. Mus.* **32** (5) : 381-543, 35 figs.

———— (1951) : New records and descriptions of new species of isopods and amphipods from South Africa. *Ann. Mag. nat. Hist.* Ser. 12, **4** : 698-709.

———— (1955) : Additions to the fauna-list of South African Crustacea and Pycnogonida. *Ann. S. Afr. Mus.* **43**(1) : 1-107, 53 figs.

BATE, C. S. (1862) : Catalogue of the specimens of Amphipodous Crustaceans in the collection of the British Museum, London, 399 pp., 58 pls.

———— & WESTWOOD, (1863) : British sessile-eyed Crustacea. Vol. 1. London, 1-507, figs.

———— (1868) : British sessile-eyed Crustacea. Vol. 2. London, 1-536, figs.

BULYCHEVA, A. I. (1957) : Morskie Blokhi Morej SSSR i sopredel 'nykh Vod. *Opred. po Faune SSSR Akad. Nauk., SSSR., Zool. Inst., Izd.* **65** : 1-186, figs. 1-66*b*.

CARTER, G. S. (1931) : Aquatic and aerial respiration in animals. *Biol. Rev.* **6** (1) : 1-35.

CHEVREUX, E. (1901) : Mission scientifique de M.Ch. Alluaud aux Iles Sechelles, 1892. Crustaces Amphipodes. *Mem. Soc. zool. Fr.* **14** : 388-438, 65 figs.

———— (1908) : Amphipodes recueillis dans les possessions francaises de l'Oceanie par M.le Dr. Seurat, 1902-1904. ibid., **20** : 470-527, 35 figs.

———— (1911) : Campagnes de la Melita. Les Amphipodes d'Algerie et de la Tunisie. ibid., **23** : 145-285, pls. 6-20.

———— (1925) : Amphipodes. Voyage de la Goelette Melita aux Canaries et au Senegal (1889-1890). Amphipodes 1-Gammariens. *Bull. Soc. zool. Fr.* **50** (10) : 278-311, 12 figs.

———— & FAGE, L. (1925) : Amphipodes. *Faune de France*, Paris **9** : 1-488, 438 figs.

CHILTON, C. (1921) : Fauna of the Chilka lake. Amphipoda. *Mem. Indian Mus.* **5** : 521-558, 12 figs.

———— (1923) : Some New Zealand Amphipoda. No. 3. *Trans. Proc. N.Z. Inst.* **54** : 200-245, 5 figs.

———— (1925) : Zoological results of a tour in the Far East. The Amphipoda of Tale Sap. *Mem. Asiat. Soc. Beng.* **6** (10) : 531-541.

CRAWFORD, G. I. (1936) : Additions to the Plymouth Marine Fauna (1931) in the Crustacean orders Tanaidacea, Isopoda and Amphipoda. *J. Mar. biol. Ass., U.K.* **21** (1) : 95-106.

———— (1937) : A review of the Amphipod genus *Corophium* with notes on the British species. ibid. **21** (2) : 589-630, 4 figs.

DANA, J. D. (1853-55) : The Crustacea. *U.S. Exploring Expedition during the years* 1838-42, **14** (2) : 805-1018, pls. 54-69.

DELLA VALLE, A. (1893) : Gammarini del Golfo di Napoli. *Fauna und Flora des Golfes von Neapel* **20** : 1-948, 61 pls.

EDNEY, E. B. (1954) : Woodlice and the land habitat. *Biol. Rev.* **29** : 185-219, 3 figs.

GILES, G. M. (1888) : Further notes on the amphipods of Indian waters. *J. Asiat. Soc. Beng.* **57** : 220-255, pls. 6-12.

GRAVELY, F. H. (1927) : Amphipoda Gammaridea. The Littoral Fauna of the Krusadai Island in the Gulf of Mannar.

Bull. Madras Govt. Mus. nat. Hist. **1** (1) : 123-124.

HASWELL, W. A. (1880*a*) : On the Australian Amphipoda. *Proc. Linn. Soc. N.S.W.* **4** (3) : 245-279, pls. 7-12.

——— (1880*b*) : On some additional new genera and species of Amphipodous Crustaceans. ibid. **4** (3) : 319-349, pls. 18-24.

——— (1885) : Notes on the Australian Amphipoda. ibid. **10** (1) : 95-114, pls. 10-18.

HURLEY, D. E. (1959) : Notes on the ecology and environmental adaptations of the terrestrial Amphipoda. *Pacific Science* **13** (2) : 107-129, 3 figs.

KUNKEL, B. W. (1910) : The Amphipoda of Bermuda. *Trans. Conn. Acad. Arts. Sci.* **16** : 1-116, 43 figs.

——— (1918) : The Arthrostraca of Connecticut. *Bull. State of Connecticut Geol. & Nat. Hist. Survey*, **26** : 1-261.

MACCAGNO, T. (1936) : Crostacei di Assab. Decapodi, Stomatopodi, Anfipodi. *Ann. Mus. Stor. nat. Genova* **59** : 171-186.

MAHENDRA, B. C. (1939) : The Zoogeography of India in the light of Herpetological Studies. *Sci. & Cult.* **4** (7) : 1-11, 5 figs.

MAYER, P. (1890) : Nachtrag zu den Caprelliden. *Fauna und Flora des Golfes von Neapel* **17** : 1-157, 7 pls.

——— (1903) : Die Caprellidae der Siboga-Expedition. *Siboga Expedite* **24** : 1-160, pls. 1-10.

——— (1904) : Caprellidae. *Rep. to Govt. of Ceylon on the Pearl Oyster Fisheries in the Gulf of Mannar* **2** (16) : 223-227, 10 figs.

MILNE-EDWARDS, H. (1840) : Histoire Naturalle des Crustaces, comprenant l'anatomie, la physiologie et la classification des ces animaux., Paris Vol. **3**.

NAYAR, K. N. (1959) : The Amphipoda of the Madras coast. *Bull. Madras Govt. Mus. nat. Hist.* **6** (3) : 1-59, 16 pls.

NICHOLLS, G. E. (1933) : The composition and biogeographical relations of the fauna of Western Australia. *Rep. Aust. and New Zeal. Assoc. Adv. Sci.* **21**.

OLIVEIRA, L. P. H. DE (1953) : Crustacea Amphipoda do Rio de Janeiro. *Mem. Inst. Osw. Cruz* **51** : 289-376, 27 pls.

PEARSE, A. S. (1912) : Notes on certain Amphipods from the Gulf of Mexico with descriptions of new genera and new species. *Proc. U.S. nat. Mus.* **43** (1936) : 369-379, 8 figs.

——— (1929) : Observations on certain littoral and terrestrial animals at Tortugas, Florida, with special reference to migrations from marine to terrestrial habitats. *Carnegie Inst. Wash. Publ.* **391** : 205-233, 3 figs.

PILLAI, N. K. (1957) : Pelagic Crustacea of Travancore. III. Amphipoda. *Bull. Res. Inst. Univ. Kerala*, Ser. C, **5** : 29-68, 17 figs.

PIRLOT, J. M. (1938) : Les amphipodes de l'Expedition du Siboga. Les Amphipodes Gammarides. *Siboga Expeditie* **33 f** (2) : 329-388, figs. 147-163.

——— (1939) : Amphipoda dans : Resultats scientifiques des croisieres du Navire-ecole Belge ' Mercator '. *Mem. Mus. Hist. nat. Belg.* (2), **15** : 47-80, 7 figs.

RAJ, B. S. (1927) : Caprellidea. The Littoral Fauna of the Krusadai Island in the Gulf of Mannar. *Bull. Madras Govt. Mus. nat. Hist.* **1** (1) : 125-128, 4 pls.

REID, D. M. (1951) : Report on the Amphipoda (Gammaridea and Caprellidea) of the coast of tropical West Africa. *Atlantidae Rep.* **2** : 189-291, 58 figs.

RUDWICK, M. J. S. (1951) : Notes on some Crustacea (Amphipoda) from Aden. *Ann. Mag. nat. Hist.*, Ser. 12, **4** : 149-156.

RUFFO, S. (1938*a*) : Studi sui Crostacei Anfipodi. VIII. Gli anfipodi marine del Museo Civico di Storia Naturale de Genova. (*a*) Gli Anfipodi del Mediterraneo. *Ann. Mus. Stor. nat. Genova* **60** : 127-151.

——— (1938*b*) : do. IX. Gli anfipodi del Red Sea. ibid. **60** : 152-180.

——— (1950) : do. XXII. Anfipodi del Venezuela raccolti dal dott. G. Marcuzzi. *Mem. Mus. Civ. Stor. Nat. Verona* **2** : 49-65, 5 figs.

——— (1954) : Anfipodi raccolti nel Venezuela dal Prof. G. Marcuzzi. ibid. **4** : 117-125, 2 figs.

——— (1956) : Nota su alcuni Anfipodi raccolti sulle coste dell : India del Dr. K. Lindberg. ibid. **5** : 211-216.

——— (1958) : Amphipodes terrestress et des eaux continentales de Madagascar, des Comores et de la Reunion. *Mem. Inst. Scient. Madagascar*, A **12** : 35-66.

——— (1959) ; Contributo alla conoscenza degli Anfipodi del mar Rosso. *Bull. Sea Fish. Res. Stn. Haifa*, **20** : 1-26, 6 figs.

SARS, G. O. (1895) : An account of the Crustacea of Norway with short descriptions and figures of all the species. 1. Amphipoda. 711 pp., 248 pls.

SCHELLENBERG, A. (1925) : Crustacea VIII : Amphipoda. *Michaelson, W., Beitrage zur Kenntnis des Meeresfauna Westafrikas* **3** (4) : 111-204, 27 figs.

——— (1926*a*) : Amphipoda 3. Die Gammariden der Deutschen Tiefsee-

Expedition. *Deutsch Tiefsee Exped.* 1898-99 (*auf dem 'Valdivia' Dampfer*) **23** (5) : 195-243, 28 figs., 1 pl.

SCHELLENBERG, A. (1926*b*): Die Gammaridender Deutschen Sudpolar-Expedition, 1901-1903. *Deutsche Sudpolar-Exped.* **18** (10) : 235-414, 68 figs.

——— (1928) : Report on the Amphipoda collected by the Cambridge Expedition to the Suez Canal, 1924. *Trans. zool. Soc. Lond.* **22** (5) : 633-692, figs. 198-209.

——— (1931) : Gammariden und Caprelliden des Magellangebietes, Sudgeorgiens und der Westantarktis. *Further Zool. Res. Swedish Antarctic Exped.* 1901-1903, **2** (6) : 1-290, 1 pl., 136 figs.

——— (1935) : Amphipoda von Chile und Juan Fernandez gesammelt von Prof. W. Gietsch. *Zool. Jb. System.* **67** (4) : 225-234, 3 figs.

——— (1936) : Amphipoda benthonica of the fishery grounds near Alexandria. *Notes & Mem. Fish. Res. Directorate Egypt* **18** : 1-27, 1 fig., 8 charts.

——— (1938*a*) : Litorale Amphipoden des tropischen Pazifiks. *K. svenska Vetensk Akad. Handl.*, Ser. 3, **16** (6) : 1-105, 48 figs.

——— (1938*b*) : Brasilianische Amphipoden, mit biologischen Bemerkungen. *Zool. Jb. System.* **71** : 202-218, 5 figs.

——— (1939) : Amphipoden des Kongo-Mundungsgebietes. *Rev. Zool. Bot. Afr.* **32** (1) : 122-138, 29 figs.

SEXTON, E. W. (1911) : The Amphipoda collected by the 'Huxley' from the north side of the Bay of Biscay in August, 1906. *J. Mar. biol. Ass. U.K.* **9** (2) : 199-227, pl. 3.

SHOEMAKER, C. R. (1921) : Report on the amphipods of the Barbados-Antigua Expedition of 1918. *Univ. Iowa Studies nat. Hist.* **9** (5) : 1-102.

——— (1933) : Two new genera and six new species of Amphipoda from Tortugas. *Pap. Tortugas Lab.* **28** : 247-256, 8 figs.

——— (1934) : The Amphipod genus *Corophium* on the east coast of America. *Proc. biol. Soc. Wash.* **47** : 22-32.

——— (1935) : The amphipods of Porto Rico and the Virgin Island. *Scientific Survey of Porto Rico and the Virgin Islands, N.Y. Acad. Sci.* **15** (2) : 229-253, 5 figs.

——— (1941) : On the names of certain Californian amphipods. *Proc. biol. Soc. Wash.* **54** : 187-188.

——— (1942) : Amphipod crustaceans collected on the Presidential cruise of 1938. *Smithson. misc. Coll.* **101** (11) : 1-52, 17 figs.

SHOEMAKER, C.R. (1945): The Amphipod genus *Photis* on the east coast of North America. *Charleston Mus. Leaf.* **22** : 1-17, 5 figs.

——— (1947) : Further notes on the amphipod genus *Corophium* from the east coast of America. *J. Wash. Acad. Sci.* **37** (2) : 47-63, 12 figs.

——— (1948) : The Amphipoda of the Smithsonian-Roebling Expedition to Cuba in 1937. *Smithson. misc. Coll.* **110** (3) : 1-15, 3 figs.

——— (1949) : The Amphipod genus *Corophium* on the west coast of America. *J. Wash. Acad. Sci.* **39** (2) : 66-82, 8 figs.

——— (1956) : Observations on the genus *Parhyale*. *Proc. U.S. nat. Mus.* **106** : 345-358, 4 figs.

SIVAPRAKASAM, T. E. (1966) : Amphipoda from the east coast of India. Part 1. Gammaridea. *J. Mar. biol. Ass. India* **8** (1) : 82-122.

STEBBING, T. R. R. (1888) : Report on the Amphipoda collected by H.M.S. Challenger during the years 1873-76. *Rep. on the Sci. Res. of the voyage of H.M.S. Challenger, Zool.* **29** : 1-1737, 212 pls., (3 vols.)

——— (1899) : Amphipoda from the Copenhagen Museum and other sources. Part 2. *Trans. Linn. Soc. Lond.* (*Zool.*), Ser. 2, **7** (8) : 395-432, pls. 30-35.

——— (1906) : Amphipoda I. Gammaridea. *Das Tierreich* **21** : 1-806, 127 figs.

——— (1908*a*) : Some South African Crustacea. Part IV. *Ann. S.Afr. Mus.* **6** : 1-96, pls. 1-14.

——— (1908*b*) : The fauna of brackishwater ponds at Port Canning, Lower Bengal. Part IX. A new species of Amphipoda. *Rec. Indian Mus.* **2** : 119-123, pl. 6.

——— (1910) : General catalogue of South African Crustacea. *Ann. S.Afr. Mus.* **6** (4) : 281-593, pls. 15-22.

——— (1917) : The Malacostraca of Durban Bay. *Ann. Durban Mus.* **1** : 435-450, 2 pls.

STEPHENSEN, K. (1915) : Isopoda, Tanaidacea, Cumacea and Amphipoda (excl. Hyperidea). *Rep. on Danish Oceanogr. Exped.* 1908-10 *to the Mediterranean and adjacent seas* **12** (1) : 1-53, 33 figs.

——— (1927) : Rivideret Fortegnelse over Denmarks Arter of Amphipoda [3 Del. Gammaridea : Gammaridae til Fam. Podoceridae (Dulichiidae ant.) Caprellidae]. *Vidensk. Medd. dansk. naturh. Foren. Kbh.* **84** : 107-150.

——— (1928) : Contribution a l'etude de la faune du Cameroun. III.

Amphipoda. *Faune des Colonies Francaises* **1** (6) : 589-591.

STEPHENSEN, K. (1933*a*) : Fresh and brackishwater Amphipoda from Bonaire, Curacao and Aruba. *Zool. Jb. System.* **64** : 415-436.

——— (1933*b*) : Amphipoda from the marine salines of Bonaire and Curacao. ibid. **64** : 437-446.

——— (1935*a*) : Terrestrial Talitridae from the Marquasas. *Bull. Bishop Mus.* **142** (3) : 19-34, 10 figs.

——— (1935*b*) : Indo-Pacific Terrestrial Talitridae. *Occ. Pap. Bishop Mus.* **10** (23) : 1-20.

——— (1942) : The Amphipoda of N. Norway and Spitzbergen with adjacent waters. *Tromso Mus. Skrifter* **3** (1-4) : 1-525, 78 figs. (1935-1942).

——— (1947) : Redescription of *Orchestia anomola* Chevreux, a terrestrial Amphipod new to Samoa. *Proc. Linn. Soc. Lond.* **158** (1) : 23-26, 2 figs.

——— (1948) : Amphipods from Curacao, Bonaire, Aruba and Margariter. *Studies on fauna of Curacao, Aruba, Bonaire and Venezuelan islands* **3** (11) : 1-20, 3 figs.

STOUT, V. R. (1912) : Studies in Laguna Amphipoda. 1*st Annual Rep. Laguna Mar. Lab.*, pp. 134-149, figs. 74-84.

——— (1913) : Studies in Laguna Amphipoda. *Zool. Jb. System.* **34** : 633-659, 3 figs.

TATTERSALL, W. M. (1922) : Amphipoda with notes on additional species of Isopoda. *Mem. Asiat. Soc. Beng.* **6** (8) : 435-460, pls. 18-21.

TATTERSALL, W. M. (1925) : Freshwater Amphipoda from Andaman Isles. *Rec. Indian Mus.* **27** (4) : 241-247, 13 figs.

WALKER, A. O. (1901) : Contributions to the Malacostracan Fauna of the Mediterranean. *J. Linn. Soc.* (*Zool.*) **28** : 290-307, pl. 27.

——— (1904) : Report on the Amphipoda collected by Professor Herdman at Ceylon in 1902. *Report to Govt. of Ceylon on Pearl Oyster Fisheries in the Gulf of Mannar* **2** (17) : 229-300, 8 pls.

——— (1905) : Marine Crustaceans, XVI. Amphipoda. *Fauna & Geogr. Maldive Laccadive Archs.* **2** (1) : 923-932, pl. 88.

——— (1909) : Amphipoda Gammaridea from the Indian Ocean, British East Africa and the Red Sea. *Trans. Linn. Soc. London* (*Zool.*) Ser 2, **12** (4) : 323-344, pls. 42 & 43.

——— (1916) : Edriophthalma from South America. *Ann. Mag. nat. Hist.*, Ser. 8, **17** : 344-346, 1 fig.

——— & SCOTT, A. (1903) : Decapod and sessile-eyed Crustaceans from Abd-el-Kuri. *Nat. Hist. of Sokotra and Abd-el-Kuri*, pp. 216-232, pls. 14A & B.

WEBER, M. (1892) : Susswasser-Crustaceen des Indischen Archipels, nebst Bemerkungen uber die Susswasser-Fauna in Angemeinum. *Zool. Ergebn. einer Reise in Neiderl. Ost-Indien* **2** : 528-571.

Sex Ratio in some Indian Bats

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INTRODUCTION

The determination of accurate sex ratio in bats is rendered difficult because most of the species live in sexually segregated colonies throughout the year except during the season of copulation. Hence, records of the sex ratio in these animals can be valid if sufficient number of specimens are collected at random throughout the year from several colonies at frequent intervals. The data so far available from the literature on the subject indicates that there is an uneven sex ratio with the females outnumbering the males in most species of bats (Wimsatt 1945 ; Gopalakrishna 1947, 1955 ; Ramakrishna 1951 ; Pearson *et al.* 1952 ; Abdulali 1949 ; Ramaswamy 1962 ; Brosset 1962 a, b, c; 1963). *Taphozous melanopogon* and *Hipposideros lankadiva* (Abdulali 1949) appear to be the only two exceptional species in which the males exceed the females.

This paper presents data pertaining to the sex ratio of the following species of bats : *Rousettus leschenaulti* (Desmaret), *Taphozous longimanus* (Hardwicke), *Megaderma lyra lyra* (Geoffroy), *Hipposideros fulvus fulvus* (Gray), *Hipposideros speoris* (Schneider), *Hipposideros ater ater* (Templeton), *Pipistrellus ceylonicus chrysothrix* (Wroughton), *Pipistrellus mimus mimus* (Wroughton) and *Pipistrellus dormeri* (Dobson). The specimens belonging to all these species, except *Taphozous longimanus,* were collected from various places in Marathwada in Maharashtra. The specimens of *Taphozous longimanus* were collected in and around Nagpur in Vidarbha, Maharashtra. In all the cases collections have been made for at least two consecutive years, and in some cases for three or four years. In most species all the calendar months of the year are represented by one or more collections. In those species having a sharply defined breeding season many collections were made during the breeding season when the males and the females live together.

Table 1 gives the monthwise collections of the specimens of all the species studied here. Infants of the two sexes are included under separate columns with respect to each species. This will not only give a clear picture of the sex ratio at different ages of life of the animals, but will indicate the months of the year when the young are carried by lactating mothers. Details of the breeding habits and associated phenomena are published elsewhere.

TABLE 1

MONTHWISE DISTRIBUTION OF THE SPECIMENS COLLECTED OF THE VARIOUS SPECIES

Month	*Rousettus leschenaulti*				*Taphozous longimanus*				*Megaderma lyra lyra*			
	a	b	c	d	a	b	c	d	a	b	c	d
January	—	73	—	95	—	3	1	6	—	37	—	85
February	—	62	—	70	—	5	2	7	—	24	—	32
March	7	61	7	70	1	3	1	12	—	17	—	49
April	35	74	34	128	—	—	—	—	—	7	—	18
May	3	43	6	38	—	—	—	—	—	—	—	—
June	—	38	—	55	1	1	2	7	—	2	—	7
July	2	17	2	38	—	2	1	5	—	2	—	2
August	1	16	—	11	1	2	2	18	—	7	—	16
September	—	29	—	34	2	12	5	20	—	—	—	6
October	—	9	—	19	2	4	2	23	—	17	—	25
November	—	68	—	67	2	3	2	12	—	65	—	92
December	—	70	—	85	1	5	1	6	—	74	—	105
Total	48	560	49	710	10	40	19	116	—	252	—	437

Month	*Hipposideros fulvus fulvus*				*H. speoris*				*H. ater ater*			
	a	b	c	d	a	b	c	d	a	b	c	d
January	—	16	—	42	—	—	—	—	—	11	—	31
February	—	5	—	11	—	7	—	24	—	23	—	56
March	—	6	—	48	—	8	—	20	—	24	—	56
April	4	4	3	17	—	5	—	11	—	1	—	8
May	15	36	21	103	—	2	—	10	—	9	2	28
June	—	23	—	44	—	—	—	—	13	6	7	36
July	—	10	—	4	—	—	—	—	—	5	—	8
August	—	12	—	37	—	2	—	4	—	6	—	8
September	—	10	—	13	—	—	—	—	—	2	—	4
October	—	32	—	39	—	—	—	—	—	9	—	9
November	—	19	—	20	—	3	—	17	—	8	—	16
December	—	12	—	18	—	—	—	—	—	4	—	20
Total	19	185	24	396	—	27	—	86	13	108	9	280

Month	*Pipistrellus ceylonicus chrysothrix*				*P. mimus mimus*				*P. dormeri*			
	a	b	c	d	a	b	c	d	a	b	c	d
January	—	24	—	50	2	39	—	73	1	16	—	40
February	—	10	—	37	—	22	—	33	—	11	—	37
March	—	23	—	51	—	35	—	64	—	7	3	38
April	—	20	—	34	—	18	—	39	—	5	4	10
May	—	36	—	81	—	9	—	23	1	5	—	4
June	—	42	—	68	—	13	—	22	1	14	—	12
July	—	56	—	124	12	14	8	40	2	6	1	16
August	4	25	3	154	—	6	—	17	—	—	—	2
September	62	23	65	142	3	4	2	17	1	8	1	25
October	2	40	—	65	1	5	1	4	—	—	—	—
November	—	31	—	47	2	24	7	48	—	6	—	26
December	—	22	—	49	3	14	2	22	—	9	—	39
Total	68	352	68	902	23	203	20	402	6	87	9	249

Note :—Column (*a*)—Young males attached to the breasts of their mothers.
Column (b)—Adult males.
Column (*c*)—Young females attached to the breasts of their mothers.
Column (*d*)—Adult females.

Observations and Conclusions

Since random collections have been made from different colonies, in all the seasons for two or more years, and since the numbers of specimens collected are reasonably large in most of the species, the conclusions drawn from the collection should be valid. A study of Table 1 indicates that in all the species studied, there is a very wide disparity in the numbers of the males and females, and in every case the females outnumber the males. If the number of males in each species is calculated to a common denominator of one thousand females, then the number of males per one thousand females in each species is as in Table 2.

Table 2

Number of males per one thousand females in the adult stage

Species	No. of males per 1000 females
Rousettus leschenaulti	788
Taphozous longimanus	343
Megaderma lyra lyra	577
Hipposideros fulvus fulvus	467
H. speoris	314
H. ater ater	386
Pipistrellus ceylonicus chrysothrix	390
P. mimus mimus	505
P. dormeri	349

Note :—The numbers are corrected to the nearest whole number.

Although in most cases the number of young recovered may not warrant a definite conclusion regarding the sex ratio during infancy, it is noteworthy that in the case of *Rousettus leschenaulti* and *Pipistrellus ceylonicus chrysothrix*, where a large number of young of both the sexes were collected, there is almost a balanced sex ratio during juvenile life. Even in the other species, except *Taphozous longimanus*, the sex ratio of the juveniles is reasonably even, and at any rate, the disparity in the adult sex ratio is not reflected at the younger stage of life. This leads to the conclusion that during the growth period there is a preferential mortality of the males resulting in an abnormal adult sex ratio in these bats.

An interesting feature is that, except in the case of the three species of *Pipistrellus*, all other species studied had a single young in each litter, and in most cases only once a year. *Rousettus leschenaulti* produces two litters in the year (Gopalakrishna & Chaudhari, in press), and *Taphozous-longimanus* breeds throughout the year in quick succession (Gopalakrishna 1954, 1955).

It is interesting to compare the present findings with the data of earlier workers on the subject. Wimsatt (1945) working on some

American species of bats (*Myotis lucifugus lucifugus, Pipistrellus subflavus, Eptesicus fuscus* and *Lasionycteris noctivagans*) indicated that in the summer colonies the females were preponderant and in the hibernating winter colonies there were more males. Since there were differences in the proportions of the two sexes in different colonies, no definite conclusion could be arrived at regarding the sex ratio in these species. An abnormal sex ratio with females far outnumbering the males was shown by one of us (1947) in *Scotophilus wroughtoni*, and by Ramakrishna (1951) in the Indian vampire bats. Pearson *et al.* (1952) have shown that whereas there is a balanced sex ratio among the juveniles of *Corynorhinus rafinesquei*, the counts of adults gave conflicting results. Abdulali (1949) recorded the sex ratio in 28 species of Indian bats, and showed that in all the species except two (*Taphozous melanopogon* and *Hipposideros lankadiva*) the females outnumbered the males. In the two exceptional species there were more males than females. About European species of bats Brosset (1963) stated, ' Recent researches have shown that the social life of the European species covers a short part of the sexual cycle.' After copulation the males and females live separately. Consequently it is not possible to determine the accurate sex ratio in these animals. He further stated that in *Miniopterus schreibersii* in France the sex ratio is equal at birth, but among the adults the females outnumber the males. Brosset (1962 a, b, c and 1963) has noted an unbalanced sex ratio with females more numerous than males in many Indian species of bats.

From the foregoing it is evident that in almost all the species of bats the females outnumber the males. Perhaps even in the exceptional cases, if collection of specimens are made all round the year, the females may turn out to be more than the males. The fact that in most cases there is an annual breeding cycle with a single young in the litter indicates that bats have a low fecundity. Since, in most cases, where valid data are available, there is a balanced sex ratio among the juveniles, the uneven sex ratio in the adult stage can only be due to the preferential mortality of the males during the growth period. This leads one to the conclusion that the higher mortality of the males among the bats may be an adaptation for effecting an economy to bring about an increase in the potential reproductive population by reducing the number of males in the adult population.

SUMMARY

1. The sex ratio in the following species of bats have been worked out on the basis of frequent collection of specimens at random from different colonies for at least two consecutive calendar years—*Rousettus leschenaulti, Taphozous longimanus, Megaderma lyra lyra, Hipposideros*

fulvus fulvus, H. speoris, H. ater ater, Pipistrellus ceylonicus chrysothrix, P. mimus mimus and *P. dormeri.*

2. In all the cases there is an unbalanced sex ratio in the adult with females far outnumbering the males, whereas the sex ratio is even during the juvenile life.

3. The present findings are compared with those of earlier workers.

4. It is concluded that the uneven sex ratio in the adults is due to the preferential mortality of the males during the growth period.

References

ABDULALI, H. (1949) : Sex ratio in Indian bats. *J. Bombay nat. Hist. Soc.* **48** : 423-428.

BROSSET, A. (1962*a*) : The bats of central and western India. Part I. ibid. **59** : 1-57.

——— (1962*b*) : do. Part II. ibid., **59** : 584-624.

——— (1962*c*) : do. Part III. ibid. **59** : 707-746.

——— (1963) : do. Part IV. ibid. **60** : 338-355.

GOPALAKRISHNA, A. (1947) : Studies on the embryology of Microchiroptera—Part I. Reproduction and breeding seasons in the South Indian vespertilionid bat, *Scotophilus wroughtoni* (Thomas). *Proc. Ind. Acad. Sci.* **26** : 219-232.

——— (1954) : Breeding habits of the Indian sheath-tailed bat, *Taphozous longimanus* (Hardwicke). *Curr. Sci.* **23** : 60-61.

——— (1955) : Observations on the breeding habits and ovarian cycle in the Indian sheath-tailed bat, *Taphozous longimanus* (Hardwicke). *Proc. Nat. Inst. Sci. India* **21** : 29-41.

GOPALAKRISHNA, A. & CHAUDHARI, P. N. : Studies on the reproduction in Megachiroptera—Part I. Observations on the breeding habits and associated phenomena in the Indian fruit-bat *Rousettus leschenaulti* (Desmaret). (in press)

PEARSON, O. P., KOFORD, M. R. & PEARSON, A. K. (1952) : Reproduction of the lump-nosed bat (*Corynorhinus rafinesquei*) in California. *Jour. Mammal.* **33** : 273-320.

RAMAKRISHNA, P. A. (1951) : Studies on reproduction in bats. I. Some aspects of reproduction in the Oriental vampires, *Lyroderma lyra lyra* (Geoff.) and *Megaderma spasma* (Linn.). *Jour. Mysore Univ.*, B **11** : 107-118.

RAMASWAMY, K. R. (1962) : Studies on the sex cycle of the Indian vampire bat, *Megaderma lyra lyra* (Geoffroy). *Proc. Nat. Inst. Sci. India* **27** : 287-307.

WIMSATT, W. A. (1945) : Notes on breeding behaviour, pregnancy, and parturition in some vespertilionid bats of the Eastern United States. *Jour. Mammal.* **26** : 23-33.

Flora of Mothronwala Swamp Forest (District: Dehra Dun, U. P., India)

BY

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The Mothronwala swamp forest lying at the foot of the Himalayas in the Dehra Dun district, U.P., India, was selected for a detailed study of its flora. During the study 367 species of flowering plants and ferns were collected of which 356 are angiosperms and 11 ferns. These are listed.

Introduction

The 'Mothronwala Swamp Forest' occupies a compact area between 30° 15′ 40″ and 30° 16′ 45″ N. and 78° 1′ and 78° 2′ 15″ E. and lies south-east of Dehra Dun at a distance of 15 km. near the military township of Clement Town. The forest lies at an altitude of 600 m. above sea-level and occupies an area of approximately 30 acres.

Kanjilal (1901)[1] drew attention to this swamp forest and mentioned few plant species represented in the forest. A reference to the Mothronwala forest is found in the 'Flora of Upper Gangetic Plain' by Duthie (1903-22) and in the 'Flora of Chakrata, Dehra Dun, and Saharanpur Divisions' by Kanjilal (1956), wherein this locality has been named in respect of certain plant species. Besides this, there is no systematic account of the flora of this region.

Therefore, in order to obtain a complete collection of the flowering plants and ferns found in the forest, and also to understand the vegetational composition of the forest this study was undertaken.

Dakshini (1960a & b, and 1965) has given details of topography of the forest, climate, soil, and vegetation and hence those details have not been included here.

The vegetation is very dense and the cover remains as such almost throughout the year, but still with the seasons the vegetational composition and denseness varies. The forest lies in the monsoon belt in the Dun valley with an annual rainfall reaching 2500 mm., most of which is received during the months July-September. The effect of rainfall is clearly seen in the phenomenal increase in vegetation density during the

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[1] Kanjilal, V. (1901): Swamp forest in Dehra Dun, N. W. Province. *Indian For.* **27**: 228-230.

rainy season. There is a direct correlation between heavy rainfall and abundance of vegetational components. The heavy rainfall of July is followed by the dense cover of August. This relationship is particularly noticeable on the ridges and slopes which are more exposed to drought and other adverse factors and are thus sparsely covered during the non-rainy days.

Methods

Collections of plant species were made at regular intervals throughout the year. The data presented here are based on the collections over a period of three years. These specimens have been carefully studied in the field and in the laboratory and descriptions drawn and also habitat (not reported here) and phenological features recorded for each species. The plant species have been arranged according to their sequence in FLORA OF BRITISH INDIA (Hooker, 1872-1897).

All the specimens collected during the present study are deposited in the herbarium of Northern Circle, Botanical Survey of India, Dehra Dun, U.P., India. Field numbers are indicated in the present communication within brackets after the name of each species.

In all 367 species belonging to 72 of families were collected and are listed here.

SYSTEMATIC ENUMERATION OF FLOWERING PLANTS AND FERNS

Ranunculaceae

Clematis gouriana Roxb. ex DC. (8082 ; 8085)

Flowers and fruits—September to December.

Ranunculus sceleratus Linn. (3912)

Flowers and fruits—September to February.

Associated with *Mimulus strictus*.

Menispermaceae

Tinospora cordifolia Miers (8058)

New leaves—June/July ; Flowers —March/April.

Cocculus laurifolius DC. (8097)

Flowers—April to June.

Cissampelos pareira Linn. (7247 ; 5515)

Flowers—February/March.

Decoctions from root and leaves are used by local people to check diarrhœa.

Cruciferae

Rorippa nasturtium-aquaticum (Linn.) Hayek (3975)

Flowers and fruits—Late January to April.

Vegetative portions are used by local people for making curry.

Coronopus didymus (Linn.) Sm. (5486)

Flowers and fruits—December to March.

Capparidaceae

Capparis zeylanica Linn. (3957)
Flowers—April/May.

Violaceae

Viola canescens Wall. (8015)
Flowers—February/March.

Bixaceae

Xylosma longifolium Clos. (3939 ; 5475)
Flowers—December to March ; Fruits—April to May.

Polygalaceae

Polygala crotalarioides Buch.-Ham. ex DC. (5541)
Flowers—May/June.

Dipterocarpaceae

Shorea robusta Gaertn. (3978)
Flowers—March/April.

Malvaceae

Sida cordata (Burm. f.) Borss. (3980)
Flowers—March to May.

S. acuta Burm. f. (7244)
Flowers and fruits—August/September.

Urena lobata Linn. (3919 ; 6249)
Flowers—August to October ; Fruits—December to February.
Variation in size and shape of leaf common.

Abelmoschus crinitus Wall. (7250)
Flowers—August to October.

A. moschatus tetraphyllus (Roxb. ex Hornem.) *var.* **pungens** (Roxb.) Hochr. (7280)
Flowers—August/September ; Fruits—December/January.

Thespesia lampas (Cav.) Dalz. & Gibs. (7245)
Flowers—August/September ; Fruits—November/December.

Kydia calycina Roxb. (6262)
Flowers—Late July to October.

Bombacaceae

Salmalia malabarica (DC.) Schott & Endl. (12488)
Flowers—February/March.

Sterculiaceae

Sterculia villosa Roxb. (8023)
Flowers—March/April ; Fruits—June/July.

Helicteres isora Linn. (7227)
Flowers—June to August ; Fruits—October/November.

Melochia corchorifolia Linn. (7300)
Flowers—August/September.

Tiliaceae

Grewia disperma Rottl. ex Spreng. (7268)
Flowers—June to September ; Fruits—November.

G. polygama Roxb. (7252)
Flowers—August/September.

Triumfetta rhomboidea Jacq. (7277)
Flowers and fruits—August/September.

Corchorus capsularis Linn. (7241)
Flowers and fruits—August to October.

LINACEAE

Reinwardtia indica Dum. (3949)
Flowers—Late February to June.

MALPIGHIACEAE

Hiptage benghalensis (Linn.) Kurz (3943 ; 8025 ; 8049)
Flowers—April/May ; Fruits—May/June.

GERANIACEAE

Geranium ocellatum Jacq. (8028)
Flowers—March/April.

OXALIDACEAE

Oxalis corniculata Linn. (5521)
Flowers and fruits—July to October.

RUTACEAE

Toddalia asiatica (Linn.) Lamk. (3952)
Flowers—March/April ; Fruits—April/May.

Acronychia pedunculata (Linn.) Miq. (5500 ; 5592 ; 6265)
Flowers—August/September ; Fruits—December.

Glycosmis pentaphylla (Retz.) Corr. (6235)
Flowers—September/October and March/April.

Murraya paniculata (Linn.) Jack (8038)
Flowers—March to May.

M. koenigii (Linn.) Spreng. (3917)
Flowers—March to May ; Fruits—April to July.

Citrus medica Linn. (8021)
Flowers—January/February ; Fruits—April to June.

BURSERACEAE

Garuga pinnata Roxb. (8051)
Flowers—April ; Fruits—June/July.

MELIACEAE

Toona ciliata Roem.
Flowers—March/April.

CELASTRACEAE

Celastrus paniculatus Willd. (8025)
Flowers—April/May.

RHAMNACEAE

Ventilago denticulata Willd. (5496)
Flowers—December/January.

Zizyphus nummularia (Burm.f.) Wt. & Arn. (8800 ; 5593)
Flowers—July to September ; Fruits—November/December.

Rhamnus virgata Roxb. (3908)
Flowers—March to May ; Fruits—November to January.

Gouania leptostachya DC. (5498 ; 3054)

Flowers—July/August ; Fruits—December/January.

Ampelidaceae

Vitis parvifolia Roxb. (8093)

Flowers—April/May.

Ampelocissus latifolia (Roxb.) Planch. (5516 ; 5577 ; 7266 ; 8053 ; 8080)

Flowers—August/September ; Fruits—October/November.

Leeaceae

Leea alata Edgeworth (5564)

Flowers—August/September.

L. edgeworthii Santapau (5543)

Flowers—July/August.

Sapindaceae

Acer oblongum Wall. ex DC. (8089)

New leaves—October to January.

Sabiaceae

Sabia paniculata Edgew. ex Hook. f. & Thoms. (8007)

Flowers—January/February. Leaves infected with *Cephaleuros* sp.

Anacardiaceae

Lannea coromandelica (Houtt.) Merrill (3962)

Flowers and furits—April/May.

Leguminosae

Crotalaria prostrata Rottl. ex Willd. (6272)

Flowers—August/September ; Fruits—October.

C. ferruginea R. Grah. ex Benth. (6241)

Flowers—August ; Fruits—September/October.

C. albida Heyne ex Roth. (3950 ; 7298)

Flowers—July/August ; Fruits—September.

C. calycina Schrank (7253)

Flowers—August.

C. sessiliflora Linn. (8071)

Flowers—September/October.

C. sericea Retz. (6258 ; 7279)

Flowers — August/September ; Fruits—October.

C. medicaginea Lamk. (6224 ; 7256)

Flowers—August.

Medicago polymorpha Linn. (8030)

Flowers and fruits—Late February to April.

Indigofera glandulosa Willd. (5588)

Flowers and fruits—August/September.

I. atropurpurea Buch.-Ham. ex Roxb. (3940)

Flowers and fruits—March/April.

Millettia auriculata Baker (5523 ; 8060)
Flowers—May/June ; Fruits—July to September.

Tephrosia candida DC. (5494)
Fruits—December.

Sesbania sesban (Linn.) Merrill (6223)
Fruits—September.

Zornia gibbosa Span. (6270)
Flowers and fruits—September/October.

Aeschynomene indica Linn. (6239)
Flowers and fruits—August/September.

Uraria picta Desv. (7231)
Flowers—July/August ; Fruits—September.

U. neglecta Prain (7295A)
Flowers—August/September.

U. rufescens (DC.) Schindl. (7295)
Flowers and Fruits—August/September.

Alysicarpus vaginalis DC. (6240)
Flowers—August/September.

A. bupleurifolius DC. (7230 ; 7260)
Flowers and fruits—August/September.

A. glumaceus (Vahl.) (6275)
Flowers—September/October.

Desmodium triangulare *var.* **congestum** (Prain) Santapau (7296)
Flowers—August/September.

D. caudatum (Thunb.) (12487)
Flowers—July to September ; Fruits—November.

D. triquetrum DC. (7248)
Flowers and fruits—August to October.

D. laxiflorum DC. (7229 ; 5594)
Flowers—July/August ; Fruits—October.

D. gangeticum DC. (3974 ; 8047)
Flowers and fruits—March to June.

D. retusum (I. Don) Swert. (7295B)
Flowers—August/September.

D. heterocarpon (Linn.) (8077)
Flowers and fruits—July to October.

D. triflorum DC. (6274 ; 5538)
Flowers—May/June ; Fruits—October.

D. motorium (Houtt.) Merrill (8797)
Fruits—October/November.

Abrus fruticulosus Wall. ex Wight & Arn. (7281)
Flowers—August/September.

Lathyrus aphaca Linn. (3934)
Flowers—February/March.

Mucuna prurita Hook. (8779)
Fruits—October/November.

Butea monosperma (Lamk.) Taubert (8022)
Flowers—March/April.

B. parviflora Roxb. (8083)
Fruits—November/December.

Pueraria phaseoloides Benth. (6222)
Flowers—August/September.

Phaseolus calcaratus Roxb. (6220)
Flowers—August/September.

Vigna capensis Walp. (7273; 8061)
Flowers—August/September.

Rhynchosia rothii Benth. ex Aitchison (6221)
Flowers—August/September.

Moghania bracteata (Roxb.) Li (6218)
Flowers—August/September.

M. semialata (Roxb.) Mukerjee (6215; 8079)
Flowers—August/September; Fruits—October.

M. postrata (Roxb. f.) Mukerjee (6241)
Flowers—August/September.

Dalbergia sissoo Roxb. (3976)
Flowers—April.

Caesalpinia decapetala (Roth.) Alston (3922)
Flowers—February/March.

Cassia occidentalis Linn. (6256)
Flowers—September/October.

C. tora Linn. (7237)
Flowers—June/July.

C. absus Linn. (8062; 7251)
Flowers—June/July.

C. leschenaultiana DC. (5589)
Flowers—August/September.

Acacia farnesiana Willd. (3963)
Flowers—February/April.

A. pennata (Linn.) Willd. (8088)
Fruits—November/December.

Albizzia stipulata Boiv. *var.* **smithiana** Prain (8042)
Flowers—March/April.

ROSACEAE

Rubus niveus Thunb. (5503)
Flowers—May/June.

Potentilla indica (Andr.) Wolf (3933)
Flowers—March/April.

Pyrus pashia Buch.-Ham. ex D. Don (3918)
Flowers—Late January to March; Fruits—August/September.

MYRTACEAE

Syzygium cerasoides (Roxb.) Chatterjee et Kanjilal f. (8044)
Flowers—April/May.

MELASTOMACEAE

Sonerila tenera Royle (8064)
Flowers—September/October.

LYTHRACEAE

Ammannia baccifera Linn. (3929)
Flowers—March/April.

Rotala rotundifolia Koehne (3941)
Flowers—March/April.

Note : Variation in the length of stamens and style common.

R. mexicana Cham. & Schlect. (6273)
Flowers—September/October.

Woodfordia fruticosa (Linn.) Kurz (3986)
Fruits—May/June.

PASSIFLORACEAE

Passiflora foetida Linn. (5567)
Flowers—July/August.

CUCURBITACEAE

Momordica dioica Roxb. ex Willd. (8058)
Flowers—June.

Cucumis melo Linn. *var.* **agrestis** Naud. (7246)
Flowers—August/September.

Mukia maderaspatana (Linn.) Roem. (7299)
Flowers—September.

UMBELLIFERAE

Oenanthe javanica (Blume) DC. (3988)
Flowers—May/June.

ARALIACEAE

Schefflera venulosa (Wt. & Arn.) Harms (8017)
Flowers—February.

RUBIACEAE

Oldenlandia corymbosa Linn. (8011, 8090)
Flowers—January/February.

Randia brandisii Gamble (5522 ; 7267)
Flowers—April to June.

Knoxia corymbosa Willd. (7271)
Flowers—August/September.

Pavetta tomentosa Roxb. ex Rees (5488)
Fruits—December.

Coffea bengalensis Roxb. (5495)
Fruits—December/January.

Borreria ocymoides DC. (7270)
Flowers—August/September.

B. articularis (Linn. f.) F.N. Wils.
Flowers—August.

Rubia cordifolia Linn. (5491)
Flowers—August.

COMPOSITAE

Vernonia cinerea Less. (7239 ; 8066)
Flowers and fruits—July to October.

Note : Trifid stigma is also common.

Adenostemma lavenia (Linn.) O. Ktze. (6246)
Flowers—September/October.

A. viscosum Forst. *var.* **elata** Hook. f. (8067)
Flowers—October.

Ageratum conyzoides Linn. (3903)
Flowers—Throughout the year.

Note : Trifid stigma is common.

Cyathocline purpurea (D. Don) O. Ktze. (3987 ; 3959)
Flowers—March to June.

Conyza japonica Less. (5534)
Flowers—May to July.

C. viscidula Wall. ex DC. (3924, 3960, 8098)
Flowers—March to May.

Blumea lanceolaria (Roxb.) Druce (3961)
Flowers—March/April.

Gnaphalium indicum Linn. (8094)
Flowers—February/March.

Inula cappa DC. (6293)
Flowers—October/November.

Vicoa indica (Linn.) DC. (3993 ; 6259)
Flowers—September/October.

Xanthium strumarium Linn. (6243)
Flowers—June/July.

Siegesbeckia orientalis Linn. (6279)
Flowers—October/November.

Eclipta prostrata (Linn.) Linn. (3997 ; 5505)
Flowers—Throughout the year.

Blainvillea acmella (Linn. f.) Philipson (7274)
Flowers—August/September.

Wedelia wallichii Less. (3998 ; 5585)
Flowers—August/September.

Bidens biternata (Lour.) Merr. & Sherff. (7237)
Flowers—July to September.

Tridax procumbens Linn. (7228)
Flowers—July to September.

Artemisia parviflora Buch.-Ham. ex Roxb. (7255)
Flowers—July to September.

A. nilagirica (Clarke) Pamp. (6234 ; 6248)
Flowers—September/October.

Echinops cornigerus DC. (7254)
Flowers—August/September.

Cirsium wallichii DC. (3964)
Flowers—March/April.

Tricholepis stictophylla Clarke (5540, 8798)
Flowers—November.

Youngia japonica (Linn.) DC. (3946)
Flowers—March to May.

Crepis acaulis (DC.) Hook. f. (5537)
Flowers—June/July.

Sonchus brachyotus DC. (3948)
Flowers—March/April.

Plumbaginaceae

Plumbago zeylanica Linn. (3956)
Flowers—March/April.

Primulaceae

Androsace umbellata (Lour.) Merr. (3942 ; 8006)
Flowers—January to March.

Anagallis arvensis Linn. (8029)
Flowers—March/April.

Myrsinaceae

Ardisia solanacea Roxb. (3906)
Flowers—April to June ; Fruits ripen—February/March.

Ebenaceae

Diospyros montana Roxb. (8034)
Fruits—March/April.

Oleaceae

Jasminum multiflorum (Burm. f.) Andr. (3905 ; 8013)
Flowers—January to April.

Apocynaceae

Carissa opaca Stapf. ex Hains (3926)
Flowers—March to June.

Rauwolfia serpentina Benth. ex Kurz (5573)
Flowers—August to early September.

Tabernaemontana divaricata (Linn.) R. Br. ex Roem. & Schult. (3923)
Flowers—March/April.

Vallaris solanacea (Roth.) O. Ktze. (8027)
Flowers—November ; Fruits—March/April.

Trachelospermum lucidum (D. Don) K. Schum. (3953 ; 8073)
Flowers—March to May ; Fruits—October/November.

Ichnocarpus frutescens (Linn.) Ait. (6263)
Flowers—October.

Asclepiadaceae

Cryptolepis buchanani Roem. & Schult. (8045)
Flowers—April/May.

Boraginaceae

Cordia dichotoma Forst. f. (3938 ; 8095)
Flowers — February/March ; Fruits—March/April.

Ehretia acuminata R. Br. (3939 ; 3967)
Flowers—March.

E. laevis Roxb. (8037)
Flowers—Late March/April.

Trichodesma indicum (Linn.) Lehm. (3990)
Flowers—April to June.

Cynoglossum meeboldii Brand. (7235)
Flowers—July to September.

Bothriospermum tenellum Fisch. & Mey.
Flowers—March/April.

CONVOLVULACEAE

Rivea ornata Choisy (7294)
Flowers—August/September.

R. ornata Choisy *var.* **griffithii** Clarke (5476)
Flowers—November.

Argyreia thomsoni (Clarke) Craib. (6213)
Flowers—August/September.

Ipomaea muricata (Linn.) Jacq. (6250 ; 7278)
Flowers—August to October.

I. pes-tigridis Linn. (6264)
Flowers—August to October.

I. eriocarpa R. Br. (6216)
Flowers—August/September.

I. dichroa (Roem. & Schult.) choisy (6216A)
Flowers—September/October.

SOLANACEAE

Solanum nigrum Linn. (3947)
Flowers—February to May.

S. torvum Sw. (5509)
Flowers—May/June.

S. indicum Linn. (5554)
Flowers—May to August.

Physalis minima Linn. *var.* **indica** Lamk. (7236 ; 7297)
Flowers and Fruits—July to September.

Cestrum nocturnum Linn. (5487)
Flowers—Different seasons.

(to be continued)

Notes on some Butterflies in the Collection of the Bombay Natural History Society

BY

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Among the nearly 2500 species, subspecies and races of butterflies in the Indian region, the Society's collection has about 1100 species, subspecies and races constituting hardly 45 per cent of the total. A very large number of the west Himalayan species and many of the plains species are not fully represented. The Lycaenids, Hesperids and Satyrids are poorly represented constituting about 38, 20 and 43 per cent respectively of the known species. While examining the specimens in this comparatively small collection it was found that some were collected from places which fall far beyond their distributional area as indicated by Evans (1932), Talbot (1939 and 1942), and Wynter-Blyth (1957). In the list below the habitat mentioned by these authors is given as distribution and the total number of specimens present is given with their locality of collection. It will be seen that quite a few which were supposed to be only Himalayan or north Indian have been caught in central and south India and vice versa. Specimens collected from such places do not show any differences in characters from those collected in the known habitat.

Family DANAIDAE

1. **Danaus aglea aglea** Cr. Glassy Tiger

15 : 1 Bombay, August ; 3, Nilgiris, January, July, October ; 5 Goa, September-October ; 4 N. Kanara, January, July, September, October ; 1 Cannanore ; 1 Ceylon, No date.

Distribution : Ceylon ; S. India up to Poona ; Himalayas from Kashmir east to Assam ; Bengal ; Burma.

Best (1951) considers it as rare in Bombay and available only in August especially at Powai. We collected one at the Malabar Hill, Bombay, in September, 1959.

Family SATYRIDAE

2. **Mycalesis perseoides** (M.) Burmese Bushbrown

4 : 2 Manipur, Jan. ; 2 Pachmarhi, Oct.

Distribution : Burma, Pegu Yomas, Chindwin, where it is said to be common.

A considerable westward extension of the known distribution.

3. **Mycalesis rama** (M.) Singalese Bushbrown

2 : Both at Kallar, Nilgiris, Aug.

Distribution : Ceylon.

This species has not been recorded in India so far, as far as I am aware.

4. **Mycalesis malsara** M. Whiteline Bushbrown

11 : 3 Palni Hills, July ; 3 Karwar, Jan., Apr., Aug. ; 5 Burma, Feb., Mar., Sept.

Distribution : Kumaon, Bengal, Sikkim, Assam ; Rangoon.

Species of *Mycalesis* are not known to migrate and the occurrence of this Himalayan form in the western Ghats shows similarity in its distribution to vertebrate species of Himalayan affinity occurring in the Western Ghats. It is possible that this rare species breeds sparsely in these places and is uncommon.

5. **Orinoma damaris** Gr. Tigerbrown

5 : 2 Nilgiris, May ; 1 Sikkim, May ; 1 Assam, May ; 1 Burma, Oct.

Distribution : Kangra to Assam and Burma.

This species which was known from the Himalayas is now recorded from the Nilgiris.

6. **Erebia nirmala** M. Common Argus

4 : 2 Assam (Garsa and Nag Tibi), July ; 2 Nilgiris, July.

Distribution : Himalayas, Kumaon, Murree, Kangra, Kashmir, Chitral.

Reported only from the Western Himalayas. It is now reported from Assam in the east and Nilgiris in the south for the first time.

7. **Erebia shallada** Lang. Mountain Argus

3 : 2 Assam (Nag Tibi), No date ; 1 Kulu, July.

Distribution : Chitral, Kashmir, Kumaon—N.W. Himalayas. Eastern range is now extended to Assam.

Family NYMPHALIDAE

8. **Diagora persimilis** (Westw.) Siren
   2 : Both in Palampur (Punjab), July.

Distribution : Simla to Assam, Orissa, Sikkim to Shan States. Palampur is far to the west of the recorded habitat.

9. **Penthema lisarda** (Doub.) Yellow Kaiser
   1 Mansi (Burma), April.

Distribution : Sikkim to Assam and Chin Hills.

Mansi extends the eastward distribution.

10. **Euthalia nais** (Forst.) Baronet
    13 : 3 Khandesh, Dec.; 8 Nilgiris, June to Oct.; 1 Telligheri, Mar.; 1 Pachmarhi, no date.

Distribution : South India, Dehra Dun to Sikkim, Konkan, Saurashtra, Madhya Pradesh and Ceylon.

Though not noted in or near Khandesh so far, it seems to be a common species all over India.

Family LYCAENIDAE

11. **Everes argiades indica** W.B. Tailed Cupid
    5 : 1 Palni Hills, July; 1 Kangra, Sept.; 2 Gund, May; 1 Gunderbal, May.

Distribution : Chitral to Kumaon to Burma, Sikkim, and Bhutan.

Another instance of a Himalayan form occurring in the Western Ghats.

12. **Nacaduba ceylonica** Fr. (=*sinhala* Orm.). Pale Ceylon 6 Lineblue
    11 : 6 Karwar, June and Aug.; 2 Kodaikanal, Oct.; 1 Darjeeling, Oct.; 2 Manipur, May.

Distribution : Ceylon.

Cantlie (1962) has called this species *N. sinhala* Orm. as *N. atrata* (the original name) is invalid and *ceylonica* Fruh. is a homonym because of page priority of *N. pactolus ceylonicus* Fruh. as pointed out by Corbet. (The underside of the various specimens is not uniform, some have pale lines, some are deep and a few of medium depth. This is not attributable to localities as this variation is found in examples collected even from the same locality. These specimens may have to be re-examined.)

13. **Nacaduba berenice plumbeomicans** WM. & DeN. Rounded 6 Lineblue
    4 : 4 Karwar, Mar., Aug., Oct.

Distribution : Assam, Andamans and Tavoy to S. Burma.

Nacaduba species love moist forests and the occurrence of the species at Karwar possessing similar environment as the recorded habitat is another instance of discontinuous distribution mentioned earlier.

14. **Heliophorus tamu tamu** Koll. Powdery Green Sapphire

5 : 1 Dangs (Gujarat), July ; 3 Gund, May ; 1 Cheena, Apr.

Distribution : Kumaon to Naga Hills, Nepal, Sikkim.

Dangs is far south of the recorded range. It is very rare in the Dangs. Only one specimen was obtained.

15. **Amblypodia atrax** Hew. Dark Brokenband Oakblue

2 : 1 Ranikhet ; 1 Burma. No dates.

Distribution : Shan States, Burma.

The occurrence at Ranikhet is a considerable extension of the westward range.

16. **Spindasis abnormis** M. Abnormal Silverline

3 : 1 Lonavla, Oct. ; 2 Coonoor, Mar.

Distribution : Coonoor, Coorg, S. India.

According to Evans, S. India includes Lonavla but the species has not been recorded beyond Nilgiris and Coorg. Bean (1968) collected them at Lonavla only recently.

17. **Tajuria jehana** M. Plains Blue Royal

9 : 4 Poona, July, Sept. ; 1 Jabalpur, July ; 3 Nilgiris, June, Oct. ; 1 Karwar, Dec.

Distribution : S. India, Ceylon, Simla to Bengal. K. Cantlie (1962) includes Bombay, Dehra Dun and Lucknow under this head. Jabalpur therefore is almost in its distributional area.

18. **Rapala scintilla** DeN. Scarce Slate Flash

5 : 1 Kallar, Nilgiris, Aug. ; 1 Calcutta, Nov. ; 1 Sikkim, no date ; 2 Manipur Sept., Oct.

Distribution : Nepal, Sikkim to Assam and Burma.

This is another example of a Himalayan species occurring in the South.

Family Pieridae

19. **Colotis vestalis** (Butl.) White Arab

11 : 1 N. Kanara, no date ; 8 Karachi, June, Oct. ; 1 Kutch, no date ; 1 Unao, no date.

Distribution : Baluchistan to Saurashtra, Punjab, Rajputana, Uttar Pradesh, Madhya Pradesh. Talbot (1939) mentions Western India but no locality south of Saurashtra is noted. N. Kanara may now be taken as the southernmost point of the distribution of this species.

20. **Colias croceus** (Four.) (=*alecto* L.) Dark Clouded Yellow

24 : 1 Dakuri (U.P.), no date ; 3 Nilgiris, July, Aug. ; 4 Assam, Apr. ; 2 Sikkim, May ; 7 Chitral, Apr. to July ; 3 Murree, Apr. ; 4 Kashmir, Apr., June.

Distribution : Baluchistan to N. Punjab, Kumaon, Sikkim, Assam, N. Burma, Nepal and Bombay.

Bombay is mentioned by Talbot (1939) and is the only place south of the Himalayas where this butterfly is found. Nilgiris now constitutes the southernmost locality for this species.

21. **Gonepteryx rhamni nepalensis** Doub. Common Brimstone

13 : 1 Nilgiris, July ; 4 Chitral, Sept. ; 8 Murree, Apr.

Distribution : N. Waziristan, Baluchistan, Himalayas, Hills of N.E. India and Burma.

Another species found in the Nilgiris hitherto supposed to be met with only in the north. The males collected from Nilgiris and Murree are fairly deep yellow as against the description given by Evans (1932) and Wynter-Blyth (1957) as sulphur yellow.

Family HESPERIIDAE

22. **Daimio bhagava** M. Common Yellowbreast Flat

7 : 5 Nilgiris, Jan., July, Nov. ; 2 Burma, Sept., Oct.

Distribution : Bombay to C.P., Sikkim to Burma, Andamans.

Wynter-Blyth (1946) mentions this as a very rare species at Kallar in Nilgiris.

23. **Hasora vitta** Butl. Plain Banded Awl

8 : 2 Dharwar, no date ; 5 N. Kanara, Mar., Aug. ; 1 Manipur, Oct.

Distribution : Kanara, Sikkim to Burma, Orissa.

A slight extension from N. Kanara to Dharwar.

24. **Ismene [Bibasis] gomata** M. Pale Green Awlet

2 : Both in Burma, July, Oct.

Distribution : Kanara, Sikkim to Assam, S. India ; China ; Malaya etc.

So far it has not been reported from Burma.

25. **Thoressa (Halpe) honorei** DeN. Madras Ace

5 : 1 Belgaum, Oct. ; 4 N. Kanara, Jan., Feb., Sept.

Distribution : Nilgiris, Palnis, N. Kanara, Trichinopoly.

Some slight extension from N. Kanara to Belgaum.

26. **Pelopidas sinensis** M. Large Branded Swift

8 : 2 Poona, Oct. ; 2 N. Kanara, Jan. ; 3 Kallar, Jan. ; 1 Loimwe, May.

Distribution : Kangra to Assam, Shan State, Bengal, Ceylon, Palnis, Nilgiris, Coorg, N. Kanara.

Poona, though fairly near to Kanara is about 300 km. north of it and the other places are farther still.

27. **Notocrypta feisthamelii** (Boisd.) Spotted Demon

10 : 4 N. Kanara, Aug., Sept. ; Oct., 1 Coorg, Oct., 2 Naga Hills, Aug., 1 Maram, Oct., 1 Manipur, Apr., 1 Ranikhet, no date.

Distribution : Murree to Assam and Burma.

This butterfly loves thick jungles and breeds in grass, ginger, palms and cardamom. Both Coorg and N. Kanara abound in such areas.

Remarks

Lepidopterists from time to time have collected butterflies from various places in India e.g. Bombay, Nilgiris, Palni Hills, Nepal etc. but these collectors generally did not come across the species mentioned above in the respective areas, except for Best (1951 and 1955) who collected most of the species mentioned and shown here as new to Bombay.

Most of the species mentioned are rare even in localities mentioned as their habitat. It is remarkable that a number of species supposed to be Himalayan in distribution occur in the Nilgiris, but have remained unnoticed so far. Some species that are common in the Himalayan region seem to be breeding in the Nilgiris though sparsely and in certain pockets only, giving a discontinuous distribution, lending support to the hypothesis propounded by Hora (1949), that the similarity of the flora and fauna of Ceylon, the Western Ghats, the Satpuras etc., to that of the Himalayas and Malaya point to their same origin and affinities.

It seems probable that some of the butterflies appear in certain localities occasionally and unless they are caught at that time remain completely undetected. *Spindasis abnormis* M., for instance, a rather rare species breeding in Lonavla (Western Ghats) year after year in small numbers and for brief periods is not met with generally in Khandala, only a few kilometres away or even in other areas of Lonavla with the same topography and climate and with the same food conditions. It is possible, therefore, that most of the species mentioned above are very rare and are not seen in spots commonly visited by collectors visiting for short periods during holidays. Unless a sustained effort is made, throughout the year and for some years it may not be possible to have a correct idea of the fauna of a particular area.

References

BAILEY, F. M. (1951): Notes on Butterflies from Nepal. *J. Bombay nat. Hist. Soc.* **50**: 281-298.

BEAN, A. E. (1968): Occurrence of *Spindasis abnormis* M. on Western Ghats. ibid. **65**: 618-632.

BEST, A. E. G. (1951): The Butterflies of Bombay and Salsette. ibid. **50**: 331-339.

————, (1955): Butterflies of Bombay and Salsette—Additions. ibid. **53**: 282-284.

CANTLIE, KEITH (1962): Lycaenidae portion of Evans Identification of Indian Butterflies. Revised. Bombay nat. Hist. Soc., Bombay.

EVANS, W. H. (1932): Identification of Indian butterflies. Bombay nat. Hist. Soc., Bombay.

HORA, S. L. (1949): Satpura Hypothesis of the distribution of Malayan Fauna and Flora to Peninsular India. *Proc. Nat. Inst. Sci. India* **15**: 307.

TALBOT, G. (1939, 1947): Fauna of British India including Ceylon and Burma. Butterflies. Vols. I and II. London.

WYNTER-BLYTH, M. A. (1957): Butterflies of the Indian Region. Bom. nat. Hist. Soc., Bombay.

————, (1946): Butterflies of the Nilgiris. *J. Bombay nat. Hist. Soc.* **45**: 47-61.

Studies on the Biology of some Freshwater Fishes

Part IV. *Mystus seenghala* (Sykes)[1]

BY

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(*With eight text-figures*)

The length frequency distribution of *Mystus seenghala* does not show any modes corresponding to year classes, excepting in one of the quarters (July-Sept.) when an indication of 6 modes was obtained. Size at first maturity in both sexes was about 50 cm. Seasonal changes in gonads were fairly regular and peak ripeness was attained in April, followed by spawning in May and June. Seasonal changes in gonad-weight confirmed spawning months as May and June. Ova diameter frequency distribution from December to May showed that there is a single batch of eggs in the ovary and each individual spawns only once during the year. The 'K' values did not show any relation with the maturation of gonads and spawning. The condition factor seemed to be governed by the feeding intensity of the fish. The main food of *Mystus seenghala* consists of forage fish, fish-fry, fingerlings, crabs, shrimps etc. The intake of food varies from season to season. Maximum feeding occurs in July after the spawning and minimum from April to June.

INTRODUCTION

Mystus seenghala, a well known food fish of India, mainly occurs in rivers, their tributaries, irrigation channels and seldom in ponds. It has been reported from all parts of India and also from Burma (Day 1878). The fish attains a fairly large size, the largest specimens being well above a metre in length. The fishery of this species has already been described by Saigal & Motwani (1961) who rank this fish as only next to 'Hilsa' in commercial importance in the Ganga River system. At Aligarh, where the fish mostly comes from the River Jamuna, this species is not as economically important as the major carps. Perhaps even among the catfishes, it ranks only next to *Wallagonia attu* and *Mystus aor* in abundance.

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[1] This work was carried out in the Department of Zoology, Aligarh Muslim University, Aligarh, U.P., in continuation of the series I-III published earlier by Qayyum & Qasim (1964) in this journal.

Earlier work on this fish includes comments on the life history, breeding and feeding (Khan 1924 & 1934 ; Raj 1940 ; Chacko & Kuriyan 1948 ; Saigal & Motwani 1961). This paper deals in detail with the various aspects of its biology.

Material and Methods

Samples were obtained from the Aligarh fish market towards the end of every month, over a period of 16 months, from Sept. 1962 to Dec. 1963, and examined. All specimens were measured and weighed. The gonads of each fish were dissected out, weighed and assigned a proper stage of maturity. The entire gut from each fish was taken out and the food items contained in it were listed.

Length Frequency Distribution

The length frequency of the total number of 616 fishes has been plotted in Fig. 1 on a quarterly basis, after pooling the values of various duplicate months. It can be seen from the figure that the various modes in the length frequency histograms are not well defined. This may be because the samples do not give a true composition of the population due to selective fishing or perhaps the rate of growth of the fish is less than the range in the size of various age groups. However, the histogram of the quarter, July-Sept. (Fig. 1) gives an indication of 6 modes, probably corresponding to 6 years. The progression of these modes cannot be easily followed in subsequent quarters.

Breeding

Maturity stages :

The classification of gonads into five maturity stages [I, immature virgins ; II, maturing virgins or recovered spents ; III, ripening ; IV, ripe and V, spent was made according to the scheme given earlier (*see* Qayyum & Qasim 1964)]. The maturity stages were defined arbitrarily on the basis of shape, colour, size and weight of the gonads. For correct identification of the five maturity stages in each sex, a little practice was found to be essential. Stages I and II in both sexes could easily be confused unless examined carefully under a microscope. Stages III and IV in females could also be confused, for in *M. seenghala* the ovaries do not enlarge to such an extent as to occupy the entire body cavity as has been found in other fishes (Qayyum & Qasim 1964). Here the ripe ovaries hardly occupy about one-half of the body cavity.

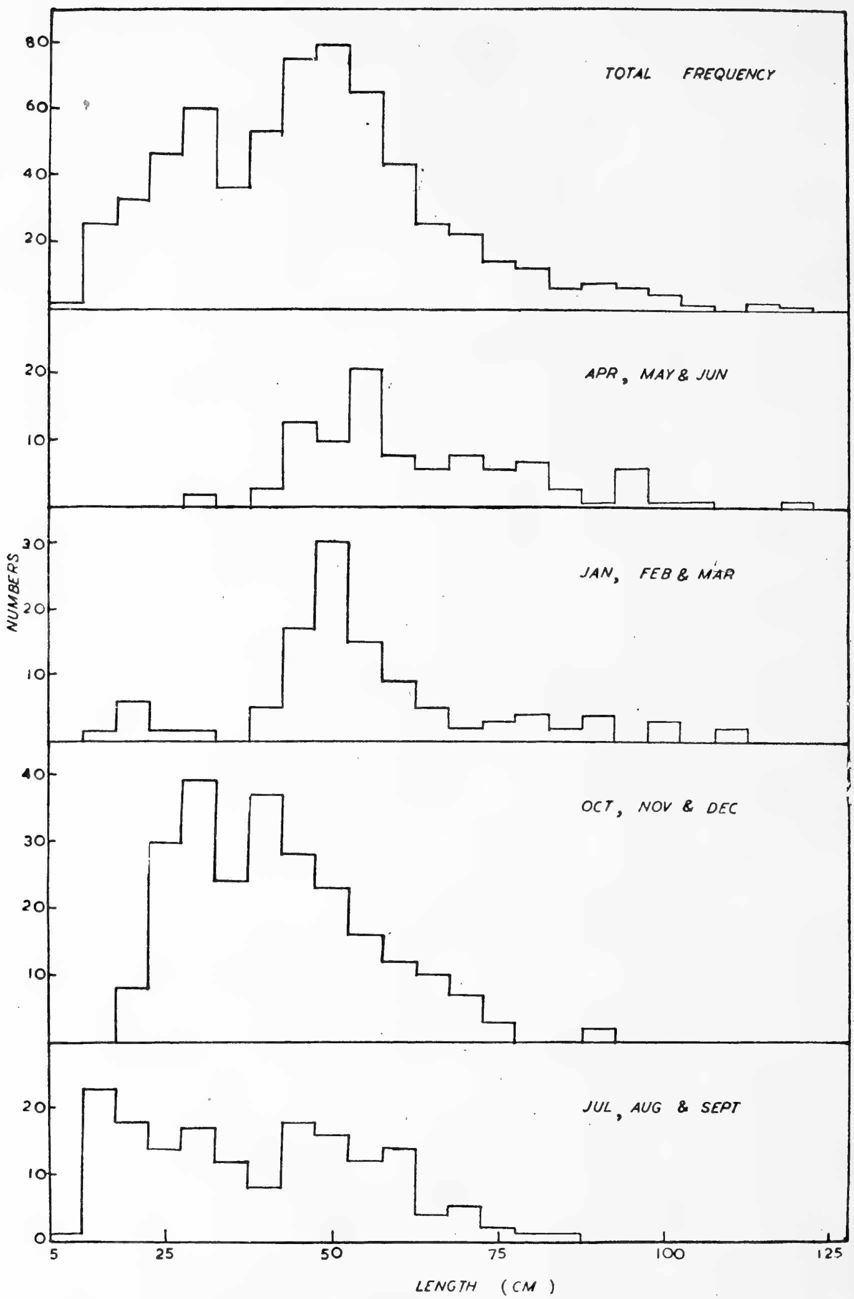

FIG. 1. Length frequency distribution of *M. seenghala*. Each histogram is based on the pooled samples of various months.

Size at first maturity :

The size of the fish in relation to various maturity stages is given in Table 1. It can be seen from the table that all fishes up to 50 cm. belonged to stage I. No fish in this group was recorded beyond stage II. In 45 cm., however, two males at stage V were found. This shows that the maturity in males is attained when they are about 45 cm. in length. In females all fishes below 50 cm. were at stage I and the higher stages of maturity were seen only when they reached more than 50 cm. in length. It, therefore, appears that males mature at a length smaller than the females. When these length groups are compared with the length frequency histograms, they correspond to the II mode (July-Sept. in Fig. 1) indicating that both sexes mature in their second year of life. This is in contrast to other fishes reported earlier (Qayyum & Qasim 1964) which mature in the first year of life.

Sex-ratio :

In all, 614 fishes were sexed during the course of this investigation. Of this number, 311 were males and 303 were females. It can, therefore, be concluded that the distribution of males and females in the population is fairly equal and that they have a ratio of almost 1 : 1. The maximum size recorded of the male was 91·5 cm. while that of the female was 120·5 cm.

Sex-dimorphism :

Although all fishes were sexed after an internal examination, the males could be distinguished externally from the females during the breeding season by the presence of a small stout projection at the genital opening which is lacking in females.

Cycle of maturation and depletion of gonads :

Fishes falling in various maturity stages have been shown in Fig. 2. It would be seen from the figure that the immature virgins (stage I) are found throughout the year. The occurrence of this stage throughout the year indicates that *M. seenghala* does not spawn in its first year of life.

The second stage (maturing virgins) is seen in all the months except in May when the fishes are generally in the next higher stages of maturity (stages III & IV).

The ripening stage (stage III) often appears in females as early as January and continues to increase till April (Fig. 2). However, after April there is a sudden fall in stage III, for in May most of the fishes become predominantly ripe. The appearance of ripening females as early as in January suggests that the fish is likely to spawn much earlier than the other cat-fishes where stage III has been reported much later

(Qasim & Qayyum 1961). In males, however, the ripening stage is only seen in March and generally not before. In May no ripening males were seen while the females did occur in small numbers at stage III.

Ripe females first appeared in March and their maximum percentage was recorded in May (Fig. 2). In June also a small percentage of females outwardly showed ripe ovaries but these did not appear to be

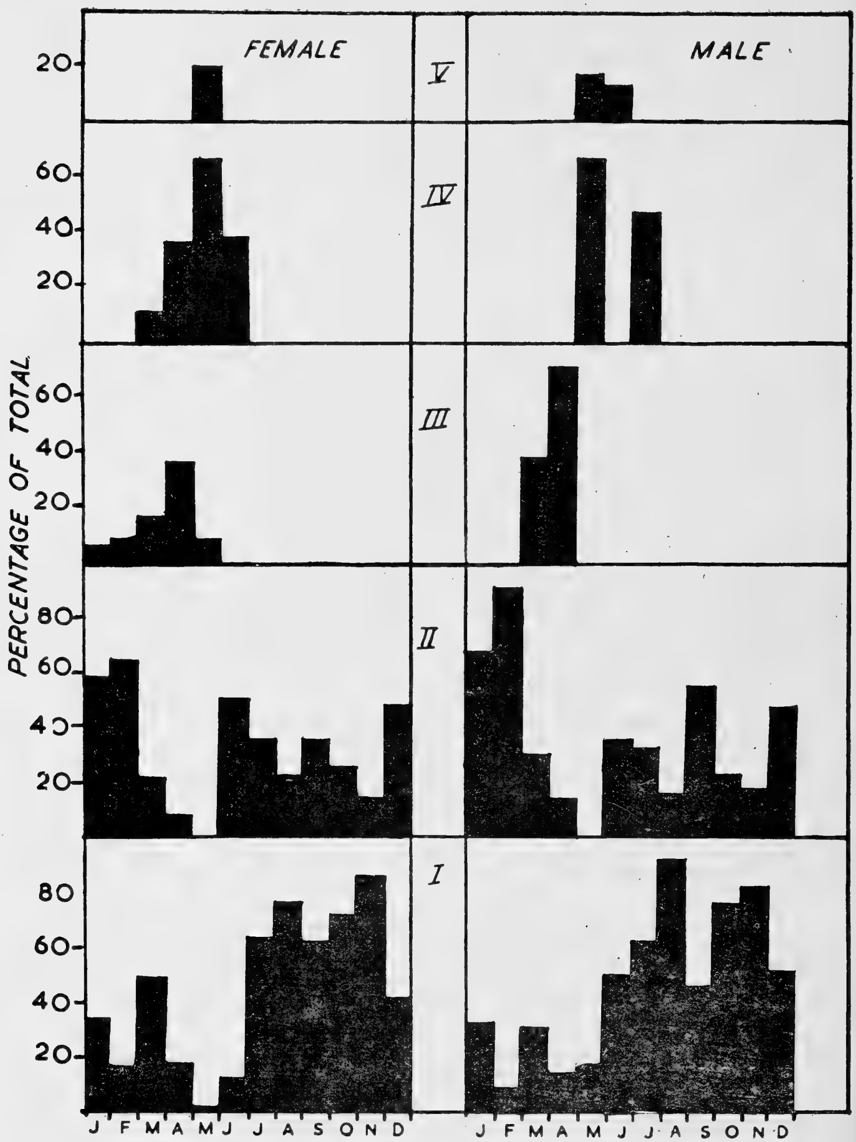

FIG. 2. Percentage of *M. seenghala* at each of the five stages of maturity of different months of the year.

truly ripe. In the latter case the gonad weight to body weight ratio was much lower than in the former. Probably these egg-bound females are either partially spent or perhaps belong to a category where the ova are in a stage of reabsorption as described in carps and *H. fossilis* (Hora 1945; Sundararaj 1959). The ripe males, on the other hand, showed a strange distribution. In May their percentage suddenly became maximum. In June no ripe males were seen, but in July a few males had ripe testes. A small percentage of spent fishes (stage V) was observed during May and June (Fig. 2).

Summing up the distribution of various maturity stages, it seems that the stage I (immature virgins) is found throughout the year. The stage II is also seen throughout the year except in May and the ripening stage (stage III) occurs from January-May. The ripe stage (stage IV) is seen from March to May (as the ripe females found in June are egg-bound fishes) and the spent (stage V) in May and June. It can, therefore, be concluded that the spawning in *Mystus seenghala* starts in early May and ends by early June. At Allahabad, Saigal & Motwani (1961) have reported the occurrence of eggs of this fish in May while from Banares, Satyanesan (1960) reported that the fish spawns in April. From these findings it seems that the spawning in this fish is not synchronized with the cycle of monsoon as has been reported in many other species (Qasim & Qayyum 1961). The spawning season being confined to May and June suggests that *M. seenghala* breeds during the hottest months of the year.

Seasonal changes in gonad weight:

The gonads of both sexes were weighed and their weight was expressed as a percentage of body weight in each month. Since the gonad weight in the immature fishes did not fluctuate much from season to season, their weights were excluded from the analyses. The mean gonad weight/body weight ratio of all fishes measuring 45 cm. and above were plotted in Fig. 3. The values show that the peak weight in females occurs in April and thereafter it shows a sudden fall. This abrupt fall in gonad weight obviously indicates the onset of spawning. It is interesting to note that the minimum gonad weight/body weight ratio is obtained in August although the spawning is over by June. This is because of the presence of egg-bound females in July and August which do not spawn. The testes, on the other hand, reach peak weight in May which falls more abruptly in June.

The weight of ovaries attaining highest values earlier than the testes signifies an early maturity in females which is in contrast to the feature reported in *Blennius pholis* (Qasim 1957), where males reach peak maturity earlier than the females. In *B. pholis* early maturity happens because of the males taking the initiative in spawning by early occupation of nesting sites. In *M. seenghala* where males have also been reported to take part in parental care (Raj 1940; Saigal & Motwani 1961), the initiative towards spawning seems to be taken by the females.

The above findings on the rise and fall of gonad weight confirm that the spawning in this fish starts from early May and continues till about June. This conclusion, however, does not seem to agree with the obser-

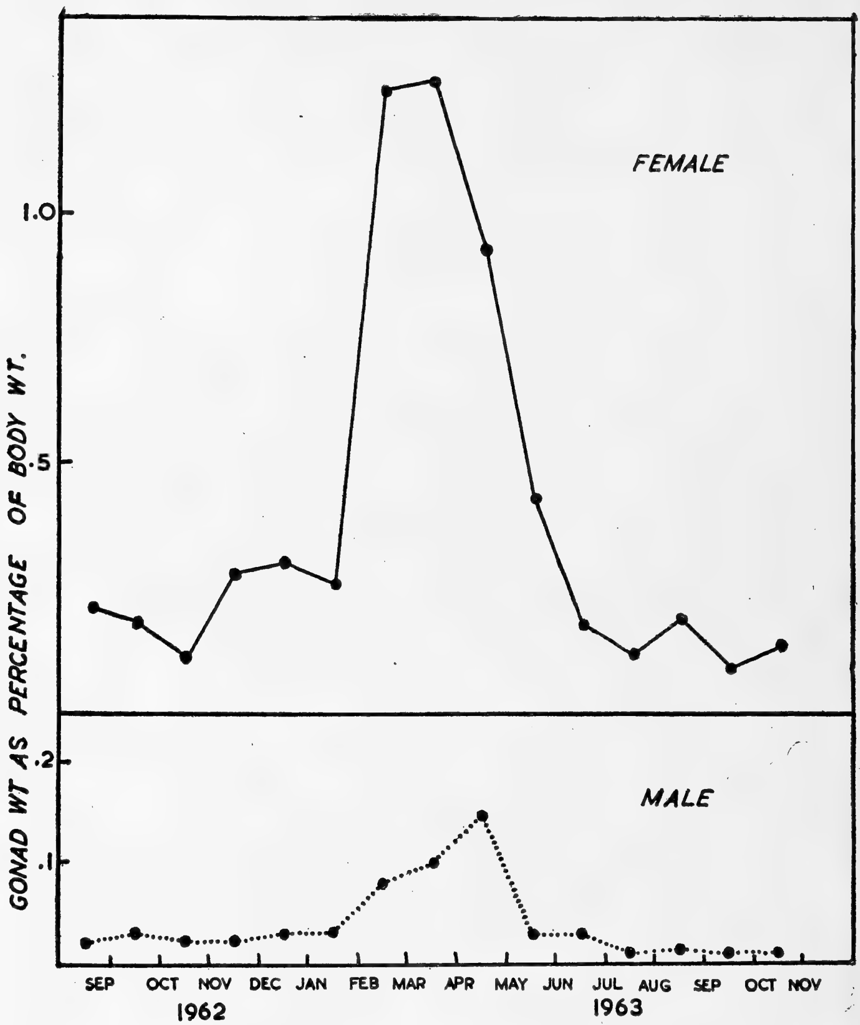

FIG. 3. Seasonal variation in gonad weight as percentage of body-weight of *M. seenghala*.

vations of Satyanesan (1960) made at Banares where the spawning phase in this fish lasted from March to May. Satyanesan (1960) drew this conclusion by a study of seasonal histology of the pituitary and gonads.

Spawning frequency :

For the study of periodicity in spawning, the ovaries were treated in the same way as has been described earlier (Qayyum & Qasim 1964). The percentage frequencies of oocytes from fishes depicting typical conditions have been shown in Fig. 4 from December to May.

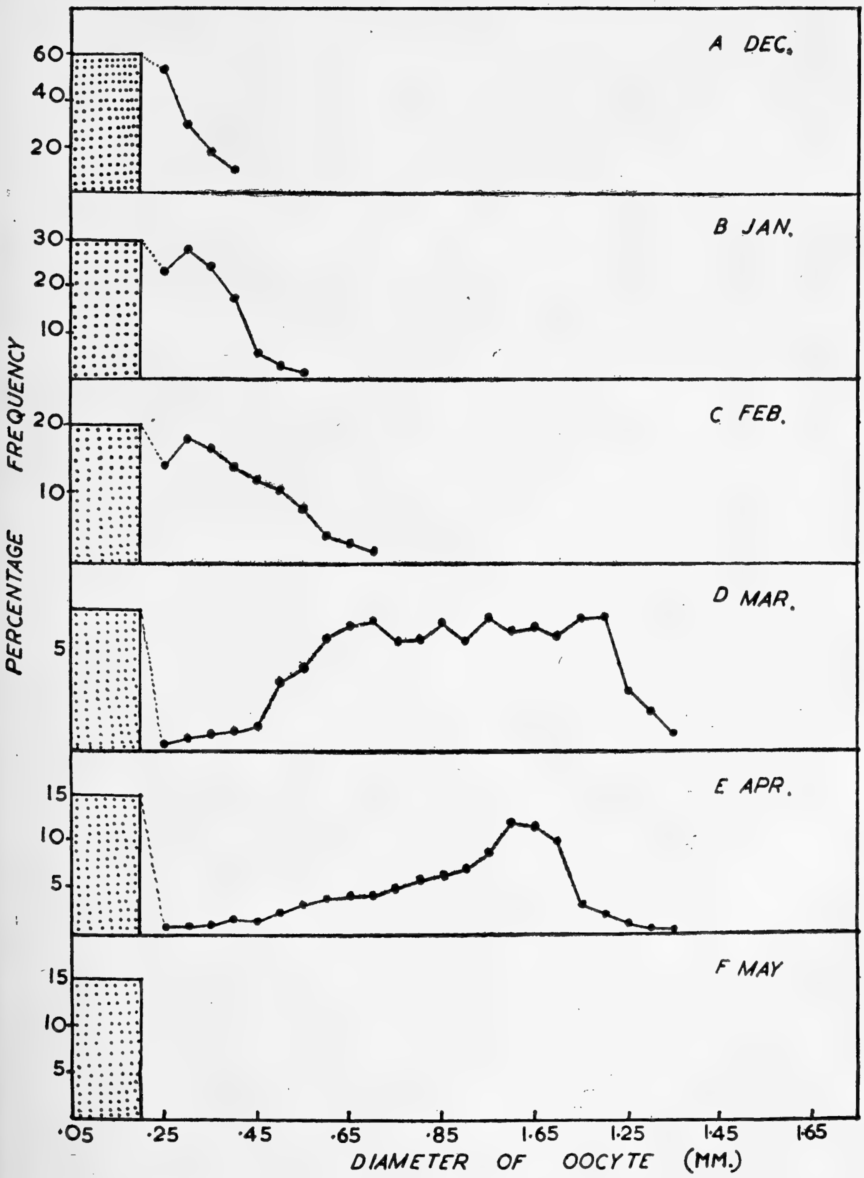

FIG. 4. Size frequency distribution of intra-ovarian eggs of *M. seenghala* from December to May. Stippled areas show small, immature eggs which were not measured.

TABLE 1

MATURITY STAGES OF *M. seenghala* IN VARIOUS LENGTH GROUPS

Maturity Stage	Length in cm.	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	Total
Male I	..	1	20	12	14	27	15	28	36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	153
Male II	..	—	—	—	—	—	—	—	—	32	35	17	10	4	3	2	1	1	—	—	—	—	—	—	105
Male III	..	—	—	—	—	—	—	—	—	5	2	1	—	4	2	2	—	—	—	—	—	—	—	—	16
Male IV	..	—	—	—	—	—	—	—	—	—	3	—	2	—	—	—	—	—	—	—	—	—	—	—	5
Male V	..	—	—	—	—	—	—	—	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	3
Total	..	1	20	12	14	27	15	28	38	37	41	18	12	8	5	4	1	1	—	—	—	—	—	—	282
Female I	..	—	4	10	19	29	17	20	28	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	133
Female II	..	—	—	—	—	—	—	—	—	23	16	13	7	7	3	—	1	4	—	1	—	—	—	—	75
Female III	..	—	—	—	—	—	—	—	—	4	2	2	2	—	—	1	—	—	—	—	—	1	—	—	12
Female IV	..	—	—	—	—	—	—	—	—	—	4	4	—	5	5	3	3	1	6	1	1	1	—	—	34
Female V	..	—	—	—	—	—	—	—	—	—	3	—	1	—	—	2	—	—	—	—	—	—	—	1	7
Total	..	—	4	10	19	29	17	20	28	33	25	19	10	12	8	6	4	5	6	2	1	2	—	1	261

As can be seen from the figure the development of eggs starts in the month of December. In January the batch of eggs, likely to be spawned, becomes differentiated from the original stock of smaller and yolkless cells. In February (Fig. 4, C) the oocytes become larger in size and in March (Fig. 4, D) they attain almost maximum diameter. The maximum size of eggs as indicated in the figure refers to those fishes which were almost ripe. In April (Fig. 4, E) there was practically no increase in the egg-size except that the eggs become more uniform and get organized into a single batch. In late May when the fishes were spent (Fig. 4, F) there were no eggs left in the ovaries.

The ova diameter frequency clearly shows that there is only one batch of eggs produced every year and that each individual spawns only once in the breeding season which commences in May.

Condition factor :

The 'K' values of both males and females were calculated from the conventional formula,

$$K = \frac{W \times 100}{L^3}$$

The immature fish did not show much change in their K values throughout the year and these were, therefore, omitted from the analysis. The mean values which are based on mature fish only have been given in Fig. 5. It can be seen from the figure that the values of K do not correspond to the cycle of spawning. A comparison of the K values of both sexes with the seasonal changes in gonad weight will reveal that the maximum weight of gonads is found in March and April which corresponds to almost minimum values of K. The three peaks in K values occurred during October, February and July when the gonad weight was considerably low. These findings leave little doubt that the K values in this fish have no correlation with the maturation of gonads and that there is hardly any indication of the onset of spawning from the seasonal changes in the condition factor. This is in contrast to many opinions held in literature that the seasonal changes in the condition factor are largely related to the spawning cycle (*see* Qayyum & Qasim 1964).

A comparison of the seasonal changes in the K values with the rate of feeding (Fig. 8) will reveal that the rise and fall of the condition factor agree closely with the feeding rhythm. In February, April and May when feeding is low, the K values are also low and similarly in July, August and November the high rate of feeding corresponds with high values of condition factor.

Many earlier authors have found that a relationship of K with the size of fish indicates the onset of maturity of the fish. In such a relationship the point of inflexion on the curve showing a diminution of K with increasing length gives an indication of the length at which sexual maturity is attained (Qayyum & Qasim 1964). Sarojini (1957) found it applicable to *Mugil parsia* by using 'K_n' values. In *M. seenghala* the *K* values of various length groups are given in Fig. 6. It can be seen from the figure that there is no indication of a secondary fall in the large size-groups.

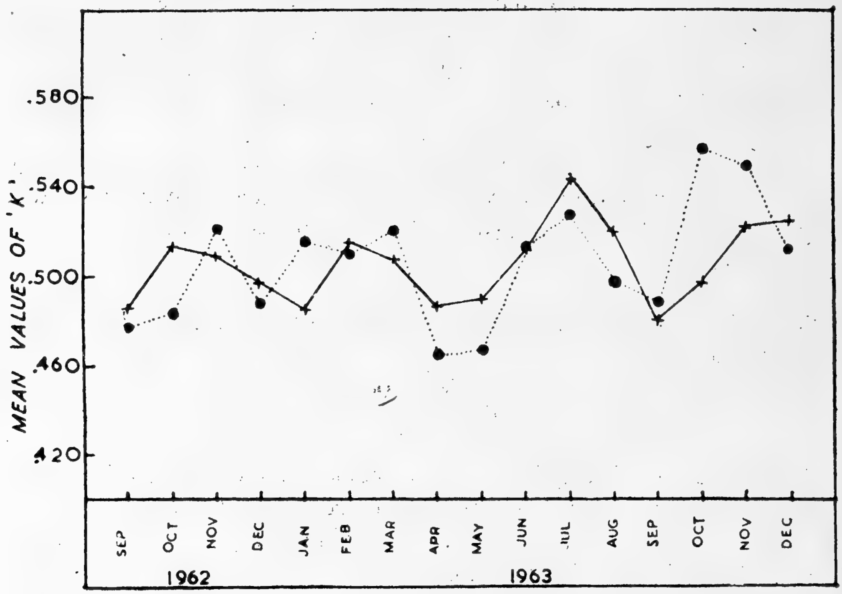

FIG. 5. Seasonal changes in the condition factor 'K' of both sexes of *M. seenghala*. Females (continuous line), males (broken line).

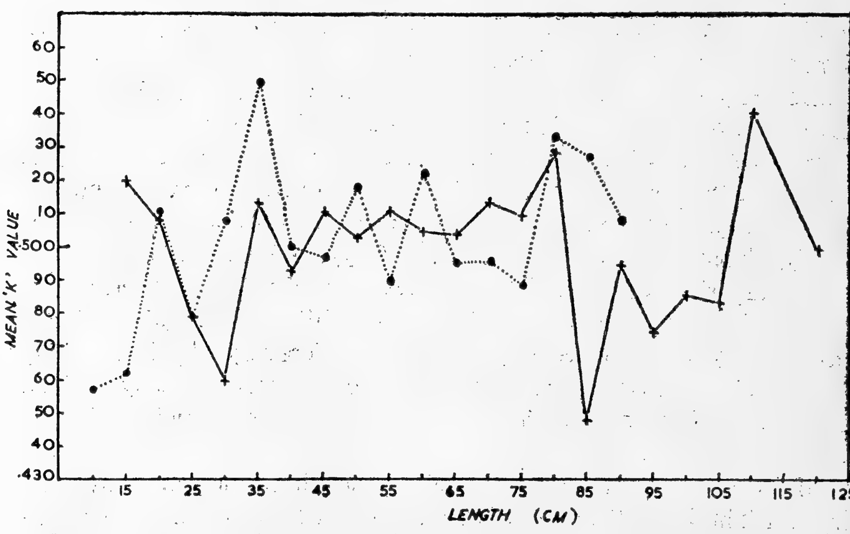

FIG. 6. Mean condition factor 'K' of *M. seenghala* at different lengths of females (continuous line) and of males (broken line).

The general trend in the K values is of a fluctuating nature which gives no clue whatsoever, to the onset of maturity.

FOOD AND FEEDING HABITS

No account is available on the food of this fish. The present investigation covers a period of 16 months during which time 567 guts were examined. The method of estimation was the same as used earlier (Qayyum & Qasim 1964).

A serious difficulty was encountered during the analysis of food of *M. seenghala* because the fish when caught, generally everts its stomach probably because of the jarring it receives from the fishermen. This was more commonly found in larger fishes, ranging between 75 cm. to 115 cm. The eversion of stomach is not normally done by the fish itself unless it is manhandled badly, for only the injured fishes had their stomachs everted. From the analysis, therefore, all such fishes which had their stomachs everted were excluded.

The food of *M. seenghala* is composed mainly of fish including fish-fry, fingerlings and small forage fishes. Fish-fry and fingerlings were mainly of carps. Often the fish-fry of cat-fishes were also seen in the gut and on one occasion a fish (female) contained a fingerling of its own kind. Despite the fact that the males are known to exhibit parental care and they are always in close vicinity of the young ones, none of them was found to contain any young fish of its own species. The percentage occurrence of fingerlings and fish-fry is given in Table 2 along with the other food items. It will be seen from the table that the fingerlings and fish-fry occurred only from May to January. This period corresponds with the breeding seasons of most of the freshwater fishes of Northern India (Qasim & Qayyum 1961).

Forage-fishes in the gut show a regular and somewhat steady occurrence. These included *Barbus stigma*, *Chela* sp., *Amblypharyngodon* sp., *Rhynchobdella* sp., *Wallagonia attu* and *Ophicephalus* sp. The presence of big scales of large-sized carps shows that *Mystus seenghala* attacks large-sized fishes and probably snaps up portions of their body.

Crabs and shrimps are also found in the guts. Shrimps were generally more common than the crabs.

Among the terrestrial insects, dragon-flies and may-flies were quite common. The aquatic insects were represented by *Notonecta* and *Nepa* sp. Dragon-flies and their nymphs often occurred abundantly. The other items of food (Table 2) were of negligible importance as these occurred in very small proportions.

According to Price (1963) the food items composing the volume or frequency of 10% or more in the guts can be taken as significant food items. If the various food items are judged on this basis, the main

TABLE 2

PERCENTAGE OCCURRENCE OF VARIOUS CATEGORIES OF FOOD IN THE GUTS OF ADOLESCENT AND ADULT *Mystus seenghala*

Food item	Month															
	1962				1963											
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
No. of fish examined ..	53	44	34	26	35	23	42	26	30	29	32	40	34	53	35	31
No. of fish with food ..	33	36	28	22	30	19	32	20	20	15	25	27	25	42	22	20
Fish fingerling and fish-fry ..	60·3	72·7	44·1	19·2	10·7	—	—	—	16·6	27·5	31·5	25·0	60·9	58·5	29·7	35·5
Forage fish (carps) ..	11·3	11·3	8·8	42·3	64·2	47·7	59·0	23·0	56·6	—	—	20·0	21·7	39·6	13·6	—
Cat-fish ..	1·9	4·5	2·9	11·7	—	4·3	—	—	—	3·4	—	—	—	11·3	8·1	2·2
Other fish ..	3·7	—	—	—	21·4	—	—	3·8	—	—	—	2·5	8·6	3·8	—	—
Crabs ..	3·7	—	—	—	—	—	2·3	—	3·3	—	3·1	—	—	—	—	—
Prawn and Shrimp ..	5·6	6·8	2·9	3·8	—	—	7·1	3·8	10·0	13·7	31·2	15·0	—	7·5	8·1	—
Insects ..	1·9	2·2	14·7	11·6	—	17·3	2·3	15·3	—	3·4	—	—	4·3	—	—	—
Molluscs ..	1·9	—	8·8	—	—	—	—	7·6	—	—	—	5·0	—	—	—	—
Higher aquatic plants ..	3·7	—	11·7	—	3·5	4·3	—	—	—	3·4	6·2	—	—	3·8	—	—
Unidentified food ..	62·2	77·2	67·5	84·6	60·7	39·1	—	34·6	30·0	48·2	46·8	32·5	30·4	39·6	37·8	58·1
Sand and mud ..	—	4·5	17·6	3·8	32·1	47·8	11·9	34·6	36·6	—	28·1	7·5	—	7·5	—	—
Amphibians (frog) ..	—	—	—	—	—	—	2·3	—	—	—	—	2·5	—	—	—	—
Insect larvae ..	—	—	—	—	—	—	—	—	—	—	18·7	12·5	—	—	—	—

food item of *M. seenghala* will be fish and prawns. Figure 7 gives the percentage occurrence of the main categories of food in various months of the year. It will be seen from this figure that some food items have a higher percentage (more than 10%) in some months and these, therefore, could be termed as important items of diet. The occurrence of minor food items in the gut seems a matter of chance. The unidentified food in the guts occurs commonly in the form of semi-digested food remains. Its regular occurrence with a high percentage (Table 2) indicates that probably the food is digested fairly quickly after ingestion.

Seasonal variation in food :

The intake of food items is subjected to significant variation from season to season. This variation, to a large extent, seems correlated with the breeding season of other fishes (Qasim & Qayyum 1961). Fish fingerlings are generally abundant in rivers and ponds during the post-monsoon months (post-breeding season of most of the fishes) and therefore, their appearance in the guts of *Mystus seenghala* corresponds with their availability in the environment. A gradual decline of these food items from the guts during subsequent months suggests a decreasing effect of predation on them as probably they become too large to remain susceptible to be seized by *Mystus seenghala*.

Sand and mud increase in the gut (Fig. 7) with the development of gonads. The sand was found to be more regular in males. It has already been reported earlier that this fish spawns in breeding pits and that the males guard the larvae and nourish them on some sort of white scum produced by their own bodies during the breeding season (Raj 1940; Saigal & Motwani 1961). Probably a greater occurrence of sand and gravel in males (parents) signifies that while guarding the young ones, the males (parents) feed mainly on debris and do not go about hunting for fish and other organisms, leaving the larvae unguarded. Active feeding in *M. seenghala* starts in July and continues till about November. From then onwards there is a cessation of feeding. In brief, the phase of active feeding lasts during monsoon and post-monsoon months. During the winter months feeding goes on at a moderate level but during summer months (April-June) the intake of food is much reduced (Fig. 8). The same feature is reflected from the percentage of empty guts in each month (Fig. 8).

Karekar & Bal (1958) have correlated the feeding intensity with the maturity stages in *Polynemus indicus*. According to these authors feeding slows down with the growing maturity stages, particularly in females and when the fish reaches the final stages of maturity, feeding is considerably reduced. It rises again after the spawning is over. Similar features seem to be true in *M. seenghala* where feeding decreases with the

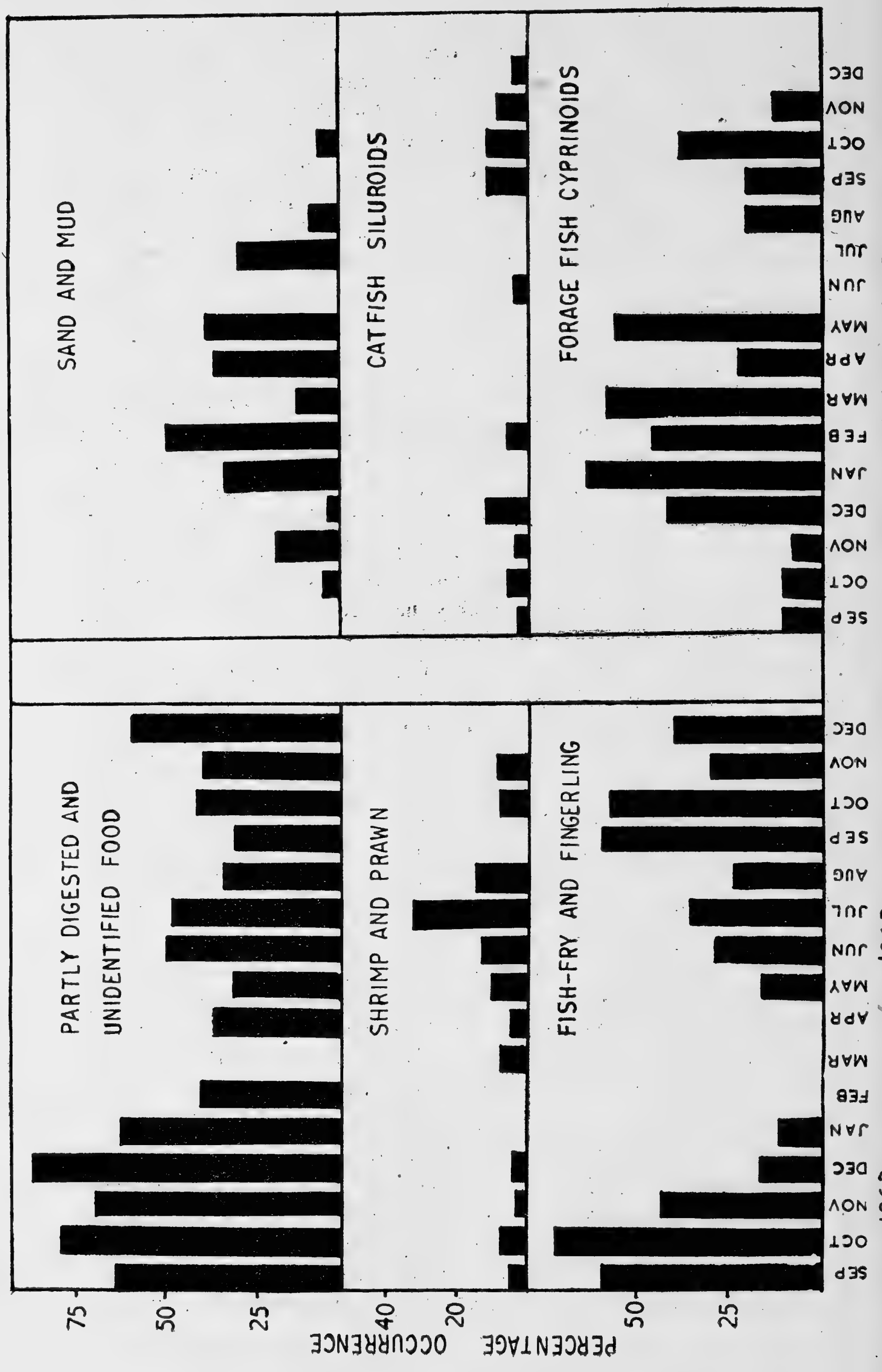

FIG. 7. Histograms showing the percentage occurrence of main categories of food of *M. seenghala* in different months.

maturation of gonads. It becomes minimum in May and June when the gonads are fully ripe and the parents are guarding the young fishes.

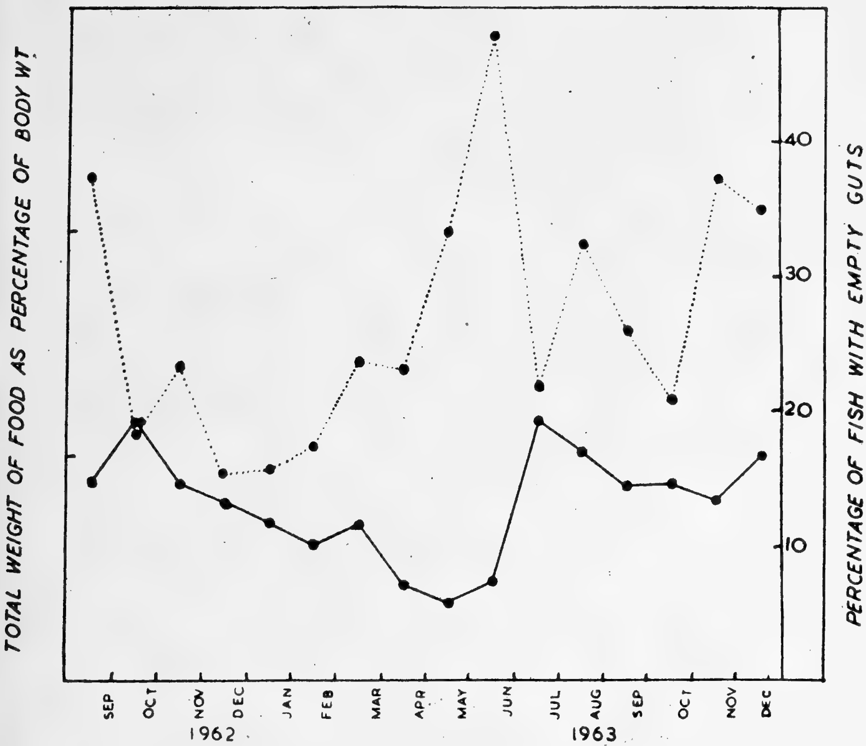

FIG. 8. Seasonal variation in the rate of feeding of *M. seenghala*. Total weight of food of adolescent and older fishes as percentage of body weight (continuous line) and percentage of empty guts (broken line).

SPAWNING OF *Mystus seenghala* IN IMPOUNDED WATERS AND AN INDIGENOUS METHOD OF FISHING

An interesting method of fishing was observed in Bahawalpur village in Dist. Farrukhabad, U.P. This village is situated near the River Ganga on the banks of a lake which gets connected with the river during the monsoon months. This lake stretches a few miles in length but is only 30-40 metres broad. During the post-monsoon months it gets disconnected from the river and in summer months (April-June), the water of the lake separates off into a number of ponds. Some of these ponds are fairly deep and perennial in nature with a lot of fishes including *Mystus seenghala* in them. Enquiries with the local fishermen showed that

M. seenghala makes pits in these ponds where it spawns. It is quite usual for the local fishermen to catch this fish along with its brood (newly hatched larvae). In such pits the fish is known to spawn freely, commencing from April onwards. The spawning of *M. seenghala* in impounded waters, much earlier than other cat-fishes (*see* Qasim & Qayyum 1961), seems rather surprising and obviously demands further investigation.

Taking advantage of the breeding habits of this fish in pits, the fishermen of that village have designed an extraordinary method of fishing of *Mystus seenghala*. As the fish is a bottom dweller, the fishermen generally disturb it at the bottom by using a thick rope with small stones hung as sinkers all along its length. The rope is held by three persons, two at either end, and the third at about the middle. Generally two or three persons follow the man in the middle, maintaining a distance of about 2-3 metres. The two persons holding the ends of the rope go to the far ends of the pond and then begin to drag the rope forward. The third man at the middle also moves in the same direction, keeping the rope slightly above, so that the sinkers do not touch the bottom. The fish when disturbed by the other sinkers, apparently rushes and tries to escape at about the middle of the rope. Thus the escaping fishes are soon trapped in country-made hand-nets called 'tapars' by the persons following the rope. The fishermen use this method exclusively for *Mystus seenghala* and generally no other fish is caught by this method probably because *M. seenghala* has a different behaviour and breeding habit. The method is interesting not because it has an advantage over the conventional drag-net, commonly used by fishermen in such remote areas, but because of the depressed condition of the village fishermen who are too poor to own a regular drag-net, and an ingenious contrivance of this nature perhaps makes an ideal substitute for the drag-net.

Acknowledgement

I am extremely grateful to Dr. S. Z. Qasim for supervising this work which formed a part of my Ph.D. thesis to the Aligarh Muslim University, Aligarh, and for much help in the preparation of this paper.

References

CHACKO, P. I. & KURIAN, G. K. (1948) : A survey of fisheries of the Tungabhadra River. *Proc. Indian Acad. Sci.* **28B** (5) : 166-176.

DAY, F. (1878) : The fishes of India. Vols. I & II. William Dawson & Sons Ltd., London.

HORA, S. L. (1945) : Symposium on the 'Factors influencing the spawning of Indian carps'. Analysis of factors influenaing the spawning behaviour of carps. *Proc. nat. Inst. Sci. India* **11** : 303-318.

KAREKAR, P. S. & BAL, D. V. (1958) : The food and feeding habits of *Polynemus indicus* (Shaw). *Indian J. Fish.* **5** (1) : 77-94.

KHAN, H. M. (1924) : Observations on the breeding habits of some freshwater fishes in Punjab. *J. Bombay nat. Hist. Soc.* **29** : 958-962.

——— (1934) : Habits and habitats of food fishes of the Punjab. ibid. **37** : 655-668.

PRICE, W. J. (1963) : The study of the Food Habits of some Lake Erie Fish. *Bulletin of the Ohio Biological Survey*, Ohio State University, Ohio **2** (1) : 1-89.

QASIM, S. Z. (1957) : The biology of *Blennius pholis* L. (Teleostei). *Proc. zool. Soc. Lond.* **128** : 161-208.

——, & QAYYUM, A. (1961) : Spawning frequencies and breeding seasons of some freshwater fishes with special reference to those occurring in the plains of northern India. *Indian. J. Fish.* **8** : 24-43.

QAYYUM, A. & QASIM, S. Z. (1964) : Studies on the biology of some freshwater fishes. Parts I-III. *J. Bombay nat. Hist. Soc.* **61** : 74-98 ; 330-347 ; 627-650.

RAJ, B. S. (1940) : The extraordinary breeding habits of cat-fish, *Aoria* (*Macrones*) *aor* (Ham.-Buch.) and *A.* (*Macrones*) *seenghala* (Sykes). *Proc. 27th Indian Sci. Congr.* (Madras) Part III, Abst. 156.

SAIGAL, B. N. & MOTWANI, M. P. (1963) : Studies on the fishery and biology of commercial catfishes of the Ganga River system, I. Early life-history, bionomics and breeding of *Mystus* (*Osteobagrus*) *seenghala* (Sykes). *Indian J. Fish.* **8** (1) : 60-75.

SAROJINI, K. K. (1957) : Biology and fisheries of the grey mullets of Bengal. I. Biology of *Mugil parsia* Ham. with notes on its fishery in Bengal. *Indian J. Fish.* **4** : 160-207.

SATYANESAN, A. G. (1960) : Correlative cyclical changes in the pituitary and gonads of *Mystus seenghala* (Sykes) and *Barbus stigma* (Cuv. & Val.). *J. zool. Soc., India* **12** : 175-190.

SUNDARARAJ, B. I. (1959) : A study of correlation between the structure of the pituitary gland of the Indian catfish *Heteropneustes* and the seasonal changes in the ovary. *Act. anat.* **37** : 47-80.

Spider Fauna of India: Catalogue and Bibliography

BY

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[*Continued from Vol.* **66** (3) : 499]

Family HETEROPODIDAE

Genus *HETEROPODA* Latreille 1804

124. **Heteropoda fabrei** Simon 1885. *Bull. Soc. Zool. France* **10** : 32, fig. 10.

Distribution : India : Ramnad, Trichinopoly.

Type : BMNH.

125. **Heteropoda hampsoni** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 495.

Distribution : India : Ootacamund.

Type : BMNH.

126. **Heteropoda lentula** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 496.

Distribution : India : Travancore, Tinnevelly.

Type : BMNH.

127. **Heteropoda nilgirina** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 495.

Distribution : India : Nilgiri Hills.

Type : BMNH.

128. **Heteropoda phasma** Simon 1897. *Mem. Soc. Zool. France* **10** : 258.

Distribution : India : Himalayas, Kasauli, Jaunsar, Mundali.

Type : MNHN.

129. **Heteropoda prompta** Cambridge 1885. *Araneidea, Second Yarkand Exp.* p. 71.

Distribution : India : Himalayas, Murree, Jaunsar, Deota, Konain.

Type : BMNH.

130. **Heteropoda robusta** Louis 1924. *Rec. Indian Mus.* **26** : 66, fig. 2a.

Distribution : India : Siju cave, Garo Hills, Assam.

Type : ZSI.

131. **Heteropoda sexpunctata** Simon 1885. *Bull. Soc. Zool. France* **10** : 14, fig. 11.

Distribution : India : Thana, Poona, Khandesh, Bellary.

Type : MNHN.

132. **Heteropoda smythiesi** Simon 1897. *Mem. Soc. Zool. France* **10** : 259.

Distribution : India : Dehra Dun.

Type : MNHN.

133. **Heteropoda venatoria** (Linn.) 1766.

Aranea venatoria Linn. 1766. *Syst. Nat.* **12** : 1035.

Distribution : India ; Ceylon ; Burma.

Type : ?

Genus *THEMEROPIS* Koch 1875

134. **Themeropis ajax** (Pocock) 1901.

Thelcticopis ajax Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 488.

Distribution : India : Ootacamund.

Type : BMNH.

135. **Themeropis bicornutus** (Pocock) 1901.

Thelcticopis bicornutus Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 489.

Distribution : India : Naga Hills, Nagaland.

Type : BMNH.

136. **Themeropis rufulus** (Pocock) 1901.

Thelcticopis rufulus Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 488.

Distribution : India : Nilgiri Hills.

Type : BMNH.

137. **Themeropis virescens** (Pocock) 1901.

Thelcticopis virescens Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 488.

Distribution : India : Trivandrum, Kerala State.

Type : BMNH.

Family LYCOSIDAE

Genus *DENDROLYCOSA* Doleschall 1859

138. **Dendrolycosa stauntoni** Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 247.

Distribution : India : Bangalore, Mysore.

Type : BMNH.

Genus *EUCAMPTOPUS* Pocock 1900

139. **Eucamptopus coronatus** Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 245.

Distribution : Tinnevelly, S. India.

Type : BMNH.

Genus *EUPROSTHENOPS* Pocock 1897

140. **Euprosthenops ellioti** (Cambridge) 1877.

Podophthalma ellioti Cambridge 1877. *Proc. Zool. Soc. London :* 567, fig. 6.

Distribution : India : Chingleput, S. India.

Type : BMNH.

Genus *EVIPPA* Simon

141. **Evippa praelongipes** (Cambridge) 1870.

Lycosa praelongipes Cambridge 1870. *Proc. Zool. Soc. London* : 822, fig. 6.

Distribution : Punjab, Assam.

Type : BMNH.

142. **Evippa rubiginosa** Simon 1885. *Bull. Soc. Zool. France* **10** : 11.

Distribution : India : Assam.

Type : MNHN.

Genus *HIPPASA* Simon 1885

143. **Hippasa agelenoides** (Simon) 1884.

Pirata agelenoides Simon 1884. *Ann. Mus. Genova* **20** : 334.

Distribution : India : Dehra Dun, U.P., Nilgiri Hills, Malabar ; Burma.

Type : MNHN.

144. **Hippasa himalayensis** Gravely 1924. *Rec. Indian Mus.* **26** : 593, fig. 1a.

Distribution : India : Darjeeling, Sevok, Pashok, Kalimpong.

Type : ZSI.

145. **Hippasa holmerae** Thorell 1895. SPIDERS OF BURMA, p. 218.

Distribution : India : Kalimpong, Darjeeling ; Burma.

Type : BMNH.

146. **Hippasa loundesi** Gravely 1924. *Rec. Indian Mus.* **26** : 594, fig. 1e.

Distribution : India : Shevaroy Hills.

Type : ZSI.

147. **Hippasa lycosina** Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 250.

Distribution : India : Poona, Nasik, Satara (Maharashtra).

Type : BMNH.

148. **Hippasa madraspatana** Gravely 1924. *Rec. Indian Mus.* **26** : 595, fig. 1j.

Distribution : India : Madras city.

Type : ZSI.

149. **Hippasa nilgiriensis** Gravely 1924. *Rec. Indian Mus.* **26** : 593, fig. 1d.

Distribution : India : Nilgiri Hills.

Type : ZSI.

150. **Hippasa pantherina** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 752.

Distribution : India : Trivandrum (Kerala), Madras, Orissa, West Bengal, Maharashtra ; Sikkim ; Ceylon.

Type : BMNH.

151. **Hippasa pisaurina** Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 250.

Distribution : India : Bangalore (Mysore), Poona (Maharashtra), Siripur, Saran (Bihar).

Type : BMNH.

Genus *LYCOSA* Latreille 1804

152. **Lycosa annandalei** Gravely 1924.

Distribution : India : Madras city, Ootacamund, Multan (Punjab), Siripur, Manbhum (Bihar), Sibsagar (Assam), Manipur, Salt Lake (Calcutta), Berhampur court, West Bengal.

Type : ZSI.

153. **Lycosa barnesi** Gravely 1924. *Rec. Indian Mus.* **26** : 599, fig. 3b.

Distribution : India : Dhoni Forest, South Malabar.

Type : ZSI.

154. **Lycosa birmanica** (Simon) 1884.

Pardosa birmanica Simon 1884. *Ann. Mag. Stor. Nat. Genova* **20** : 333.

Distribution : India : Western Ghat, Orissa, Punjab, U.P., Bihar, Calcutta, Darjeeling (West Bengal) ; Burma.

Type : MNHN.

155. **Lycosa bistriata** Gravely 1924. *Rec. Indian Mus.* **26** : 600.

Distribution : India : Bangalore, Bandipur, Mysore, Madras city, Birbhum district, West Bengal, Calcutta, Darjeeling.

Type : ZSI.

156. **Lycosa carmichaeli** Gravely 1924. *Rec. Indian Mus.* **26** : 604, fig. 4b.

Distribution : India : Darjeeling, Kathgodam, U.P., Assam ; Bhutan frontier.

Type : ZSI.

157. **Lycosa catula** Simon 1885. *Bull. Soc. Zool. France* **10** : 457.

Distribution : India : Coimbatore, Shevaroy Hills.

Type : MNHN.

158. **Lycosa chaperi** Simon 1885. *Bull. Soc. Zool. France* **10** : 8.

Distribution : India : Wagra-Karoor near Guntakal, Bellary district.

Type : MNHN.

159. **Lycosa fletcheri** Gravely 1924. *Rec. Indian Mus.* **26** : 606, fig. 4f.

Distribution : India : Punjab, Simla ; N.W.F. Province.

Type : ZSI.

160. **Lycosa fuscana** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 485.

Distribution : India : Poona, Maharashtra.

Type : BMNH.

161. **Lycosa goliathus** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13**: 484.

Distribution : India : Satara district, Maharashtra.

Type : BMNH.

162. **Lycosa himalayensis** Gravely 1924. *Rec. Indian Mus.* **26** : 603, fig. 3g.

Distribution : India : Singla, Ghumti, Pashok, Soom, Kalimpong, Sonarpur, Assam.

Type : ZSI.

163. **Lycosa indagatrix** Walcknear 1837. *Ins. Apt.* **1** : 339.

Distribution : India : Pondicherry, Bellary, Eastern Ghats, Shevaroy Hills, Chingleput, Madras ; Ceylon.

Type : ?

164. **Lycosa iranii** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 485.

Distribution : India : Poona, Maharashtra.

Type : BMNH.

165. **Lycosa kempi** Gravely 1924. *Rec. Indian Mus.* **26** : 602, fig. 3f.

Distribution : India : Darjeeling, Mangaldai, Assam ; Bhutan.

Type : ZSI.

166. **Lycosa khudiensis** Sinha 1950. *Rec. Indian Mus.* **48** : 22, fig. 1d.

Distribution : India : Manbhum, Bihar.

Type : ZSI.

167. **Lycosa leucostigma** Simon 1885. *Bull. Soc. Zool. France* **10** : 10.

Distribution : India : Trivandrum, Madras city, Barkuda Islands, Birbhum district, West Bengal, Calcutta, Siripur, Bihar.

Type : MNHN.

168. **Lycosa mackenziei** Gravely 1924. *Rec. Indian Mus.* **26** : 606, fig. 4h.

Distribution : India : Bangalore, Mysore ; Siripur, Bihar ; Calcutta.

Type : ZSI.

169. **Lycosa madani** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 486.
Distribution : India : Cochin, Bangalore, Barkuda Islands, Chilka lake, Eastern Ghats, Siripur, Bihar.
Type : BMNH.

170. **Lycosa masteri** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 484.
Distribution : India : Satara district, Maharashtra.
Type : BMNH.

171. **Lycosa nigrotibialis** Simon 1884. *Ann. Mus. Genova* **20** : 330.
Distribution : India : Bangalore, Poona, Khandala, Bombay, Katihar, Bihar, Birbhum district, West Bengal, Calcutta, Darjeeling, Kalimpong, Sibsagar and Garo Hills, Assam, Bhutan ; Burma.
Type : MNHN.

172. **Lycosa phipsoni** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 751.
Distribution : India : Bombay, Satara, Kanara, Nasik, Maharashtra.
Type : BMNH.

173. **Lycosa pictula** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 486.
Distribution : India : East Khandesh, Maharashtra.
Type : BMNH.

174. **Lycosa prolifica** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 485.
Distribution : India : Poona, Maharashtra.
Type : BMNH.

175. **Lycosa punctipes** Gravely 1924. *Rec. Indian Mus.* **26** : 603, fig. 3i.
Distribution : India : Bangalore, Lucknow, Mirzapur, Siripur, Bihar, Calcutta, Berhampur, West Bengal.
Type : ZSI.

176. **Lycosa quadrifer** Gravely 1924. *Rec. Indian Mus.* **26** : 608, fig. 4k.
Distribution : India : Parambikulam, Kerala State ; Ceylon.
Type : ZSI.

177. **Lycosa stictopyga** (Thorell) 1895
Tarentula stictopyga Thorell 1895. SPIDERS OF BURMA, p. 232.
Distribution : India : Calcutta, Darjeeling, Garo Hills, Kalimpong, Bangalore, Siripur, Bihar, Mawplong, Khasi Hills.
Type : BMNH.

178. **Lycosa sumatrana** Thorell 1890. *Ann. Mag. Stor. Nat. Genova* **10** : 136.

Distribution : India : Bangalore, Mysore, Ootacamund, Madras city, Bombay, Siripur, Bihar, Birbhum district, West Bengal, Calcutta, Darjeeling, Garo Hills, Assam ; Nepal and Bhutan.

Type : BMNH.

179. **Lycosa sutherlandi** Gravely 1924. *Rec. Indian Mus.* **26** : 606, fig. 4g.

Distribution : India : Darjeeling, Pashok, Singla, Kalimpong.

Type : ZSI.

180. **Lycosa tatensis** Tikader 1964. *Rec. Indian Mus.* **59** : 265, fig. 6a, b.

Distribution : India : Tate, Central Himalayas.

Type : ZSI.

181. **Lycosa wroughtoni** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 751.

Distribution : India : Bulsar, Gujarat.

Type . BMNH.

Genus *OCYALE* Audouin 1826

182. **Ocyale atlanta** Audouin 1826. SAV. DESCR. EGYPTE, ARACH. p. 150.

Distribution : India : Barkuda Island, Chilka Lake, Orissa, Siripur, Saran, Bihar ; Ceylon.

Type : ?

Genus *PARDOSA* Koch 1847

183. **Pardosa atropalpis** Gravely 1924. *Rec. Indian Mus.* **26** : 610, fig. 5b.

Distribution : India : Bangalore, Mysore, Nilgiri Hills, Madras city, Chilka Lake, Orissa.

Type : ZSI.

184. **Pardosa leucopalpis** Gravely 1924. *Rec. Indian Mus.* **26** : 610, fig. 5d.

Distribution : India : Madras city, Barkuda Island, Chilka Lake, Orissa ; Ceylon.

Type : ZSI.

185. **Pardosa oakleyi** Gravely 1924. *Rec. Indian Mus.* **26** : 610, fig. 5c.

Distribution : India : Ootacamund, Nilgiri Hills, Siripur, Saran, Bihar.

Type : ZSI.

186. **Pardosa pusiola** (Thorell) 1891.

Lycosa pusiola Thorell 1891. *K. Sven. Vet. Adad. Handl.* **24** : 65.

Distribution : India : Darjeeling ; Ceylon.

Type : BMNH.

Genus *PERENETHIS* Koch 1878

187. **Perenethis indica** (Simon) 1897.

Tetragonophthalma indica Simon 1897. *Bull. Mus. Paris* p. 295.

Distribution : India : Poona ; Karachi.

Type : MNHN.

Genus *THALASSIUS* Simon 1885

188. **Thalassius phipsoni** Cambridge 1898. *Proc. Zool. Soc. London,* p. 31, fig. 5.

Distribution : India : Mahim, Bombay, and Dorun.

Type : BMNH.

Genus *VENONIA* Thorell 1895

189. **Venonia himalayaensis** Gravely 1924. *Rec. Indian Mus.* **26** : 608, fig. 41.

Distribution : India : Darjeeling.

Type : ZSI.

Family OECOBIIDAE

Genus *OECOBIUS* Lucas 1846

190. **Oecobius marathaus** Tikader 1962. *J. Bombay nat. Hist. Soc.,* **59** : 684, fig. 2a, b.

Distribution : India : Poona, Maharashtra.

Type : ZSI.

191. **Oecobius putus** Cambridge 1876. *Proc. Zool. Soc. London*, p. 544, pl. 58, fig. 1.

Distribution : India : Calcutta, Poona, Madras ; Lahore ; Egypt ; Tripoli ; Yemen ; Tanganyika.

Type : BMNH.

Family OONOPIDAE

Genus *ISCHNOTHYREUS* Simon 1892

192. **Ischnothyreus shillongensis** Tikader 1968. *J. Bombay nat. Hist. Soc.* **65** : 257, figs. 1-5.

Distribution : India : Shillong, Assam.

Type : ZSI.

Genus *TRIAERIS* Simon 1891

193. **Triaeris khashiensis** Tikader 1966. *Current Science* **35** : 520, figs. 1-3.

Distribution : India : Shillong, Assam.

Type : ZSI.

(*to be continued*)

Some observations on distribution of *Scoparia dulcis* Linn. in India[1]

BY

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Scoparia dulcis L. a member of tribe Gratioleae and family Scrophulariaceae is an undershrub with small white flowers and little capsules full of minute seeds. The plant is distributed throughout the tropical regions of both the hemispheres. Pennel (1935) reports that it is a widespread weed of lowland tropical America, occurring in waste places and cultivated ground, specially where sandy. It occurs through the Florida peninsula to southern Georgia, and along the Gulf coast to southern Louisiana. Pennel (1943) further observes that the genus *Scoparia* has about 20 neotropical species, of which *Scoparia dulcis* is adventive to the old world tropics ; it is one of the commonest tropical weeds. ' *Scoparia dulcis* Linn. is the only species occurring in our area (India) ' (Chatterjee & Bharadwaj 1955). It is a weed of cultivated and waste lands.

According to Ridley (1930) *S. dulcis* was first described in 1753 by Linnaeus from specimens collected in Jamaica and Curaçao ; it is undoubtedly of South American and West Indian origin. Linnaeus did not give the etymology of the name, but it is evidently from the Latin *Scopae*, meaning broom, an allusion to the habit of the plant (Pennel 1935).

Ridley (1930) reports that ' J. Rotheram, a pupil of Linnaeus, who died in 1804, has written in his copy of Linnaeus " Species Plantarum ", a manuscript note to the effect that the plant was used in Guinea, West Africa, as a drug for venereal diseases'. This shows that the plant had arrived in Guinea much before 1804 ; ships connected with the slave trade might have carried the plant from South America. Loureiro saw this plant in Indo-China in 1773, perhaps brought by Jesuit missionaries as a drug. The plant was found by Robert Brown in Australia in Shoal Waterbay on the north-east coast in 1802. From Hong Kong the plant was reported in 1853 and 1856, and was used by natives as a drug for consumption. The earliest record of this plant from Malay Peninsula

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[1] Experimental work was done at the Department of Botany, Banares Hindu University, Varanasi.

is 1884. The Malayans call it ' TeMacao ' (Macao Tea), implying that it came from China (Ridley 1930).

Ridley (1930) visualises two secondary centres of dispersal of this plant. *Scoparia dulcis* first migrated from West Indies to Africa in the 18th century ; then the Jesuits, either accidentally, or in cattle fodder or as a drug, carried it from South America to the Philippines and from there through cattle to Malay Archipelago and Malay Peninsula and to China. The cause of its absence in India in the earlier part of the 19th century may be due to the fact that there was no cattle trade from either Africa or Malaya to this country.

S. dulcis was reported in India in 1845 by Voigt at Serampore (Fischer 1921), though Fischer (1932) himself in the list of the specimens at Kew Herbarium observes that Thompson collected the plant in July, 1843, at Moradabad in the United Provinces (now Uttar Pradesh).

Fischer (1921*a*) remarked : ' apparently this little plant has spread from Serampore since 1845. It has extended throughout the peninsula in suitable localities ; have met with it in Ganjam, Coimbatore and Malabar. It is increasing in the localities occupied in abundance and it may well become a pest. It is an introduced species that has run wild in the moist western deciduous forest only'. Fischer in 1925 reported the plant on Lushai Hills.

Hooker (1885) observes : ' though now a super-abundant Bengal plant according to Mr. Clarke, it was unknown in Roxburgh's time and occurs in no Indian herbarium except Clarke's. Voigt mentions it (1845) as found about Serampore, whence probably it has spread quite recently '.

Blatter & Hallberg (1918) noted the great rapidity with which this tropical American plant has spread over large areas of India. They also mention that ' Dalzell and Gibson in their BOMBAY FLORA (1861) do not mention the plant '. In 1918 the plant was to be found all over Bombay Island.

It is called a Bengal plant, perhaps because of its dispersal from Bengal. Whatever may be the exact date and place of its first report, it is certain that this plant had come to India by the middle of the nineteenth century.

In the later part of the nineteenth and the early part of the twentieth century the plant became abundant ; in less than fifty years the plant spread to nearly all the provinces of India. Cooke (1903-1906) says that ' this weed, a native of tropical America, is becoming naturalised in many parts of India, notably in Bengal.' Woodrow (1897) reports having found it in a salt swamp near Bombay. Duthie (1903-1920) writes : ' often met with as a weed of cultivated ground, more specially in the Sub-Himalayan tracts of Rohilkhand and North Oudh '.

Kirtikar & Basu (1918) do not mention the plant in their INDIAN

MEDICINAL PLANTS (1918 edition), but the 1935 edition says : 'In India it is used in infusion in ague. In Guiana every part of the plant is used as an emetic. As a gargle the plant is used as a cure for toothache. A decoction of the root is given in blennorrhagia and in excessive menstruation. The root is considered astringent, mucilaginous. The Antnanka of Madagascar use an infusion of the leaves in stomach troubles. In Guinea, it is considered diuretic and is a popular remedy for children. On the Gold Coast, the twigs are pounded and mixed with Guinea grain or hire (a white clay) and with water, the liquor being drunk to cure sore throat.' Nath & Banerjee (1948) extracted 'antimellitus principle' from fresh *Scoparia dulcis* plants and have used with success the decoction of the plant for the cure of diabetes.

It is interesting to observe that this plant came to India in the middle of the nineteenth century, and within about fifty years has become a weed throughout India. What special characteristics the plant possesses that it has become so abundant ?

With a view to examine the potentialities of the plant with regard to its reproductive capacity both sexual and vegetative the following experiments were conducted.

Field observations:

Number of fruits per plant, number of seeds per capsule and weight per seed were recorded from plants of *Scoparia dulcis* collected from different localities in Varanasi. The data have been given in the Table.

TABLE

	Number of		
	Capsules per plant	Seeds per capsule	Weight of each seed in mg.
	418	275	4·2
	590	203	1·5
	507	221	4·5
	471	280	1·3
	339	200	5·0
	370	230	3·2
Average	449	235	3·3

$$\text{Seed output} = 449 \times 235 = 105515$$

100 seeds were put between moist filter papers on 12th February 1964, and after 6 days 95 seeds had germinated. Thus the percentage germination was 95%.

The reproductive capacity (Salisbury 1942) may be indicated as

$$\frac{\text{Seed output} \times \text{percentage germination.}}{100}$$

Accordingly the reproductive capacity of *Scoparia dulcis*

$$=\frac{105515\times 95}{100}=100239{\cdot}25 \text{ or } 100239.$$

The seedlings were seen in nature in the month of July and August; plants attain their normal size within two or three months. After flowering and fruiting the capsules dehisce and the seeds are dispersed by wind.

In nature very small plants also bear fruits and these plants were found to have sprouted from underground parts perennating under the soil. The vegetative propagation of *S. dulcis* takes place by sprouting of axillary buds ; one single piece of underground stem may give rise to one or more aerial shoots.

The plant is equipped with very efficient method of dispersal and high reproductive capacity. This sexual method of propagation is supplemented with perennation and regeneration of vegetative parts under the soil which also gives rise to adult fruiting plants.

Discussion

Salisbury (1942) has shown that *Linaria vulgaris* Mill., a member of Scrophulariaceae possesses the capacity of reproduction by seeds and regeneration by vegetative means. He is of the opinion that though the viability of the seeds is low, yet its local abundance is due to prolific means of vegetative multiplication by adventitious shoots from the roots. The latter fact has been confirmed in the same plant by Bakshi & Coupland (1960). Shah (1966) has shown in the case of *Bacopa monnieri* that seeds are not the effective means of reproduction but the regeneration of a single node or a single leaf with an axillary bud has facilitated the plant for migration from coastal sea shores to inland fresh water. Thus *Scoparia dulcis* possesses both efficient migratory mechanism with high viability of seeds supplemented by regeneration by vegetative means ; these may be the causes of the widespread distribution of the plant in India within a short period of time.

Summary

Scoparia dulcis Linn., a member of the family Scrophulariaceae, is distributed throughout the tropical regions of both the hemispheres. A historical sketch of its distribution has been attempted. The plant was first reported in the middle of the nineteenth century in India and

within fifty years it has become a common weed. The widespread distribution and local abundance of *S. dulcis* can be explained by the efficient migratory mechanism, high reproductive capacity and prolific method of regeneration by vegetative means.

Acknowledgements

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References

Bakshi, T. S. & Coupland, N. T. (1960) : Vegetative propagation in *Linaria vulgaris. Canadian J. Bot.* **38** : 243-249.

Blatter, E. S. J. & Hallberg, F. (1918) : New Indian Scrophulariaceae and some notes on the same order. *J. Bombay nat. Hist. Soc.* **25** : 426-427.

Chatterjee, D. & Bharadwaj, R. C. (1955) : Revision of Scrophulariaceae of the Upper Gangetic plain and adjoining areas. Excerpt from the *Bulletin of the Bot. Soc. Bengal* **9** (2) : 127-153.

Cooke, T. The flora of the Presidency of Bombay. Reprinted by Bot. Sur. Ind., Calcutta. 1958. II.

Duthie, J. F. Flora of Upper Gangetic Plain and adjacent Siwalik and Sub-Himalayan tracts, Vols. I-III. Reprinted by Bot. Sur. Ind., Calcutta.

Fischer, C. E. C. (1921) : *Scoparia dulcis* Linn. *J. Indian Botany* **2** : 57.

——— (1921) : Flora of the Anaimalais. *Rec. Bot. Sur. India.* **9**(1) : 127.

——— (1925) : Flora of Lushai Hills. ibid. **10** (2) : 116.

——— (1932) : *Scoparia dulcis* Linn. *J. Indian Bot. Soc.* **11** : 348.

Haines, H. H. (1921-1925) : Botany of Bihar and Orissa. London.

Hooker, J. D. (1872-1897): The Flora of British India, Ashford, Kent.

Kirtikar, K. R. & Basu, B. D. (1918) : Indian Medicinal Plants, Allahabad.

——— (1935) : Indian Medicinal Plants (2nd. Ed.), Allahabad.

Nath, M. C. & Banerjee, S. R. (1943) : New antidiabetic principle (amellin) occurring in nature. I. Biochemical properties. II. Effect on Glycosuria and Hyperglycæmia in cases of human diabetes. *Ann. Biochem. Exp. Med.* **3** : 55-62, 63-84.

Pennel, F. W. (1935) : The Scrophulariaceae of Eastern North temperate America. *Acad. Nat. Sci. Philadelphia Monograph* **1** : 108.

——— (1943) : The Scrophulariaceae of the Western Himalayas. ibid. **5** : 1-1963.

Ridley, H. N. (1930) : The dispersal of Plants throughout the World.

Shah, J. D. (1966) : Studies on the growth and development of *Bacopa monnieri* (L.) Penn.—a medicinal herb. Thesis accepted for Ph.D. degree, Banares Hindu University, Varanasi.

Salisbury, E. J. (1942) : The Reproductive Capacity of Plants. London.

Woodrow, G. M. (1897) : Plants of a Bombay Swamp. *J. Bombay nat. Hist. Soc.* **11** : 88-94.

The Tiger in India: An enquiry—1968-69

BY

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The status of the tiger in India is a cause for anxiety to conservationists. Though definite data are not available that the population has gone down in numbers, the progressive deforestation of most of the tiger habitats and available information of uncontrolled and unethical shooting and other methods of killing justify this anxiety. No information is available on the status of the species in the various states of the Union. Estimates of the total population based on conjecture, for example the estimate of 4000 tigers made by the late Mr. E. P. Gee, are undesirable as they are likely to be interpreted as the actual position. The tiger has adapted itself to live in all but the extreme life zones in the country and the population in the various zones would vary according to the environmental conditions; knowledge of the situation in one or two life zones cannot be used as a basis for estimating the position in other areas and such statements on the tiger population become meaningless.

A census is very necessary but beyond the capacity of a single individual to undertake considering the vastness of the tiger habitat in the country. However, it was felt, that information on the position of the tiger in the various states could be immediately obtained through a questionnaire circulated among the field staff of the Forest Departments at the level of foresters, who are the most likely to see tigers or their tracks. The Chief Conservators of Forests of the various states were approached and those of the States of Maharashtra, Gujarat, Mysore, Andhra Pradesh, Rajasthan, Madhya Pradesh, Assam, Madras, and W. Bengal very kindly agreed to circulate among their field staff, a questionnaire seeking information on the tiger/tigers in their range or beat and whether their information is based on sighting or tracks, whether resident or visitors, if visitor cause for migration, and information on when a tiger was last seen and when a tiger was last shot in the area. Completed questionnaires covering either the whole or part of the States of Maharashtra, Madhya Pradesh, Rajasthan, Uttar Pradesh, West Bengal and Assam were received and the data obtained are discussed below:

Maharashtra

Out of the 26 Civil districts in Maharashtra completed questionnaires were received from 12 districts only covering 18 forest divisions (Table 1). Tigers probably occur in the Ghat areas of Kolhapur, Satara, and Poona districts and in the 4 Vidarbha districts of Buldana, Amaravati, Nagpur, and Yeotmal. How far the data obtained represent the true position is discussed in the concluding part of this note. Where it was once well known the tiger has now become almost extinct or has disappeared.

TABLE 1

POPULATION ESTIMATES OF TIGERS IN FOREST DIVISIONS OF MAHARASHTRA

Civil District	Forest Division	Number of tigers reported
Ratnagiri	Sawantwadi	5
Kolaba	Kolaba	15
Thana	Thana	6
Nasik	East Nasik	1
	West Nasik	13
Dhulia	North Dhulia	4
	West Dhulia	0
Jalgaon	East Khandesh	4
	Yawal	4
Aurangabad	Aurangabad	0
Nanded	Nanded	12
Akola	Akola	9
Wardha	Wardha	9
Chandrapur	East Chanda	32
	Bhamragad	53
	West Chanda	75
	South Chanda	8
Bhandara	Gondia	17
	Total	267

Madhya Pradesh

The information obtained is not complete coming from only 5 out of 43 Civil districts and covering six forest divisions (Table 2). This is unfortunate as Madhya Pradesh still has some of the best tiger habitats in the country and a report covering the whole state is essential for precise estimates of the total population.

TABLE 2

POPULATION ESTIMATES OF TIGERS IN FOREST DIVISIONS IN MADHYA PRADESH

Civil District	Forest Division	Number of tigers reported
Betul	West Betul	14
Raigarh	Jashpur	9
Sehore	West Bhopal	17
Mandla	North Mandla	3
	South Mandla	78
Seoni	South Seoni	18
	Total	139

Rajasthan

The reports from five forest divisions of Rajasthan cover five out of the 26 Civil districts and represent probably all the available tiger habitat in the State (Table 3). The tigers of Rajasthan represent the western limits of the population in the Gangetic Plain at the present time.

TABLE 3

POPULATION ESTIMATES OF TIGERS IN FOREST DIVISIONS IN RAJASTHAN

Civil District	Forest Division	Number of tigers reported
Ajmer	Ajmer	0
Bharatpur	Bharatpur	4
Jhalawar	Jhalawar	3
Bundi	Bundi	6
Tonk	Sawaimadhopur	7
	Total	20

Uttar Pradesh

The reports received cover 16 out of the 54 Civil districts and 31 forest divisions and appear to represent almost all areas in the State holding the tiger (Table 4). It is noteworthy that the tiger is restricted to the districts bordering the Himalayas and districts in the south and east bordering tiger habitats in Madhya Pradesh and Bihar. The districts adjoining Nepal appear to have the largest population.

TABLE 4

POPULATION ESTIMATES OF TIGERS IN FOREST DIVISIONS IN UTTAR PRADESH

Civil District	Forest Division	Number of tigers reported
Varanasi	Varanasi	10
Jhansi	Bundelkhand	2
	Banda	6
Lakhimpur Kheri	North Kheri	52
	South Kheri	39
Pilibhit	Pilibhit	50
Gorakhpur	Gorakhpur	15
Gonda	North Gonda	74
	South Gonda	0
Bahraich	Bahraich	28
Garhwal	Landsdowne	23
	Kalagarh	18
	Corbett Nat. Park	50
Bijnor	Landsdowne	7
	Bijnor Plantation	5
	Jaspur (W)	6
Pauri Garhwal	Landsdowne	6
	Kalagarh	4
Nainital	Ramnagar	39
	Tarai & Bhabar	16
	Haldwani	20
	Pilibhit	8
Rampur	Rohilkhand	3
Dehradun	Dehradun (East)	12
	Dehradun (West)	10
Sahranpur	Siwalik	13
Allahabad	Allahabad	0
Mirzapur	North Mirzapur	4
	Varanasi	2
	Dudhi	4
	Son	2
	Total	528

West Bengal

The three civil districts of North Bengal appear to hold the majority of the tigers in West Bengal (Table 5). There are probably a few in the Midnapur and 24-Parganas districts.

TABLE 5

POPULATION ESTIMATES OF TIGERS IN FOREST DIVISIONS IN WEST BENGAL

Civil District	Forest Division	Number of Tigers reported
Jalpaiguri	Cooch Behar	17
	Jalpaiguri	1
Darjeeling	Kalimpong	12
Cooch Behar	Cooch Behar	23
	Total	53

Assam

The reports from the 18 forest divisions of 10 civil districts cover all the major tiger habitats in the State (Table 6). Districts on the north bank of the Brahmaputra appear to hold the majority of tigers.

TABLE 6

POPULATION ESTIMATES OF TIGERS IN FOREST DIVISIONS IN ASSAM

Civil District	Forest Division	Number of Tigers reported
Mizo Hills	Mizo Hills	4
Kamrup	Wild Life	6
	South Kamrup	15
Sibsagar	Kaziranga	30
	Sibsagar	170
Garo Hills	Garo Hills	1
Darrang	Darrang	158
	North Kamrup	32
Goalpara	North Kamrup	5
	Goalpara West	0
	Kachugaon	3
	Goalpara East	5
	Hathigaon	5
Cachar	Cachar	1
United Khasi and Jaintia Hills	United Khasi and Jaintia Hills	5
Lakhimpur District	Dibrugarh	19
	Digboi	42
Nowgong	Nowgong	15
	Total	516

Other States

Some isolated responses were received from other states. In Himachal Pradesh, the Nahan Forest Division of Sirmur District reports a tiger (Table 7). This is apparently the limit of the western distribution of the species in India.

The Secretary of the High Range Game Associations (Kerala) lists 4 tigers as occurring in the Kanan Devan Tea Concession area of the Anaimalai Hills. A member of the Society in Adilabad District, Andhra Pradesh, feels that there are perhaps 12 tigers in the Nirmal Forest Division of the district.

TABLE 7

POPULATION ESTIMATES OF TIGERS IN FOREST DIVISIONS IN OTHER STATES

States	Civil District	Forest Division	Number of tigers reported
HIMACHAL PRADESH	Sirmur	Nahan	1
KERALA	Anaimalai		4
ANDHRA PRADESH	Adilabad	Nirmal	12
		Total	17

TABLE 8

TOTAL POPULATION ON THE BASIS OF THE QUESTIONNAIRE

Maharashtra	267
Madhya Pradesh	139
Rajasthan	20
Uttar Pradesh	528
West Bengal	53
Assam	516
Himachal Pradesh, Kerala and Andhra Pradesh	17
Total	1540

DISCUSSION

The main difficulty in assessing the data obtained through the questionnaire is that unless the person evaluating the information has personal knowledge of the areas covered by the reports it is impossible to have an accurate assessment. For instance, in a Forest having four beats one tiger may be reported by each of the four beat officers and it would be impossible without personal knowledge to determine whether one or more than one tiger is involved. However, the study of the reports shows that in the majority of cases the officials concerned have reported conservatively and avoided exaggeration. It is difficult to accept the large numbers reported from one area on the basis of tracks, as it is extremely unlikely that the person reporting has the knowledge to separate tracks with that amount of accuracy. I am also unable to accept the figures of 30 tigers for Kaziranga and 50 for Corbett National Park. Similarly, I view with considerable scepticism the estimate from the Western range of Darrang Division, Assam, which reports 100 tigers, all non-resident visitors ! The estimates for Darrang and Sibsagar districts require very cautious interpretation. The majority of the replies received speak of visits during particular months of the year and reports of resident tigers are few.

This note was circulated in draft form among persons with experience of conditions in various parts of Maharashtra State. Opinions expressed suggest that it is very unlikely that 15 tigers occur in Kolaba District and possibly leopards are meant. It was also suggested that resident tigers are unlikely in the districts of Thana, Kolaba, Nasik, Ahmednagar, Poona, Satara and Kolhapur. According to Mr. G. V. Bedekar of the Society's Executive Committee a census on 1961-62 showed a total of 467 tigers in the State. It is quite likely that the data obtained from the various states may need considerable revision when examined by knowledgeable persons in those states.

In view of the difficulties in assessing the data the information obtained can only be considered as giving a clue to the total population of the tiger in India. The number of tigers in the States of Maharashtra, Madhya Pradesh, Rajasthan, Uttar Pradesh, West Bengal and Assam totals 1523 in the areas covered by the completed questionnaires ; the excess listed is perhaps countered by the animals existing in areas from which information was not obtained. Tigers do not occur in Punjab, Haryana and Kashmir and even if half the number for the six states for which data are available, are added to the total to cover tigers in the States of Gujarat, Mysore, Kerala, Tamil Nadu, Andhra Pradesh, Orissa, N.E.F.A., Nagaland, and Manipur, the total still remains below 2500. This is by no means a conservative figure.

The tiger should be considered a species in danger of extinction and should be protected against both shooting and the poisoning of its kills with zinc phosphide, endrin, folidol, and other insecticides, which along with deforestation were given in the completed questionnaires as the main reasons for their decline. The trend is for the population of tigers in different parts of the country to become isolated. Shooting of tigers is banned in some states but without a ban on the shooting of its food

7

species, the tiger will come into conflict with human interests and will be exterminated.

It is essential that serious efforts be made to obtain precise information on the tiger. All forest officials of the cadre of foresters and rangers in the tiger habitat should be asked to maintain a diary of sighting records in their area and the information so obtained should be evaluated every three months by a senior official of the State Forest Department and independently by a very senior forest official of the all India cadre who should be enabled to visit all tiger habitats in the country to evaluate reports and form his own estimates.

The Thalassinoidea (Crustacea, Anomura) of Maharashtra

BY

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(*With four text-figures*)

Though Thalassinoidea to which mud-lobsters or ghost-shrimps belong, has been accepted as a distinct superfamily of Decapod crustacea, there have been contradictory opinions regarding its taxonomic status. Alcock & Anderson (1894), de Man (1925 and 1928) and Holthuis (1956) have included it in Macrura, while Borradaile (1907), Calman (1909), Balss (1927 and 1957) and Barnard (1950) are of the opinion that it belongs to Anomura. Gurney (1938) working on the larvae of Thalassinoidea and Nephropsidea, suggests separation of Thalassinoidea into two groups, a Homarine and an Anomuran. In the present study, however, the changes effected by Calman (op. cit) have been followed in the inclusion of Thalassinoidea in Anomura.

In India, studies on Thalassinoidea have been mainly undertaken with reference to the deep sea forms (Miers 1884; Henderson 1893; de Man 1887-88; Alcock & Anderson 1894; Anderson 1896; Alcock 1901; Borradaile 1907 and Kemp 1915). Comparatively much less work has been done on the coastal forms: on the east coast, Southwell (1906) deals with Thalassinids from Ceylon; Gravely (1927) while working on the fauna of Krusadai Island, deals with 1 species of Callianassidae which he refers to subgenus *Calliadne* (=*Gebiopsis*); Chopra (1933) discusses the taxonomic position of *Entrichocheles modestus* in the family Axiidae. On the west coast, Pillai (1954) deals with *Callianassa maxima* in brief and Sankolli (1963) deals with the occurrence and natural history aspect of *Thalassina anomala*. Thus practically no work has been done on the intertidal forms along the west coast and more especially along the Maharashtra coast.

In Maharashtra, the superfamily Thalassinoidea is represented by 4 species belonging to 3 families, collected from intertidal areas. Of these one species, *Laomedia astacina* de Haan is a new record to India and two

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species, *Callianassa* (*Callichirus*) *kewalramanii* and *Upogebia* (*Upogebia*) *kempi* are new to science.

Identification of the present material is mainly based on de Man (1888, 1927, 1928a & b).

Key to the families of Thalassinoidea

I. No *linea thalassinica*; both movable and fixed antennal thorns present though sometimes minute; abdominal pleura large.............. *Axiidae*

II. *Linea thalassinica* present (except in Callianidea); fixed antennal thorn wanting, scale (movable thorn) reduced to a flattened vestige or wanting; abdominal pleura usually small.

1. Sutures on both the rami of uropods; abdominal pleura of good size.. .... *Laomediidae*

2. No sutures on uropods; abdominal pleura small.

(*a*) Second leg chelate or simple; no podobranchs on legs; third to sixth abdominal appendages broad; antennal scale present as a vestige.................................... *Callianassidae*

(*b*) Second leg sub-chelate; podobranchs on first to third legs; all abdominal appendages narrow; no vestige of antennal scale.. .... *Thalassinidae*

Family Laomediidae

Remarks: This family contains 2 genera and in Maharashtra, it is represented by a single genus *Laomedia.*

Genus *Laomedia* de Haan

1. **Laomedia astacina** de Haan (Figs. 1-2).

Laomedia astacina, de Haan, 1849, p. 165; Ortmann, 1892, p. 51; Borradaile, 1903, p. 540; Kamita, 1957, pp. 105-106; Sakai, 1962, pp. 27-34.

Carapace (Fig. 1, a): Rostrum fairly long reaching nearly to the middle of the penultimate joint of the antennal peduncle; provided with 3 minute teeth on either lateral margin near the tip. Length more or less equal to breadth at base. Antennal angles fairly well-developed. No tubercles or hairs on carapace except for short hairs on the antennal and maxillary margins. Cervical groove distinct, dividing the carapace into two equal parts, the anterior and the posterior.

Linea thalassinica is rather well-developed. The eyes reach slightly more than $\frac{1}{2}$ the length of the rostrum.

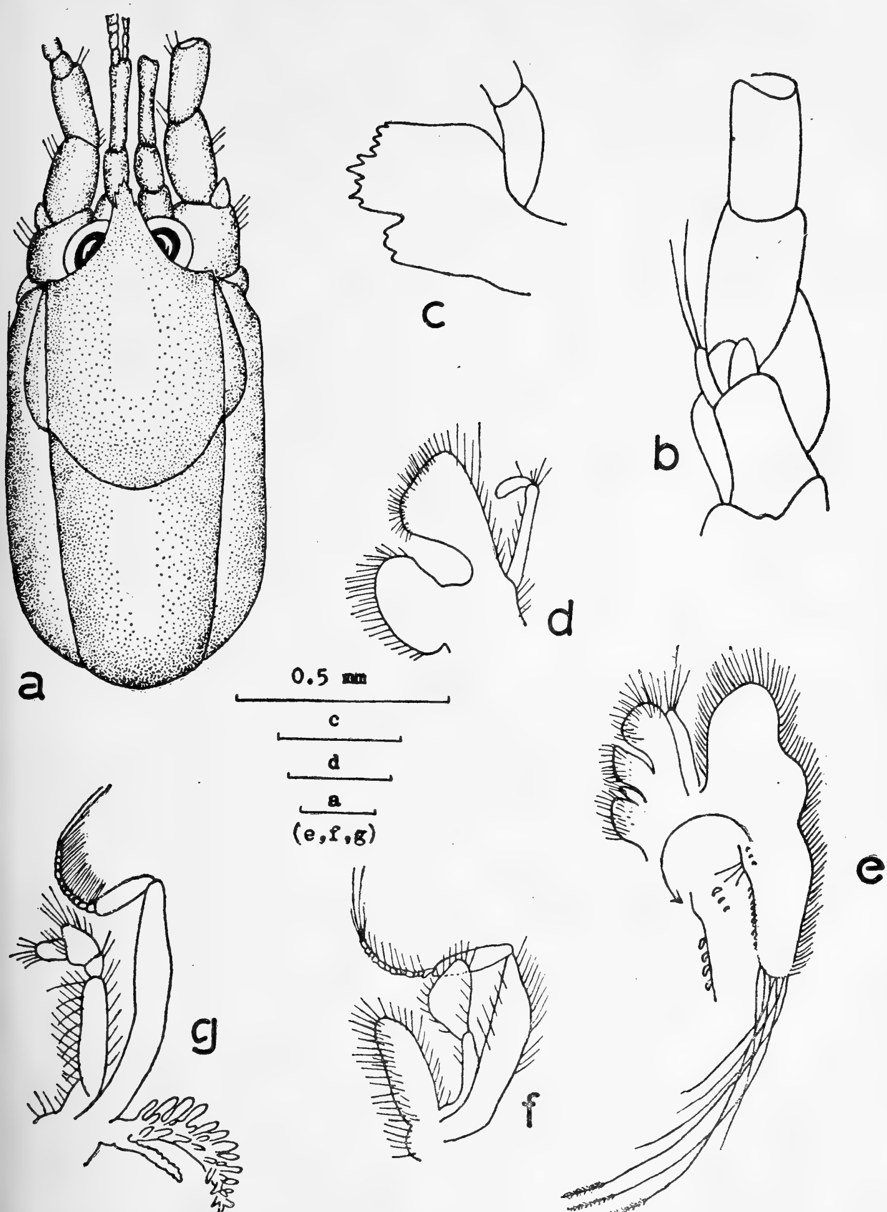


Fig. 1. *Laomedia astacina* de Haan. *a*—anterior part of animal (legs etc. not shown), *b*—antenna, *c*—mandible, *d*—first maxilla, *e*—second maxilla, *f*—first maxilliped, *g*—second maxilliped.

Antennule (Fig. 1, a) : The basal segment falls short of reaching the rostrum. The penultimate joint is almost half the length of the ultimate joint.

Antenna (Fig. 1, b) : The antenna consists of 5 segments and a flagellum. The peduncle extends slightly beyond the antennular peduncle, whereas in the Japanese specimens, it extends well beyond the antennular peduncle as figured by Sakai (1962). The coxopodite shows the opening of the antennal gland. The 2nd segment is divided into two parts and these two parts are clearly seen in the outer-lateral view of the peduncle. The inner part distally bears the scale which is triangularly oval and the outer part bears the antennal thorn which is not that well-developed as the scale or scaphocerite. The 3rd segment which is hardly seen in the dorsal view, is situated latero-ventrally. The 4th segment is slightly longer than the last segment. The antennal peduncle is stouter than the antennular peduncle.

Mandible (Fig. 1, c) : The cutting edge of the ventral plate is provided with 9 unequal teeth and that of dorsal has 3 teeth. The palp is 3-jointed.

First maxilla (Fig. 1, d) : The lower endite is broad and more or less rounded, the upper endite is almost as broad as the lower and the palp is well-developed with its tip deflexed.

Second maxilla (Fig. 1, e) : Both its endites are bilobed, the upper lobe of the lower endite being very small. The palp is long, narrow and does not reach the inner margin of the upper lobe of the upper endite. The scaphognathite is large with a convexity near the distal half on the outer margin. The posterior end bears about 11 very large setae which are minutely spinulose distally except at the tip portion where it is naked. There are several bent hook-like projections present on the inner margin and a few such projections are also present on the anterior portion of the inner margin.

First maxilliped (Fig. 1, f) : The endites are separated by a distinct notch, the palp is well-developed and has a broad, roughly triangular lobe at its distal end. The exopod is well-developed and has a flagellum which is almost as long as the non-flagellated portion and is sub-divided into several joints.

Second maxilliped (Fig. 1, g) : It is normal in shape, with well-developed endopod and exopod. A small, elongated epipod and a single podobranch are present.

Third maxilliped : The dactylus is longer than the propodus and the propodus in turn is slightly longer than the carpus. The merus is longer than the dactylus and the ischium is longer than the merus and is provided with about 12 teeth on its inner margin. The exopod almost reaches the middle of the merus and is segmented in the distal part.

Pereiopods : The first pair of legs is equal in size and shape and much stouter than the second pair.

Cheliped (Fig. 2, a) : The ischium is short (as long as the fixed finger) and bears about 18 or more minute and fine teeth almost all along the posterior margin. The merus is shorter than the propodus and its anterior margin is plain. The posterior margin is provided almost along the proximal half with several minute and fine teeth of which the proximal ones are more prominent than the remaining ones. The carpus is about ½ the length of the merus and its inner upper surface is armed in its distal half with small rounded tubercles, of which the distal ones are more prominent. The propodus is longer than broad and is about 1.3 times the length of the merus. The fixed finger is almost as long the ischium and its cutting edge is provided with several minute teeth of which the proximal 3rd to 7th are larger. The dactylus is more than ½ the length of the propodus and its upper surface is traversed by a thin, longitudinal ridge, which begins near its articulation with propodus, runs a short distance obliquely outwards and then joins the anterior margin. The cutting edge is armed with 2 blunt, tooth-like processes at the proximal portion and then onwards there are several minute teeth more or less uniformly arranged. In the Japanese specimens (Sakai 1962), none of the segments bear tubercles or spines.

Fingers cross each other.

Second leg (Fig. 2, b) : It is simple, non-chelate. The dactylus is narrow and less than ½ the length of the merus. The propodus measures about 1½ the length of the dactylus and the carpus is nearly ⅓ the length of the merus. None of the segments bear any spine or tubercle.

Third leg (Fig. 2, c) : The dactylus is slender, though slightly broad near the base. Minute, elongated tooth-like spines are arranged compactly along its posterior margin on the dorsal surface. The propodus is broader than the dactylus and is about twice the length of the latter. The carpus is nearly ⅔ the length of the propodus and the merus is nearly as long as the dactylus and propodus combined.

Fourth leg (Fig. 2, d) : It is very similar to the third leg. The dactylus is twice the length of the propodus and the carpus is slightly more than ½ the length of the propodus. The merus is nearly 3 times the length of the dactylus.

Fifth leg : The dactylus is absent. The propodus is nearly as long as the merus and the carpus is almost $\frac{1}{2}$ the length of the merus.

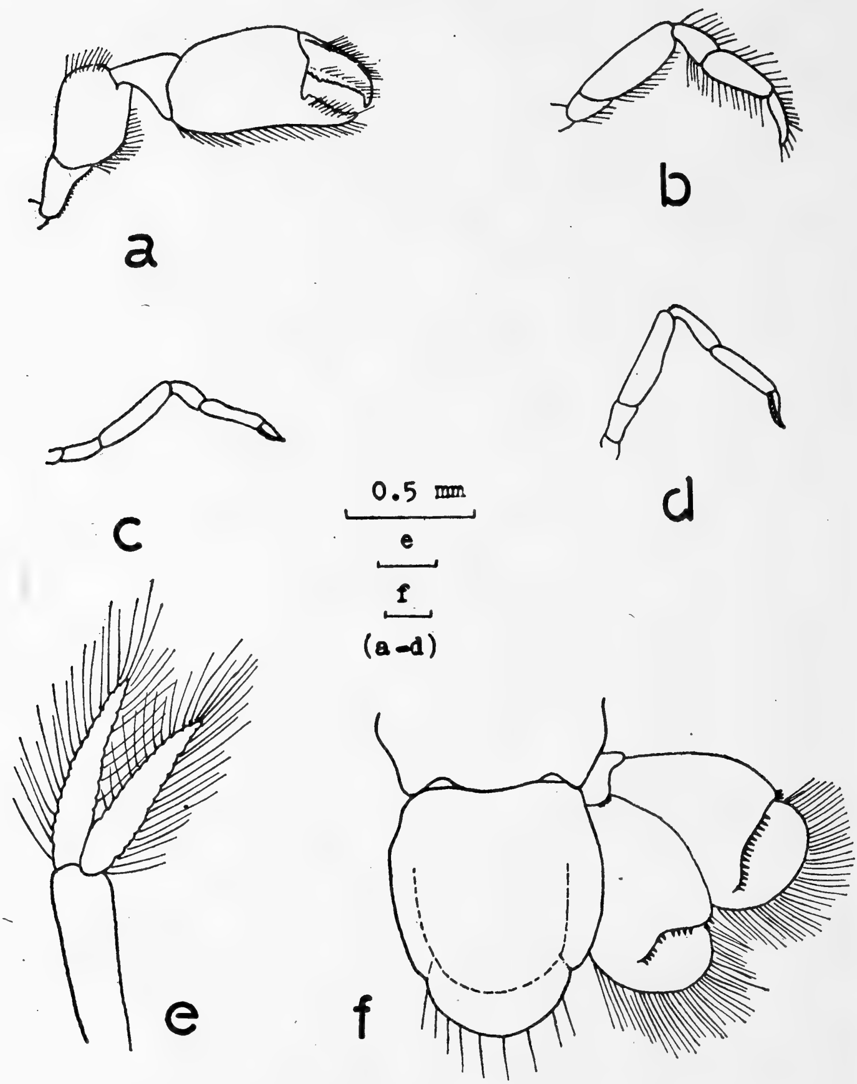


Fig. 2. *Laomedia astacina* de Haan, *a*—first leg, *b*—second leg, *c*—third leg, *d*—fourth leg, *e*—first pleopod, *f*—telson with uropods.

Abdomen : It is normal in shape and is about $1\frac{1}{2}$ times the length of the carapace. The pleura are well-developed. The first segment is the smallest, the 6th is more than $1\frac{1}{4}$ times the 1st, and the 2nd to the 6th are more or less equal in size, but the 1st and the 6th are slightly narrower.

Pleopods (Fig. 2, e) : The 1st abdominal segment does not bear pleopod and there are 4 pairs of pleopods present on the 2nd to 5th segments. Each pleopod consists of a long and stout basal stalk and sabre-like, membranous endopod and exopod. The endopod and exopod are more or less of the same size and shape and are slightly larger than the basal stalk.

Uropods and Telson (Fig. 2, f) : The protopod of the uropod bears 3-4 microscopic blunt teeth on its posterior margin facing the endopod. The exopod and endopod are quite similar in shape—roughly oval, though endopod is slightly smaller than the exopod. The anterior margin of either ramus is convex and terminates distally in a distinct notch from where the convex distal margin begins. From this lateral notch starts a very thin, wavy horizontal ridge which bears several minute but prominent teeth and extends almost beyond the $\frac{3}{4}$ area of the ramus. The exopod bears on the lateral notch 3 minute teeth of which the one near the junction of the distal and anterior margins is larger than the remaining two. There are 14-16 such teeth on the horizontal ridge of the exopod. In the endopod there are two minute teeth on the lateral notch and about 10 teeth on the horizontal ridge. No mid-longitudinal suture was observed.

Telson (Fig. 2, f) : It is longer than broad with its lateral and posterior margins convex, the posterior margin being more convex than the lateral. There is on either side a shallow notch at the junction of the posterior and lateral margins. There are no teeth, tubercles, spines or carinae on the telson.

MATERIAL

A single specimen (male) was collected at the edge of Karla creek (Ratnagiri) while digging for *Thalassina anomala* (Herbst).

1 ♂

$$\left.\begin{array}{l}\text{Length of carapace} = 8{\cdot}00 \text{ mm.}\\ \text{Length of abdomen} = 13{\cdot}5 \text{ mm.}\end{array}\right\} \quad \text{Total length} = 21.5 \text{ mm.}$$

Variation :

The Japanese specimens as described by Sakai (1962) differ from the single Ratnagiri specimen in the following :

Rostrum has 5 lateral teeth ; all the joints of the chelipeds are smooth with no tubercles or teeth ; in the abdomen, the 6th segment is more than 3 times the 1st segment, the 2nd and 3rd are larger than the 6th, and the 4th and 5th are more or less of the same size ; no lateral notch on the rami of the uropods, protopodite without tubercles, a mid-longitudinal suture on the rami ; no lateral notch on the telson.

DISTRIBUTION : Tokyo Bay ; Rukuoka, Amakusa ; Kagoshima ; Iriomote-jima, Ryukyu ; Schuan, Korea.

This species is recorded for the first time from India.

Family THALASSINIDAE Dana

The family is monotypic.

Genus *Thalassina* Latreille

2. **Thalassina anomala** (Herbst) (Figs. 3-4).

Cancer (*Astacus*) *anomalus* Herbst, 1804, p. 45 ; *Thalassina anomala* de Man, 1915, p. 445 ; 1928 b, p. 5 ; Sankolli 1963, p. 600.

Carapace : As observed by de Man (1928 b), there are considerable variations in the armature of the carapace, chelipeds and the anterior margin of the sterna of the second to fifth abdominal segments of *T. anomala*. He has given fairly substantial account of these variations in the 22 specimens of the species, examined by him. However, whether these variations occur due to sex, size, season or locality have not been ascertained. As such studies from this viewpoint were extended to 70 specimens collected by me over a period of $4\frac{1}{2}$ years. Though recorded, it is considered superfluous to include here an elaborate description of all the characters much less specimenwise in all the 70 specimens examined by me. However, an account of the range of variations in each of the characters is furnished as under :

The rostrum is triangular, with a slight median furrow and extends to the distal end of the last but one segment of the antennular peduncle. Its lateral margin is dentate. The teeth are small, broad and their number varies from minimum of 8-9 and maximum of 14-20 on either side in males, and from 3-6 to 17-19 in females.

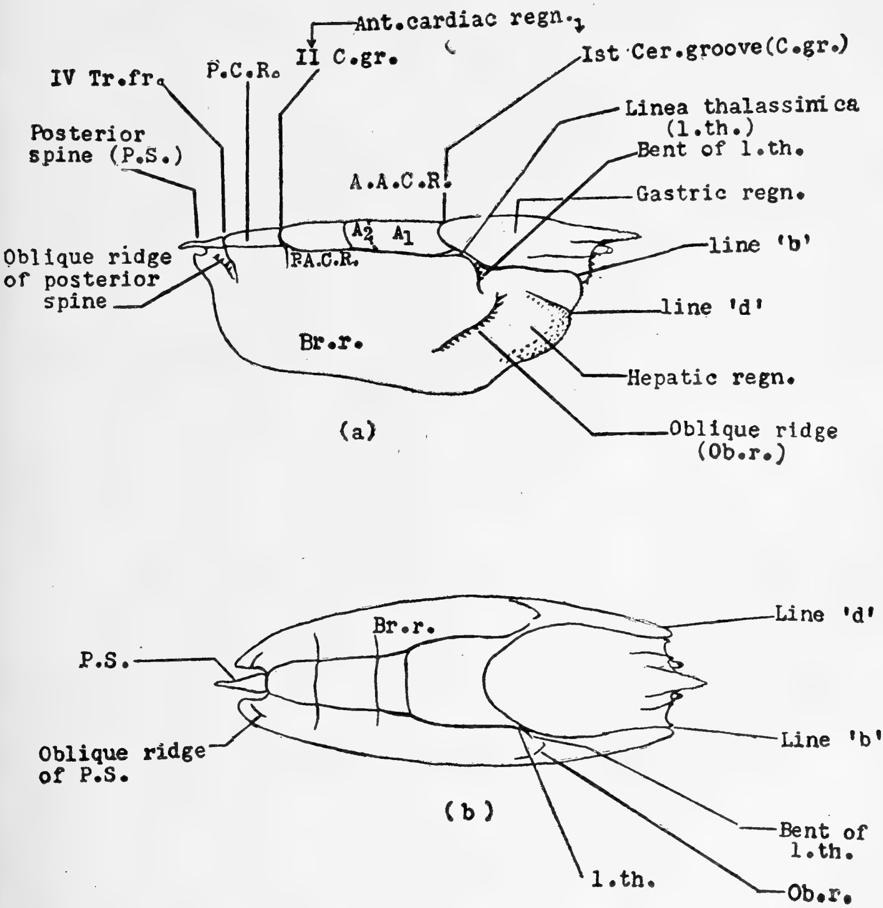
The eyes are small and the cornea is generally antero-laterally placed and not dilated, but in a few cases, it is anteriorly situated.

The gastric region is practically smooth except for a few punctae situated anteriorly and several rugae-like irregular depressions posteriorly on the sides (Fig. 3a & b).

The cervical groove is deep and armed with 2-12 spine-like tubercles.

The cardiac region which extends from 1st cervical groove to the 4th transverse furrow in front of the posterior spine, is divided into anterior and posterior (P.C.R.) portions by the 3rd transverse furrow or the 2nd cervical groove.

The anterior cardiac region, in turn, is further divided into anterior (A.A.C.R.$=A_1+A_2$) and posterior (P.A.C.R.) portions by the 2nd transverse furrow. The anterior portion of the anterior cardiac region is again divided into two halves (A_1 and A_2) by the 1st transverse furrow. The A_1 region is armed with 1-2 spines on either side and a few punctae. Generally the 1st transverse furrow is distinctly visible. In two males, however, the furrow was very indistinct and A_1 region was provided with 5 spines. The A_2 region is also armed with spines which vary from 0-4 on either side, though 2 seems to be the common number. The 2nd



Thalassina anomala (Herbst) (Diagrammatic)

Fig. 3. *a.* Dorso-lateral view of anterior part of body, *b.* Dorsal view of anterior part of body.

transverse furrow is generally indistinct. A.P. (=P.A.C.R.), i.e. the posterior portion of the anterior cardiac region, is provided with 0-10 small spines, except in a male, 124 mm. long, which had 14 such spines.

The posterior cardiac region (P.C.R.), presents a lot of variations in its armature. There are 0-9 spines which are blunt to sharp and some punctae or irregular depressions. It is very rarely smooth.

The posterior spine (P.S.) region shows 0-4 tubercles which are blunt to sharp with irregular depressions.

The oblique ridge on either side of the posterior spine is armed with 3-4 sharp, erect spines, with their tips bent anteriorly.

The lower half of the branchial region (Br.r.) is studded with minute, sharp tubercles and in the anterior half, the tubercles become more sharp and prominent. The upper half between the *linea thalassinica* and the oblique ridge (Ob.r.) is provided with sharp spines which are fairly larger than those on the lower half. The remaining middle area of the branchial region is almost smooth with minute punctae. The oblique ridge is provided with 11-18 sharp, long spines.

The hepatic region is armed with granular but acute tubercles along its anterior border and the remaining part of its surface is smooth.

The antennal margin, situated between the lines 'b' and 'd' bears 5-15 small spines to irregular tubercles and the region between these two lines, is quite smooth.

The front between the rostrum and the line 'b' is armed with 2-6 acute spines of which the one nearest to the rostrum is generally much larger than the remaining ones, though sometimes it is twice as large as the others.

Chelipeds (Fig. 4, g): The chelipeds are equal, subequal and similar or often unequal and dissimilar, the right or left being larger.

Dactylus: Its upper surface is smooth with a few punctae in the middle; the upper border is often minutely dentate. The upper inner margin is armed almost to the tip with 24-28 compressed, small teeth, decreasing in size distally. A row of minute granules is present on the inner surface, more or less parallel to its cutting edge and a broken row of 3-5 unequal, minute tubercles present on the proximal half near the upper inner margin and is often armed with a large blunt tubercle at its base. Between this row and the cutting edge, which is armed with 24-26 unequal teeth, the proximal 1-3 of which are larger, there are 2-3 unequal but large, blunt tubercles proximally. The blunt tubercles are very large in larger specimens.

Propodus: The outer surface is studded entirely with small granules which are quite prominent in the lower half and near the carpal articulation; the surface is smooth near the articulation with the dactylus. The upper inner margin is provided with 13-23 compressed teeth, which decrease in size distally. The upper outer border is armed with about 30-48 sharp teeth which are often depressed and quite low in larger specimens, and decrease in size distally. A row of 37-41 much depressed flat tubercles is present on the mid-lateral surface; this row sometimes

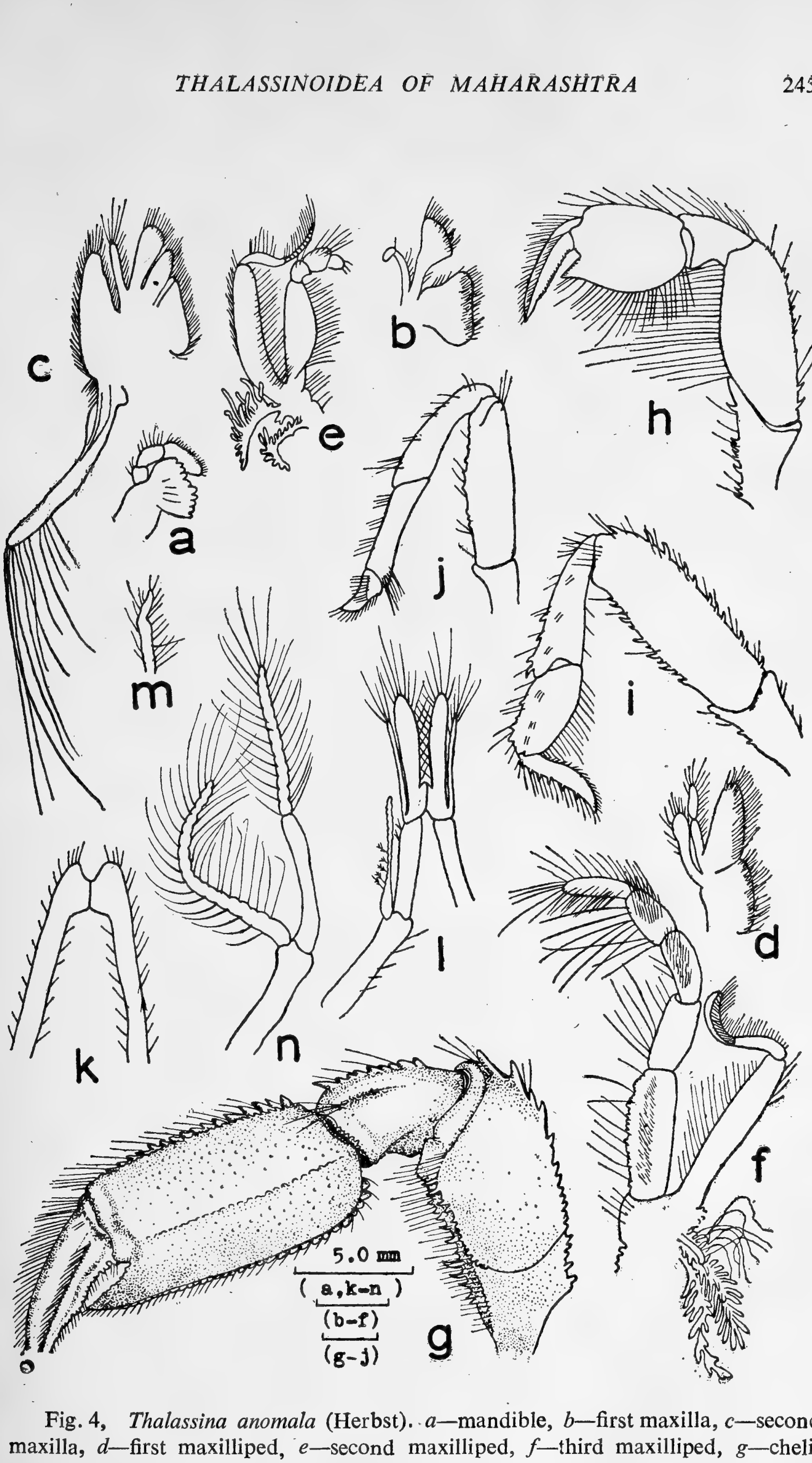


Fig. 4, *Thalassina anomala* (Herbst). *a*—mandible, *b*—first maxilla, *c*—second maxilla, *d*—first maxilliped, *e*—second maxilliped, *f*—third maxilliped, *g*—cheliped, *h*—second leg, *i*—third leg, *j*—fifth leg, *k*—first pleopod of male, *l*—second pleopod of male. *m*—first pleopod of female, *n*—second pleopod of female.

practically fades away near the distal margin. The outer lower margin is armed with 24-34 compressed teeth all along upto the base and not to the tip of the fixed finger. The inner surface is covered with fairly large conical tubercles in its lower proximal portion and with finely granulated tubercles on the rest of the area, as on the outer surface. There are two parallel rows, on the inner surface, of well-developed conical tubercles running near and along the outer lower margin, these two rows finally uniting into one near the distal $\frac{1}{3}$ and continuing almost to the tip of the fixed finger. There is generally, a semicircular row of 4-14 tubercles at the base on the inner side of the fixed finger but in very few specimens this row is absent. The outer surface of the fixed finger is practically smooth in my material. The oblique row of 12-13 tubercles on the outer surface of the fixed finger, as mentioned by de Man (1928b), is not present in my specimens.

The fixed finger is $\frac{1}{4}$ to $\frac{1}{2}$ the length of the dactylus and its cutting edge is armed with 11 low, flat teeth of which the proximal 1-3 are larger in many specimens.

In males, the proportion of length to breadth of palm was 1·37 : 1 and in females it was 1·56 : 1.

Carpus : The upper inner border is armed with 6-12 teeth of which the distal teeth are larger. The outer surface is almost smooth except for granular tubercles in the distal portion along the outer lower margin. There is, sometimes, a row of 2 small and 2-3 slightly larger tubercle-like teeth on the upper half of the outer surface, almost parallel to the upper inner margin. The inner surface, sometimes, has in the middle 4-5 granular tubercles, otherwise it is generally smooth.

Merus : The upper margin has generally 14-18 acute, small teeth of which the distal 3-4 are larger, though in a few specimens, the number of teeth was 24. The outer lower margin is armed with 14-23 spines, 15-18 appears to be the common number ; the distal 3-8 are generally larger. The mid-ventral line is fringed with long setae and armed with 3-9 unequal spines, 3-6 being the common number. The inner lower margin is with 21-24 low, short teeth which decrease in size distally.

Ischium : Its mid-ventral surface is armed with 5-9 unequal spines of which generally the distal 3-5 are thick and strongly developed. These spines are edged on the outer side with long setae as in the merus.

Smaller cheliped : In all the specimens examined, it does not differ much from the major cheliped except for the smaller size and the length of the propodus which is 1·53 times its breadth.

Second leg (Fig. 4, h) : It is subchelate. The propodus is highly flattened with its lower distal portion forming the chelate structure with the dactylus. The basi-ischial joint is armed with 6-11 unequal spines of which the distal 1-2 are the largest. The upper margin of the merus is provided with 5-8, unequal anteriorly bent sharp spines and its lower border is smooth. This segment of the second leg is much broader than the corresponding segment of the remaining legs.

Third leg (Fig. 4, i) : The merus bears on its anterior margin 3-17 unequal spines, 6-11 (6-9 common) on outer posterior margin, of these the distal ones are larger than the rest. The inner posterior margin has 3-4 unequal tooth-like spines, the distal ones being larger. The basi-ischial joint has 3-9 spine-like tubercles, though 2-3 is the common number. The coxopodite is provided with 3-6 spine-like tubercles in the mid anterior margin.

Fourth leg : The anterior margin of the merus is provided with 3-10 small spines ; the inner posterior with 7-12 unequal spines. The outer posterior border bears 4-9 unequal spines. The basi-ischium is armed with 2-7 unequal spines. The coxopodite has 3-9 spine-like tubercles arranged along the mid-anterior portion, the number of tubercles rarely reaching up to 12.

Fifth leg (Fig. 4, j) : The merus has on its anterior margin 2-9 unequal spines or teeth and 2-8 very small teeth on its inner posterior margin. Its outer posterior margin is provided with 2-7 small, unequal teeth. The basi-ischium does not bear any spines or teeth. The coxopodite bears 3-9 unequal spines on its posterior margin.

Abdomen : In length the 4th abdominal tergum is 1·40 times its breadth. The lateral ridge of the second segment has 6-10 granular tubercles which are often indistinct. The lateral ridge of the third segment is less developed and in the subsequent segments this ridge becomes less and less prominent than that of the first segment and is provided with punctae. The pleural margin of the second to sixth abdominal segments is generally distinctly tuberculate, though sometimes with rudimentary tubercles.

The sternum of the second abdominal segment is provided at the middle with a single prominent and rather sharp tubercle which is either anteriorly or ventrally directed and the side tubercles are entirely absent. The median tubercle of the third segment is somewhat blunt and the side tubercles are generally absent but in one specimen (male, 124 mm.) a single distinct tubercle was present on the left anterior margin. In the fourth and fifth segments, the median tubercles though prominent, is posteriorly directed and the side tubercles are absent, but in the specimen mentioned above i.e. male, 124 mm., the fifth sternum has 2 distinct tubercles on either anterior margin. In the sixth segment, the median tubercle is almost invariably absent, though in a male, 141 mm. there is a prominent tubercle just on either side of the middle and also in a female, 120 mm., a single very small tubercle is present on the middle. The side tubercles are usually absent but in a male, 150 mm., there is one tubercle present on either anterior margin and in another male, 138 mm., 2-3 minute indistinct tubercles are present on the right anterior margin only.

Antennal scale : It is generally absent but in a female (120 mm. long), a triangular, well-developed, movable, entire antennal scale was present on the right side only. The scale extended beyond the distal end of the last but one segment of the antennal peduncle. On the left side, however, the scale was found to be completely broken. Also in a male (145 mm. long), a partially broken scale was observed on the left side only, whereas on the right side it was altogether broken.

de Man (1928b, p. 9) remarks regarding a young male (116 mm. long) from the mouth of the river Barito, that the specimen presented, perhaps, on each antennal peduncle, a scaphocerite. But he could not observe it with certainty. Also regarding var. *squamifera* he expresses '. . . . it must be left to the later researchers to examine whether characters of this variety are indeed constant so that the possession of the scaphocerite constantly coincides with the characters of the sternal ridges.' Of course, the knowledge of *squamifera* is based on 4 specimens only—1 male and 3 females. Hence, it is possible that the presence or absence of the antennal scale may not be a reliable character in separating out the var. *squamifera* from the typical species *T. anomala*, as per above observations.

MATERIAL :

About 70 specimens were collected from the following localities : Karla and Mazgaon (Ratnagiri) ; Vengurla (Ratnagiri District) and Versova (Bombay suburban).

The males ranged from 86 to 155 mm. ; non-ovigerous females from 95 to 143 mm. and ovigerous females from 150 to 160 mm.

I have seen colonies of mounds of *T. anomala* in the mangrove swamps off Karla, Mazgaon and Vengurla in Ratnagiri District and in Versova and Port Navha in the Bombay suburban area. The detailed observations on the ecology of this animal is dealt with elsewhere (Sankolli 1963).

Only once, a few (3) berried females were collected in the month of October 1963. Thereafter, I have not been able to collect berried females.

Remarks :

This study reveals that variations are individual rather than due to sex, size, season or locality.

Also, the presence or absence of antennal scale or scaphocerite appears to be a variable character and probably it is not a reliable taxonomic character.

DISTRIBUTION: Mergui Archipelago; North Coast of Nias; Sumatra; Indonesia; Singapore; East China Sea; Philippines; British New Guinea; New Guinea; North West Australia; New Britain; Fiji Islands; Samoa Islands.

(*to be continued*)

Pre-foliation in *Scindapsus officinalis* Schott

BY

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(*With a text-figure*)

Introduction

This brief paper deals with the way the lamina and the petiolar sheath of the araceous ever-green climber, *Scindapsus officinalis*, are rolled in the bud. The relationship of the ptyxis of one leaf to that of its immediate neighbouring leaves has also been studied.

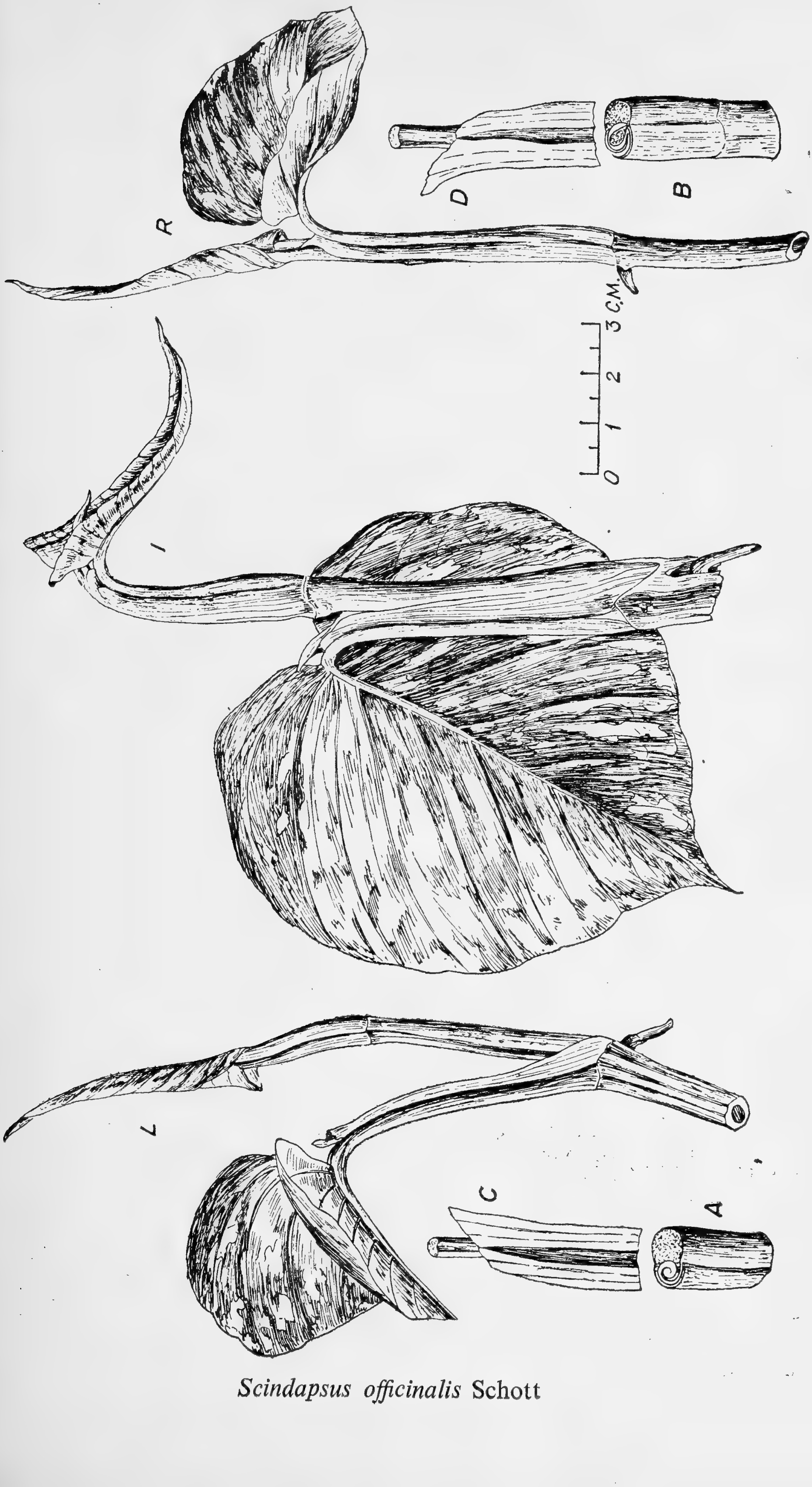
Scindapsus officinalis, a tropical Himalayan weak-stemmed shrub is distributed from Sikkim eastwards along West and East Bengal, Burma and the Andaman Islands.

Hooker (1894) described this species as having a stem as thick as the little finger. The leaves are green. The peduncle is solitary, terminal and much shorter than the petiole. The spathe is about 4-6 inches long, green outside and yellow within. The spadix is as long as the spathe, greenish yellow and it elongates in fruit. The stigma is elongated but the fruit is hemispheric. The few berries that ripen are fleshy. The seed is ovate-cordate.

One of the varieties of *Scindapsus officinalis*, commonly known as Money Plant, is a popular ornamental plant on account of its variegated leaves with entire and/or incised margins. Its capacity to thrive even under partial shade for long periods makes it an deal drawing room plant. The presence of numerous nodal and internodal climbing roots enables the plant to be a successful epiphyte on large trees.

Asymmetry of the leaves

The leaves of *Scindapsus officinalis* are clearly alternate and are more or less distichous on shoots that creep firmly on a wall or similar support. But when the slender branches hang, as many of them do gracefully in large plants, the leaves are spread out in all directions. Where the leaves are arranged in two rows, every third leaf falls on the same row, as may be



Scindapsus officinalis Schott

expected. There is a prominent petiole which is conspicuously sheathed at its lower three-fourths of the length. When young, the sheath encloses the immediate younger leaf, and the free margins of the sheath overlap each other. In some leaves, this overlapping is clockwise (left-handed), and in others,counter-clock wise (right-handed) (Fig. 1B & A respectively). The lamina is obovate to cordate and the area of one half is slightly greater than that of the other. The rolling of the lamina while in bud is either convolute or involute. Convolution may be either left-handed or right-handed. The directions of the overlapping of the sheath and the convolution of the lamina are determined by holding the leaf vertically with its lamina over the petiole. Where it rolls left-handed, the sheath of the same leaf overlaps right-handed, and vice versa, where the lamina has right-handed convolution. But when the lamina is involute, the overlapping of the sheath is rather difficult to predict since in some such leaves, the overlapping is left-handed and in others, right-handed. The tip of the sheath on one margin grows beyond the level of that on the other margin. If the leaf sheath overlaps right-handedly, its right margin happens to be longer compared to that of the other (Fig. 1C). If the sheath is left-handed, its left margin becomes longer (Fig. 1D). Leaves showing left convolution, involution, and right convolution are represented by L, I and R of Fig. 1 respectively.

Observations

50 shoots from three large *Scindapsus officinalis* plants growing on huge mango trees at the premises of the Indian Statistical Institute, Calcutta, were labelled and the type of the ptyxis on the 627 leaves produced on them during 75 days commencing from the first of May 1965 were studied, The data are presented in Table 1, a-c. On an average, a shoot produced about 12·5 leaves during the 75 days of the pre-monsoon period. That is, a leaf was produced almost every six days. During the monsoon months of July-September, the rate of leaf-production is much greater.

Table 1, a-c gives data on the sequence of production of left- and right-convoluting as well as involute leaves in the individual plants. Plant 3 produced equal numbers of left- and right-convoluting leaves, while for plants 1 and 2, the lefts are greater although the differences are not statistically significant. The occurrence of involute leaves seems to vary from plant to plant. Plant 1 has the highest proportion (53·33%) followed by plants 2 and 3 with 23·11 and 18·30 percentages respectively. Since the data were collected simultaneously from three plants standing close to each other, one plant showing a very high proportion of involute leaves has to be regarded as a peculiarity of this individual. As the data relate to a short period, it is not known whether the proportion of leaves showing involute and convolute ptyxis would vary significantly with season.

A perusal of the data suggests that among the convoluting leaves, there is a tendency for a leaf with left-handed convolution to be followed or preceded by one with right-handed convolution. To verify this, the type of each leaf in relation to its immediate older one was determined. The data are presented in Table 2.

TABLE 1*a*

Scindapsus officinalis : PRE-FOLIATION (PLANT 1)

Shoot	Directions of rolling of laminae										L	R	I	Total
1	L R	I I	I I	I I	I I	I I	I I	I I	I I	I I	1	1	18	20
2	R L	L R	L R								3	3	—	6
3	R I	I I	L R	L I	I R	I I	I I	I L			3	3	10	16
4	L I	L I	L L	I I	I I	I I	I I	I R	L		5	1	11	17
5	L R	L R	L R	L R	R I						4	5	1	10
6	R L	R L	I L	I L	I L	R L	R I	I I	I I		6	4	8	18
7	L R	I I	I L	I L	I R	L I	I I	I L			5	2	9	16
8	L R	L R	L I	R I	I I	I I	L R	I R	L		5	5	7	17
										Total	32	24	64	120

TABLE 1*b*

Scindapsus officinalis : PRE-FOLIATION (PLANT 2)

Shoot	Directions of rolling of laminae									L	R	I	Total
1	L R	L L	L L	L R	L R	L R	L			9	4	—	13
2	R L	R L	I L	L R	I I	L I				5	3	4	12
3	L R	L R	L I	I R	L R	L R	R L			6	6	2	14
4	L R	L R	L R	L R	L R	L R				6	6	—	12
5	L R	L I	I L	L R	L R	L R	L R			7	5	2	14
6	R L	R L	R L	R L	I R	I I	I I			4	5	5	14
7	R L	L L	R L	R L	R L	L R				7	5	—	12
8	R I	I L	R I	R L	R I	R I	L I	I I		3	5	8	16
9	L R	L I	L I	L L	I L	R I	I I	I I	I	6	2	9	17
10	R R	L R	L R	L L	L					5	4	—	9
11	L R	L R	L R	R I	I L	I R				4	5	3	12
12	L R	L R	L R	L R	L R	L R				6	6	—	12
13	L R	L R	L							3	2	—	5
14	L I	I R	L R	L I	L I	I I	I R	R R	L R	5	6	7	18
15	L R	L R	I I	L I	I L	R L	R L	I I		6	4	6	16
									Total	82	68	46	196

TABLE 1c

Scindapsus officinalis : PRE-FOLIATION (PLANT 3)

Shoots	Directions of rolling of laminae									L	R	I	Total
1	L R	R L	R L	R L	R L	R L				6	6	—	12
2	R L	R I	I L	R I	I I	I I	I I	I L	R I	3	4	11	18
3	L R	L I	L R	L R	L R	L R	L R	L R		8	7	1	16
4	L L	R I	L R	L R	L R	L R	L R	L		8	6	1	15
5	L R	L R	L R	L						4	3	—	7
6	L R	L R	R L	R R	R L	R L				5	7	—	12
7	R L	R L	R L	R L	R L	R				5	6	—	11
8	L L	R L	R L	R						4	3	—	7
9	L R	L I	L R	L I	I R	L R	L I			6	4	4	14
10	L R	L R	L I	L R	R I	R I	I I	R L		5	6	5	16
11	L L	R L	I L	R R	L I	L I	L R	L R	L	9	5	3	17
12	L R	R R	L R	L L	R L					5	5	—	10
13	L R	L R	L R	L R						4	4	—	8
14	R L	R R	I I	L R	L I					3	4	3	10
15	R L	R L	I L	R L	R L	I R	I R	L R	I	6	6	5	17
16	L R	I I	I I	I I	R I	I I	R L	R		2	4	9	15
17	I L	R I	L R	L I	I R	I L	R L	R		5	5	5	15
18	L R	L R	L R	L						4	3	—	7
19	L R	L R	L R	L						4	3	—	7
20	R L	R L	I L	I R	I L	I I	L R	L		6	4	5	15
21	L R	L R	L I	L R	L L					6	3	1	10
22	R R	L R	L R	L						3	4	—	7
23	R L	R L	R L	R L	R L	R L	I I			6	6	2	14
24	R L	R L	R L	R						3	4	—	7
25	R R	R R	L R	R R	I R	I R	L			2	9	2	13
26	R R	L R	L							2	3	—	5
27	R L	R L	L R							3	3	—	6
									Total	127	127	57	311

L—leaf with left-handed convolution.
R—leaf with right-handed convolution,
I—leaf having involute lamina.

TABLE 2

Scindapsus officinalis : PTYXIS OF LEAVES

First leaf	Second leaf			Total
	Left	Right	Involute	
Left convolution	20	155	44	219
Right convolution	150	21	34	205
Involute	47	16	90	153
Total	217	192	168	577

$X_4^2 = 330{\cdot}80$

The hypothesis that the ptyxis of the first leaf and that of the second leaf are statistically independent is rejected since the x^2 value with 4 degrees of freedom turns out to be 330·80. Therefore, a left-handed lamina is followed or preceded by a right-handed one in a significant number of cases. However, in the case of involution, there is greater chance of a leaf to be an involute if the immediate older one is already involute. Data relating to the involuting leaves were tested to find out whether the involutes that were followed or preceded by a left-handed convolution were greater than those that followed or preceded by a right-handed convolution. It was found that the LI or IL were occurring more frequently than the RI or IR, and statistically significantly. The frequency of an involute leaf following another involute leaf is significantly more than a left- or right-convoluting leaf following an involute leaf.

Since the sheath and the lamina of the same leaf roll oppositely, it was considered necessary to study the condition of the sheaths of leaves having involute laminae. A number of leaves from different shoots of two plants were examined in March 1967. It was seen that if a left-convoluting leaf having a right-handed sheath (which is generally the rule) is followed by an involute leaf, the latter leaf will have left-handed sheath, and vice-versa if it follows a right-convoluting leaf. In a shoot where many consecutive involute leaves are produced, the sheath shows more or less a left followed or preceded by a right-handed overlapping. However, it is not always steady, and some leaves moved erratically.

Discussion

The ptyxis in *Scindapsus officinalis* varies considerably. The tendency that a left-convolution (of lamina) is followed or preceded by a right convolution, or vice versa may be attributed to the distichous nature of the leaves. This situation is similar to that found in many grasses where the leaves are distichous and their laminae show a right followed or preceded by a left convolution. In some other species of Araceae such as *Colocasia antiquorum* or *Alocasia indica*, all the leaves of a shoot show more or less the same kind of convolution as evidenced by the data collected on many plants, a small portion of which is presented in Table 3.

TABLE 3

PTYXIS IN *Alocasia indica*

Shoot	Convolution of lamina of consecutive leaves															Total L	Total R
1	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	15	
2	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	—	15
3	L	L	L	L	L	L	L	L	L	R	L	L	L	R	L	13	2
4	R	L	R	R	R	R	R	R	R	R	R	R	R	R	R	1	14
															Total	29	31

Though a shoot maintains more or less the same type of convolution throughout, the individual shoots in a clump of *Colocasia antiquorum* show either left-handed or right-handed convolution as per data collected on 19 clumps at Calcutta during 1967 and presented in Table 4.

TABLE 4

Colocasia antiquorum : LEFT- AND RIGHT-HANDED SHOOTS PER CLUMP

Clump	Convolution of shoots: Left	Right	(L+R)	(L—R)
1	7	3	10	4
2	3	4	7	–1
3	9	6	15	3
4	5	4	9	1
5	4	5	9	–1
6	5	3	8	2
7	3	6	9	–3
8	4	3	7	1
9	3	4	7	–1
10	3	3	6	—
11	6	2	8	4
12	—	5	5	–5
13	3	4	7	–1
14	1	6	7	–5
15	4	3	7	1
16	3	4	7	–1
17	4	3	7	1
18	5	4	9	1
19	7	1	8	6
Total	79	73	152	6

$$X^2_1 = 0{\cdot}267$$

The left- and right-handed shoots in a clump are distributed more or less in the ratio 1 : 1.

In the case of *Dieffenbachia* sp. (Araceae), the leaves are arranged in two spirals and they run clockwise in one shoot and counter-clockwise in another. In a shoot having a left-handed foliar spiral, the ptyxis of the lamina is always right-handed, and vice versa, in a shoot with right-handed foliar spiral. However, in many species of *Cordyline* and *Dracaena* of Agavaceae, where the shoots show clear spirality like *Dieffenbachia*, in a left-handed shoot, the ptyxis is invariably left-handed, and right-handed if the shoot has right-handed foliar spiral. However, in the case of *Cordyline rubra*, 18·69 per cent of the shoots have their foliar spiral and ptyxis veering along opposite directions (Davis & Ghosh 1969). An examination of the rolling of the leaf sheath and lamina in these 18·69 per cent of *Cordyline rubra* showed that the leaf sheath always rolls in accordance with the foliar spiral, but only the lamina portion gets reversed. This ' abnormality ' in the case of *C. rubra* seems to be the general rule in *Scindapsus officinalis*, because in a leaf with left convolution, the sheath always shows right convolution and vice versa. Where the lamina is involute, it is difficult to predict the direction of the sheath even though there is a tendency for the odd numbers of leaves of a shoot to bear one kind of overlapping of sheath, and the even numbers the opposite kind. In some Scitaminous species of *Musa*, *Canna*, *Maranta* and *Ravenala*, though the leaves are two-ranked, the ptyxis of the lamina is always right-handed (with about 5 per cent reversals in *Ravenala*). In some species of *Heliconia*, *Curcuma* and *Zingiber* of the same family, a left-convoluting leaf is followed or preceded by a right-hander as a general rule.

SUMMARY

The leaves of *Scindapsus officinalis* are alternate and arranged more or less distichously. Both the leaf sheath and the lamina roll in the bud stage. The lamina either convolutes or involutes. Convolution may be either left-handed or right-handed. The margins of the leaf sheath overlap either clockwisely or counter-clockwisely. If the lamina convolutes clockwisely, its sheath will overlap counter-clockwisely, and vice versa, if the lamina convolutes counter-clockwisely. The sheath of an involuting leaf may overlap either clockwisely or counter-clockwisely.

In the three large *Scindapsus officinalis* plants from where data were collected, the leaves showing right-handed and left-handed ptyxis were observed to produce almost equally. One plant produced a higher percentage of involute leaves than in the others. There is a strong tendency that a leaf with left-handed ptyxis is followed or preceded by a

right-hander. Also the probability of a leaf to be involute if it follows an involute leaf is very high.

The drawing is by Mr. S. K. De, Senior Scientific Assistant of the Indian Statistical Institute.

REFERENCES

DAVIS, T. A. & GHOSH, S. S. (1969): Foliar spiral and ptyxis in *Cordyline rubra*. *Proc. Nat. Inst. Sci. B.*, **35**: 267-272.

HOOKER, J. D. (1894): Flora of British India VI. L. Reave and Co., London.

Foraminifera of the Gulf of Cambay

BY

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[*Continued from Vol.* **66** (3) : 596]

(*With 37 figures in three plates*)

Genus *Nodosaria* Lamarck 1812

Nodosaria calomorpha Reuss (Fig. 32)

Nodosaria calomorpha Brady, 1884, vol. 9, p. 497, pl. 61, figs. 23-27 ; Brady, Parker & Jones, 1888, vol. 12, p. 223, pl. 44, figs. 1, 4 ; Cushman, 1913, 71 (3), p. 48, pl. 25, fig. 6.

Description : Test straight with usually three chambers ; first chamber subglobular, later chambers slightly oval in outline. Wall smooth and translucent. Aperture entosolenian and situated at the centre of the tip of the ultimate chamber without a neck.

Length : 0·41 mm.

Locality : Station A.

Distribution : North Pacific, Hawaiian Islands, Ki Islands, Philippine Islands, Arabian Sea and Atlantic.

Nodosaria radicula (Montagu) (Fig. 33)

Nodosaria radicula Williamson, 1858, p. 15, pl. 2, figs. 36-38 ; Sethulekshmi Amma, 1958, p. 53, pl. 2, fig. 79.

Description : Test elongate with two to five chambers ; initial chamber larger than the succeeding ones and with a blunt spine. Wall calcareous and marked with conspicuous longitudinal costae. The last formed chamber drawn into a neck with a round aperture at the end.

Length : 0·40 mm.

Locality : Station A.

Distribution : British Isles and Arabian Sea.

Nodosaria roemeri (Neugeboren) (Fig. 34)

Nodosaria roemeri Brady, 1884, vol. 9, p. 505, pl. 63, fig. 1 ; Cushman, 1913, 71(3), p. 55, pl. 24, figs. 4-6.

Description : Test elongate with a few chambers ; later chambers slightly inflated. Sutures slightly oblique. Wall calcareous and smooth.

Length : 0·37 mm.

Locality : Station A.

Distribution : Hawaiian Islands, Midway Islands and near Guam, and Arabian Sea.

Nodosaria perversa Schwager (Fig. 35)

Nodosaria perversa Brady, 1884, pl. 64, figs. 25-27, p. 512 ; Cushman, 1933, 161(2), p. 13, pl. 3, figs. 13-15 ; Dakin, 1906, vol. 5, p. 235.

Description : Test elongate with the initial chamber provided with a slight blunt spine, ultimate segment drawn into a short and narrow neck, primordial chamber small and later formed chambers increasingly larger. Surface of the test marked with numerous longitudinal parallel costae. Aperture radiate.

Length : 0·38 mm.

Locality : Station A.

Distribution : Indo-Pacific Region, and Ceylon coast.

Nodosaria subperversa Cushman (Fig. 36)

Nodosaria subperversa Cushman, 1917, vol. 51, p. 655 ; Cushman, 1921, 100, vol. 4, p. 208, pl. 37, fig. 3.

Description : Test long with a few chambers, primordial chamber slightly larger than the subsequently formed ones. Sutures distinct. Wall smooth but marked with fine longitudinal striations. The ultimate chamber without a neck. Aperture terminal.

Length : 0·55 mm.

Locality : Station A.

Distribution : Pacific Ocean, east coast of Mindanao and Arabian Sea.

Genus *Lagena* Walker & Jacob 1798

Lagena globosa (Montagu) (Fig. 37)

Entosolenia globosa Williamson, 1858, p. 8, pl. 1, figs. 15, 16 ; *Lagena globosa* Brady, 1884, vol. 9, p. 452, pl. 56, figs. 1-3 ; Dakin, 1906, vol. 5, p. 234 ; Cushman, 1913, 71(3), p. 3, pl. 4, fig. 2 ; 1923, 104(4), p. 20, pl. 4, figs. 1, 2 ; 1933, 161(2) p. 20, pl. 4, figs. 10 a, b ; Sethulekshmi Amma, 1958, p. 54, pl. 2, fig. 80.

Description : Test nearly spherical, apertural end slightly produced. Wall smooth and translucent. Aperture slit-like with an entosolenian neck.

Length : 0·27 mm.

Locality : Station A.

Distribution : North Pacific, off Chatham Islands, Honolulu, Tropical Pacific, Philippines, Ceylon coast, off Gulf of Mannar, Arabian Sea, Atlantic and British Isles.

Lagena marginata (Walker & Boys) (Fig. 38)

Lagena marginata Brady, 1884, vol. 9, p. 476, pl. 59, figs. 21-23 ; H. B. Brady, Parker & Jones, 1888, vol. 12, p. 222, pl. 44, figs. 27, 29, 30, 32 ; Cushman, 1913, 71(3), p. 37, pl. 22, figs. 1-7 ; 1921, 100, vol. 4, p. 182 ; 1933, 161(2), p. 17, pl. 4, figs. 9 a, b, 11, 12, 14-16 ; pl. 5, figs. 2 a, b, 4 a, b, 6 a, b, 8, 9 ; Sethulekshmi Amma, 1958, p. 56, pl. 11, fig. 85.

Description : Test more or less globular, compressed, rounded at both ends. Apertural end slightly narrow. Periphery with a marginal keel. Aperture entosolenian.

Length : 0·18 mm.

Locality : Station B.

Distribution : North and Eastern Pacific, Hawaiian Islands, off Japan, Arabian Sea, Atlantic and British Isles.

Lagena striata (d'Orbigny) (Fig. 39)

Lagena striata Brady, 1884, vol. 9, p. 460, pl. 57, figs. 22, 24 ; Cushman, 1913, 71(3), p. 19, pl. 7, figs. 4, 5 ; 1921, 100, vol. 4, p. 177 ; 1933, 161 (2), p. 32, pl. 8, figs. 11, 13 ; Sethulekshmi Amma, 1958, p. 56, pl. 2, fig. 86.

Description : Test oval with an elongated neck at the apertural end. Wall marked with numerous fine longitudinal costae starting from the aboral end of the test to the base of the neck. Wall calcareous and translucent.

Length : 0·23 mm.

Locality : Station B.

Distribution : North Pacific, off Philippines, Red Sea, Arabian Sea, Atlantic, and British Isles.

Lagena quadrata (Williamson) (Fig. 40)

Lagena quadrata Williamson, p. 11, pl. 1, figs. 27, 28 ; Brady, 1884, vol. 9, p. 475, pl. 59, figs. 3, 16 ; Bagg, 1908, vol. 34, p. 142 ; Cushman, 1913, 71(3), p. 35, pl. 14, fig. 9 ; Sethulekshmi Amma, 1958, p. 58, pl. 2, fig. 89.

Description : Test ovate, periphery with a marginal keel. Wall smooth and translucent. Aperture entosolenian ; apertural orifice slit-like.

Length : 0·12 mm.

Locality : Station B.

Distribution : North Pacific, off Hawaiian Islands and between Guam and Yokohama, Arabian Sea, Atlantic and British Isles.

Lagena orbignyana (Seguenza) (Fig. 41)

Lagena orbignyana Brady, 1884, vol. 9, p. 484, pl. 59, figs. 1, 18, 24, 26 ; Brady. Parker and Jones, 1888, vol. 12, p. 222, pl. 44, fig. 20 ; Dakin, 1906, vol. 5, p. 234 ; Cushman, 1913, 71(3), p. 42, pl. 19, fig. 1.

Description : Test oval in outline with a prominent marginal keel having within a secondary keel. Surface of the test smooth with large pits. Aperture slit-like with an entosolenian neck.

Length : 0·14 mm.

Locality : Station A.

Distribution : Tropical Pacific, off Levuka, Fiji, off Ceylon coast, Arabian Sea and British Isles.

Family NONIONIDAE

Genus *Nonion* Montfort 1808

Nonion boueanum (d'Orbigny) Hada (Fig. 42)

Nonionina boueana Brady, 1884, vol. 9, p. 729, pl. 109, figs. 12, 13 ; Dakin, 1906, vol. 5, p. 240 ; *Nonion boueanum* Daniel, 1949, p. 71, fig. 114 ; Cushman, 1933, 161(2), p. 42, pl. 10, fig. 3 ; Sethulekshmi Amma, 1958, p. 21, pl. 1, fig. 32.

Description : Test circular in outline, chambers numerous, involute, nine to fifteen chambers in final whorl. Sutures depressed and curved towards the umbilicus ; umbilicus slightly depressed and filled with granular material. Wall calcareous, smooth and finely punctate. Aperture a curved slit lying at the base of last chamber.

Diameter : 0·30 mm.

Locality : Station A.

Distribution : Pacific, China Sea off Hong Kong and Tawi Tawi, off Japan, Red Sea, Mauritius, Kerimba Archipelago, Gulf of Mannar off Ceylon coast, and Indian seas.

Nonion pompilioides (Fichtel & Moll) (Fig. 43)

Nonionina pompilioides Brady, 1884, vol. 9, p. 727, pl. 109, figs. 10, 11 ; Millet, 1904, p. 601 ; Bagg, 1908, vol. 34, p. 164 ; Cushman, 1914, 71(4), p. 25, pl. 17, fig. 2. *Nonion pompilioides* Cushman, 1933, 161(2), p. 41, pl. 10, figs. 1, 2 ; Ganapati & Satyavati, 1958, p. 108, pl. 3, figs. 83, 84.

Description : Test circular with several chambers, the final whorl of ten chambers. Peripheral margin rounded. Sutures limbate and distinct. Wall with coarse perforations. Aperture a curved slit lying at the base of the last chamber.

Diameter : 0.37 mm.

Locality : Station C.

Distribution : North Pacific, Bering Sea, off Japan, Hawaiian Islands, between Hawaiian and Midway Islands, between Guam and Japan, and Indian seas.

Nonion pacificum (Cushman) (Fig. 44)

Nonion pacificum Cushman, 1933, 161(2), p. 44, pl. 10, figs. 9 a, b.

Description : Test circular, compressed with a few chambers, eight chambers in the final whorl ; chambers involute. Peripheral margin rounded. Wall calcareous, smooth and finely foraminated. Aperture a long slit at the base of last chamber.

Diameter : 0·14 mm.

Locality : Station D.

Distribution : Pacific Ocean and Arabian Sea.

Nonion depressula (Walker and Jacob) (Fig. 45)

Nonionina depressula Brady, 1884, vol. 9, p. 725, pl. 109, figs. 6, 7 ; Brady, Parker & Jones, 1888, vol. 12, p. 229, pl. 43, fig. 25 ; Bagg, 1908, vol. 34, p. 164 ; Cushman, 1914, 71(4), p. 23, pl. 17, fig. 3.

Description : Test circular with ten to twelve chambers in the final whorl, chambers slightly inflated, sutures depressed. Peripheral margin lobulated. Umbilical region slightly depressed and filled with a clear granular shell material which extends outward along the sutures. Aperture a narrow curved slit lying at the base of last chamber.

Diameter : 0·12 mm.

Locality : Station D.

Distribution : North Pacific, off Hawaiian Islands, off Japan and between Japan and Guam, and Arabian Sea.

Genus *Elphidium* Montfort 1808

Elphidium crispum (Linnaeus) (Fig. 46)

Polystomella crispa Brady, 1884, vol. 9, p. 736, pl. 110, figs. 6, 7 ; Cushman, 1914, 71(4), p. 32, pl. 18, fig. 1. *Elphidium crispum* Cushman, 1933, 161(2), p. 47, pl. 11, fig. 4 a, b.; *Elphidium macellus* Gnanamuthu, 1943, No. 2, pt. 5, p. 16, *Elphidium crispum* Daniel, 1949, p. 74, figs. 115-116 ; Sethulekshmi Amma. 1958, p. 22, pl. 1, fig. 33.

Description : Test biconvex, circular in shape with numerous chambers. Sutures slightly raised and distinct with retral processes which extend between the sutures. Peripheral margin acute, umbonal region raised. Aperture consists of numerous pores on the apertural face of last chamber.

Diameter : 0·29 mm.

Locality : Station A.

Distribution : Pacific, Atlantic, British Isles, Mediterranean, Gulf of Mannar, and Indian seas.

Elphidium jenseni (Cushman) (Fig.47)

Elphidium jenseni Cushman, 1933, 161(2), p. 48, pl. 11, figs. 6, 7.

Description : Test flat, many chambered. Peripheral margin with a slight keel. Sutures slightly raised with retral processes which bridge the gap between sutures, the areas between the sutures somewhat depressed, umbilical region with slight projections.

Diameter : 0·38 mm.

Locality : Station A.

Distribution : In Pacific Ocean from Fiji Islands, Marshall Islands and Landrone Islands, off Australia, and Arabian Sea.

Family CAMERINIDAE

Subfamily Camerininae

Genus *Operculina* d'Orbigny 1826

Operculina granulosa (Leymerie) (Fig. 48)

Operculina granulosa Brady, 1884, vol. 9, p. 744, pl. 112, figs. 6, 7, 9, 10 ; Cushman, 1933, 161(2), p. 56, pls. 14, 15, 16, figs. 1-3; Sethulekshmi Amma, 1958, p. 19, pl. 1, fig. 29, a, b, c ; Ganapati & Satyavati, 1958, p. 108, pl. 4, fig. 92.

Description : Test compressed, bilaterally symmetrical, the final whorl composed of numerous chambers. Sutures evenly curved. Wall ornamented with beads or bosses along the suture lines and usually concentrated at the centre space and scattered in the interspaces. Aperture at the base of last chamber.

Diameter : 0·40 mm.

Locality : Station C.

Distribution : Pacific Ocean, Honolulu, Red Sea, Ceylon, and Indian seas.

Operculina gaimairdi d'Orbigny (Fig. 49)

Operculina gaimairdi Cushman, 1921, vol. 4, No. 100, p. 375.

Description : Test strongly compressed with an adult coil of about fifteen chambers with a large central area. Sutures marked with beads with interspaces smooth.

Diameter : 0·32 mm.

Locality : Station A.

Distribution : Philippines, in the vicinity of Jolo, Sulu Archipelago, Siasi, Tawi Tawi group ; between Burias and Luzon, in the Gulf of Davao and Arabian Sea.

Family PENEROPLIDAE

Subfamily Orbitolitinae

Genus *Sorites* Ehrenberg 1838

Sorites marginalis (Lamarck) (Fig. 50)

Orbitolites marginalis Carpenter, 1883, vol. 7*, p. 20, pl. 3, figs. 1-7, pl. 4, figs. 1-5 ; Cushman, 1917, 71(6), p. 92, pl. 38, figs. 1-2. *Sorites marginalis* Cushman, 1930, 104(7), p. 40, pl. 18, figs. 1-4 ; Sethulekshmi Amma, 1958, p. 28, pl. 1, fig. 41.

Description : Test circular in shape with numerous chambers in a single plane, the primordial chamber opens into the second chamber, followed by numerous chambers arranged spirally in one plane. Each chamber divided into numerous small chamberlets having connections with the adjacent ones of previous and following annular chambers. Wall smooth. Apertures numerous along the periphery of the test.

Diameter : 0·31 mm.

Locality : Station C.

Distribution : North Pacific, Hawaiian Islands, Red, and Arabian Seas, coast of Madagascar and Mediterranean Sea.

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* Rep. Voy. Challenger, Zoology.

Family BULIMINIDAE

Subfamily Bulimininae

Genus *Bulimina* d'Orbigny 1826

Bulimina marginata d'Orbigny (Fig. 51)

Bulimina marginata Brady, 1884, vol. 9, p. 405, pl. 51, figs. 3-5 ; Cushman, 1911, 71(2), p. 83, text-fig. 136 a, b ; 1922, 104(3), p. 91, pl. 21, figs. 4-5 ; Sethulekshmi Amma, 1958, p. 44, pl. 2, fig. 66 a, b.

Description : Test oval in outline, many-chambered, tapering, later chambers more inflated than the earlier ones ; lower margin of each chamber provided with spines or crenulations. Wall calcareous, smooth, and opaque. Aperture slit-like situated at the inner face of last chamber.

Length : 0·16 mm.

Locality : Station D.

Distribution : Atlantic, Gulf of Mexico, Gulf of Southern Ocean, Mediterranean, Adriatic, British Isles, Arabian Sea and North Pacific.

Subfamily Virgulininae

Genus *Virgulina* d'Orbigny 1826

Virgulina squamosa d'Orbigny (Fig. 52)

Virgulina squamosa Brady, 1884, vol. 9, p. 415 ; Cushman, 1911, 71(2), p. 91, text-fig. 145 ; Sethulekshmi Amma, 1958, p. 45, pl. 2, fig. 67.

Description : Test elongate, thin and tapering towards the initial end with few obliquely arranged chambers. Peripheral margin somewhat lobulated. Sutures slightly depressed. Wall calcareous, smooth, punctate and translucent. Aperture loop-shaped.

Length : 0·22 mm.

Locality : Station B.

Distribution : Atlantic, Mediterranean, Red Sea, Antarctic, Arabian Sea and North Pacific.

Genus *Bolivina* d'Orbigny 1839

Bolivina punctata d'Orbigny (Fig. 53)

Bolivina punctata Brady, 1884, vol. 9, p. 417, pl. 52, figs. 18, 19 ; Cushman, 1911, 71(2), p. 32, text-fig. 53 ; 1921, vol. 4, No. 100, p. 136, pl. 26, fig. 5.

Description : Test very long, compressed, tapering and many chambered with a blunt apical end. Sutures somewhat depressed. Wall smooth and finely punctate. Aperture an elongate slit situated at the inner margin of last formed chamber.

Length : 0·44 mm.

Locality : Station D.

Distribution : North and Eastern Pacific, Hawaiian Islands, off Japan, Gulf of Mannar off Ceylon coast, and Indian seas.

Bolivina nobilis Hantken (Fig. 54)

Bolivina nobilis Brady, 1884, vol. 9, p. 424, pl. 53, figs. 14, 15 ; Chapman, 1895, p. 24 ; Cushman, 1911, 71(2), p. 39, text-fig. 64 ; Sethulekshmi Amma, 1958, p. 45, pl. 2, fig. 68.

Description : Test elongate, compressed and tapering with a blunt apical end, chambers numerous, slightly inflated. Test wall about half portion from the apical end covered with many fine longitudinal costae, the other half smooth and finely punctate. Sutures depressed. Aperture oval in outline placed at the apertural face of last chamber.

Length : 0·28 mm.

Locality : Station D.

Distribution : North and South Pacific, Hawaiian Islands, Philippines, Arabian Sea, Mediterranean and British Isles.

Bolivina aenariensis (Costa) (Fig. 55)

Bolivina aenariensis Brady, 1884, vol. 9, p. 423, pl. 53, figs. 10, 11 ; Cushman, 1911, 71(2), p. 44, text-fig. 71.

Description : Test compressed and tapering with many chambers, the apical end with or without a spine and when there is no spine it is usually blunt. Sutures depressed. Wall covered with two or more longitudinal thickenings or costae. Aperture long slit-like with a lip placed on the apertural face.

Length : 0·25 mm.

Locality : Station C and D.

Distribution : North Atlantic, West and North-west of Ireland, North Pacific, off Philippines, off Japan, coast of California, Hawaiian Islands and Arabian Sea.

Bolivina vadescens Cushman (Fig. 56)

Bolivina vadescens Cushman, 1942, 161(3), p. 15, pl. 5, fig. 4 ; Ganapati & Satyavati, 1958, p. 109, pl. 4, fig. 99.

Description : Test long and many chambered, later formed chambers somewhat inflated. Peripheral margin rounded. Sutures sigmoid and distinct. Wall smooth and finely foraminated. Aperture loop-shaped, situated at the base of ultimate chamber.

Length : 0·22 mm.

Locality : Station C.

Distribution : Tropical Pacific Ocean, Fiji, Levuka, Viva Anchorage, Makemo Lagoon, Paumotu Islands, Rotonga, Guam Anchorage, Landrone Islands and Indian seas.

Bolivina rhomboidalis (Millett) (Fig. 57)

Bolivina rhomboidalis Cushman, 1922, 104(2), p. 44 ; 1942, 161(3), p. 19, pl. 6, figs. 7, 8.

Description : Test triangular and longer than broad ; seven chambers on one side and six on the other side excluding the primary chamber, later chambers increasing in size as added. Periphery obliquely truncate. Sutures oblique and distinct. Wall smooth. Aperture long, situated at the inner wall of last chamber.

Length : 0·41 mm.

Locality : Station C.

Distribution : Pacific Ocean, Hawaiian Islands, Malay Archipelago and Arabian Sea.

Bolivina nitida Brady (Fig. 58)

Bolivina nitida Brady, 1884, vol. 9, p. 420, pl. 52, fig. 30 a, b ; Cushman, 1942, 161(3), p. 25, pl. 7, fig. 5.

Description : Test long, compressed, tapering towards commencement with a few broad and flattened chambers. Peripheral margin rounded and subcarinate. Sutures limbate, distinct and obliquely set ; a narrow band of clear shell material at the sutures and around the periphery. Aperture long, narrow slit placed obliquely extending almost the whole length of the inner margin of last chamber.

Length : 0·25 mm.

Locality : Station D.

Distribution : Tropical Pacific, Eastern Mancoeur Island, Bass Strait, off Raine Island, Torres Strait, East of Wollongong off Australia and Arabian Sea.

Genus *Loxostoma* Ehrenberg 1854

Loxostoma limbatum (Brady) (Fig. 59)

Bolivina limbata Brady, 1884, vol. 9, p. 419, pl. 52, figs. 26-28 ; Cushman, 1911 71(2), p. 47, fig. 78 a, b, c. (in text). *Loxostoma limbatum* Cushman, 1942, 161(3), p. 35, pl. 10, fig. 1. *Loxostomum limbatum* Ganapati & Satyavati, 1958, p. 109, pl. 4, fig. 102.

Description : Test somewhat twisted, longer than broad and compressed with biserially set chambers, later formed chambers inflated and broader than long. Sutures distinct and limbate. Wall smooth and coarsely perforated. Aperture an elongate slit at the terminal end of last chamber.

Length : 0·25 mm.

Locality : Station C.

Distribution : Indo-Pacific, West Indies and Indian seas.

Subfamily Uvigerininae

Genus *Uvigerina* d'Orbigny 1826

Uvigerina tenuistriata Reuss (Fig. 60)

Uvigerina tenuistriata Brady, 1884, vol. 9, p. 574, pl. 74, figs. 4-7 ; Chapman, 1895, p. 35 ; Cushman, 1913, 71(3), p. 95, pl. 42, fig. 4.

Description : Test cylindrical in shape, longer than broad, with a narrow apical end. Wall ornamented with numerous distinct longitudinal costae, the last formed chamber often without costae. Aperture with a phialine lip at the terminal end of a short neck.

Length : 0·34 mm.

Locality : Station C.

Distribution : North Pacific, off Philippines and Arabian Sea.

Family ROTALIIDAE

Subfamily Spirillininae

Genus *Spirillina* Ehrenberg 1841

Spirillina vivipara Ehrenberg (Fig. 61)

Spirillina perforata Williamson, 1858, p. 92, pl. 7, fig. 202. *Spirillina vivipara* Brady, 1884, vol. 9, p. 630, pl. 85, figs. 1-5 ; Dakin, 1906, vol. 5, p. 237 ; Cushman, 1915, 71(5), p 3, pl. 1, figs. 1, 2 ; Sethulekshmi Amma, 1958, p. 63 pl. 3, fig. 96.

Description : Test planispiral, flat, the first formed coils narrow compared to the later formed ones. Sutures depressed and distinct. Peripheral margin round. Wall with large perforations. Aperture circular at the end of the tube.

Diameter : 0·13 mm.

Locality : Station B.

Distribution : Arctic, North and South Atlantic, North and South Pacific, Indian and Southern oceans, Mediterranean and Red seas, Ceylon and Arabian Sea.

Spirillina limbata Brady (Fig. 62)

Spirillina limbata Brady, 1884, vol. 9, p. 632, pl. 85, figs. 18-21 ; Dakin, 1906, vol. 5, p. 237 ; Cushman, 1915, 71(5), p. 5, pl. 2, figs. 1, 2 ; 1931, 104(8), p. 8, pl. 2, fig. 2 a, b ; Sethulekshmi Amma, 1958, p. 63, pl. 3, fig. 97.

Description : Test planispiral with both faces somewhat flattened or slightly concave. Peripheral margin square. Sutures slightly raised because of the presence of a ridge of shell substance. Test wall finely foraminated. Aperture more or less compressed lying at the end of the tube.

Diameter : 0·27 mm.

Locality : Station A.

Distribution : North and South Pacific, North and South Atlantic, Mediterranean, Ceylon coast and Arabian Sea.

Subfamily Discorbinae

Genus *Discorbis* Lamarck 1804

Discorbis globularis (d'Orbigny) (Fig. 63)

Discorbina globularis Brady, 1884, vol. 9, p. 643, pl. 86, figs. 8, 13. Cushman, 1915, 71(5), p. 11, pl. 9, fig. 4; 1931, 104(8), p. 22, pl. 4, fig. 9 a-c; Sethulekshmi Amma, 1958, p. 66, pl. 3, fig. 101 a, b.

Description : Test planoconvex, chambers numerous. All the chambers visible on the dorsal side but only those of the last whorl of about five chambers on the ventral side. Sutures depressed and distinct. Peripheral edge round and carinate. Test wall with coarse perforations. Aperture an elongate slit on the ventral side of inner edge of ultimate chamber.

Diameter : 0·19 mm.

Locality : Station C.

Distribution : Indo-Pacific region, North Pacific, Atlantic, British Isles, Western Europe, Eastern channel of Korean Strait.

Discorbis rosacea (d'Orbigny) (Fig. 64)

Discorbina rosacea Brady, 1884, vol. 9, p. 644, pl. 87, figs. 1, 4 ; Dakin, 1906, vol. 5, p. 238 ; Cushman, 1915, 71(5), p. 13, fig. 13 ; Gnanamuthu, 1943, p. 20, pl. 4, fig. 16 ; Sethulekshmi Amma, 1958, p. 65, pl. 3, fig. 100 a, b.

Description : Test many chambered, dorsal side conically convex, ventral side flat or slightly concave. Sutures depressed and distinct. Test wall finely foraminated. Umbilical region on the ventral side filled by a thickening of shell substance. Aperture a large elongate opening situated at the inner margin of last chamber.

Diameter : 0·23 mm.

Locality : Stations A & C.

Distribution : North Pacific, Atlantic, Faroe Islands, shores of Shetland, Ceylon coast and Indian seas.

Discorbis vilardeboana (d'Orbigny) (Fig. 65)

Discorbina vilardeboana Brady, 1884, vol. 9, p. 645, pl. 86, figs. 9, 12 ; pl. 88, fig. 2 ; Dakin, 1906, vol. 5, p. 238 ; Bagg, 1908, vol. 34, p. 157 ; Cushman, 1915, 71(5), p. 14, pl. 9, fig. 2 ; Sethulekshmi Amma, 1958, p. 67, pl. 3, fig. 103 a, b.

Description : Test planoconvex with numerous chambers, the outer whorl with five to seven chambers. Peripheral edge rounded. Sutures somewhat depressed and distinct. Wall finely foraminated. Aperture an arched slit situated on the ventral side of test lying close to the umbilical region.

Diameter : 0·27 mm.

Locality : Station A.

Distribution : North Pacific, Hawaiian Islands, Laysan Island, Japan, Atlantic, Ceylon coast and Arabian Sea.

Discorbis bertheloti (d'Orbigny) (Fig. 66 a, b)

Discorbina bertheloti Brady, 1884, vol. 9, p. 650, pl. 89, figs. 10-12 ; Brady, Parker & Jones, 1888, vol. 12, p. 227, pl. 46, figs. 7, 8 ; Dakin, 1906, vol. 5, p. 238 ; Cushman, 1915, 71(5), p. 20, pl. 7, fig. 3.

Description : Test planoconvex, compressed, periphery acute and slightly carinated. Dorsal side of test somewhat flat, ventral side convex. Outer whorl of five to seven chambers. Sutures depressed. Wall punctate. Aperture a narrow slit situated ventrally at the inner edge of ultimate chamber.

Diameter : 0·22 mm.

Locality : Station A.

Distribution : North Pacific, Chatham and Laysan islands, off Guam, Japan, Philippines, Ceylon coast and Indian seas.

Discorbis nitida (Williamson) (Fig. 67)

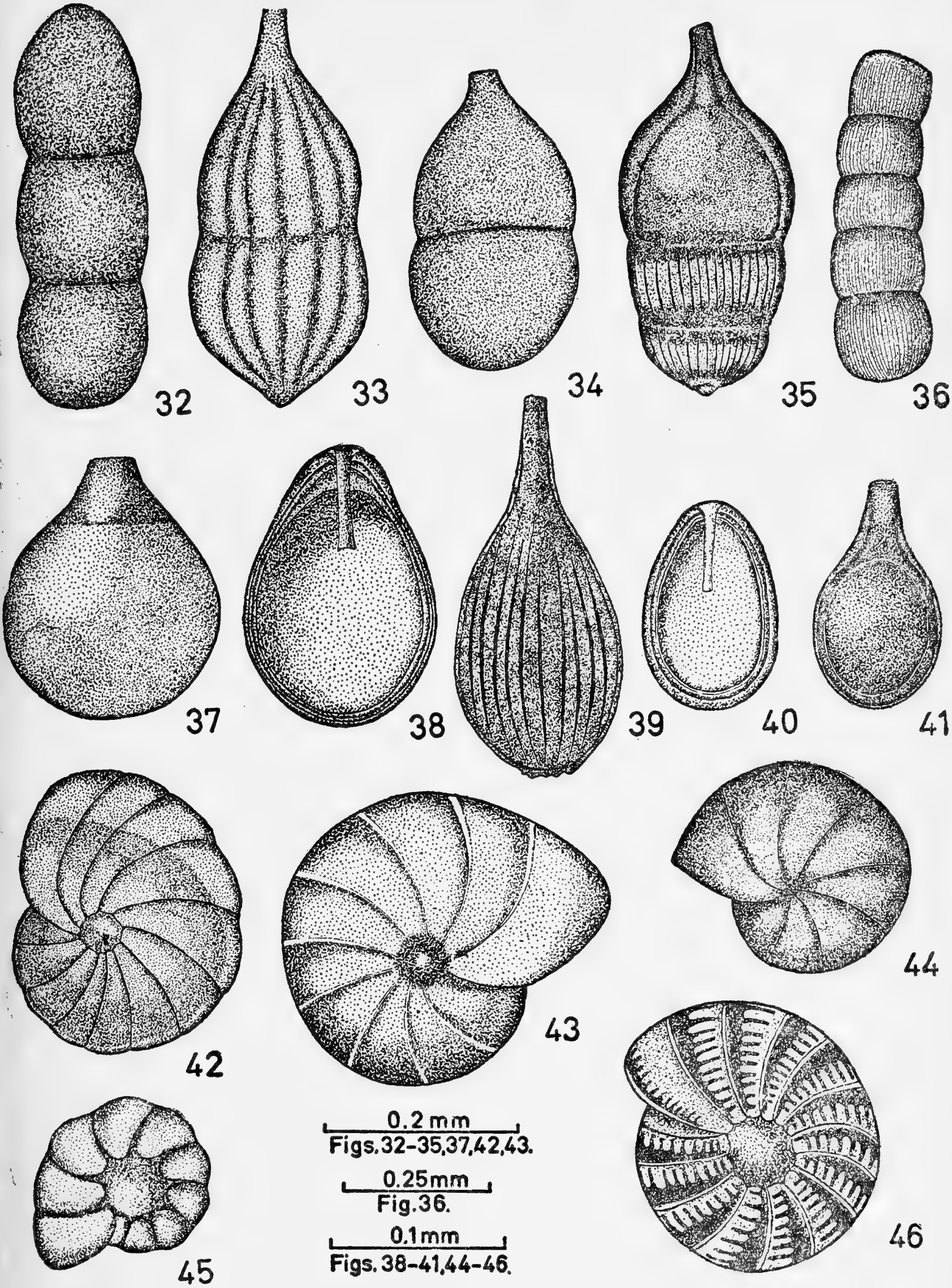
Rotalina nitida Williamson, 1858, p. 54, pl. 4, fig. 106-108. *Discorbis nitida* Cushman, 1931, 104(8), p. 26, pl. 6, fig. 1 a-c ; Sethulekshmi Amma, 1958, p. 70, pl. 3, fig. 109.

Description : Test trochoid, many chambered with a little more than two coils, final whorl composed of about six chambers. Peripheral margin with a distinct keel. Sutures slightly depressed below and flush with the surface above. Wall smooth, finely foraminated and transparent. Aperture on the ventral side at the base of the final chamber.

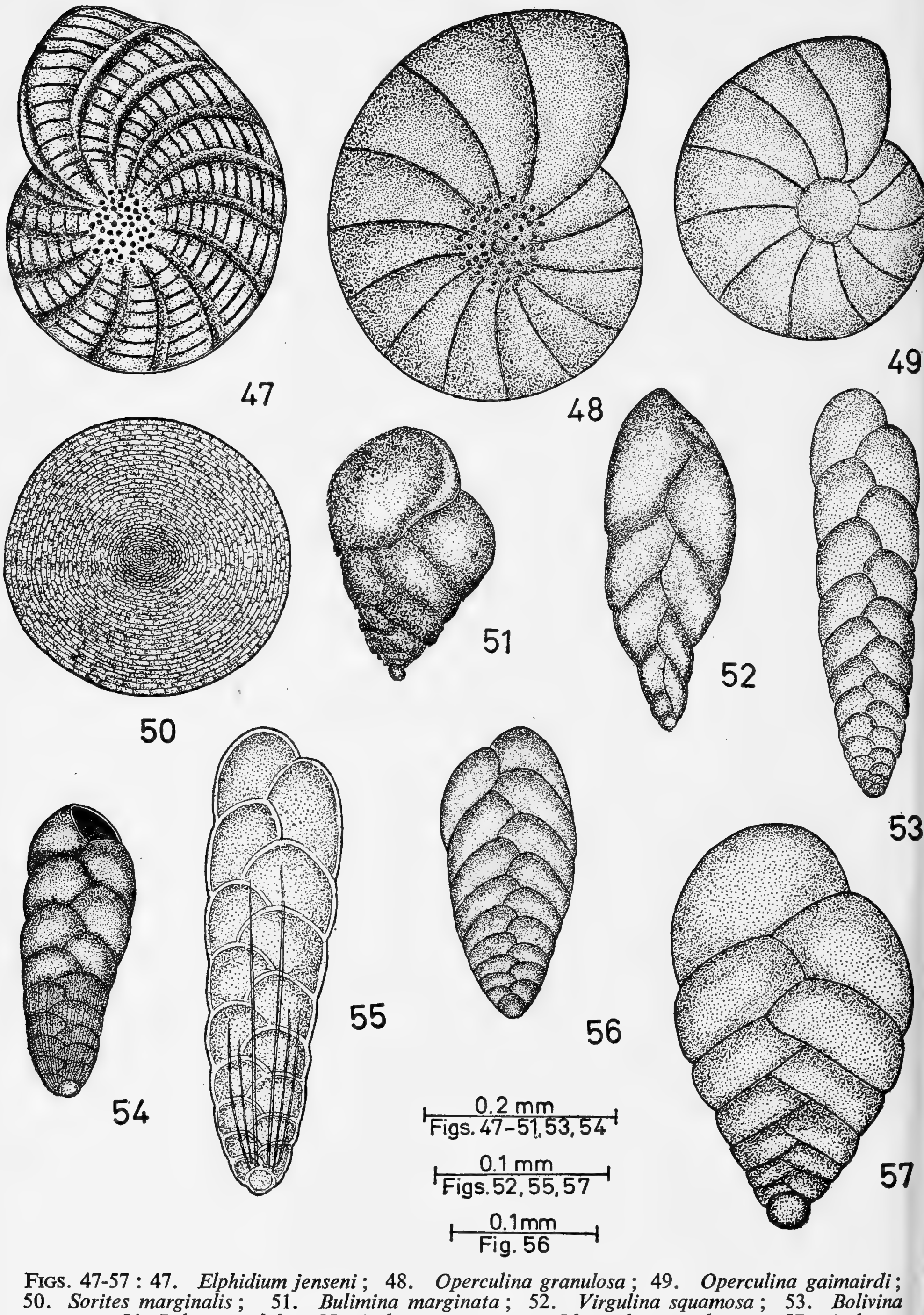
Diameter : 0·14 mm.

Locality : Station D.

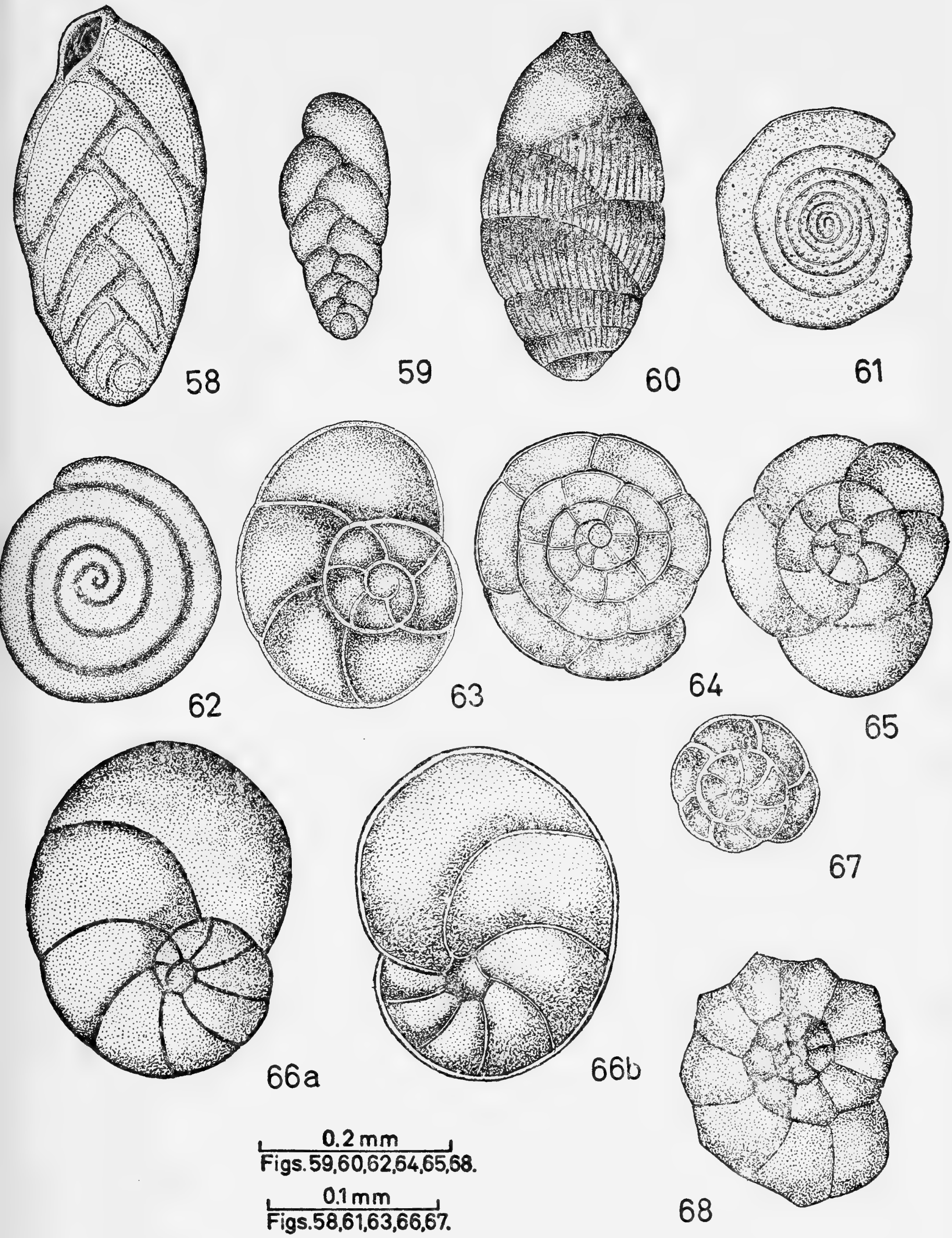
Distribution : Atlantic, European coast, British Isles and Arabian Sea.



FIGS. 32-46 : 32. *Nodosaria calomorpha* ; 33. *Nodosaria radicula* ; 34. *Nodosaria roemeri* ; 35. *Nodosaria perversa* ; 36. *Nodosaria subperversa* ; 37. *Lagena globosa* ; 38. *Lagena marginata* ; 39. *Lagena striata* ; 40. *Lagena quadrata* ; 41. *Lagena orbignyana* ; 42. *Nonion boueanum* ; 43. *Nonion pompilioides* ; 44. *Nonion pacificum* ; 45. *Nonion depressula* ; 46. *Elphidium crispum*.



FIGS. 47-57 : 47. *Elphidium jenseni*; 48. *Operculina granulosa*; 49. *Operculina gaimairdi*; 50. *Sorites marginalis*; 51. *Bulimina marginata*; 52. *Virgulina squamosa*; 53. *Bolivina punctata*; 54. *Bolivina nobilis*; 55. *Bolivina aenariensis*; 56. *Bolivina vadescens*; 57. *Bolivina rhomboidalis*.



FIGS. 58-68 : 58. *Bolivina nitida* ; 59. *Loxostoma limbatum* ; 60. *Uvigerina tenuistriata* ; 61. *Spirillina vivipara* ; 62. *Spirillina limbata* ; 63. *Discorbis globularis* ; 64. *Discorbis rosacea* ; 65. *Discorbis vilardeboana* ; 66. *Discorbis bertheloti*—a, dorsal view ; b, ventral view ; 67. *Discorbis nitida* ; 68. *Rotalia calcar*.

Subfamily Rotaliinae

Genus *Rotalia* Lamarck 1804

Rotalia calcar (d'Orbigny) (Fig. 68)

Rotalia calcar Brady, 1884, vol. 9, p. 709, pl. 108, fig. 3, fig. 4?; Dakin, 1906, vol. 5, p. 239; Cushman, 1915, 71(5), p. 69, pl. 28, fig. 2, pl. 29, fig. 2. Sethulekshmi Amma, 1958, p. 73, pl. 3, fig. 113 a, b; Ganapati & Satyavati, 1958, p. 110, pl. 5, figs. 118, 119.

Description : Test many chambered with both faces of the test convex, all chambers visible on the dorsal side and on ventral side only those of the last whorl. The outer whorl consists of ten chambers. Sutures limbate. Peripheral margin of each chamber drawn into a pointed end. Test wall finely foraminated. Aperture a narrow slit between periphery and umbilicus on ventral side.

Diameter : 0·28 mm.

Locality : Stations A & C.

Distribution : North Pacific, Hong Kong Harbour, Cebu, Philippines, Ceylon coast and Indian seas.

(*to be continued*)

Eco-toxicology and Control of Indian Desert Gerbil, *Meriones hurrianae* (Jerdon)

VI—One-Shot Baiting Technique

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INTRODUCTION

The idea behind the one-shot baiting technique is to impregnate a single unit of bait material with the lethal dose of a poison and then to mix it with unpoisoned ones in a particular proportion. This mixture is then used for control operations. The unpoisoned materials provide a built-in prebaiting system and, thus, by providing poisoned and unpoisoned baits together, the cost and time of prebaiting is saved simultaneously. Gooding (1961) tried one-shot baiting method for the control of wild rabbits in Western Australia by incorporating the lethal dose of Sodium mono-fluoroacetate (1080) in a single oat grain by the vacuum impregnation process and then using these in the field for killing rabbits after mixing with unpoisoned ones in the ratio of 1 lethal oat : 99 unpoisoned oats. In the present study, instead of using any foodgrains as the medium for poisoning the desert gerbil, air-dried fruits of *Zizyphus nummularia* (*ber*) were used as the baiting material. This material was chosen on the basis of our earlier studies on the intake of seeds of various plant species by desert gerbils (Prakash, Purohit & Kametkar 1967).

METHODS

For finding out the acceptability of air-dried fruits of *Zizyphus nummularia* (*ber*) to desert gerbils in the field where other foods are also available to them, 5 *ber* were placed near each of ten active burrow openings of these animals. Their consumption was watched from a distance with the help of binoculars. The burrow openings were checked at hourly intervals and the unconsumed fruits were counted.

The air dried *ber* were soaked in solutions having different concentrations of 1080 poison to make each *ber* lethal with 1 mg. to 3 mg./kg.

dosages. One *ber* each having a different concentration of the poison was given to sets of ten gerbils for each concentration and their mortality was observed.

Before mixing the poisoned fruits with unpoisoned ones, it was checked if the desert gerbils can distinguish between the two. One *ber* of each type was given together to each of 10 desert gerbils in captivity and their preference was noted.

For determining the proportion in which the unpoisoned *ber* should be mixed with poisoned ones, they were mixed in the ratio of 1 : 4, 1 : 9 and 1 : 14 and were tried in the laboratory as well as in the field. In the field each proportion was tried in replications of four in units of ten active burrows. Population estimation of desert gerbils both before and after the one-shot baiting operation was made by the burrow closing-opening technique (Prakash 1963).

Results

Acceptability of ber *fruits in the field :* It was observed with the help of binoculars that the gerbils started feeding on the pulp of the berry as soon as they came out of the burrows. They did not eat the seeds at the beginning but later on a majority of them were eaten. Out of 50 *ber* placed near ten burrow openings, 72 per cent were consumed within an hour and all were consumed within a four hour duration. These observations indicated that the air-dried *ber* are quite acceptable to the desert gerbils.

Distinguishing capability of desert gerbils : One each of air-dried, unpoisoned *ber* and poison-soaked *ber* were given to 10 desert gerbils in individual cages to see if they can differentiate between the two. It was found that the consumption of poisoned ones was more than the others, probably, due to availability of moisture in them. Since the desert gerbils were not able to differentiate between the two, it was safe to mix unpoisoned ones (prebaiting) and poisoned ones (poison baiting).

Incorporation of lethal dose in a single ber *:* 100 [1] air-dried *ber* absorb 25 cc. of water in 24 hours. Therefore, the requisite amount of poison according to the dosage with which a *ber* has to be made lethal should be incorporated in 25 cc. of water. In an earlier study (Prakash, Fitzwater & Jain 1969), it was found that by administering the various dosages of 1080 by stomach tubes, its LD_{50} for desert gerbil was 0·6 mg./kg. Keeping this in view, *ber* were soaked in solutions having 1080 to impregnate 1, 1·5, 2 and 3 mg./kg. dosage in every *ber*. One each of poison-

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[1] Average Weight 32 gm.

impregnated *ber* of various dosages was given to 10 desert gerbils in individual cages. The per cent kill and hours of death are presented in Table 1. Although 100 per cent kill was observed when desert gerbils fed *ber* having 1·5 mg./kg. dosage of 1080, hours to death extended up to 48 hours but when *ber* were soaked to impregnate them with 3 mg./kg. dosage, this time was reduced to 24 hours, the kill being 100 per cent. Hence, this dosage was selected for further trials.

TABLE 1

THE PER CENT KILL AND HOURS TO DEATH OF DESERT GERBILS WHEN FED ON 1080 IMPREGNATED *ber*

Dosages of 1080 (mg./kg.) in which *ber* was soaked	No. of animals tried	% kill	Hours to death
1	10	80	18-48 hrs.
1·5	10	100	30-48 ,,
2·0	10	90	30-48 ,,
3·0	10	100	24 ,,

PROPORTION OF LETHAL AND UNPOISONED BER, AND KILL RATIOS

In the Laboratory : Poisoned *Zizyphus* fruits with 3 mg./kg. dosage were mixed in three proportions with ordinary fruits: 1 : 4, 1 : 9 and 1 : 14 and each proportion was tried on ten desert gerbils. The results are shown in Table 2.

TABLE 2

KILL PER CENT AND HOURS TO DEATH OF DESERT GERBILS WHEN FED ON POISONED AND UNPOISONED *ber* IN VARIOUS PROPORTIONS

Proportion of lethal and ordinary *ber*	No. of animals tried	% kill	Hours to death
1 : 4	10	90	24 hrs.
1 : 9	10	80	24 ,,
1 : 14	10	40	24 ,,

It is obvious that the per cent kill decreased with the increase in the proportion of unpoisoned *ber* in the one-shot baits in as much as that the kill was only 40 per cent where 1 : 14 proportion of lethal and non-lethal *ber* was tried. But in all the trials the rodents died within 24 hours which further indicates the feasibility of impregnating the 3 mg./kg. dosage in each *ber*.

In the Field: Results of field trials indicate that per cent kill of desert gerbils was highest when lethal and unpoisoned *ber* were mixed in the ratio of 1 : 4 (Table 3). The per cent kill of desert gerbils decreased with the increase in the proportion of unpoisoned fruits which is in conformity with the results of experiment done in the laboratory. The per cent kill values were transformed to the Arcsin scale and analysis of variance was carried out but it was found that the differences between the per cent kill due to lethal *ber* mixed with various proportions of unpoisoned ones were not significant. However, the maximum kill was observed in the ratio 1 : 4 and therefore, it will be appropriate to use this proportion for field operations.

TABLE 3

SHOWING PER CENT KILL OF DESERT GERBILS IN FIELD WHEN POISON BAITING WAS DONE WITH ONE LETHAL *Zizyphus* FRUIT IN VARIOUS PROPORTIONS OF ORDINARY ONES

Habitat	Proportions of lethal and unpoisoned *Zizyphus* fruits and kill per cent		
	1 : 4	1 : 9	1 : 14
I	80	70	90
II	90	80	60
III	90	70	50
IV	70	80	50
Mean	82·5	75·0	62·5

ECONOMICS OF THE METHOD

The shrub, *Zizyphus nummularia* grows abundantly throughout the desert region and the farmers can collect berries without incurring any expenditure. The labour involved will be meagre as compared to other methods (Chitty 1954; Prakash 1963; Srivastava 1966; Narayangowda 1966 and Batra 1966) which require prebaiting for 2-5 days before poison-baiting for 1-3 days: as in one-shot baiting technique, both prebaiting and poison-baiting are done simultaneously. The cost of poison required for poisoning 100 desert gerbils per hectare will be only one Paisa. Sardar Singh (1966) described the cost of anti-rat measures with various poisons and by fumigation to be ranging from Rs. 0.62 to 15·78 per hectare. Comparing these figures, the one-shot baiting technique will prove to be the cheapest among the ones in vogue in India.

Pingale (1966) mentioned that about 300 gm. of food grains are required for the control of each rodent. The one-shot baiting method does not require any food grain for pre- or poison-baiting as it is based on a wild growing fruit which is quite palatable to desert gerbils. Thus this method will save a large amount of food grains for human consumption which would have otherwise been utilised for baiting rodents. However, the poison 1080 is very toxic and, therefore, it should be used with great care and should be handled only by trained personnel.

This method also opens avenues for trying different wild fruits for baiting various rodent pests in India.

Summary

One-shot baiting technique for the control of the Indian desert gerbil, *Meriones hurrianae* Jerdon, is described. The method utilizes the fruits of wild *Zizyphus nummularia* and does not involve any requirement of food grains. In this method, air-dried fruits of *Z. nummularia* are soaked in solution of Sodium mono-fluoroacetate (1080) impregnating a 3 mg./kg. dosage in every fruit so as to make every one of them lethal to desert gerbil. The lethal fruits are mixed with unpoisoned ones in the proportion of 1: 4 and are placed inside the burrows of desert gerbils in fields.

Acknowledgements

Thanks are due to Dr. G. C. Taneja, Director and Shri C. P. Bhimaya, Ex-Director, for taking keen interest in the study; and to Shri H. P. Sharma, Junior Scientific Assistant for assistance.

References

Batra, H. N. (1966): Results of rat control operations in Intensive Agricultural Districts Programme. *Proc. Indian Rodent Symp.* pp. 139-143.

Chitty, D. (1954): Control of rats and mice. Oxford, Clarendon Press.

Gooding, C. D. (1961): One-shot baiting—A recent development in rabbit poisoning technique. *Rabbit Control Symp.* Perth **2**: 1-9.

Narayangowda, S. D. (1966): A Short note on rodent control in Kolar district, Mysore State, as part of the plague control operations. *Proc. Indian Rodent Symp.* pp. 291-299.

Pingale, S. V. (1966): Studies on development and control of rat populations. ibid. (In press).

Prakash, Ishwar (1963): Destructive rodent of desert grassland. *Gosamvardhana* **XI**: 15-18.

Prakash, Ishwar, Purohit, K. G. & Kametkar, L. R. (1967): Intake of seeds of grass, shrub and tree species by three species of gerbils in Rajasthan desert. *Indian For.* **93**: 801-805.

————, Fitzwater, W. D. & Jain, A. P. (1969): Toxic chemicals and baits for the control of two gerbils, *Meriones hurrianae* Jerdon and *Tatera indica* Hardwicke. *J. Bombay nat. Hist. Soc.* **66**: 500-509.

Singh, Sardar (1966): Organisation of Field rat control and its economics. *Proc. Indian Rodent Symp.* pp. 305-314.

Srivastava, A. S. (1966): Evolution, development and standardisation of a technique for the eradication of field rats. ibid. pp. 283-290.

A Catalogue of the Birds in the Collection of the Bombay Natural History Society—7

Scolopacinae (part), Phalaropinae, Rostratulidae, Recurvirostridae, Dromadidae, Burhinidae, Glareolidae, Stercorariidae, Laridae

BY

HUMAYUN ABDULALI

[*Continued from Vol.* **67** (1) : 56]

404 **Capella solitaria solitaria** (Hodgson) (Nepal) Eastern Solitary Snipe **6** : 257

15 : 4 ♂♂ 3 ♀♀ 8 o?

3 Chitral, N.W.F.P. ; 1 Patiala, 1 Dharmsala, Kangra ; 1 Srinagar, 1 Dabbian, Lidar Valley, 1 Puga Valley, Rupshu ; 1 Mussoorie, 1 Almora ; 1 Lachung, N. Sikkim ; 2 Balipara, 1 Shillong, 1 Manipur.

	Wing	Bill	Tarsus	Tail
♂♀	159-169 av. 165	65-74 av. 70·6	32-35 av. 33·7	68-75 av. 71·6
	(153-169)	(67-77)	(*c.* 28-38)	(55-63)

405 **Capella nemoricola** (Hodgson) (Nepal) Wood Snipe **6** : 255

14 : 1 ♂ 2 ♀♀ 11 o?

1 Thana, 1 Talegaon, Poona; 1 Almora, U.P.; 2 Khasia Hills ; 1 *Kaliawa*, 7 *Taunggyi, Upper Burma*, 1 *Burma*.

The measurements differ from those in FAUNA quoted in INDIAN HANDBOOK.

	Wing	Bill	Tarsus	Tail
♂♀	139-152 av. 145	64-72 av. 67·5	35-38 av. 36	49-62 av. 54
	(133-141)	(61-67)	(*c.* 30-36)	(63-74)

406 **Capella stenura** (Bonaparte) (Sunda Islands) Pintail Snipe **6** : 263

27 : 9 ♂♂ 10 ♀♀ 8 o?

3 Bombay, 2 Thana, 1 Panvel, 1 Ratnagiri ; 2 Karwar, 1 Bangalore ; 1 Gudalur, Nilgiris; 1 Muthukuzhi, 5 Tenmalai, 1 Thekkady, Periyar Lake, Kerala; 1 Bakhri, Monghyr, Bihar ; 1 Birbhum, 1 Calcutta Market, Bengal ; 1 Khetri, Assam ; 2 Andamans ; 2 *Sagaing, Upper Burma*, 1 *Klongyai, S.E. Siam*.

5 of them (Bombay, Panvel, Ratnagiri, Assam, and Burma) are isabelline in colour with varying degrees of markings on the upper parts.

Another from Bangalore (No. 14952) has the markings all over very much paler than in the normal plumage.

	♂♂		♀♀
Wing	128-139 av. 132		129-137 av. 133·7
	(125-134)		(130-138)
Bill	56-65 av. 61		59-71 av. 63·7
	(57-61)		(59-64)
Tarsus	30-33 av. 31·6		32-36 av. 33·9
		(♂♀ 32-36)	
Tail	44-50 av. 47		46-50 av. 47·3
		(♂♀ 45-52)	

In some specimens the bill is appreciably longer than accepted in IND. HANDBOOK quoting from Stuart Baker.

407 **Capella megala** (Swinhoe) (Between Takoo and Peking, China) Swinhoe's Snipe **6** : 264

8 : 1♂ 5 ♀♀ 2 o?

1 Malangad, 1 Thana, Bombay; 1 Walmer, Nilgiris; 2 Tindivanam, S.I.; 1 *Tharrawady, Lower Burma*; 1 *Ampang, near Kuala Lumpur, Malaya*; 1 *Temple of Heaven, Peking, China.*

	Wing	Bill	Tarsus	Tail
♂♀	135-144 av. 140	64(3), 66	33-37 av. 35·5	51-60
	(128-139 Baker, 142-151 La Touche)	(59-74 ; 61-72)	(*c*. 32-34 ; 33-35 ; 37, 38)	(52-57 ; 55-62)

See Miscellaneous Note, *JBNHS* **67** : 108. One more specimen, obtained in 1952 and put aside for confirmation, was discovered after the publication of this note. Except for a 51 mm. tail, the measurements are within the limits indicated in my note.

408 **Capella media** (Latham) (England) Great Snipe **6** : 261

9 : 1♂ 4 ♀♀ 4 o?

1 *Basra, Mesopotamia*; 5 *Katunak, near Shiraz*; 1 Bangalore; 1 Walmer, Nilgiris; 1 *Moulmein, Burma.*

	Wing	Bill	Tarsus	Tail
♂♀	138 (frayed)-150 av. 143·7	60(2), 62, 66	32-40 av. 36	50-57 av. 54·2
	(139-150)	(57-69)	(♂ 33-37)	(♂ 51-59)

See Miscellaneous Note *JBNHS* **67** : 109.

409 **Capella gallinago gallinago** (Linnaeus) (Sweden) Common or Fantail Snipe **6** : 259

35 : 11 ♂♂ 18 ♀♀ 6 o? (2 albinoids)

1 *Hawi Plain, Samara*, 1 *Mesopotamia*; 2 *Shiraz*, 1 *Arabistan*; 1 Chitral, 1 N.W.F.P.; 1 Darazpur, Ambala, Punjab; 2 Kohistan, 1 Pithora, Sind; 1 Jaipur; 1 Dhari, Amreli, 1 Kaira District; 4 Nasik Dist.; 2 near Bombay, 3 Thana, 2 Panvel, 1 Alibag, Kolaba; 2 Karwar, 1 Bangalore; 3 Bakhri, Monghyr; 1 Calcutta Market; 1 *Prome Dist.*; 1 *Bangkok.*

No. 14951 (Bangalore) and 19434 (Bombay) are albinoid with a buffish wash all over, generally similar to the albinoid *C. stenura.*

	Wing	Bill	Tarsus	Tail
♂♂	129-136 av. 132	64-71 av. 66·5	31-34 av. 32·7	57-65 av. 59·7
	(128-138)	(60-71·5)	(29-33)	(53-61)
♀♀	128-137 av. 133·4	62-72 av. 63	31-36 av. 33·3	53-60 av. 55·6
	(130-140)	(64-73)		

The outermost tail feathers are tipped with white (instead of brown) in 7 of the 11 males and in only one of the 18 females.

410 **Capella minima** (Brünnich) (E. Christiansö, Denmark) Jack Snipe **6** : 265

20 : 4 ♂♂ 14 ♀♀ 2 o ? (1 albinoid, 1 melanistic)

1 Thar and Parkar ; 1 Ambala, Punjab ; 1 Chaduva, Kutch ; 1 Jaipur ; 1 Kaira District ; 2 Ghoti, 3 Thana ; 1 Kalianpur, Cawnpur, 6 Meerut ; 1 Tirhut, 1 Bakhri, Monghyr ; 1 no locality, albinoid.

	Wing	Bill	Tarsus	Tail
♂♂	111, 114, 115, 116	38, 39, 39, 41	23, 23, 24, 24	47, 48, 49, 49
	(108-117)	(39-41)	(23-25)	(46-51)
♀♀	106-113 av. 108	38-43 av. 40·6	23-25	42-52 av. 47
	(107-115)	(40-43)	—	—

411 **Scolopax rusticola rusticola** Linnaeus (Sweden) Woodcock **6** : 252

15 : 7 ♂♂ 8 ♀♀ (also 2 pairs wings only, 1 Chitral and 1 Assam)

(a) 2 *Bandar-e-Gaz, near Astrabad, Caspian Province* ; 1 *Birjand, Persia* ; 1 Kilia, 1 Drosh, 2 Chitral, N.W.F.P. ; 1 *Katha Dist., Upper Burma.*

(b) 2 Simla, 1 Palanpur ; 1 Ootacamund, Nilgiris ; 2 Lobha, Garhwal ; 1 Temi, West Sikkim ; 1 Laitlyngkot, Assam, 1 *Chin Hills.*

The material available falls into two distinct groups which I have listed separately above. The birds in group (a) are paler above, while those in group (b) show darker and more pronounced barrings with the pale interspaces less white. The rufous on the upper tail coverts is also appreciably deeper than in the western birds. Keeping both sexes together they measure

	Wing	Bill	Tarsus	Tail
(*a*)	193-207 av. 200·7	69-80 av. 74·5	36-41 av. 38·7	74-87 av. 82
(*b*)	192-197 av. 195	72-81 av. 76	36-41 av. 38	71-85 av. 81
	(184-208)	(67-80)	(34-38)	(71-82)

Except for one bird from the Chin Hills, group (a) lies west of group (b). The pair of wings from Assam are noticeably darker than any of the others.

I would have been inclined to consider recognition of Hodgson's *indicus* from Nepal and/or Koelz's *ultimus* from Sangau, Lushai Hills, had not both forms been so positively ignored in recent literature. I trust that somebody with more material available for examination will examine this matter more closely.

412 **Calidris canutus canutus** (Linnaeus) (Sweden) Knot **8** : 698

2 : 1 ♀ 1 o ? Point Calimere, Thanjavur Dist., Tamil Nadu.

Though there is a single record for Ceylon, these specimens obtained by the B.N.H.S. Bird Ringing Camp considerably extend the known range of this species.

413 **Calidris tenuirostris** (Horsfield) (Java) Eastern Knot **6** : 243

1 ♀ Muthupet, Thanjavur Dist., Tamil Nadu.
Wing 178 (165-185) ; bill 44 (39-47) ; tarsus 34 (34-38) ; tail 66 (63-69).

This bird obtained by the B.N.H.S. Bird Ringing Camp is also a valuable record. The map in IND. HANDBOOK (**2** : 291) appears to indicate that there are many records from the east coast, but I cannot trace any earlier ones. Jerdon's record for Madras may refer either to this species or *canutus* (Whistler, *JBNHS* **39** : 258)

414 **Calidris albus** (Pallas) (Coast of the North Sea) Sanderling **6** : 231

4 : 3 ♂♂ 1 ♀

1 *Charbar*, 1 *Tanb Island, Persian Gulf* ; 1 Karachi ; 1 Gorai, Bombay.

Wing	119, 121, 121, 123, (♂♀ 117-130)
Bill	22, 23, 24, 27, (♂♀ 23-29)
Tarsus	23, 25(3) (♂♀ 22-26)
Tail	47, 47, 48, 52, (♂♀ 46-55)

415 **Calidris ruficollis** (Pallas) (Southern Transbaikalia) Eastern Little Stint **6** : 236

3 : 1 ♀ Chilka Lake, Orissa ; 1 ♂ 1 ♀, *Osaka, Japan.*

Sp. No. 14793 collected by Maj. H. J. Walton at Chilka Lake on 10th June 1902 is marked *Tringa ruficollis* but being indistinguishable in colour from *Calidris minutus* has remained under that name. However, its 112 mm. wing and 21 mm. bill from feathers are both noticeably larger than in *minutus* (90-102 and 17-20). Though presumably recorded from the Andaman and Nicobar Islands (*JBNHS* **61** : 519)[1] and ' occasional specimens appear to be found in India, west of the Bay of Bengal' (Blanford **4** : 274), I cannot trace any specific published records from the Indian continent, whence it is omitted in the SYNOPSIS. In IND. HANDBOOK (**2** : 301) it is said to have been recorded from Rameshwaram Island Tamil Nadu.

416 **Calidris minutus** (Leisler) (Hanau am Main, Germany) Little Stint **6** : 234

63 : 27 ♂♂ 26 ♀♀ 10 o?

2 *Baghdad*; 3 *Pushtkuh Khasan*; 1 Baluchistan ; 1 Chitral ; 4 Kandla, Kutch ; 25 Bombay, 7 Thana, 6 Kolaba ; 1 Pt. Calimere, Tamil Nadu ; 3 Chilka Lake, Orissa; 1 Meerut, U. P. ; 4 Darbhanga, 2 Bakhri, Bihar ; 2 Calcutta Market ; 1 *Henzada, Burma*.

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[1] See also *JBNHS* **64** : 162.

417 **Calidris temminckii** (Leisler) (Hanau am Main, Germany) Temminck's Stint **6** : 237

21 : 6 ♂♂ 9 ♀♀ 6 o?
2 *Mesopotamia*; 1 Ladak; 1 Sind ; 6 Bombay ; 1 Cawnpore ; 2 Calcutta Market ; 1 Rajputee, 3 Monghyr, Bihar ; 2 *Burma* ; 2 *China*.

418 **Calidris subminutus** (Middendorff) (Western slopes of the Stanovoi Mountains and mouth of the Uda) Longtoed Stint **6** : 236

8 : 2 ♂♂ 6 ♀♀
1 Bakhri, Monghyr District, Bihar ; 1 Calcutta Market ; 4 Port Blair, Andamans ; 1 *Hsipaw, Shan States*, 1 *Kyethe, Prome District, Burma*.

Wing ♂♂ 87, 91 ♀♀ 89-98 av. 92·6 (♂♀ 87-95)
Bill ♂♀ 17-20 av. 19 (17-19)

419 **Calidris acuminatus** (Horsfield) (Java) Asian Sharptailed Sandpiper **6** : 239

2 : 1 ♂ 1 o?
1 *Tientsin, China*, 4th May 1901 ; 1 *Osaka, Japan*.

420 **Calidris alpinus alpinus** (Linnaeus) (Lapland) Dunlin **6** : 241
nil.

421 **Calidris alpinus centralis** (Buturlin) (Yakutsk, eastern Siberia)

22 : 11 ♂♂ 9 ♀♀ 2 o?
1 *Abadi*, 1 *Amara*, 1 *Sheik Saad*, 1 *Hawi Plain, Mesopotamia*; 1 *Charbar*, 1 *Sanauch, Persian Gulf*; 4 Pasni, 1 Baluchistan; 2 Karachi ; 1 Kandla, Kutch ; 2 Salsette, Bombay, 1 Panvel, 4 Rewas, Kolaba ; 1 Calcutta Market.

	Wing	Bill	Tarsus	Tail
♂♂	112-119 av. 116	31-38 av. 33	22-28 av. 24·5	44-51 av. 48·5
Ticehurst (Sind)	112-121	29-36	24-27	—
BR. HANDBOOK	111-116	28·5-31	23-25	48-52
♀♀	114-122 av. 116·4	31-38 av. 34	24-26	47-55 av. 50
Ticehurst (Sind)	116-123	34-39	25-27	—
BR. HANDBOOK	116-119	31-34·5	23-25·5	—

Stuart Baker referred only to the nominate form from Indian limits. Later Buturlin (1932, *Alauda* **4** : 265) when describing *centralis* suggested that it (*centralis*) may winter in India. Witherby (BR. HANDBOOK 1940) did not accept this form as separable from the nominate, but Ripley and Sálim Ali (SYNOPSIS & IND. HANDBOOK) have again, with no definite identifications, agreed that it may occur in India.

The measurements of the present series as also those of the birds from Sind measured by Ticehurst are generally larger, particularly as to the wing and bill, than those of *C. a. alpinus* and of *C. a. centralis* (which presumably does not differ in size from *C. a. alpinus*) ; also, none of the specimens in the present series shows ' a brownish, and not white outer web to the outer secondaries ' as is said to occur in *centralis*. Martti Soikkeli [On the variation in bill-and wing - length of the Dunlin (*Calidris* *alpina*) in Europe (1966, *Bird Study* **13**: (3) 256-259)] considers the mean bill-lengths over a large number as 31·4 mm. in males and 34·2 in females, and stresses the existence of a 3·9 ± 0·2 mm. difference in size between the bill measurements of sexes. This difference does not show in Indian material.

It could appear that this matter requires a closer examination with more material, particularly from eastern India. I have for the moment queried the subspecific identification of both the races. IND. HANDBOOK (**2** : 310) has a typographical error in quoting Hartert's measurements of the wing of the race (*sakhalina*) showing 177-123 instead of 117-123.

EL **Calidris alpinus schinzii** (Brehm) (Ragen, Germany) Dunlin

1 ♂ in breeding plumage, Rossiten.

422 **Calidris testaceus** (Pallas) (Holland) Curlew-Sandpiper **6** : 224

13 : 5 ♂♂ 2 ♀♀ 6 o ?

4 Kandla, Kutch ; 1 Bassein, 3 Gorai Washi, Bombay ; 2 Chilka Lake, Orissa ; 1 Calcutta Market ; 2 *Tientsin, China.*

	Wing	Bill	Tarsus	Tail
♂♀	125-133	33-40	29-33	43-57
	(124-137)	(37-45 from skull)	(28-32)	(43-52)

Of the seven in breeding plumage the two from Tientsin appear darker above than the others.

423 **Eurynorhynchus pygmeum** (Linnaeus) (Eastern Asia) Spoonbilled Sandpiper **6** : 232

nil.

424 **Limicola falcinellus falcinellus** (Pontoppidan) (Denmark) Broad-billed Sandpiper **6** : 245

nil.

425 **Limicola falcinellus sibirica** Dresser (Siberia and China) Eastern Broadbilled Sandpiper **6** : 246

11 : 5 ♂♂ 3 ♀♀ 3 o ? (No. 14862 Dharamtar Creek, missing)

2 *R. Rohtak, near Sib, Persian Baluchistan* ; 1 Pasni, Baluchistan ; 1 Karachi ; 5 Salsette, Bombay, 1 Rewas, 1 Dharamtar Creek, Kolaba.

	Wing	Bill	Tarsus	Tail
♂♂	99-107 av. 103·4	28-32 av. 29·6	21-22	35-39 av. 37·4
♀♀	105, 106, 110	31, 31, 34	22, 23, 23	36, 38, 38
(♂♀	101-113	30-36	20-23	35-42)

Seven (5th August to 1st September) are in breeding plumage. Two obtained near Bombay on 5th and 28th August appear darker above than the others, suggesting the nominate race, which would make others obtained in the same area in different years *sibirica*. Without definitely named specimens in similar plumage, the subspecific identity will have to remain undetermined.

The bird from Karachi collected by J. A. Murray in 1877, was listed as a Jack Snipe (*Gallinago gallinula*)!

425a **Tryngites subruficolis** (Vieillot) (Paraguay) Buffbreasted Sandpiper

nil.

426 **Philomachus pugnax** (Linnaeus) (Southern Sweden) Ruff **6** : 228

37 : 22 ♂♂ 15 ♀♀ (8 by wing size)

1 *Western Europe*; 2 *Baghdad*, 1 *Mesopotamia*; 1 *Sib, Persian Baluchistan*; 1 Baluchistan; 1 Sind; 3 Ambala; 1 Bahawalpur; 1 Delhi; 4 Bharatpur, 3 Jaipur; 1 Gwalior, M.P.; 4 Nasik, 1 Bhyander, Bombay, 2 Panvel, 1 Alibag, Kolaba; 1 Gundlupet, Mysore; 1 Baghowni, 1 Tirhut, 1 Darbhanga; 1 Gonda, 2 Kalianpur, Cawnpur; 2 Calcutta Market.

	Wing	Bill	Tarsus	Tail
17 ♂♂	179-194 av. 185·5	33-40 av. 35	46-50 av. 48	63-71 av. 66
♂♂ FAUNA	173-190	30-36	46-50	78-89*
♂♂ BR. HAND.	186-198	34-38	45·5-52	61-68
12 ♀♀	144-157 av. 152	29-32 av. 30·3	37-43 av. 40	50-59 av. 54
♀♀ FAUNA	150-166	29-31	41-44	64-70
♀♀ BR. HAND.	149·5-163	29·5-33	—	—

The wing measurements of the males and females appear mutually exclusive, and two of each sex which do not fit in have been excluded as being presumably wrongly sexed. The only male from Europe is in breeding plumage and has the bill appreciably larger than in the others (40 mm. cf. 33-36 av. 34·8). Part of this disparity may be due to recession of the feathering on the forehead.

The tail measurements for both sexes, reproduced in IND. HANDBOOK from the FAUNA, appear to be completely out.

427 **Phalaropus fulicarius** (Linnaeus) (Hudson Bay) Grey Phalarope **6** : 248

nil.

428 **Phalaropus lobatus** (Linnaeus) (Hudson Bay) Rednecked Phalarope **6** : 249

9 : 3 ♂♂ 5 ♀♀ 1o?

1 *Sib* 3630′, *Persian Baluchistan*; 1 Gajar 3200′, 2 Manguli 2500′, 2 Drakalo 4000′, Baluchistan; 1 Chitral, N.W.F.P.; 1 Bhavnagar, 1 off Rann of Kutch.

	Wing	Bill	Tarsus	Tail
♂♂	103, 108, 111	23, 24	20, 21, 22	44, 48, 50
	(106-110)	(20-24)	(19-20)	(43-47)
♀♀	105-111 av. 106·8	20-24 av. 21·5	19-21 av. 19·6	44-49 av. 46·4
	(112-118)	(20-25)	—	

The measurements in IND. HANDBOOK (**2** : 325) reproduced from BR.

HANDBOOK (**4** : 222) indicate that the female is larger, but the present small series does not support this.

429 **Rostratula benghalensis benghalensis** (Linnaeus) (Asia) Painted Snipe **6** : 45

40 : 16 ♂♂ 18 ♀♀ 6 o ? (2 pull.).
1 Rawalpindi, 1 Campbellpore, 4 Ambala, Punjab ; 1 Thar Parkar, Sind ; 1 Bharatpur ; 1 Jhansi, C.P. ; 7 Thana, 7 Bombay, 5 Panvel ; 2 Karwar, N. Kanara ; 5 Darbhanga, Bihar ; 2 Calcutta Market ; 1 *Prome District, Burma* ; 2 *Japan.*

Two in female plumage are marked ♂, but are probably wrongly sexed.

430 **Himantopus himantopus himantopus** (Linnaeus) (Southern Europe) Indian Blackwinged Stilt **6** : 193

27 : 15 ♂♂ 10 ♀♀ 2 o ? (1 chick).
1 *Amara*, 1 *Beled* (?), *Mesopotamia* ; 1 *Charbar, Persian Gulf* ; 1 *Hamun Lake, Persia* ; 1 Hajergang, Baluchistan ; 1 *Gyantse* (13,000′), *Tibet* ; 5 Pithoro, Sind ; 1 Kharirohar, 1 Mandvi, Kutch ; 1 Patan, Jaipur ; 1 Delhi ; 1 Dabka, Gujarat ; 3 Bombay ; 2 Thana ; 4 Tamarakulam 1100′, Palnis ; 1 Wangalu Tank, Nellore, A.P. ; 1 Kanpur.

	♂♂	♀♀
Wing	211-249 av. 235·5	215-242 av. 228
	(240-253 ; ♂♀ 222-253)	(222-240)
	(*ceylonensis* 233-249)	(*ceylonensis* 230-234)
Bill	57-69 av. 63	60-71 av. 65
	(60-69)	(54-69)
	(*ceylonensis* 62-74 from skull)	(*ceylonensis* 64·5-70 from skull)
Tarsus	108-136 av. 123·5	108-126 av. 120·5
	(115-145)	—
	(*ceylonensis* 110-124)	(*ceylonensis* 107-120)
Tail	76-89 av. 82·7	76-89 av. 79·5
	(80-90)	—
	(*ceylonensis* 73-85)	(*ceylonensis* 73-80·5)

In 1951 (*JBNHS* **49** : 789-790), when recording the nesting of the stilt near Bombay, I drew attention to the fact that both parents had white heads (which were common in photographs of nesting birds in India and elsewhere)—a character on which Whistler had described *ceylonensis* from Ceylon. The race is accepted in IND. HANDBOOK (**2** : 331) presumably for the same character.

Dementiev in BIRDS OF SOVIET UNION (1969, English translation, **3** : 309) refers to the black tones growing purer and the head whiter, with age, and this may be the correct explanation.

The distributional map in IND. HANDBOOK also excludes *H. h. himantopus* from an unnecessarily large area in western India.

431 **Himantopus himantopus ceylonensis** Whistler (Kalawewa, Ceylon) Ceylon Blackwinged Stilt

nil.

No specimens are available in our collection and, in an attempt to clarify the position mentioned under the nominate form, I requested the British Museum (Natural History) to lend me material from Ceylon. They have been good enough to send me 4 specimens which do not differ from Indian birds in size and colour, except that the 3 adults (♀ 24 July, ♂ 12 November, and ♀ 5 December) have almost pure white heads against only two (both Kutch, ♂ 12 March, and ♀ 28 July) among the Indian specimens listed above.

One of the females is blackish, metallic green above, and, like Indian birds, this character does not appear to be confined to the males.

The juvenile with its wings and bill not yet fully grown shows dark grey on the head.

432 **Recurvirostra avosetta** Linnaeus (Italy) Avocet **6** : 195

8 : 4 ♂♂ 1 ♀ 3 o?

2 *Amara, Iraq* ; 1 Bassein, 1 Bhyander, Thana ; 3 Kolaba ; 1 Tirhut, Bihar.

	Wing	Bill	Tarsus	Tail
♂♂	220, 221, 225, 232	85, others broken	89, 91(2), 95	81(2), 83, 90
♀	222	—	81	76
(♂♀	220-235	84-91	*c.* 84-90	86-96)

None of the specimens show a jet black head, as dark as the colour on the wing ; the darkest was collected on 23 September, the others November to February.

433 **Ibidorhyncha struthersii** Vigors (Himalayas) Ibisbill **6** : 196

6 : 1 ♂ 1 ♀ 4 o? 2 imm. without black heads and chins.

1 Peshawar Valley, N.W.F.P.; 1 Garhwal, U.P. ; 1 Sikkim ; 1 Dafla Hills, Assam ; 1 *Kashgar* 4400′, 1 *Peking Market, China.*

♂♀	Wing	234, 235, 243, 248 (230-245)
	Bill	70, 72, 73, 84 (68-80)
	Tarsus	46, 48, 49, 51 (*c.* 47-49)

434 **Dromas ardeola** Paykull (India) Crab Plover **6** : 94

5 : 3 ♂♂ 2 ♀♀.

1* *Warba Island*, 1 *Buna Is. Persian Gulf* ; 2 Pt. Calimere, Thanjavur Dist., Tamil Nadu, 1 N. Button Island, Middle Andamans.

	Wing	Bill	Tarsus		Tail	
♂♂	220(3)* (202-225)	59, 62, 64* (55-61)	90, 92, 95*	88-100	63, 66*, 70	64-76
♀♀	209, 215 (201-216)	55, 58 (54-56)	90, 91		68, 73	

435 **Burhinus oedicnemus saharae** (Reichenow) (Tunis) Persian Stone Curlew **6** : 79

4 : 1♂ 3 o?

1 *Lake Akkakurf*, 1 (No. 14051) *Shat-el-Adhain, R. Tigris, Iraq*; 1 *Frontier of Arabistan* (*Khuzistan*); 1 Gili (Jau) 190 m. southwest of Kalat, Baluchistan.

These birds are pale and rufous above, being very distinct from those from India under *indicus*. In addition to their larger wing 230, 236, 250, 252 (IH 228-244) cf. 206-222 av. 213 (IH 203-222), they differ in having the white edge to the first primary noticeably longer (62-75 mm.) than in Indian birds (25-50 av. 36).

The specimen from Gili is the easternmost record of *saharae* and the material available does not support the statement in IND. HANDBOOK that this form is resident in Kutch and Gujerat.

This race is actually paler and *more* buff than *indicus* and the key in IND. HANDBOOK (**3** : 1) appears to err in stating that it is *less* buff.

436 **Burhinus oedicnemus indicus** (Salvadori) (Himalayas, i.e. north India) Indian Stone Curlew **6** : 77

12 : 5 ♂♂ 6 ♀♀ 1 o?

1 Bharatpur, Rajasthan; 1 Bhuj, 1 Nadiad, Gujerat; 1 Sanchi, Bhopal, 1 Gonda, M.P.; 1 Bulandshahr, U.P.; 1 East Khandesh, 1 Karjat, Kolaba; 2 Bellary, 1 Salem, Tamil Nadu; 1 ?

The birds from Kutch and Gujerat show tinges of rufous but are certainly very different from *saharae*. I would have included them with *harterti* (?) but, being appreciably smaller (wings ♂ 223 ♀ 210) and lacking the large white border to the first primary, they are for the moment left with this form. The male from Bharatpur (wing 221) is typical *indicus*.

EL **Burhinus oedicnemus harterti** Vaurie (Kafir Qala, northeastern Khorasan, northeastern Iran)

3 : 1♂ 1 ♀ 1 o?

1 *Shat-el-Adhain* (No. 14052), 1 *Sheik Saad, Mesopotamia*; 1 *Shustar, Iran*.

These differ from birds listed under *saharae* in their upper parts being darker and very similar to *indicus*, except that two have larger wings (230, 245) and longer white edges to the primary (63, 75). The third, a male from Sheik Saad has a 217 mm. wing and also a small 30 mm. white edge to the first primary. The Mesopotamian birds were both obtained in October and may well be winter migrants.

437 **Esacus magnirostris recurvirostris** (Cuvier) (Nepal) Great Stone Plover **6** : 80

6 : 3 ♂♂ 3 ♀♀.

1 Indus River, 1 Madhupur, Punjab; 1 Mandvi, Kutch; 1 Cawnpore, U.P.; 1 Daspalla, Orissa; 1 Panvel, Kolaba, Maharashtra.

	Wing	Bill	Tail
♂♀	258-273 av. 263	72-78 av. 74	112-119 av. 115
	(252-273)	(74-87)	—

The uptilted appearance of the bill is greatly accentuated by the shape of the lower mandible. The shape of the whole bill is different from that of the nominate form.

438 **Esacus magnirostris magnirostris** (Vieillot) (Australia) Australian Stone Plover **6** : 81

1 ♀ North Button Island, Ritchie's Archipelago, Andamans.
Wing 270 (266-277) ; bill 77 (76-82) ; tail 113 ; tarsus 81 (80-84).

439 **Cursorius cursor cursor** (Latham) (Kent) Creamcoloured Courser **6** : 85

11 : 5 ♂♂ 5 ♀♀ 1 o ? (4 juv.).
1 *Felujah, R. Tigris, Mesopotamia* ; 1 *Shaiba, Saudi Arabia* ; 1 *Shuster, S. Persia* ; 2 Pirandar, 2000 ′, *c.* 190 m. SSW. of Kalat, 1 Chad, 5350′, 58 m. south of Kalat, 1 Kojdar, 27°48′ N. ; 66°36′ E., Baluchistan ; 1 Harunabad, Bahawalpur, Punjab ; 1 Khavda, Kutch, 1 Palanpur, 1 Patan, Mehsana, Gujerat.

In addition to traces of barring on the back and the absence of grey on head, the four juveniles have white tips to the inner primaries, which are all black in the adults.

Among the adults the single specimen from Mesopotamia appears paler above than any of the others. It may be worth noting that Vaurie (1965 p. 452) accepts *bogolubovi* Zarudny as the form visiting our area, but the description of this form in BIRDS OF SOVIET UNION (**3** : 28) does not agree with any of the specimens.

	Wing	Bill	Tarsus	Tail
♂♂	156, 164, 165	23, 25	52, 58, 59	60, 64, 66
	(IH 160-171)			
♀♀	158, 160, 162, 164	23, 25(2), 26	53, 55, 56, 57	63(2), 64, 65
	(IH 162-166)			
	(♂♀ 150-171	21-26	55-60	58-72)

440 **Cursorius coromandelicus** (Gmelin) (Coromandel Coast) Indian Courser **6** : 86

20 : 9 ♂♂ 8 ♀♀ 3 o ? (2 juv.).
1 Jullunder, 2 Ambala, Punjab ; 4 Kutch ; 1 Karaghoda, 1 Rajkot, 1 Kodinar, 1 Deesa ; 1 Sinnar, Nasik, 1 Atgaon, Thana, 1 Andheri, Salsette, 1 Kirkee, Poona ; 1 Dharwar, Mysore ; 1 Bina, C.P. ; 1 Rajputtee, Chupra, 2 Baghowni, Tirhut, Bihar.

	Wing	Bill	Tarsus	Tail
♂♂	137-151 av. 146·4	19-22 av. 20	49-55 av. 51·6	50-61 av. 54
♀♀	147-162 av. 155·5	19-21 av. 20·6	48-58 av. 52·7	55-61 av. 57
	[IH ♂♀ 143-163	23-30 (from skull)	49-57	45-64]

Some specimens have darker heads than others but it is not possible to associate this with sex, season, or place of origin. No. 14092 a female from Kutch is a partial albino, having most of its wing quills white and paler underparts.

441 **Cursorius bitorquatus** (Blyth) (Eastern Ghats) Jerdon's Courser **6** : 88

nil.

442 **Glareola pratincola pratincola** (Linnaeus) (Austria) Collared Pratincole **6** : 89

11 : 2 ♂♂ 2 ♀♀ 7 o ?

2 *Sera Tigris*, 2 *Feluja*, *Euphrates*, *Mesopotamia*; 2 *Ahwaz*, *Iran* ; 1 Peshawar ; 1 Karachi ; 2 Coimbatore ; 1 no locality.

443 **Glareola pratincola maldivarum** J. R. Forster (Open sea in the latitude of the Maldive Islands) Large Indian Pratincole **6** : 90

8 : 1 ♂ 1 ♀ 6 o ?

3 Bhavnagar, Gujerat ; 2 Bhyander, Bombay ; 1 Haphlong, Cachar ; 1 Car Nicobar ; 1 *Mandalay*, *Burma*.

Though Vaurie (p. 453/4) treats *maldivarum* as a separate species from *pratincola* it is not easy to tell them apart. In my Nicobar paper (*JBNHS* **64** : 163) I referred to differences in the colour of the shaft of the first primary, but I am afraid this was in error, and this is not an infallible index.

444 **Glareola lactea** Temminck (Bengal) Small Indian Pratincole **6 : 92**

24 : 8 ♂♂ 13 ♀♀ 3 o ? (4 juveniles*).

2 Madhopur, Gurdaspur, Punjab ; 1 Bulandshahr, U.P. ; 1 Calcutta Market* ; 2 Nasik, 3 Panvel*, 4 Khangaon, Dhond, Maharashtra ; 3 Godavari Delta, Andhra ; 2 Chupra, Bihar ; 2 Orissa ; 1 Margherita, Assam ; 1 *Prome*, 2 *Chindwin*, *Burma*.

The males (153-162 av. 156·5) have slightly larger wings than the females (142-158 av. 149·5).

Three juveniles shot out of one flock have varying traces of spots on the throat and are greyer, less sandy above than the others. The last character may be due to foxing, for those most recently obtained are the greyest.

E L **Glareola nordmanni** Fischer (Steppes of southern Russia)

2 o ? *Feluja*, *R. Tigris*, *Mesopotamia*.

These specimens constitute the only records of this species from Iraq—see Marchant (1963) *Bull. B.O.C.* **83** : 52.

445 **Catharacta skua antarctica** (Lesson) (Falkland Islands) Antarctic Skua

nil.

446 **Catharacta skua lönnbergi** Mathews (New Zealand Seas) Brown or Great Skua.

1 ♂ Malwan Coast, Ratnagiri Dist.
Wing *c.* 400 (397-400) ; bill 53 (53-58) ; tarsus 70 (70-79) ; tail 145 broken.

This was separated from *antarctica* ' by its much larger size : wing 433 mm. ' ; I cannot reconcile this with the specimen, which is accepted as of this race both in SYNOPSIS and INDIAN HANDBOOK (**3** : 19).

446a **Catharacta skua maccormicki** (Saunders) (Possession Island, Victoria Land) South Polar Skua.

1 o ? Udipi, South Kanara.
Wing 377 (IH 390-410) ; bill 49 (IH 47-52) ; tarsus 59 (IH 62-66) ; tail 152.

This specimen which is the only record from India was ringed in the Antarctic as of this race (*JBNHS* **62** : 565) but the wing and tarsus are smaller than indicated for this race in IND. HANDBOOK (**3** : 18). It is noteworthy that one of the Ceylon specimens originally identified as *maccormicki* was said to be *antarctica* (SYNOPSIS p. 138) but is now again listed in this group.

447 **Stercorarius pomarinus** (Temminck) (Arctic regions of Europe) Pomatorhine Skua or Jaeger **6** : 98

nil.

448 **Stercorarius parasiticus** (Linnaeus) (Coast of Sweden) Richardson's Skua

nil.

449 **Larus hemprichii** Bruch (Red Sea) Sooty Gull **6** : 104

4 : 3 ♂♂ 1 ♀.
2 *Aden*, 1 *Muscat, Arabia* ; 1 *Astola Is., Persian Gulf.*

	Wing	Bill	Tarsus	Tail
♂♂	315, 336, 347	48, 49, 51	53, 55, 55	112, 129
♀	321	45	51	114
	(♂♀ 320-348	43-48	50-58	139-159)

450 **Larus argentatus heuglini** Bree (Zeyla, Somaliland) Yellowlegged Herring Gull **6** : 107

5 : 1 ♂ 4 ♀♀ Bombay Harbour.

All are in adult plumage with all-white tails and yellow bills with very faint markings towards the tip. They are a darker grey above than the adult under the next form. Birds in immature plumage are possibly included in the latter.

	Wing	Bill	Tarsus	Tail
1 ♂	440	59	64	169
4 ♀♀	410, 422, 434(2)	51(2), 55, 62	62(2), 65, 66	159, 163, 165, 167
	(♂♀ IH 415-450	49-63	62-77	158-180)

451 **Larus argentatus mongolicus** Sushkin (Uriug-noor, NW. Mongolia) Pinklegged Herring Gull **6** : 109 (part)

Adult 3 : 1 ♂ Bombay Harbour ; 1 ♀ off Bombay ; 1 o ? Chitral, N.W.F.P. Immature 8 : 4 ♂♂ 3 ♀♀ 1 o ? (These may include specimens of other races). 1 near Kiti, 1 Karachi, Sind ; 1 Bombay, 4 Bombay Harbour, 1 off Bombay.

Those in adult plumage have the upper parts a lighter grey than in the last. The bird from Chitral is the palest, has the outer primary moulting and a short (51 mm.) and slender bill. No. 20879 collected off Bombay, (Wing 401 + moulting, 61, 68, 165) is light grey above but has a greenish-yellow bill marked with black towards the tip and with central tail feathers not pure white but as in 3rd winter birds of the nominate race (BR. HANDBOOK **5** : 92).

	Wing	Bill	Tarsus	Tail
Adult ♂	422	59	66	167
Imm. ♂♂	441, 447, 465, 466	53, 54, 57, 58	67, 68, 69, 70	157, 169, 174, 175
Adult ♀	401 moulting	61	68	165
Imm. ♀♀	412, 415, 424	51, 52, 54	61, 64, 65	146, 154, 159
(IH ex Stegemann ad. and imm.	435-480 av. 462	—	63-75	—)

There is considerable variation in size and colour. The grey adults of these two races were listed under *L. fuscus* while three specimens of *L. ichthyaetus* and one bird yet unidentified (No. 14188 Bushire) were included in this species. In the dry stage all the specimens appear to have yellowish legs and feet rather than pale fleshy pink or bluish as required in Vaurie (1965 p. 472). As is generally admitted, further study of this group is necessary.

452 **Larus fuscus fuscus** Linnaeus (Sweden) Lesser Blackbacked Gull **6** : 107

As mentioned above, the specimens listed under this species have been found to be adults of *Larus argentatus* of two races.

453 **Larus ichthyaetus** Pallas (Caspian Sea) Great Blackheaded Gull **6** : 101

7 : 1♂ 2 ♀♀ 4o ? (3 with black heads and all white tails).
2 Bhavnagar, Gujerat ; 1 Trombay Is., Bombay ; 1 Kedra, Kanara ; 3 Kerala.

While many wing tips are broken, the largest is a ♂ from Trivandrum, Kerala, in non-breeding plumage which measures 461 cf. 475-510 (BR. HANDBOOK **5** : 76).

454 **Larus brunnicephalus** Jerdon (West coast of Indian Peninsula) Brownheaded Gull **6** : 103

18 : 8 ♂♂ 4 ♀♀ 6 o ? (5 brown-headed ; 4 immature, with brown band on tail), 1 *Sheik Saad* ; 1 Bagor, Indus River ; 1 Kutch ; 1 Nasik, 4 Bombay, 1 Ratnagiri,

1 Honavar; 1 Cannanore; 1 Kayamkulam, 1 Neendakara, Kerala; 1 Orissa; 1 Tirhut, 2 Darbhanga, Bihar; 1 Benares, U.P.

The immature birds with brown bands on the tail have their primaries all-black and do not show the 'mirror' which identifies the adults.

455 **Larus ridibundus ridibundus** Linnaeus (European seas—England) Blackheaded Gull **6**: 102

22: 9 ♂♂ 8 ♀♀ 5 o? (8 immature, with band on tail).
1 *Holland*; 4 *Sheik Saad*; 2 *Muscat*; 1 *Persia*; 2 Chitral; 1 Kashmir; 11 Bombay.

The measurements of the wings and culmen are slightly larger than in IND. HANDBOOK (ex. BR. HANDBOOK).

Wings	♂	293-325 av. 308 (IH 295-315, one 320).
,,	♀	287-330 (fresh) av. 298·5 (IH 285-302).
Culmen	♂	32-37 av. 35·8 (IH 31-36).
,,	♀	30-37 av. 33·7 (IH 29-33).

As in *brunnicephalus* the immature bird has a brown bar across the tail, but in this species the pattern of the immature primaries is similar to that of the adult.

456 **Larus genei** Brème (Sardinia) Slenderbilled Gull **6**: 106

9: 2 ♂♂ 3 ♀♀ 4 o? (4 adults, with all-white tails).
1 *Euphrates*; 5 *Persian Gulf*; 1 Baluchistan; 1 Bhavnagar, Gujerat; 1 Greater Bombay.

In the FAUNA, the wings of both sexes are said to be 280-316. In the small number available, the males have slightly larger wings, 302-310, than the females, 287-295. In both sexes the tails 104-122 are smaller than the FAUNA measurements 119-144.

457 **Larus minutus** Pallas (Rivers of Siberia and in Russia=Berezovo, Tobolsk, Siberia) Little Gull

nil.

EL **Larus canus canus** Linnaeus (Sweden) Common Gull

3: 2 ♂♂ 1 ♀ *Sheik Saad, R. Tigris, Mesopotamia.*
Wing 360, 369, 370.

458 **Chlidonias hybrida indica** (Stephens) (Cawnpore, India) Indian Whiskered Tern **6**: 111

20: 9 ♂♂ 5 ♀♀ 6 o?
1 (Sp. No. 14197) *R. Euphrates, Mesopotamia*; 1 *R. Rhotak, near Sib, Persian Baluchistan*; 1 Hazariganj, Kalat, Baluchistan; 1 Kashmir; 1 Delhi; 1 Bharatpur, 1 Kandla, 1 Bhuj, Kutch; 1 Powai, Bombay, 1 Belapur, Thana; 1 Edanad, Kerala; 1 Balugaon, Chilka, 2 Samastipur, Orissa; 1 Gorakhpur, U.P.; 1 Calcutta Market; 1 *Upper Burma*, 2 *Kyithe, Prome Dist.*; 1 *N. China.*

6 (1 ♂, 2 ♀, 3 o?) in breeding plumage with black caps and bellies are dated from 'April' to 15 August. 4 obtained between 19 September

and 28th December have brown markings on the back and presumably indicate a juvenile phase.

	Wing	Bill	Tarsus	Tail
♂♂	221-231 av. 224	29-32 av. 30·5	21-23 av. 22	71-85 av. 77
	(221-229)	(32-37)*	(22-23)	(76-81)
♀♀	221(2), 223	26(2), 28(2)	20, 21(3)	76-84 av. 80
	(213-219)	(32-36)	(20-23)	(77-80)

* These measurements are from the skull. The unsexed bird from Bharatpur (October) has a 232 mm. wing.

EL **Chlidonias hybrida hybrida** (Pallas) (S. Russia, S. Volga and Sarpa Lake).

1 ♂ *Sheik Saad, Mesopotamia*

This Sp. No. 14199 in non-breeding plumage has its wing larger (243) than another in breeding plumage from Mesopotamia listed under *C. h. indicus*. The latter has the tips of both first primaries blown off, but judging from the second primary (221 mm.) would have been under 230. It is possible that *indica* is resident and the nominate form a non-breeding migrant.

459 **Chlidonias leucoptera** (Temminck) (Coasts of the Mediterranean) Whitewinged Black Tern

4 : 2 ♂♂ 2 o ? (2 in breeding plumage, 30 April and 27 July).
2 *Somaliland*; 2 *Mesopotamia* (one male marked shot on nest).

Wing	207, 208, 209	Bill 21, 22, 23, 24	Tarsus 19(3), 20	Tail 66, 69, 70, 74
	(♂♀ IH 192-210)	(IH 23-24)	(IH 19-22)	(IH 67-75)

459a **Chlidonias niger niger** (Linnaeus) (near Uppsala, Sweden) Black Tern

nil.

460 **Gelochelidon nilotica nilotica** (Gmelin) (Egypt) Gullbilled Tern **6** : 117

26 : 12 ♂♂ 8 ♀♀ 6 o ? (5 with black caps).
1 *Lake Akkakurf, Iraq*; 1 *Warba Is.*, 1 *Bubiyan Is.*, *Persian Gulf*; 3 Mandvi, 1 Kandla, Kutch ; 2 Ghoti, Nasik, 1 Padgha, Thana, 7 Salsette, Bombay, 1 Pushpir Is., 1 Arnala Is., off Bombay, 1 Panvel, 2 Rewas, 1 Rewdanda, Kolaba ; 1 Edathur, 1 Neendakara, Kerala ; 1 Calcutta Market.

In an earlier note (1958 *JBNHS* **55** : 169-170) I had referred to some of the birds in the collection being smaller than indicated for the nominate form, and suggested that they were *affinis* (Horsfield), type locality Java. The five birds with black caps obtained between 26th March and 29th May from Bombay and westwards are larger than the others, with white heads, and are compared with three from near Calcutta presumably *affinis* q.v.

		Wing	Bill	Tarsus	Tail
♂♀	With black caps	315-330 av. 320	36-39 av. 37·8	32-33	116-133 av. 125
	Others	298-324 av. 306·5	34-40 av. 37·4	30-33	110-133 av. 119
	affinis	293, 295, 300	34, 38, 38	29, 32, 33	110, 110, 114

Without topotypical material of both races we can only assume, not unreasonably, that most of the specimens represent an intermediate population.

461 **Gelochelidon nilotica affinis** (Horsfield) (Java) Javan Gullbilled Tern **6** : 118

3 : 2 ♀♀ 1 o ? Khajir Bheri, Salt Lake, east of Calcutta.

See remarks under 460.

462 **Hydroprogne caspia caspia** (Pallas) (Caspian Sea) Caspian Tern **6** : 115

4 : 3 ♀♀ 1 o ?

2 *Warba Is.*, 1 *Persian Gulf*; 1 Manchar Lake, Sind.

463 **Sterna aurantia** J. E. Gray (India) Indian River Tern **6** : 125

13 : 9 ♂♂ 2 ♀♀ 2 o ?

1 Chandigarh, 1 Mubarikpur, Punjab ; 2 Indus Delta, Sind ; 1 Bodeli, Baroda ; 1 Seoni, 1 Saugor, M.P. ; 1 Poona, Maharashtra ; 1 Nellore, A.P. ; 2 Shahjehanpur, Kheri, U.P. ; 2 *Prome, Burma.*

	Wing	Bill	Tarsus	Tail
♂♂	260-290 av. 275	39-42- av. 40·6	20-21	134-215
♀	276	38	20	200
	(♂♀ 260-280	39-43	*c.* 20-22	178-228)

464 **Sterna hirundo hirundo** Linnaeus (Sweden) European Common Tern **6** : 130

8 : 3 ♂♂ 4 ♀♀ 1 o ?

1 *Somaliland* ; 2 *Hindia Barrage*, 1 *Basra*, 1 *Sheik Saad, Mesopotamia* ; 2 *Warba Island, Persian Gulf* ; 1 *Sib, Rohtak R., Persian Baluchistan.*

Five of these were listed under *Sterna repressa*, from which they can be separated by their longer wings and white, not grey, upper tail. Two immature birds (Nos. 14284 and 14286) have pale grey upper tail coverts. The broken wing tips in one and the shortest wings (255) in the other together with the absence of definitely identified juvenile skins of *repressa* renders their identification uncertain, unless the white underparts are a certainly diagnostic character (Cave & MacDonald 1955, BIRDS OF SUDAN, p. 159).

465 **Sterna hirundo tibetana** Saunders (Tibet) Tibetan Common Tern **6** : 130

3 : 1 ♂ 1 ♀ 1 o?
2 *Kashgar*, 1 *Yarkand, China.*

These birds differ from the nominate form in being slightly darker above, and by a distinct greyish tinge below cf. white in the latter.

466 **Sterna dougallii korustes** (Hume) (Andaman Islands) Roseate or Rosy Tern **6** : 132

1 ♀ North Button Island, Middle Andamans.

466a **Sterna macrura** Naumann (Island Nordstrand and coast of West Schleswig) Arctic Tern

nil.

467 **Sterna repressa** Hartert (Fao, Persian Gulf) Whitecheeked Tern **6** : 128

5 : 1♂ 3 ♀♀ 1 o?
2 *Dora Island*, 1 *Kubhai Island*, 1 *Persian Gulf*; 1 Ratnagiri, Maharashtra.

	Wing	Bill	Tarsus	Tail
♂♀	235-244	32-35	19(5)	124, 133, 136, 140, 141
	(227-254)	(36-38)	(*c.* 19-21)	(124-154)

468 **Sterna sumatrana sumatrana** Raffles (Sumatra) Eastern Blacknaped Tern **6** : 39

8 : 2 ♂♂ 5 ♀♀ 1 o? North Button Island, Middle Andamans.

469 **Sterna sumatrana mathewsi** Stresemann (Aldabra Islands, type from Ile Piquart) Western Blacknaped Tern

nil.

470 **Sterna acuticauda** J. E. Gray (Cawnpore, India) Blackbellied Tern **6** : 127

17 : 8 ♂♂ 8 ♀♀ 1 o? (3 with white underparts).
1 Ghaggar, 1 Madhopur, Punjab; 3 Delhi; 1 Saiat, Kaira, Gujerat; 2 Nellore, 1 Godavari Delta, A.P.; 1 Golapalli, Bastar State, 1 Kymore, M.P.; 1 Daspalla, Orissa; 2 Meerut, 1 Nahrosa, Pilibhit, U.P.; 1 *Henzada*, 1 *Burma*.

	Wing	Bill	Tarsus	Tail
♂♂	228-242 av. 235	37-42 av. 38·5	14-15	123-163
♀♀	228-235 av. 233	33-36 av. 35	14-15	116-167
	(♂♀ 221-240	32-40	*c.* 15-16	145-152)

The three birds with white underparts are dated 11th August and 22nd December (2), while those with black bellies are on various dates between 14th August (moulting) and 6th April.

471 **Sterna anaethetus anaethetus** Scopoli (Panay, Philippine Islands) Philippine Brownwinged Tern **6** : 141

472 **Sterna anaethetus fuligula** Lichtenstein (Red Sea) Red Sea Brown-winged Tern **6** : 142

nil.

473 **Sterna anaethetus antarctica** Lesson (Mauritius and Calcutta) Southern Brownwinged Tern

16 : 7 ♂♂ 2 ♀♀ 7 o?

1 *Muscat*, 4 *Persian Gulf*; 3 Bandra, 1 Colaba, 1 Bombay, 3 Bombay Harbour ; 1 Alibag, Kolaba ; 1 Ross Island, 1 off Narcondam, Andamans.

There has been confusion regarding the identity of some of these specimens. I am also unable to separate the three races accepted from our area (Abdulali, *JBNHS* **67** : 110).

474 **Sterna fuscata nubilosa** Sparrman (India Orientalis) Sooty Tern **6** : 144

nil.

475 **Sterna albifrons albifrons** Pallas (Holland) Little Tern **6** : 135

15 : 5 ♂♂ 6 ♀♀ 4 o?

1 *Somaliland* ; 3 *Mesopotamia*; 1 *Boonah Is., Persian Gulf*; 1 Karachi ; 2 Kandla, 1 Jamnagar, 1 Bhavnagar ; 1 Bombay Harbour ; 4 Rewas, Kolaba.

476 **Sterna albifrons saundersi** Hume (Karachi, Sind) Blackshafted Ternlet **6** : 138

9 : 5 ♂♂ 3 ♀♀ 1 o?

2 Karachi ; 4 Kandla, Kutch, 3 Pirotan, Gulf of Kutch.

477 **Sterna albifrons sinensis** Gmelin (China) Whiteshafted Ternlet **6** : 136

6 : 3 ♂♂ 3 ♀♀.

4 Uttan Washi, 2 Bhyander, Salsette, Bombay.

478 **Sterna bergii velox** Cretzschmar (Red Sea coasts) Large Crested Tern **6** : 120

11 : 9 ♂♂ 2 o? (1* fledgling ♂).

1 *Berbera, Somaliland* ; 1 *Muscat*, 1 *Quishim Is.*, 1 *Persian Gulf* ; 2 *Astola Island, off Mekran Coast* ; 1 Karupadanna, Cochin, 1 Travancore, 2 Kalyamkolumbur, Kerala ; 1 Baliapanni Atoll, Laccadives (fledgling *).

It is curious that the nine sexed specimens are all males. The two with all-black heads were obtained on Astola Island on 17th July 1906. One of them being marked 'Breeding'. The fledgling from the Laccadives was collected on 22 October, while the others in winter plumage (with the black of the head speckled with white) are between 25 November and 29 May.

479 **Sterna bengalensis bengalensis** Lesson (Coasts of India) Indian Lesser Crested Tern **6** : 124

14 : 7 ♂♂ 6 ♀♀ 1 o?

1 *Somaliland*; 1 *Buna Is., Persian Gulf*; 3 Versova, Salsette, 6 Bombay Harbour; 1 Neendakara, Kerala; 2 N. Button Is., Middle Andamans.

Three specimens obtained on 10th April (2) and 20th June have all-black heads. The others 7th February [through March (2), April (2), May (4)] to 29th May have black heads varyingly marked with white, and white foreheads.

No. 14252 a male from the Persian Gulf has one wing 320 mm., the other damaged and much shorter.

480 **Sterna sandvicensis sandvicensis** Latham (Sandwich, Kent, England) Sandwich Tern **6** : 119

2 : 1♂ 1 ♀.

1 *Texel, Holland* (juv.); 1 *Samarrah* (?), *Persian Gulf*.

481 **Anoüs stolidus pileatus** (Scopoli) (Philippines) Noddy Tern **6** : 145

4 : 1 ♀ 3 o?

3 Ormara, Mekran Coast, Baluchistan; 1 Laccadives.

482 **Anoüs tenuirostris worcesteri** (McGregor) (Cavilli Island, Sulu Sea) Whitecapped Noddy

nil.

483 **Gygis alba monte** Mathews (Seychelles) Indian Ocean White Tern

nil.

484 **Rynchops albicollis** Swainson (India) Indian Skimmer **6** : 150

5 : 3 ♂♂ 2 ♀♀ (* without head).

1 * Hyderabad, Sind; 3 Bulandshahr, U.P.; 1 *Padung, Prome Dist., Burma*.

Though most of the specimens are in poor condition and cannot be correctly measured, the males appear to have appreciably larger wings, bills, tarsi, and tails than the females.

(*to be continued*)

Studies in Indian Euphorbiaceae—IV[1]

The Genus *Agrostistachys* Dalz. in India, Burma and Ceylon

BY

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(*With two plates*)

Introduction

The genus *Agrostistachys* Dalzell (1850) aptly so named for its inflorescence resembling the graminaceous spikes was based on *A. indica* collected from an unspecified locality in northern parts of Western Ghats in peninsular India. From the southern parts of the Western Ghats, Wight (1852) described the monotypic genus *Sarcoclinium* based on *S. longifolium.* Baillon (1858) and Mueller Argoviensis (1866) treat these two genera separately. However, in 1880 Bentham united the two genera, reducing *Sarcoclinium* as a section of *Agrostistachys.* This has been followed by J. D. Hooker (1887) and Pax (1890). In DAS PFLANZENREICH, Pax & Hoffman (1912) raised *Sarcoclinium* to the subgeneric level when they monographed *Agrostistachys.*

While this genus is quite distinct and isolated in Euphorbiaceae, its systematic position is rather obscure and comparatively difficult to assess. It is obvious that this genus belongs to the subfamily *Crotonoideae* as treated by most authors. Pax & Hoffman (1931) place it under the subtribe Irregulares of the tribe Chrozophoreae. The closely related genera are *Pseudagrostistachys* Pax & Hoffm. and *Grossera* Pax, both natives of Africa and differing from the former in the presence of episepalous glandular disk and from the latter in the presence of pistillodes in male flowers. The subgenus *Agrostistachys* differs, from subgenus *Sarcoclinium* in the spikes being short, bracts closely imbricate and male bracts 1-flowered. The present study indicates that the earlier arrangement of Pax & Hoffman (1912) of *Sarcoclinium* as a subgenus of *Agrostistachys* to be appropriate.

Agrostistachys consisting of about 11 species is confined to the tropical and subtropical regions of southeast Asia. Apparently the genus is of East Malaysian origin, having its greatest diversity in the eastern parts

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[1] Part III in Bull. Bot. Surv. India 10 : 245 (1968)

of Malaya. This genus is represented by three species and two varieties in India, Burma and Ceylon. *A. hookeri* and *A. meeboldii* var. *coriacea* are endemic to Ceylon whereas *A. meeboldii* var. *meeboldii* is endemic to southern parts of Western Ghats in peninsular India. *A. indica* var. *indica* has a wide range of distribution in peninsular India, Ceylon, Indo-China and Malaya. *A. indica* var. *longifolia* is endemic to southern Burma.

The specimens studied and cited in this paper are from three herbaria of the Botanical Survey of India, namely, Central National Herbarium, Calcutta (CAL), Southern Circle Herbarium, Coimbatore (MH) and Western Circle Herbarium, Poona (BSI) and also from the herbarium of Royal Botanic Gardens, Kew (K). I thank the Keepers of these herbaria for their valuable help.

Agrostistachys Dalzell in Hook. Kew J. Bot. 2 : 41, 1850 ; Muell. Arg. in DC. Prodr. 15 (2) : 725, 1866 ; Benth. in Benth. & Hook. f. Gen. Pl. 3 : 302, 1880 ; Hook. f. Fl. Brit. Ind. 5 : 405, 1887 ; Pax in Engler & Prantl, Pflanzenfam. 3 (5) : 43, 1890 ; Pax & Hoffm. in Engler, Pflanzenr. 57 : 98, 1912, et in Engler & Harms, Pflanzenfam. ed. 2, 19C ; 96, 1931. *Sarcoclinium* Wight, Ic. Pl. Ind. Or. 5 : 24, t. 1887-1888, 1852 ; Muell. Arg. l.c. 726, 1866 ; Baillon in Adansonia 11 : 93, 1873. *Argythamia* sect. *Agrististachys* Post & Kuntze, Lexicon 43, 1904. *Heterocalyx* Gagnep. Not. Syst. 14 : 33, 1950.

Glabrous shrub or small tree. *Leaves* alternate, shortly petioled or subsessile, entire or serrate, denticulate, coriaceous, pinnately nerved, stipulate. *Flowers* dioecious, in axillary or supraxillary bracteate racemes or spike which are solitary or clustered ; bracts concave, striate, rigid. *Male flowers* : small, few or many within each bract, subsessile or shortly pedicelled. *Calyx* globose, splitting into 2-5-valvate lobes. *Petals* 5, rarely 6-8, shorter than calyx lobes or equal. *Disk* 5-glandular, episepalous, alternate with petals. *Stamens* 8-13, biseriate, outer epipetalous, filaments nearly free, tips subulate ; anther-lobes pendulous from the glanduliferous thick connective, free below, longitudinally dehiscing. *Pistillode* usually large, entire or 2-3-fid. *Female flowers* : solitary in each bract ; pedicels long. *Calyx* 5- or rarely 4-fid, lobes narrow, more rigid than male calyx. *Petals* longer than calyx lobes, deciduous. *Disk* of 5 glands, thick. *Staminodes* 0. *Ovary* 3-celled ; style bifid, spreading ; ovules one in each cell. *Capsule* of 3 two-valved cocci, crustaceous or sub-fleshy. *Seeds* sub-globose ; testa crustaceous, shining, ecarunculate ; albumen fleshy ; cotyledons broad, laterally flat.

Type species : *A. indica* Dalzell.

Distribution : About 11 spp. ; Peninsular India, Ceylon, Burma, Malaya, Indo-China, and Philippines.

KEY TO THE SPECIES OF *Agrostistachys*

1. Spikes short ; bracts closely imbricate, male bracts 1-flowered............................Subg. *Agrostistachys*
   2. Secondary nerves less than 15 pairs ; margins of leaves spinulose-dentate..........1a. *A. indica* var. *indica*
   2. Secondary nerves more than 16 pairs ; margins of leaves distantly denticulate, not spinulose..........................1b. *A. indica* var. *longifolia*

1. Spikes elongate ; bracts distantly placed, male bracts many-flowered....................Subg. *Sarcoclinium*
   3. Stipules small, less than 1 cm. long, broadly triangular.
      4. Capsules about 13 mm. wide............2a. *A. meeboldii* var. *meeboldii*
      4. Capsules about 8 mm. wide........2b. *A. meeboldii* var. *coriacea*
   3. Stipules large, more than 5 cm. long, lanceate, attenuate............ 3. *A. hookeri*

Subgenus I. AGROSTISTACHYS. Genus *Agrostistachys* Baill. Etud. Gen. Euphorb. 318, 1858. Section *Euagrostistachys* Hook. f. Fl. Brit. Ind. 5 : 406, 1887 ; Pax in Engler & Prantl, Pflanzenfam. 3, 5 : 43, 1890. Subgenus *Euagrostistachys* (Hook. f.) Pax & Hoffm. in Engler, Pflanzenfam. ed. 2, 19c : 96, 1931.

Spikes of both sexes axillary or supra-axillary, serially glomerate like short spines ; bracts densely imbricate, 1-flowered, lowermost bracts sterile. Pistillode entire.

1. **Agrostistachys indica** Dalzell in Kew J. Bot. 2 : 41, 1840 ; Dalz. & Gibs. Bombay Fl. 232, 1861 ; Muell.-Arg. in DC. Prodr. 15 (2) : 726, 1866 ; Beddome, Ic. Pl. Ind. Or. 1 : t. 241, 1874 ; Hook. f. Fl. Brit. Ind. 5 : 406, 1887 ; Trimen, Handb. Fl. Ceyl. 4 : 55, 1898 ; Talbot, Trees Bomb. ed. 2, 313, 1902 et For. Fl. 2 : 477, 1911 ; Pax & Hoffm. in Engler, Pflanzenr. 57 : 103, 1912 ; Gagnep. in Lécomte, Fl. Indoch. 5 : 466, t. 57, ff. 7-11 et. t. 58, ff. 1-2, 1926 ; Gamble Fl. Pres. Madras 1317, 1925 ; ibid Reprint ed. 921, 1957 ; Cooke, Fl. Pres. Bombay 2 : 605, 1906 ; ibid Reprint ed. 3 : 102, 1958 ; Bor, Man. Ind. For. Bot. 179, 1953 ; Airy Shaw in Kew Bull. 14 : 47, 1960. *A. longifolia* ssp. *genuina* Muell-Arg. in DC. Prodr. 15 (2) : 726, 1866. *A. gaudichaudii* sensu Hook. f. Fl. Brit. India 5 : 406, 1887 (non Muell.-Arg. 1866). *Heterocalyx laotica* Gagnep. in Not. Syst. ed. Humbert. 14 : 33, 1950.

Stout shrub, 1-2 m. tall, occasionally reaching up to 3 m. high, glabrous, except flowers ; branches tough, marked with scars of petioles and stipules. *Leaves* numerous, crowded, alternate, elliptic-oblong or oblong-lanceolate, spathulate, narrowed or cuneate at base, acuminate or bluntly caudate at apex, coarsely and sharply serrate with incurved spinulose teeth or minutely denticulate at margins, 12-48 cm. long, 4-15 cm. wide, coriaceous, glabrous ; secondary nerves 8-18 pairs, arched, prominent, tertiaries reticulate, faint ; petioles 2-6 cm. long, broad at base ; stipules ovate-lanceolate, subulate, acuminate, early deciduous, $\pm$ 1 cm. long. *Spikes* of both sexes axillary or supra-axillary, glomerate, clustered together, shorter than petiole, 7-15 mm. long, terete or slightly compressed ; bracts distichous, densely imbricate, ovate-acute, $\pm$ 4 mm. long, $\pm$ 3 mm. wide, finely serially ciliate outside and margins, basal bracts of each spike sterile ; flowers of both sexes solitary in axils of each bract, pedicellate. *Male flowers* : sepals 5, membranous, ovate-lanceate ; petals 5-8, white, rounded or subquadrate, lanceolate to obovate, equal to sepals ; disk glandular, large, 5-lobed ; stamens 8-13, anthers apiculate ; pistillode simple, undivided. *Female flowers* : solitary for each spike, pedicels with 3-5 scale-like sterile bracts at base ; ovary glabrous or minutely puberulous, disk cupular covering the base of ovary ; styles 3, each bifid. *Capsules* $\pm$ 1 cm. in diameter, 3-lobed, glabrous, reddish-brown, seeds globose, smooth, pale brown, $\pm$ 6 mm. in diameter.

Distribution : Peninsular India (Western Ghats), Ceylon, Burma, Indo-China and Malaya.

1a. var. **indica.**

Agrostistachys indica Dalzell in Kew J. Bot. 2 : 41, 1840. TYPE : *Dalzell* s.n. ! *A. longifolia* ssp. *genuina* Muell.-Agr. l.c. *Heterocalyx laotica* Gagnep. l.c. TYPE : *Kerr* 20895 (K !).

Leaves elliptic-oblong, acute at base, sharply spinulose-dentate at margins, 12-40 cm. long, 4-15 cm. wide : secondary nerves 15 or less pairs.

Flowering and Fruiting : February-May.

Distribution : Peninsular India (Western Ghats), Ceylon, Indo-China and Malaya.

Specimens examined : CEYLON : Without locality, *Alston* 261 (K) ; without locality, *Gardner* 781 (CAL) ; Central Provinces, *Gibson* 2156 (CAL) ; without locality, *Thwaites* CP 2156 (K) ; without locality, *Walker* 30 (K). KERALA : Wynaad, *Beddome* s. n. (K) ; Travancore, *Bourdillon* 16 (CAL, K) ; 53 (MH) ; 526 (K) ; Attapadi, Malabar, *Fischer* 2798 (CAL, K) ; Devicolam, Travancore, *Meebold* 13467 (CAL). TAMIL NADU : Coimbatore Dist., Paralai, *Barber* 4053 (CAL, K, MH) ; Anamalais, *Beddome* s. n. (K, MH) ; Anamalais, *Beddome* 80 (CAL) ; Ayyamalai, *Fischer* 4051 (CAL) ; Akkamalai, *Joseph* 15540 (MH). Madurai Dist., High Wavy Mountain, *Blatter & Hallberg* 909 (CAL) ; High Wavy Estate, *Gopalan* s. n. (MH). Tirunelveli Dist., Kannikatti, *Barber* 420 (MH) ; Tirunelveli, *Beddome* s. n. (MH) ; Tirunelveli, *Bourdillon* s. n. (CAL) ; Ichikuzhi, *Henry & Chandra Bose* 19914 (MH) ; Naterikal, *Hooper & Ramaswami* 38572 (K) ; 38641 (CAL) ; Naterikal, *no collector's name* 14471 (MH). MYSORE : Without locality, *Dalzell* s. n. (Type in

CAL, K); Bababudan Hills, *Law* s. n. (CAL); Jog Falls, *Puri* 2083 (BSI); Madanad, Coorg, *Puri* 31778 (BSI); Concan, *Stocks* & *Law* 59 (CAL); Yellehole, Agumbe, *Sundara Raghavan* 86467 (BSI); Barakana, Agumbe, *Sundara Raghavan* 97256 (BSI); Belgaum, *Talbot* 4003 (BSI); N. Kanara, *Talbot* s. n. (BSI). NO LOCALITY: Herb. Wight, *Wallich* 7452 (CAL, K); *Wight* 2610 (CAL).

1b. var. **longifolia** Muell.-Arg. in DC. Prodr. 15 (2): 726, 1866. TYPE: *Helfer* 4921 ! *A. longifolia* (Muell.-Arg.) Kurz, Prelim. Rep. Veg. Pegu, App. A: 111, App. B: 79, 1875 et For. Fl. Brit. Burma 2: 377, 1877. *A. gaudichaudii* Hook. f. Fl. Brit. Ind. 5: 406, 1887; Bor, Man. Ind. For. Bot. 179, 1953 (non Muell.-Arg. 1866). *A. indica* ssp. *longifolia* (Muell.-Arg.) Pax & Hoffm. in Engler, Pflanzenr. 57: 107, 1912.

Leaves subentire, minutely denticulate, spathulate, oblanceate, attenuate and narrowed at base, 24-48 cm. long, 5-11 cm. wide; secondary nerves 16-18 pairs. (Plate I).

Flowering and Fruiting: February-April.

Distribution: Endemic to south Burma.

Specimens examined: BURMA: Tenasserim, *Helfer* 4921 (Type in CAL, K); Island of Mergui, Tenasserim, *Proudlock* 51 (CAL); Heinze, *Russell* 1953 (CAL); Valley of Sidi Chang, Tavoy, *Russell* 133 (CAL); Tavoy, *Sungyi* 911 (CAL).

Subgenus II. SARCOCLINIUM (Wight) Pax & Hoffm. in Engler, Pflanzenr. 57: 99, 1912. Genus *Sarcoclinium* Wight, Ic. Pl. Ind. Or. 5: 25, t. 1887-1888, 1852; Baillon, Etud. Gén. Euph. 309, t. 11, ff. 17-18, 1858; Muell. Arg. in DC. Prodr. 15 (2): 726, 1866. *Agrostistachys* sect. *Sarcoclinium* (Wight) Benth. in Benth. & Hook. f. Gen. Pl. 3: 303, 1880; Hook. f. Fl. Brit. Ind. 5: 406, 1887; Pax in Engler & Prantl, Pflanzenfam. 3, 5: 43, 1890.

Spikes of both sexes axillary, solitary or fasciculate, elongate; bracts distantly arranged, male bracts many-flowered, female bracts single-flowered, pistillode 2-3 fid.

2. **Agrostistachys meeboldii** Pax & Hoffm. in Engler, Pflanzenr. 57: 100, 1912; Gamble, Fl. Pres. Madras 1318, 1925; ibid Reprint ed. 922, 1957; Bor, Man. Ind. For. Bot. 179, 1953. *Sarcoclinium longifolium* Wight, Ic. Pl. Ind. Or. 5: 24, t. 1887-1888, 1852; Thwaites, Enum. Pl. Zeyl. 279, 1861; Muell. Arg. in DC. Prodr. 15 (2): 727, 1866; Beddome, For. Man. 205, t. 23. f. 1, 1873. *A. longifolia* (Wight) Benth. ex Hook. f. Fl. Brit. Ind. 5: 407, 1887, excl. var. *malayana* et var. *latifolia* (non Kurz, 1875); Trimen, Handb. Fl. Ceyl. 4: 56, 1898; Talbot, Trees Bombay, ed. 2. 313, 1902 et For. Fl. 2: 478, 1911; Cooke, Fl. Pres. Bombay 2: 605, 1906; ibid Reprint ed. 3: 103, 1958; Bourdillon, For. Trees Travancore

341, 1908 ; Pax & Hoffm. l.c. 100, 1912. *A. coriacea* Alston in Trimen, Handb. Fl. Ceylon 6 (Suppl.) : 265, 1931.

Large shrub or small tree, 3-6 m. high ; branches terete, stout, glabrous, marked with scars of petioles and stipules ; bark thin, dark, resinous ; wood pale brown, moderately hard. *Leaves* numerous, crowded at the ends of branches, oblanceolate, spathulate, shortly or obtusely acuminate at apex, narrowed and gradually tapering into the petiole, entire, glabrous, coriaceous, leathery, 14-30 cm. long, 3-9 cm. wide ; secondary nerves 10-15 pairs, arched, prominent beneath; petioles broad at base, 5-15 mm. long ; stipules ± 2 mm. long, ovate, acute, coriaceous, caducous. *Spikes* of both sexes axillary, solitary, 8-14 cm. long, shorter than leaves ; rachis rigid, subglabrous ; bracts distantly placed, ovate, denticulate at margins, ± 2 mm. long. *Male flowers* 3-5 in each axil of bract ; pedicels 2-3 mm. long ; sepals 2-3, entire or lobed, acute, broad at base ; petals 5, ovate, denticulate at margins, subacute to obtuse at apex ; disk 5-glandular ; stamens 10, 5 within the disk, 5 outside, anthers apiculate ; pistillode 2-cleft. *Female flower* solitary in axil of each bract : sepal 5, free, ovate-acute to lanceolate-acuminate ; petals 5, ovate, obtuse, entire ; staminodes 5, subulate ; disk cupular, covering the base of ovary, entire ; ovary puberulous, styles 3, each bifid. *Capsale* depressed-globose, ± 6 or ± 8 mm. long, ± 8 or ± 13 mm. wide, rugulose, minutely pilose or subglabrous ; seeds oblong, subglobose, 5-6 mm. in diameter.

Distribution : Western Ghats of Peninsular India and Ceylon.

2a. var. **meeboldii**. *Agrostistachys meeboldii* Pax & Hoffm. l.c. *Sarcoclinium longifolium* Wight, l.c. TYPE : *Wight* 2612 ! *A. longifolia* (Wight) Benth. ex Hook. f. l.c. 1887 (non Kurz 1875).

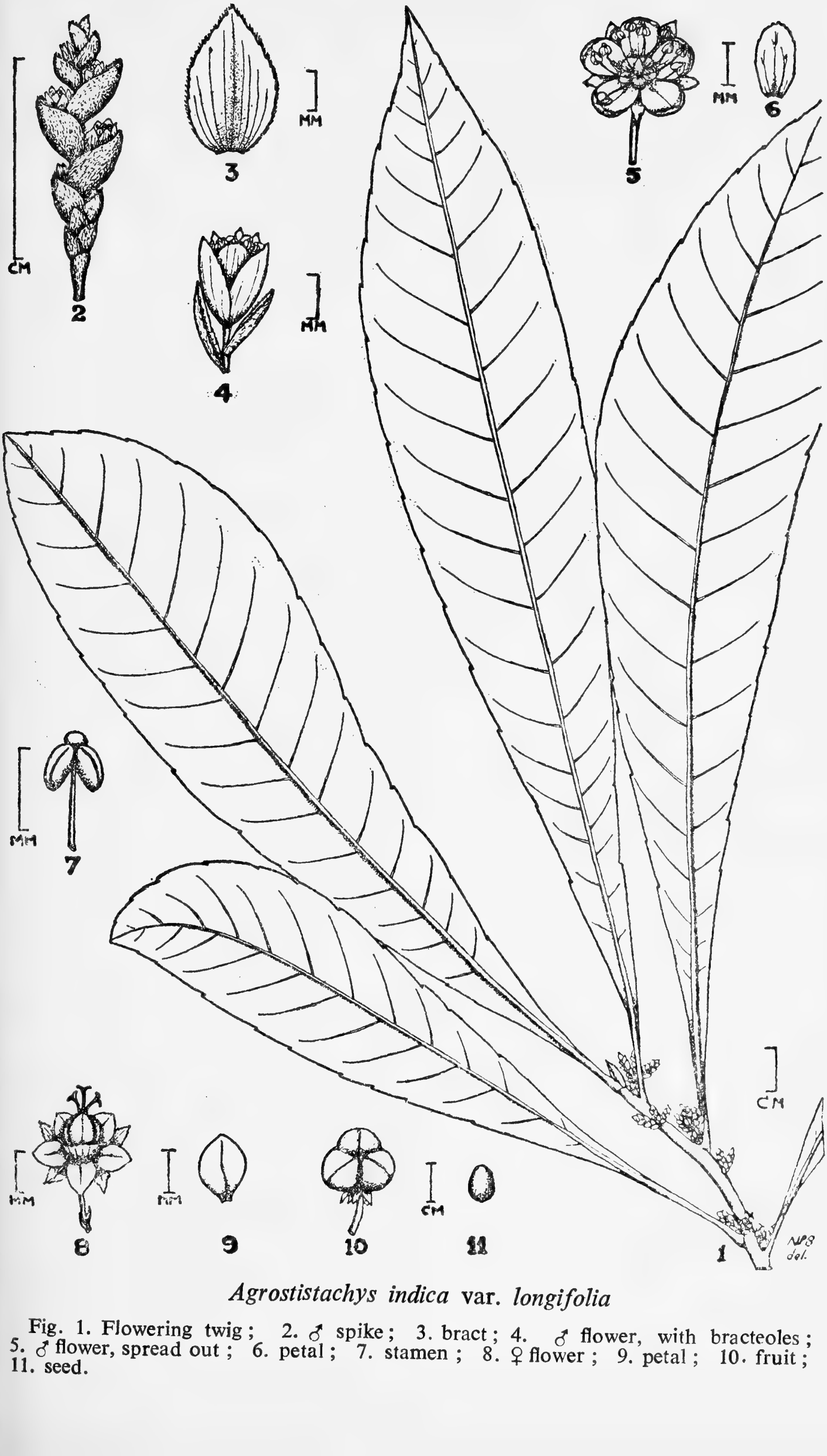
Leaves 14-30 cm. long ; capsule ± 13 mm. wide, ± 8 mm. long. (Plate II).

Flowering : August-October ; *Fruiting* : December-February.

Distribution : Western Ghats of Peninsular India.

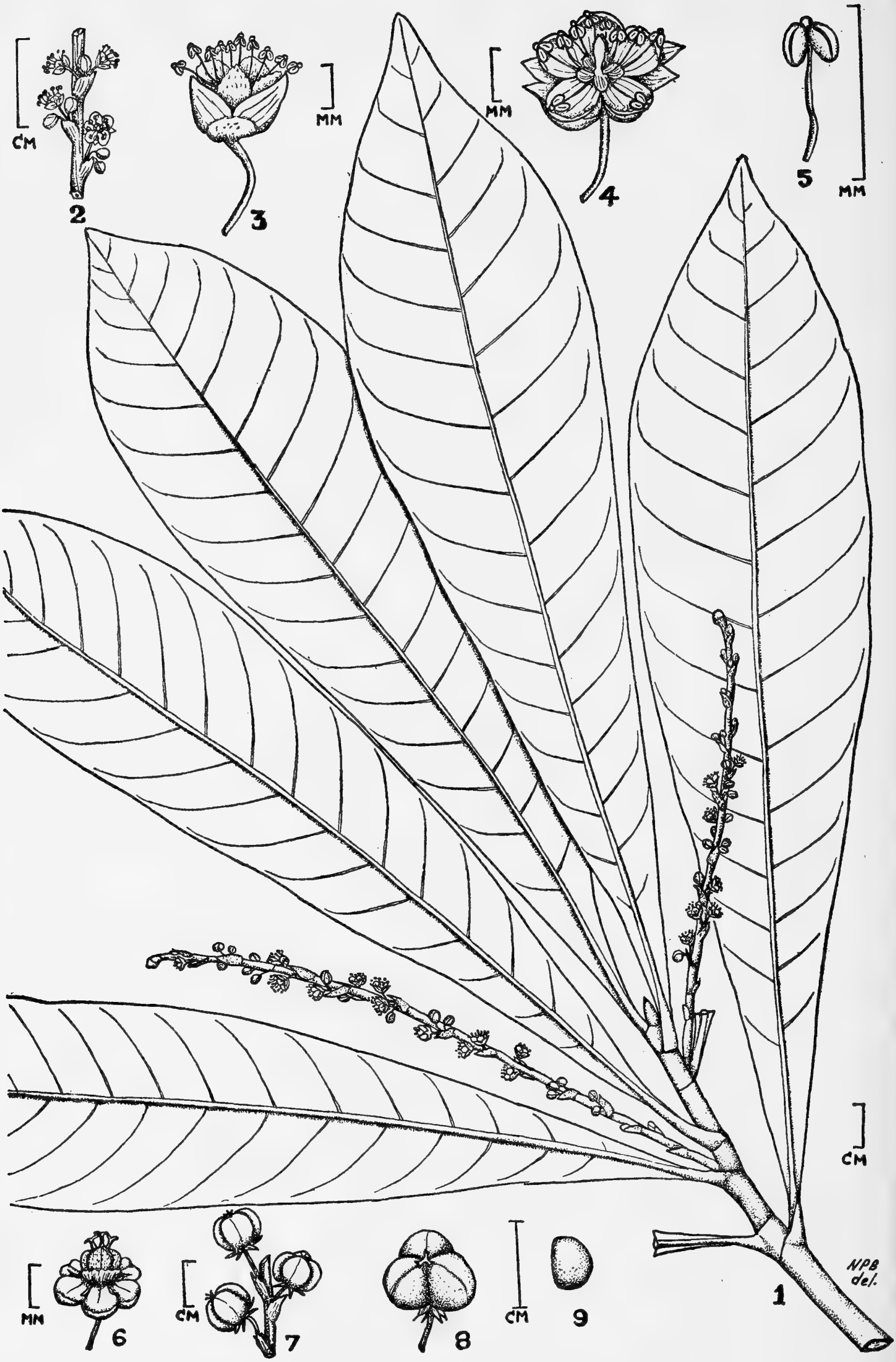
Specimens examined : KERALA : Wynaad, Malabar, *Beddome* s.n. (MH) ; Wynaad, *Gamble* 15428 (CAL, K) ; Calatoorpoly, Travancore, *Lawson* 102 (CAL, K) ; Udumbansholay, Travancore, *Meebold* 13079 (CAL). TAMIL NADU : Monica, Anamalais, *Barber* 3875 (CAL, MH) ; Poonachi, Anamalais, *Barber* 8441 (MH) ; Anamalai Hills, *Beddome* 95 (CAL) ; Iyerpadi, Anamalais, *Fischer* 3713 (CAL) ; Sispara Ghat, Nilgiris, *Gamble* 14465 (CAL, K) ; Kannikatti, Tirunelveli Distt., *Jacob* s.n. (MH) ; Courtallam, *Wight* 2612 (Type in CAL, K) ; Naterikal, Tirunelveli

Balakrishnan: Genus *Agrostistachys.*



Agrostistachys indica var. *longifolia*

Fig. 1. Flowering twig; 2. ♂ spike; 3. bract; 4. ♂ flower, with bracteoles; 5. ♂ flower, spread out; 6. petal; 7. stamen; 8. ♀ flower; 9. petal; 10. fruit; 11. seed.



Agrostistachys meeboldii var. *meeboldii*

Fig. 1. Flowering twig ; 2. part of male spike ; 3. ♂ flower ; 4. the same, spread out ; 5. stamen ; 6. ♀ flower ; 7. part of fruiting spike ; 8. mature fruit ; 9. seed.

Distt., *no collector's name* 14513 (MH) ; Anamalais, *no collector's name* 83564 (MH). MYSORE : N. Kanara, *Talbot* 1600 (BSI, CAL).

2b. var. **coriacea** (Alston) Balak. stat. nov. *Sarcoclinium longifolium* sensu Thwaites, Enum. Pl. Zeyl. 279, 1861 (non Wight et auctt. plnr.). *A. longifolia* sensu Trimen, Handb. Fl. Ceylon 4 : 56, 1898 ; Pax & Hoffm. in Engler, Pflanzenr. 57 : 100, 1912 (non Kurz 1875). *A. coriacea* Alston in Trimen, Handb. Fl. Ceylon 6 (Suppl.) : 265, 1931. TYPE : *Thwaites* CP 596 A !

Leaves 10-20 cm. long ; capsule ± 8 mm. wide, ± 6 mm. long.

Distribution : Endemic to Ceylon.

Note : This variety differs from var. *meeboldii* in having smaller leaves and smaller fruits only. These differences do not justify a specific rank.

Specimens Examined : CEYLON : *Gardner* 785 (CAL, K) ; Hills of Kandy, *Macrae* 46 (K) ; *Thwaites* CP 596 A, B (Type in CAL, K) ; *Walker* s.n. (CAL, K) ; *Wallich* 1318 (K).

3. **Agrostistachys hookeri** (Thw.) Benth. in Benth. & Hook. f. Gen. Pl. 3 : 303, 1880 ; Hook. f. Fl. Brit. Ind. 5 : 406, 1887 ; Trimen, Handb. Fl. Ceylon 4 : 54, 1898 ; Pax & Hoffm. in Engler, Pflanzenr. 57 : 103, 1912 ; Alston in Trimen, Handb. Fl. Ceylon 6 (Suppl.) : 264, 1931 ; Abeysundere & Rosayro, Checklist For. Trees Brit. Emp. 4: 26, 1939. *Sarcoclinium hookeri* Thw. Enum. Pl. Zeyl. 4 : 279, 1861 ; Baillon, Étud. Gén. Euph. 310, t. 11, ff. 17-18, 1858 ; Muell.-Arg. in DC. Prodr. 15 (2) : 727, 1866. TYPE : *Thwaites* CP 3429 A !

Moderate-sized tree, 8-10 m. high; branches thick, glabrous. *Leaves* subsessile, oblanceolate, spathulate, minutely glandulose-denticulate or subentire, cuneate to attenuate at base, shortly acuminate at apex, coriaceous, 55-66 cm. long, 10-15 cm. wide ; secondary nerves 35-50 pairs, spreading horizontally, straight or slightly curved, prominent beneath ; petiole thick, very broad-based, 5-20 mm. long ; stipules lanceate, acuminate, broad at base, rigid, 3-6 cm. long, striate, brown, subpersistent. *Male flowers* : unknown. *Female flowers* : Spikes 30-50 cm. long, equal to or shorter than leaves, slender, rigid, glabrous; bracts distantly placed, ovate-lanceolate, ± 3 mm. long ; pedicels solitary in each bract axile, ± 1·5 cm. long, articulate near middle, spreading laterally ; calyx-lobes 4, minute, ± 1·5 mm. long, triangular, subequal, puberulous at margins ; disk 4-lobed ; ovary sparsely tomentose ; styles 3, thick, short, 2-fid up to middle ; branches emarginate, bifid. *Capsule* sub-baccate, ± 2 cm. wide, + 1·3 cm. long, trigonous, black ; cocci obtusely angled ; seeds brown, subglobose, ± 1·5 cm. in diameter.

Distribution : Endemic to Ceylon.

Note : This species known only from the type collection is characteristic in having very large leaves and stipules. The male flowers are still unknown.

Specimens Examined : CEYLON : *Thwaites* CP 3429 A, B, C. (Type in CAL, K).

Reviews

1. THE VANISHING JUNGLE. By Guy Mountfort. pp. 286 (16×24 cm.). Illustrated with coloured and black-and-white photographs by the author, Eric Hosking and others. London, 1969. Collins. Price 63*s*. net.

As the subtitle explains this is the narrative of the two expeditions to Pakistan under the auspices of the World Wildlife Fund in order to make a first hand assessment of the present status of the varied and once prolific wildlife of the two wings of Pakistan. The expeditions, under the author's leadership, were undertaken at the invitation of the Pakistan Government, with full official co-operation and the active participation of knowledgeable naturalists residing in Pakistan.

Apart from his fame as joint author of A FIELD GUIDE TO THE BIRDS OF BRITAIN AND EUROPE Guy Mountfort is best known to Nature Conservationists throughout the world for his share in saving the Coto Donana in southern Spain as a Nature Reserve from threatened disintegration, and for his studies of the wildlife problems of Jordan in 1963 and 1965 and the recommendations which led to the creation of the Azraq Desert National Park and to other far reaching measures for the preservation of the wildlife of that country. His present recommendations also seem to have received full approval of the Pakistan Government. Some of them have already been implemented and it is to be hoped that others, for the creation of sanctuaries for species endangered through the rapid industrialization of the country and the destruction of their natural habitats, will also bear fruit. It is unfortunate that the book saw the light just as President Ayub Khan was quitting the political scene. It was from the President's personal interest and wholehearted co-operation that further adequate implementation of the recommendation was confidently expected. One can only hope that his successors will endorse the wisdom of the measures proposed and do everything possible to put them through with vigour and efficiency. Indeed, the status of several of the more spectacular species such as the Markhor, Ibex and Shapu in West Pakistan, and the tiger and most of the cats in East Pakistan seems to be extremely precarious and becomes increasingly imperilled by the absurdly high prices currently offered for their skins in the world market. Unless such action as recommended by the survey team is initiated immediately, it may be in one human generation or less that some of these interesting animals become extinct. To those familiar with the sordid story of the near-vanished Blackbuck on the subcontinent this may not sound such a fanciful prediction.

The narrative accounts of the expeditions are of absorbing interest as one would expect from the author of PORTRAIT OF A WILDERNESS and of A RIVER, and A DESERT. They describe the country, its human and animal inhabitants and their habitats, the descriptions of the Cholistan Desert and Punjab Salt Range of West Pakistan, and the Chittagong Hill Tracts of the eastern wing being the most fascinating and vivid. The book is fully and appropriately illustrated with some remarkable coloured as well as black-and-white photographs mostly the author's and Eric Hosking's They are of an excellence that is inseparable from the work of this gifted nature photographer. Among several other photographs the two I find especially commendable are of a Lagger Falcon at p. 52 by the author himself, and of an adult tigress at p. 212 by George Schaller—the latter amongst the finest pictures of a wild tiger I have seen. At the same time I am constrained to observe that some inexplicable slip seems to have occurred in captioning the lower photo at p. 220 as a Red Junglecock. It is most definitely not that bird; the large comb, the loosely dangling lappets and squamated plumage all belie its identity!

There are also some other slips of fact and proof reading which could easily have been avoided; thus on p. 46 *Saccharum bengalensis* is referred to as a tall tree, and on p. 51 as a tall grass (on p. 114 spelt *Saccarum*). In the former case *Ficus bengalensis* is obviously meant. On p. 72 *Pycnonotus* spelt with an *i*. On p. 113 hearing of the song of the Malabar Whistling Thrush is mentioned; however, East Pakistan is entirely out of the range of that species.

The four Appendixes giving the expeditions' observations on the mammals of Pakistan, a list of amphibians and reptiles, a list of birds observed in Pakistan, and Notes on Photography (by Eric Hosking) are of great usefulness. A selected Bibliography precedes the index. Incidentally Corbett's famous book is entitled MAN-EATERS OF KUMAON and not *India* as mentioned in the bibliography!

Apart from these minor though unfortunate blemishes the book makes a valuable, timely, and highly readable contribution to the topic of nature conservation in the Indo-Pakistan subcontinent and will appeal to every lover of Nature.

S. A.

2. THE SPOTTED SPHINX. By Joy Adamson. pp. 224 (24 × 16·5 cm.). With numerous black and white photographs, and 14 coloured plates. London, 1969. Collins & Harvill Press. Price 45*s*. net.

How wonderful Joy Adamson is. It is a unique achievement to keep the affection and trust of a cheetah living in the wild, so that she will take you to see her new-born cubs, sitting and waiting patiently when you cannot go as fast as she can. Readers of the Elsa books will know that it is not easy to rehabilitate a young carnivore, and this book makes it quite clear that to do it successfully you have to arrange your life to suit the animal. Mrs. Adamson and her assistants walked miles every day in difficult country, carrying meat for Pippa and her cubs, who might be anywhere in a wide territory, and who might not even be hungry. She also helped the cheetah family through several illnesses, deticked them and fed them vitamins, and worried endlessly over them. Her reward was the knowledge that Pippa instead of being a pet was living a free, full, and independent life, and a great deal of information about cheetah behaviour which could not have been obtained in any other way.

A few miles away from Mrs. Adamson her husband George has his camp, where he is rehabilitating lions, as described in BWANA GAME. There is a difference between them. One feels that Mr. Adamson is accepted by the lions as a lion, and his camp is the headquarters of the pride. Mrs. Adamson's is the even greater achievement of a friendship on equal terms between a human being and a wild animal, a relationship she had once before, with Elsa the lioness. Pippa did not care for the camp and seldom visited it. She was also much more secretive and less demonstrative than the lions in her affection. Altogether, lions have much more personality than cheetahs. But cheetahs grow on one the more one looks at the magnificent photographs that illustrate this book. They are such elegant long-legged cats, whether jumping, running, climbing, or merely sprawled on the ground; the cubs are charming and grew into leggy juveniles. Those slender legs seem to be the cheetah's weak point. Sprains and fractures were frequent in Mrs. Adamson's cheetah family. Altogether, the mortality among Pippa's cubs was very high; two of her four litters were lost soon after birth. A little leopard cub called Taga makes a brief but memorable appearance.

Those of us who lack the capacity to live as Mrs. Adamson does, but who enjoy living her life vicariously, will hope for another book continuing the story of Pippa, who remains in many ways, the spotted sphinx of the title.

R. R.

3. THE KINGFISHER. By Rosemary Eastman. pp. 159 (21·5×14 cm.). With four colour, and four black and white plates and a map. London, 1969. Collins. Price 30*s*. net.

Out of the 84 existing species of Kingfishers in the world, only one *Alcedo athis* is found in Europe and England. In India we have a dozen species including *Alcedo athis*. They are, as everyone will admit one of the most attractive group of birds, but because they nest in tunnels excavated by themselves in mud banks, not much has been known of their nesting behaviour in the early stages after the young are born. The husband and wife team of Ron and Rosemary Eastman, by means of assiduous observation and ingenious photography on the river Test around their home in Hampshire, have produced a fascinating book in which they reveal the intimate secrets of the life of the Common Kingfisher. To give one example their photographs indicate that the final part of the dive inside the water is executed with eyes closed. Obviously to get a photograph of this nature an artificial tank was built inside the river, in the territorial area most favoured by the pair under observation. The recording was done at 300 Frames per second, and the camera focussed at a depth of about 14 inches in the water. The results are magnificent. Apart from the photographs of under-water dives, there is a unique photograph of kingfishers mating, of a youngster with its black feet (as against the red of the adults) and tiny white spot at the end of its bill; of a female with its rose coloured under-mandible, the only distinguishing external feature between the sexes.

To photograph young nestlings inside the nest Ron removed the natural earthen ceiling of the tunnel and replaced it with a plywood substitute. The next day in full sunlight the ceiling was removed by slow stages and the six young were photographed. Surprisingly the parents did not appear to be unduly disturbed by this unusual situation.

The remarkable film produced by the Eastmans 'The Private Life of the Kingfisher' has proved 'one of the most sought after of all natural history films', and since then the Authors have an assignment for the BBC for a 'Private lives' series which is eagerly awaited.

Z. F.

4. A WEALTH OF WILDFOWL. By Jeffery Harrison. Illustrated by Pamela Harrison. Introduction by Peter Scott. pp. 176 (17×21·5 cm.), with many illustrations. London, 1967. Andre Deutsch Limited. Price 30*s*. net.

This is the eighth of a series of 'Survival Books' published along with television documentaries on wildlife. The name of the author, together with an introduction by Peter Scott and illustrations by Pamela Harrison, promises a wealth which certainly exists.

This book primarily deals with conditions in the United Kingdom, but the main problems of providing ducks, geese, and swans with secluded breeding and safe feeding grounds apply not only to all parts of the world but also to all forms of wildlife. The damage done by the reclamation of large areas of marsh-land, and by the new sportsman (supplemented in India by the crop-protection licence-holder) who 'shoots at anything that flies caring nothing for the law', is accentuated by that caused by nuclear testing, electric powerlines, and lead shot (one pellet swallowed is said to be sufficient to kill a bird). Rapidly deteriorating conditions in the early 'fifties have been checked by the 'marriage' between the wildfowlers and the conservationists which appears to have been achieved in the United Kingdom. The book examines in detail the earlier efforts, the negotiations, and the present successful collaboration.

Normal duck-shooting in India is different from wildfowling, but twenty years ago every largish village pond in the Konkan near Bombay held a few migrant duck and almost every snipe shoot produced a teal or two flushed out of some secluded piece of water. The duck population here (and perhaps all over India) was never so concentrated as it appears to be in the United Kingdom (22,000 birds in Greater London in the cold weather) but the same reasons, drainage and the new sportsman, have changed conditions so that a duck is now rarely seen except on the larger lakes and rivers.

The book goes into great detail, listing the food known to be taken by the different species at different times of the year. One method of preserving the whole alimentary tract for the identification of its food is given in some detail. The author suggests that plans for new reservoirs should be conditional on shallow areas being set aside as reserves. In India, one can only hope for the early removal of the 'hard-core conviction that all sportsmen are villains'; unless this happens, the 'marriage' which is so essential for conservation cannot be achieved.

This book should be read and studied by all interested in or associated with wildfowl or any other form of wildlife, for it has the pattern and knowledge which can only be exhibited by one who is a personal example of the 'marriage' within himself.

H. A.

5. THE WHITE IMPALA: THE STORY OF A GAME RANGER. By Norman Carr. pp. 190 (21 × 14 cm.). One coloured and 17 half-tone illustrations. One map. London, 1969. Collins. Price 36*s*. net.

The author spent his early childhood in a British concession at the mouth of the Zambezi River, where his imagination was fired by travellers' tales of hunting in the interior of Africa. As a schoolboy in England he took little interest in scholastic studies, in the opinion of his headmaster failing to attain even the 'abysmally low standard' he set himself. On rejoining his parents on a tobacco farm in what was then Nyasaland he set out on the long longed-for hunting adventures, and by the age of twenty had accounted for his fiftieth elephant; he frankly confesses that much of this was pure poaching, and it is probable that many an elephant for the destruction of which he was rewarded with the ground tusk could really not be tracked back to a 'garden' which it had raided. Fortunately, before he had gone long in this career he was called to responsible work, work entirely to his heart, by being appointed Elephant Control Officer in the Luangwa valley in northern Rhodesia (now Zambia). As was to be expected, he entered on his duties with enthusiasm and in his very first season shot 200 elephants! After an interruption of five years of military service during the Second World War he resumed duty in the newly-established Game Department and, as not unusually happens, his impelling motive imperceptibly changed from the urge to kill to an interest in the animals themselves, both big and small, and he found himself making observations of natural history interest and thinking in terms of control by the establishment of extensive sanctuaries at safe distances from human cultivation. After a spell as Game Warden, he finished up as a professional Hunter, in which capacity he inaugurated his 'wilderness trail', his name for walking tours in which a white hunter conducts a party of four or less tourists in a non-hunting round of the game reserves.

With his background, the author has much of interest to tell the reader. I find it difficult, however, to accept his story of the wonderful African porters who carried his baggage on erect outstretched arms and walked across flooded streams with 'their heads completely immersed'. I am also unable to figure out from his map how, on his way to report for military duty, his direct route from the Congo-Tanganyika border was a trek 'due west' to Mpika, the headquarters of the District Commissioner.

The book concludes with a chapter on wildlife control in which the author points out that conservation of habitat is as important as conservation of wildlife, meaning animal life thereby, and that proper wildlife management may actually involve a regular 'cropping' of wildlife and thus provide an additional source of income.

Several good photographs of wild animals add to the attraction of the book.

D.E.R.

6. INDIAN THYSANOPTERA. By T. N. Ananthakrishnan. pp. 171 (24×16 cm.) with 10 plates and 38 text-figures. New Delhi, 1969. Publications and Information Directorate, C.S.I.R. (Zoological Monograph No. 1). Price Rs. 26; 52*s*.; $ 8.

Books on Indian entomology are few and those written by H. M. Lefroy, T. B. Fletcher, C. F. C. Beeson, T. V. R. Ayyar and others, though very useful have become dated and are also of general nature. The Indian Fauna volumes (Insects) mainly give descriptions of adult insects. Only a very few exceptions such as Vol. V on Moths, by Bell & Scott give life history and description of immature stages. The Council of Scientific and Industrial Research, therefore, has done well in deciding to publish comprehensive monographs on important subjects in zoology. The selection of Thysanoptera for the first monograph is fortunate as there is no comprehensive compilation on this group though a very large number of papers have been published by various authors in a number of periodicals. The extremely small insects of this order cause extensive damage to agricultural and horticultural plants but the insects themselves are not easily detected by laymen till the damage is done. The book will fill a badly needed want in this field for college students, research workers and the modern farmer.

The book is divided into six sections. The first deals with bionomics in which ecology, variations in the population according to the climatic and topographic conditions, their habit of deforming plant tissues in a variety of ways, predation etc. are described and their insect enemies are mentioned. The second deals with taxonomy, including a general survey of the work so far done and keys to the two main suborders, super families, families, subfamilies, tribes and Indian genera. The keys are not quite clear. For instance out of the four families in Terebrantia mentioned by the author, genera of only two are described probably because there are practically no species in India belonging to the other two families. If so this should have been mentioned. Similarly under the suborder Tubulifera the arrangement of genera is not made under each subfamily as is done in Tere-

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brantia—Thripidae. These two suggestions, I hope, will be kept in mind for the next edition.

General morphology is dealt with in the 3rd section and reproduction and development forms the 4th section. The 5th section in which structural diversity in natural populations of thrips is discussed is very interesting. According to the author the differences in individual adaptability to environments are brought about by diverse gene patterns. How this works and variability is brought about even in the same species and populations is discussed. The sixth describes economic importance of thrips in relation to agriculture and horticulture, and important species of crop pests are mentioned.

The book includes an useful appendix containing a classified list of species of Indian Thysanoptera as well as an exhaustive list of references. A number of good illustrations enhance the value of the book.

N.T.N.

7. WATERFOWL IN AUSTRALIA. By H. J. Frith, Chief, Division of Wild Life Research, C.S.I.R.O. pp. xxi+328 (16×24 cm.) with many illustrations. Sydney, 1967. Angus & Robertson Ltd. Price $10.00.

Of the 23 species of Waterfowl in Australia, two are introductions (Mallard and Mute Swan) and two strays (Shoveller and Garganey) the other 19 being resident with no regular breeding or non-breeding migrants unlike other parts of the world.

A chapter is devoted to each species and the amount of information offered is in marked contrast to the little we know in our country about our birds! The crop contents of several hundreds of each species have been examined in detail and the proportion of vegetable and/or animal food in different parts of the year is indicated, associating this with the change in water-level which appears to be the main factor controlling the inland, but often extensive, movement of waterfowl. Call notes of some of the species are expressed in sonograms, while banding has been carried to such a great extent that, though a lake may appear to hold the same number of birds at different times, it is possible to state whether it consists of the same birds or there has been a change in individuals.

As in other Australian groups, the waterfowl include strange and exceptional species like black swans, the musk duck, and the magpie geese.

Excellent photographs of birds in their natural habitats accompany the text, including one of swans flying across in which neck-bands placed on them for purposes of individual recognition are visible.

The bibliography at the end contains 101 titles, including 16 by the author himself who is conducting researches into the biology of the different species on behalf of the C.S.I.R.O. as Chief of its Division of Wild Life Research.

While the book may not be of particular interest to the average sportsman or bird-watcher in India, it contains a great deal of information (including some on the Cotton Teal, a race of which is resident in Australia) and is indispensable as a work of reference on any study of waterfowl. It can only be hoped that some attempts at such studies, which were obviously in close collaboration with sportsmen, will be taken up in India before it is too late.

H.A.

8. HANDBOOK OF FERN GARDENING. By P. Kachroo. pp. 39 (23·75×16 cm.) with 12 plates & 15 text-figures. New Delhi. 1968. Indian Council of Agricultural Research. Price Rs. 4.

The Indian Council of Agricultural Research is devoting considerable attention to gardening and has published several books dealing with various garden plants.

This book like Prof. Kachroo's ROCK GARDENING IN THE HILLS is meant for the amateur gardener who takes an interest in the nature of the plant material with which he deals. The chapters on potting and culture are specially useful.

A large number of garden ferns are described with some very good drawings, and photographs, which make identification quite easy. One only wishes there were a few more drawings, as some of the more difficult varieties to identify are not illustrated.

At the end is a glossary of botanical terms which should be most useful.

A.J.A.

9. THE COMPLEAT FLEA. By Brendan Lehane. pp. x+126 (21·5×13·5 cm.). With 8 half-tone plates and 7 illustrations in the text. London, 1969. John Murray. Price 25*s*. net.

This delightfully written little book is the result of a writer's obsession with fleas, which developed after he shared a flat with them in Dublin. Few people can feel an affection for these pests—even Mr. Lehane admits his fondness grew with absence; but fleas *are* fascinating as compared with other parasites. In the first place they are complicatedly and beautifully adapted to their way of life; and in the second, they are so active that catching them needs concentration and skill and has something of the excitement of the chase. Anyone who has hunted down and despatched animal fleas (the human variety now having been banished from polite society by hygiene and D.D.T.) will recognise the expression of quiet satisfaction and absorption of the lady in the picture reproduced opposite page 39 who is about to crack a flea between her fingernails. The time was, however, when it was considered no disgrace to have fleas, and a poet could address a poem to his lady's fleas without feeling that they detracted at all from her charms. Fleas provided entertainment in flea circuses and they had their supporters—in Aesop's fables fleas play a firmly moral role—, but William Blake expressed most people's feelings when he painted the ghost of a flea as a muscle-bound man with talons and a bowl for collecting blood.

Scientific study began comparatively late. Robert Hooke made a detailed engraving of a flea in 1665, and van Leeuwenhoek examined them under his microscopes and refuted the theory of spontaneous generation on their behalf. It was not till 1898 that a Japanese scientist, Ogata, suggested that rat fleas carry plague to man, and 1910 when the Plague Commission confirmed that this was the main method of transmission. Mr. Lehane also touches briefly on more recent work on fleas, especially that of the Hon. Miriam Rothschild on the complicated life-history of the rabbit flea.

The style is so easy that one tends to overlook the amount of scholarship that has gone into the writing of this little book. There is a lot here to amuse and delight scientist and non-scientist alike.

R.R.

10. PREHISTORIC ANIMALS AND THEIR HUNTERS. By I. W. Cornwall. With illustrations by M. M. Howard. pp. 214 ($21 \cdot 5 \times 16$ cm.). 29 drawings. London, 1968. Faber and Faber. Price 42*s*. net.

This is a book on prehistory with a difference. There are many books on prehistoric man, and others on the evolution of the animals we know today as well as their extinct relatives and ancestors. This one is about the environment of early man, and his relationship with the animals of his time. It was a changing environment, and adaptability was at a premium for survival. During successive glaciations the ice at the poles extended, and the temperate zones shrank; while in the interglacial periods the ice retreated and the climate became warm and temperate. Early man competed with the cave lion and the cave bear for his home, while the forests and plains of the northern hemisphere supported a rich mammalian fauna. The most spectacular species in what is now Europe were probably the bison *Bison priscus*, the mammoths *Mammuthus primigenius* and others, the woolly rhinoceros *Tichorhinus antiquitatis* and other species of rhinoceros. The earliest hominids, the Australopithecines, seem to have lived on small animals like snakes, lizards, and rodents, which they could kill with their simple tools. Their defence against the large predators depended on agility and cunning. The earliest cutting tools are attributed to another hominid, *Homo habilis*. These made man a big game hunter, able when in groups to attack even the big carnivores. After this, man continued to perfect his killing and trapping techniques. He also became a domesticator of some useful species He probably did not contribute very greatly to the extinction of the great mammals of his time. He was certainly aware of the necessity of the survival of the species he most commonly used for food. The well known cave paintings of human beings and animals are believed to be part of magic rites to ensure fertility of both man and animals. Nevertheless there are instances of wholesale slaughter. The upper Palaeolithic people of Solutré drove herds of the wild horse *Equus caballus* over a steep cliff, as evidenced by the numerous remains at the foot of the cliff. Similarly, accumulated remains in Magdalenian deposits show where man camped at strategic sites along the routes of migrating reindeer and killed large numbers of them.

However, men were not then numerous enough to seriously endanger the existence of species. The major factor which led to the disappearance of many species must have been changes in climate and biotope. Many species were so well adapted to particular biotopes, and so restricted to them, that their presence in a particular place at a particular time can be used as an indicator of the prevailing climate. Thus, of three contemporary rhinoceros species, *Tichorhinus antiquitatis* was confined to arctic tundra, *Dicerorhinus hemitoechus* to grassland, and *D. kirchbergensis* to deciduous forest. There are also mysteries, such as why horses should have become extinct in the New World, when they migrated successfully to survive the glacial periods of the Old World. Modern man is endangering many animal species by being so numerous as to destroy biotopes but, the first time in the history of the world, he has the knowledge and the technology at his command to preserve other species. It remains to be seen whether he will make use of his unique opportunity.

The illustrations add greatly to the enjoyment of this fascinating book, and are a tribute not only to Mr. M. M. Howard but also to the accurate observation and skill of the primitive artists.

R.R

Miscellaneous Notes

1. FIRST POSITIVE RECORD OF *PIPISTRELLUS SAVII* (CHIROPTERA: VESPERTILIONIDAE) FROM INDIA

The only records of the Sind Bat, *Eptesicus nasutus* (Dobson), from the Indian subregion are from localities in what is now West Pakistan (Siddiqi 1969:9) and from a specimen identified by Tate (1942:275) from 'Amballa, Siwalik Hills' (Ambala, Punjab, India; 30°19′ N, 76°49′ E.). In conjunction with a study of the bats of Afghanistan, I have re-examined the specimen on which Tate's record is based, and find it to be incorrectly identified. Based on comparisons with specimens available to me in the Field Museum of Natural History, Chicago, Ill., U.S.A., and with descriptions in the literature, I have determined that the bat is a Savi's Pipistrelle, *Pipistrellus savii* (Bonaparte). The subspecific category cannot be determined with certainty but skull profile and measurements (Table) suggest alliance with *P. s. caucasicus* (Satunin). The bat is preserved as skin and skull, number 5147, in the collections of the Museum of Comparative Zoology (MCZ), Cambridge, Mass., U.S.A. It was collected by M. M. Carleton and was received by the MCZ in January, 1875 (pers. comm., Miss Barbara Lawrence, Curator of Mammals, MCZ).

Two subspecies questionably related to *P. savii* have been reported from India by Ellerman & Morrison-Scott (1951:170), *P.* (?) *s. cadornae* Thomas and *P.* (?) *s. austenianus* Dobson. Hill (1962:133) regards *cadornae* as a distinct species, *P. cadornae*. The relationship of *austenianus* to *P. savii* has yet to be satisfactorily determined. Ellerman & Morrison-Scott (op. cit.) also question the relation of *caucasicus* to *P. savii*. My conclusion that *caucasicus* is properly allied to typical *P. savii* is based on the similar morphology of the penis and baculum of the two forms. Thus, *P. savii* may definitely be recorded from India, and *E. nasutus* should be removed from the faunal list.

TABLE

MEASUREMENTS IN MM. OF *Pipistrellus savii* FROM AMBALA, INDIA
EXTERNAL MEASUREMENTS FROM DRY SKIN

Forearm	36·7	Total length, skull	14·2
2nd metacarpal	33·2	Condylobasal length	13·9
3rd metacarpal	34·8	Zygomatic width	9·3
3rd digit, 1st phalanx	12·9	Interorbital constriction	3·8
3rd digit, 2nd phalanx	11·2	Breadth of brain case	6·8
4th metacarpal	33·7	C-M^3	4·5
4th digit, 1st phalanx	11·6	C^1-C^1	4·6
4th digit, 2nd phalanx	8·2	M^3-M^3	6·0
5th metacarpal	33·8	C-M^3	5·4
5th digit, 1st phalanx	8·7	Mandible	10·3
5th digit, 2nd phalanx	6·4		

ACKNOWLEDGEMENTS

I would like to thank Miss Barbara Lawrence of the Museum of Comparative Zoology and Dr. Joseph Curtis Moore of the Field Museum of Natural History for the privilege of examining pertinent specimens, and for their contributions to this note. Financial support for these studies was provided by a William H. and Stella M. Rowley Fellowship and a Karl P. Schmidt Fund grant from the Field Museum of Natural History.

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REFERENCES

ELLERMAN, J. R. & MORRISON-SCOTT, T. C. S. (1951): Checklist of Palaearctic and Indian Mammals 1758 to 1946. British Museum, London.

HILL, J. E. (1962): Notes on some insectivores and bats from Upper Burma. *Proc. Zool. Soc. Lond.* **139**: 119-137.

SIDDIQI, M. S. U. (1969): Fauna of Pakistan. Agricultural Research Council, Government of Pakistan, Karachi.

TATE, G. H. H. (1942): Review of the Vespertilionine bats, with special attention to the genera and species of the Archbold collections. *Bull. Am. Mus. Nat. Hist.* **78**: 221-297.

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2. A NOTE ON THE YELLOW THROATED MARTEN *MARTES FLAVIGULA* (BODDAERT) IN WEST PAKISTAN

Since this animal is partly diurnal in its activities, and like other members of the 'Mpstelinidae', is quite bold and fearless of man, it would seem a suitable subject for the amateur naturalist to study. Despite this in S. H. Prater's BOOK OF INDIAN ANIMALS it is stated that nothing has been recorded of their breeding habits, and it is evident that much still needs to be learned about its biology.

During the late 1950s and early 1960s this beautiful animal could often be seen in the more secluded parts of the Murree Hills in West Pakistan. It is distressing therefore to record that during eight days spent at Dunga Gali in the Murree Hills in early April 1970 that no trace of the Yellow Throated Marten was observed by the author even though localities were searched where one could previously count on seeing them. In early April human disturbance is minimal in this area, particularly as the local hill-folk remain in their winter residences lower down the hillside until there is sufficient spring growth of vegetation to support their grazing and browsing livestock. It would appear therefore that in the more accessible forested areas of the Himalayas that the Yellow Throated Marten is already under pressure from increased human interference and hunting and that the few observations which the author has been able to collect about this species may be worth publishing.

Five subspecies were recognized (Ellerman & Morrison-Scott 1951). Races occurring in Indonesia and Malaya are undoubtedly characterised by darker and richer coloration of the fur particularly the yellow fur along the sides of the throat and neck. All the forms occurring in West Pakistan territory belong to the nominate race. After examining between seventy and eighty skins in the possession of fur traders, in Peshawar, Rawalpindi, and Murree, it is only possible to state that there is considerable colour variation amongst the West Pakistan specimens. But on average there is rather more cream or silver tipped guard hairs extending over the shoulders and upper part of the back as compared with the specimens of *Martes f. peninsularis* & *M. f. indochinensis* which the author has been able to study in the British Museum collection. It has also been noticed that sub-adult specimens from West Pakistan have a more uniformly brown coat over the shoulders and a less grizzled effect from pale tipped hairs. Generally the central part of the throat and upper breast is almost pure white whilst it deepens to rich cream and even bright canary-yellow in some West Pakistan specimens at the upper edge of the throat.

Besides the above comments it is interesting to note the degree to which this member of the genus *Martes* has modified the family characteristics so as to adapt itself to a sylvatic existence. Compared with the eight marten species occurring throughout the northern hemisphere, *M. flavigula* has the longest tail. Obviously an extremely useful balancing device for tree climbing. Also the limbs are comparatively long and the fore-legs extremely powerfully developed compared to other mustelinedae which again is a valuable adaption for an arborial existence. Though *M. flavigula* appears relatively clumsy and slow when it gallops across the ground, the tremendous muscles in its fore-arms give it astonishing agility in trees. The author once observed an adult Yellow Throated Marten run swiftly down a straight and vertical tree trunk. A feat which is surely unusual considering its size and weight and even rivals the ability of monkeys in this respect. It is further worth recording that even in the northern Himalayas of West Pakistan, where snow often persists until the end of April, and the temperatures are particularly cold at night, that *M. flavigula* does not develop a thick under-fur or wool. This is in sharp contrast to *M. foina* which is more an inhabitant of drier barren mountainous areas. The explanation presumably lies in the ability of *M. flavigula* to find well protected and snug tree hollows for sleeping during the winter months. A specimen killed March 30th, in Dunga Gali; when there was still deep snow there had no underfur and surprisingly thin fur on the belly. It is also worth noting that this specimen which was an adult female and appeared of normal size, measured twenty-five inches from nose-tip to root of tail and nineteen inches in tail length. These measurements are slightly above the maximum given for the species by Prater (op. cit.). Perhaps one could infer from this that the average size of specimens inhabiting the north-western part of the Himalayas is considerably above the measurements given in THE BOOK OF INDIAN ANIMALS. This female specimen when fresh killed weighed seven-and-a-half pounds.

Feeding Habits:

These have already been described by earlier writers (Pocock and Prater op. cit.). *M. flavigula* is a bold and fearless hunter, capable not only of killing domestic chickens, but also newly born deer of the smaller species as well as wild birds and squirrels. In West Pakistan Flying Squirrels (*Petaurista* and *Hylopetes* spp.) undoubtedly form an important part of their diet as they invariably occur in the same forest areas. However, *M. flavigula* evidently has a distinctly sweet tooth, and besides being extremely fond of ripe fruit and honey, it also shows an ability to adapt its diet to whatever food is seasonally abundant. In mid-June in the outer Himalayan range the berries of the ill-scented Viburnum, (*Viburnum nervosum*), are ripe and this bush dominates the forest understory. These dark purplish berries form the bulk of the diet of the martens at this season. Adult animals have been observed on several occasions clambering all over such bushes and pulling the bunches of berries to their mouth with one paw and feeding thus for prolonged periods. In the Murree Hills in late July a certain species of cicada emerges from the forest litter to hatch out into the winged adult. In the process it climbs up any suitable shrub or tree trunk for the larval skin to dry out and crack open. A young female Yellow Throated Marten shot at this season was found to have the stomach full of the partly digested remains of cicadas. *M. flavigula* normally finds its food within the forest limits but at certain seasons it descends to the lower, open cultivated orchards when these are bearing ripe fruit. In July 1965, a specimen was killed robbing the ripe laden apricot trees in village Malach at 6000 feet and approximately one-half mile below the timber line. This happened at night showing that they are not exclusively diurnal in feeding habits. They have been reported also as stealing apples in October but such reports have to be treated with caution since *Paguma larvata* and *Martes foina* do occur in the same area, and the local hill-folk do not always distinguish between these species. In the forest itself wild hill bees build nests in tree hollows during late June and July and it is well known by the local hill people, that *M. flavigula* is passionately fond of honey and successfully robs such nests. The author once observed a marten enter a tree hole which was obviously occupied by bees, at about five p.m. in early July. The hole was located high up in a Sycamore tree (*Acer caesium*). Despite watching for about ten minutes, the marten did not re-emerge though there was evidence of bees coming and going to the entrance of the hole. No definite conclusions can be made from such an observation but it seems likely that the marten is not afraid of being stung and that it was trying to dig out and reach the honey-comb. A story recounted to the writer by a German engineer is worth recording. This gentleman was a very keen hunter of both big and small game. One autumn whilst hunting in the outer ranges of the Murree foot-hills, at about 3000 feet elevation, he shot a Yellow Throated Marten. He put the animal in his knapsack which was slung on his back. Due to the anal glands possessed by this species there is always a distinct and slightly foetid odour emanating from a dead specimen. The ability of Hymenoptera to find food by scent is well known. The savage plain's bee (*Apis dorsata*) occurs in that locality, and some of these bees apparently recognized the smell of their traditional enemy. At any rate the gentleman was suddenly and viciously attacked by a swarm of bees. He rolled on the ground to escape and ultimately rushed into a nearby creek and plunged into the water. Apparently he fell unconscious and later reached home with difficulty (Major Albert M. Gsells pers. comm.)

Breeding Biology:

The Mustelidae are known in many cases to exhibit delayed implantation of the ovum (WILDLIFE MANAGEMENT TECHNIQUES 1969). In some instances it is difficult to understand the exact value or biological significance of such a phenomenon. However, for several species of the genus *Martes* the period of gestation has been observed to last from 220-290 days (Walker 1964). With only two exceptions, the author has always observed that the Yellow Throated Marten spends its active hours hunting alone. Pairs do not appear to form any lasting bond relationship. A young family of three martens was observed to be attended exclusively by one adult which was presumably the mother. However, on two occasions one in late July and the other in early August, two adult martens were observed together. On August 10th one marten was observed excitedly chasing a second animal and making quite a loud chattering noise. This was the occasion already described when one animal was observed swiftly but sure-footedly running down a completely vertical tree trunk. Both animals ignored the observer and were not hunting. It would be reasonable to associate such behaviour with courtship or breeding activity in view of all the other observations of single animals. The female marten killed on March 30th, already referred to earlier, was found to contain two well developed but completely naked foetuses. Presumably they would have been born sometime around the middle of April and the above slender evidence would seem to support the supposition that *M. flavigula* mates in late July and early August and at least in the northwest Himalayas the young are born in April. Such a long period of gestation also suggests delayed implantation of the ova.

One year, I was fortunate to discover at Dunga Gali a den and family of three young martens in early July. At this time they were well grown, and only slightly smaller than the parent which would also seem to suggest birth in mid-April at least in this region. Up to about July 28th, they remained in the vicinity of the den which was located in a deep fissure in the bowl of a yew tree (*Taxus baccata*). This was approximately one furlong from the nearest frequented foot track and on a very steep forested slope. The three young were extremely playful and inquisitive and also remarkably vocal. It is impossible to transcribe in words the variety of squeaks, grunts and chattering noises which these young martens made when they were playing together. In fact it was their calls which revealed their presence. The top of a square cut tree stump near the den was a favourite platform for sun basking and waiting for the mother's arrival. Twice the adult parent was observed in mid-July accompanied by the three young, foraging for insects, birds' nests etc., in both instances within about one-and-a-half furlongs of the den. On two occasions when watching the young the parent appeared but if she (?) had brought food for them she was too wary to reveal the fact and had presumably catched her prey before showing herself. The female has four teats, two of these in the inguinal region. Prater and Walker refer to litter sizes of up to five young (loc. cit.). But a smaller number would appear to be more usual for *M. flavigula*.

Distribution:

Most of the above observations were made in the Murree Hills. The Yellow Throated Marten has also been observed in Swat Kohistan where it is not uncommon as well as Dir and in the southern portion of Chitral. It is also well known to the local hill people in the lower part of the Kaghan Valley (District Hazara) and of course the Murree Hills as already mentioned. All these areas are characterised by temperate evergreen forest. Though primarily a sylvatic animal and having its centre of origin presumably in the more tropical forests of southeast Asia, it is obviously very adaptable and can also survive in stunted sub-tropical sclerophyllous forest in foothill zones. Thus, it has been seen not only in regions such as Kahuta and the Lehtrar Valley north of Rawalpindi but also in the Kalah Cheetah Hills of Campbellpur District where the dominant species are *Olea cuspidata* and *Acacia modesta* which only grow to 10 or 12 feet height. It has also been recorded in stunted oak forest (*Quercus balot*), in southern Chitral. Such ilex oak country represents the extreme west of its known range and perhaps not un-coincidentally the western limit of *Petaurista albiventer* (the Large Red Flying Squirrel).

ROBERTS COTTON ASSOCIATES LTD., T. J. ROBERTS
KHANEWAL,
WEST PAKISTAN,
May 9, 1970

References

ELLERMAN, J. R. & MORRISON-SCOTT, T. C. S. (1951): Checklist of Palaearctic and Indian Mammals. British Museum. London.

POCOCK, R. T. (1939): Fauna of British India—Mammalia Vol. II. Taylor & Francis Ltd., London.

PRATER, S. H. (1965): The Book of Indian Animals. Revised Edition 1965. Bombay Natural History Society.

WALKER, E. P. (1969): The World of Mammals Vol. II. Johns Hopkins Press, Baltimore.

3. THE DUGONG, *DUGONG DUGON* (MULLER) IN BURMESE WATERS

In 1964 and 1965 two dugongs were caught in the nets of the Lampi State Fisheries, Mergui Archipelago. Both were males.

In 1965 and 1966 dugongs were recorded only from Manaung township, Kyaukpyu district, Arakan division, along the Burma coast.

On 24 August 1965 a male dugong was caught near Akyab in the Arakan sea. It was brought from Akyab to Rangoon and arrived at the Zoological Gardens on 27 August. It died on 3rd November 1965.

A female captured in the coastal waters off Cheduba Island, about three or four miles from the Arakan coast on 26th October 1966, was brought from Akyab to Rangoon by boat and arrived at the Zoological Gardens on 2nd November 1966. It died on 25th March 1967. A large male was reported to have been trapped in a fishing net in the same area where the female was caught, but had to be released as it was too strong and would have dragged the fishing net away. Another male caught by a fisherman of Zayatkon village in Cheduba township off the sea coast of Cheduba Island in January 1970 arrived at the Zoological Gardens on 15 January 1970. It died on 20 February 1970. A female dugong caught by the same team in February 1970, arrived at the Zoological Gardens on 13 February 1970. It was still alive on 26 February 1970, the date on which I recorded this note [1].

Method of Capture:

In Burma dugongs are not caught deliberately for food. They are usually caught along with fish during beach fishing. Sometimes when the dugong is observed, fishermen leave the fish to catch the dugong as it brings in more cash. Occasionally dugongs are caught on request from the Management Board, Zoological Gardens, Rangoon.

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[1] Died on 30 Aug. 1970.

According to the Director of Fisheries, Burma (U Tint Hlaing) and Head of the Marine Biology Section, Moulmein College, Moulmein (U Kyaw Myint) who have tasted the flesh cooked in different ways, the flesh is said to be tender and of good eating. The fat smells of cod liver oil, like many of the other marine mammals. The fat melts at 72°C.

As in the Gulf of Mannar (Prater 1965, BOOK OF INDIAN ANIMALS: 316) the flesh is highly esteemed by the villagers from Arakan coast. They say the flesh is better than pork.

25, INYA MYAING ROAD, TUN YIN
RANGOON,
UNIVERSITY P.O.,
BURMA,
February 26, 1970.

4. STRANDING OF FOUR WHALES ALONG GOA COAST BETWEEN DECEMBER 1968 AND APRIL, 1970

This paper records the stranding of four specimens of baleen whales along Goa coast during a period of 16 months. I have not seen stranded whales along Goa coast between August 1964 to November 1968 and enquiries made at various fish landing centres along the coast reveal that there have been very few occasions when whales have been washed ashore during the last 50 years. The months when the four specimens of whale were stranded along Goa coast are listed below:

Month	Place	Distance from Panaji and direction	Length
December 1968	Mandrem	20 Km. North	15·00 metres
February 1969	Baina	12 Km. South	14·85 ,,
January 1970	Canacona	30 Km. South	13·85 ,,
April 1970	Candolim	10 Km. North	13·50 ,,

The stranding at Candolim was on first April, 1970, Candolim is a fishing village about 12 Km. north of Panaji. The specimen was seen on 3 April 1970, when putrification had already reached an advanced stage. Since it was not possible to drag the whale to Panaji it was decided to bury it at Candolim for extracting its skeleton for keeping at the National Institute of Oceanography at Panaji. Its weight was estimated to be approximately 25 tons. The following measurements of the specimen were taken:

Total length (tip of lower jaw to tip of flukes) ..	13·50 m.
Length from base of flipper to tip of lower jaw ..	4·00 ,,
Length of flipper ..	1·55 ,,
Ratio of flipper length to total length ..	1 : 9 : 1
Total number of ventral grooves ..	67

The ventral grooves extended far behind the flipper reaching as far as the anal region.

The exact coloration could not be ascertained because of the decomposed nature of the specimen. However, on the shoulder region the skin was dark grey whereas on the ventral side near the flippers it was white. Flippers were pale black in colour and the frayed baleen plates were blackish grey and fluke greyish blue in colour. Nasal opening was triangular.

The stomach was everted indicating that the specimen had vomitted prior to death. The sex could not be determined. However, the specimen appeared to be immature.

The ratio of flipper length to the total length of the specimen was 1:9 which identifies it as *Balaenoptera physalus*.

All the four specimens are approximately of the same length which suggests that they belong to the same year class which probably migrate in the cold season from November to April along the coast.

The author is thankful to Dr. P. V. Dehadroi, Scientist, N.I.O. Panaji for critically going through the manuscript.

RAJINDER M. DHAWAN

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DIRECTORATE OF FISHERIES,
PANAJI, GOA,
May 1, 1970.

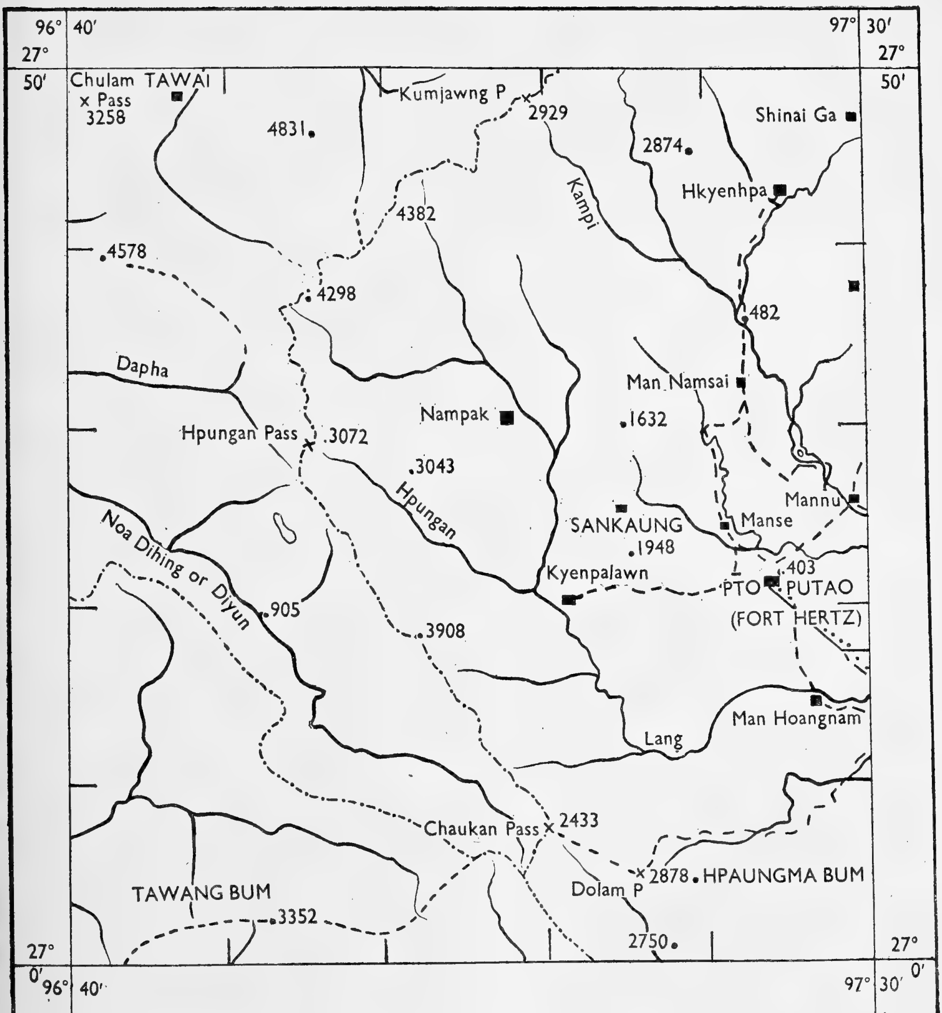
5. RECORD OF THE HIMALAYAN MONAL *LOPHOPHORUS IMPEJANUS* (LATHAM) IN BURMA

(*With a map*)

Three rare pheasants, two cocks and a hen arrived at the Zoological Gardens, Rangoon, from Putao on 27 June 1969. They were identified as the Himalayan Monal *Lophophorus impejanus*. No mention of the presence of this monal in Burma, is made in Smythies BIRDS OF BURMA. I sent photographs to Mr. Philip Wayre, Hon.

Director, The Ornamental Pheasant Trust, England, and author of A GUIDE TO THE PHEASANTS OF THE WORLD and he confirmed the identification. The three Monals were trapped on Hpungan Pass—Latitude 27° 30′, Longitude 96° 48′, 3072 metres (Map). Extracts from a letter dated 9 February 1970, which I received from Mr. Wayre, are quoted below.

'I am quite sure that this constitutes an extension of this bird's range, the eastern limit of which was previously believed to be the Mishmi Hills. I have checked all the literature and can find no reference to its occurrence east of those hills other than in the mountains of south-western Sikang.



The distribution according to Vaurie BIRDS OF THE PALAEARCTIC FAUNA is Eastern Afghanistan (Nuristan and Safed Koh) and North West Frontier Province, eastward through the Himalayas to Bhutan and north-eastern Assam (Mishmi Hills) and neighbouring southern Tibet to south-western Sikang. [Pome and southern Chamdo to the valleys of Po Yigrong and Po Tsangpo, to at least the region of Showa Dzong, or to about 95° 30′ E. long.].

25, INYA MYAING ROAD, UNIVERSITY P.O., RANGOON, — TUN YIN

February 20, 1970.

6. INTERESTING EAGLES IN WESTERN INDIA

While scanning through my notes recently I found that I had somehow failed to report three occurrences of interesting eagles in Kutch. One of them was Pallas's Fishing Eagle *Haliaeetus leucoryphus* (Pallas), seen by me in the cold weather of 1947-48 near Ganga Nāl (a tidal creek 3-4 miles west of Mandvi).

The second and the most interesting discovery was that of the White-tailed Sea Eagle *Haliaeetus albicilla* (Linnaeus) in 1949-50 near Mundra (about 30 miles south of Bhuj). A solitary individual was sitting on an earthen mound when I saw it while trying to catch up with and collect a Houbara Bustard *Chlamydotis undulata macqueenii* (J. E. Gray) wounded by me. I do not remember whether I bagged the Houbara, but I now certainly regret my folly in not at once trying to collect the eagle at that time for only a single record of it in India is apparently made (Ali & Ripley, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Vol. 1, page 286). When I went back to the place where I had seen this extremely rare sea eagle it had disappeared and I failed to spot it again.

In December 1966 I saw an Imperial Eagle *Aquila heliaca* Savigny. This too is a rare visitor in Kutch having been recorded by Sir Geoffrey Archer, but others, including the Sálim Ali[1] survey, have not come across it (Ali, BIRDS OF KUTCH, vide Appendix B—page 172).

[1] Reported from Pung Bet, Little Rann and Kaira Dist. in 'The Birds of Gujarat', *JBNHS* **52** : 397, by Sálim Ali—Eds.

It was sitting right in the middle of the Bhuj-Mandvi road, approximately 8 miles from Bhuj, eating a hare which was left behind when it flew off as I got very near the bird in my jeep.

BHUJ, KUTCH, HIMMATSINHJI
March 31, 1970.

7. NOTES ON INDIAN BIRDS—12. EXTENSION OF THE SOUTHERN LIMITS OF THE EASTERN STOCK DOVE (*COLUMBA EVERSMANNI* BONAPARTE)

The Eastern Stock Dove (*Columba eversmanni* Bonaparte), a winter migrant to India, is known to occur as far south as Darbhanga, Bihar, in the east but on the western side it has not been noted south of Ambala and Ludhiana in the Punjab.

The Society's collection includes a ♀ No. 12903, obtained at Gwalior, C.I., by C. Marie on 9 March 1903, with the label marked 'Very large flocks on peepal'.

I also find in my notes on a three-day visit to Bharatpur, Rajasthan, in October 1951, a reference to some pigeons 'very like the Blue Rock (*C. livia*) but slightly smaller and all with pure white rumps. In pairs and in parties of 15/20 in open. Once put out of tree'. Upon my return, I identified them as *C. eversmanni* but omitted to record them.

It would appear that this bird is found further south than accepted, though it is uncertain if this is only occasional or happens every year. The white rump (really croup or lower back) is very distinctive.

75, ABDUL REHMAN STREET, HUMAYUN ABDULALI
BOMBAY-3,
April 10, 1970.

8. AN ADDITION TO THE LIST OF INDIAN BIRDS—THE MIGRATORY JUNGLE NIGHTJAR, *CAPRIMULGUS INDICUS JOTAKA* TEMM. & SCHL.

On the night of 28th April 1970, we left Port Blair, Andamans, by a police launch for Narcondam Island, 160 miles north-east. At about 5 a.m. the following morning, I came on deck and was surprised to see a dark dove-sized bird flying low over the water about 30 yards away. The white spots on the wings suggested a nightjar but the thought was dismissed as absurd, and desperate attempts were made to place it among the birds likely to be met far out at sea. As nothing plausible suggested itself, I obtained the Captain's approval and rushed down for my gun. When I returned, the bird had shifted over to the other side of the boat. As it dropped to my shot it was evident that it was a nightjar.

In Bombay we identified the bird as a Jungle Nightjar, *Caprimulgus indicus*, but it differed from *hazarae* Whistler & Kinnear (Abbottabad, Hazara, Himalayas) and appeared to be *C. i. jotaka* Temm. & Schl. (type locality: Japan). In the absence of material for comparison, the specimen (♂, wing 214) was sent to the Smithsonian Institution at Washington, where Mr. Bond has kindly confirmed that it is 'a good example of *jotaka*'.

This race is a well known migrant from Japan and China to the Malay Peninsula and further east, but this is the first record from the Andamans, in fact the first record from India.

75, Abdul Rehman Street, HUMAYUN ABDULALI
Bombay-3,
June 25, 1970.

9. GREYHEADED MYNA, *STURNUS MALABARICUS* (GMELIN) IN KUTCH

I saw the Greyheaded Myna for the first time in Kutch on 31st December, 1969. Four of these birds alighted on the bare twigs of a small tree in the Vijaya Vilas Plantation (Mandvi) so close to me that I did not even have to use my field glasses to observe them during the few moments they stayed there before flying on to a banyan tree nearby.

There is no specific mention of its distribution or occurrence in the BIRDS OF SAURASHTRA (R. S. Dharmakumarsinhji), however, I happened to see a pair of these Mynas busy carrying nesting materials into a hole in a casuarina tree at Wankaner in July 1967. One bird (what appeared to me to be the female of the pair) had, in contrast to its partner, a rather pale coloured plumage. Except for the head, neck and the primaries along with tail feathers which were grey, it was pale grey all over the rest of its body with a diffusion of a faint ferruginous wash particularly noticeable under the wings, on the breast and downwards to the abdomen. This of course is not very unusual for abnormally coloured individuals are sometimes to be seen in this species.

I may also mention here that I observed a Forest Wagtail *Motacilla indica* Gmelin once again in Kutch. It was seen by me at Vijaya Vilas on 31st December 1969. My first observation of this wagtail in this district was at Bhuj in 1967 (*JBNHS* **65** (1):225).

BHUJ, KUTCH, HIMMATSINHJI
January 19, 1970.

10. *NOTES ON THE WHITE-EYE* (*ZOSTEROPS PALPEBROSA*) AND WHITEBREASTED KINGFISHER (*HALCYON SMYRNENSIS*)

Last December I had an opportunity of exploring the mangrove flats near Jamnagar along the Gulf of Kutch and found white-eyes to be very plentiful and confiding. This reminded me of a note appearing in Ticehurst's BIRDS OF SIND [*Ibis* 1923:22-23] of an isolated colony in mangroves off Karachi (W. Pakistan). It seems probable that White-eyes affect mangrove forests all along the west and as these extend to Karachi the little bird had an uninterrupted range which later was disturbed by the destruction of mangroves by man. It may be interesting to compare Karachi specimens with those from mangrove forests near Bombay on the one hand, and with specimens from the mangroves of Jamnagar as well as of other parts of coastal Saurashtra and Gujarat.

White-eyes seem to go fairly high in the Himalayas. I have seen at over 7,500 ft. a number of White-eyes at Vashishta near Manali, both in cultivation and in Oak forests. This may well be an altitudinal record for this little bird.

I have always considered the Whitebreasted Kingfisher as a plains bird possibly going up some of the major valleys to about 3,000′ and it was therefore a surprise to have one advertising its territory at over 7,500 ft. in Oak and spruce forest just above the terraced cultivation of Vashishta Village.

MANALI, LAVKUMAR J. KHACHER
KULU VALLEY,
HIMACHAL PRADESH,
May 11, 1970.

11. NOTES ON THE INDIAN SAND SKINK *OPHIOMORUS TRIDACTYLUS* (BLYTH)

The skink, *Ophiomorus tridactylus* inhabits sandy desert regions of Western Rajasthan, India, where 90 per cent of the rain (100 mm. to 400 mm.) falls during the monsoon (July to September). May and June are the hottest months with the mean maximum temperature at 40·5°C. In association with heat waves, 50°C. has also been recorded. Dust storms are not infrequent. The desert is dominated by sand dunes, but rocky outcrops occur at Jodhpur, Barmer, and Jaisalmer. Localities from which *Ophiomorus* was collected (1964-68) were Ganganagar, Hanumangarh, Raisingnagar, Suratgarh, Sadulpur, Churu, Jhunjhunu, Pilani, Ratangarh, Sikar, Lunkaransar, Bikaner, Shergarh, Pachpadra, Balotra, Shiv, Barmer, Gadra Road, Munabau, Sundra, Kolayat, Bap, Phalodi, Pokran, Mohangarh, Nagaur, Ramgarh, Jaisalmer, Devikot, Hindumal Kot, Osian and Jodhpur.

The skinks can be collected abundantly from the month of February to May after the cold weather and September to November after the monsoon. The skinks leave zig-zag tracks while moving under sand. These tracks always commence from a bush and can be followed to their apex and if a finger is lightly pressed into the sand at this point the presence of the lizard can be felt by its slow movement under the sand. If a sieve is then shoved into the sand the lizard can be lifted out. This is the best way of collecting this slippery lizard, if the tail is not to snap. On the sand dunes, the skinks normally venture out soon after dusk and cease their activity before dawn. In captivity the skinks were in a state of torpor in late December and January. In March a few among the captive skinks moulted, the skin peeling off in flakes. Dead specimens of other terrestrial lizards are found on the road, crushed by vehicles but *Ophiomorus* has not been sighted so far in this condition.

The coloration of the skin is creamy or pale brown on the dorsal side and the belly is whitish yellow. The dorsal side of the lizard is studded with distinct longitudinal series of pigment spots. In some cases, the spots get intermingled, so that only a broad band of faint, diffused spots, is formed.

The tail length varies individually in relation to the snout vent length. A few specimens had regenerated tails.

The maximum snout vent length is 95 mm.; tail 70 mm. The greatest body diameter at the middle of the body is 25 mm.

MAHARISHI DAYANAND COLLEGE, M. S. RATHOR
SRI GANGANAGAR,
RAJASTHAN,
July 12, 1969.

12. NOTES ON BITES BY THE SAW-SCALED VIPER, *ECHIS CARINATUS* IN THE DEOGAD AREA OF RATNAGIRI DISTRICT, MAHARASHTRA

Dr. M. R. Nene, a general practitioner who has a clinic in the village of Jamsande, a few miles from Deogad town, has treated over 300 cases of *Echis* bite since 1955. During the heavy monsoon that this coastal area receives, the viper *Echis carinatus* becomes the most abundant terrestrial snake. Some of the points of interest and brief case histories noted down during an informal interview on July 24, 1969, are given below.

The village people of Deogad Taluka, seem more inclined to see a doctor in the event of a snakebite than in other areas of Maharashtra and India. Except where a medical doctor becomes well-known for successfully treating snakebites, the people generally call upon a local 'medicine man' or holy man to try to save the victim. The annual collection of *Echis* in this area for Haffkine Institute's serum production programme has helped create this awareness. Out of 300 bites there have been 4 deaths—each time these were cases when the victim came or was brought 4 to 7 days after the bite, when loss of blood and associated complications had brought him to the critical point. Patients usually died of heart failure after continual hæmorrhage for days. Patients that recovered from severe systemic symptoms were treated for anæmia.

The oldest patient was 65 years, youngest 2 years; average 20 to 40 years, more males than females. Most bites occurred from July to October; September being the month of most bites. Eighty-five per cent of bites were in daytime; bites used to be higher at night when the road was a simple dirt road, pointing to the Viper's habit of lying in loose sand or dirt. Ninety per cent of bites were on the feet, ten per cent on hands. Most bites occurred as labourers cut grass, piled stones and worked on crops; a few bites occurred in homes. Most patients came within 1-2 hours after the bite; of these, most had come straight to the doctor without seeking any local cure. Others came 1-7 days later, usually after trying local remedies, and occasionally after trying other medical doctors. Ninety per cent of the patients came with some sort of tourniquet, usually too tight. Dr. Nene does not employ or recommend mechanical measures such as cut/suction to try to withdraw venom from the site of bite.

Early symptoms of *Echis carinatus* bite include: fang-punctures leaking blood; localized œdema (80%) 6 to 7 inches up the extremity; severe pain (burning at site of bite in all) ascending up to upper extremity in most; pain in glands in armpit (this may be severe even when local swelling is very slight or absent). After 1 hour there may be sharp 'lightning' pains up the arm (or leg). Ten to twelve hours after the bite, bleeding from the gums is a common systemic symptom. Later, blood in urine, fæces, sputum. In later stages of severe envenomation, anal and vaginal bleeding may occur. In a lethal bite, in from 12 hours to one or more weeks, pulse may become feeble, blood pressure drops to unrecordable and the patient expires. In two fatal cases convulsions preceded death.

Dr. Nene treats every snake bite case as an emergency. When symptoms of envenomation are manifest in a victim, he makes a slow intravenous injection of Haffkine Polyvalent Antivenin Serum. He keeps syringes of cortisone and adrenalin prepared for the possibility of allergic reaction to the horse serum. Anaphylaxis is a hazard of intravenous injection of any horse serum without prior testing for patient sensitivity. Dr. Nene says that five per cent of the patients showed moderate to severe allergic reaction, including urticaria, shock symptoms. He has observed no allergic shock in patients receiving intramuscular horse serum injections.

Case histories: (*a*) 20 year old male worker came after 7 days, hæmorrhaging moderately. He had been treated with antivenin (intramuscular) one day following the bite and sent home by another doctor. Efforts of village medicine men at stopping bleeding from various sites failed. Antivenin was immediately injected intravenously and the man went into allergic shock. He was treated for shock for 1½ hours and again antivenin was injected. The man recovered in one day.

(*b*) Male worker came on 4th day after bite, bleeding profusely; blood in urine, anal bleeding etc. Antivenin, Vitamin K, Calcium Gluconate were administered. Patient recovered in 16 hours, except for anæmia.

After treatment with sufficient doses (1 to 3 vials) intravenously, pain and bleeding cease rapidly. Swelling remains for 3 to 4 days. In the 300 cases of *Echis* bite there were only 3 known cases of necrosis. These were very slight cases, involving sloughing of tissue near the fang marks. No other complications (except anæmia, sometimes acute) following recovery from bites were noted. No post-mortems in fatal cases.

Dr. Nene has treated 6 Russell's Viper bites, 5 proved fatal. He feels that the time factor is far more critical in this species than others because of quantity of venom injected and the rapid massive clotting action of one of the venom constituents, which results in rapid death by heart failure. He also feels that the titer of the Haffkine Polyvalent Antivenom Serum to this venom may be lower than desirable, or may be slow in its neutralising effect on *Vipera* *russellii* venom. Two cobra bites during the 14 year period were treated successfully.

Though we have no additional data, such as how many snake-bite victims in the area did not come to the doctor, it appears that *Echis carinatus* bites are fatal only in cases of exceptional envenomation and only after a matter of days after the bite (less than 2% of the 300 in this study). This points to death by complications of, rather than direct envenomation.

C/o CHATTOPADHYAYA,
CHATEAU MARINE NO. 6,
MARINE DRIVE,
BOMBAY-20,
August 1, 1969.

ROMULUS WHITAKER

13. CAPTURE OF A WHALE SHARK *RHINEODON TYPUS* SMITH IN RATNAGIRI WATERS

On 11 May 1965, a large shark was landed at Mirkarwada, Ratnagiri. The fish was identified as *Rhineodon typus* Smith based on its characteristic colour pattern and three longitudinal ridges on either side of the mid-dorsal region. The fish was caught in 13 fathoms in nylon gill nets, and was towed ashore.

This is the first record of the species from Ratnagiri. Recording of the capture of the Whale shark *Rhineodon typus* off the coast of India has been considered as a matter of interest, as these large fish occur rather rarely. Prater (1941) reviewed the data of the occurrence of the species from Indian waters. Since then, there have been a few additions, Kulkarni (1948) from Bombay, Chacko & Mathew (1954) from Malabar coast, Kaikini *et al.* (1959) from Mangalore, and Gopalan (1962) from Veraval, Gujarat State. Silas & Rajagopalan (1963) who reported it from Tuticorin have suggested a proforma for collecting detailed information whenever records of the Whale sharks are made. Information on the lines suggested by them is given below. The measurements are in millimetres.

Total length	5180
Standard length	4000
Head length	1380
Girth of body	1000
Width of mouth	820
Vertical height of 1st dorsal	460
Vertical height of 2nd dorsal	230
Length of caudal along upper margin	1480

Snout to 1st dorsal	2380
Snout to 2nd dorsal	2380
Snout to pectoral	1120
Interspace between 1st & 2nd dorsal	560
Interspace between 2nd dorsal & caudal	460
Length of pectoral	920
Length of 1st dorsal	660
Length of 2nd dorsal	280
Diameter of orbit	40
Interorbital distance	900

The weight was about 900 kg. It was a male. Two sucker fishes (*Remora remora*) were collected from the pectoral fins of the fish. No external parasitic copepods were observed.

ACKNOWLEDGEMENTS

We are grateful to Dr. C. V. Kulkarni, Director of Fisheries, for his encouragement and to Dr. H. G. Kewalramani, Senior Scientific Officer, for his help in going through the manuscript and making helpful suggestions.

MARINE BIOLOGICAL RESEARCH STATION,
RATNAGIRI,
March 6, 1970.

M. R. RANADE
SHAKUNTALA S. SHENOY
FAHIM AHMED

14. FISHING METHODS FOR THE SPINY EEL *MASTOCEMBELUS ARMATUS* IN MADHYA PRADESH

The Spiny Eel frequents very weedy waters and hides among the weeds or in holes and crevices on the bank during the day. The latter habit is used in catching the eel. At Bhopal, the method used is to dig a small outlet at the edge of the water and cover it with stones. After three to four days a triangular hand net is kept at the mouth of the outlet and the fish frightened into it by stamping on the stones covering the outlet. Another method is to drop into the water cow dung-filled gunny bags with a few holes in them. The eel is said to be attracted into the bag by the dung but is unable to escape owing to the dorsal spines becoming entangled. Pots with holes are also left in the water and removed after a few days, trapping the fish sheltering in them. In north Madhya Pradesh, hollow bamboos with the internode bored at one end are used in the same manner. The eel is also caught with hook & line using shrimps, earthworms and tadpoles as bait.

I wish to thank Dr. R. D. Gaur of M.V.M. College, Bhopal, for his useful suggestions.

ASST. FISHERY OFFICER,
GANDHI SAGAR DAM,
MANDSAUR, M.P.,
March 9, 1970.

B. M. GUPTA

15. A REVIEW OF THE TAXONOMY OF THE INDIAN FROG-FISHES (FAMILY BATRACHOIDIDAE)

(With a photograph and a text-figure)

INTRODUCTION

During a general study of marine fish collections in the Zoological Survey of India, we had the opportunity to study eleven specimens of Indian Frog-fishes (Family Batrachoididae) collected from the following localities: Mangalore area (5 specimens); Tellicherry (1); Calicut (1); Bombay (3) and Calcutta (1). In the course of the work it became apparent that the taxonomy of these forms needed revision.

SYSTEMATIC ACCOUNT

Linnaeus (1758) described from East Indian seas, *Cottus grunniens* characterized by two dorsal spines in the first dorsal fin. Linnaeus does not mention the presence of any pore in the axilla of his specimen. Bloch and Schneider (1801) included *Cottus grunniens* L. in the genus *Batrachus*. Hamilton (1822) described *Batrachoides gangene* from the estuaries of the River Ganges. Valenciennes (in Cuvier & Valenciennes 1837) described *Batrachus dussumieri* from the Malabar coast and *B. grunniens* from the West coast of India. Günther (1861) described *Batrachus trispinosus* from the seas of Bombay, Singapore and Penang, basing his account on Valenciennes' description (*op. cit.*) of *B. grunniens*. Day (1878) recognized two species of the Frog-fishes from Indian seas, namely, *Batrachus grunniens* (L.) and *B. gangene* (Ham.), the former with a pore in the axilla and the latter without a pore in the axilla. Menon (1963) synonymised *B. gangene* (Ham.) with *B. grunniens* (L.), and *B. trispinosus* Günther with *B. dussumieri* Val.; the former without a pore in the axilla and the latter with a pore in the axilla. However, even though *B. grunniens*

(L.) and *B. gangene* (Ham.) may agree in the absence of a pore in the axilla, yet they differ in the number of dorsal spines—which are of taxonomic significance—since the former possesses two dorsal spines and the latter has three dorsal spines in the first dorsal fin. Thus, these two species cannot be considered as being synonymous. Menon (*op. cit.*) also synomymized *B. dussumieri* Val. and *B. trispinosus* Günther on the basis of both species possessing a pore in the axilla. We have found the following additional reasons for this. The gill-covers bear four backwardly directed spines, two on the opercle and two on the sub-opercle (Photo, fig. 1); the last spine is often indistinct and sometimes only two opercular spines are visible. The sub-opercular spines are sometimes hidden under thick skin, if the skin is dissected the two sub-opercular spines are seen clearly (Text-fig. 1: a, b, c). It may be noted that Dr. M. Blanc, Museum National D'Histoire Naturelle, Paris (pers. comm.), states that the type-specimen of *Batrachus dussumieri* Cuv. et Val. (n° A 4748— Bombay—Dussumier) possesses 3 spines on the left gill-covers and four spines on the right gill-covers. Thus, the gill-cover spines appear to be of little taxonomic significance by themselves.

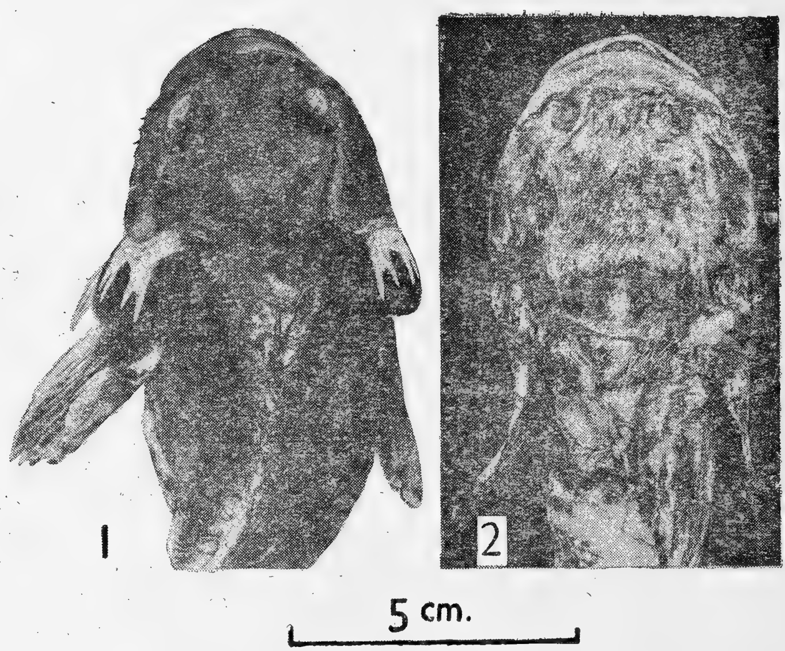


FIG. 1: *H. dussumieri* (Val.), 155 mm. total length, collected from the Malabar coast. The four gill-cover spines are clearly visible after dissection.

FIG. 2: *H. gangene* (Ham.), Z.S.I., F. 2066, 195 mm. total length, collected by F. Day from Calcutta.

According to Valenciennes (*op. cit.*), *B. dussumieri* possesses 'villiform bands of teeth' on the palatines. Our specimens, collected from the type-locality, exhibited the following arrangement of the teeth: In a specimen of 100 mm. total length, two rows of conical teeth are present in both the jaws, the inner rows being incomplete towards the distal ends of the jaws; there are three rows of conical teeth at the symphysis-region in each jaw and an irregular single row of conical teeth on the vomer and palatines. In a larger specimen measuring 170 mm. total length, two rows of conical teeth are present in the upper jaw and there is a single row in the lower jaw; there are three rows at the symphysis-region in each jaw. In the upper jaw, the outer row of teeth and in the lower jaw, the inner row of teeth, are irregularly longer, in the symphysis-region. The vomer carries an irregular row of conical teeth and a posterior row of regularly arranged conical teeth of similar size. The palatines bear a single row of short, stumpy, caniniform teeth, anteriorly these teeth appear to be grouped into one set of 2-3 teeth on each palatine. The gap separating the palatine from the vomerine-teeth, is much reduced in the larger specimen relative to the condition seen in the smaller specimen. The above description indicates that 'villiform bands of teeth' on the palatines do not occur in *B. dussumieri* Val., and the arrangement agrees in general with the teeth-pattern seen in *B. trispinosus* Günther (Text-fig. 2, a, b).

We have provisionally assigned the two valid species *Batrachus dussumieri* Val. and *Batrachus gangene* (Ham.) to the genus *Halophryne* Gill 1863, following the arrangement suggested by De Beaufort (1962).

A brief systematic account of the two Indian species, along with a simple key for their identification, is given below:

KEY TO THE VALID INDIAN SPECIES OF THE GENUS *Halophryne*

1. A pore in the pectoral axilla. Gill-opening much wider than the pectoral base.......................................*Halophryne dussumieri* (Val.)
2. No axillary pore. Gill-opening shorter than the pectoral base............ ....*Halophryne gangene* (Ham.)

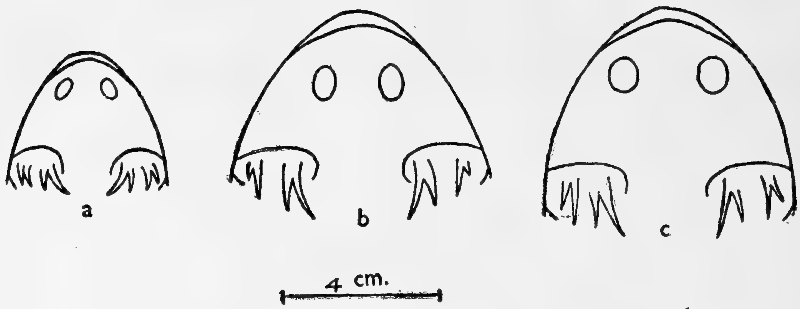
Halophryne dussumieri (Val.)

1837. *Batrachus grunniens* Valenciennes (in Cuvier et Valenciennes), *Hist. Nat. Poiss.* 12, p. 466 (nec. L.).

1837. *Batrachus dussumieri* Valenciennes (in Cuvier et Valenciennes), *Hist. Nat. Poiss.* 12, p. 477 (Type-locality : Malabar Coast).

1861. *Batrachus trispinosus* Günther, *Cat. Fish. Brit. Mus.* 3, p. 169 (Type-locality : Seas of Bombay, Penang, and Singapore).

1878. *Batrachus grunniens* Day, *Fish. India*, p. 269, pl. 59, fig. 1 (nec. L.).
1889. *Batrachus grunniens* Day, *Faun. Brit. Ind. Fish.* 2, p. 229, fig. 83 (nec. L.).
1955. *Batrachus grunniens* Munro, *The Marine and Freshwater Fishes of Ceylon*, p. 285, pl. 56, fig. 832 (nec. L.).
1962. *Halophryne trispinosus* De Beaufort, *The Fishes of the Indo-Australian Archipelago* 11, p. 186.
1963. *Austrobatrachus dussumieri* Menon, *LABDEV, J.S.T.* 1.



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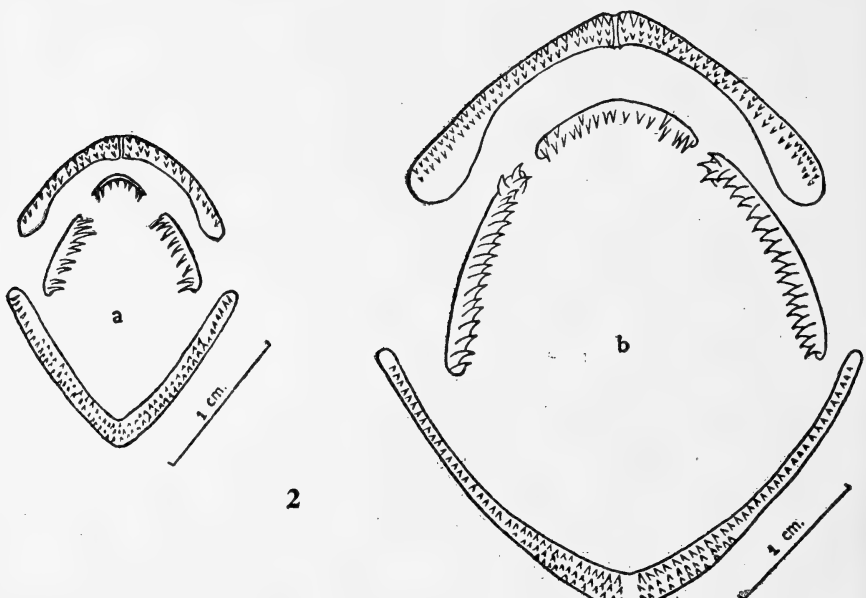

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TEXT-FIG. 1. Dissected gill-covers showing the opercular and sub-opercular spines in *H. dussumieri* (Val.) collected from the Malabar Coast.
(*a*) A specimen of 98 mm. total length.
(*b*) A specimen of 132 mm. total length. Note the reduced sub-opercular spine.
(*c*) A specimen of 155 mm. in total length.

TEXT-FIG. 2. Teeth arrangement in *H. dussumieri* (Val.) collected from the Malabar Coast (Note the difference with growth).
(*a*) A specimen of 100 mm. total length.
(*b*) A specimen of 170 mm. total length.

MATERIAL : (5), 145 to 170 mm., total length, Mangalore area, Coll. K. V. Rama Rao and K. V. Surya Rao, 22.12.1964 ; (1), 170 mm., total length, Tellicherry, Coll. K. V. Rama Rao and K. V. Surya Rao, 30.12.1964 ; (1), 100 mm., total length, Vellayial, Calicut, Coll. K. V. Rama Rao and K. V. Surya Rao, 7.1.1965 ; (3), Z.S.I., F. 1805-1807, 45·0 to 125 mm., total length, Bombay, Coll. F. Day.

Distribution: Persian Gulf, coasts of India, Ceylon, Malay Peninsula; inhabits seas and estuaries.

Remarks: McCulloch (1929) and Herre (1953) considered *Batrachus dussumieri* Cuvier et Valenciennes to be identical with *Coryzichthys diemensis* (Lesueur); but this is untenable since the former has a pore in the axilla, which the latter lacks.

Halophryne gangene (Ham.)

1786. *Cottus grunniens* Bloch, *Ausland. Fische* 2, p. 157, Taf. 179 (nec. L.).
1801. *Cottus grunniens* Bloch and Schneider, *Syst. Ichth.*, p. 43, (nec. L.).
1822. *Batrachoides gangene* Hamilton, *Fishes of the Ganges*, p. 34, 365, pl. 14, fig. 8 (Type-locality : Salt estuaries of River Ganges).
1861. *Batrachus grunniens* Günther, *Cat. Fish. Brit. Mus.* 3, p. 168 (nec. L.).
1878. *Batrachus gangene* Day, *Fish. India*, p. 270, pl. 60, fig. 1.
1889. *Batrachus gangene* Day, *Faun. Brit. Ind. Fish.* 2, p. 229.
1962. *Halophryne gangene* De Beaufort, *Fishes of the Indo-Australian Archipelago* 11, p. 188.
1963. *Batrichthys grunniens* Menon, *LABDEV, J.S.T.* 1.

MATERIAL : (1), Z.S.I., F. 2066, 195 mm., total length, Calcutta, Coll. F. Day.

Distribution: Madagascar, Muscat, Persian Gulf, coasts of India, Siam, Indo-China, Straits of Malacca, Penang, Philippines; inhabits seas and estuaries.

Remarks: Day's (1878, pl. 60, fig. 1) illustration, which is labelled as *Batrachus grunniens*, is actually that of *Halophryne gangene*; further, the shape of the head of the specimen is not properly shown, hence a photograph of his original specimen has been taken by us (Photo, fig. 2).

ACKNOWLEDGEMENTS

We are grateful to the Director, Zoological Survey of India, Calcutta, for facilities. Our indebtedness to Dr. A. G. K. Menon, Superintending Zoologist, Zoological Survey of India, Calcutta, is gratefully acknowledged for making available the specimens of Frog-fishes deposited in the National Zoological collections. Our thanks are also due to Dr. M. Blanc of the Museum National D'Histoire Naturelle,

Paris, for kindly making available data on the type-specimen of *Batrachus dussumieri* Cuvier et Valenciennes.

ZOOLOGICAL SURVEY OF INDIA,
8, LINDSAY STREET,
CALCUTTA-16,
24 *October*, 1968.

A. K. NAGABHUSHANAM
K. V. RAMA RAO

REFERENCES

BLOCH, M. E. & SCHNEIDER, J. G. (1801): Systema ichthyologiae, Berlin, pp. 42-43.

DAY, F. (1878): Fishes of India. Wm. Dawson & Sons, Lond., pp. 269-270.

——— (1889): The Fauna of British India, including Ceylon and Burma Fishes. London **2** : 228-230.

DE BEAUFORT, L. F. (1962): The Fishes of the Indo-Australian Archipelago. Leiden **11** : 185-190.

GILL, T. (1863): Descriptive enumeration of a collection of fishes from the western coast of Central America. *Proc. Acad. Nat. Soc., Philadelphia*, p. 170.

GÜNTHER, A. (1861): Catalogue of the Actinopterygian fishes in the collections of the British Museum. *Cat. Fish. Brit. Mus.* **3** : 166-177.

HAMILTON, F. B. (1822): An account of the fishes found in the River Ganges and its branches. Edinburgh, pp. 34, 35 and 365, pl. 14, fig. 8.

HERRE, A. W. (1953): Checklist of Philippine fishes. *Research Report* 20, *Fish and Wildlife Service, U.S. Dept. of Interior*. p. 820.

LINNAEUS, C. (1758): Systema Naturae Ed. 10, p. 264.

MCCULLOCH, A. R. (1929): A Checklist of the fishes recorded from Australia. *Mem. Austr. Mus.* **5** : 359.

MENON, A. G. K. (1963): Taxonomy of the Indian Frog-fishes (Fam. Batrachoididae). *LABDEV, J.S.T., Kanpur*, 1.

VALENCIENNES, A., (in Cuvier et Valenciennes) 1837. *Hist. Nat. Poiss.* **12** : 466-474.

16. AN ASSESSMENT OF DAMAGE AND LOSS BY LINSEED CATERPILLAR *LAPHYGMA EXIGUA* HB.

Laphygma exigua Hb. (Noctuidae: Lepidoptera) is a destructive polyphagous pest in India causing serious damage to linseed, peas, lentil, lucerne etc. every year. However, no quantitative work has been done on the extent of loss caused by the pest to these crops. A study was, therefore, undertaken at Jabalpur to assess the extent of loss by the pest to linseed during 1967-68 when the crop was infested by this pest alone.

The experiment was done on 64 pairs of plants in 8 rows, each row having 16 plants. In each pair there was one treated and one untreated plant. Row to row and plant to plant distances were 1 metre and 0·5 metre respectively. Sowing was done in the last week of December, 1967, and the pest infestation started in the last week of January 1968. The infestation developed fast and reached its maximum in the 2nd and 3rd weeks of February when there were about 18 to 27 larvae per plant (untreated), usually found feeding gregariously in the webbed apical portions of plants. The larvae fed on the leaves, apical growing points and flower buds and thus checked the height and capsule formation in plants. Spraying schedule on treated series of plants consisted of 4 sprayings with a mixture of 0·02% endrin+0·03% dimethoate (Rogor) emulsions, applied at weekly intervals starting from the 1st week of February. Spraying was done with a baby sprayer on plants in alternate rows. The other rows were left untreated. Drift of spray was prevented by using tin sheets in between rows. When the plants attained maturity and stopped vegetative growth the height of the individual plants was recorded. During harvesting, each individual plant was kept in separate bag with a label of its plant number. The number and weight of capsules of each plant were recorded. The data were subjected to statistical analysis and are given in the Table.

TABLE

EFFECT OF *Laphygma* INFESTATION ON THE HEIGHT AND YIELD OF LINSEED PLANTS

Specifications	Total height of plants (in cm.)	Total no. of capsules	Total weight of capsules (in gm.)
In 64 treated plants ..	3641	5247	404·12
In 64 untreated plants ..	3057	2800	224·28
Difference ..	584	2447	179·84
Calculated 't' value ..	8·52*	8·09*	10·09*

*Highly significant at 1% level

The above data show that the pest *Laphygma exigua* reduced the plant height and yield significantly. The percentage reduction due to the pest in plant height and in the number and weight of capsules was 16·0, 46·6 and 44·3%, respectively.

DEPARTMENT OF ENTOMOLOGY, R. R. RAWAT
J. N. KRISHI VISHWA VIDYALAYA, R. R. DESHPANDE
JABALPUR-4 (M.P.),
July 6, 1968.

17. A NEW RECORD OF *BRACHYDEUTERA LONGIPES* HENDEL (DIPTERA: EPHYDRIDAE) FROM WEST BENGAL

Wirth (1964)[1] recorded the occurrence of the species *Brachydeutera longipes* Hendel from Chabau, Assam, Coimbatore and Nedugadu, S. India, and from Delhi. The species has not been reported elsewhere

[1] WIRTH, W. W. (1964): A revision of the shore flies of the genus *Brachydeutera* Loew (Diptera: Ephydridae). *Ann. ent. Soc. Am.* 57 (1): 3-12, 20 figs.

in India. During examination of a collection of shore flies, I came across a few examples of this species from W. Bengal.

MATERIAL EXAMINED: 1 ex., Calcutta, coll. A.P. Kapur, 14.3.50. 10 exs., Chinsura, W. Bengal, coll. M. Ghosh & K. D. Chatterjee, 11.6.65.

Remarks: Frons, scutum and scutellum rust red, base of scutellum and facial keel brownish instead of dull-green as noticed by Wirth. Three lateroclinate fronto-orbitals, the anterior one very weak.

Distribution: India to the Philippines, Taiwan, and Japan.

ACKNOWLEDGEMENTS

I thank Dr. A. P. Kapur, Director, Zoological Survey of India, and Dr. A. N. T. Joseph, Officer-in-Charge of Diptera section, Zoological Survey of India, for permission to examine the material.

ZOOLOGICAL SURVEY OF INDIA, CALCUTTA-12,
May 24, 1968.

K. RAMACHANDRA RAO

18. FIRST RECORD OF *COENOMYIA* LATREILLE (DIPTERA: COENOMYIIDAE) FROM INDIA

Coenomyia Latreille, a Holarctic genus, is represented by three species in the world, namely, *Coenomyia ferruginea* (Scopoli), *Coenomyia comans* Enderlein and *Coenomyia bituberculata* Enderlein.

During a recent faunistic survey of Kameng Frontier and Subansiri Frontier Divisions, NEFA (April-May, 1966), I collected 7 examples of *Coenomyia ferruginea.* The genus *Coenomyia* is recorded here from India for the first time.

MATERIAL EXAMINED: 3 ♂♂, 3 ♀♀, Tawang (3200 m.), Kameng Frontier Division, NEFA, 27.IV.1966. 1 ♂ from the same locality on 28.4.1966.

Remarks: ♂ Dark, thorax with white hairs. Abdomen with black and white hairs; second tergum with grey quadrate spots bearing short white hairs; third with blackish brown hind margin, with or without median and lateral markings of the same colour; third, fourth and fifth with the same colour pattern, but the blackish brown markings more distinct and covering larger area; venter dark brown to orange.

♀ Frons with hairs. Abdominal segments posteriorly orange, otherwise orange masked with fuscous.

Besides exhibiting strong sexual dimorphism, the specimens of *Coenomyia ferruginea* showed the following individual variations:

Male specimen (Z.S.I. Registration No. 4220/H6). Compound eyes not contiguous but separated by less than the breadth of median ocellus. Female specimen (Z.S.I. Registration No. 4222/H6). Frons bulges out, interfrontalia separated from parafrontalia by two distinct grooves; wing with posterior cross-vein incomplete.

Distribution: Holarctic Region.

The boundaries of Palæarctic and Oriental regions are not sharply defined and as is well-known there is an intermingling of fauna from both the regions over the Himalayas. The present record of *Coenomyia ferruginea*, a Holarctic species, in Kameng Frontier Division of NEFA, is yet another example of this.

ACKNOWLEDGEMENTS

I am grateful to Dr. A. P. Kapur, Director, Zoological Survey of India, Calcutta, for permission to study the material and to Sri K. S. Pradhan, Superintending Zoologist, Zoological Survey of India, Calcutta, for encouragement.

ZOOLOGICAL SURVEY OF INDIA, A. N. T. JOSEPH
CALCUTTA-12,
May 7, 1969.

19. THE TIME OF EMERGENCE AND THE PERIODICITY OF OCCURRENCE OF THE TIGER BEETLE, *CICINDELA CANCELLATA* DEJ. (ORDER: COLEOPTERA—FAMILY: CICINDELIDAE)

Cicindela cancellata Dej. is a fairly common tiger beetle, occurring almost all over India. In Kerala State, it is quite common, particularly in coastal regions and is generally found in sandy areas. It escapes general attention because of its protective coloration which blends very well with the background, on account of a colour pattern involving sandy-cream and black on the elytra. These beetles and their larvae are active predators and have been observed in the field to feed mostly on small ants and sometimes on other small insects such as small nymphs of grasshoppers and leafhoppers.

The authors have been studying the bionomics of these beetles in the field and in the laboratory for about three years. Observations in the Malabar Christian College Compound, Calicut, have shown that these tiger beetles are not found at all, from November to March. During the remaining period of the year they are found all over the place and several generations are passed through, and towards the close of this period, around the end of October, the individuals in the pupal stage enter into a stage of dormancy and remain so for about four months. Every year, the first emergence of the adult tiger beetles takes place soon after the first or second shower around March or April. The first emergence in the field was observed in the third week of March in 1966, in the first week of April in 1967 and in the second week of March in 1968. But in all these cases, it was observed that the emergence took place soon after the first rains.

The population of the tiger beetles then gradually increases and reaches the peak during the months of July, August and September. Then their numbers steadily decline and eventually reach zero level around November or December. During the period November to March, the population levels of the prey insect species may therefore show a rise in the absence of active predation by these voracious tiger beetles and their larvae, unless this component of environmental resistance is imposed on them by some other predaceous species.

Grateful acknowledgement is made of a grant from the University Grants Commission to one of the authors (A.B.S.) for the study of tiger beetles.

DEPARTMENT OF ZOOLOGY,
MALABAR CHRISTIAN COLLEGE,
CALICUT-1, KERALA,
April 29, 1968.

A. B. SOANS
J. S. SOANS

20. SWARMING OF BUTTERFLIES AND MOTHS

Swarms of butterflies and moths were attracted to the trees of *Caesalpinia coriaria* Willd. in flower, during September-October, 1969, in and around Coimbatore, Tamil Nadu. The most unusual feature about this phenomenon was, that the insects went straight to the flowers of *C. coriaria* even when these trees were surrounded by other flowering plants like *Lantana, Zinnia, Chrysanthemum, Bougainvillea, Petunia, Peltophorum, Margosa* etc. A few butterflies were flying about Lantana, Zinnia and Chrysanthemum, but thousands were seen resting, feeding or flying about the *C. coriaria* trees. The following species of butterflies and moths resting on the trees were collected and identified:

NYMPHALIDAE

1. *Precis hierta* (Fabricius).
2. *P. lemonias* (Linnaeus).
3. *P. almana* (Linnaeus).

DANAIDAE

4. *Euploea core* (Cramer).
5. *Danais chrysippus* (Linnaeus).
6. *D. melanippus* (Cramer).
7. *D. limniace* Cramer.

PAPILIONIDAE

8. *Tros hector* (Linnaeus).
9. *T. aristolochiae* (Fabricius).
10. *Papilio polytes* Linnaeus.
11. *P. demoleus* Linnaeus.
12. *Graphium agamemnon* (Linnaeus).

PIERIDAE

13. *Colotis eucharis* (Fabricius).
14. *Anaphaeis aurota* (Fabricius).
15. *Catopsila pyranthe* (Linnaeus).
16. *C. pomona* (Fabricius).
17. *Eurema hecabe* (Linnaeus).
18. *Hebomoia glaucippe* (Linnaeus).

SPHINGIDAE

19. *Macroglossa vialis* Bull. (*M. affictitia* Bull.).
20. *Cephonodes* sp.

PYRALIDAE

21. *Hymenia recurvalis* C.
22. *Psarah bipunctalis* F.

Apart from the Lepidopteran insects, a few wasps were also noticed on the trees, but no honey bees. No caterpillars of these insects were found in the surrounding areas. It is possible that the insects are attracted by the sweet strong fragrance of the flowers of *C. coriaria* to feed on the honey produced by them.

Wynter-Blyth (1957) in his book BUTTERFLIES OF THE INDIAN REGION (p. 42) has reported that butterflies are attracted to the trees of *Buddleia* in the Himalayas and *Poinsettia* and *Moringa* at lower elevations. The present report is probably such a phenomenon.

COIMBATORE,
January 20, 1970.

M. MOHANASUNDARAM
C. V. SIVAKUMAR

21. OBSERVATIONS ON THE MATING BEHAVIOUR IN THE ANT *MONOMORIUM GRACILLIMUM* SMITH (HYMENOPTERA: FORMICIDAE)

Monomorium gracillimum Smith is a small dark brownish-red ant, about 2 mm. in length and is a very common household pest, nesting in the ground or floor and in the crevices of walls. On June 16, 1968, at about 5 p.m. when the weather was cloudy and slightly rainy, the authors found large numbers of workers and alate males and females of *Monomorium gracillimum* just outside the opening of the nest in the ground floor of the Malabar Christian College building. Evidently, the colony was going through the process of swarming. Some workers and winged reproductives were collected in a tube and were transferred into an artificial nest in the laboratory, for observation. The ants were fed with honey and dead houseflies. The next morning, the winged males and females were observed mating. Within the artificial nest, the alate forms showed no tendency to fly. The mating behaviour under conditions of captivity which could easily be observed through the transparent top-cover of the nest, is as follows:

An alate male (4 mm.) is much smaller than an alate female (7·5 mm.). The alate male approaches the female from behind and strokes the tip of its gaster with its antennae and front pair of legs. The female starts walking about and is closely followed by the male in tandem fashion. The male then grasps and holds firmly the posterior half of the gaster of the female, with its three pairs of legs. The thoracic part of the male now comes to lie on the dorsal side of the gaster of the female. The gaster of the male is then bent downwards almost at right angles, at the pedicel, to the longitudinal axis of its body and the ædeagus is in turn directed at right angles to the position of the gaster, almost horizontally and inserted into the vagina of the female. During copulation, the anterior half of the gaster of the female is stroked by the antennae of the male. Other alate males also try to climb over the copulating male to have access to the female but they slip and drop down. The female mostly keeps walking about slowly, carrying the copulating male on the dorsal side of its gaster. The male and the female separate after about fifteen minutes.

DEPARTMENT OF ZOOLOGY,
MALABAR CHRISTIAN COLLEGE,
CALICUT-1,
June 21, 1968.

A. B. SOANS
J. S. SOANS

22. VARIOUS ASSOCIATES OF SESSILE BARNACLES IN BOMBAY WATERS

INTRODUCTION

Numerous instances of associations ranging from simple commensalism to total parasitism and symbiosis are to be abundantly found in literature. Majority of these associations occur in the crowded littoral and sublittoral zones as there is often competition for space. Cirripedes, being a major sedentary component of the biota and occupying a great deal of area, contribute towards such relationships to a great extent. These relationships, it is reported, range from sea-weeds to whales, numbering about 2000 species of living organisms. In this account an attempt has been made to compile the list of organisms that were found associated with the balanomorphs found around Bombay.

MATERIAL AND METHODS

Collections of sessile barnacles were made at random and brought to the laboratory. The associates from the shells were removed carefully, narcotised, if necessary, so as to obtain them in fully extended state and then preserved.

Observations

Organisms ranging from algae to mollusca found associated with barnacles are described below.

The algal associates included *Ulva lactuca* Linn., *Enteromorpha* sp., *Laurentia* sp., *Polysiphonia forrulacea*, Suhr, *Gelidium heteroplatos* and the calcareous form *Cheilosporum spectabilis*. All the algae were associated with *Balanus tintinnabulum*.

Fairly good number of sponges were found covering the shells of *Balanus amaryllis* at Chowpatty. This association was not observed at any other locality. Further classification of these sponge specimens is yet to be completed. Among the coelenterates associated with barnacles were *Sertularia* sp., *Cribrinopsis* sp. and *Diadumene schilleriana* (Stoliczka). Forms of *Sertularia* sp. were found as dense colonies anchored on *B. tintinnabulum* shells. The lattter two, the *Actinozoans*, were associated with *B. amaryllis* shells. The forms of *Cribrinopsis* sp. were characterised by light pink column covered with weakly developed red verrucae on its distal one-third region. These forms were of quite common occurrence. The occurrence of *Diadumene* along with barnacles has been previously recorded by Annandale (1907) and Bhatt (1959).

The errantian polychaetes included *Nereis talehsapensis* (Fauvel). These worms were small, thin and tapered posteriorly and showed certain differences in the teeth compared to Fauvel's description (Fauvel 1932). In addition, forms of *Perinereis nigro-punctata* Horst were also observed and some had the characteristic colour pattern on the dorsal surface of anterior segments. These polychaetes were associated with *B. tintinnabulum* and *B. amaryllis*.

The sedentary polychaetes consisted of *Polydora coeca* Oersted and *Dasychone serratibranchis* Grube. The former were found in great number at Chowpatty forming a distinct zone below that of *B. amphitrite*. Sometimes a few segments of their bodies, especially the anterior, were found among the clusters of barnacle shells. It is reported that this form bores into coral rocks and shells. Similar activity by them as regards barnacle shells may occur. The latter form viz. *D. serratibranchis* were found occasionally, attached to *B. amaryllis* shells collected at Cuffe Parade and Chowpatty.

The crustacean associates included isopods, amphipods and cirripedes. Of the isopods, two species occurred *Sphaeroma walkeri* Stebbing and *S. annandeli* Stebbing. Both were abundant among the shells of *B. amphitrite*. The boring nature of *S. annandeli* has been earlier proved by Erlanson (1936) and Pillai (1955). The mandibles of these forms have a cutting edge, formed of two, well-separated and powerful teeth.

Between their cutting edge and the strong molar is a series of small spines. As regards *S. walkeri* its boring nature is doubtful and contradictory opinions have been expressed by various workers. Ganapati & Nagabhushnam (1955), Srinivasan (1955) and Palekar (1957) have regarded it as a wood or rock borer. However, Calman (1919), Baker (1928), Pillai (1955) and Bhatt (1959) do not consider it a borer. Amphipods belonging to suborder Gammaridea were abundantly associated with all the species of balanomorphs. Among the cirripedes, *Ibla cumingi* was found attached to *B. tintinnabulum* at Bandra. Darwin (1854) and Hiro (1937) had similarly found these forms attached to *Pollicipes mitella* and *Mitella mitella* respectively. In India, however, they have been recorded so far as attached to rocks only (Patil 1951; Daniel 1956; Bhatt 1959).

The molluscan associates included the shells of *Acanthochitona mahensis* Winckworth; *Littorina intermedia* Phil., *Drupa konkanensis* Melvill, *Thais* sp. (probably *rudolphi*), *Arca bistrigata* Dunker, *Modiolus striatulus* Linn., *Brachyodontes karachiensis* Melvill and *Ostrea cuculata*. In addition, the egg cases of some molluscs were also found attached to barnacle shells.

Conclusion

The exact relationship of these organisms is not known and hence they have been grouped under the broad heading of associates. Most of the relationships might have originated fortutiously. However, more complex relationships are possible.

Acknowledgements

We are grateful to Dr. N. K. Panikkar, Director, Indian Programme of the International Indian Ocean Expedition, (at present the Director, National Institute of Oceanography, Panaji-Goa), for his keen interest and constant encouragement in the investigations and its further pursuance. One of us (ABW) gratefully acknowledges the award of fellowship by the Indian National Committee on Oceanic Research, CSIR, New Delhi.

National Institute of Oceanography, A. B. WAGH
Panaji,
Goa, D. V. BAL
Kirti College,
Bombay-28,
February 14, 1970.

References

ANNANDALE, N. (1907): The fauna of brackish ponds at Port Canning, Lower Bengal. Part III. *Rec. Indian Mus.* **1**: 46-74.

BAKER, W. H. (1928): Australian species of the Isopod family Sphaeromidae (contd.) *Trans roy. Soc. S. Aust.* **3**: 49-61.

BHATT, Y. M. (1959): A study of intertidal organisms. *Ph. D. thesis, University of Bombay* (Unpublished).

CALMAN, W. T. (1919): Marine Boring Animals. *British Museum (Nat. Hist.) Economic Series* No. 10.

DANIEL, A. (1956): The cirripedia of the Madras coast. *Bull. Madras Govt. Mus. New Ser Nat. Hist.* **VI** (2): 1-42.

DARWIN, Ch. (1854): A monograph on the sub-class cirripedia, Balanidae, Verrucidae, etc. *Roy. Soc.* London.

ERLANSON, E. W. (1936): A preliminary survey of marine boring organisms in Cochin harbour. *Curr. Sci.* **4**: 726-732.

FAUVEL, P. (1932): Annelida Polychaeta of the Indian Museum, Calcutta. *Mem. Indian Mus.* **12**: 1-262.

GANAPATI, P. N. & NAGABHUSHNAM, R. (1955): Crustacean wood borers of Visakhapatnam harbour. *Curr. Sci.* **24**: 200.

HIRO, F. (1937): Studies on cirripedian fauna of Japan II. *Mem. Coll. Sci. Kyoto.* **XII** (B): 385-478.

PILLAI, N. K. (1955): Wood boring Crustacea of Travancore. I. Sphaeromidae. *Bull. Res. Inst. Univ. Travancore, ser.* **c 4**: 127-139.

PALEKER. V. C. (1957): Marine Organisms injurious to submerged timber *Inst. Sci. Mag. Bombay* **25** (1956): 41: 46.

——— & BAL, D.V. (1957): Stray occurrence of Crustacean Wood borers in Bombay Waters. *J. Timber Dryers' Preservers' Ass.* **3**: 2-3.

PATIL, A. M. (1951) Fauna of Karwar—Part I. *J. Bombay nat. Hist. Soc.* **50**: 128-139.

SRINIVASAN, T. K. (1955) Crustaceans in relation to underwater timber structures. *Curr. Sci.* **24**: 342.

23. ON A NEWLY RECORDED HOST SPECIES OF *DENDROPHTHÖE FALCATA* (L.F.) ETTINGSH

During a random survey of phanerogamic parasites in the Indian Botanic Garden, Calcutta, I noted an infestation by the very common flowering parasite, *Dendrophthöe falcata* (L.f.) Ettingsh. on *Ropalocarpus lucidus* Boj. This host species appears to be a new record and may be added to the hosts of the parasite, which now number 331.

BOTANICAL SURVEY OF INDIA, R. B. GHOSH
INDIAN BOTANIC GARDEN,
SIBPORE,
HOWRAH,
July 4, 1969.

[See note No. 29 which concerns the same species but under a synonym—EDS.]

24. OCCURRENCE OF *CERATOPTERIS THALICTROIDES* (LINN.) BRONGN. IN RAJASTHAN

During the course of a botanical exploration of south-eastern part of Rajasthan, the author made extensive collections of ferns and fern allies. The fern *Ceratopteris thalictroides* (Linn.) Brongn., has not been reported earlier from any locality in Rajasthan, and its occurrence at Kelwarah (Kotah District) is a new locality record for the species.

The plant is quite common along the margins of Kelwarah tank and in rice fields. The tank is large, and is situated on the south-western side of Baran-Shahabad road near Kelwarah village. The plant community of the tank includes *Ceratopteris thalictroides* (Linn.) Brongn., *Nymphoides cristatum* (Roxb.) O. Kuntze, *Nymphaea stellata* Willd., *Hygroryza aristata* Nees, *Ottelia alismoides* Pers. and *Utricularia stellaris* Linn.

Ceratopteris thalictroides (Linn.) Brongn. is an annual, aquatic or marshland, light green fern; young plants rooted in mud; Fronds dimorphic. *Hindi*—Pani Ka Karála, *V. Singh* 74430.

The specimens have been deposited in the Herbarium of the National Botanic Gardens, Lucknow.

NATIONAL BOTANIC GARDENS,
LUCKNOW,
June 30, 1969.

VIJENDRA SINGH
Junior Research Fellow

25. THE IDENTITY OF *PIMPINELLA LATERIFLORA* DALZ.

Dalzell (1861) described *Pimpinella lateriflora* based on specimens collected from ravines in the Deccan, but unfortunately he left no herbarium specimen of his new species.

Clarke (1879) maintained *Pimpinella lateriflora* Dalz. as a distinct species, but indicated that he had not seen the type and his description was after Dalzell and Gibson. At the same time he also described a new species, *Carum stictocarpum*, together with a variety, *hebecarpa*, based on other specimens collected from Concan by Stocks and Law.

Now, if the description given by Dalzell for *P. lateriflora* and that of Clarke for *Carum stictocarpum* are compared they are seen to be identical except for the fruits which vary from granular to hispidulous hairy and the leaves from bipinnate to ternate. The relevant characters as given by the authors are presented below:

	Carum stictocarpum	*Pimpinella lateriflora*
1.	Plants glabrous or minutely hairy.	Plants puberulous.
2.	Stem 1-3 ft., erect.	Stem 1-1½ ft. high ; erect.
3.	Leaves 2—pinnate, ultimate segments of the lower cauline leaves narrowly linear-lanceolate, upper often with linear segments.	Leaves ternate, leaflets twice ternately divided, lobes of the lower leaves lanceolate, of the upper linear, all acute and mucronate.

4. Bracts 3-6, nearly linear ; bracteoles 4-8, linear-lanceolate ($\frac{1}{4}''$).	Involucre (bracts) of 3-7 subulate leaflets ; involucel leaves (bracteoles) similar, about 7, as long as pedicels.
5. Pedicels 8-20 in number ($\frac{1}{8}$-$\frac{1}{4}''$).	Umbels (pedicels) 3-10 in number.
6. Fruits minutely pubero-punctate, ultimately shining, yellow, the dots microscopical (or hispidulous sometimes densely so and fuscus in the var. *hebecarpa*).	Fruits densely covered with small granular tubercles.

Cooke (1903), however, records both *Pimpinella lateriflora* and *Carum stictocarpum* for peninsular India. But in a note under the former species, which has been included on the authority of Dalzell and Gibson, he states that he has neither seen a specimen nor has the species been found by any other collectors, though it is supposed to be common in ravines in the Deccan.

Meanwhile, Wolff (1927) separated Clarke's species from the genus *Carum* Linn. and placed it under the genus *Trachispermum* Linn., now spelt *Trachyspermum* (*nom. cons.*). He also retained *Pimpinella lateriflora* in spite of his statement that he has not seen the original or any other well-authenticated specimen of the same.

Santapau (1953) is the first worker to point out that his specimens listed under *Trachyspermum stictocarpum*, may also belong to *Pimpinella lateriflora* except for a few minor characters. He also writes that 'In Sedgwick's copy of Cooke's Flora (now available in BLAT—Bombay) there is a marginal note against *Pimpinella lateriflora:* Hallberg says there is no such plant. This is *Carum stictocarpum*.'

With this background and with the extensive studies and collections made by us along the ravines and the ranges of the Sahyadris and adjoining hills, it is evident, as stated by Dalzell, that this is the only species under the genus which is common in Deccan ravines with pink flowers and fruits with granular tubercles but, however, with a few more variations. The size of the plant varies from a few centimetres to one metre and the colour of the flowers from white to pink or tinged with lilac and the fruits are granular otherwise glabrous and shining or sparsely to densely hispidulous hairy. The latter character, namely the hispidulous condition of fruits which is now found to be quite unstable, might have induced Clarke to describe even a variety *hebecarpa*. With such understanding of the taxon both on the basis of field studies and also herbarium material, it may safely be concluded that *Trachyspermum stictocarpum* together with its variety *hebecarpa* is conspecific with *Pimpinella lateriflora*.

Under the normal procedure, the name *Carum stictocarpum* would have become superfluous, had not the specific epithet *lateriflora* of

Dalzell been preoccupied by an European species, *Pimpinella lateriflora* Link (En. Hort. Berol. 1:285, 1821 descr.). Hence the next available epithet, *stictocarpum* of Clarke is accepted for this taxon and the full synonymy is as follows:

Trachyspermum stictocarpum (C.B.Cl.) Wolff in Pfreich. 43:89, 1927, (*Trachispermum*); Santapau in Rec. Bot. Surv. Ind. 16(1):125, 1953. *Carum stictocarpum* C.B.Cl. in Fl. Brit. Ind. 2:681, 1879; Cooke, Fl. Pres. Bomb. 1:564, 1903. *C. stictocarpum* var. *hebecarpa* C.B.Cl. *l.c.* 682; Cooke *l.c.* *Pimpinella lateriflora* Dalz. in Dalz. & Gibs. Bomb. Fl. 106, 1861, *non* Link (1821); C B Clarke *l.c.* 689; Cooke *l.c.* 567. *Trachyspermum stictocarpum* var. *hebecarpa* (C.B.Cl.) Wolff, *l.c.*, Santapau *l.c.*[1]

As no specimen of Dalzell is available and no type of whatever kind is located at Kew or in any other herbaria as far as we are aware it may be appropriate as per rules to select a *neotype* for *Pimpinella lateriflora* Dalz. As such, the following specimen collected from the type locality region in general, is designated as *Neotype* and deposited in CAL. The duplicates of the same are being distributed to various World herbaria.

Neotype: Shivneri fort, Junnar in Poona district (Maharashtra State), *Hemadri* 104346 on 1-11-64.

The authors wish to express their thanks to Dr. Bakhuizen van den Brink, Rijksherbarium, Leiden, and to the Director, Royal Botanic Gardens, Kew, for their useful comments and suggestions on this subject.

BOTANICAL SURVEY OF INDIA, R. S. RAO
WESTERN CIRCLE, K. HEMADRI
POONA,
April 19, 1969.

[1] '*Pimpinella dalzellii* P. K. Mukh. nom. nov. in Ind. For. **95** (8): 567, 1969 is a superfluous name for *Trachyspermum stictocarpum*.'

26. NOMENCLATURAL NOTES ON INDIAN PLANTS

The following new combinations are proposed for two taxa:

(1) **Centaurium centaurioides** (Roxb.) Rolla Rao et Hemadri *comb. nov. Chironia centaurioides* Roxb. (Hort. Beng. 16, 1814, *nom. nud.*, '*centauroides*' Fl. Ind. 1:584, 1832 ('*centaureoides*'). *C. brachiata* Willd. ex Criseb. Gen. et Sp. Gentian, 145, 1839. *Erythraea roxburghii* D. Don in Lond. & Edinb. Phil. Mag. & Journn. Sci. 8:77, 1836; G. Don, Syst. 4:206, 1837; Wt. Ic. t. 1325, 1848; C. B. Clarke in Fl. Brit.

Ind. 4:102, 1883; Cooke, Fl. Pres. Bomb. 2:190, 1904; Gamble, Fl. Madras Pres. 876, 1923. *Centaurium roxburghii* (D. Don) Druce in Rep. Bot. Exch. Club. Brit. Isl. 4:614, 1916 (1917); Santapau in Rec. Bot. Surv. Ind. 16(1):181, 1953. *Erythraea roxburghii* var. *saxatilis* C. B. Clarke *l.c.* 104.

(2) **Salacia salacioides** (Roxb.) Rolla Rao et Hemadri *comb. nov.* *Johnia salacioides* Roxb. (Hort. Beng. 5, 1814, *nom. nud.*) Fl. Ind. 1:172, 1820 & 1:168, 1832; DC. Prodr. 1:571, 1824. *Salacia roxburghii* Wall. [Cat. no. 4217, 1831, *nom. nud.*] ex Wt. & Arn. Prodr. 105, 1834; Lawson in Fl. Brit. Ind. 1:627, 1875.

Critical study of the Wallichian sheets and other material cited as synonyms under this species by Lawson and Wight & Arnott has clarified the following points:

(*a*) Only Wallich's Cat. nos. 4217 & 4217c and Roxburgh's Ic. no. 1520 belong to the present species. (*b*) ? *Indeterminata* Wall. Cat. no. 4291 belongs to *Cassine glauca* (Rottb.) O. Ktze. and not the present taxon as doubted by Lawson (*l.c.*). (*c*) The taxon in question is mostly confined to Assam forests, extending up to lower Fagu in Bhutan (*H. H. Haines* 1048 on 1-2-1905, DD). (*d*) *Salacia roxburghii* of Dalz. et Gibs. (Bomb. Fl. 33, 1861) from Ramghat of Western Ghats is definitely a misidentification and possibly represents *Salacia beddomei* Gamble (Kew Bull. 1916:133, 1916). (*e*) *Salacia cochinchinensis* Lour. and *S. chinensis* Linn. indicated by Lawson (*l.c.*) as doubtful synonyms do not belong to this taxon but are distinct species by themselves.

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE,
POONA-1,
May 27, 1969.

R. S. RAO
K. HEMADRI

27. NOMENCLATURE OF TWO INDIAN PLANTS

1. **Justicia santapaui** Bennet nom. nov.

J. montana (Nees) T. Anderson in J. Linn. Soc. 10:509, 1867; Clarke in Hooker's Fl. Brit. Ind. 4:525. 1885; Santapau in Univ. Bomb. Bot. Mem. 2:85, 1951, non Roxb. (1805).

Hemichoriste montana Nees in Wall. Pl. As. Rar. 3:102, 1832 & in DC. Prodr. 11:367, 1847.

The epithet *montana* cannot be used for this plant under *Justicia* as used by T. Anderson and followed by others, because of the earlier name *Justicia montana* Roxb. (Pl. Corom. 2:t 176, 1805) for an entirely different plant. As there is no other validly published name for this species, it is here named after Dr. H. Santapau, whose contributions to Indian botany are valuable.

2. Daizell (in Hooker's J. Bot. 3:282, 1851) described an Orchidaceous species *Micropera viridiflora* from Western India. In 1859 Lindley (J. Proc. Linn. Soc. Bot. 3:36) transferred Dalzell's species to *Saccolabium* under the name *Saccolabium viridiflorum* and in 1891 O. Kuntze (Rev. Gen. Pl. 2:661) made a combination *Gastrochilus viridiflorus* based on *Saccolabium viridiflorum* Lindley. Cooke in 1907 (Fl. Pres. Bomb. 2:697) transferred Dalzell's species to *Sarcochilus*, but the name is a latter homonym of *Sarcochilus viridiflorus* (Thw.) Hooker f. (Fl. Brit. Ind. 6:385, 1890), which was based on a different type, *Aërides viridiflorum* Thwaites (Enum. 4305 1864) which occurs in Ceylon. So, for Dalzell's plant under *Sarcochilus*, Santapau (Kew Bull. 498, 1948) gave the new name *Sarcochilus dalzellianus*. Then in 1962 Santapau & Kapadia (J. Bomb. nat. Hist. Soc. 59:842) made the combination *Gastrochilus dalzellianus*, based on *Sarcochilus dalzellianus* Sant., because they thought the name *Gastrochilus viridiflorus* (Lindl.) O. Ktze. is applicable to another plant and not for Dalzell's plant. The correct name and citation for Dalzell's plant under *Gastrochilus* should be

Gastrochilus viridiflorus (Dalz.) O. Ktze. Rev. Gen. Pl. 2:661, 1891.
Micropera viridiflora Dalz. in Hooker's J. Bot. 3:282, 1851.

BOTANICAL SURVEY OF INDIA,
CALCUTTA-14,
May 21, 1969.

S. S. R. BENNET

28. ON THE OCCURRENCE OF *BUDDLEJA DAVIDII* FRANCH. (LOGANIACEAE) IN INDIA

Buddleja davidii Franch, a native of China, perhaps introduced long ago for cultivation in gardens as an ornamental plant, is now naturalized in Simla and other Himalayan hill-stations. This is the first report of its occurrence in wild state from India. A concise description is given.

Buddleja davidii Franch. in Nouv. Arch. Mus. Paris Ser 2 (10):65, 1887-88; Marquand in Kew Bull. 196, 1930; Backer & Bakh. f. in Fl. Java 2:212, 1965. *B. variabilis* Hemsl. in Journ. Linn. Soc. Bot. 26:120, 1889.

Erect shrubs, 1 m. to 3 m. tall. Stem slender, subterete or obtuse-angular, often narrowly margined, glabrous except for the densely pubescent or tomentose young tops. Leaves opposite, usually with a pair of inter-petiolar, ovate-suborbicular, entire to dentate, 0·3-0·8 cm. long auricles, sub-sessile or on short petioles formed by narrowing leaf base, ovate-lanceolate or elliptic-lanceolate-oblong, with a narrowed acute or rounded base, narrowed upwards into an acute apex, entire-serrate, glabrous above on maturity, white tomentose beneath, 5-21 × 1·5-6 cm. long. Bracts linear-subulate, 0·3-0·5 cm. long, usually hairy. Pedicels 0·1-0·15 cm. long, pubescent. Calyx 0·25-0·3 cm. long, divided less than halfway down, glabrate or hairy, lobes ovate-lanceolate, acute. Corolla 0·8-1 cm. long, tube erect, glabrous without, patent-hairy within, lobes 4, obovate-rounded, crenate-dentate. Anthers sessile, inserted at the middle of corolla-tube, linear, 0·8-1 mm. long. Ovary glabrous. Style clavate. Capsule linear-narrowly oblong, acute, glabrous, 0·6-1 cm. long. Seeds 0·5-0·8 mm. long.

A common shrub of cold weather and usually found along the hill tracks.

Flowers and fruits: July-November.

Specimen examined: HIMACHAL PRADESH, Simla, Jakku hills, *Kanai Lal Mali* 38 (CAL).

This taxon is closely allied to *Buddleja delavayi* Gang.—also a native of China, but this is easily recognizable by the longer and narrower leaves, longer inflorescence and bigger fruits.

CENTRAL NATIONAL HERBARIUM,
BOTANICAL SURVEY OF INDIA,
HOWRAH-3,
August 6, 1969.

S. N. BISWAS
R. PRASAD

29. FURTHER STUDIES ON THE HOST RANGE IN *LORANTHUS LONGIFLORUS* DESV.

It is of particular interest to note that all the species of host plants, hithertofore recorded for *L. longiflorus*, belong to the families of dicotyledons. Monocots in general do not seem to be susceptible to loranthaceous parasites.

In the present investigation, ten more new species of host plants have been recorded by way of experimental observations. Six of these species belong to five families already reported, while the remaining constitute four more new plant families. Thus there are now totally on record 68 species of host plants, coming under 32 dicot families.

Experiments conducted by allowing the seeds of the parasite to germinate on branches of different new host-species indicate clearly that at least some of them are not susceptible to the parasite. While some monocots have also been tried, none of the seeds grew to attain maturity. Although invariably all the seeds germinate within a fortnight to produce small green leaves and a massive haustorium, the fate of the parasite is decided only when the haustorium penetrates the host tissue. One of the most important factors determining the further growth of the parasite is the osmotic pressure-relationship between the host and the parasite. The study of the osmotic concentration of the host and the parasite is well under way, and this would throw much light on the host-parasite relationship.

The following are the new experimental host species for *L. longiflorus:*

Tamarix gallica L. (Tamaricaceae), *Cassia glauca* Lamk. (Caesalpinaceae), *Terminalia catappa* L. (Combretaceae), *Ixora parviflora* Vahl (Rubiaceae), *Mussaenda frondosa* L. (Rubiaceae), *Vernonia elegens* Gardn. (Compositae), *Tabebuia pentaphylla* Hemsl. (Bignoniaceae), *Tectona grandis* L. (Verbenaceae), *Bougainvillaea spectabilis* Willd. (Nyctaginaceae), and *Grevillea robusta* A. Cunn. (Proteaceae).

It may be concluded from the foregoing observations that nowhere in the study of angiospermic parasites has there been such a wide range of host plants affected by a single parasitic species and that there is a possibility of this parasite attacking many more species of host plants.

BOTANY DEPARTMENT, R. SAMPATHKUMAR
ANNAMALAI UNIVERSITY,
ANNAMALAINAGAR,
May 31, 1969.

[See Note No. 23 which gives the total number of hosts known so far for this species—EDS.]

30. ON THE PRODUCTION OF ADVENTITIOUS ROOTS FROM THE EXCISED PETIOLES OF SOME ANGIOSPERMS

(*With a photograph*)

Previous observations indicate that the production of foliar roots is common in Acanthaceae and Labiatae. The present investigation includes 33 new species of plants, belonging to 13 angiospermic families, as listed below:—

Portulaca grandiflora Lindl. (Fig. 1), *Cissus quadrangularis* Linn.

(Fig. 2), *Cayratia mollissima* Gagnep. (Fig. 3), *Eclipta alba* Hassk. (Fig. 4), *Chrysanthemum indicum* Linn. (Fig. 5), *Notonia grandiflora* DC., *Ageratum conyzoides* Linn. (Fig. 6), *Elephantopus scaber* Linn. (Fig. 7), *Jasminum sambac* Ait. (Fig. 8), *J. flexile* Vahl (Fig. 9), *Per-*

gularia minor Andr. (Fig. 10), *Ipomoea cairica* (Linn.) Sweet, *Ipomoea batatas* Poir. (Fig. 11 & 11A), *I. sepiaria* Koen., *I. reptans* Poir. (Fig. 12 & 12A), *I. obscura* Ker-Gawl., *I. pes-tigridis* Linn. (Fig 13), *I. pes-caprae* Sweet., *Evolvulus nummalarius* Linn. *Moniera cuneifolia* Michx., *Adhatoda vasica* Nees. (Fig. 14), *Barleria prionitis* Linn. (Fig. 15), *B. caprae* Sweet., *Evolvulus nummularius* Linn. *Moniera cuneifolia* Michx., *Echolium linneanum* Kurz (Fig. 18), *Asteracantha longifolia* (L.) Nees (Fig. 19)., *Lantana aculeata* Linn. (Fig. 20), *Leucas aspera* Spr. (Fig. 21), *Mirabilis jalapa* Linn. (Fig. 22), *Alternanthera sessilis* (L.) DC. (Fig. 23), *Telanthera ficoidea* Moq. (Fig. 24), *Gomphrena globosa* Linn. (Fig. 25), and *Sansviera roxburghiana* Schult. f.

While in majority of cases, the cut ends of the petioles were planted in moist soil, a few leaves were also left in glass containers with tap water. Prior to the production of adventitious roots, a massive callus (Fig. 11A) at the cut-ends of the petioles is formed in many cases, while in others no such tissue appears. In a few cases, aerial shoots (Fig. 12A, 16, & 17A) also appear from the callus so differentiated, and these shoots may be successfully grown into mature individuals. In the case of *Cayratia mollissima* Gagnep. (Fig. 3), root tubers are also produced.

BOTANY DEPARTMENT,
ANNAMALAI UNIVERSITY,
ANNAMALAINAGAR,
July 11, 1968.

R. SAMPATHKUMAR

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Editors

ZAFAR FUTEHALLY
J. C. DANIEL & P. V. BOLE

DECEMBER 1970

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3. All scientific names to be printed in italics should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and subspecific names always begin with a small letter even if they refer to a person or a place, e.g. *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri.*

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EDITORS,
Journal of the Bombay Natural History Society.

Hornbill House,
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Singh Road,
Bombay 1-BR.

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Editorial

This issue of the Journal is a Father Santapau Commemorative number. Soon after his death in January, 1970, it was decided that a Special Issue be published in his memory, and an attempt made to make it one of high quality.

We are grateful to the many contributors who responded to our appeal and who have written for this special number. An obituary of Fr. Santapau appeared in the April 1970 issue of the Journal, but we cannot help referring again to the great loss the Society and natural History in general have suffered because of his early death. His enthusiasm was infectious, and one of the projects which was discussed at almost the last Executive Committee meeting which he attended was the preparation of a book on Indian Wild Flowers. There is great need for such a book to stimulate interest in our country-side, and nothing suitable is available. Would some of our readers, who are in a position to contribute towards such a project, please write in?

At the Tenth General Assembly of the International Union for Conservation of Nature and Natural Resources which was held in November, 1969, in New Delhi, Fr. Santapau spoke strongly for the preservation of our flora, and referred among other areas to the Gir Sanctuary where pressures of domestic cattle and human encroachment were destroying the unique habitat. Fr. Santapau was the Principal Scientist of the ecological studies in the Gir which are now under way. He spoke of an earlier incident where the Maldharis of the Gir had stated that "If the Minister of Forests of Gujarat did not give them sufficient concessions in the Sanctuary they would change the Minister." Politics reigns supreme in our country (as it does in others) but recently there has been considerable re-thinking in India and elsewhere on the need for the validation of development projects on an ecological basis. The environment continues to be under great pressure from every side, and it is only by the vigilance and understanding of the citizens that our natural resources can be maintained in the way they should be, and exploited only on a sustained yield basis.

As a Special Memorial to Fr. Santapau it has been decided to recommend to the Government of Maharashtra that an area of evergreen forest in Khandala be renamed after him. The Government of Maharashtra have shown an interest in this proposal, and it is hoped that a floral sanctuary will come into being soon.

JOURNAL
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1970 DECEMBER Vol. 67 No. 3

Observations on the Nilgiri Tahr (*Hemitragus hylocrius* Ogilby, 1838)

BY

GEORGE B. SCHALLER
New York Zoological Society

(*With two plates and four text-figures*)

The *Hemitragus* wild goats differ in appearance from those belonging to the genus *Capra* in that males have no beard and the short horns of males and females differ only slightly in size (Lydekker 1898). Three species of tahr are generally recognized. The Arabian tahr (*H. jayakari*) occurs in the mountains of Oman in Arabia and its habits remain unknown (Fitter 1968). The Himalayan tahr (*H. jemlahicus*) ranges along the southern slopes of the Himalayas from Kashmir to Bhutan (Burrard 1925), and the Nilgiri tahr (*H. hylocrius*) is confined to the hills of south India. Various aspects of the biology of the Himalayan tahr have been studied in New Zealand where the species has been introduced (Anderson & Henderson 1961 ; Caughley 1965, 1966), but information on the Nilgiri tahr, or ' ibex ' as it is known locally, consists chiefly of hunting accounts (Shakespear 1862 ; An Old Shikarri 1880 ; Hawkeye 1881 ; Hamilton 1892 ; Pollock 1894 ; Russell 1900 ; Fletcher 1911 ; Stockley 1928) or of brief descriptions of encounters with the animal (Hornaday 1885 ; Brown 1960 ; Bassett 1964 ; Willet 1968). The limited knowledge about the Nilgiri tahr has been summarized by Blandford (1888-91) and Prater (1965). Information about it is needed because its limited distribution and low numbers have qualified it for inclusion into THE RED BOOK of the world's threatened species (Fisher *et al.* 1969). To gather data on the status, distribution, and biology of the Nilgiri tahr, I spent September 26 to November 14, 1969, in south India.

The Nilgiri tahr is a stocky goat in which both sexes have a short, coarse pelage and a bristly mane a few centimetres long, in contrast to the male Himalayan tahr which has a long, shaggy mane on the shoulders, throat and chest. The pelage of subadults, females, and young males is dusky brown to grey-brown in colour except for a whitish abdomen and a dark brown band that runs down the length of the back. There is also a conspicuous dark spot just above the carpal joint or knee. The horns curve sharply backwards and are about 30 cm. long in females (Plate 2). The front of the horn of the Nilgiri tahr is almost flat with the keel confined to the inner edge, whereas the horn of the Himalayan tahr has a prominent keel in front (Fig. 1).

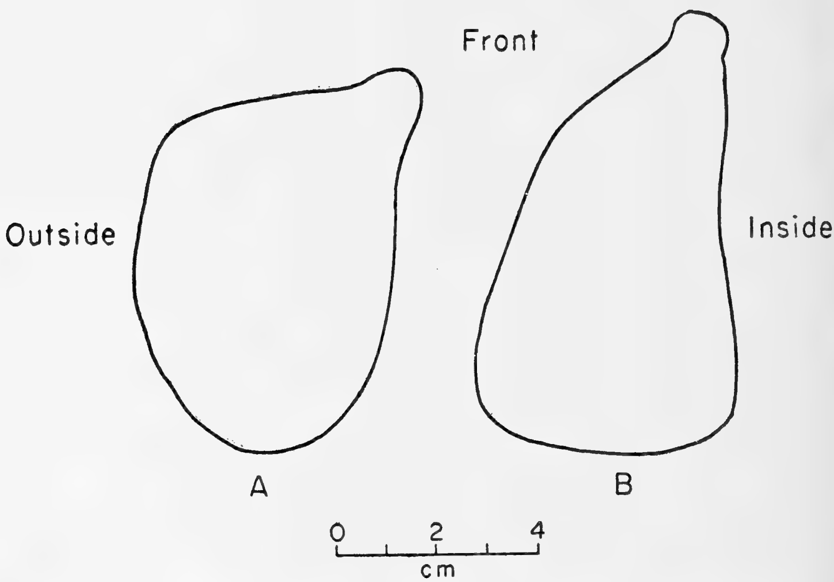

Fig. 1. Cross-sections of tahr horns, taken near the base, showing characteristic shape of (A) the Nilgiri tahr and (B) the Himalayan tahr.

Adult males are handsome creatures, weighing an estimated 80-100 kg. and standing about 100 cm. tall at the shoulders, considerably larger than the females. Their pelage is dark brown, almost black, except for their grizzled white lower back, sides, and sometimes also the rump, a feature responsible for their being called 'saddlebacks' by sportsmen. The sides of the neck, too, are often grey. The abdomen and throat are white, and a pale streak runs from each ear down the side of the muzzle and a light-coloured ring surrounds each eye. The spot above the carpal joint is white, rather than black as in the other animals. Their horns are up to about 40 cm. long and some 22 cm. in circumference at the base, both longer and more massive than those of females (Plate 2).

Distribution and Numbers

The Nilgiri tahr is known only from the hills of southern India, ranging 'from the Nilgiris to the Anaimalais and thence southwards along the Western Ghats . . .' (Prater 1965). Unlike the Himalayan tahr which lives for at least part of the year among brushy ravines and on forested slopes (Garhwali 1911), the Nilgiri tahr prefers open terrain, cliffs and grass-covered hills, a highly discontinuous habitat largely confined to altitudes of from 1200 to 2600 m. Tahr probably occupied all suitable areas in the past, but hunting and habitat destruction have decimated them to such an extent that they now exist only in a few isolated sites. I was not able to check all possible tahr localities in the short time available to me, and, instead, devoted most effort to censusing the animals in the two main areas where they occur, devoting 15 field days to the Nilgiri Hills of Tamil Nadu (Madras), and 19 days to the High Range of Kerala. Two days were also spent in the Anamalai Hills in Tamil Nadu, but for information on other areas I depended on correspondence with local sportsmen and tea planters.

Nilgiri Hills. The Nilgiris rise abruptly from the plains to a lofty tableland some 1800 sq. km. in size. The lower slopes are densely covered with forest, particularly with wet evergreen forest on the Western side, surmounted often by sheer granite cliffs towering to the plateau above (Plate 1). The uplands consist of a large expanse of steeply rolling hills at an altitude of about 2000 m. Grass covered most of the hills in recent times, except for patches of stunted evergreen forest, the 'sholas', confined to ravines and sheltered slopes. But in the past few years most of the area has either been cultivated or converted into wattle and *Eucalyptus* plantations. It is probable that forests covered much of the plateau in the past, with grasslands only in boggy hollows and on steep slopes. Annual fires during the dry seasons in January and February and grazing by domestic buffalo belonging to the original inhabitants, the Todas, pushed back the forests slowly (Jeyadev n.d.) until only patches of it remained when the first Europeans penetrated the areas between 1812 and 1819 (Fletcher 1911).

'In former times, that is about fifty years ago, the Ibex appears to have roamed at will in vast herds over all the grassy uplands of the higher plateau of the Nilgiris . . .' (An Old Shikarri 1880). By 1879, however, hunting had reduced the tahr to such an extent that their number 'probably did not exceed a dozen head all told' according to Phythian-Adams (1939). This estimate may be too low for Russell (1900) found herds readily in 1886 and 1888. By the end of the century the tahr survived largely along the western edge of the plateau, an area remote from human habitation where the huge cliffs and inclement weather (up to

750 cm. of rain a year) protected them from the casual hunter. In addition, the Nilgiri Wild Life Association, formed in 1877, interested itself in the species and afforded it protection. By 1927, about 400 tahr were thought to exist in the western Nilgiris (Phythian-Adams 1927), and by the late 1930's 'not less than 500' (Phythian-Adams 1939). The Nilgiri Wild Life Association conducted the first census of the tahr in 1963. The area in which they occur was divided into 4 sections and 4 teams of 2 men each counted the tahr over a period of 4 days (Davidar 1963a). 'The tahr actually seen and counted amounted to 292 . . . So it can be safely estimated that there are about 400 tahr in the Nilgiris . . .' (Davidar 1963b). The various figures suggest that the size of the tahr population had remained relatively stable or declined only slightly in the past 40 years, although a few small herds, such as one near Glen Morgan (Davidar 1963b), had disappeared. Davidar, however, wrote to me in March, 1970 : 'I have been chasing them . . . for the last 16 years and I can assert with certainty that they have increased during this period.'

Most tahr in the Nilgiris inhabit the western escarpment from Nilgiri Peak south to the Bangitappal and Sispara Pass area, a continuous stretch of terrain about 37 km. long (Fig. 2). I spent a week searching for tahr in the northern third of this range, between Nilgiri Peak and Pichal Bettu, and found a total of 63 different animals. The tahr confined their activity to the cliff faces and grasslands immediately adjoining them, a strip 1 km. or less in width, as indicated by repeated sighting of animals or their sign such as droppings and resting places. It is thus unlikely that any large herds were overlooked. In the census conducted by Davidar (1963a) a total of 79 tahr were recorded in the same area. I did not visit the central third of the tahr's range, but Davidar (1963a) found 66 animals there.

The hills along the southern third of the escarpment are rockier and more rugged than those farther north with the result that an area of about 50 sq. km. has remained free of forest plantations. A week of searching along all bluffs and major ridges revealed a total of 113 tahr, as compared to 112 reported by Davidar (1963a) from the same area. Most animals were along the escarpment where they were easy to spot, but a few small herds were inland as well. Considering the excellent visibility and the fact that in all cases except one a herd was located after finding fresh sign, it seems likely that the count was fairly complete. A small population of about 35 animals existed near the Chembar River slightly to the east of the Sispara area in 1963 according to Davidar (1963a). I did not visit the site.

The similarity in the1963 and 1969 counts in 2 areas indicates that the tahr population has remained stable during the past 6 years and numbers about 300 animals in the Nilgiris as a whole.

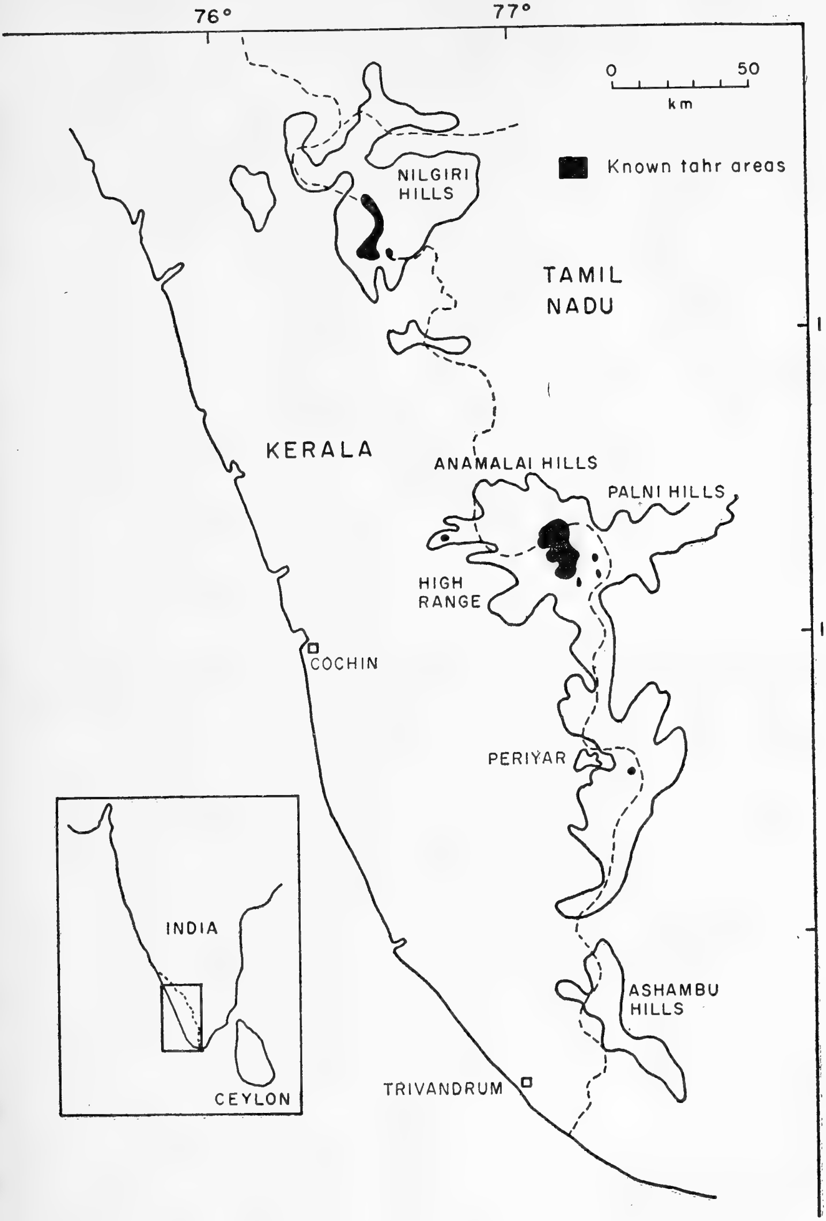

Fig. 2. The hill ranges of south India, drawn along the 1000 m. contour line showing the precise locations at which tahr were seen in 1969 or known to have occurred in 1967 and later. Other small populations existed in the Anamalai and Palni hills and possibly elsewhere but it was not possible to obtain detailed information on these in the time available for the survey.

High Range. A gap of about 100 km. separates the tahr in the Nilgiris from those in the High Range and Anamalai Hills to the south. The High Range with its deeply dissected valleys, massive peaks, and towering crags is ' surpassingly grand, and incomparably beautiful ', in the words of Hamilton (1892), one of the first visitors to the area in 1854. Tea plantations now cover the valleys, leaving indigenous forests only on the steep slopes, but the cliffs and grassy plateaus above an altitude of 2000 m. still provide suitable tahr habitat. The Eravikulam area, also known as Hamilton's Plateau, a private shooting reserve owned by the Kanan Devan Hills Produce Company, contains the largest tahr population in the High Range (Plate 1). Protected from poachers, pastoralists, and agriculturalists since 1895 by the High Range Game Preservation Association, as well as by the cliffs that border the 80 sq. km. plateau on 3 sides, the tahr there have remained relatively undisturbed in recent years. Fire and slash-and-burn cultivation by the Muduvars, who occupied the area sometime after the 14th century (Thurston 1909) are probably responsible for the little forest that is left on the plateau.

The Eravikulam area, including Rajamallay and Anamudi Peak, was divided into 7 blocks for census purposes. Each day I searched for tahr along all cliffs and ridges in one block. Visibility in the open, undulating hills was so good that animals were sometimes seen with binoculars or spotting scope from 1 to 2 km. away. Only the clouds which usually settled against the cliffs by noon hampered the census work. Undisturbed herds moved little from day to day, making it unlikely that animals were counted twice by shifting from one block to another. However, disturbed herds may flee as far as 3 km. without stopping, and care must be taken not to duplicate such animals in a count. A total of 439 tahr were seen. In addition, fresh sign indicated the presence of another herd but I was unable to find it in the clouds that engulfed the hills at the time. The total number of tahr in the reserve was thus about 500.

Mr. Gouldsbury told me that small herds of a dozen or so each occur on Tertian's Plateau, Karinkulam, and Periavurrai. All 3 localities are small plateaus separated only by a valley from each other or from the Eravikulam Reserve.

Anamalai Hills. The Anamalai Hills border the High Range to the north without an intervening physical barrier. Hawkeye (1881) saw tahr in these rugged, grass-covered hills in herds of hundreds and Hornaday (1885), too, found them ' quite abundant '. In 2 days of searching for tahr within an area of some 40 sq. km. bordering the Eravikulam Reserve, only one herd numbering about 25 animals was seen. Human disturbance in that area is great and includes a road, tree plantations, and, according to my guide, much poaching. K. Mathew, Divisional Forest Officer, told me that a number of tahr occurred in the Parambikulam

Above: Typical tahr habitat in the north-western part of the Nilgiri Hills. *Below:* The Eravikulam Reserve in the High Range as viewed from Anamudi Peak. The distant ridge lies in the Anamalai Hills. Tahr remained mainly along the cliffs such as those in the foreground.

(*Photos : Author*)

Above : Nilgiri tahr watching the observer alertly. In the centre is an adult female; the animals on the right and left are yearlings almost 2 years old. *Below :* A saddleback male grazes on a steep slope. His grey saddle, the greyish neck, and spot above the knee are clearly visible.

(*Photos : Author*)

Sanctuary in the western part of the Anamalais in 1967. R. Steele, a tea planter, wrote to me that tahr could still be seen in several areas in the hills.

Palni Hills. H.H. the Raja of Pudukkotai noted that ' there are still a few Nilgiri Tahr left in the Palni Hills, may be there are about a 100 to 150 on the whole roaming about the cliffs ' (letter, 1970). I was unable to obtain more information through correspondence and my time was too limited for a visit to the area.

Other areas. Tahr probably occurred as far south as the Ashambu Hills in the past[1]. A few animals possibly survive in the Periyar Sanctuary and surrounding areas. K. Mathew told me that tahr were wiped out in the sanctuary, but M. C. Jackson, a tea planter at Vandiperiyar, wrote that a friend of his encountered 2 tahr there in 1967.

Summary. A total of 640 tahr was seen during the visit to south India and other information raised the known number of animals to at least 1000 of which 300 were in the Nilgiris, 530 or so in the High Range, and most of the remainder in the Anamalai and possibly the Palni Hills. However, a precise estimate of the total number of Nilgiri tahr surviving in the wild cannot be made until the status of the species has been determined in the Anamalai and Palni Hills as well as in the region lying to the south of the High Range.

Population Dynamics

While censusing, each herd was counted and when possible classified into adults (2 years old and older), yearlings (1 to 2 years) and young (0 to 1 year). Adult males were divided into 3 age classes according to size and pelage colour : saddlebacks, dark brown males lacking a saddle, and light brown males of the same size and colour as females. Himalayan tahr can be accurately aged by the conspicuous growth rings on the horns which are laid down each winter other than the first (Caughley 1965). Rings were not readily discernible on free-living Nilgiri tahr, but 6 mounted heads, which judging by horn size belonged to dark brown males or saddlebacks, all had 5 to 7 faint growth rings. There is, of course, no evidence that the Nilgiri tahr grows one ring a year like its Himalayan relative, but I would assume that such males are at least 5 years old. Yearlings, which at the time of the study were almost 2 years old, were about 1/4 to 1/3 smaller in size than an adult female and their horns were

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[1] In April, 1970, J. C. Daniel of the Bombay Natural History Society visited the hills south of the High Range and was told by various informants of 14 localities where tahr are still said to occur.

more slender than those of adults. Most young, nearly one year old, had straight or slightly curved horns some 7 to 12 cm. long.

POPULATION COMPOSITION. Of 176 tahr seen in the Nilgiris, 164 were classified. One herd of 7 disappeared in fog before I could find out the age and sex of the animals, and 6 others separated from a large herd during a count. I was unable to classify all animals in the High Range, except the dark brown males and saddlebacks. The figures for light brown males, females and subadults are, therefore, based on a sample of herds totalling 260 tahr.

In the Nilgiris, 21% of the population consisted of adult males of which 9% were saddlebacks (Table 1). Adult females comprised 34%

TABLE 1

COMPOSITION OF THE TAHR POPULATION IN THE NILGIRIS AND HIGH RANGE

Sex and Age Class	Nilgiris %	High Range %
Saddleback	9·1	11·0
Dark brown male	4·3	4·2
Light brown male	7·9	4·2
Adult female	34·2	33·6
Yearling	18·9	17·3
Young	25·6	29·6

and subadults (yearling and young) 45%, indicating a vigorous population with good reproduction. The figures for the High Range were similar to those of the Nilgiris with adult males at 19%, of which 11% were saddlebacks, adult females at 34%, and subadults at 47% (Table 1). If it is assumed that dark brown males and saddlebacks are over 5 years old and that there are at least as many adult females of similar age in the population, then 25-30% of all animals were 5 years old and older and 25-30% were 2 through 4 years old. Female Himalayan tahr in New Zealand may reach an age of 17 years though only 3% exceed 12 years (Caughley 1966). The ratio of 2 males to 3 females indicates either an unequal sex ratio at birth or a higher death rate among males than females at some time during the life cycle. I was unable to sex most young with precision, but a count of 31 yearlings in the Nilgiris, for example, showed that 11 were males and 20 were females. Although these figures do not differ statistically in a significant manner from a 1 : 1 ratio, they do suggest that more females than males may already be present among subadults. Phythian-Adams (1927) found that ' the does outnumber the bucks by some 20 to 1 ', but he does not give the basis for his statement.

Reproduction. Published information on the reproductive biology of the tahr is confusing. Stockley (1928) noted that ' kids may be dropped at any time of the year ', and An Old Shikarri (1880), Willet (1968) and others made similar statements. On the other hand, Kinloch (1926) and Prater (1965) wrote that most young are born at the beginning of the hot weather, presumably in March, and Lydekker (1898) stated that parturition is in June and July. If births occur throughout the year, then young of all sizes would be expected in the population. Of 133 young classified (and many other seen) all but three were of approximately the same size, indicating a sharp birth peak. The young were large, with conspicuous horns up to 12 cm. long, and many adult females were heavily pregnant in November. From this evidence, I would judge that most young are born during the cool season between December and February. One young in the Nilgiris was less than a month old in October and another was perhaps 2 months old, indicating that occasional births occur in other months as well. With a birth peak from December to February and a gestation period of 6 months (Fisher *et al.* 1969), the main rut would be in June, July, and August, mostly during the south-west monsoon, rather than in December and January as stated by Stockley (1928).

The Nilgiri tahr has 2 teats (unlike the Himalayan tahr which has 4, two of them rudimentary). Stockley (1928), Kinloch (1926), Prater (1965) and others noted that one young is the rule, and this was my impression too. Sterndale (1884), on the other hand, stated that tahr usually have twins. Yearling females were not visibly pregnant at the age of nearly 2 years, suggesting that most tahr had their first young at the age of 3 years.

Mortality. Generally the per cent of yearlings entering the adult class of a stable population roughly equals the per cent of adults disappearing through death or emigration. About 18% of the tahr comprised yearlings (see Table 1). The Nilgiri population was thought to have remained stable in the past years, and the High Range one showed no striking fluctuations during the 1960's although Gouldsbury (pers. comm.) felt that it was increasing slowly. Thus, in the Nilgiris at least, annual adult mortality might be as high as 18%. Mortality of young was low. Assuming that each adult had one young early in 1969, then 76% of the females in the Nilgiris and 88% in the High Range raised one offspring almost to the age of one year. If production and survival of young was as high in 1968 as in 1969, then the difference between the percent of yearlings and young gives an indication of mortality between the two age classes. The Nilgiris showed a 44% drop in number, the High Range 27%. Although these figures are based on several assumptions, they do suggest that many yearlings and perhaps as many as 1/6 of the adults die each year, there being no evidence of large-scale emigration. Possible causes of death include disease and predation.

Disease. No sick tahr were seen. Rinderpest is said to have decimated the High Range population long ago (Gouldsbury, pers. comm.), and lame animals are sometimes encountered in April, a time of year when foot-and-mouth disease is prevalent in local cattle, according to my guide, a tribal Muduvar. The remains of only one tahr, an adult female, were found in many miles of hiking. However, sick animals probably retreat to the cliffs and fall into the dense brush below when they die.

Predation. Tahr share their habitat with several potential predators. Jackal (*Canis aureus*) possibly kill newborn young on occasion. To obtain some idea of jackal food habits, 119 sets of droppings from the High Range were examined and the results in Table 2 show that small

TABLE 2

FREQUENCY OF OCCURRENCE OF FOOD ITEMS IN 119 JACKAL DROPPINGS, HIGH RANGE

Food items	Frequency of occurrence (%)
Small rodent	94·4
Lizard and snake	29·4
Crab	10·0
Insect	6·7
Seed	5·8
Sambar	2·5
Hare	0·1
Snail	0·1

rodents provided most food during October and November. The sambar hair in the droppings undoubtedly represented carrion. Thyagarajan (1958) once observed wild dogs (*Cuon alpinus*) hunt tahr and on this basis assumed that predation is 'the most important factor operating against their survival'. Wild dogs are rare, however, and packs visit an area only at long intervals. Observers both in the Nilgiris and High Range told me that sambar (*Cervus unicolor*), not tahr, are the main prey of wild dogs in the hills. Davidar (pers. comm.) once watched a leopard (*Panthera pardus*) stalk tahr unsuccessfully. I saw only one set of tracks of this uncommon cat. One tiger (*Panthera tigris*) frequented the Bangitappal area of the Nilgiris and two the Eravikulam Reserve during my visit. All 10 tiger droppings which I found contained sambar remains and one also crab shells. In sum, all these predators are now rare to uncommon, and there is no evidence that they have any controlling influence on the tahr populations.

Saddlebacks may be legally hunted but only a few are shot each year. The average annual kill in the Nilgiris between 1912 and 1938 was 4·6 (Phythian-Adams 1939) and between 1940 and 1966 it was 2·3 (Davidar 1968). An average of only 1·9 animals per year were shot in the High Range between 1958 and 1969. Hamilton (1892), who in 1854 was the first European to hike through the Eravikulam area, found that tahr ' were extremely wild, which was accounted for from their having been lately harassed by hill men, the Moodowas, who had constructed across one of their runs, a barrier of stout bushes, forming a strong hedge, with weak places ten or twelve feet apart ; across which a strong running noose was firmly secured. The ibex were then driven up to these barriers and were ruthlessly snared and shot.' Hawkeye (1881) and Thyagarajan (1958) describe similar methods of killing in the Anamalai Hills. Illegal hunting has undoubtedly been responsible for the extirpation or drastic reduction of tahr in most of their former habitats, and the remaining populations are still subjected to a certain amount of it. Recently, for example, a High Range police official shot 2 tahr that had come near a road, and Davidar told me that several poachers were encountered in the Bangitappal area shortly after my visit there.

This discussion about possible causes of mortality provides little precise information about the factors which actually influenced the tahr populations, and it is obviously important to monitor the animals throughout the year to find out if disease, for instance, affects them at certain times.

Herd Structure

Tahr are social animals which usually associate in groups of two or more individuals. One adult female was seen alone as were 3 different dark brown males and 5 saddlebacks, but such animals were uncommon. Groups can be divided into mixed herds, consisting of females and subadults, and, on occasion, also of males, and into male herds composed solely of males.

Herd size. My observations, as well as those in the literature, indicate that tahr seldom occur in mixed herds exceeding 50 individuals. Sterndale (1884) mentioned herds with 60, 65, and 120 animals, Kinloch (1926) with 60 and 90, and Fischer (1915) one with at least 86. Twenty-three mixed herds counted during the census work varied in size from 6 to 104 animals with an average of 23 (Fig. 3). A total of 9 different male herds were tallied, and these varied from 2 to 12 animals each with an average of 5·5.

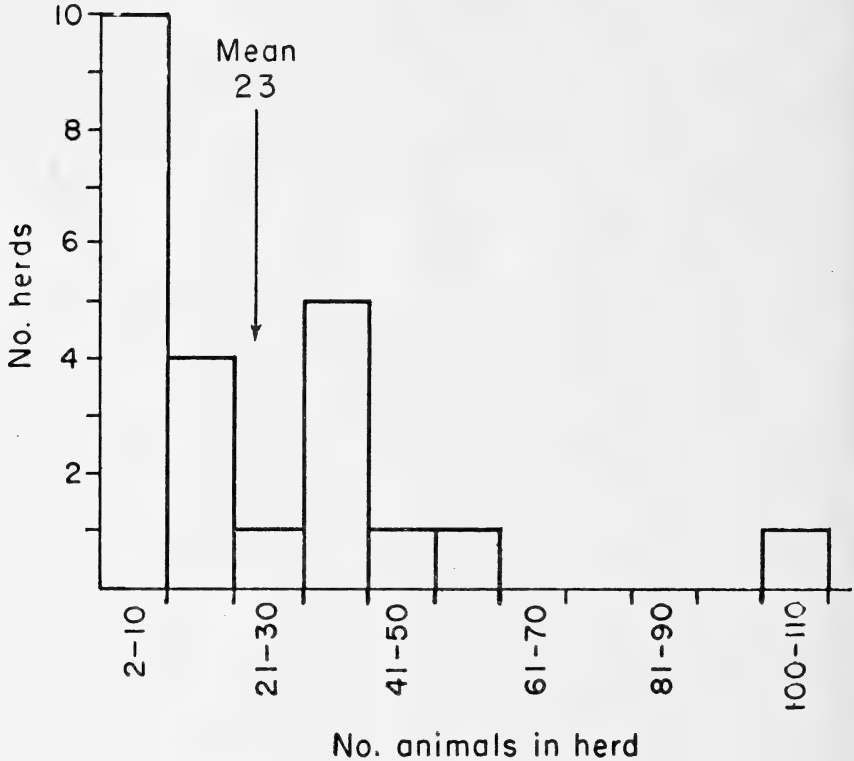

Fig. 3. The size of 23 mixed tahr herds.

Herd composition. Mixed herds characteristically contain light brown males, females, and subadults, but dark brown males and saddlebacks are only sporadic members (Table 3). At the time of my study, some large young and yearlings tended to form their own group, remaining either at the periphery of a mixed herd or becoming widely separated from it. For example, one herd consisting of a yearling female and 5 young was at least 3 km. from the nearest adults. Young also left their mothers and attached themselves to other animals when herds split with the result that some contained 2 to 3 times as many young as adult females whereas others had few or no young.

Tahr herds may change in composition from day to day as they split and join without obvious pattern. For instance, one herd of 34 was joined by 2 dark brown males and 3 females in the course of a day. A herd of 43 split into herds of 16 and 27. When encountered again the following day 38 animals were together. Of these a saddleback left alone, 29 crossed a deep valley, and 7 females and a light brown male moved in the opposite direction.

TABLE 3

COMPOSITION OF SOME TAHR HERDS IN THE NILGIRIS AND HIGH RANGE

Male				Female			
Saddleback	Dark brown	Light brown	Yearling	Adult	Yearling	Young	Total
2		1	1	2			6
					1	5	6
				2		6	8
2				3		3	8
1		2	1	6		4	14
		1			4	10	15
		2	3	12	7	10	34
1	1	2	2	17	3	8	34
1	1	6	1	16	4	9	38
1	2	3	5	12	7	9	39

Dark brown males and saddlebacks enter and leave mixed herds intermittently on their own volition. When not in a mixed herd such males are alone or in male herds (Table 4). In the Eravikulam area the

TABLE 4

COMPOSITION OF SOME MALE HERDS IN THE NILGIRIS AND HIGH RANGE

Saddleback	Dark brown	Total
2		2
3		3
	2	2
3	3	6
7		7
4	5	9
9	3	12

males tended to congregate. Whereas mixed herds were scattered along the cliffs, 30 of the 69 dark brown males and saddlebacks in the reserve were in the western corner. The fact that males leave mixed herds has been noted frequently (Hamilton 1892 ; Willet 1968), but opinions differ as to the season when they do so. Stockley (1928) felt that the separation occurs in the cold season and Kinloch (1926) that it happens in the hot season. Each dark brown male and saddleback seen in the Nilgiris and High Range was classified according to whether he was alone, in a male herd or in a mixed herd. Table 5 shows that during the first half of

TABLE 5

PER CENT OF MALES SEEN ALONE, IN MALE HERDS, AND IN MIXED HERDS DURING OCTOBER

Date	No. males in sample	% males alone	% males in male herds	% males in mixed herds
Sept. 30-Oct. 16 ..	31	19	29	52
Oct. 17-31 ..	75	9	72	19

October, when I worked in the Nilgiris, about half of the males associated with mixed herds, and that during the second half, when I was in the High Range, over 3/4 of the males were alone or in male herds. My sample for November is too small to include in Table 5, but only one of 9 mixed herds contained a dark brown male or saddleback. The largest males in an ungulate population usually do most of the mating (*see* Geist 1966 ; Schaller 1967), and the highest per cent of dark brown males and saddlebacks would, therefore, be expected around mixed herds during the rut from June to August. Afterwards, when few females come into œstrus, the males associate only casually with them. Mixed herds which one day included a saddleback frequently lacked one the next day, confirming the transitional nature of the contacts. Anderson & Henderson (1961) found that ' apart from the rutting season, which extends from late April to early July, the sexes range separately ' in the Himalayan tahr of New Zealand. Transitional contacts between mixed herds and males are also found in many other species of hoofed animals such as the gaur (*Bos gaurus*) and axis deer (*Axis axis*) in India (Schaller 1967), the ibex (*Capra ibex*) in Switzerland (Nievergelt 1967), the wild goat (*Capra hircus*) in Pakistan (Roberts 1967) and the bighorn sheep (*Ovis canadensis*) in Canada (Geist 1968).

Light brown males, estimated to be 2 to 4 years old, did not become solitary or join male herds, in contrast to young *Capra ibex* males which may join male herds at the age of 2 and 3 years (Nievergelt 1967).

Behaviour

The behaviour of undisturbed tahr was observed for 53 hours, often from 1 km. or more away to reduce the chances of being detected by the animals. However, the erratic winds frequently carried my scent to them, and this, together with clouds that often obscured the cliffs, made prolonged observations difficult. Nor were October and November the most auspicious times for recording behaviour. The bonds between females and their young were essentially broken, and the rut was finished. For example, my observations on sexual behaviour were limited to males twice sniffing the vulva of urinating females and curling their lip up afterwards.

General behaviour. Fletcher (1911) and other observers stated that tahr are active mainly in the early morning and late afternoon, but Kinloch (1926) also found them feeding at midday. An Old Shikarri (1880) noted that they are active at all hours, an observation which agrees with what I saw. Herds gave the impression of being restless as feeding and rest periods of varying lengths followed each other. Frequently one animal in a herd began to graze and all others joined within 10 minutes. They remained active for perhaps 30 to 45 minutes and then lay down again one at a time. To find out if tahr follow some general daily pattern of activity, I recorded the number of animals grazing and not grazing every 5 minutes in each undisturbed herd. The 6 points in each 1/2 hour period were lumped and expressed as per cent of animals feeding in Fig. 4 which is based on 10,968 activity observations. Most tahr fed until about 08.00 hours. There was a sharp drop in activity between 08.00 and 08.30 hours and then about 2/3 of the animals rested at any one time until 10.30 hours. After that and until 14.30 hours at least half the tahr fed, followed by a slight drop in activity between 14.30 and 15.30 hours. A second feeding peak occurred after 16.00 hours. Phythian-Adams (1950) stated that tahr remain on the cliffs at night.

In October and November, when green forage was plentiful throughout their habitat, the tahr fed mostly on or near cliffs. Grazing herds moved either as a fairly compact unit or loosely scattered over the slope. Occasionally they travelled to another site in single file with an adult female in the lead and saddlebacks usually in the rear. The animals were silent except on one occasion when I heard several bleats. Green grass was the tahr's principal food during the period of study. In addition the leaves of a shrub (*Strobilanthes kunthianus*), of an Umbelliferae (*Heracleum* sp.) and a wattle (*Acacia* sp.) were also eaten. Between January and March, after the dry grasses have been burned and before the first April showers produce a growth of new grass, tahr are said to browse along the edge of the thickets and the bases of the cliffs. Some patches of soil on steep slopes had been extensively pawed by tahr and these possibly represented saltlicks.

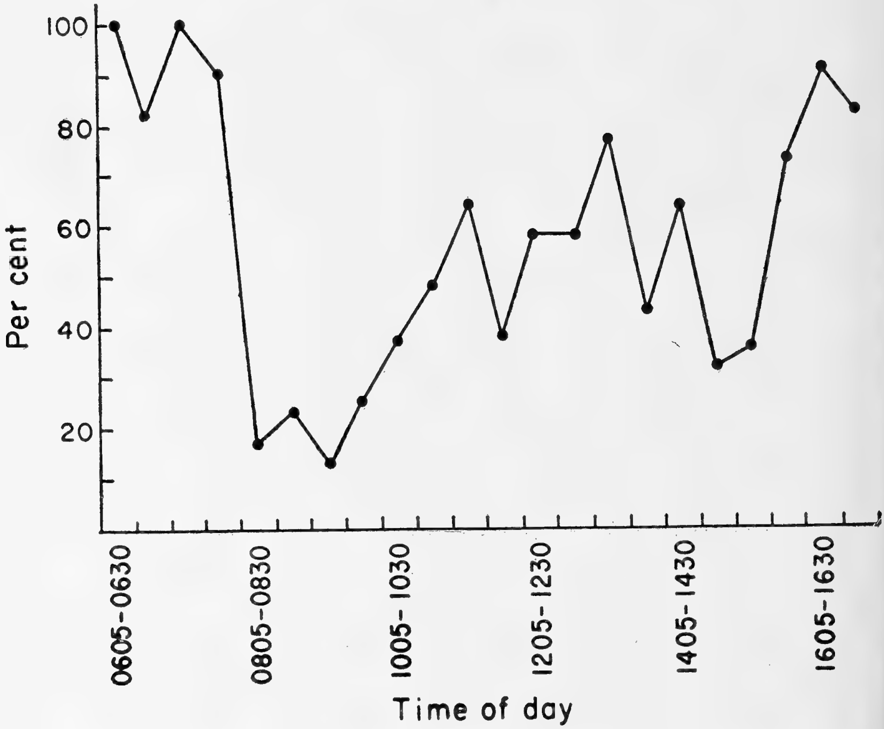

Fig. 4. Per cent of tahr grazing at various times of day, 06.00 to 17.00 hours.

Herds usually rested along the rim of the escarpment or on the cliff ledges. They reclined either with legs tucked under the body or more often with one or both forelegs stretched out in front of them and sometimes with the hindlegs extended to one side as well. Many chewed cud, at the rate of about 3 chews per 2 seconds. Occasionally one rose and scratched its head or neck with a hindfoot or its upper back with a tip of the horn.

Undisturbed herds remained in the same area for long periods. A herd encountered on a cliff one day could usually be found in the general locality or even in the same spot on subsequent days. One population of about 135 tahr, divided into 3 or more herds, was always found along the same 5 km. stretch of cliffs between October 22 and November 12. Female Himalayan tahr have distinct home ranges (Caughley 1966). Gouldsbury told me that tahr wander away from the precipices in search of food during the dry season and that they tend to take shelter from the high winds and lashing rain on the eastern side of the plateau during the south-west monsoon. The casual joining and parting of animals and the readiness with which herds flee long distances into terrain occupied by others indicates that tahr have no territory in the sense of an area exclusively used by a group or individual, at least during October and November.

Agonistic behaviour. Aggressive contacts between animals were uncommon. Sometimes one hooked another lightly with a horn when the herd was bunched up after a disturbance. On 6 occasions a tahr walked to a reclining one, jabbed it with a horntip in the flank, and, after it moved, appropriated the resting site. Five of these instances involved a female replacing a young and one a light brown male replacing a yearling male. On 2 occasions, when a yearling male jabbed a yearling male and a light brown male, respectively, the recipient did not relinquish its resting place.

Fights between two tahr were observed 53 times. Eighteen (33%) of these involved the side butt. The animals stood parallel and facing the same direction and in unison jerked their head sideways rapidly once or twice thereby clashing their horn against one of the opponent's. They were never seen to push with shoulder and hips in such situations as feral goats do (Geist, pers. comm.). The head-on butt was used in 22 (42%) of the interactions observed. Two tahr faced each other, a metre or less apart, lowered their heads abruptly and one or both lunged so that the horns met with a crash. Usually one of the combatants struck predominantly with one horn while the other caught the blow between his horns, a method of striking also used by American mountain sheep (Geist 1966). Most contacts were brief, one or two clashes, and were seldom preceded or followed by other interactions. On one occasion a light brown male mounted a saddleback before they fought, in contrast to bighorn sheep where the dominant characteristically mounts a subordinate one (Geist 1968).

The shoulder push was used in 13 (25%) of the fights observed, and the actions were more prolonged than the other types of combat. Two animals characteristically stood parallel and facing in opposite direction, then pushed each other, shoulder to shoulder, often circling rapidly as they did so. Once two males kneeled and circled in a fighting pattern reminiscent of that used by zebra (*Equus burchelli*) as described by Klingel (1967). As the animals turned, they jabbed each other gently or vigorously in the side, flank or occasionally the abdomen with the tip of one horn. Sometimes they stopped, faced each other and butted head-on before circling again. Twice one animal hooked the other into the lower part of the neck during a pushing interval. Occasionally a tahr pawed the ground with a foreleg before or after the fight or assumed the hunch posture (see below). This method of fighting is similar to one described by Geist (1964) in the American mountain goat (*Oream-*

nos americanus) : ' They fight keeping side by side while moving about one another. Goats, strike up and sideways with their head, driving the horns into the opponent's body region.'

The fourth type of combat, rearing up, was not observed in its full form during the study, possibly because it is used primarily by males during the rut. Hutton (1947) saw one fight on August 3 : A young male stamped his forefeet when approached by a saddleback. They looked at each other from a distance of about 10 m. and both stamped their forefeet and nodded their heads. Then ' the two animals almost simultaneously reared up on their hindlegs and seemed to " dance " in front of each other, while keeping their distance and circling. Suddenly they would close in and bring their heads together with a resounding crack'. After half an hour of combat the saddleback rammed the other male in the shoulder thus ending the fight. He then approached a female and mated with her. On one occasion, a light brown male kneeled on his forelegs and rubbed his horns in the grass with lateral motions. Suddenly he reared up on his hindlegs with his chin tucked in and turned slightly to one side and the forelegs drawn close to the body. Facing him was another light brown male with his head averted. On another occasion, a female snorted and lunged at another female with both forelegs off the ground in a manner similar to that used by fighting mountain goats (Geist 1965).

The type of fighting, as well as the frequency with which each type was used, varied with the age and sex of the tahr (Table 6). Males, females and subadults all butted from the side or head-on, both with animals of their own age and sex and with others. The shoulder push

Table 6

NUMBER OF ANIMALS IN EACH SEX AND AGE CLASS INVOLVED IN VARIOUS TYPES OF FIGHTING, BASED ON 106 COMBATANTS

Sex and Age Class	Approx. composition of mixed herds in %	Side butt %	Head-on butt %	Shoulder Push %
Saddleback and d.b. male ..	5	8·3	0	3·8
Light brown male ..	6	5·6	29·5	34·6
Female ..	38	41·7	13·6	0
Yearling ..	20	36·1	43·2	61·5
Young ..	31	8·3	13·6	0

was not observed among females and young, and of 16 sexed yearlings involved in that type of combat all were males. Either the larger or the smaller of two participating males initiated the shoulder push. Once, for instance, a yearling jabbed a light brown male repeatedly in the side, abdomen and flanks before the latter responded, and they then circled shoulder to shoulder. On another occasion, a light brown male initiated the fight with a yearling male. Dark brown males and saddlebacks fought seldom, but light brown males were involved in head-on butts and shoulder pushes (but not side butts) much more frequently than would be expected from their number in the population. Females side-butted as often as expected but used the head-on butt little and shoulder push not at all. Yearlings fought often by all three methods and young seldom. A ranking of the classes based on the relative frequency of fighting would place light brown males at the top, followed in decreasing order by yearlings, females, dark brown males and saddlebacks, and young.

Two additional kinds of behaviour were associated with aggression. On 8 occasions an animal was seen to rub its horns and face either up or down on a sapling or laterally on the ground, sometimes for as long as one minute. Two animals kneeled on their frontlegs while doing so. The behaviour occurred in 2 females, 3 yearling males, a dark brown male, and 2 light brown males, and only in the last was it seemingly directed at a particular individual. In one of these instances, the male rubbed his head on the ground in front of a reclining saddleback. He then jabbed the saddleback in a hindleg, wedged a hoof between the horns and pulled. The saddleback ignored the gesture. Rubbing in tahr appeared to be analogous to similar behaviour among deer, such as the wapiti, *Cervus canadensis*, (Struhsaker 1967) and antelope, such as the grant's gazelle, *Gazella granti*, (Walther 1965). The actions undoubtedly leave both visual and olfactory signals of the animal's presence in the environment.

A conspicuous posture termed the 'hunch' was observed 16 times, twice in females, the others in yearling and adult males. The animal hunched its back and arched its neck down, sometimes with the nose merely pointing forward but often with it perpendicular and almost touching the ground or pointing back between the legs. The ears were laid back, and the animal walked or trotted with a stiff gait, the legs bunched beneath the body. This display is strikingly similar to one described by Geist (1965) in the mountain goat : 'The male erects itself by stretching front and hind legs until they are straight and stiltlike. The back is arched upwards ; the belly is drawn in ; the neck is arched down...' Occasionally a tahr displayed in no particular circumstance or it briefly combined the behaviour with other patterns. One dark brown male, for example, separated by 60 m. from the herd, hunched his back, then rubbed his horns in a shrub. The hunch is also seen during interactions between males. Once two light brown males met on a narrow ledge. Each arched its back before pushing gently with the shoulders. On other occasions a light brown male approached a yearling male in a hunch before they butted head-on, and two yearling males walked parallel and 5 m. apart in a hunch after fighting. One dark brown male approached a reclining saddleback with his back arched. The saddleback rose and walked broadside slowly past the other male in a hunch, displaying his striking profile. The hunch makes the animal conspicuous, and it may be hypothesized that it serves to intimidate an opponent, that it is a substitute for fighting, similar to the displays described in numerous other hoofed animals (Walther 1960/61 ; Geist 1966 ; Schaller 1967).

Paleontologists suggest that the caprids evolved from rupicaprids of which the American mountain goat and serow (*Capricornis sumatraensis*) are living examples. The tahr appear to be a link in many physical characters between the two groups, as Geist (in press) has pointed out, and various aspects of their agonistic behaviour are thus of interest when compared with *Capra* on the one hand and with the rupicaprids on the other. ' Mountain goats do not fight head to head... ' (Geist 1964), but tahr and *Capra ibex* (Nievergelt 1967) do so. On the other hand, the distinctive shoulder push of the tahr has not been described for *Capra*, although feral goats push with shoulders and hips when standing parallel (Geist, pers. comm.), but mountain goats possess an analogous pattern in which they circle and jab the opponent around the ventral region. Tahr also rear up on their hindlegs, a typical method of fighting in such goats as *Capra ibex* (Walther 1960/61a) and *Capra falconeri* (Roberts 1969). This behaviour does not occur in the mountain goat (Geist 1964). Lateral displays of one form or another are found in antelopes, deer, gaur, and other hoofed animals on such diverse groups that the pattern is undoubtedly an old one in the evolution of aggression (Geist 1966). *Capra ibex* and *Capra falconeri*, too, show a lateral display (Walther 1960/1961b), although it is not well-developed, possibly because the large horns of these species have assumed the display function. The hunch of the tahr is so similar to the lateral display of the mountain goat that it suggests a rupicaprid origin. The Nilgiri tahr thus retain a number of distinct aggressive patterns which reflect their ancestry. Their method of butting is characteristic of sheep and goats in general, their pushing and hooking into the posterior part of the opponent as well as their lateral display point to a rupicaprid relationship, and their distinct way of rearing up is a typical caprid trait.

Anti-predator behaviour. Although I did not see tahr respond to predators, some of their reactions to my presence were probably typical of their anti-predator behaviour in general. The preferred habitat of the tahr, the cliffs broken by grassy ledges, affords the animals protection from predators and it was probably for this reason that they were usually found near precipices and that their behaviour was oriented toward them. Mixed herds were encountered 44 times and 36 of these were on or within 0·5 km. of the cliffs bordering the Nilgiri and Hamilton's plateaus. Of the remaining 8 herds, 5 were on inland cliffs and only 3 were more than 0·5 km. from a precipice. Solitary males and male herds, too, frequented the vicinity of cliffs although they ventured inland more readily than did mixed herds. During one census, 14 out of 29 males seen singly and in groups that day were over 0·5 km. from a cliff, and on another day a herd of 12 rested on a gentle slope some 1·5 km. from the escarpment. Animals disturbed by man characteristically bunched up and ran to the nearest cliff. On three occasions, however, tahr left the protection of a cliff and fled across rolling terrain for two or more kilometres. While tahr on a cliff quickly detected the approach of a person below them, they were less alert to potential danger from above and it was often possible to creep close to them in that fashion.

' A sentinel is invariably posted to watch over the slumber of the herd. . . ' (Fletcher 1911), and Kinloch (1926) and others made similar statements. The ' sentinel ' is usually said to be a female. In 7 out of 24 resting mixed herds observed, one animal (5 females, 2 saddlebacks) stood or reclined conspicuously above the others and would have fitted the popular definition of sentinel. However, such animals achieved their isolated position usually by accident rather than choice. On two occasions a female reclined while the herd continued to graze. The other animals passed and finally rested on the slope below leaving a ' sentinel '. Of course, an animal in a prominent position is more likely to spot a potential source of danger before the others and it thus functions as a sentinel without the need to imply that the behaviour is purposeful. The general restlessness of herds also helped them to detect danger. With one or another animal almost constantly shifting position or grazing, it would have been difficult for a predator to approach undetected. Although tahr seemed to have good eyesight they used their acute sense of smell rather than vision to detect danger in most instances, and even if the source was clearly visible they sometimes verified it by scent before responding with flight. The animals often smelled me downwind at distances of from 200 to 300 m. On the other hand, I crept upwind on several occasions to within 10 m. of them while they were out of sight below the rim of a precipice, and once I walked slowly in full view to within 20 m. of a resting saddleback before the wind shifted and he scented me. On another occasion, 15 tahr came to within 20 m. of me as I reclined on an open slope. At first they whistled and stamped their feet, but after several minutes some lay down and chewed cud seemingly oblivious to me. After 30 minutes the wind shifted and they bolted.

Tahr communicated the presence of danger to others by sound and by several gestures. If danger was imminent or obvious, tahr merely fled, an action which elicited similar behaviour in the rest of the herd. The alert posture with body held rigid as the animal stared with raised neck in a certain direction drew the attention of the others and they too then looked there. In addition two auditory signals enhanced the alert posture. One was foot-stamping. The tahr stamped a forefoot on the ground with a thump one or more times. Once a female leaped into the air several times in succession on the same spot and brought both forefeet down in unison after she detected me 50 m. away. A conspicuous signal was the whistle, described by Hamilton (1892) and others, a piercing sound made by expelling the air forcefully through the nostrils. Whistling was prevalent when tahr detected danger but seemed uncertain about its nature or location. Tahr seldom whistled after seeing or smelling me clearly, but they occasionally did so after a glimpse of me, particularly if I was upwind. Usually one or two members of a herd whistled in a particular situation. One saddleback, after detecting my presence 30 m. away in fog, gave 4 whistling snorts, sounds which seemed intermediate between the aggressive snort and the whistle. If one animal whistled, the others jerked to attention. For example, 33 tahr fled 30 m., looked around, then resumed grazing after one animal whistled once. On another occasion, 104 tahr rested on a slope. When one whistled, two-thirds of the animals leaped up. Members of one herd briefly looked around when hearing the alarm bark of a sambar nearby, but they did not respond to the 4 deer that walked through the herd, passing within 2 m. of some tahr, a few minutes later.

Conservation

With possibly fewer than 1500 tahr in existence, 800 of them in two restricted localities, the species is in obvious danger of extinction. What can be done to insure its survival in the wild ? Sometime in the future it would be desirable to stock tahr in the ranges once occupied by them, for, considering the slow and erratic rate of natural dispersal among wild goats under ideal conditions, it seems unlikely that tahr will recolonize their former habitats much today. But for the present, the most urgent task is the preservation of existing herds. The tahr in the Nilgiris, confined to a narrow strip of land along the western escarpment, have lost most of their habitat to forest plantations. Only the hills south of Bangitappal remain relatively undisturbed, and it would be commendable if the Tamil Nadu Forest Department reserved this road-less area not only for the animals but also for visitors to enjoy. Roads have been or are being built into most parts of the tahr's range making access easy. Constant vigilance must be maintained to prevent poaching both by labourers in the plantations and hunters from the towns.

The Eravikulam Reserve in the High Range is a magnificent piece of hill country, an area which in some future year would make an excellent national park for those who like to hike, fish, and observe wildlife. The tahr there have for many years been managed well by the High Range Game Preservation Association, and it would obviously benefit the species to have this organization continue with its jurisdiction over the area.

The tahr is still shot on licence as a game animal in the Nilgiris and on special permission from the owners in the High Range. It might be argued that such a rare animal should be fully protected. However, as Davidar (1963b, 1968) has pointed out, the number of animals shot is negligible and to eliminate such hunting would actually be detrimental to the tahr. The animals survive in the Nilgiris and High Range only because the local wildlife associations have protected them for years for sporting purposes. In areas where tahr have not had the benefit of such private initiative, where they have had to rely solely on the protection afforded by the state government, they have either been wiped out or reduced to a few scattered herds. The revoking of shooting rights would eliminate whatever interest the wildlife associations have in the animal and the resulting increase in poaching and habitat destruction might well tip the balance of the species from tenuous security to extinction.

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References

Anderson, J. & Henderson, J. (1961): Himalayan tahr in New Zealand. New Zealand Deerstalkers' Ass. Special Publ. No. 2.

'An Old Shikarri,' (1880): Nilgiri sporting reminiscences. Higginbotham and Co., Madras.

Bassett, T. (1964): A visit to the High Range, Kerala. *J. Bombay nat. Hist. Soc.* **61**(2): 431-432.

Blanford, W. (1888-91): The fauna of British India. Taylor & Francis, London.

Brown, L. (1960): Wild life in some areas of South India. *J. Bombay nat. Hist. Soc.* **57**(2): 403-408.

Burrard, G. (1925): Big game hunting in the Himalayas and Tibet. H. Jenkins, London.

Caughley, G. (1965): Horn rings and tooth eruption as criteria of age in the Himalayan tahr, *Hemitragus jemlahicus*. *New Zealand J. Science* **8**(3): 333-351.

——— (1966): Mortality patterns in mammals. *Ecology*. **47**(6): 906-918.

Davidar, E. R. C. (1963a): Honorary superintendent's report (Nilgiri Wild Life Association). 2 pp. mimeo.

——— (1963b): Census of the Nilgiri tahr *Hemitragus hylocrius* (Ogilby) in the Nilgiris. *J. Bombay nat. Hist. Soc.* **60**(1): 251-252.

——— (1968): The Nilgiri Wild Life Association and status of wild life in the Nilgiris. *ibid.* **65**(2): 431-443.

Fischer, C. (1915): The Nilgiri wild goat (*Hemitragus hylocrius* Jerdon). *ibid.* **24**(1): 189.

Fisher, J., Simon, N. & Vincent, J. (1969): The Red Book. Collins, London.

Fitter, R. (1968): Vanishing wild animals of the world. Franklin Watts. New York.

Fletcher, F. (1911): Sport on the Nilgiris and in Wynaad. Macmillan, London.

'Garhwali' (1911): Seventeen years' shikar in the Himalayas. *The Asian.* Sept. 28, Dec. 16.

Geist, V. (1964): On the rutting behaviour of the mountain goat. *J. Mammal.* **45**(4): 551-568.

——— (1966): The evolution of horn-like organs. *Behaviour.* **27**(3-4): 175-214.

——— (1968): On the interrelation of external appearance, social behaviour and social structure of mountain sheep. *Z. f. Tierpsych.* **25**: 199-215.

——— (in press): Mountain sheep: a study in behaviour and of evolution. University of Chicago Press, Chicago.

Hamilton, D. (1892): Records of sport in Southern India. R. H. Porter, London.

'Hawkeye.' (1881): Game. Higginbotham and Co., Madras.

Hornaday, W. (1885): Two years in the jungle. Kegan Paul, Trench and Co., London.

Hutton, A. (1947): The Nilgiri tahr (*Hemitragus hylocrius*). *J. Bombay nat. Hist. Soc.* **47**(2): 374-376.

Jeyadev, T. (no d.): Working plan for the Nilgiris Forest Division for the period 1st April 1954 to 31st March 1964. Forest Department, Madras.

Kinloch, A. (1926): The Nilgiri tahr (*Hemitragus hylocrius*). *J. Bombay nat. Hist. Soc.* **31**(2): 520-521.

Klingel, H. (1967): Soziale Organisation und Verhalten freilebender Steppenzebras. *Z. f. Tierpsych.* **24**: 580-624.

Lydekker, R. (1898): Wild oxen, sheep, and goats of all lands. Rowland Ward, London.

Nievergelt, B. (1967): Die Zusammensetzung der Gruppen beim Alpensteinbock. *Z. f. Saugetierkunde.* **32**(3): 129-144.

Phythian-Adams, E. (1927): Game preservation in the Nilgiris. *J. Bombay nat. Hist. Soc.* **32**(2): 339-343.

——— (1939): The Nilgiris Game Association—1879-1939. *ibid.* **41**(2): 384-396.

——— (1950): Jungle memories, Part VII. *ibid.* **49**(3): 418-426.

Pollock, A. (1894): Sporting days in Southern India. Horace Cox, London.

Prater, S. (1965): The book of Indian animals. Bombay Natural History Society, Bombay.

Roberts, T. J. (1967): A note on *Capra hircus blythi* Hume, 1875. *J. Bombay nat. Hist. Soc.* **64**(2): 358-365.

——— (1969): A note on *Capra falconeri* (Wagner, 1839). *Z. f. Säugetierkunde.* **34**(4): 238-249.

Russell, C. (1900): Bullet and shot in Indian forest, plain and hill. W. Thacker and Co., London.

Schaller, G. (1967): The deer and the tiger. University of Chicago Press, Chicago.

Shakespear, H. (1862): The wild sports of India. Smith, Elder and Co., London.

Sterndale, R. (1884): Natural history of the mammalia of India and Ceylon. Thacker, Spink and Co., Calcutta.

Stockley, C. (1928): Big game shooting in the Indian Empire. Constable and Co., London.

STRUHSAKER, T. (1967) : Behaviour of elk (*Cervus canadensis*) during the rut. *Z. f. Tierpsych.* **24** : 80-114.

THURSTON, E. (1909) : Castes and tribes of Southern India. Government Press, Madras.

THYAGARAJAN, M. (1958) : The vanishing ibex. *Indian Forester.* **84**(3) : 188-191.

WALTHER, F. (1960/61a) : Entwicklungszüge in Kampf—und Paarungsverhalten der Horntiere. *Jahrbuch G. v. Opel-Freigehege.* **3** : 90-115.

WALTHER, F. (1960/61b) : Einige Verhaltensbeobachtungen am Bergwild des Georg von Opel-Freigeheges. *ibid.* **3** : 53-88.

——— (1965) : Verhaltensstudien an der Grantgazelle (*Gazella granti* Brooke, 1872) im Ngorongoro-Krater. *Z. f. Tierpsych.* **22**(2) : 167-208.

WILLET, J. (1968) : The Nilgiri tahr, *Hemitragus hylocrius* Ogilby. *J. Bombay nat. Hist. Soc.* **65**(3) : 769-771.

Genetic-evolutionary studies on cultivated Cannas

VII: Taxonomic treatment and horticultural classification

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(*With eleven figures*)

In order to evaluate the garden cannas taxonomically, their characters were charted against those of the elemental species. It became clear that the cultivars neither resolve round a pattern of their own nor around any of the elemental species. As expected they show an intricate mixture of characters of different elemental species, and together constitute a 'syngameon'. Accordingly, more for an utilitarian and routine horticultural purpose all the garden cultivars need to be included in two synthetic hybrid species, *C.* X *generalis* Bailey and *C.* X *orchiodes* Bailey. Such a treatment is not only sound taxo-genetically, but also avoids inordinately long names that the two synthetic species are expected to get under international rules of nomenclature for cultivated plants. Indian cultivars of canna have been classified horticulturally more to fulfil a purpose in the garden than to stress discrete botanical differences of qualitative character which are in fact wanting in the cultivars.

INTRODUCTION

From an analysis of phenotypic variation, breeding, pollination and meiotic systems and parallelism between natural and induced mutations (Mukherjee & Khoshoo 1970 a-d; Khoshoo & Mukherjee 1970a), a reasonably well integrated and coherent picture of the origin and evolution of the ornamental cannas has emerged (Khoshoo & Mukherjee 1970b). The variation pattern thus unravelled needs to be expressed in the traditional taxonomic units so as to express genetic relationships as accurately as possible. Furthermore, the cultivars of ornamental cannas grown in Indian gardens need to be horticulturally classified to fulfil a purpose in the garden rather than stress discrete botanical differences.

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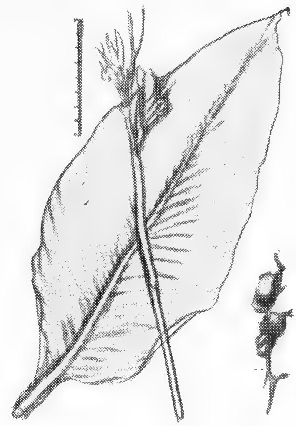

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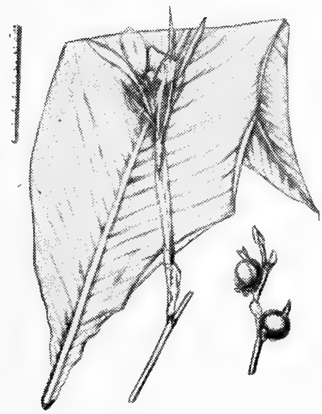

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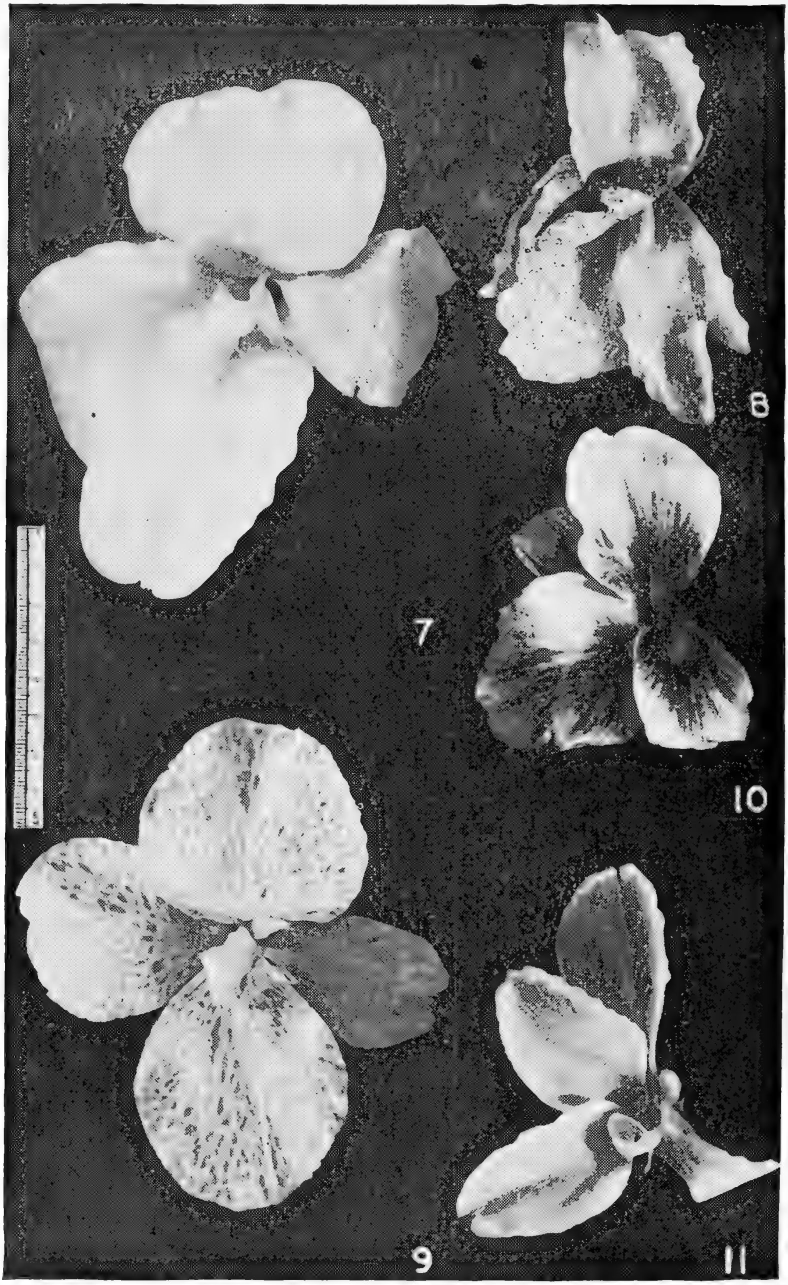
Elemental species of ornamental Cannas.

Fig. 1. *C. glauca* Linn.; Fig. 2. *C. indica* Linn.; Fig. 3. *C. iridiflora* Ruiz & Pav.; Fig. 4. *C. warscewiczii* A. Dietr.; Fig. 5. *C. flaccida* Salisb.



Horticultural classification of canna cultivars.

Fig. 7. Self coloured, *Pink Satin*; Fig. 8. Bicoloured, *Prince of Wales*; Fig. 9. Spotted, *Queen Elizabeth*; Fig. 10. Blotched, *Rajaji*; Fig. 11. Margined, *Star of India*.

Taxonomic Treatment

It is adequately clear that ornamental cannas have arisen from the five different elemental species, namely *C. glauca* Linn. (Fig. 1), *C. indica* Linn. (Fig. 2), *C. iridiflora* Ruiz & Pav. (Fig. 3), *C. warscewiczii* A. Dietr. (Fig. 4) and *C. flaccida* Salisb. (Fig. 5), all belonging to the Subgenus *Canna*, Sect. *Trialatae* and Subsect. *Glaucae*, *Coccineae* (or *Indicae*), *Elatae* and *Achirida* (Kränzlin 1912). The variation pattern of these botanical species was charted using such characters of rhizome, leaf, inflorescence and flower upon which their taxonomic delimitation is based. Against this background characters of 45 well recognised cultivars of ornamental cannas were also charted (Fig. 6).

As is evident from the scatter diagram, no discrete groups of cultivars bound by some common qualitative character combinations are recognizable. In other words, the cultivars neither resolve round a pattern of their own, nor around any of the basal species, but most of them have height less than 150 cm., length/breadth ratio of leaf ranging from 1·5 to 3 and have an intricate mixture of characters of different elemental species which is the result of extensive hybridization associated with their origin (Khoshoo & Mukherjee 1970b). Most of the cultivars represent, what may be called, ' macro-recombinants '. The entire collection, except those cultivars in which *C. flaccida* is involved, constitutes more or less a homogamic and clonal hybrid complex (*sensu* Grant 1953) in which different components are predominantly diploid, meiotically normal and often retaining sexual mode of reproduction but always vegetatively reproduced. The entire complex is a ' phylogenetic reticulum ' or a ' syngameon ' (*sensu* Grant 1957).

A full-fledged species more often has an ecological, morphological, chromosomal and genetical distinctness and such a concept cannot be applied to synthetic taxa like the ornamental cannas. In comparison to the elemental species, the garden cannas have been much transformed and have developed large flowers with many fancy colours at the expense of reduction in vigour. This has happened to many cultivated plants including ornamentals like hyacinth (Darlington, Hair & Hurcombe 1951) and pansy (Mukherjee & Khoshoo 1969). Furthermore, not much intersterility has developed between them and their elemental species, It is, therefore, apparent that for reasons more than one, the usual concept of species cannot be applied to ornamental cannas although they are distinguishable from the elemental species, on account of their height, leaf length/breadth and flower size and colour.

Bailey (1947) has classified garden cannas in two species which though apparently distinguishable (Table 1) are not always so in practice, because of some intergrading types. Our investigations (Khoshoo & Mukherjee 1970a) have shown that *C.* X *generalis* Bailey includes Crozy cannas which are diploid, interchange heterozygotes and autotriploids, while *C.* X *orchiodes* Bailey includes Italian cannas derived from the crosses

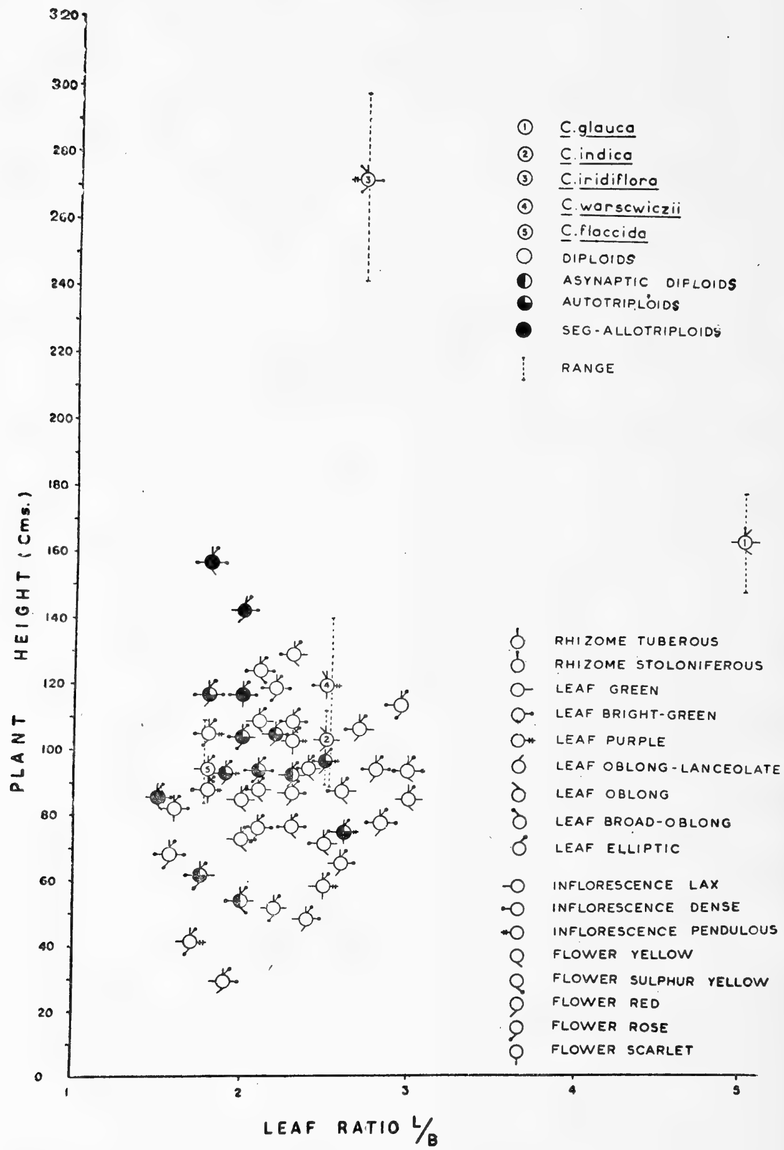


Fig. 6. Scatter diagram depicting the morphological diversity in 45 garden cultivars using important characters distinguishing the elemental species.

between *C.* X *generalis* and *C. flaccida.* These are asynaptic non-seeded diploids and allo- or segmental allotriploids. All these are totally sterile because *C. flaccida* appears to be at a cenospecific level with the other four species and also with Crozy cannas. The ideal situation perhaps was to classify the cultivars around the variation pattern of the elemental

TABLE 1

COMPARISON OF THE CHARACTERS OF *C.* X *generalis* AND *C.* X *orchiodes*.

Character	*C.* X *generalis* Bailey	*C.* X *orchiodes* Bailey
Flower		
Diameter	Medium to large, less than 12·5 cm.	Very large, 12·5 to 21 cm.
Colour	Many	Bright yellow to deep red. Striped or splashed. Not pink or clear white.
Petals	Narrow, erect or ascending	Reflexed after about the first day.
Tube	About 1·25 cm. long, not longer than sepals	About 2·5 cm. or more, much longer than sepals.
Staminodia	Narrow to broad, mostly erect or strongly upright, well separated in outline	Broad and soft with flowing outline, lip funnel-form at the base.
Cultivars	Crozy, Gladiolus or French Dwarf cannas	Italian, Iris, Orchid or Giant flowered cannas.

species, but, as indicated above (see Fig. 6), this cannot be done precisely. In spite of some intergrading types, the classification of ornamental cannas into two synthetic ' horticultural ' species as proposed by Bailey (1947) appears to be essentially sound because it is genetically correct, utilitarian and takes care of the mode of ancestry and the morphological transformation that has taken place in the cultivars over the years. Since both the species are of hybrid origin, the rules of the International Code of Nomenclature for Cultivated Plants (1961) demand that they be designated by their parents. Following this, *C.* X *generalis* Bailey is actually *C. glauca* Linn. X *C. indica* Linn. X *C. iridiflora* Ruiz & Pav. X *C. warscwiczii* A. Dietr., while *C.* X *orchiodes* Bailey is (*C. glauca* Linn. X *C. indica* Linn. X *C. iridiflora* Ruiz & Pav. X *C. warscwiczii* A.Dietr.) X *C. flaccida* Salisb. In view of such long and cumbersome names it may be useful to designate the two synthetic species simply as *C.* X *generalis* Bailey and *C.* X *orchiodes* Bailey. Of course, such a treatment is good more for the routine horticultural, than for taxogenetic purposes.

This procedure has also been followed in the case of several ornamentals like *Verbena* X *hybrida* Voss. (*V. chamaedryfolia* X *V. phlogiflora* X *V. incisa* X *V. teucrioides* ; Bailey 1909), *Viola* X *wittrokiana* Gams (*V. tricolor* X *V. lutea* ; Mukherjee & Khoshoo 1970), *Petunia* X *hybrida* Hort. (*P. axillaris* X *P. violacea* ; Bailey 1947), etc. all of which are of hybrid origin having been developed by man for purposes of ornamental novelty.

Horticultural Classification

The flowers of most of the botanical species of *Canna* are too small to make an effective floral display. The notable exception is the night flowering *C. flaccida*. However, garden cannas flower almost throughout the year and have a good deal of variability that has emerged from the extensive interbreeding with the result they can no longer be classified by the characters distinguishing the five elemental species involved in their origin. Furthermore, a horticultural classification is not intended to stress botanical differences but to resolve cultivars into convenient groups to fulfil a purpose in the garden.

Depending upon the origin of garden cannas, horticulturists recognize two groups : Crozy, Gladiolus or French Dwarf cannas and Giant, Orchid, Iris or Italian cannas. The former have a relatively dwarf habit, dense inflorescences and a wide range of colour in flowers in comparison to the latter which are bigger in size with larger flowers in fewer colours. Percy Lancaster (1957) increased the number of such groups to six, namely Normal, Dreadnought, Pygmy, Bouquet, Miniature or Hyacinth flowered and Candelabra. However, his classification does not take care of all the heterogeneity that exists in cannas which, because of the considerable variability in size and colour, suits almost all tastes and situations. Since flowers are not sufficiently durable, garden cannas are not good as cut flowers. However, they are very useful in different formal and informal schemes ranging from an ideal bedding plant for landscaping public parks for bold mass effect, to planting them singly or in very small clumps in a hardy border or amongst shrubbery (Bailey 1909 ; Buckley 1968). Therefore, height is one of the important considerations, as taller varieties (80-150 cm.) are selected for back rows or as centre pieces in circular beds and dwarf varieties (50-80 cm.) for the front rows of a border or a bed. Next to height, the colour of foliage, whether green or purple, is also effective. Finally, the colour and size of flowers is very important and offers considerable range. Five categories are recognizable. These are : Selfs which have the same colour in all petaloid staminodia (Fig. 7), Bicoloured with a different colour in the lip or inner staminodium (Fig. 8), Spotted (Fig. 9), Blotched (Fig. 10) and Margined where margins of staminodia are of a different colour (Fig. 11). Based on the width of staminodia, cultivars can be classified into two groups : Broad (5 to 7 cm.) and Narrow (3 to 5 cm.)

A classification taking care of most of these characters was first suggested in *Gardener's Chronicle* (Anonymous 1893), later adopted by Bailey (1909) and is still by far the best. Using this, important canna cultivars grown in India have been classified here for the first time. As is the case in most other ornamentals, in garden cannas also there exist too many horticultural names. The obvious reason is that from time to time horticulturists have given new fancy names to the original varieties perhaps to boost their sales.

With the help of Mr. S. Percy Lancaster, a veteran horticulturist of India, attempts were made to check the names, as far as possible. Most of the cultivars with unfamiliar names are generally the hybrids raised by his father Mr. Percy Joseph Lancaster between 1889 and 1904 and by him at the (Royal) Agri-Horticultural Society, Alipore, Calcutta (Khoshoo 1966).

A. **C. X GENERALIS** Bailey (CROZY, GLADIOLUS OT FRENCH DWARF CANNAS)

I. Tall varieties (80–160 cm).

1. FOLIAGE GREEN

(i) *Narrow Staminodia* (3 to 5 cm.)

(*a*) Self coloured :

'Aida', 'Electra', 'Sir John Anderson', 'Ariel', 'The Queen', 'Nerissa', 'City of Portland', 'Oriole', 'Mamie', 'Excelsior'.

(*b*) Bicoloured :

Primary hybrid II, 'Doris', 'King Alfred', 'Sangri La', 'Eureka', 'Charmion', 'Prince Philip', 'Sirius', 'Dainty Maid', 'Lorelei', 'Anarkali'.

(*c*) Spotted :

Primary hybrid IV, 'Goldilocks', 'Arjun', 'Queen Elizabeth', 'Fair Maid', 'Colette', 'Edith', 'Claire'.

(*d*) Blotched :

'Dragon's Tongue', 'Matchless'.

(*e*) Margined :

Primary hybrid I, 'Aristrocrat', 'Orange King', 'Queen Mab'.

(ii) *Broad staminodia* (5 to 7 cm.)

(*a*) Self coloured :

'Plume', 'Pink Satin', 'Alison', cv. 204, 'Lord Reading', 'Gloria', 'Diana', 'Afler Glow', 'Florence'.

(*b*) Bicoloured :

'President', 'Cherub', 'Olive', 'Dream', 'Isobel'.

(*c*) Spotted :

'Percy Lancaster', 'Goliath', 'Jehangir'.

(*d*) Blotched :

'Daphne'.

(*e*) Margined :

cv. 153, 'Rosamund Coles', 'Louis Cayeux', 'Yellow Gal', 'Carmine King'.

2. Foliage Purple

(i) *Narrow staminodia* (3 to 5 cm.)

(*a*) Self coloured :

Primary hybrid III, 'Bridal Veil', 'Ai Petzi', 'Brocade', 'Lord Buddha'.

(*b*) Bicoloured :
'Barbara', 'Julia'.

(*c*) Blotched :
'Rajaji', 'Bo Peep'.

(ii) *Broad staminodia* (5 to 7 cm.)

Self coloured :

'Sun Set', 'Stromboli', 'Atom bomb', 'Raj Mahal'.

II. Dwarf varieties (50 to 80 cm.)

1. Foliage Green

(i) *Narrow Staminodia* (3 to 5 cm.)

(*a*) Self coloured :

'Janet', 'Professor Thacker', 'Soldier Boy', cv. 3, 'Perfection', 'Golden Standard'.

(*b*) Bicoloured :
'Imperator', 'Sweet Heart', 'Morning Glow'.

(*c*) Spotted :
'Gladiator', 'Louise', 'Ethel', 'Heart's Desire', 'Aileen'.

(*d*) Blotched :
'Striped Queen'.

(*e*) Margined :
cv. 196, 'Star of India', 'Masterpiece'.

(ii) *Broad Staminodia* (5 to 7 cm.)

(*a*) Self coloured :
'Sans Souci'.

(*b*) Bicoloured :
'Enchantress', 'Angel's Robe'.

2. Foliage Purple

(i) *Broad Staminodia.*

Self coloured :

'Black Knight', 'Aga Khan', 'Rose Queen'.

B. C. X **ORCHIODES** Bailey (Italian, iris, orchid or giant flowered cannas)

I. Tall varieties (80–160 cm.)

1. Foliage Green

(ii) *Broad Staminodia*

(*a*) Self coloured :

'Bharat', 'Wintzer's Colossal', 'Indiana'.

(*b*) Bicoloured :
'New Red', 'Flaccida-type'.

(*c*) Spotted :
'Queen of Italy'.

II. Dwarf varieties (50–80 cm.)

1. FOLIAGE GREEN

(i) *Narrow Staminodia* (3 to 5 cm.)

(*a*) Self coloured :
'Trinacria Variegata'.

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REFERENCES

ANONYMOUS (1893) : The florists' cannas. *Gdnr's. Chron.* Oct., 7 : 432.

BAILEY, L. H. (1909) : Cyclopedia of American Horticulture. Macmillan Company, New York.

——— (1947) : Manual of cultivated Plants. Macmillan Company, New York.

BUCKLEY, A. R. (1968) : Majestic Cannas. *Gdnr's. Chron.* March, 15 : 163.

DARLINGTON, C. D., HAIR, J. B. & HURCOMBE, R. (1951) : The History of the Garden Hyacinths. *Heredity* **5** : 233-252.

GRANT, V. (1953) : The role of hybridization in the evolution of the leafy stemmed gilias. *Evolution* **7** : 51-64.

——— (1957) : The plant species in theory and practice. The species problem, E. Mayr. Ed. *Amer. Assoc. Adv. Publ.* **50** : 39-79.

KHOSHOO, T. N. (1966) : Percy Lancasters—Doyens in Indian Horticulture. *Indian Hort.* **10** : 13-14.

KHOSHOO, T. N. & MUKHERJEE, I. (1970a) : Genetic-evolutionary studies on cultivated Cannas. III : Variation in meiotic system. *La Cellule.* (In Press).

KHOSHOO, T. N. & MUKHERJEE, I (1970b) : Genetic-evolutionary studies on cultivated Cannas, VI : Origin and evolution. Theoret. Appl. Genet. **40** : 204-217.

MUKHERJEE, I. & KHOSHOO, T. N. (1969) : The origin and evolution of garden pansy. *The Nucleus.* **12** : 178-186.

——— (1970a) : Genetic-evolutionary studies on cultivated Cannas. I : Variation in phenotype. *Proc. nat. Inst. Sci.* **36**B. (In Press).

——— (1970b) : Genetic-evolutionary studies on cultivated Cannas. II : Pollination mechanism and breeding system. *ibid.* (In Press).

——— (1970c) : Genetic-evolutionary studies on cultivated Cannas. IV : Parallelism between natural and induced somatic mutations. *Rad. Bot.* **10** : 351-364.

——— (1970d) : Genetic-evolutionary studies on cultivated Cannas. V. Intraspecific polyploidy in starch yielding *Canna edulis. Genet. Iber.* (In Press).

PERCY LANCASTER, S. (1957) : Canna. *Bull. nat. Bot. Gdns. Lucknow.* No. 3.

Analogous Bioclimates and introduction of Economic Exotics

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(*With nine text-figures*)

The methods generally used to derive the climatic analogies are reviewed and the results obtained by Thornthwaite's system by previous workers are critically analysed. The bioclimatic methods of Gaussen are developed to establish the homoclimatic counterparts of the stations of the dry tracts of the Indian sub-continent.

Introduction

Bioclimate may be defined as the climate in relation to life. One of the aims of applied bioclimatology is to establish the analogous climates of the world for the exchange of economic plants. The need for the introduction of more food-, fruit-crops and those providing raw materials for industries is at the moment more pressing than ever.

Although India is rich in timber species, introduction of some woods of special quality is desirable. For instance, the wood of *Ocotea rodiaei* Mex. is very useful in sub-marine construction as it resists the attack of the marine worm *Teredo*. *Ochroma lagopus* Swartz. has a very light wood used in the construction of aeroplanes. Both these species are natives of tropical America and they may be successfully tried in suitable parts of peninsular India. This part of the sub-continent suffers from the scarcity of conifers too ; trials of pines of S.E. Asia and Central America (*Pinus merkusii* Jung., *P. insularis* Endle., *P. tropicalis* More., *P. occidentalis* Swartz., *P. montezumae* Lamb. etc.) may yield encouraging results.

It is on record that an economic species has become better established in the country of its introduction than in its indigenous area. Zanzibar is the principal producer of the clove (followed by Penang, Madagascar and Indonesia) though the original home of the clove tree [*Eugenia caryophyllus* (Spreng.) Bullock and Harrison] is the Moluccas. The rubber tree (*Hevea brasiliensis* Muell) transported from S. America to Malaysia, helped towards the unemployment problem. The local labour being insufficient, it brought about migrations from India and China.

One can go on multiplying examples of such economic plants which may be profitably introduced in the Indian sub-continent with its wide range of climates (*see* Meher-Homji 1963).

Attempts made to derive the homoclimates may be grouped into three categories :

(1) Physical and meteorological methods using climatic formulae, indices and coefficients.

(2) Diagrammatic representations, examples : hydrothermic figure (Raunkiaer 1908), clima-diagram (Chaptal 1933), agro-climate diagram (Azzi 1954), hythergraph (Taylor 1920a, b), ombrothermic diagram (Bagnouls & Gaussen 1953) and the modified version of the latter ' klima-diagramme ' (Walter 1955a, b).

(3) Biological criteria to reflect the climatic analogies : (*a*) floristic (systematic, floral elements) ; (*b*) ecological (hydrophyte, xerophyte in relation to water ; megatherms, microtherms for temperature ; heliophyte, sciaphyte for light) ; (*c*) vegetational [growth-forms of Humboldt (1805) and Grisebach (1884) ; life-forms of Raunkiaer (1908), physiognomy and structure]. Of all these biological criteria, only the vegetation types based on the characteristics of physiognomy and structure are shown to reflect the climatic similitudes (Meher-Homji 1963).

In the first category may be cited the formulae of Transeau (1905), Penck (1910), Köppen (1900, 1918), Lang (1920), de Martonne (1926) and Thornthwaite (1933, 1948) among others. Only the later work of Thornthwaite has been frequently used to derive the climatic homologies; Nuttonson (1947a, b, c, 1951) has used it to seek climatic analogies between parts of Asia, Europe and North America; Melwyn Howe (1960), Kaushik *et al.* (1969) and Subrahmanyam & Sastry (1969) have applied the method to establish the homoclimatic counterparts of certain stations of India.

Comments on results obtained by Thornthwaite's method

None of the above formulae have given absolutely satisfactory results to explain the vegetation types of India (Bharucha & Shanbhag 1957 ; Meher-Homji 1963, 1967).

Some analogies are questionable in the works of the followers of Thornthwaite's system.

(1) Melwyn Howe (1960) on the homoclimes within the British Commonwealth.

(*a*) In the prehumid climate with little or no water deficiency (*Ar*), certain tropical stations of India and Ceylon, Ootacamund and Rangalla for example, are shown to have the same formula (B'_1 a) as Buxton (England) and Clayoquot (British Columbia), stations having a temperate climate.

In the opinion of this author, the altitude of Ootacamund may compensate the latitude factor for the temperature, at least partly[1], but not for the photoperiod.

(*b*) In the humid climate (*Bir*) with little or no water deficiency, it is surprising to see a dry station like Karachi placed together with Gauhati (India), Kuala Lumpur (Malaysia) and Belize (Honduras).

(*c*) In the arid climate (*E*), Jodhpur having summer rains and Peshawar having an irregular regime of rains are classified together (*A′ a′*).

(2) Kaushik *et al.* (1969) on the homoclimates of the arid and semi-arid zones of India.

(*a*) Sri Ganganagar is equated to Dera Ismail Khan, Khushab and Lyallpur (arid *Ed*, second megathermal climate *A′* 2′).

However, the last two stations have 10 months dry and 257 to 266 biologically dry days. Sri Ganganagar has 11 months dry with 280 dry days and Dera Ismail Khan 12 months dry with 300 biologically dry days, according to the classification of Bagnouls & Gaussen (1957).

Further, the ratio of the cold season (Nov. to March) precipitation to that of the hot season (May-Sept.) is 1 : 3·4 for Sri Ganganagar and Khushab, whereas 1 : 5 for Lyallpur and 1 : 2 for Dera Ismail Khan ; this low ratio suggests an irregular regime for Dera Ismail Khan (62 mm. of winter and spring rains ; 137 mm. of summer rains). For the remaining stations, the ratios indicate a tropical tendency.

(*b*) In the third megathermal (*A′* 3) type, Sirsa and Hissar (*a*2′) are compared to Sibi, Multan, Montgomery, Jacobabad, Sukkur of West Pakistan and Insalah of Algeria.

The contrasting points are :

—Hissar has an annual average rainfall of 425 mm. but Jacobabad, Sukkur and Insalah receive less than 100 mm. and Sibi 117 mm.

—Hissar has 9 months dry with 237 biologically dry days ; excepting Montgomery (11 months dry), the remaining stations experience a dryness of 12 months (with over 290 days biologically dry). Insalah may not receive any rain certain years and is classified as *true desertic* by Emberger, Gaussen *et al.* (1962-63) with over 355 dry days. Hissar on the other hand is shown as subdesertic with tropical régime.

Tropical tendency is also observed for Multan, Montgomery, Jacobabad and Sukkur but not for Sibi having 64 mm. of summer precipitation against 59 mm. of winter and spring (irregular régime).

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[1] Thermic amplitude i.e. the difference between the mean temperature of the hottest and the coldest months is very low (about 4°C) for the altitudinal stations of south India ; it is about 15°C for the stations of temperate latitude. On the other hand, the diurnal range of temperature is very important for the tropical montane stations.

(*c*) In the *Ed*, *A′* 3, *a*3′ type of climate, Jodhpur, Khanpur, Las Bela, Ormara, Hyderabad (W. Pakistan), Wadi Halfa and Bilma are placed together.

OMBROTHERMIC DIAGRAMS

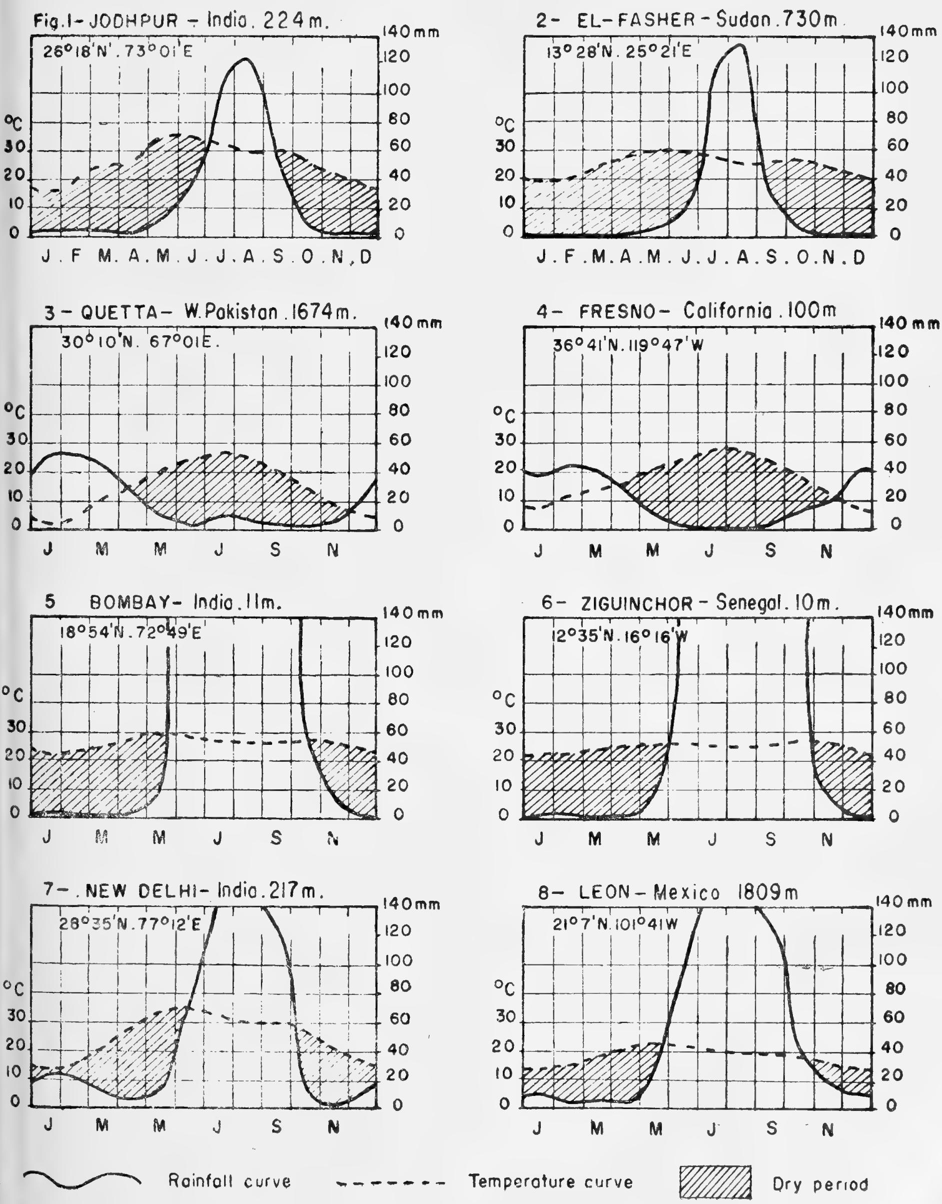
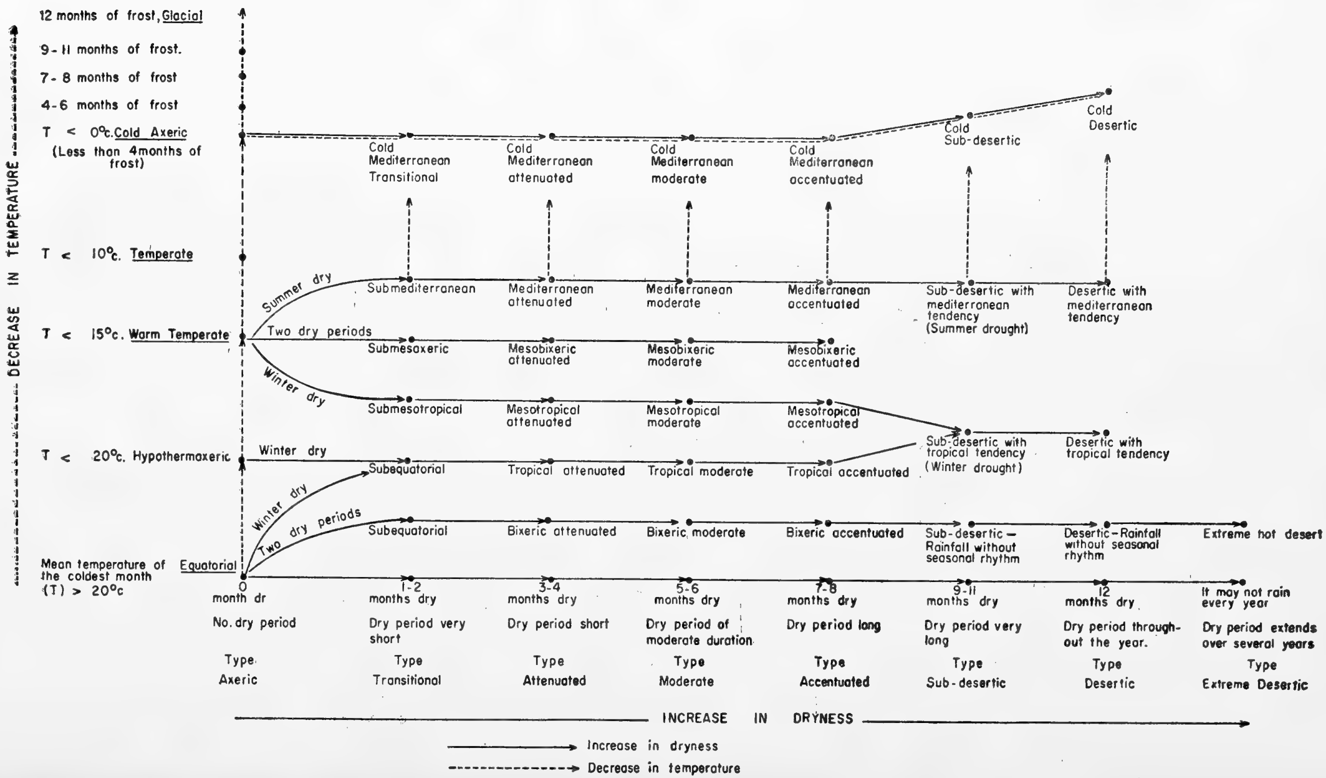


Fig. 9

DIAGRAMMATIC REPRESENTATION OF THE CLASSIFICATION OF BIOLOGICAL CLIMATES OF BAGNOULS AND GAUSSEN (1957)



As a matter of fact, Wadi Halfa (Sudan) and Bilma (W. Africa) have a *true desertic* climate with 360 biologically dry days like Insalah (Emberger, Gaussen *et al.* 1962-63). Ormara shows mediterranean tendency with 117 mm. (i.e. 76% of total rainfall) in winter and spring, and just 20 mm. (13%) in summer. Jodhpur comes near Hissar—subdesertic with tropical tendency (9 months dry, 262 dry days).

Were it not for the régime, the olive tree (*Olea europaea* L.) of the subdesertic parts of North Africa (with mediterranean climate) would thrive in the dry parts of Rajasthan.

(*d*) In the fifth megathermal class (A' 5), the analogy pointed out between Bellary and Aden is too far fetched. Bellary has an annual average rainfall of 509 mm. whereas Aden receives only 44 mm.

(3) Subrahmanyam & Sastry's (1969) climatic analogues for the dry zone of India.

(*a*) Nagpur is classified in the category of dry sub-humid climate (C_1) having no adequacy of moisture at any time of the year (C_1 d) but Seoni situated in the vicinity of Nagpur is placed in the category of large summer water surpluses (C_1 W_2). However, the total of the average April-October rainfall is hardly about 100 mm. more for Seoni (1278 mm., as against 1180 mm. of Nagpur).

The differences in the temperature of these months are also not marked. At Seoni the mean monthly temperature varies from 24°C (October) to 32°C (May) and at Nagpur from 26·5°C (Oct.) to 35·3°C (May). Besides the vegetation in the Nagpur-Seoni tract is of the same type,—a dry deciduous teak forest.

(*b*) Visakhapatnam and Coimbatore are both classified together in the semi-arid climate (*Dd*, A' 4, a' 9), though the former has 962 mm. of annual rainfall and 6 months dry and the latter only 590 mm. and as many as 9 months dry.

(*c*) Finally, the non-recognition of distinct régimes for Trincomalee, Jaffna of Ceylon (tropical dissymetric), Halfeka, Cyprus (Mediterranean) and Cambridge, England (temperate-atlantic) in the class C_1 S_2 (large winter water surplus) is unfortunate.

Bioclimatic Methods

One of the simplest methods to bring out analogous climates would be to compare the curves of mean monthly precipitation and temperature of various stations on a graph. The greater the resemblance in the graphs, the more analogous would be the climates. Some examples are provided in Figs. 1 to 8. The similarity in the pairs of diagrams is striking ; the diagram on the left belongs to a station of the Indian subcontinent, that on the right is a station of another country.

These graphs are in fact the ombrothermic diagrams of Bagnouls & Gaussen (1953). The abscissa bears January as the first month for the stations of the northern hemisphere but July for the southern hemisphere. Thus the stations are rendered comparable between the two hemispheres. The dry period is also depicted on the diagram by hatches according to the definition of these authors that a month is dry when its average precipitation (in mm.) is less than twice its mean temperature (in °C) : $P<2T$. The precipitation and temperature values are the results of the averages of several years and so of course the inter-yearly variability which may be important in certain cases is not considered. Another disadvantage of comparison of climates by diagrams is that only relatively few stations show a strict similarity in the precipitation and temperature curves. Therefore analogy by means of diagrams alone is not possible and there arises the need of a classification. Bagnouls & Gaussen's (1957) classification of biological climates is presented in a diagrammatic form by this author in Fig. 9. Within the framework of this broad classification based mainly on the rhythms of precipitation and temperature, a further climatic analogy may be reached by resemblances in the temperature, rainfall and length of the dry season classes.

The factor of temperature is indicated by the letter (t). Gaussen (1949) distinguishes 6 principal classes of temperature on the basis of the mean temperature of the coldest month (m) of the year which is a limiting factor for the vegetation, or of the hottest month (M) of the year. The values of the classes of temperature modified from those of Gaussen are given below :

t_1	: $M<10°C$
$t_{1/2}$	: $M>10°C$. $m<-15°C$
t_2	: $M>10°C$. $m<-5°C$
t_3	: $-5<m<0°C$
$t_{3/4}$	: $0<m<10°C$
t_4	: $10<m<15°C$
$t_{4/5}$	: $15<m<20°C$
t_5	: $m>20°C$. Mean annual $<30°C$
t_6	: Mean annual $>30°C$

The factor of precipitation is designated by the letter 'S' and its values as modified from the scale of Gaussen (l.c.) are :

S_1	: >3000 mm. of annual precipitation
$S_{1/2}$	: 2500 to 3000 mm. of annual precipitation
S_2	: 2000 to 2500 ,, ,, ,, ,,
$S_{2/3}$	: 1500 to 2000 ,, ,, ,, ,,
S_3	: 1250 to 1500 ,, ,, ,, ,,

$S_{3/4}$	:	1000 to 1250 mm. of annual precipitation
S_4	:	750 to 1000 ,, ,, ,, ,,
$S_{4/5}$	:	500 to 750 ,, ,, ,, ,,
S_5	:	250 to 500 ,, ,, ,, ,,
$S_{5/6}$	:	100 to 250 ,, ,, ,, ,,
S_6	:	< 100 ,, ,, ,, ,,

The dry period is indicated by the letter 'X'. The dryness is expressed in number of dry months (P<2T). The values of the classes of 'X' are:

X_1	:	1 month dry
$X_{1/2}$	:	2 months dry
X_2	:	3 ,, ,,
$X_{2/3}$	:	4 ,, ,,
X_3	:	5 ,, ,,
$X_{3/4}$	:	6 ,, ,,
X_4	:	7 ,, ,,
$X_{4/5}$	:	8 ,, ,,
X_5	:	9 ,, ,,
$X_{5/6}$	:	10 ,, ,,
X_6	:	11 to 12 months dry

In the cold climates, the frost period should also be taken into account.

Results obtained with reference to the dry tract of the Indian sub-continent

The above bioclimatic methods are applied here to bring out those stations of the world which have climates analogous to the stations of the dry tracts of the sub-continent (Table 1). Evidently the dry bioclimates fall within several categories (desertic, subdesertic with tropical, mediterranean, irregular régimes ; mediterranean and tropical accentuated types with 7 to 8 months dry) as may be seen in Table 1.

In the first column of this Table is presented the bioclimate according to the biological classification of climates of Bagnouls & Gaussen (1957) and in the second column the value of each ecological factor. Stations and their respective countries figure in columns 3 and 4. Latitude, longitude form columns 5-6. The latitude factor is of particular interest as a representative of the photoperiod ; it may account both for the intensity and duration of light. In the last column is presented the vegetation type of the station according to Champion (1936) for the stations of the Indian sub-continent and according to Schimper & Von Faber (1935) and Dansereau (1957) for the other stations.

Stations falling within the same biological climate (or bioclimate) imply a general analogy. Further precision is given by the values of the temperature, precipitation and the length of the dry season classes pointing out the degrees of similitude.

TABLE 1

BIOCLIMATES OF THE STATIONS OF THE DRY TRACTS OF THE INDIAN SUB-CONTINENT AND STATIONS HAVING ANALOGOUS BIOCLIMATES IN THE WORLD

Bioclimate (1)	Value of each ecological factor (2)	Station[1] (3)	Country (4)	Latitude (5)	Longitude (6)	Vegetation (7)
Hot desertic with mediterranean tendency (winter rains)	t_4 S_6 X_6	*Nokkundi*	W. Pakistan	28° 49′N	62° 45′E	Desert
	,,	Helwan	UAR	29° 52′N	31° 20′E	,,
	,,	Abbasia	,,	30° 5′N	31° 17′E	,,
	,,	As Salman	Iraq	30° 5′N	44° 3′E	Semi-desert
	$t_{4/5}$ S_6 X_6	Lima	Peru	12° 05′S	77° 03′W	Desert
	t_6 $S_{5/6}$ X_6	Massaoua	Erytrea	15° 36′N	39° 27′E	,,
Hot desertic with tropical tendency (Summer rains)	$t_{3/4}$ $S_{5/6}$ X_6	El Paso	USA	31° 47′N	106° 30′W	,,
	,,	Mendoza	Argentina	32° 53′S	68° 50′W	,,
	,,	*Gilgit*	Kashmir	35° 55′N	74° 23′E	,,
	t_4 $S_{5/6}$ X_6	*Bahawalpur*	W.Pakistan	29° 24′N	71° 47′E	,,
	,,	*Khanpur*	,,	28° 39′N	70° 41′E	,,
	,,	*Multan*	,,	30° 12′N	70° 31′E	Thorn forest
	t_4 S_6 X_6	*Jacobabad*	,,	28° 17′N	68° 27′E	Desert
	$t_{4/5}$ $S_{5/6}$ X_6	*Las Bela*	,,	26° 14′N	66° 19′E	,,
	$t_{4/5}$ S_6 X_6	*Sukkur*	,,	27° 47′N	68° 54′E	,,
	,,	Fort Gouraud	Mauritania	22° 41′N	12° 42′W	,,
	t_5 S_6 X_6	Faya Largeau	Tchad	18° 00′N	17° 10′W	,,
Hot desertic rains without seasonal rhythm	$t_{3/4}$ $S_{5/6}$ X_6	Puerto-Madryn	Argentina	43° 15′S	65° 22′W	Desert
	,,	Las Vegas	Nevada, USA	36° 10′N	115° 10′W	,,
	t_4 S_5 X_6	Alice-Springs	Australia	23° 38′S	133° 37′E	Scrub
	t_4 $S_{5/6}$ X_6	Metlaoui	Tunisia	34° 20′N	8° 22′E	Desert
	,,	Ouled-Djellal	Algeria	34° 25′N	5° 04′E	,,
	,,	*Sibi*	W.Pakistan	29° 33′N	67° 53′E	,,
	,,	*Panjgour*	,,	26° 58′N	64° 06′E	,,
	,,	*Dera Ismail Khan*	,,	31° 49′N	70° 55′E	,,
	,,	Tucson	Arizona, USA	32° 15′N	110° 57′W	,,
	,,	Kalgoorlie	Australia	30° 45′S	121° 3′E	Scrub
	t_4 S_5 X_6	Swakopmund	S.W. Africa	22° 42′S	14° 32′E	Desert

Bioclimate	Value of each ecological factor	Station[1]	Country	Latitude	Longitude	Vegetation
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	t_4 s_5 x_6	Mossamedes	Angola	15° 12′S	12° 09′E	Desert
	,,	Tamanrasset	Algeria	22° 50′N	5° 31′E	,,
	,,	Yuma	Arizona, USA	32° 45′N	114° 36′W	,,
	$t_{4/5}$ S_6 X_6	Port Etienne	Mauritania	20° 56′N	17° 03′W	,,
	t_5 S_6 X_6	Aden	Arabia	12° 46′N	45° 3′E	,,
	,,	Lambayeque	Peru	6° 43′S	79° 54′W	,,
Hot-sub-desertic with mediterranean tendency	$t_{3/4}$ S_6 X_5	Krasnovodsk	USSR	40° 09′N	52° 59′E	,,
	$t_{3/4}$ S_6 X_6	*Dalbandin*	W.Pakistan	28° 54′N	64° 26′E	,,
	,,	Zahedan	Iran	29° 30′N	60° 52′E	Semi-desert
	t_4 $S_{5/6}$ X_5	Beersheba	Israel	31° 15′N	34° 43′E	Desert
	t_4 $S_{5/6}$ $X_{5/6}$	Almeria	Spain	36° 50′N	2° 26′W	Steppe
	,,	Baghdad	Iraq	33° 20′N	44° 20′E	Scrub
	,,	Alexandria	UAR	31° 12′N	29° 53′E	Semi-desert
	t_4 $S_{5/6}$ X_6	Broken Hill	Australia	31° 57′S	141° 30′E	Scrub
	,,	Jéricho	Jordan	31° 52′N	35° 28′E	Desert
	,,	O'okiep	S.Africa	29° 36′S	17° 52′E	Scrub
	t_4 S_6 X_6	Punta Tortuga	Chili	29° 55′S	71° 22′W	Desert
	$t_{4/5}$ $S_{5/6}$ $X_{5/6}$	*Ormara*	W. Pakistan	25° 15′N	64° 39′E	,,
	$t_{4/5}$ $S_{5/6}$ X_6	*Pasni*	,,	25° 16′N	63° 28′E	,,
	,,	Iranchere	Iran	27° 13′N	60° 42′E	,,
	t_5 $S_{5/6}$ $X_{5/6}$	Souakin	Sudan	19° 07′N	37° 20′E	Semi-desert
Hot sub-desertic with tropical tendency	$t_{3/4}$ S_5 $X_{5/6}$	*Bannu*	W.Pakistan	33° 00′N	70° 36′E	Dry sub-tropical forest
	$t_{3/4}$ $S_{5/6}$ $X_{/6}$	Santa Maria	Argentina	26° 41′S	66° 40′W	Scrub
	t_4 $S_{4/5}$ X_5	*Agra*	India	27° 10′N	78° 02′E	Thorn forest
	t_5 S_5 X_5	Catamarca	Argentina	28° 29′S	65° 44′W	Scrub
	,,	Fort Tuli	Rhodesia	21° 52′S	29° 12′E	Savanna
	,,	Rehoboth	S.West Africa	23° 19′S	17° 3′E	Scrub
	,,	*Hissar*	India	29° 10′N	65° 44′E	Thorn forest
	t_4 S_5 $X_{5/6}$	*Lyallpur*	W.Pakistan	31° 26′N	73° 04′E	,,
	,,	*Khushab*	,,	32° 18′N	72° 22′E	,,
	,,	Omaruru	S. West Africa	21° 35′S	18° 13′E	Scrub

Bioclimate (1)	Value of each ecological factor (2)	Station[1] (3)	Country (4)	Latitude (5)	Longitude (6)	Vegetation (7)
	t_4 S_5 X_6	*Sri Ganganagar*	India	29° 55′N	73° 53′E	Desert
	,,	*Montgomery*	W.Pakistan	30° 39′N	73° 08′E	Thorn forest
	t_4 $S_{5/6}$ X_6	Arequipa	Peru	16° 22′S	71° 33′E	Desert
	$t_{4/5}$ S_4 X_5	Mazatlan	Mexico	23° 12′N	106° 25′W	Scrub
	$t_{4/5}$ $S_{4/5}$ X_5	*Kotah*	India	25° 11′N	75° 51′E	Thorn forest
	,,	*Ajmer*	,,	26° 27′N	74° 37′E	,,
	,,	*Jaipur*	,,	26° 55′N	75° 50′E	,,
	,,	*Mainpuri*	,,	27° 14′N	79° 03′E	,,
	$t_{4/5}$ S_5 X_5	*Jamnagar*	,,	22° 29′N	70° 04′E	,,
	,,	*Jodhpur*	,,	26° 18′N	73° 01′E	,,
	$t_{4/5}$ S_5 $X_{5/6}$	*Barmer*	,,	25° 45′N	71° 23′E	,,
	$t_{4/5}$ S_5 $X_{5/6}$	*Bikaner*	,,	28° 01′N	73° 18′E	Thorn forest
	,,	*Bhuj*	,,	23° 15′N	69° 48′E	,,
	,,	El-Fasher	Sudan	13° 28′N	25° 21′E	Scrub
	$t_{4/5}$ $S_{5/6}$ X_6	*Hyderabad*	W.Pakistan	25° 23′N	68° 25′E	Thorn forest
	,,	*Badin*	,,	24° 38′N	68° 54′E	,,
	,,	*Karachi*	,,	24° 48′N	66° 59′E	,,
	,,	Kidal	Sudan	18° 26′N	1° 22′E	Semi-desert
	t_5 $S_{4/5}$ X_5	Diourbel	Senegal	14° 50′N	16° 09′W	Savanna
	,,	Baroma	Mozambique	16° 0′S	33° 12′E	,,
	,,	Lome	Togo	6° 07′N	1° 14′E	,,
	,,	Fort Lamy	Tchad	12° 10′N	14° 60′E	,,
	,,	*Deesa*	India	24° 14′N	72° 12′E	Thorn forest
	,,	*Bellary*	,,	15° 09′N	76° 51′E	,,
	t_5 S_5 X_5	Elobeid	Sudan	13° 11′N	25° 21′E	Scrub
	,,	Abécher	Tchad	13° 49′N	20° 51′E	,,
	,,	St. Louis	Senegal	16° 01′N	16° 30′W	Savanna
	t_5 S_5 $X_{5/6}$	Joco-Capelo	Angola	8° 48′S	13° 13′E	,,
	,,	*Dwarka*	India	22° 22′N	69° 05′E	Thorn forest
	,,	Tulear	Madagascar	23° 20′S	43° 41′E	Scrub
	t_5 S_5 X_6	Nouakchott	Mauritania	18° 07′N	15° 56′W	Semi-desert
	,,	Khartoum	Sudan	15° 37′N	32° 33′E	Desert
Hot sub-desertic without seasonal rhythm	$t_{3/4}$ S_5 X_5	Roswell	New Mexico, USA	33° 24′N	104° 33′W	Steppe
	,,	*Fort Sandeman*	W.Pakistan	31° 29′N	69° 27′E	Dry sub-tropical forest

Bioclimate (1)	Value of each ecological factor (2)	Station[1] (3)	Country (4)	Latitude (5)	Longitude (6)	Vegetation (7)
	$t_{3/4}$ S_5 $X_{5/6}$	*Miranshah*	W. Pakistan	33° 57′N	70° 07′E	Dry-Sub-tropical forest
	$t_{3/4}$ $S_{5/6}$ $X_{5/6}$	Ain-Sefra	Algeria	32° 45′N	0° 35′W	Semi-desert
	t_4 S_5 X_5	*Lahore*	W.Pakistan	31° 35′N	74° 20′E	Thorn forest
	,,	*Peshawar*	,,	34° 01′N	71° 35′E	Dry sub-tropical forest
	,,	St. Luis-Potosi	Mexico	22° 9′N	101° 01′W	Scrub
	,,	Coolgardie	Australia	30° 57′S	121° 10′E	,,
	t_4 $S_{5/6}$ X_6	Phoenix	Arizona, USA	33° 28′N	112° 0′W	Semi-desert
	$t_{4/5}$ S_5 X_5	Ghinda	Erytrea	15° 26′N	39° 07′E	Scrub
	t_5 $S_{4/5}$ X_5	*Coimbatore*	India	11° 00′N	76° 58′E	Thorn forest
	t_5 S_5 X_5	Bardera	Somalia	2° 30′N	42° 53′E	Scrub
Mediterranean accentuated (7-8 months dry)	$t_{3/4}$ $S_{5/6}$ X_4	El-Kantara	Algeria	31° 13′N	32° 43′E	Semi-desert
	,,	Matmata	Tunisia	33° 37′N	9° 54′E	Scrub
	,,	Teheran	Iran	35° 42′N	51° 25′E	Semi-desert
	,,	Santa-cruz	Argentina	50° 1′S	68° 32′W	Steppe
	$t_{3/4}$ S_5 $X_{4/5}$	*Wana*	W.Pakistan	32° 18′N	69° 44′E	Dry sub-tropical forest
	,,	Dizfoul	Iran	32° 25′N	48° 35′E	Semi-desert
	$t_{3/4}$ $S_{5/6}$ $X_{4/5}$	Deir-es-Zor	Syria	35° 20′N	40° 11′E	Scrub
	,,	*Kalat*	W.Pakistan	29° 02′N	66° 35′E	Dry sub-tropical forest
	,,	*Quetta*	,,	30° 10′N	67° 01′E	,,
	,,	*Chaman*	,,	30° 55′N	66° 28′E	,,
	,,	Fresno	California, USA	36° 41′N	119° 47′W	Semi-desert
	,,	Kerman	Iran	30° 03′N	57° 02′E	,,
	,,	Sarmiento	Argentina	45° 35′S	69° 4′W	Steppe
Tropical accentuated (7-8 months dry)	t_5 S_4 $X_{4/5}$	Soalala	Madagascar	16° 04′S	45° 20′E	Savanna
	,,	Maroua	Cameroons	10° 35′N	14° 20′E	,,
	,,	Kaolack	Senegal	14° 02′N	16° 04′W	,,
		Kayes	Sudan	14° 25′N	11° 34′W	,,
	,,	*Pamban*	India	9° 16′N	79° 15′E	Thorn forest
	,,	Quixeramobim	Brazil	5° 12′S	39° 18′W	Scrub

Bioclimate (1)	Value of each ecological factor (2)	Station[1] (3)	Country (4)	Latitude (5)	Longitude (6)	Vegetation (7)
	t_5 $S_{4/5}$ X_4	*Ahmednagar*	India	19° 05′N	74° 55′E	Thorn forest
	,,	*Sholapur*	,,	17° 40′N	75° 54′E	,,
	,,	*Poona*	,,	18° 32′N	73° 51′E	,,
	,,	*Bijapur*	,,	16° 49′N	75° 43′E	,,
	,,	*Gulburga*	,,	17° 21′N	76° 51′E	,,
	,,	*Raichur*	,,	16° 12′N	77° 01′E	,,
	,,	*Kurnool*	,,	15° 50′N	78° 04′E	,,
	,,	*Gadag*	,,	15° 25′N	75° 38′E	,,
	,,	*Hyderabad* (Dn)	,,	17°26′ N	78°27′ E	,,
	,,	*Miraj*	,,	16° 49′N	74°41′E	,,
	,,	*Rentichintala*	,,	16° 33′N	79° 33′E	,,
	,,	Betioky	Madagascar	21° 30′S	44° 26′E	Scrub
	t_5 $S_{4/5}$ $X_{4/5}$	Matam	Senegal	15° 38′N	13° 13′W	Savanna
	,,	Segou	Sudan	13° 30′N	6° 15′W	,,
	,,	*Dohad*	India	22° 50′N	74° 16′E	Thorn forest
	,,	*Rajkot*	,,	22° 18′N	70° 50′E	,,
	,,	*Veraval*	,,	20°55′ N	70° 22′E	,,
	,,	*Bhavnagar*	,,	21° 45′N	72° 12′E	,,
	,,	*Malegaon*	,,	20° 33′N	74° 32′E	,,
	,,	*Ahmedabad*	,,	23° 02′N	72° 53′E	,,
	,,	*Aurangabad*	,,	19° 53′N	75° 20′E	,,
	t_6 $S_{4/5}$ $X_{4/5}$	Niamey	Nigeria	13° 30′N	2° 06′E	Savanna
Meso-tropical accentuated (7-8 months dry)	t_4 S_4 $X_{4/4}$	*Aligarh*	India	27°53′N	78° 04′E	Thorn forest
	t_4 $S_{4/5}$ X_4	Bulawayo	Rhodesia	20° 9′S	28° 40′E	Savanna
	,,	Monterrey	Mexico	25°40′ N	100° 18′W	Scrub
	,,	Zacatecas	,,	22° 58′N	102° 19′W	,,
	,,	Salta	Argentina	24° 47′S	65° 25′W	,,
	t_4 $S_{4/5}$ $X_{4/5}$	*New Delhi*	India	28° 35′N	77° 12′E	Thorn-forest
	,,	Léon	Mexico	21° 7′N	101° 41′W	Scrub
	t_4 S_5 X_4	Mahalapyá	Bechuanaland	23° 6′S	26° 40′E	,,
	t_4 S_5 $X_{4/5}$	Windhoek	S.West Africa	22° 34′S	17° 12′E	,,

[1] The stations of the Indian sub-continent are in italics.

The Climatological Tables of Observatories in India, World Weather Records—Smithsonian Misc. Publications and *Annales des Services Météorologiques de la France d'Outre-Mer* are the main sources of the climatic data.

It ensues from this Table 1 that the vegetation in the hot desertic climate is predominantly of a desertic type, 30 out of 34 stations possessing this type, the remaining few having semi-desert, scrub or thorn forest. More than half the number of stations in the hot subdesertic climate have either thorn forest (22 stations) or its physiognomically allied type the scrub (17 stations). The difference between thorn forest and scrub is mainly one of the nomenclature. The remaining types are desert, semi-desert, savanna and steppe.

In the mediterranean accentuated climate, there are 5 stations having semi-desert, 4 having dry subtropical forest and 2 each having steppe and scrub. In the tropical and meso-tropical accentuated type there are 21 thorn forest stations, and 8 each of savanna and scrub. The difference in the land-use may account for the existence of thorn forest in India and savanna in Africa under the same bioclimate. In other cases the soils may intervene in deciding the vegetation.

Concluding Remarks

Further work on analogous bioclimates is in progress. It is essential to recognise stable and unstable climates and the variability in the climatic elements of the latter type where the climate of a given year may not be comparable in rainfall amount, régime and distribution to that derived from the figures of averages.

It may also be remembered that bioclimate is only a part of the complete ecology of a species. For the introduction of exotics, a study of the total ecological requirements of the species is indispensable. This includes not only the edaphic factors but also the biotic ones. The vanilla orchid (*Vanilla planifolia* Andrews) when planted in the Reunion Island grew well but did not fructify naturally in the absence of the pollinating insect from its native Central America.

In the framework of climate, the critical factor involved in determining the area of a species may not be an apparent one. For instance, teak (*Tectona grandis* L.f.) has quite a broad amplitude for the rainfall conditions : 750 to 2500 mm. of annual rainfall, length of dry season of 4 to 8 months and mean temperature of the coldest month from 15 to over 20°C ; yet it is absent on the Coromandel coast where conditions well within these amplitudes are obtained. However, the season of occurrence of rains in this belt is quite peculiar (dissymetric) and teak disappears from those regions of southern India where May and/or June rains are very poor (Legris & Meher-Homji 1968).

In the distribution of sal (*Shorea robusta* Gaertn.) the crucial factor is the timely arrival of rains for the germination of seeds which have a very short period of viability. Nursery practices overcome such difficulties in artificial plantations.

Finally, the soil factor may intervene to compensate the climate and may result in imparting a wide distributional range to the species. *Cassia auriculata* L. thrives on the black clayey cotton soils of the semi-arid Deccan where annual rainfall is of the order of 700 mm. with 7 to 8 months dry. In the coastal region of Tamil Nadu with a more humid climate (rainfall over 1000 mm. ; 6 months dry), *C. auriculata* is encountered on the less water retentive sandy loamy soils. *Soymida febrifuga* Juss. occupies wet sites (valleys) in a dry region like Sariska in N.E. Rajasthan ; in humid tracts of Orissa and Bihar it grows on eroded localities. In the mediterranean climate of France, the holly oak (*Quercus ilex* L.) is indifferent in its edaphic requirements but in the wetter atlantic climate it occurs only on calcareous soil which provides a dry substratum, and on warmer southern slopes.

References

Azzi, G. (1954) : Ecologie agricole. J. Ballière et fils, Paris.

Bagnouls, F. & Gaussen, H. (1953) : Saison sèche et régime xérothermique. *Documents pour les cartes des productions végétales*. t. III, vol. **I**, art 8, 47 p. Toulouse.

——— (1957) : Les climats biologiques et leurs classification. *Ann. de Géogr.* **355** : 193-220.

Bharucha, F. R. & Shanbhag, G. Y. (1957) : Precipitation effectiveness in relation to the vegetation of India, Pakistan and Burma. *Bot. Mem.* No. **3**, University of Bombay.

Champion, H. G. (1936) : A preliminary survey of the forest types of India and Burma. *Indian For. Rec.* **1** : 1-286.

Chaptal, L. (1933) : La représentation graphique des climats. *Bull. Assoc. Géogr. fr.*

Dansereau, P. (1957) : Biogeography. An ecological perspective. The Ronald Press Co., New York.

de Martonne, E. (1926) : Aréisme et indice d'aridité. *C.R.Acad. Sci.* **182** : 1395-1398.

Emberger, L. & Gaussen, H. *et al.* (1962-63) : Carte bioclimatique de la Région Méditerranéenne. Recherche sur la zone aride, 22. Unesco, Paris; FAO, Rome.

Gaussen, H. (1949) : Projects pour diverses cartes du monde au 1/1.000.000. La carte écologique du tapis végétal. *Ann. Agron.* t. **19** : 78.

Grisebach, A. (1884) : Die Vegetation der Erde. Bd. I und II. Leipzig.

Humboldt, A. (1805) : Essai sur la géographie des plantes. Paris.

Kaushik, R. C., Kaul, R.N. & Subrahmanyam, V. P. (1969) : Homoclimes and introduction of trees and shrubs with special reference to the arid and semi-arid zone of India. *Indian For.* **95**(5) : 283-292.

Köppen, W. (1900) : Versuch einer Klassification der Klimate vorsugsweise nach ihren Bezeihungen zur Pflanzenwelt. *Geogr. Zeitschr.* **6** : 593-611 ; 657-679.

——— (1918) : Klassification der klimate nach Temperature, Niederschlag und Jahresverlauf. *Peterm. Mittel.* **64** : 193-203 ; 243-248.

Lang, R. (1920) : Verwitterung und Bodenbuildung als Einfuhrung in die Bodenkunde. Stuttgart, Schweizerbartsche verlagobuchlgd. 123 p.

Legris, P. & Meher-Homji, V. M. (1968) : Vegetation maps of India. Symp. Recent Adv. Trop. Ecol. **1** : 32-41. Varanasi.

Meher-Homji, V. M. (1963) : Les bioclimats du sub-continent Indien et leurs types analogues dans le monde. *Trav. Sect. Sci. Tech. Inst. Fr. Pondicherry*, **7**(1-2) : 1-386.

——— (1967) : On delimiting arid and semi-arid climates of India. *Indian Geogr. J.* **42** : 1-6.

Melwyn Howe, G. (1960) : Homoclimes within the British Commonwealth. *Indian J. Met. & Geophys.* **11**(3) : 223-238.

Nuttonson, M. Y. (1947a) : Ecological crop geography of Greece and its agroclimatic analogues in North America. *American Inst. of Crop. Ecol. Intern. Agro. Climatol. Series,* Study no. 5, Washington.

NUTTONSON, M. Y. (1947b) : Ecological geography of Czechoslovakia and its agro-climatic analogues in North America. ibid. Study no. 3.
——— (1947c) : Ecological crop geography of China and its agro-climatic analogues in North America. ibid. Study no. 7.
——— (1951) : Ecological crop geography and field practices of Japan. Japan's natural vegetation and agro-climatic analogues in North America. ibid.

PENCK, A. (1910) : Versuch einer klimaklassification auf physiologischer grundlage. *Sitz. Ber. Phys. Math. Kl. Preuss Akad. Wiss.* Berlin, 236.
RAUNKIAER, C. (1908) : Livsformens Statistik Som Grundlag for biologisk plantgeographi. *Botanisk Tidsskr.* **29**(1).
SCHIMPER, A. F. W. & VON FABER, F. C. (1935) : Pflanzengeographie auf physiologischer Grundlage. Fischer, Jena.
SUBRAHMANYAM, V.P. & SASTRY, C.V.S. (1969): Climatic analogues for the dry zone of India. *Trop. Ecol.* **10**(1) : 34-44.
TAYLOR, G. (1920a) : Australian Mete orology. Oxford.
——— (1920b) : Agricultural climatology of Australia. *Quart. Jour. Royal Meteor. Soc.* **46**.
THORNTHWAITE, C. W. (1933) : The climates of the earth. *Geogr. Rev.* **23** : 433-440.
——— (1948) : An approach towards a rational classification of climate. *Geogr. Rev.* **38** : 55-94.
TRANSEAU, E. (1905) : Forest centres of Eastern America. *The American Naturalist* **39**.
WALTER, H. (1955a) : Die Klimagramme als Mittel zur Beurteilung der Klimaverhaltnisse fur ökologische, vegetationskundliche und landwirtschaftliche Zwecke. *Ber. der deutschschbotan. Gesellschaft.*
——— (1955b) : Klimadiagrammkarte der Turkei. Ulmer Vlg. Stuttgart.

Arthropod Fauna of the nests of some common birds in Poona, India, with special reference to blood sucking forms

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A study of the arthropod fauna of the nests of six common birds of Poona was made. The number of nests examined were : 56 *Corvus splendens*, 35 *Ploceus philippinus*, 14 *Acridotheres tristis*, 4 *Passer domesticus*, 4 *Hirundo concolor* and one *Copsychus saularis*. All the arthropods collected were classified and the frequency of their occurrence and number collected were recorded. The blood sucking forms received special attention. Those collected were: *Mites:—Ornithonyssus bursa*, and a new species of *Pellonyssus* of the family Dermanyssidae and two species of *Laelaps* of the family Laelaptidae; *Ticks* :—one species each of *Haemaphysalis* and *Argas ; Diptera* :—Four species of *Culicoides* and one species of Sandfly (Sergentomyia); one louse and two species of anthocorid bugs.

The factors governing the association of these blood sucking forms and the avian hosts are discussed. Mites were the most abundant among the arthropods collected. While crow nests harboured both the common species, viz. *O. bursa* and *Pellonyssus*, weaverbird nests did not, except for a solitary specimen, have *Ornithonyssus*.

INTRODUCTION

It is well known that nests of birds harbour a rich and varied arthropod fauna. Though naturalists including those in India, have often been attracted by them there have been till recently few studies exclusively devoted to them. Most of the observations of the fauna of bird nests have been stray ones made in connection with the habits of the birds concerned. Woodroffe (1953) made an outstanding contribution to the subject by his study of the insects and mites in the nests of some birds in Great Britain and by presenting a useful bibliography. He has also critically reviewed the important work of Nordberg (1936) in Finland, which had been completely overlooked by other workers. A brief but very informative review has also been made by Rothschild & Clay (1952).

While nests of birds offer to the zoologist an interesting ecological niche to study the inter-relationships between birds, their ectoparasites

[1] The Virus Research Centre was, jointly maintained by the Indian Council of Medical Research and the Rockefeller Foundation at the time this study was made.

and other nest-inhabiting fauna, they provide the medical research workers with a convenient place to look into for the probable arthropod vectors of diseases of man and animals, particularly of those diseases in the epidemiology of which birds have a role. The observations recorded in this paper were made in the course of a wider study of the ectoparasites of birds in connection with virological investigations in India.

The main objective of these studies was to determine the blood sucking arthropods associated with birds and their fledglings within their nests. While the other arthropods collected were also enumerated and preserved there was neither time nor immediate necessity to embark upon a detailed taxonomic study of all the forms. It has however been possible to sort out the fauna at least up to orders but in the case of blood sucking forms the identifications have been made up to species wherever possible. As it is believed that this is the first systematic study of its kind on the nests of Indian birds the data collected are deemed worthy of presentation though they may fall short of the requirements of a thorough ecological investigation. The work was done mainly during the year 1953 and has hitherto remained unrecorded. Subsequently nests of several species have been examined from time to time and the findings of the previous study generally confirmed.

The authors gratefully acknowledge the help given by Mr. B. S. Lamba in the collection of the nests and their transportation to the laboratory. Dr. J. A. Kerr, the then Director, and Dr. Harold N. Johnson the then Virologist at this Centre made many useful suggestions for which thanks are due to them.

Materials and Methods

The material consisted of 56 nests of *Corvus splendens* (the Common House Crow); 35 of *Ploceus philippinus* (the Baya or the Common Weaver-bird); 14 of *Acridotheres tristis* (the Common Myna); 4 of *Passer domesticus* (House Sparrow); 4 of *Hirundo concolor* (the Dusky Crag Martin) and one of *Copsychus saularis* (the Magpie Robin). The studies were carried out mainly between May and November 1953 and were supplemented by a few observations in 1954. The nests were collected in and around Poona City and brought to the laboratory in bags or sheets of plastic cloth well sealed to prevent the escape of arthropods. Data recorded for each nest included the date, the name of the tree, or a description of the location, the number of eggs or fledglings found and their approximate age. On a few occasions more than one nest located on the same tree have been handled as one nest.

On arrival at the laboratory the nests were pulled apart and processed the same day in Berlese funnels which were specially designed for the purpose. The funnels were made of bright new tinplate and had an upper diameter of 18 inches and a length of 24 inches. They tapered down to a diameter of one inch at the bottom which had a stem 2 inches long and one inch in diameter. A grid made of 1/4 inch galvanised wire netting was fitted inside the funnel at its middle height. Over the funnel was a 150 watt electric bulb with a polished conical reflector made of tinplate. Three such funnels were mounted on a wooden stand. Conical glass flasks of one litre capacity were sealed with adhesive tape and paraffin to the stems of the funnels to receive the arthropods which would crawl away from the nests when the light was turned on. The apparatus was kept functioning for 24 hours but the first collecting flask was replaced by a new one at the end of the first two hours. It was the general experience that the vast majority of the arthropods collected by this method were found in the flasks within the first two hours. The arthropods were chloroformed and examined immediately after the removal of the flasks from the funnels. All the blood sucking arthropods were immediately separated, identified and those which could be used for virological studies were made into pools for inoculation into mice. Adequate samples were however retained for further identifications. The remaining material was preserved either in spirit or mounted on slides as found necessary.

No special descriptions of the nests are necessary as they were typical of the nests of the birds studied. Regarding the location of the nests 13 crow nests were on Banyan trees, 18 on Tamarind trees and 10 on Neem trees and the rest on five other kinds of trees. Sixteen weaverbird nests were on Babul trees and five on Toddy palms. Twelve myna nests were in holes in stone road bridges or in stone walls and two in holes in trees. All the sparrow nests were in holes in a stone bridge.

Of the 56 nests of crows, eight were deserted, 15 had one to five eggs, two had an egg and two fledglings each and the remaining had one to four fledglings. Among the 35 weaverbird nests, 12 were deserted, eight had one to four eggs and the remaining one to four fledglings each. One myna nest was deserted and 13 had one to three fledglings each. Two sparrow nests had three fledglings each and one had three eggs each and one had three eggs and one fledgling.

All the weaverbird nests examined contained one or more small lumps of clay inside. This is a well known feature but there was no evidence of any larvae of beetles being stuck into them. It may be recalled that there is popular belief among some naturalists that the Baya uses the mud for sticking light producing larvae of beetles.

RESULTS

The data collected are summarised in Tables 1, 2 and 3. Table 1 provides information on the number of nests of each kind of bird examined and the months during which they were examined. Table 2 provides information on the blood sucking arthropods collected and Table 3 gives the data on all arthropod groups collected and the number of times they were found.

TABLE 1

NUMBER OF BIRD NESTS EXAMINED, POONA

Month	*Corvus splendens*	*Ploceus philippinus*	*Acridotheres tristis*	*Passer domesticus*	*Hirundo concolor*	*Copsychus saularus*
1953						
May	..	..	..	..	..	..
June	28	..	2	..	..	..
July	25	..	5	..	..	..
August	..	..	6	3	1	..
September	..	13	1	..	3	..
October	..	15	..	..	..	..
November	..	2	..	..	..	1
1954						
February	..	..	..	1	..	..
April	3	..	..	..	..	..
November	..	5	..	..	..	..
Total	56	35	14	4	4	1

From the point of view of sheer numbers mites, particularly parasitic mesostigmatid mites, were the predominating group of arthropods in the nests of all birds except the House sparrow. From the point of view of frequency of occurrence Coleoptera and Diptera share the pride of place. Whether numerical abundance or frequency of occurrence should be used as the criterion for determining the dominance of any group is generally a moot question but for the purpose of this study it seems best to grade the groups according to both. The order of abundance of the major groups may be represented as follows :

Nests of House Crow		Nests of Weaverbird		Nests of Myna	
Numbers	Frequency	Numbers	Frequency	Numbers	Frequency
Mites	Diptera	Mites	Coleoptera	Mites	Coleoptera
Diptera	Coleoptera	Psocoptera	Hemiptera	Coleoptera	Mites
Coleoptera	Mites	Hemiptera	Mites	Diptera	Diptera

Hymenoptera	Psocoptera	Diptera	Psocoptera
Psocoptera	Hemiptera	Hymenoptera	Hymenoptera
Collembola	Lepidoptera		
Lepidoptera	Collembola		

TABLE 2

BLOOD SUCKING ARTHROPODS COLLECTED IN NESTS OF THREE SPECIES OF BIRDS

Nests of	*Corvus splendens*	*Ploceus philippinus*	*Acridotheres tristis*
Total number of nests examined	56	35	14
DIPTERA			
Culicoides spp.			
No. of times found	34	11	2
Total found	198	88	3
Maximum No. found in any nest..	47	21	2
Sergentomyia sp.			
No. of times found	4	..	..
Total found	4	..	..
Maximum No. found in any nest..	1	..	..
HEMIPTERA			
Anthocoridae			
No. of times found	14	25	..
Total found	73	281	..
Maximum No. found in any nest..	18	51	..
ACARINES			
Ornithonyssus bursa			
No. of times found	19	1	6
Total found	13,742+	1	709+
Maximum No. found in any nest..	10,000+	1	400+
Pellonyssus sp.			
No. of times found	13	29	5
Total found	2172+	15,876+	464+
Maximum No. found in any nest..	1500+	10,000+	200+
Laelaptidae			
No. of times found	..	2	2
Total found	..	300+	10
Maximum No. found in any nest..	..	200+	9
TICKS			
Haemaphysalis sp.	..	1	..
Argas sp.	1	..	..

In the nests of House sparrows the most abundant group was Collembola followed closely by mites.

TABLE 3

ARTHROPODS COLLECTED FROM BIRD NESTS

	Corvus splendens	*Ploceus philippinus*	*Passer domesticus*	*Acridotheres tristis*	*Hirundo concolor*	*Copsychus saularis*	Total number of arthropods
Number of nests	56	35	4	14	4	1	112
Insecta							
Thyasanura	9/16	..	..	..	..	..	16
Collembola	15/87	..	2/ 1001	1/ 4	..	..	1092
Orthoptera (Cockroaches)	4/ 4	..	3/ 136	..	..	..	140
Dermaptera	2/ 2	..	..	1/ 8	..	..	10
Embioptera	2/ 3	..	..	..	..	1/1	4
Isoptera (Termites)	1/ 2	..	..	..	..	..	2
Psocoptera (Psocids)	33/175	25/ 632	..	2/ 4	..	..	811
Anoplura	..	..	..	1/ 1	..	..	1
Hemiptera :							
Anthocoridae (Two spp.)	14/ 73	25 /281	..	..	..	..	354
Others	16/ 36	6/ 99	..	..	..	..	135
Lepidoptera :							
Adults	4/ 4	..	..	..	..	..	4
Larvae	10/ 51	1/ 2	..	..	..	..	53
Trichoptera :	1/ 2	..	..	..	..	..	2
Diptera :							
Larvae	13/ 57	1/ 1	1/ 4	3/ 24	..	..	86
Psychodinae	22/65	..	..	2/ 7	..	..	72
Phlebotominae	4/ 4	..	..	..	..	..	4
Culicoides sp.	34/ 198	11/ 88	..	2/3	..	..	289
Chloropidae	14/ 180	..	..	..	..	..	180

Note : No. of nests positive No. of specimens.

	Corvus splendens	*Ploceus philippinus*	*Passer domesticus*	*Acridotheres tristis*	*Hirundo concolor*	*Copsychus saularis*	Total number of arthropods
Others	16/ 51	3/ 6	..	3/ 4	..	..	61
Hymenoptera (ants)	17/ 206	20/ 120	1/ 2	1/ 2	..	..	330
Coleoptera—Adults	44/ 191	31/ 143	2/ 16	10/108	1/3	..	461
Larvae	27/ 250	5/ 8	1/ 11	13/240	..	..	509
Arachnida							
Spiders	16/ 36	2/ 5	..	1/ 35	..	..	76
Scorpions	1/ 1	..	..	..	..	..	1
Pseudoscorpions	4/ 5	..	1/ 4	2/ 2	..	..	11
Ticks							
Haemaphysalis sp.	..	1/ 1	..	..	..	..	1
Argas sp.	1/ 1	..	..	..	..	..	1
Mites							
Dermanyssidae : *Ornithonyssus bursa*	19/13,742+	1/ 1	..	6/709	..	..	14,452+
Pellonyssus sp.	13/1172	29/15,876	..	5/464	..	..	18,512+
Fedriziidae	..	..	..	1/ 20	..	..	20
Trombidiformis : Smarididae	2/ 4	..	..	..	..	..	4
Cheyletidae	2/ 2	..	..	..	..	..	2
Others	5/ 8	..	..	..	..	..	8
Hydrachnellae	1/ 1	..	..	..	..	..	1
Sarcoptiformis :							
Epidermoptidae	..	1/ 2	..	..	..	..	2
Tyroglyphidae	1/ 100	..	..	..	..	..	100
Others	..	..	..	..	1/1	..	1
Uropodina	..	..	3/ 35	1/ 5	..	..	40
Oribatei	5/ 51	..	2/218	3/827	..	..	1096
Laelaptidae	..	2/ 300	..	2/ 10	..	..	310
Undetermined mites	3/ 73	..	..	..	..	..	73
Myriapoda							
Centipedes	..	..	1/ 3	..	..	..	3
Millipedes	..	..	1/ 1	..	..	..	1

The blood sucking forms will be first considered in detail followed by a general review of the fauna. The blood sucking arthropods found were :—

Mites	Dermanyssidae	*Ornithonyssus bursa* (Berlese), *Pellonyssus* sp. n.
	Laelaptidae	*Laelaps* spp. Two species.
Ticks	Ixodidae	*Haemaphysalis* sp. (once only).
	Argasidae	*Argas* sp. (once only).
Diptera	Psychodidae	*Sergentomyia punjabensis* (=*Phlebotomus antennatus* Sinton).
	Ceratopogonidae	*Culicoides oxystoma.*
		C. guttifer.
		Culicoides (*Trithecoides*) *flaviscutatus.*
		Wirth & Hubert 1959 (formerly included under the *Culicoides anophelis* group on the basis of the presence of 3 spermathecae, and subsequently the group has been studied and a new species established).
		Culicoides sp. undet.
Anoplura		Genus and species indet (once only).
Hemiptera : (Provisionally included)	Anthocoridae	*Blaptostethus piceus* Aabr. and *Cardiastethus* sp.

Ornithonyssus bursa (formerly known as *Bdellonyssus bursa*) is the well known tropical fowl mite having a wide distribution in the tropics of both eastern and western hemispheres. In and around Poona it occurs in good numbers in coops of domestic chicken. Fonseca (1948), in his monograph on Macronyssidae (now family Dermanyssidae) lists *Gallus domesticus, Columba livia domestica, Passer domesticus domesticus* ' Hibou ' a bird, and *Homo* as the recorded hosts of which *Gallus* and *Homo* are recorded as hosts in India. Strandtmann & Wharton (1958) add the bandicoot and ' hen, turkeys, wild birds and wood thrush ' to the host list. The present study therefore adds *Corvus splendens* and *Acridotheres tristis* to the host list for the species. Apart from the finding of these mites in the nests they have been collected directly off the bodies of the birds themselves.

It is interesting that while 19 out of 56 crow nests and six out of 14 myna nests harboured *O. bursa*, except for one solitary specimen this mite was not found in any of the 35 weaverbird nests examined. Even the solitary specimen might have been accidentally introduced. This is remarkable considering the findings that this species is very widely distributed in and around Poona and that weaverbird nests harbour large numbers of another mite of the same family. The largest number found in any nest was conservatively estimated as 10,000+ in a crow nest examined on June 29, 1953. Usually all the developmental stages were found in the nests and a good proportion of adults and protonymphs had taken fresh blood meals.

The species of *Pellonyssus* (formerly included under *Steatonyssus*)[1] found in the nests seem to be a new one and is being recorded here for the first time. It is being separately described[2]. Only four species of '*Steatonyssus*' (as understood earlier) had hitherto been recorded from India, viz. *Pellonyssus viator* Hirst (=*Steatonyssus viator*) from *Cypselus* (=*Micropus*) *affinis*, the Indian Swift, from Calcutta; *Steatonyssus javensis* (Oudemans) from an unknown host, probably a bat, from Khandala some 45 miles NW of Poona City; *Steatonyssus hubli* Hiregaudar & Bal, from a bat, *Pipistrellus ceylonensis*, in the Deccan, and *Steatonyssus musculi*, from a mammal (probably a bat) in Bombay (Strandtmann & Wharton 1958). The present records of *Corvus splendens*, *Acridotheres tristis* and *Ploceus philippinus* as hosts are new for the genus *Pellonyssus*. It is significant to note that for a common species, *Pellonyssus* has not been taken at any time in the coops of domestic chicken.

Pellonyssus sp. was found in 13 crow nests, 29 weaverbird nests and five myna nests. On two occasions it was associated with *O. bursa* in crow nests and on four occasions in myna nests. It was the sole representative (except for the solitary specimen of *O. bursa* mentioned above) of Dermanyssidae in weaverbird nests. The maximum number found in any nest was approximately 10,000+ in a weaverbird nest examined on October 8, 1953. This species was comparatively more numerous than *O. bursa* wherever it occurred. All developmental stages were usually found and a good proportion of adults and protonymphs were found to have taken fresh blood meals.

Laelaptidae are characteristically parasites of mammals and their occurrence in the nests of birds calls for special comment. There was not a single specimen of this family in the nests of crows. They were found in only two weaverbird nests collected on the same day and in two

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[1] The genus *Pellonyssus* was erected in 1956 (Claude & Yunker 1956) separating it from *Steatonyssus* on the basis of differences in the shape of the female sternal plate and the male chela. *Pellonyssus* are primarily ectoparasites of birds, and *Steatonyssus* of mammals, particularly chiropterans.

[2] Proposed to be named *P. deccanus* Rao. Thanks are due to Dr. F. Da Fonseca of Instituto Butantan, Sao Paulo, Brazil, for pointing out that this is a new species.

myna nests. A few deserted weaverbird nests were collected on November 5, 1954, long after the nesting season for the bird. B. S. Lamba who collected the nests immediately noticed that one of them contained a few young mice. The nest was brought to the laboratory and when examined was found to contain inside a secondary nest of field mice. Nine live young mice with a large number of mites crawling on their bodies were taken out. The nest itself yielded about 200 mites all of most probably *Laelaps* sp. Another nest collected later in the day by one of the authors (TRR) also contained a secondary mouse nest and though there were no live mice in it, yielded about 100 laelaptid mites. The single myna nest from which nine laelaptids were collected was located in a hole in a stone bridge, and had two fledglings. In all the three cases the mites showed evidence of having taken blood meals. While in the case of weaverbird nests one may infer that the mites had fed on mice there was no evidence for a similar opinion in the case of the myna nest. But the location of the myna nests was such that mice might have normally frequented them and it may be that the laelaptid mites there had been introduced by the visiting mice. The specific identifications of the laelaptids have not yet been made. Two species seem to be present.

Among ticks only one engorged specimen of a nymph of *Haemaphysalis* sp. was found in the nest of a weaverbird and one *Argas* sp. in the nest of a crow. Several *Haemaphysalis* species have been collected on birds in and around Poona by us and therefore the finding of only one specimen in the nest is surprising. The specimen has not been well preserved and specific identification is not possible. *Argas* spp. are not quite common round about Poona though they have been occasionally collected in chicken houses. Several unsuccessful special searches for Argasidae were made in the holes and crevices and under bark of trees on which birds roost at night. The scarcity of Argasidae in the nests is therefore not unexpected.

The Phlebotominae found consisted of only four specimens, two males and two females, one each in four crow nests. All belong to the recumbent haired group of sandflies and the males have been identified as *Sergentomya punjabensis* (formerly known as *P. antennatus*). Large numbers of sandflies have sometimes been collected in the hollows and crevices of trees in and around Poona, and their occurrence in the nests may be accidental.

Culicoides spp.[1] were the sole representatives in the nests of blood sucking Diptera. Twenty-seven males and 171 females were found in

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[1] The authors are grateful to Dr. R. A. O. Smith at that time of the All India Institute of Hygiene, Calcutta, for examining representative slides and confirming the identifications of *Culicoides*. He was of the opinion that the single specimen of the fourth species found in a crow nest may be a new species. It has perfectly clear wings and is unlike the only other species with clear wings described from India, *C. albipinnes* (now known as *C. kamrupi*).

34 crow nests, 27 males and 61 females in 11 weaverbird nests and no males and three females in two myna nests. The species found were :

C. oxystoma	in 17 crow nests and two myna nests.
C. guttifer	in 16 crow nests and seven weaverbird nests.
C. flaviscutatus	in one crow nest [formerly included under *C. anophelis* because of the presence of three spermathecae. Subsequently this group has been studied and several species with three spermathecae have been discovered. Sen & Dasgupta (1959) have recorded 33 species of *Culicoides* in India].
Culicoides sp. indet.	

It is noteworthy that *C. oxystoma* did not occur in weaverbird nests at all. In crow nests *C. oxystoma* and *C. guttifer* were found together on eight occasions. Many of the females had taken fresh blood meals and though the suspicion is strong it cannot be stated that all of them had fed on the birds in the nests.

Anthocoridae formed the majority of Hemiptera collected in the nests. They are a cosmopolitan group of bugs some of which are well known to occur in bird's nests. The two forms found in the present studies were *Blaptostethes piceus* and *Cardiastethes* sp.[1] They were found in 14 crow nests, 25 weaverbird nests. All developmental stages were found and the maximum number found was 83 in a weaverbird nest. In general appearance they were bright pinkish in colour and many of them had a bright pink fluid in their abdomen. Whether it was blood or whether the colour of the fluid was merely a secondary effect of the general coloration of the body cannot be stated. The members of this family are mainly predators on mites but at least one species, the cosmopolitan *Lytocoris compestris* is definitely known to bite human beings and ' suck ' blood (Imms 1951 ; Rothschild & Clay 1952 ; and Woodroffe 1953). Therefore the *Anthocoridae* are for the present provisionally included in the blood sucking arthropods.

A solitary specimen of Anoplura was found in the nest of a myna which has not yet been identified. As sucking lice are rarely, if ever, found on birds its presence in the nest may be accidental.

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[1] The identification of the two species of *Anthocoridae* has been kindly made by Dr. W. E. China of the British Museum. He says that *Blaptostethes piceus* var *pallescens* has been recorded from Bombay and that *Cardiastethes* sp. may be a new species or a small race of the European species, the Palaearctic *C. fasciventris* (Garbl). The authors are most grateful to Dr. China for these comments.

Arthropods other than the blood sucking forms have not been studied in detail and only brief notes regarding each group will be given below.

The *non-parasitic mites* found were :—

Mesostigmata	..	Uropodina ; once in myna nest and thrice in sparrow nest. They were quite abundant on a couple of occasions.
		Fedrizzina ; once in myna nest.
		Others ; thrice in crow nests.
Trombidiformes	..	Cheyletidae ; twice in crow nests.
		Smaridiidae ; thrice in crow nests.
		Others ; five times in crow nests.
Sarcoptiformes	..	Tyroglyphidae ; once in crow nest.
		Oribatei ; five times in crow nests, thrice in myna nests and twice in sparrow nests.
Hydrachnellae	..	Once in crow nest.
Others	..	Once in weaverbird nest.

Generic identifications have not been made. Some are predators and some scavengers attracted to the nests by the other fauna. Uropodina and Oribatei were the only two groups found in any appreciable numbers.

Collembola : None was found in the weaverbird nests but some numbers commonly found in other nests. In one sparrow nest over a thousand were collected.

Thysanura : They were rare and *Lepisma* sp. was the only form.

Orthoptera : They were rare but over hundred were collected from a sparrow nest. They were almost entirely members of the Blattidae.

Dermaptera : Forficulidae were found on two occasions in crow nests and once in myna nest.

Psocoptera : They were abundantly found in crow and weaverbird nests.

Hemiptera : Apart from the *Anthocoridae* already referred to the only other family found was Pentatomidae, in 16 crow nests and six weaverbird nests.

Embioptera : They were rare having been found only twice in crow nests and in a magpie-robin nest.

Lepidoptera : Adults of Microlepidoptera were found on four occasions in crow nests. Larvae of Lepidoptera were common.

Coleoptera : They were rich both in number and variety. Both adults and larvae were frequently found. No identifications of adults have been made but among the larvae commonly found were Chrysomelidae, Dermestidae, Coccinellidae and Buprestidae.

Diptera : They were quite abundant in crow nests. The majority of the adults of Diptera other than *Culicoides* were members of Psychodidae and Chloropidae. Psychodinae occurred in 22 crow nests and two myna nests. Chloropidae ('Eyeflies') were found in 14 crow nests. Neither of these families was represented in weaverbird nests. The larvae found mainly consisted of Muscidae, Calliphoridae and a few Psychodidae.

Hymenoptera : They consisted mainly of ants.

Myriapoda : Only three centipedes and one millipede were found in sparrow nests.

Arachnids other than mites and ticks : They were comparatively rare. Pseudoscorpions occurred only in four crow nests, two myna nests and one sparow nest. Spiders were found twice in weaverbird nests and 16 times in crow nests. One crow nest had a scorpion.

Discussion

The primary objective of this study was the determination of the blood sucking arthropods associated with the common birds in their nests in and around Poona. It was established that two species of dermanyssid mites, viz. *Ornithonyssus bursa* and *Pellonyssus* sp., and two species of *Culicoides*, viz. *C. oxystoma* and *C. guttifer* are very frequently associated with the birds studied. The other blood sucking arthropods except the anthocorid bugs which are provisionally included among them, were too few to merit comment.

While both the species of mites and both the species of midges mentioned above were found in the nests of House crows and mynas, *O. bursa* and *C. oxystoma* were not found in the nests of weaverbirds. This may either be due to a real difference in the host parasite relationship or to causes connected with the environment and habits of the birds. Furthermore extensive studies would be needed to answer this question.

The occurrence of mites in the nests was expected but the frequent presence of *Culicoides* was somewhat of a surprise. They cannot be regarded as accidental visitors for they were present in 47 of the 112 nests examined. The presence of both males and females leads one to the question whether their occurrence in the nests was merely due to the facilities offered by the nest material for breeding or to a direct attraction exerted by the birds. So little is known of the biology of this group of midges in India that one hesitates to dwell on this question at any length. Mention may be made in this connection of the suspected role they play in the transmission of the virus of Blue tongue of sheep and African horse sickness both of which have occurred in India.

The anthocorid bugs were found in 39 nests. This group has received practically no attention from medical entomologists considering the fact that at least one member of the family is known to suck blood and that they are frequently found in the nests of birds. It would be worthwhile to study their habits in greater detail and explore the possibility of their being connected with the dissemination of disease producing organisms.

Notable for their complete absence in the nests studied were members of Siphonaptera (fleas), Cimicidae (' bed-bugs ') and Hippoboscidae (louseflies) all of which have been reported frequently as occurring in the nest in other countries. Fleas are apparently not common parasites of birds in and around Poona as no flea has been collected on any of a good number of wild birds examined (VRC unpublished data), though *Echidnophaga gallinacea* has sometimes been found in chicken houses.

Cimicidae are known to occur in the nests of some birds in India. Reference may be made to the interesting observation by Abdulali (1942) on the occurrence of *Cimex rotundatus* in the nests of swifts and terns in the Vengurla Rocks off the southernmost coast of Bombay State.

Hippoboscid flies were quite frequently found by the authors on the bodies of crows and mynas in and around Poona and their total absence in the nests is noteworthy. These flies have the habit of leaving the body of the host within a matter of seconds after the bird is knocked down by gun shot and very quick action was usually necessary on the part of the collector to put the knocked down bird into the collecting bag in order to secure the flies. But in the case of nests there is no possibility of such a quick escape of the flies as the nests were collected and secured in the collecting bag intact. Therefore the complete absence of hippoboscid flies in the nests would indicate that the flies do not parasitize the fledglings as readily as they do the adult birds. As no pupae of the louseflies were also found in the nests perhaps the birds become infested elsewhere.

The total absence of Mallophaga and feather mites in the nests also calls for comment. All the species of birds examined in and around Poona have been infested by Mallophaga and several families of feather mites. Sometimes the infestation is quite heavy particularly in the case of the crows. It is well known that these groups of parasites rarely leave the bodies of the hosts but one would have expected that a few of them would stay away from the birds and be found in the nest material.

An ecologist would like further to analyse the arthropod fauna of nests either quantitatively to determine the constancy of occurrence and dominance of any group and ' fidelity of association between the several groups of nidicoles ' or qualitatively to classify them as ectoparasites of birds, scavengers, predators and parasites, accidental visitors and so on. Interesting and profitable as such studies are, the data collected in the present investigation are not detailed enough for the purpose.

The studies were all made on nests collected during daytime. There is no doubt that the nests are visited by several types of arthropods at night notably by mosquitoes and sandflies. Strictly speaking they should also be included in the lists of arthropods found in the nests, but classified as visitors rather than as regular members of the fauna.

Several pools made from mites and *Culicoides* found in the nests were inoculated into mice but no pathogenic virus was isolated. Much significance need not be attached to this negative finding as it is well known that a virus isolation in nature would require an enormous amount of effort at the appropriate time. Neither *O. bursa* nor any species of *Pellonyssus* has yet been definitely incriminated anywhere as a vector of any virus disease though the former has long been suspected in view of its close association with domestic poultry. None of the pools of *Culicoides* processed have yielded any virus though their role in the epidemiology of some virus diseases (Blue tongue, African horse sickness) is known. Because of their association with birds they deserve more attention than they have received hitherto.

Mention may, however, be made here of the isolation of Sindbis virus, from a pool of *Ornithonyssus bursa* collected from domestic chicken in a place in Kanara District (formerly in Bombay State and from November 1956 in Mysore State) (Shah *et al.* 1960). The mere isolation from arthropods does not, however, confirm its status as a vector.

References

Abdulali, H. (1942) : The terns and Edible-nest swifts at Vengurla, West Coast India. *J. Bombay nat. Hist. Soc.* **43**(3) : 446-451.

Clark, G. M. & Yunker, C. E. (1956) : A new genus and species of Dermanyssidae (Acarina : Mesostigmata) from the English sparrow, with observations on its life cycle. *Proc. Helminthol. Soc. Washington* **23** : 93-101.

Fonseca, F. Da (1948) : A monograph of the genera and species of Macronyssidae Oudemans, 1930 (Synon : Liponyssidae Vitzthum, 1931). *Proc. Zool. Soc. Lond.* **118** (2) : 249-334.

Hiregaudar, L. S. & Bal, D. V. (1956) : Some ectoparasites of bats from India. *Agra Uni. J. of Res.*, (*Science*) **5**(1) : 1-134.

Imms, A. D. (1951) : A general text book of Entomology. Metheun and Co. Ltd. London.

Nordberg, S. (1936) : Biologisch-oiklogische Untersuchungen Uber die Vogelnidicolen. *Acta Zoologica Fennica*, 21, Helsingfors (In German).

ROTHSCHILD, M. & CLAY, T. (1952) : Fleas, Flukes and Cuckoos. A study of bird parasites. Collins. St. James Place, London.

SEN, P. & DAS GUPTA, S. K. (1959) : Studies on Indian *Culicoides* (Ceratopogonidae : Diptera). *Ann. Ent. Soc. Amer.* **52** : 617-630.

SHAH, K. V., JOHNSON, H. N., RAO, T. R., RAJAGOPALAN, P. K. & LAMBA, B. S. (1960) : Isolation of five strains of Sindbis virus in India. *Ind. J. Med. Res.* **48** : 300-308.

STRANDTMANN, R. W. & WHARTON, C. V. (1958) : Manual of Mesostigmatid mites. Contribution No. 4 of Institute of Acarology, College Park, USA.

WOODROFFE, C. E. (1953) : An ecological study of the insects and mites of certain birds in Britain. *Bull. Ent. Res.* **44** : 739-772.

Preliminary observations on the natural resistance of sixty-nine Species of Indian timber to Marine Borer attack at Bombay

BY

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(*With a text-figure*)

INTRODUCTION

Destruction of timber constructions in sea water by marine wood borers being well known and universal in occurrence, problems pertaining to protection of timber in marine environments have engaged the attention of scientists from very early times. It is known that certain species of timber possess a high degree of resistance to the destructive activity of wood borers, though none of them has absolute immunity to their attack. Several investigators have studied the natural durability of different kinds of timber in a bid to select the right type for marine constructions (Atwood & Johnson 1924 ; and Wangaard 1953, in America ; Gonggrijp 1932 ; Spoon & Loosjes 1946 ; Bavandamm 1948, 1949 ; and Roch 1955, in Europe ; Wilson 1941, and Johnson & Moore 1950, in Australia ; Thomas 1933, in Malaya ; Edmondson 1955, in Hawaii Islands ; Bianchi 1932 and 1934, in Indonesia ; Scott 1932, in Burma ; and Fforde 1931, in Africa). In India some of the earliest studies on this subject are those of Troup (1909), Messent P. Glynn (1920), Pearson (1932) and Howard (1948). Observations of Nair (1956) in Madras harbour and Kayamkulam backwaters (Kerala), of Nagabhushanam (1960) in Visakhapatnam harbour and of Balasubramanyam & Menon (1963) in Cochin harbour are recent contributions in this field.

The durability of timber varies considerably in different localities on account of variations in species of borers and their abundance. Salinity and temperature usually act as limiting factors on the activity and distribution of these pests and the rapid reaction of borers, especially shipworms, to even slight change in conditions, results in varying performance of a timber species in different localities. It is, therefore, necessary to study the life of the same species of timber in different regions.

The work of Nair (1956) and of Balasubramanyam & Menon (1963) include only very few species of timber and that of Nagabhushanam (1960) is confined to the east coast of India. The present paper gives a preliminary report on the resistance of sixty-nine species of Indian timber to marine borers in Bombay waters.

Material and Method

Panels of sixty-nine species of timber, studied in the present work, were received from the Forest Research Institute & Colleges, Dehra Dun. These panels, 30 cm. × 3·8 cm. × 3·8 cm. were arranged as 'ladders', each containing 10 panels, by tying them with 5 mm. diameter nylon rope threaded through holes bored at each end (Fig. 1). The distance between two adjacent panels was about 7·5 cm. Seven such 'ladders' (one of them containing 11 panels as *Bombax ceiba* Linn. and *Pinus roxburghii* Sargent have been procured from two growing areas, making the total number of panels 71) were firmly secured to a pair of long slotted iron bars. The whole set was then suspended on sufficient length of mild steel chain so that the panels were always five feet below the extreme low tide level. The frame was properly weighted so as to anchor it in position.

The test site—the Burmah-Shell Jetty at Trombay—provides typical marine conditions which are influenced only by the south-west monsoon. Intensive borer activity and heavy settlement of foulers have been noticed in this place, both marked by seasonal variations. The test panels were immersed on 15th March 1967, and were removed to the laboratory for final inspection and assessment of destruction on 16th December 1967, after a period of nine months' continuous submergence. No periodic examination of the panels was made during the course of the studies. However, the panels were taken out and scraped clean of the foulers at intervals of two months so as to allow access to borer larvae to the timber surface. This was actually found necessary because of the heavy settlement of barnacles, completely covering the panels and giving them a sort of mechanical protection from borer infestation. During final assessment in the laboratory the panels were cleaned well and the number of borer holes was carefully counted and recorded. (In cases where more than 300 borers could be counted, the number has been expressed as 'numerous'). The panels were later cut open into halves and the extent of internal destruction was roughly assessed by visual examination.

Results

The important borers encountered during the present study are *Bankia campanellata* Moll & Roch, *Lyrodus pedicellatus* Quatrefages, *Bankia rochi* Moll and *Martesia striata* Linnaeus. Of these *B. rochi*

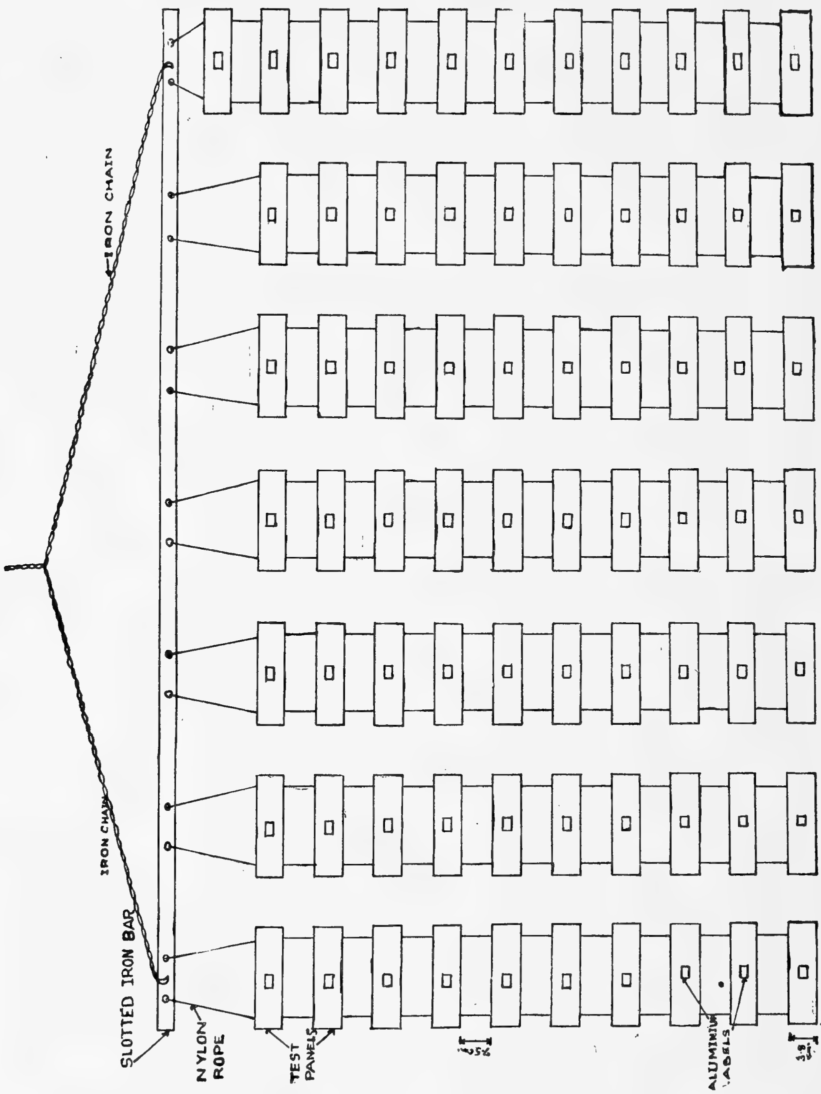

Fig. 1:- DESIGN OF THE EXPERIMENT

and *M. striata* were found to settle only in very small numbers. One specimen of *Nausitora hedleyi* Schepman was also collected from a panel of *Albizzia odoratissima* Benth.

Data on incidence of borers on different panels, the extent of damage caused to them expressed in percentage, localities from where the panels were procured and the common names of timber species are given in Table 1. The table shows that while none of the sixty-nine species escaped attack of borers, 21 species suffered destruction below 20%, 11 of them between 21 to 50% and the remaining 27 species over 50% destruction. Family-wise distribution of resistant species of timber is given in Table 2.

Discussion and Summary

1. Observations on natural durability of sixty-nine species of Indian timber, belonging to 30 families are included in this report. Even though the duration of observation may be insufficient for a definite evaluation of the life of many species, the studies enable elimination of non-resistant varieties and screening out promising ones, worthy of consideration for further studies. A scrutiny of Table 2 reveals that *Moraceae* and *Leguminosae* contain some species which are highly resistant to borer attack.

2. The durability of any untreated panel is very much influenced by the time of the year at which it is exposed to borer-attack. In other words, it depends upon seasonal variations in the intensity of borers available to carry out destruction. Earlier studies have revealed that in the present locality the peak settlement of borers and the consequent destruction of a panel are maximum during July-August and a panel of *Mangifera indica* Linnaeus, immersed during this short period alone, suffered 58% destruction (Santhakumaran, unpublished). Hence it is justifiable to believe that, although the duration of the experiment was nine months starting from March, the non-durable species might have suffered heavy destruction even within a much earlier period, that is to say, months before the study was terminated in December. Moreover, the highly vulnerable species had only few, small, live specimens in the burrows showing that the early settlers had already perished when the timber was exhausted due to overcrowding.

3. A scrutiny of the data, given in Table 1, indicates that there is no definite correlation between the number of borer holes and the internal damage caused to the timber panels. For example, although the species of *Artocarpus lakoocha* Roxb. (272 borers), *Hopea parviflora* Bedd. (numerous) and *Lannea coromandelica* (Houtt.) Merr. (= *Odina wodier* Roxb., numerous) have harboured large number of borers, the destruction of timber is only about 2%, 5%, and 18% respectively. On

TABLE 1

PARTICULARS OF TIMBER SPECIES AND EXTENT OF DESTRUCTION CAUSED BY BORERS IN PRELIMINARY TRIALS AT BOMBAY

No.	Timber species	Family	Trade name	State from which procured	Borer entry holes on panels		Extent of damage %	Rem
					Ship worms	*Martesia*		
1.	*Madhuca indica* (Gmel.) (=*Bassia latifolia* Roxb.)	Sapotaceae	Mahua	Orissa	151	3	1·0	Many pits
2.	*Terminalia paniculata* Roth.	Combretaceae	Kindal	Tamil Nadu	83	2	1·0	
3.	*Artocarpus lakoocha* Roxb.	Moraceae	Lakooch or Barhal	West Bengal	272	3	2·0	Pits only
4.	*Artocarpus heterophyllus* Lamk. (=*Artocarpus integrifolia* L.f.)	-do-	Kathal	Tamil Nadu	160	1	2·0	Pits only
5.	*Kingiodendron pinnatum* (Roxb.) Harms. (=*Hardwickia binata* Roxb.)	Leguminosae	Piney	-do-	72	5	2·0	
6.	*Pterocarpus marsupium* Roxb.	-do-	Bijasal	-do-	145	1	2·0	Pits only
7.	*Xylia xylocarpa* Taub.	-do-	Irul	-do-	98	Nil	2·0	
8.	*Steriospermum chelonoides* DC.	Bignoniaceae	Padri	West Bengal	85	2	4·0	
9.	*Hopea parviflora* Bedd.	Dipterocarpaceae	Hopea	Coorg	Numerous	Nil	5·0	Pits only
10.	*Borassus flabellifer* Linn.	Palmae	Palmyra Palm or Tari	Bihar	103	2	7·0	
11.	*Lagerstroemia parviflora* Roxb.	Lythraceae	Lendi	Orissa	152	4	8·0	Pits only
12.	*Pterocarpus dalbergioides* Roxb.	Leguminosae	Padauk	Andaman	190	10	8·0	
13.	*Tectona grandis* Linn. f.	Verbenaceae	Teak	Tamil Nadu	181	6	11·0	Superficial small tunnels
14.	*Holoptelea integrifolia* Planch.	Ulmaceae	Kanju	Bihar	203	7	11·0	Many pits

15.	*Dalbergia latifolia* Roxb.	Leguminosae	Rosewood	Bombay	115	8	12·0	
16.	*Calophyllum elatum* Bedd. (=*Calophyllum tomentosum* Wt.)	Guttiferae	Poon	Tamil Nadu	79	6	13·0	
17.	*Artocarpus* sp.	Moraceae		-do-	103	7	13·0	
18.	*Schleichera oleosa* Oken. (=*Schleichera trijuga* Willd.)	Sapindaceae	Kusum	Uttar Pradesh	96	3	15·0	
19.	*Lannea coromandelica* (Houtt.) Merr. (=*Odina wodier* Roxb.)	Anacardiaceae	Jhingan	Bombay	Numerous	Nil	18·0	Tunnels at right angle to the grain
20.	*Eucalyptus* sp.	Myrtaceae		Uttar Pradesh	173	5	18·0	
21.	*Tetrameles nudiflora* R. Br.	Datiscaceae	Maina	Andaman	163	9	20·0	One of the ends of the panel worn out due to abrasion
22.	*Aphanamixis polystachya* (Wall.) Parker (=*Amoora rohituka* W. & A.)	Meliaceae	Pitraj	Tripura	254	1	22·0	
23.	*Amoora wallichi* King	-do-	Amari	West Bengal	53	3	23·0	One huge tunnel
24.	*Dipterocarpus* sp.	Dipterocarpaceae		Mysore	183	5	27·0	One end severely damaged
25.	*Terminalia chebula* Retz.	Combretaceae	Myrabolan or Hararh	West Bengal	Numerous	2	30·0	Numerous small pits
26.	*Hopea* sp.	Dipterocarpaceae		Tamil Nadu	87	2	31·0	
27.	*Artocarpus hirsuta* Lamk.	Moraceae	Aini	Coorg	171	4	33·0	
28.	*Bridelia retusa* Spreng.	Euphorbiaceae	Kasi	Uttar Pradesh	265	2	37·0	
29.	*Terminalia arjuna* (Roxb.) W. & A.	Combretaceae	Arjun	Bihar	102	1	42·0	
30.	*Dipterocarpus turbinatus* Gaertn. f.	Dipterocarpaceae	Teli Gurjan	Manipur	195	1	44·0	Ends severely damaged
31.	*Lagerstroemia lanceolata* Wall.	Lythraceae	Benteak	Bombay	226	5	48·0	
32.	*Dalbergia sissoo* Roxb.	Leguminosae	Shisham	Punjab	266	6	49·0	
33.	*Anogeissus latifolia* Roxb.	Combretaceae	Axlewood	Tamil Nadu	Numerous	3	56·0	
34.	*Mesua ferrea* Linn.	Guttiferae	Masua or Ironwood	Mysore	-do-	2	57·0	

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1.	*Madhuca indica* (Gmel.) (=*Bassia latifolia* Roxb.)	Sapotaceae	Mahua	Orissa	151	3	1·0	Many pits
2.	*Terminalia paniculata* Roth.	Combretaceae	Kindal	Tamil Nadu	83	2	1·0	
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4.	*Artocarpus heterophyllus* Lamk. (=*Artocarpus integrifolia* L.f.)	-do-	Kathal	Tamil Nadu	160	1	2·0	Pits only
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6.	*Pterocarpus marsupium* Roxb.	-do-	Bijasal	-do-	145	1	2·0	Pits only
7.	*Xylia xylocarpa* Taub.	-do-	Irul	-do-	98	Nil	2·0	
8.	*Steriospermum chelonoides* DC.	Bignoniaceae	Padri	West Bengal	85	2	4·0	
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15.	*Dalbergia latifolia* Roxb.	Leguminosae	Rosewood	Bombay	115	8	12·0	
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19.	*Lannea coromandelica* (Houtt.) Merr. (=*Odina wodier* Roxb.)	Anacardiaceae	Jhingan	Bombay	Numerous	Nil	18·0	Tunnels at right angle to the grain
20.	*Eucalyptus* sp.	Myrtaceae		Uttar Pradesh	173	5	18·0	
21.	*Tetrameles nudiflora* R. Br.	Datiscaceae	Maina	Andaman	163	9	20·0	One of the ends of the panel worn out due to abrasion
22.	*Aphanamixis polystachya* (Wall.) Parker (=*Amoora rohituka* W. & A.)	Meliaceae	Pitraj	Tripura	254	1	22·0	
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24.	*Dipterocarpus* sp.	Dipterocarpaceae		Mysore	183	5	27·0	One end severely damaged
25.	*Terminalia chebula* Retz.	Combretaceae	Myrabolan or Hararh	West Bengal	Numerous	2	30·0	Numerous small pits
26.	*Hopea* sp.	Dipterocarpaceae		Tamil Nadu	87	2	31·0	
27.	*Artocarpus hirsuta* Lamk.	Moraceae	Aini	Coorg	171	4	33·0	
28.	*Bridelia retusa* Spreng.	Euphorbiaceae	Kasi	Uttar Pradesh	265	2	37·0	
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30.	*Dipterocarpus turbinatus* Gaertn. f.	Dipterocarpaceae	Teli Gurjan	Manipur	195	1	44·0	Ends severely damaged
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34.	*Mesua ferrea* Linn.	Guttiferae	Masua or Ironwood	Mysore	-do-	2	57·0	

No.	Timber species	Family	Trade name	State from which procured	Borer entry holes on panels		Extent of damage %	Remarks
					Ship worms	*Martesia*		
35.	*Terminalia alata* Heyne ex Roth. var. *nepalensis* (Haines) Fernandez (=*Terminalia tomentosa* W. & A.)	Combretaceae	Laurel	Vindhya Pradesh	Numerous	1	58.0	
36.	*Gmelina arborea* Linn.	Verbenaceae	Gamari	Bombay	-do-	4	58·0	
37.	*Careya arborea* Roxb.	Myrtaceae	Kumbhi	Tripura	-do-	Nil	58·0	
38.	*Diospyros melanoxylon* Roxb.	Ebenaceae	Ebony	Bombay	-do-	1	60·0	Three huge tunnels
39.	*Dillenia indica* Linn.	Dilleniaceae	Dillenia or Chalta	Assam	-do-	6	60·0	
40.	*Bombax ceiba* Linn. (=*Bombax malabaricum* DC.)	Bombacaceae	Semul	Dehra Dun	227	5	65·0	80% destruction in a panel from Kutch
41.	*Albizzia* sp.	Leguminosae		Madhya Pradesh	115	2	67·0	Twelve large tunnels
42.	*Albizzia odoratissima* Benth.	-do-	Kalasiris	Uttar Pradesh	89	3	68·0	Five huge tunnels
43.	*Michelia champaca* Linn.	Magnoliaceae	Champ	West Bengal	Numerous	1	68·0	
44.	*Michelia doltsopa* Bush. Ham. ex DC. (=*Michelia excelsa* Blume)	-do-	Champ	-do-	220	2	68·0	
45.	*Syzygium cumini* (L.) Skeels (=*Eugenia jambolana* Lam.)	Myrtaceae	Jamun	Madhya Pradesh	Numerous	3	70·0	
46.	*Dysoxylum malabaricum* Bedd.	Meliaceae	White cedar	Tamil Nadu	Numerous	4	70·0	
47.	*Cynometra polyandra* Roxb.	Leguminosae	Ping	Assam	194	8	70·0	
48.	*Castanopsis hystrix* A.DC.	Cupuliferae	Hingori	-do-	187	3	72·0	
49.	*Shorea robusta* Gaertn. f.	Dipterocarpaceae	Sal	Vindhya Pradesh	260	3	72·0	
50.	*Casuarina equisetifolia* Forst.	Casuarinaceae	Casuarina	Bombay	Numerous	2	75·0	

51. *Chukrasia velutina* Wt. & Arn. (=*Chukrasia tabularis* A. Juss.)	Meliaceae	Chickrassy	Mysore	Numerous	3	75·0	
52. *Cryptomeria japonica* D.Don	Taxodiaceae	Suji	West Bengal	-do-	Nil	75·0	
53. *Palaquium ellipticum* (Dalz.) Engler. (=*Dichopsis elliptica* Bth.)	Sapotaceae	Pali	Mysore	-do-	5	78·0	
54. *Grewia tilaefolia* Vahl	Tiliaceae	Dhaman	Tamil Nadu	290	4	80·0	
55. *Zanthoxylum limonella* (Dennst.) Alston.	Rutaceae	Mullilam	Kerala	Numerous	Nil	80·0	
56. *Soymida febrifuga* A. Juss.	Meliaceae	Rohini	Bombay	239	4	80·0	
57. *Mimusops* sp.	Sapotaceae		Andaman	Numerous	5	80·0	
58. *Ougeinia oojeinensis* (Roxb.) Hochreut (=*Ougeinia dalbergioides* Benth.)	Leguminosae	Sandan	Uttar Pradesh	-do-	1	80·0	
59. *Albizzia chinensis* (Osbeck) Merr. (=*Albizzia stipulata* Boiv.)	-do-	Siris	Andhra Pradesh	-do-	Nil	80·0	Seven huge tunnels
60. *Mangifera indica* Linn.	Anacardiaceae	Mango	Assam	-do-	4	85·0	
61. *Pinus roxburghii* Sargent (=*Pinus longifolia* Roxb.)	Coniferae	Chir	Kashmir	Numerous	4	85·0	95% destruction in a panel from Dehra Dun
62. *Exbucklandia populnea* (R. Br. ex Griffith) R.W. Brown (=*Bucklandia populnea* R.Br.)	Hamamelideae	Pipli	West Bengal	-do-	1	90·0	
63. *Cedrus deodara* (Roxb. ex Lambert) G. Don	Coniferae	Deodar	Kashmir	-do-	Nil	90·0	
64. *Machilus macrantha* Nees	Lauraceae	Machilus	Kerala	-do-	1	92·0	
65. *Polyalthia fragrans* (Dalz.) Bedd.	Anonaceae	Gauri	Coorg	-do-	3	92·0	
66. *Picea smithiana* (Wall.) Boiss (=*Picea morinda* Link).	Coniferae	Spruce	Himachal Pradesh	-do-	6	94·0	
67. *Vateria indica* Linn.	Dipterocarpaceae	Vellapine	Kerala	-do-	Nil	95·0	
68. *Sonneratia apetala* Ham.	Lythraceae	Keora	West Bengal	-do-	Nil	96·0	
69. *Salmalia insignis* (Wall.) Schott & Endl. (=*Bombax insigne* Wall.)	Bombacaceae	Semul	Andaman	-do-	2	97·0	

The species are arranged in the order of decreasing resistance to borers.

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47.	*Cynometra polyandra* Roxb.	Leguminosae	Ping	Assam	194	8	70·0	
48.	*Castanopsis hystrix* A.DC.	Cupuliferae	Hingori	-do-	187	3	72·0	
49.	*Shorea robusta* Gaertn. f.	Dipterocarpaceae	Sal	Vindhya Pradesh	260	3	72·0	
50.	*Casuarina equisetifolia* Forst.	Casuarinaceae	Casuarina	Bombay	Numerous	2	75·0	
51.	*Chukrasia velutina* Wt. & Arn. (=*Chukrasia tabularis* A. Juss.)	Meliaceae	Chickrassy	Mysore	Numerous	3	75·0	
52.	*Cryptomeria japonica* D.Don	Taxodiaceae	Suji	West Bengal	-do-	Nil	75 0	
53.	*Palaquium ellipticum* (Dalz.) Engler. (=*Dichopsis elliptica* Bth.)	Sapotaceae	Pali	Mysore	-do-	5	78·0	
54.	*Grewia tilaefolia* Vahl	Tiliaceae	Dhaman	Tamil Nadu	290	4	80·0	
55.	*Zanthoxylum limonella* (Dennst.) Alston.	Rutaceae	Mullilam	Kerala	Numerous	Nil	80·0	
56.	*Soymida febrifuga* A. Juss.	Meliaceae	Rohini	Bombay	239	4	80·0	
57.	*Mimusops* sp.	Sapotaceae		Andaman	Numerous	5	80·0	
58.	*Ougeinia oojeinensis* (Roxb.) Hochreut (=*Ougeinia dalbergioides* Benth.)	Leguminosae	Sandan	Uttar Pradesh	-do-	1	80·0	
59.	*Albizzia chinensis* (Osbeck) Merr. (=*Albizzia stipulata* Boiv.)	-do-	Siris	Andhra Pradesh	-do-	Nil	80·0	Seven huge tunnels
60.	*Mangifera indica* Linn.	Anacardiaceae	Mango	Assam	-do-	4	85·0	
61.	*Pinus roxburghii* Sargent (=*Pinus longifolia* Roxb.)	Coniferae	Chir	Kashmir	Numerous	4	85·0	95% destruction in a panel from Dehra Dun
62.	*Exbucklandia populnea* (R. Br. ex Griffith) R.W. Brown (=*Bucklandia populnea* R.Br.)	Hamamelideae	Pipli	West Bengal	-do-	1	90·0	
63.	*Cedrus deodara* (Roxb. ex Lambert) G. Don	Coniferae	Deodar	Kashmir	-do-	Nil	90·0	
64.	*Machilus macrantha* Nees	Lauraceae	Machilus	Kerala	-do-	1	92·0	
65.	*Polyalthia fragrans* (Dalz.) Bedd.	Anonaceae	Gauri	Coorg	-do-	3	92·0	
66.	*Picea smithiana* (Wall.) Boiss (=*Picea morinda* Link).	Coniferae	Spruce	Himachal Pradesh	-do-	6	94·0	
67.	*Vateria indica* Linn.	Dipterocarpaceae	Vellapine	Kerala	-do-	Nil	95·0	
68.	*Sonneratia apetala* Ham.	Lythraceae	Keora	West Bengal	-do-	Nil	96·0	
69.	*Salmalia insignis* (Wall.) Schott & Endl. (=*Bombax insigne* Wall.)	Bombacaceae	Semul	Andaman	-do-	2	97·0	

The species are arranged in the order of decreasing resistance to borers.

the other hand, species like *Albizzia odoratissima* Benth, *Castanopsis hystrix* A.DC., *Cynometra polyandra* Roxb. and *Albizzia* spp. have less than 200 borers, whereas their damage was found to be 68%, 72%, 70% and 67% respectively. In the case of *A. odoratissima*, 92 borers accomplished 68% destruction. The larvae of shipworms show no special attraction to any timber and their settlement on a timber substratum is only accidental and influenced by the fouling accumulation. Hence it is possible that a test panel receives a large number of larvae, but the number of successful borers and their depth of penetration depend on the natural durability of that particular species of timber. In many cases, like *Terminalia chebula* Retz. and *Tectona grandis* Linn. f. only a few superficial tunnels were noticed and the holes were mere pits indicating unsuccessful penetration resulting in low percentage destruction compared to the number of entry holes. The number of borer holes as a criterion for grouping the results has been used by many workers (Purushotham & Santhakumaran 1962), but such expressions do not offer any satisfactory means for comparative studies. Splitting open the panel and assessing the internal damage by visual examination are essential for this purpose. If continuation of the test is needed, X-ray photography can be used.

4. The incidence of *M. striata* appears somewhat higher on panels comparatively unmolested by shipworms (Table 3). In most of the resistant panels, the destruction is mainly caused by large specimens of *M. striata* and the shipworms are present either as numerous pits or as a few superficial tunnels. Similar behaviour has been noticed by Edmondson (1955). Moore (1947) noted that no timber is naturally resistant to *Martesia* attack, although it may resist teredinids and crustacean borers. Spoon *et al.* (1946) also state that *Martesia* is capable of attacking hard woods.

5. Of the twenty-one species which were found to possess some degree of resistance to borer attack, many like *Kingiodendron pinnatum* (Roxb.) Harms. (=*Hardwickia binata* Roxb.), *Steriospermum chelonoides* DC., *Borassus flabellifer* Linn., *Schleichera oleosa* Oken. (=*S. trijuga* Willd.), *Artocarpus lakoocha* Roxb. and *Holoptelea integrifolia* Planch. are not presently used in marine constructions (Appendix 4, *Journal of the Timber Dryers' and Preservers' Association of India*, 7(2), 1961). It may be mentioned in this connection that *K. pinnatum* (=*Hardwickia binata* Roxb.) is sometimes used as a substitute for teak, in planking for cargo barges built at Kakinada (Paul B. Zeiner & Kjeld Rasmussen 1958). It, however, cracks when cut into thin planks and in spite of its durability, this might restrict its use in fishing vessels. Timber species most commonly used at present for marine construction generally belong to the largely non-resistant varieties. The present studies indicate the possibility of substituting these non-durable species with better timber

in constructional work. Troup (1909), while discussing the resistance of Indian timber, has mentioned that *A. lakoocha* and *Madhuca indica* (Gmel.) (=*Bassia latifolia* Roxb.) are borer resistant. The present

TABLE 2

FAMILYWISE DISTRIBUTION OF RESISTANT SPECIES OF TIMBER

No.	Family	Species	Percentage destruction
1.	Anacardiaceae	*Lannea coromandelica* (Houtt.) Merr. (=*Odina wodier* Roxb.)	18·0
2.	Bignoniaceae	*Steriospermum chelonoides* DC.	4·0
3.	Combretaceae	*Terminalia paniculata* Roth.	1·0
4.	Datiscaceae	*Tetrameles nudiflora* R.Br.	20·0
5.	Dipterocarpaceae	*Hopea parviflora* Bedd.	5·0
6.	Guttiferae	*Calophyllum elatum* Bedd. (=*Calophyllum tomentosum* Wt.)	13·0
7.	Leguminosae	*Dalbergia latifolia* Roxb.	12·0
		Kingiodendron pinnatum (Roxb.) Harms. (=*Hardwickia binata* Roxb.)	2·0
		Pterocarpus dalbergioides Roxb.	8·0
		Pterocarpus marsupium Roxb.	2·0
		Xylia xylocarpa Taub.	2·0
8.	Lythraceae	*Lagerstroemia parviflora* Roxb.	8·0
9.	Moraceae	*Artocarpus heterophyllus* Lamk. (=*Artocarpus integrifolia* L.f.)	2·0
		Artocarpus lakoocha Roxb.	2·0
		Artocarpus sp.	13·0
10.	Myrtaceae	*Eucalyptus* sp.	18·0
11.	Palmae	*Borassus flabellifer* Linn.	7·0
12.	Sapindaceae	*Schleichera oleosa* Oken. (=*Schleichera trijuga* Willd.)	15·0
13.	Sapotaceae	*Madhuca indica* (Gmel.) (=*Bassia latifolia* Roxb.)	1·0
14.	Ulmaceae	*Holoptelea integrifolia* Planch.	11·0
15.	Verbenaceae	*Tectona grandis* Linn. f.	11·0

TABLE 3

INCIDENCE OF *Martesia* ON DIFFERENT SPECIES OF TIMBER

Range of destruction	Number of timber species	Number of *Martesia*		
		Range	Total number	Average
0 to 20%	21	nil to 10	84	4·00
21 to 50%	11	1 to 6	32	2·91
51 to 75%	20	nil to 88	56	2·80
76 to 100%	17	nil to 6	40	2·35

results support this statement. Pearson (1932), has listed, *Shorea robusta* Gaertn. f., *Terminalia alata nepalensis* (Haines) Fernandez

(=*T. tomentosa* W. & A.), *Tectona grandis* Linn. f., *Steriospermum* spp. as suitable for harbour work. However, the first two species have shown no borer resistance in the present study.

6. A comparison of the results given in this report with that of Nagabhushanam (1960) shows that most of the timber found resistant in Bombay, are badly damaged in Visakhapatnam harbour, probably due to increased activity of *Martesia* (in Trombay this borer is never found to settle in large numbers). This is again in accordance with the observations of Spoon *et al.* (1946) and Moore (1947).

7. Balasubramanyam & Menon (1963), found the performance of *Terminalia alata nepalensis* (=*T. tomentosa*) much better than *Artocarpus hirsuta* Lamk., in Cochin waters. In this study, it was noticed that while the former had reached a destruction of 58%, the latter showed only 33% damage. The destruction suffered by the various species tested at Cochin was far less than the corresponding values obtained at Bombay, even though the duration of immersion in Bombay was only 9 months and that in Cochin was about 15 months.

8. Seven species reported in this paper, namely *Mangifera indica* Linn., *Casuarina equisetifolia* Forst., *Cryptomeria japonica* D. Don, *Bombax ceiba* Linn., *Syzygium cumini* (L.) Skeels [=*Eugenia jambolana* Lam., *E. cumini* (L.)], *Tectona grandis* Linn. f. and *Artocarpus heterophyllus* Lamk. (=*A. integrifolia* L.f.), have been studied in Hawaiian waters (Edmondson 1955) with almost identical results. The first five species are quickly damaged by marine borers in both the localities. Panels of *M. indica* were badly damaged in Kayamkulam within 3 months (Nair 1956). As for *T. grandis* the period of destruction in Hawaii ranged from 3 months to 3 years, whereas in Bombay it suffered only 11% damage in 9 months. However, as mentioned by Edmondson (1955), there is always too much inconsistencies in the performance of teak samples. Kuriyan (1952) has found teak absolutely free from any attack during 365 days of continuous immersion at Krusadai, whereas Nair (1956) noticed light attack in 6 months at Kayamkulam (Kerala). *A. heterophyllus* was badly damaged by *Teredo* and *Limnoria* within five months at Hawaii. In the present study it has undergone only 2% destruction. It may be due to variation in the repellant factors. However, more study is required to substantiate the present result.

9. Opinions differ as to the exact phenomenon that can be accounted for the natural durability of wood in marine conditions. Many of the foreign timber, which were accredited with great natural durability, have been found to possess certain poisonous chemicals Moll (1948), while discussing the factors responsible for the resistance of wood against borers, attributes it to the presence of 'beberine' in Green-heart [*Ocotea rodiaei* (R. Schomb.) Mez.], turpentine oil in Turpentine (*Syncarpea laurifolia* Ten.) tannins in Oak (*Quercus* spp.) and resins

in some pine wood. He also correlates the density and hardness of wood to their resistance. However, according to Gonggrijp (1932), Amos & Dadswell (1948), and Edmondson (1955), the silica content of the wood play an important role in their borer resistance. But the inconsistent behaviour of timber samples having different quantities of silica content tends to make it apparent that silica content is of little effect and the poisonous inclusions separately or combined with density and hardness of wood may be the important factors.

Further studies on natural durability, with particular reference to species of the more resistant families, are in progress.

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REFERENCES

AMOS, G. L. & DADSWELL, H. E. (1948) : Siliceous inclusions in wood in relation to marine borer resistance. *Jour.Counc.Scient.Indust.Res.(Australia)* **21**(3) : 190-196.

ATWOOD, W. G. & JOHNSON, A. A. (1924) : Marine structures and their deterioration. Rept. Comm. Marine Piling Invest., Nat. Research Council, Washington.

BALASUBRAMANYAM, R. & MENON, T.R. (1963) : Destruction of boat building timbers by marine organisms in the Port of Cochin, Part I—Raft tests. *J. Mar. biol. Assoc. India* **5**(2) : 294-309.

BAVENDAMM, W. (1948) : Die naturliche Dauerhaftigkeit des Holzes. *Holz-Zentralbl. (Stuttgart)* **74**(32) : 263-264.

——— (1949) : Tests on the natural resistance of wood, particularly of tropical wood, to fungi, termites and marine borers. Commonwealth Scientific and Industrial Research Organisation, Division of Forest Products, Australia-1.

BIANCHI, A. T. J. (1932) : Nadere gegevens omtrent de aantasting van Nederlandisch-Indische houtsoorten door paalworm en andare in zee -en brakwater levende dieren. *Mededeelingen van het Boschbouwproefstation (Batavia)* **25** : 101-147.

——— (1934) : The resistance of some Netherlands East Indian timbers against the attack of shipworms (*Teredo*). *Fifth Pacific Sci. Congress (Canada*, 1933), *Proc.* **5** : 3903-3906.

EDMONDSON, C. H. (1955) : Resistance of woods to marine borers in Hawaiian waters. *Bull. Bernice P. Bishop Museum* **217** : 1-91.

FFORDE, F. C. (1931) : Sea water tests of timbers of Kenya Colony. *Rep. Comm. (Deter. Structures). Inst. Civil Engin. (London)* **12** : 14-16.

Gonggrijp, J. W. (1932): Gegevens betreffende een onderzoek naar Nederandsch-Indische houtsoorten, welke tegen den paalworm bestand zijn, *Mededeelingen van het Boschbouwproefstation*, **25** : 1-99.

Howard, A. L. (1948) : A manual of the timbers of the world : their characteristics and uses. IIIrd ed., (London).

Iredale, T., Johnson, R. A. & McNeill, F. A. (1932) : Destruction of timber by marine organisms in the port of Sydney. *Rep. Maritime Service Board of New South Wales :* 1-148.

Johnson, R. A. & Moore, D. D. (1950) : The natural resistance of timber to marine borer attack : Western Australia timbers. *Port of Sydney Jour.* **3**(2) : 55-57.

Kuriyan, G. K. (1952) : Notes on the attachment of marine sedentary organisms on different surfaces. *J. Zool. Soc. India* **4** : 157-171.

Messent, P. G. (1920) : *Bombay Rep. Comm. (Deter. Structures) Inst. Civil Engin., (London)* **1** : 214-219.

Moll, F. (1948) : Naturliche dauerhaftigkeit des Holzes. *Holz-zentralbl* (Stuttgart), **74**(21) : 163.

Moore, D. D. (1947) : Destruction of timber by marine borers. *Martesia striata. Port of Sydney Jour.* **1**(3) : 74-75.

Nagabhushanam, R. (1960) : Resistance of Indian timbers to attack by marine borers. *Journal of the Timber Dryers' and Preservers' Association of India* **6**(1) : 1.

Nair, N. B. (1956) : Resistance of certain untreated Indian timbers to marine borer attack. *Jour. Sci. Industr. Res.* **15**C(12) : 282.

Pearson, R. S. & Brown, H. P. (1932) : Commercial timbers of India. *Govt. of India, Central Publication Branch, Calcutta.*

Purushotham A. & Santhakumaran, L. N. (1962) : Table giving details of replies received from various organisations regarding panel tests on timber species in sea waters. *Journal of the Timber Dryers' and Preservers' Association of India* **8**(3) : 12-31.

Roch, F. (1955) : Die Terediniden Ost-und Westindiens der Hollandischen Museum—Sammlungen zu Amsterdam und Leiden. *Zool. Mededeelingen* **34**(8) : 125.

Scott, C. W. (1932) : Tests in the Rangoon river on the damage by marine borers to various woods, including Burma Teak and British Guiana Greenheart, creosoted and untreated. *Burma Forest Bull.* **28** : 1-10.

Spoon, W. & Loosjes, F. R. (1946) : Onderzoek naar de duurzaamheid tegen paalworm van eenige tropische houtsoorten. *Overgedrukt uit het weekblad 'De Ingenieur'* **32** : 1-8.

Thomas, A. V. (1933) : Tests on the resistance to marine borer attack of some Malayan timbers untreated and treated with preservatives. *Malayan Forester* **2**(4) : 179-182.

Troup, R. S. (1909) : Indian woods and their uses, *Indian Forest Mem. Econ. Products, Calcutta Ser.* **1**(1) : II+CCXVIII.

Wangaard, F. F. (1953) : Tropical American woods for durable waterfront structures, report of marine borer conference (1952), sponsored by the William Clapp Laboratory and the Marine Laboratory, University of Miami, Section T : 1-25.

Wilson, H. B. (1941) : Resistance of Australian timbers to attack by marine borers. *Jour. Counc. Scient. Indust. Res. (Australia)* **14**(4) : 263-265.

Ziener, Paul, B. & Rasmussen, Kjeld. (1958) : Report No. 1 to the Government of India on fishing boats. *FAO Report No.* 945.

Studies on bottom-living diatoms of a freshwater fish pond

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(*With three plates*)

INTRODUCTION

Bottom-flora of ponds, dominated mainly by diatoms, have a direct bearing on the production of bottom feeding fishes, since they form the food of these fishes directly, or indirectly through zooplankters which feed on the algae. They also serve as indicators of the soil and water conditions at the bottom of the water body. Very little work has been done on the soil diatoms of India and, in particular, of fish ponds. Much work pertaining to the bottom living algae and their distribution in relation to physico-chemical conditions has been done by Round (1953, 1955, 1957, 1960). A preliminary taxonomic study of the soil diatom flora of Kolhapur was made by Gandhi (1956). In view of the scanty information available on the soil diatom flora of ponds in India, an attempt has been made to study the diatom flora of a fish pond with special reference to their taxonomy and seasonal fluctuation in relation to certain chemical factors of bottom soil and water. The data obtained are presented here.

MATERIALS AND METHODS

The samples for the present investigation were collected at monthly intervals from April 1966 to March 1967 from the Barang fish farm. Barang (20° 20′ N. 85° 50′ E.) is situated at a distance of 12 km. from Cuttack in Orissa State. To collect the bottom soil and water an Ekman dredge and a locally made water sampler of one litre capacity respectively were used. To provide the medium for the growth of bottom algae sufficient quantity of water and soil were collected. Pond water was filtered twice with Whatman filter paper No. 44 to make it free from living organisms as far as possible and also to supply the dissolved mineral nutrients required for the growth of soil algae. Different experimental

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jars were set up with double filtered pond water and soil to assess the diatom population. In these jars, a set of four slides fitted in cork were inserted in such a way that the free ends of the slides touched the soil at the bottom of the jars.

The qualitative and quantitative estimation was made following the method suggested by Sladeckova (1962) by examining the diatoms which appeared in area of 24×50 mm. on each slide and also by counting the diatom remains obtained by cleaning and boiling a sample of the soil used in the experimental jars in a mixture of sulphuric acid and nitric acid. After washing, the diatom remains were mounted in styrax on slides and all the species in each sample were recorded. For observations on seasonal fluctuations average counts from three sets were taken. The arbitrary terms like abundant, common, present, rare and absent were used to denote the percentage of organisms recorded ranging from 76 to 100 ; 51 to 75 ; 26 to 50 ; 1 to 25 and zero respectively.

In all, 10 genera representing 25 species of diatoms and their seasonal fluctuations in relation to certain chemical features of water and soil are described. The water samples were analysed for pH, phosphate, silica and nitrates following the methods given in ' Standard methods for the examination of the water and waste water ' A.P.H.A. (1965), and the soil according to the methods given by Piper (1950). The classification as given by Hustedt (1930) has been followed.

Systematic List

1. **Synedra affinis** Kütz.

   F. Hustedt in A. Pascher's *Die Süsswasserfl. Mitteleuropas* 10 : 159-160, f. 184, 1930. (Text-fig. 1)

   Length—110 μ ; breadth—4-5 μ ; striations—12-13 in 10 μ.

2. **S. ulna** (Nitz.) Ehr. var. **subaequalis** Grun.

   Van Heurck, *Syn. Dist.* t. 38, f. 8, 11, 12, 13, 2 ; t. 39, f. IB, 1881. (Text-fig. 2)

   Length—113-116 μ ; breadth—4-5 μ ; striations—12-14 in 10 μ.

3. **Eunotia pseudolunaris** Venkt. in *Proc. Indian Acad. Sci.* (B), 10 : 311, f. 53, 61, 1939. (Text-fig. 3)

   Length—129-199 μ ; breadth—4-5 μ ; striations—15-18 in 10 μ.

4. **E. valida** Hust. in A. Pascher's *Die Süsswasserfl, Mitteleuropas* 10 : 178, f. 229, 1930. (Text-figs. 4, 5, 6)

   Length—35-64 μ ; breadth—3-6 μ ; striations—12-16 in 10 μ.

5. **E. pectinalis** (Kütz.) Rabh. var. **ventralis** (Ehr.) Hust. ibidem 10 : 182, f. 241, 1930. (Text-fig. 7)
Length—36-40 μ ; breadth—9-10 μ ; striations—11-12 in 10 μ.

6. **E. sudetica** O. Müll. var. **bidens** Hust. ibidem 10 : 182, f. 243, 1930. (Text-fig. 8)
Length—40-48 μ ; breadth—6-9 μ ; striations—12-13 in 10 μ.

7. **Neidium affine** (Ehr.) Cleve var. **longiceps** (Greg.) Cleve F. Hustedt, ibidem 10 : 244, f. 318, 1930. (Text-fig. 9)
Length—30-45 μ ; breadth—7-8 μ ; striations—22-24 in 10 μ and clearly punctate.

8. **Gomphonema sphaerophorum** Ehr.
F. Hustedt, ibidem 10 : 372, f. 695, 1930. (Text-fig. 10)
Length—38-58 μ ; breadth—8-10 μ ; striations 13-14 in 10 μ.

9. **G. gracile** Ehr.
F. Hustedt, ibidem 10 : 376, f. 702, 1930. (Text-fig. 11)
Length—61-75 μ ; breadth—9-10 μ ; striations—11-13 in 10 μ.

10. **Navicula radiosa** Kütz. Van Heurck, *Syn. Diat.* t. 7, f. 20, 1881. (Text-fig. 12)
Length—41-45 μ ; breadth—6-7 μ ; striations—12-14 in 10 μ.

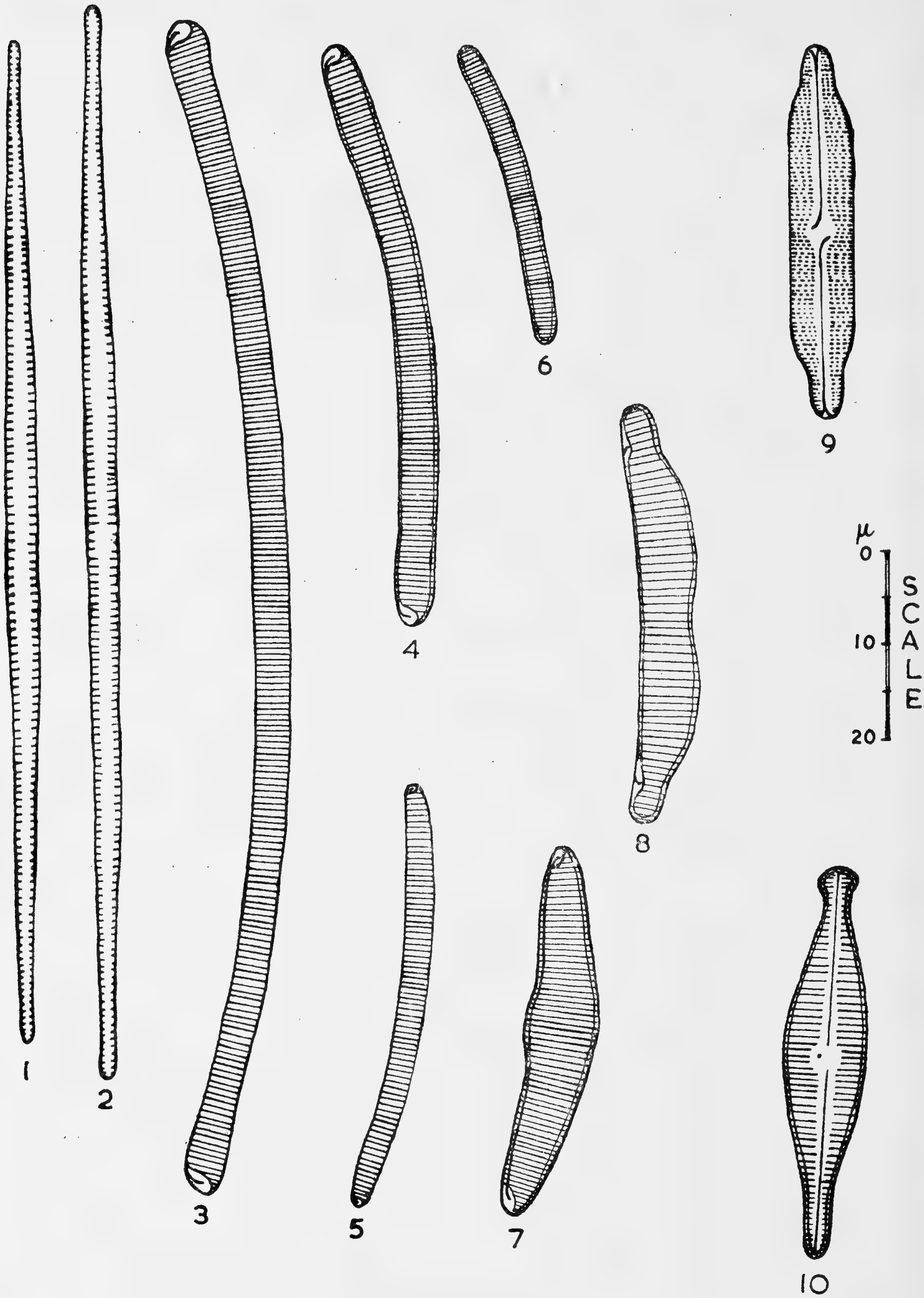
11. **N. ingrata** G. Krasske in *Arch. Hydrobiol.* 33 : 528, t. 11, f. 17-18. 1938 et in F. Hustedt, *Die Kieselalgen* 7 (3) : 137, f. 1270, 1930-1932. (Text-fig. 13)
Length—33-35 μ ; breadth—9-10 μ ; striations—24-26 (faintly visible) in 10 μ.

12. **N. subadnata** Hust. in Rabenhorst's *Kryptogamen-flora* 7 (3·2) : 233, f. 1354, 1932. (Text-figs. 14-15)
Length—9-10 μ ; breadth—5 μ ; striations—22 in 10 μ.

13. **N. krasskei** Hust. in A. Pascher's *Die Süsswasserfl. Mitteleuropas* 10 : 287, f. 481, 1930. (Text-fig. 16)
Length—6-15 μ ; breadth—4-6 μ ; striations—38-40 (very faintly visible) in 10 μ.

14. **Pinnularia interrupta** W. Smith
F. Hustedt, ibidem 10 : 317, f. 572, 1930. (Text-fig. 17)
Length—49-52 μ ; breadth—8-10 μ ; costae—10-12 in 10 μ.

15. **P. gibba** Ehr.
F. Hustedt, ibidem 10 : 327, f. 600, 1930. (Text-fig. 18)
Length—50-71 μ ; breadth—7-12 μ ; costae—10-12 in 10 μ.



Text-figs. 1-10. 1. *Synedra affinis* Kütz. 2. *S. ulna* (Nitz.) Ehr. var. *subaequalis* Grun. 3. *Eunotia pseudolunaris* Venkt. 4-6. *E. valida* Hust. 7. *E. pectinalis* (Kütz.) Rabh. var. *ventralis* (Ehr.) Hust. 8. *E. sudetica* O. Müll. var. *bidens* Hust. 9. *Neidium affine* (Ehr.) Cleve var. *longiceps* (Greg.) Cleve. 10. *Gomphonema sphaerophorum* Ehr.

16. **P. major** W. Smith, *Syn. Brit. Diatom.* 1 : 54, pl. 17, f. 162, 1853. (Text-fig. 20)

Length—96-98 μ ; breadth—18-19 μ (in middle) and 13-14 μ (towards ends) ; costae—9-10 in 10 μ.

17. **P. viridis** (Nitz.) Ehr. var. **turgidus** Singh in *Proc. nat. Acad. Sci.* (B) 32 : 239, f. 28, 29, 1962. (Text-fig. 19)

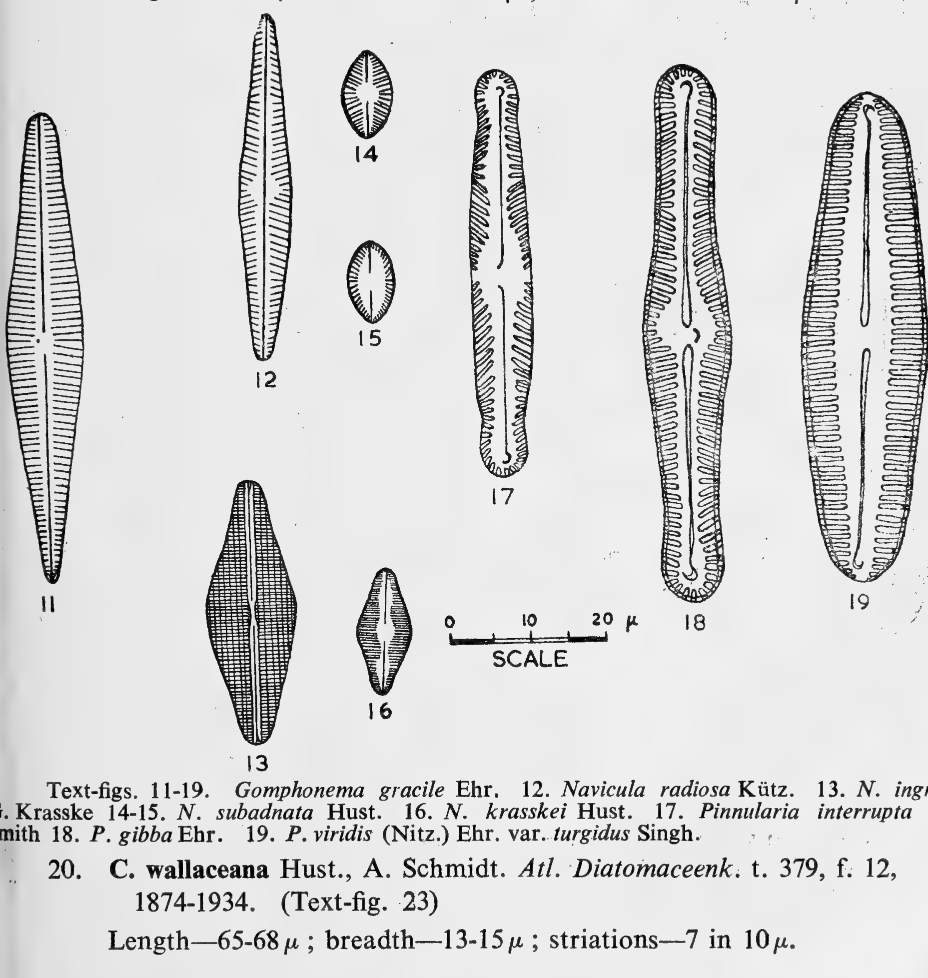
Length—60-62 μ ; breadth—15-16 μ ; costae—9-10 in 10 μ.

18. **Amphora veneta** Kütz., F. Hustedt in Pascher's *Die Süsswasserfl. Mitteleuropas* 10, p. 345, f. 631, 1930. (Text-fig. 21)

Length—20-25 μ ; breadth—4-6 μ ; striations—10-12 in 10 μ.

19. **Cymbella turgida** (Grog.) Cleve, Van Heurck, *Syn. Diat.* t. 3, f. 12 1881. (Text-fig. 22)

Length—38-41 μ ; breadth—10-11 μ ; striations—6-7 in 10 μ.



Text-figs. 11-19. *Gomphonema gracile* Ehr. 12. *Navicula radiosa* Kütz. 13. *N. ingrata* G. Krasske 14-15. *N. subadnata* Hust. 16. *N. krasskei* Hust. 17. *Pinnularia interrupta* W. Smith 18. *P. gibba* Ehr. 19. *P. viridis* (Nitz.) Ehr. var. *turgidus* Singh.

20. **C. wallaceana** Hust., A. Schmidt. *Atl. Diatomaceenk.* t. 379, f. 12, 1874-1934. (Text-fig. 23)

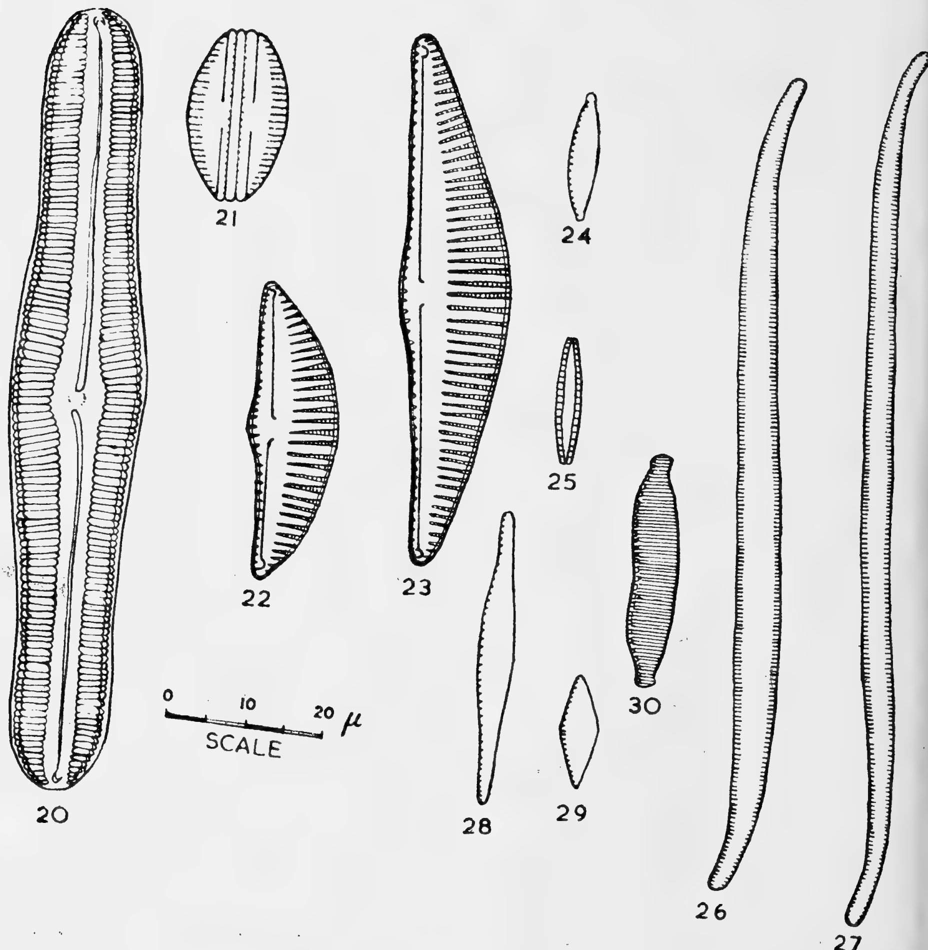
Length—65-68 μ ; breadth—13-15 μ ; striations—7 in 10 μ.

21. **Nitzschia palea** (Kütz.) W. Smith, Cleve-Euler, *Diat. Schwed. Finn.* 5 : 90, f. 1504 a-b, 1951-55. (Text-figs. 24, 25)

Length—16-25 μ ; breadth—3-4 μ ; keel punctae—12 in 10 μ ; striations—28-30 in 10 μ.

22. **N. lorenziana** Grun. var. **subtilis** Grun., A. Schmidt. *Atl. Diatomaceenk.* t. 335, f. 6-8, 1874-1934. (Text-figs. 26, 27)

Length—110-145 μ ; breadth—6-7 μ ; striations—22-24 (very faint) in 10 μ.



Text-figs. 20-30, 20. *Pinnularia major* W. Smith. 21. *Amphora veneta* Kütz. 22. *Cymbella turgida* (Greg.) Cleve. 23. *C. wallaceana* Hust. 24-25. *Nitzschia palea* (Kutz.) W. Smith. 26-27. *N. lorenziana* Grun. var. *subtilis* Grun. 28. *N. acicularis* W. Smith. 29. *N. paleacea* Grun. 30. *Hantzschia amphioxys* (Ehr.) Grun. var. *densestriata* (Fout.) Cleve.

TABLE 1

SEASONAL FLUCTUATIONS IN SOIL DIATOM POPULATION IN A POND AT BARANG, ORISSA, DURING THE PERIOD APRIL 1966 TO MARCH 1967

S. No.	Species	April	May	June	July	August	September	October	November	December	January	February	March
		1966									1967		
1.	*Synedra affinis*	+	+	+	+	+	+	+++	++	++	++	++	+++
2.	*S. ulna* var. *subaequalis*	—	—	+	—	+	+	+++	+	+	+	++	++
3.	*Eunotia pseudolunaris*	+	+	+	+	+	+	+	++	+	+	—	+
4.	*E. valida*	—	—	—	—	—	+	++	+++	++	+	+	—
5.	*E. pectinalis* var. *ventralis*	+	—	—	—	+	—	+	+	+	+	+	—
6.	*E. sudetica* var. *bidens*	+	—	+	+	+	++	++	++	++	—	+	++
7.	*Neidium affine* var. *longiceps*	—	—	—	+	+	+	+	+	+	+	+	+
8.	*Gomphonema sphaerophorum*	++	++	+	+	+	+	+++	++++	++	++	+	++
9.	*G. gracile*	+	+	+	++	+++	++	++++	++++	++	++	++	++

10. *Navicula radiosa*	+	—	—	—	++	+++	+++	++++	+++	++	+	++
11. *N. ingrata*	+	+	—	—	—	—	++	+	+	+	—	—
12. *N. subadnata*	—	+	+	++	+++	++	+++	++	++	—	+	++
13. *N. krasskei*	+++	—	—	—	+++	+++	+++	+++	+++	++	++	++
14. *Pinnularia interrupta*	—	+	++	++	++++	+++	+++	+++	+++	+++	+++	+++
15. *P. gibba*	+	+	+	+	++	++	+++	+++	++	++	++	+
16. *P. major*	+	+	+	+	+	—	—	++	—	+	+	+
17. *P. viridis* var. *turgidus*	—	—	—	++	++	++	++	++	+	+	—	—
18. *Amphora veneta*	+	++	—	—	—	++	++	++	++	—	—	—
19. *Cymbella turgida*	+	—	—	—	++	—	++	+++	+	+	++	++
20. *C. wallaceana*	+	+	+	+	+	+	—	—	+	—	—	+
21. *Nitzschia palea*	+	+	+	+	—	+	+	+	+	+	+	+
22. *N. lorenziana* var. *subtilis*	—	—	—	—	—	+	+	++	++	—	—	—
23. *N. acicularis*	+	+	+	—	—	—	+	++	+++	+++	++	++
24. *N. paleacea*	—	—	—	+	+	+	++	++	+	—	++	+
25. *Hantzschia amphioxys* var. *densestriata*	+	+	+	—	—	+	+	++	++	++	+	+

N.B. :—Abundant (++++) ; Common (+++) ; Present (++) ; Rare (+) ; and Absent (—).

23. **N. acicularis** W. Smith, F. Hustedt loc. cit. 10 : 423, f. 821, 1930. (Text-fig. 28)

    Length—30-36 μ ; breadth—3-4 μ ; keel punctae—15 in 10 μ ; striations—invisible.

24. **N. paleacea** Grun., A. Schmidt *Atl. Diatomaceenk.* t. 349, f. 14, 1874-1934. (Text-fig. 29)

    Length—14-16 μ ; breadth—4-5 μ ; keel punctae—10-12 in 10 μ ; striations—invisible.

25. **Hantzschia amphioxys** (Ehr.) Grun, var. **densestriata** (Fout.) Cleve in Cleve—Euler, *Diat. Schwed. Finn.* 5 : 49, f. 1419 n-p, 1951-55. (Text-fig. 30)

    Length—30-34 μ ; breadth—5-6 μ ; keel punctæ—small 8-9 in 10 μ ; striations—19-23 (very faint) in 10 μ.

TABLE 2

SEASONAL RANGES IN SOME PHYSICO-CHEMICAL CONDITIONS OF BOTTOM SOIL AND WATER OF A POND AT BARANG DURING APRIL 1966 TO MARCH 1967

Period	Soil				Water			
	pH	Phosphate ppm	Silica ppm	Nitrate ppm	pH	Phosphate ppm	Silica ppm	Nitrate ppm
April-June	6·5	4·5 to 5·6	16·0 to 18·0	2·9 to 3·0	7·0	0·05 to 0·06	9·0 to 10·5	0·04 to 0·05
July-September	6·5	5·8 to 6·0	18·0 to 20·0	3·0 to 3·05	7·0	0·08 to 0·1	12·0 to 15·0	0·07 to 0·09
October-December	6·5	4·4 to 4·5	14·0 to 15·0	2·4 to 2·5	7·2	0·04 to 0·05	9·0 to 9·5	0·03 to 0·04
January-March	6.5	5·0 to 5·5	14·0 to 17·5	2·5 to 2·6	6·8	0·06 to 0·07	11·0 to 11·5	0·05 to 0·06

DISCUSSION

Variations in number of diatoms were observed throughout the year, which is evident from the above data. Similar observations were recorded by other workers like Lund (1942), Round (1957, 1960). However, Table 1 shows comparatively more diatoms during the months of October, November and December. During this period the abundant forms were *Gomphonema sphaerophorum*, *G. gracile*, and *Navicula radiosa* and common forms were *Synedra affinis*, *S. ulna* var. *subaequalis*, *Eunotia valida*, *Navicula subadnata*, *N. krasskei*, *Pinnularia interrupta*, *P. gibba*, *Cymbella turgida* and *Nitzschia acicularis*. Their presence coincided with considerable reduction in phosphate, silica and nitrate values, (Table 2). It is a well known fact that nitrate is essential in the synthesis and maintenance of protein, carbohydrates and fats in plant cells and that diatoms are capable of reducing nitrate to nitrite in ponds (Reid 1966). Phosphate is often considered to be the most critical single factor in the operation of energy transfer system during metabolism of cells and is normally required in a very small amount. Silica is equally important in the formation of frustules of diatoms. It is evident from the present investigations that during the months of October, November and December when the phosphate, silica and nitrate contents are at their minimum, the cell number increases (Tables 1 & 2). It clearly indicates the inverse relationship between the diatoms and the chemical factors mentioned above. Pearsall (1923) has also observed that when diatoms come up in large numbers, nitrates and silica get depleted. My observations agree with the conclusions drawn by Patrick (1948), Round (1960), Singh (1964) and Reid (1966).

Acknowledgements

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References

Anonymous (1965) : Standard methods for the examination of water and waste water. American Public Health Association, 1965, New York : 796 p.

Gandhi, H. P. (1956) : A preliminary account of the soil diatom-flora of Kolhapur. *J. Indian bot. Soc.* **35** : 402-408.

Hustedt, Fr. (1930) : *Bacillariophyta* (Diatomaceae) in A. Pascher, *Die Süsswasserflora Mitteleuropas* **10** : 1-466. Jena.

Patrick, R. (1948) : Factors affecting the distribution of diatoms. *Bot. Rev.* **14** : 473-524.

Pearsall, W. H. (1923) : A theory of diatom periodicity. *J. Ecol.* **11** : 165-183.

Piper, C. S. (1950) : Soil and plant analysis. University of Adelaide, 368 p.

Reid, G. K. (1966): Ecology of Inland waters and Estuaries. Reinhold Publishing Corporation, New York, pp. 176-202.

Round, F. E. (1953) : An investigation of two benthic algal communities in Malham Tarn, Yorkshire. *J. Ecol.* **41** : 174-197.

——— (1955) : Some observations on the benthic algal flora of four small ponds. *Arch. Hydrobiol.* **50**:111-135.

——— (1957, 1960) : Studies on bottom-living algae in some lakes of the English lake Districts. *J. Ecol.* **45** : 133-148 ; 342-360, 1957 ; **48** : 529-547, 1960.

Singh, C. S. (1964) : Seasonal fluctuation in diatom population. *Internat. Tropical Ecol.* **5** : 42-51.

Sladeckova, A. (1962) : Limnological investigation methods for the periphyton community. *Bot. Rev.* **28** : 286-350.

Observations on the breeding of Storks in India and Ceylon

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(*With five plates*)

This paper reports on some observations made on breeding storks in India and Ceylon during August-October 1966, August-December 1967, and January 1968. Observations are reported on breeding dates, behaviour, ecology, morphology, and taxonomic relationships of the six species nesting in this area.

Based on these studies I would recommend the following changes from the classification given by Peters (1931) : *Ibis leucocephalus* to *Mycteria leucocephala; Dissoura episcopus* to *Ciconia episcopus*; *Xenorhynchus asiaticus* to *Ephippiorhynchus asiaticus.*

Introduction

The Indian subcontinent contains six breeding species of storks (Ciconiidae). In number of breeding species it is surpassed only by Africa, which contains eight. My visits to India in August-October 1966 and August-December 1967 and to Ceylon in December 1967-January 1968 were part of a continuing study of the ecology and comparative behaviour of the storks of the world.

In India, breeding storks were studied principally in and near the Keoladeo Ghana Sanctuary at Bharatpur, Rajasthan ; in the Brahmaputra flood-plain of central Assam ; and at Periyar Sanctuary, Kerala. In Ceylon, I studied storks at Wilpattu National Park and, briefly, at Kalamatiya Lagoon, on the south-west coast.

In this paper I have followed the nomenclature of Peters (1931) but have suggested changes where I feel that new evidence warrants them.

Storks of India and Ceylon

Ibis leucocephalus Painted Stork

An abundant nester at Bharatpur, where several thousand pairs breed in years of adequate flooding. In 1966 and 1967 egg-laying began in late August after the monsoon rains and water from a nearby reservoir had flooded the nesting and feeding areas, and fish had moved into the shallow water. Most nests were built in low 'babul' trees (*Acacia arabica*), growing in shallow water. Here Painted Storks nest in close association with a variety of other water birds (Plate I) such as *Anastomus oscitans, Threskiornis melanocephala, Platalea leucorodia, Egretta garzetta, E. intermedia,* and *Phalacrocorax niger.* The breeding colonies at the Keoladeo Ghana have been previously described by Ali (1953).

Whenever one member of a pair of Painted Storks, returns to the nest after an absence, the bird and its mate greet each other with a version of the 'Up-Down' display, shown in a variety of forms by all species of storks. Both birds point their bills upward, gape them widely open, and utter a weak, hissing scream of 1-2 seconds duration, which sounds much like the 'fizz' produced by uncapping a carbonated beverage. The head and neck are then moved downward and from side to side (Plate I); during the downward motion, the vocalization is repeated once or twice at 2-3 second intervals. Between vocalizations—during which the bill is gaped open—single, double, or triple audible snaps of the bill are given in rapid succession. However, the Painted Stork does not produce a true prolonged clattering sound during the greeting display—as do some other storks, such as *Ciconia, Dissoura, Xenorhynchus,* and *Leptoptilos.* True clattering in the Painted Stork is heard only during copulation and, occasionally, in short bursts during other courtship displays and during intra- or interspecific fights.

Behaviour patterns observed in the Painted Stork were qualitatively similar to homologous patterns shown by the Yellowbilled Stork (*Ibis ibis*) of Africa, the Milky Stork (*Ibis cinereus*) of south-east Asia, and the Wood Stork (*Mycteria americana*) of the Americas (details to be published separately). Their agreement in behaviour, coupled with morphological similarities, confirms their close relationships, and I believe that they should be united under one genus. The genus *Mycteria* has priority and, thus, the scientific name of the Painted Stork would become *Mycteria leucocephala* (Pennant).

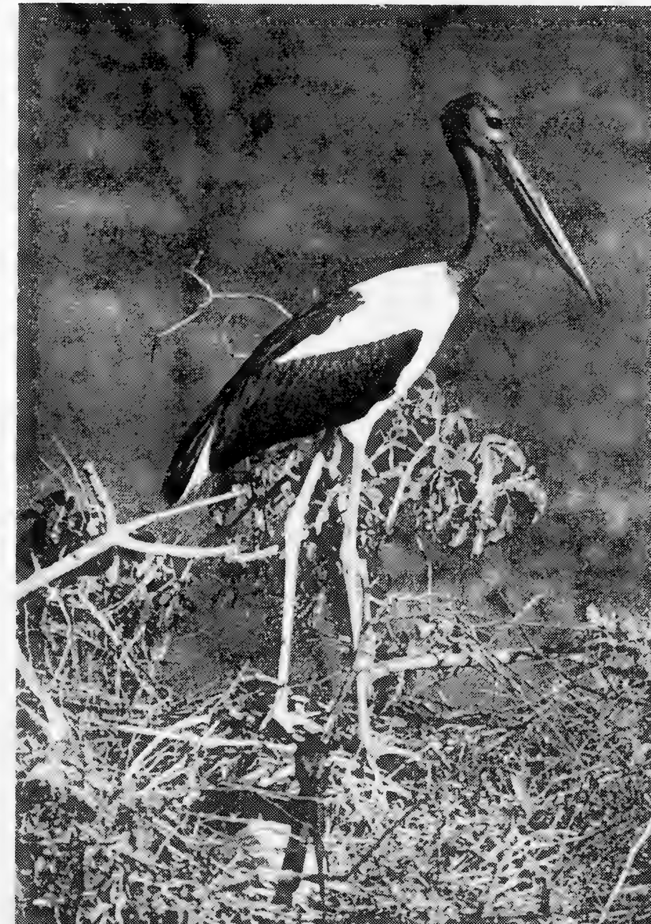
Anastomus oscitans Asian Openbill Stork

Another abundant colonial species at Bharatpur, found breeding in the same trees as the previous species but generally beginning to nest several weeks earlier. In 1966 some Openbills laid eggs in early August and many had completed clutches by the third week in August. In 1967 both the monsoon flooding and egg-laying occurred about 10 days later. Apparently Openbills begin breeding only after flooding increases the availability of their food supply by bringing the *Pila* snails out of æstivation (Saxena 1956). At Wilpattu National Park, Ceylon, Openbills were just starting to nest, but had not yet laid eggs in the nests that I saw, in late December 1967. Extralimital observations were also made in the large breeding colony at Wat Pai Lorm, near Bangkok, Thailand,

Above : A typical nest-tree at the Keoladeo Ghana colony, containing nests of the Painted and Openbill Storks. *Below :* The "Up-Down" greeting display, being given by a pair of Painted Storks. The male is on the right. Note erection of upper-back feathers and drooping of under-tail coverts.

(*Photos : Author*)

The "Up-Down" greeting display, being given by a pair of Openbill Storks. The male is on the left.



A pair of Blacknecked Storks at their nest at the Keoladeo Ghana Sanctuary, Bharatpur. Male standing; female incubating (note yellow eye) where nests in all stages—from eggs to large, nearly-fledged young—were found in early February 1968.

The large fresh-water snail, *Pila globosa*, is a favourite food of Openbills. I agree with Ali & Ripley (1968 : 96) that the gap in the bill is not meant for crushing snails. The techniques used by *Anastomus* to extract molluscs from their shells—generally without extensive damage to the shell—is the subject of another paper (Kahl, in press, a). Briefly, the bird wedges the thin tip of the lower mandible under the operculum of the snail and, apparently, severs the snail's columellar muscle, freeing the body from the shell. Usually the operculum is snipped off by the tip of the bill, but in the case of small snails, the body may be swallowed with the operculum still attached.

At the beginning of the breeding season, adult Openbills are immaculate white, with black primaries, secondaries, scapulars, and tail, and with bright, deep-pink legs. Soon after the eggs are laid the white plumage turns a dirty grey, apparently through a change in the individual feathers (without a moult), and the legs fade to a duller pink.

In the nests at Bharatpur that I was able to follow closely, both parents shared the duties of incubation and feeding of the young. On several occasions a parent was seen to regurgitate a quantity (estimated at 100-200 cc.) of water and drool it over the eggs. Whether this was mainly to cool the eggs or to maintain a proper humidity is not known. Hume & Oates (1890 : 225) recorded that Openbill nests are somehow wetted by the parents but apparently did not see them regurgitate water into the nest ; they hypothesized that such moisture aided in fermentation, which in turn added warmth for incubation. Watering of the eggs has been noted in the African Openbill and several other species of storks (Kahl, unpub. notes), and in the lapwing, *Vanellus malabaricus* (Jayakar & Spurway 1965), although in the latter species the water was carried in the belly feathers rather than being regurgitated.

The 'Up-Down' greeting display of the Openbill (Plate II) is remarkably similar to that in the Painted Stork (described above). The neck is much more strongly arched forward, and the vocalizations are rather loud, oft-repeated, low-pitched and hollow honking sounds, approximately 0·5 second in duration and uttered about once per second. It is perhaps appropriate here to point out that the photograph of *Anastomus oscitans* reproduced in Thomson's (1964) NEW DICTIONARY OF BIRDS (Plate 28) and labelled 'greeting display' is actually a head-rubbing comfort movement ; it was correctly captioned when originally published in Huxley (1962). During the 'Up-Down' display the Openbill does not throw its head all the way over onto the back, as does the White Stork (*Ciconia ciconia*) nor does it clatter. During the hundreds of hours that I spent observing Openbills during two breeding seasons, I never heard true bill-clattering given during a ritualized display. During copulation the male beats his bill rapidly back and forth against the bill of the female and produces a clattering sound ; however, here the clattering comes from the contact of the two bills, rather than from a rapid opening and closing of the bill as in the other storks.

Dissoura episcopus Whitenecked or Woollynecked Stork

This stork is widespread, if uncommon, as a breeder in northern India but does not nest in colonies. During 1966 and 1967 I located three active nests within a 50 km. radius of Bharatpur and another at Sholaka, approximately halfway between Bharatpur and New Delhi. From the ages of the young in the nests, I calculated that egg-laying in this area had occurred in early or mid-July. At Periyar Sanctuary, Kerala, I found a nest in mid-December 1967 that, judging by the parents' behaviour, probably contained eggs. Dr. Sálim Ali (personal comm.) once saw a nest with large young at Periyar during the month of February.

The nests I found were of medium bulk, approximately 1 m. in diameter, and composed of sticks and small branches. They were placed in the tops of 'Neem' (*Azadirachta indica*) and 'Imli' (*Tamarindus indicus*) trees and were from 10-20 m. above the ground.

Half-grown nestlings resemble adults in pattern, except that they lack the purple iridescence on their wings and breast and have white feathers on the parts of the face that are bare plumbeous skin in the adults.

Few social displays were seen in wild birds, probably because most nests were found late in the season after the young were well grown. Furthermore, my observations on a number of species of storks suggest that in the tropics the solitary-nesting species probably mate for life, and, thus, are less demonstrative at the nest with a 'familiar' mate ; whereas colonial-nesting species probably choose a new mate each season, and, thus, tend to display more. This hypothesis is based partly on the fact that solitary species often return to the same nest in successive years, and are frequently seen in pairs even outside the breeding season.

In colonial species, there is much shifting about of females, from nest to nest, during pair-formation, and such a system would seem incompatible with a permanent pair-bond. Moreover, it is unlikely that many colonial storks reclaim the same nest in successive seasons, because few of the flimsy structures survive from one year to the next. From ringing data we know that the White Stork (*C. ciconia*) of Europe—normally a non-colonial species—often remates with the same partner for many seasons ; in this species the attraction seems to be mainly to the nest, rather than to the individual mate, *per se* (Schuz 1938 : 578).

The question of the duration of the pair-bond in the various storks will, of course, remain open until it can be demonstrated through extensive ringing operations. Such a programme would seem highly desirable—and feasible—at the Keoladeo Ghana Sanctuary, especially among the colonial species.

I did witness an ' Up-Down ' display in a pair of Whitenecked Storks in the Dehiwela Zoo, Colombo, Ceylon, in December 1967. This display and the accompanying high-pitched, whistling vocalizations were strikingly similar to the ' Up-Down ' of Abdim's Stork (*Sphenorhynchus abdimii*) of Africa, and also showed affinities with the Maguari Stork (*Euxenura galeata*) of South America, and the White Stork (*C. ciconia*) and Black Stork (*C. nigra*) of Europe ; details of these displays will be published elsewhere. Based on these observations, as well as other behavioural and morphological similarities, I propose that all of these genera be included in the genus *Ciconia*. Thus, the scientific name of the Whitenecked Stork would become *Ciconia episcopus* (Boddaert) ; such a nomenclature has already been adopted for *episcopus* by Ripley (1961) and Ali & Ripley (1968).

Xenorhynchus asiaticus Blacknecked Stork

This species was observed at length only in the vicinity of Bharatpur, where I found two nests in 1966 and seven nests (occupied by at least five different pairs) in 1967. The massive solitary nests, about 2 m. in diameter and 1-1·5 m. deep, were placed in the crowns of ' Peepul ' (*Ficus religiosa*) or ' Kadum ' (*Mitragyna parvifolia*) trees, usually in flooded woodlands. A nest with at least one young about two weeks old was found on 15 October 1966, indicating that egg-laying had occurred in early September. In 1967 a few nests were visited by Blacknecks in late August and early September, but egg-laying in most pairs probably was not until late September or October. The rains were more prolonged in 1967 and flooding was more extensive ; perhaps these ecological conditions caused the delay in the initiation of breeding.

Several times I saw Blacknecked Storks regurgitate a large quantity (1-2 litres) of water and drool it over the contents of the nest (presumed to be eggs). On one occasion a bird drank 21 times in the marsh, flew back to the nest, and regurgitated the water over the platform. Watering the eggs has also been observed in the closely related Saddlebill Stork (*Ephippiorhynchus senegalensis*) in Africa (Kahl, unpubl. notes).

To my knowledge the Blacknecked Stork is exclusively a solitary nester. Pairs of birds were frequently seen together before nesting began, and I think it highly likely that they remain mated for life.

Most pairs watched were quite undemonstrative at the nest, seeming to pay scant attention to the comings and goings of their mate. However, I did witness and take motion-pictures of the spectacular greeting display—homologous to the ' Up-Down ' in other storks—on several occasions. This display was described by Hume & Oates (1890 : 266) and has apparently not been recorded since. Hume's observations were of birds on the ground, away from the nest, but I saw it performed only by pairs in trees, usually on nest-platforms. The birds stood erect, facing each other, with their wings widely spread and the tips of one bird's wings nearly touching those of the other. They fluttered their wings rapidly (*c.* 3-4 times per second) and clattered loudly while holding their bills in the normal position, about 30-45° below the horizontal.

Unlike the other Indian storks, the sexes of the Blacknecked can be distinguished at a glance. The male has a dark brown iris, whereas the female has a bright lemon-yellow iris, which contrasts sharply with the black feathers of the head (Plate II). In this sexual dimorphism, as well as in numerous other aspects of morphology and in general behaviour, the Blacknecked Stork shows very close affinities with the Saddlebill Stork (*Ephippiorhynchus senegalensis*) of Africa. I believe that the two should be considered congeneric. Both genera were described on the same page of Bonaparte (1857) ; however, the name *Ephippiorhynchus* appeared first on the page and, thus, has priority (Mayr, Linsley & Usinger 1953 : 222) over *Xenorhynchus*. Therefore, the scientific name of the Blacknecked Stork would become *Ephippiorhynchus asiaticus* (Latham).

Leptoptilos dubius Greater Adjutant Stork

Non-breeding individuals or small flocks were seen at Bharatpur in August 1966 and near New Delhi in August 1967. However, the only nest (Plates III & IV) found was in the Kaziranga Wildlife Sanctuary, Assam, in November-December 1967. This is apparently the only record in this century of *L. dubius* breeding within the borders of India (Ali & Ripley 1968 : 107).

The Kaziranga nest was in the crown of a ' Satian ' tree (*Aistronia scholaris*) about 27-30 m. high, growing in a small forest at the edge of an elephant-grass savannah (Plate III). The nest was in the highest tree within 500 m. When found on 27th November 1967, it contained two young approximately 30-35 days old, indicating that the eggs had been laid in late September.

Most behaviour patterns of the adults at the nest and of non-breeding wild birds, as well as of captives observed in the New Delhi and Calcutta Zoos, were closely similar to those of the Marabou Stork (*L. crumeniferus*) which was extensively studied in Africa (Kahl 1966a). However, the ' Up-Down ' greeting display was an exception. In the Marabou's ' Up-Down ', the bird throws its head vertically upward, utters a series of high-pitched squeals and lower-pitched, cow-like ' moos ', and then points its bill *downward* and clatters loudly. The homologous display in *dubius* is similar in form and vocalizations, except that the clattering is done *upward* ; as the head is lowered toward the normal position, all clattering ceases before the bill has reached the horizontal.

Nest-tree of *L. dubius* in Kaziranga Wildlife Sanctuary, Assam. The nest is at the top of the main trunk. (Rings around trunk are a ladder used by climbers to trim branches surrounding nest for an unobstructed view.)

(*Photo : Author*)

Kahl : Storks

A pair of Greater Adjutants on their nest in Kaziranga Wildlife Sanctuary, Assam, in December 1967. The female, on the left, is bringing a stick to add to the nest.

Since the ' Up-Down ' display appears to be of major importance in the maintenance of the pair-bond in all storks, I doubt that *dubius* and *crumeniferus* would freely interbreed even if sympatric. Therefore, I would reject the suggestion of some authors (*e.g.* Meinertzhagen 1951) that they be considered conspecific. I do feel that *dubius* and *crumeniferus* are closely enough related to be considered a superspecies (Amadon 1966).

Although my observations on *dubius* were incomplete, judging from the behaviour I did see and the behaviour of its close relative *crumeniferus*, I would question the statement made by Baker (1935 : 447), and reiterated by Ali & Ripley (1968 : 107), that the ' courtship dance ' of *dubius* is similar to that of the Blacknecked Stork. The behavioural repertoires of these two species are really quite different. A more complete discussion of the behaviour of the Adjutants is presented elsewhere (Kahl, in press, b).

Leptoptilos javanicus Lesser Adjutant Stork

In late November 1967 approximately 36 active nests of *javanicus* were found in the Laokhowa Reserve, near Nowgong, Assam. Most of the nests contained nestlings 30-75 days of age, indicating that egg-laying took place between mid-August and late September.

The nests were scattered in a loose colony—with 1-6 nests per tree—over several hectares of second-growth forest. Most were in the tops of ' Satian ' (*Aistronia scholaris*) and ' Simul ' (*Salmalia malabarica*) trees 15-20 m. high. The structures were rather flimsy platforms of sticks, 0·7-1 m. in diameter, lined with smaller twigs and green leaves.

The Lesser Adjutant is reputed to be less of a scavenger than its larger cousin, *dubius* (Ali & Ripley 1968 : 108). My observations of food brought to the nest tend to confirm this, although, like *crumeniferus* in Africa (Kahl 1966b), *dubius* may also bring a significant proportion of live prey to its young. Food given to *javanicus* nestlings was fed by regurgitation and consisted of fish, frogs, and rats. Most of these items were probably captured alive in nearby marshes and fields. However, the tremendous odour given off by one large rat brought to a nestling in a nest only 8 m. from my observation platform indicated that it had been picked up dead. Both adults fed the nestlings in the nests that I watched. Several times I witnessed parents regurgitating water to nestlings (Plate V). Watering the young has been observed in several other species of storks (Kahl 1966b, & unpubl. notes) and may be related to the peculiar mechanism for thermoregulation that all storks possess. Birds of this family commonly excrete a dilute urine onto the bare portion of the leg ; the evaporative cooling produced by this liquid apparently aids in the prevention of hyperthermia (Kahl 1963). Thus, nestling storks require more water than do other species that do not employ polyuria as a thermoregulatory device.

The majority of behaviour patterns observed in Lesser Adjutants were closely similar to those of the Greater Adjutant. The ' Up-Down ' greeting display incorporated an *upward* clattering (Plate V), similar to *dubius* (see above) and quite different from *crumeniferus* in Africa. Vocalizations heard during displays of *javanicus* were hoarser and more rasping than those given by *dubius.* I did not find *javanicus* to be more shy than *dubius* (at least at the nest), as has been previously reported (Ali & Ripley 1968 : 108).

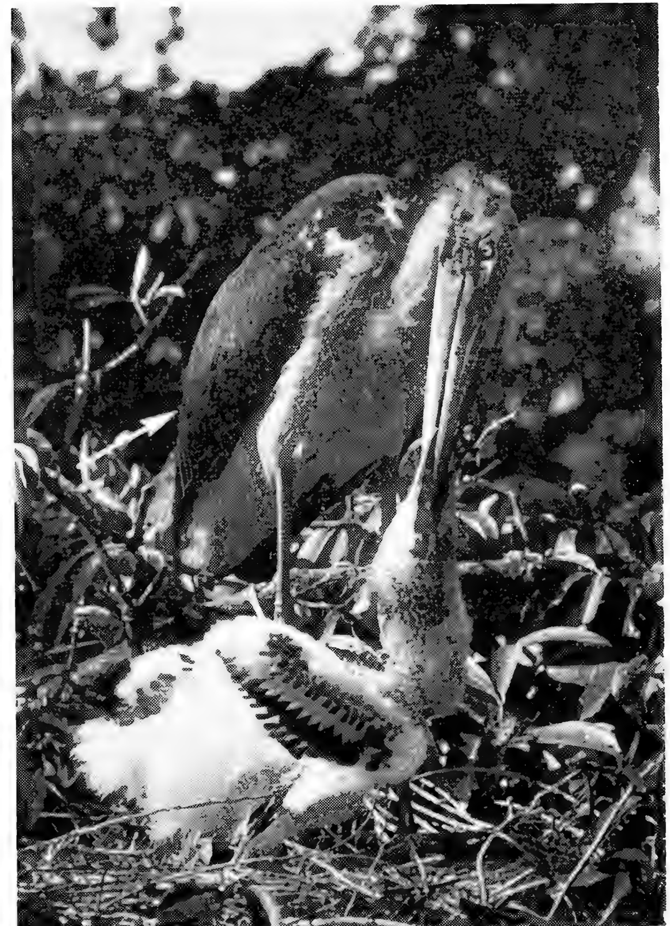
Since the observed behaviour of the two species appeared similar, one wonders what factors serve as isolating mechanisms to prevent interbreeding in areas, such as Burma, where the two Adjutants nest together in large mixed colonies (Smythies 1953). Perhaps there are important differences in the displays which function during courtship and pair-formation (Kahl, in press, b), or perhaps the morphological differences between the two species are sufficient to prevent the formation of hybrid pairs.

In appearance, the two Adjutants are generally similar, but there are a number of discreet differences that are most apparent during the breeding season (cf. Plates III & IV). Both Adjutants have dark blue-black upper parts in non-breeding plumage. The back and wings of *dubius* take on a noticeably paler, almost powder-blue, colour during the breeding season and the greater secondary coverts become a very light grey, forming a contrasting light band down the wing that is conspicuous when the bird is standing or in flight. In *javanicus* the upper parts remain a dark, slaty, blue-black in the breeding plumage, and only the inner 4-5 greater secondary coverts are very narrowly edged with white. The *median* secondary coverts (not the greater coverts, as is widely stated in the literature) have oval copper-coloured spots, approximately 20 mm. long, near their tips.

In breeding plumage both Adjutants possess well-developed, fluffy under-tail coverts, which are spread and drooped conspicuously during social displays. In *javanicus* these coverts are pure white, but in *dubius* they grade from white at their base to dark smoky-grey at their tips.

Furthermore, the heads and necks of the two species differ significantly. The bill of *dubius* is more massive, often with a slightly decurved culmen ; that of *javanicus* is slimmer and slightly recurved. The forehead of *dubius* is covered with dark encrustations, having the appearance of scabs of dried blood, whereas *javanicus* has a smooth, light yellowish-tan frontal-plate. The neck of *dubius* is largely unfeathered and has at its base in front a large air sac that can be inflated to a length of 20-30 cm. Although I did not observe it, I think it probable that this throat-sac in *dubius* is displayed prominently during courtship, as is the similar sac of *crumeniferus* (Kahl 1966a). A large, pendant throat-sac is lacking in *javanicus.*

The "Up-Down" greeting display, being given by a pair of Lesser
(centre) has its mandibles open during clattering. The male of the pair



Lesser Adjutant giving water to its 30-40 day old nestling;
Laokhowa Reserve, Nowgong, Assam, in November 1967. The

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REFERENCES

ALI, S. (1953): The Keoladeo Ghana of Bharatpur (Rajasthan). *J. Bombay nat. Hist. Soc.* **51**: 531-536.

——— & RIPLEY, S. D. (1968): Handbook of the Birds of India and Pakistan. Vol. 1. Bombay: Oxford Univ. Press.

AMADON, D. (1966): The superspecies concept. *Syst. Zool.* **15**: 245-249.

BAKER, E. C. S. (1935): The nidification of birds of the Indian Empire. Vol. **4**. London: Taylor & Francis.

BONAPARTE, C. L. (1857): Conspectus generum avium. Tom. 2. Leiden: E. J. Brill.

HUME, A. O. & OATES, E. W. (1890): The nests and eggs of Indian birds. Second Edition. Vol. 3. London: R. H. Porter.

HUXLEY, J. S. (1962): The Openbill Stork, *Anastomus oscitans*. *Ibis* **104**: 112.

JAYAKAR, S. D. & SPURWAY, H. (1965): The Yellow-wattled Lapwing, *Vanellus malabaricus* (Boddaert), a tropical dry-season nester. II. Additional data on breeding biology. *J. Bombay nat. Hist. Soc.* **62**: 1-14.

KAHL, M. P. (1963): Thermoregulation in the Wood Stork, with special reference to the role of the legs. *Physiol. Zool.* **36**: 141-151.

——— (1966a): Comparative ethology of the Ciconiidae. Part 1. The Marabou Stork, *Leptoptilos crumeniferus* (Lesson). *Behaviour* **27**: 76-106.

——— (1966b): A contribution to the ecology and reproductive biology of the Marabou Stork (*Leptoptilos crumeniferus*) in East Africa. *J. Zool.* **148**: 289-311.

——— (in press, a): Food and feeding behavior of Openbill Storks. *J. f. Ornith.*

——— (in press, b): Comparative ethology of the Ciconiidae. Part 2. The Adjutant Storks, *Leptoptilos dubius* (Gmelin) and *L. javanicus* (Horsfield).

MAYR, E., LINSLEY, E. G. & USINGER, R. L. (1953): Methods and principles of systematic Zoology. New York: McGraw-Hill.

MEINERTZHAGEN, R. (1951): Some relationships between African, Oriental, and Palaearctic genera and species. *Ibis* **93**: 443-459.

PETERS, J. L. (1931): Check-list of birds of the world. Vol. **1**. Cambridge, Mass.: Harvard Univ. Press.

RIPLEY, S. D. (1961): A Synopsis of the Birds of India and Pakistan. Bombay. Bombay Natural History Society.

SAXENA, B. B. (1956): Some observations on the ecology and behaviour of the common Indian apple-snail, *Pila globosa* (Swainson). *J. Bombay nat. Hist. Soc.* **53**: 733-736.

SCHÜZ, E. (1938): Über Biologie und Ökologie des Weissen Storchs (*Ciconia c. ciconia*). *Proc. Internat. Ornith. Congr.* **8**: 577-591.

SMYTHIES, B. E. (1953): Birds of Burma. Edinburgh: Oliver & Boyd.

THOMSON, A. L. (1964): A new dictionary of birds. London: Nelson.

Cyclonic damage to Plant Tissues

BY

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(With two plates containing eight text-figures)

Following a cyclone in Madras the foliage of certain trees and shrubs exhibited marked symptoms of decay and defoliation. In *Azadirachta indica* the margins alone suffered decay while the remaining part of the lamina continued to function normally. A histological study of such leaflets indicates that the exposed cells of the lamina proliferate into wound tissue which contributes towards the reconstitution of a new margin. During this process the mechanism of regeneration is very similar to that described for leaf tissues subjected to artificial surgery.

On 3-xi-1966, the coastal regions of Madras City and neighbourhood suffered one of the worst cyclonic ravages. According to the official meteorological reports there was 61 mm. rainfall during 12 hours with a wind velocity of 120 km. per hour. In the city of Madras several trees were uprooted, branches mutilated, and the growing parts of many arborescent and shrubby plants that were directly exposed to the cyclone, damaged.

Various types of pathological reactivity were noticed on different genera of plants. In most of the relatively large, thin, simple leaved plants the lamina was subjected to severe degrees of tearing, the torn parts eventually dropping away. In *Minusops* and *Thespesia* the leaves turned uniformly yellow and got abscissed within 24 hours after the cyclone. In quite a number of genera possessing small or large simple leaves like *Cletodendron, Duranta, Lantana, Bougainvillea, Morinda,* etc., discoloration of the leaf margin was noticed immediately after the cessation of the gale; the leaves, however, remained intact on the trees for varying periods from one to two weeks. In the leaves of *Colophyllum, Morus* and *pongamia* the discoloration associated with desiccation extended centripetally throughout the laminal surface subsequent to which abscission followed. Discoloured lesions appeared as endemic spots on the leaves of *Lagerstroemia.*

The reaction exhibited by taxa possessing compound leaves belongs to a different category. In *Peltophorum* and *Deionix* the leaflets abscissed following discoloration while the gale was at its peak. In *Azadirachta indica* A. Juss. the margins of the leaflets to a distance of 2 to 4 millimetres suffered discoloration associated with necrosis of the constituent cells. The first sign of discoloration and necrosis was noticed at the apex of the leaflet, soon spreading in the basipetal direction along the margins. At the optimum level of affectation the concerned area showed from outside (*a*) a blackish colour of lighter intensity merging into a darker pitch of the same colour and (*b*) a lighter green zone immediately adjoining the colour of the normal leaflet (Fig. 2). Separation of the affected area occurred interior to the light green zone. The affected area began drying up a day after the cyclone; on the next day it separated itself off from the lamina in the form of a dry, papery membrane. The most surprising phenomenon, however, is that the residual leaflets remained on the tree as long as the newly produced leaves or older leaves borne on that side of the tree which was not directly hit by the cyclone. In other words, in spite of the damage the residual leaflets appeared to carry on normal function. These leaflets simulate the shape of the normal ones obviously because of the discoloured zone which runs nearly parallel to the outline of the leaflet (cf. Figs. 1 & 3).

When the residual leaflet continues to take part in the metabolic activities, one naturally suspects a mechanism to 'heal' the exposed margins. The following account is concerned with a study of this phenomenon.

'Healing' process

In the normal leaflet the adaxial palisade tissue stops short of the extreme margin. Beneath the hypodermis along the margin is a nest of cells, the primary walls of which show thickenings similar to the collenchyma cells (Fig. 4). It is from this margin to a depth of 2 to 4 mm. that becomes affected. The zone 'A' deteriorates at a very rapid rate and as such the histological changes in this zone prior to decay could not be studied. In zone 'B' the first indication of the decay is seen in the slight enlargement of the mesophyll cells; the palisade cells increase slightly along the narrow diameter and the spongy cells increase in surface area. As a consequence, the cell alignment becomes disturbed more conspicuously in the spongy part of the mesophyll (Fig 5; cf. cells in 'B' zone with those in 'L'). The chloroplasts lose their typical green colour and the capacity to retain biological stains and the nucleus conspicuously shrinks in size exhibiting a rather amorphous structure.

With the decay being initiated in the zone 'B', the adjacent palisade cells begin to divide by walls parallel to the surface of the lamina.

Although the width of this tissue exhibiting division from the zone 'B' varies slightly at different leaves of one and the same leaflet, on an average measures 300 microns. It is not all the cells of this tissue that undergo division and the largest number of cells show only one division wall particularly in the interior. Towards the edge, however, two or three walls could be seen in many cells which in turn undergo a division or two by walls at right angles to the surface. These cells enlarge and re-align themselves (*see* arrow in Fig. 6). In the spongy part of the mesophyll the exposed cells divide by walls parallel to the exposed surface. A larger number of divisions occur in these cells than in those of the palisade tissue and the thus formed tissue appears relatively more compact presenting a semblance of seriation (Fig. 7). It is quite possible that a few of the deep-seated cells of the spongy mesophyll also may initiate one or two divisions.

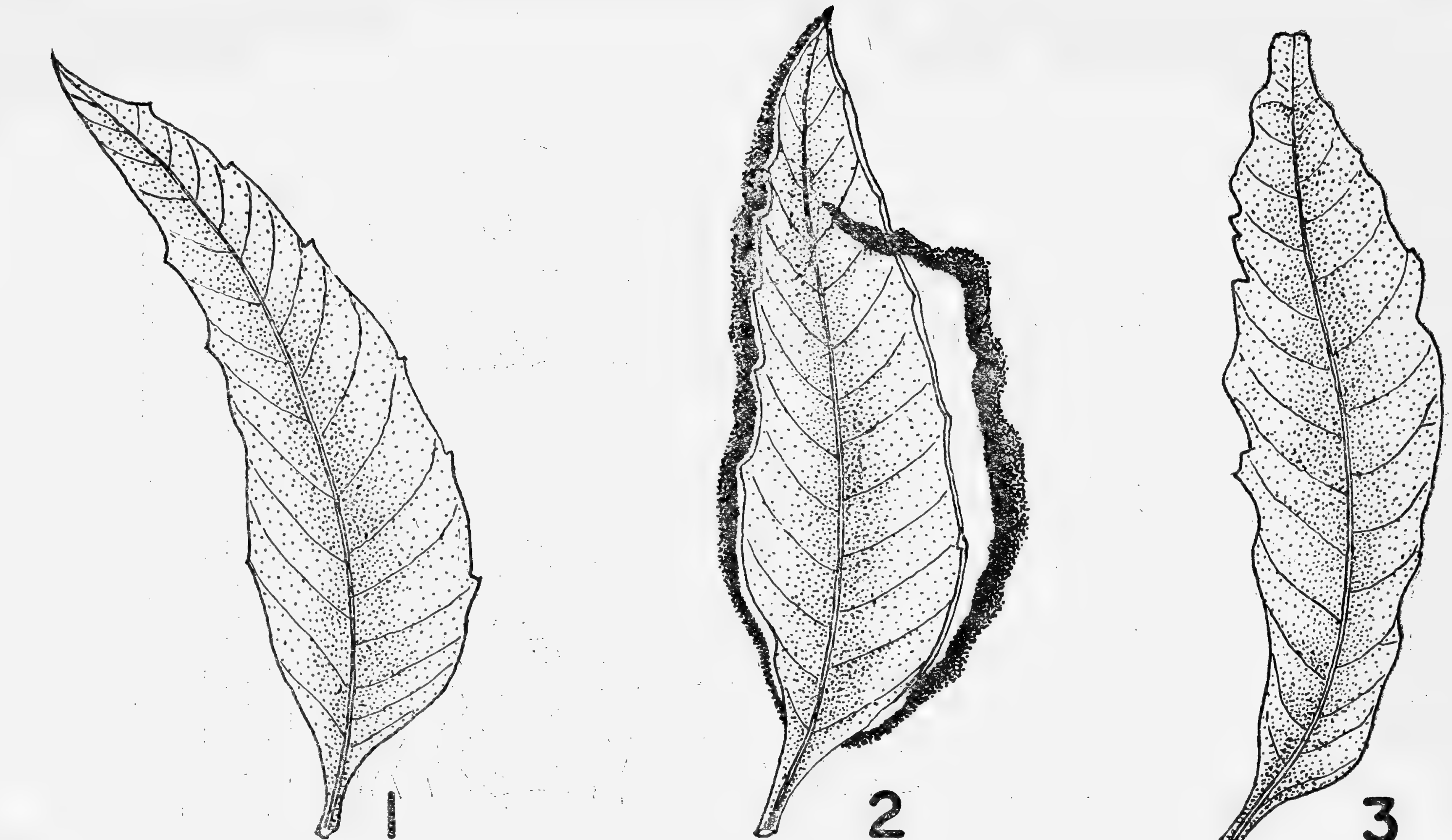
The newly produced cells of the spongy mesophyll sector soon lose their seriate arrangement partly due to slight enlargement and partly due to de-differentiation as oil secreting idioblasts (Fig. 8). A few of these cells also show the accumulation of tannin materials as in the normal tissue. It is noteworthy that the newly formed surface cells fail to develop cuticular deposits on their outer faces. On the other hand, their surface is covered over by the cutinised debris of zone 'B' (Figs. 7 & 8).

Discussion

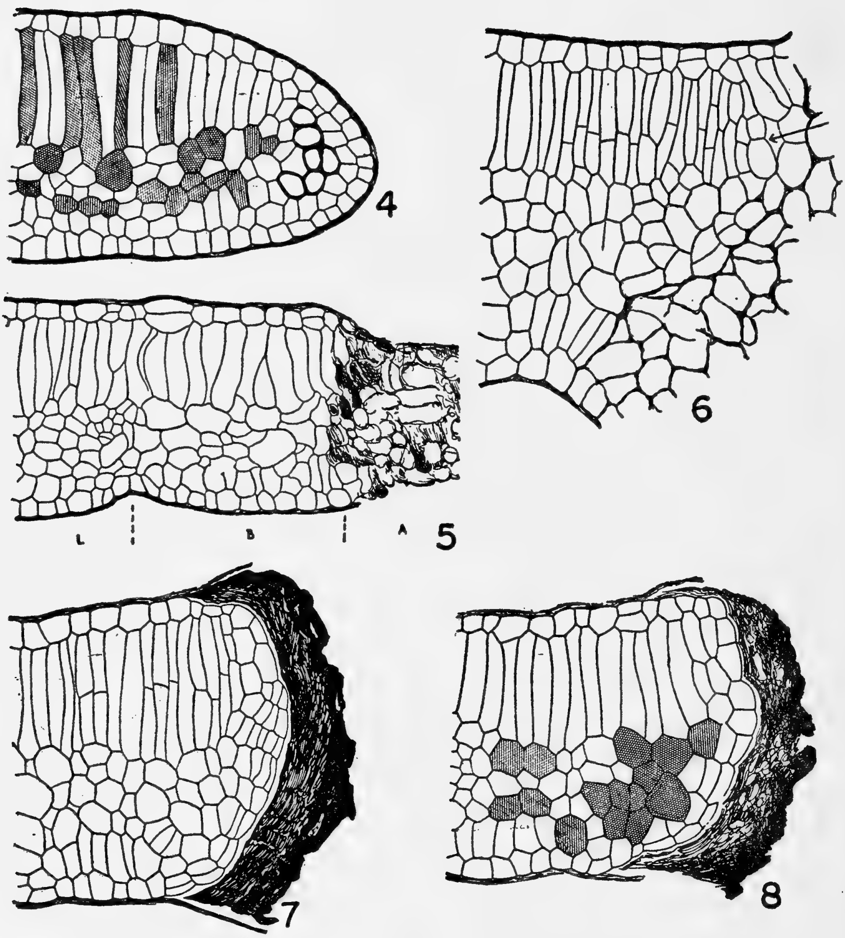
A generalized sequence of events leading to the reconstitution of the exposed margin of the lamina following the decay of the true margin of the leaflet of *Azadirachta* involves (*a*) division of the superficial parenchyma cells by walls parallel to the surface resulting in (*b*) a provisional seriate arrangement of the derivative cells and (c) differentiation of these cells into some of the very cell types that is normally associated with the unaffected part of the lamina, like the secretory idioblasts and tanniferous cells. This sequence of events is not very different from that seen in the wound healing phenomenon in the dicotyledonous tissues. The degree of morphological expression of the phenomenon in the present case, however, is rather feeble.

With particular reference to the leaves of Dicotyledons the histological responses observed in the present case are somewhat similar to the condition described by Wylie (1930). He recognizes two zones in the affected tissues, pseudocicatrice and cicatrice. In the pseudocicatrice region the cells collapse as such (due to the loss of water from the exposed surface according to the author) and in the cicatrice

Swamy: Cyclone damage



FIGURES 1 to 3: Fig. 1. Normal leaflet. Fig. 2. Deterioration and separation of the affected margin. Fig. 3. Leaflet after the falling away of the deteriorated part. (All figures × $1\frac{1}{2}$).



FIGURES 4 to 8: Fig. 4. Transection of the marginal part of a normal leaflet. Fig. 5. An early stage in the onset of pathological condition. For explanation of 'L', 'B' & 'A' see text. Fig. 6. Cell divisions in the palisade and spongy mesophyll layers in the region 'L'. Arrow points to the divisions in the palisade layer. Figs. 7 & 8. Progressive stages in the reconstitution of the new margin of the leaflet. (All figures × 630).

The stippled cells represent tanniferous cells or oil secreting cells.

region the cells become dilated. It is the latter cells that divide and contribute to the wound tissue. In the present case the pseudocicatrice region may be identified with margin of the leaflet that appears dark in colour. If the dilation of cells is taken to be a criterion for identifying the cicatrice zone, it would correspond to the pale streak area in the affected leaflet. However, divisions are not noted in the cells of this area; after dilation, there is a gradual loss of protoplasts and the cells collapse persisting as debris along the reconstituted margin. On the other hand, the cells that contribute towards the differentiation of wound tissue are those that lie in immediate contact with the latter debris. This difference between Wylie's observations and that of ours may possibly be due to the artificial surgery and natural injury respectively. However, the generality of the wound healing phenomenon in either case remains the same.

The totipotency of parenchyma cells in dicotyledons is becoming increasingly evident through recent experimental studies. The parenchyma cell appears to retain its morphological designation as long as it remains in contact with its neighbouring cells in a given tissue or structure. In the present case the palisade cells and the spongy mesophyll cells continue to retain their morphological identity as long as the lamina remains uninjured. The moment injury occurs, wound tissue proliferates alike from both palisade cells and spongy mesophyll cells of this area; after dilation, there is a gradual loss of protoplasts to differentiate into cell types of the same morphological category, they do differentiate into other cell types associated with the leaf tissue, such as secretory idioblasts and tanniferous cells.

Reference

Wylie, R. B. (1930) : Cicatrization of foliage leaves. 1. Wound responses of certain mesophytic leaves. *Bot. Gaz.* **90** : 260-278.

Agricultural Research—Progress, Problems and Prospects

BY

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(With four text-figures)

LANDMARKS IN AGRICULTURAL EVOLUTION

Taking world agriculture as a whole, the selection of plants suitable for domestication from the extensive wild flora and their subsequent improvement through conscious or unconscious breeding, the conversion of geological deposits into soils and planned efforts to conserve and provide water to crops have been the major components of progress until the 17th century. The next significant advance came with the introduction of cereal-legume rotations and addition of nutrients in the form of fertilizers in the 18th and 19th centuries. The beginning of this century marked the re-discovery of Mendel's laws of inheritance and the use of the principles of genetics in the tailoring of plants adapted to the changing physico-chemical, biological, technological, economic and social components of the environment. This development in turn triggered rapid progress in industrial activity related to agriculture, particularly those relating to fertilizers, pesticides and other agricultural chemicals, machinery and post-harvest technology. A few of the significant landmarks of this recent evolutionary phase are indicated in Table 1 (adapted from Witwer 1969). Countries which have taken advantage of these scientific developments are today faced with the problem of surpluses of farm and animal produce, while those which neglected them are fighting for food self-sufficiency.

FACTORS CONTRIBUTING TOWARDS COMPARATIVE STAGNATION IN AGRICULTURAL PRODUCTIVITY IN INDIA

During the first half of this century more and more food and milk were being produced respectively from less and less land and cow population in several countries of the world. In contrast, productivity remained stagnant in many of our important food crops during this period, although a rise in total production occurred due to an increase in the area both under cultivation and under irrigation. Organised

TABLE 1

SOME SIGNIFICANT MILESTONES IN AGRICULTURAL ADVANCE IN THE 20TH CENTURY

Milestone	Approximate year of widespread use
Hybrid Maize ..	1933
Chlorinated hydrocarbons for insect control ..	1945
Minimum tillage ..	1945
Foliar feeding ..	1945
Direct application of anhydrous ammonia ..	1947
Hybrid Sorghum ..	1957
Chemical weed control ..	1958
Systemic biocides ..	1959
Dwarf wheat ..	1961
Dwarf rice ..	1965
Opaque-2 Maize ..	1965
Gossypol-free cotton seed ..	1969
Hybrid barley ..	1969

scientific efforts in agriculture began with the establishment of the Indian Agricultural Research Institute in 1905 at Pusa in Bihar Research, however, did not make an appreciable impact on production except in crops like sugarcane, largely due to the absence of the developmental substrate essential for research results to strike roots. Research, particularly in the fields of plant breeding and plant protection, did, however, help to minimise the fluctuations in production, excepting those caused by the weather, in crops like wheat and rice. Developments in the post-independence era such as the initiation of the Community Development programme, national extension net-work, irrigation projects, fertilizer factories, and finally the Intensive Agriculture District programme provided the stimulus for a radical reorientation of agricultural research policies and goals. The High-yielding Varieties programme and the National Demonstration programme generated the feed-back relationship between agricultural scientists on the one hand and extension agencies and farmers on the other, which is vital for a dynamic research programme.

REORIENTATION OF RESEARCH GOALS

Half of a scientist's difficulties are over once the problem needing solution is clearly formulated. The widespread awareness now in evidence of the role of science in promoting agrarian prosperity has in turn led to a re-examination and reorientation of research programmes. For example, the following are some of the major research goals in cross breeding set for themselves by the scientists of the Indian Agricultural Research Institute:

(*a*) Enhancement of the content of oral contraceptive principles like Diosgenin present in some plants, so as to help in population control programme.
(*b*) Combining yield with the genetic upgrading of the quality and quantity of proteins present in cereals, pulses, tuber crops and other food as well as fodder and feed crops, so as to contribute towards the elimination of protein-calorie malnutrition.
(*c*) Development of varieties suitable for increasing the income and employment potential of farms of small size through a series of multiple and mixed cropping systems, based on choices and alternatives from an economic standpoint and on sound principles of ecology from the scientific standpoint.
(*d*) Achieving stability of production as well as improvement in yield in areas characterised by low and uncertain rainfall and adverse environmental problems such as flood or alkalinity or salinity.
(*e*) Development of strains in the major agricultural and horticultural plants which would help to achieve the yield potential theoretically possible under a given environment.
(*f*) Breeding varieties of crops which can stimulate the development of industries in areas characterised by poverty and population pressure, such as the monoculture rice belts.
(*g*) Upgrading the quality and yield of industrial crops such as fibre, sugar and oilseed crops.
(*h*) Development and use of genetic techniques for accelerating the pace of breeding for better yield and quality in perennial crops such as fruit and forest trees, plantation crops such as tea, coffee, rubber and pepper, and palms like coconut and arecanut.
(*i*) Tailoring varieties in appropriate plants to the specifications of the food industry and of the export market.
(*j*) Collection and conservation of gene pools.

Development of high-yielding varieties

Exploitation of F_1 hybrid vigour as in mainze, *Sorghum* and pearl millet, the introduction of a plant type possessing a dwarf and non-lodging habit and photo-insensitivity as in wheat and rice and population improvement procedures as in maize and *Sorghum* have been the major genetic mechanisms employed so far in developing crop varieties which respond well to good soil fertility and management. In many of the currently available high-yielding varieties, the total dry matter production is similar to that of the earlier tall varieties, but the harvest index (i.e., the ratio of grain to total dry matter) is far better resulting in higher yield. A further improvement in yield potential can come about if a substantial improvement in total dry matter production together with a high harvest index can be achieved. For achieving this, conceptual models of different crop plants (termed 'ideotype' by Donald 1968) based on a synthesis of knowledge from morphology, physiology, biochemistry, climatology, ecology and pathology would have to be constructed and used in plant breeding programmes.

Some of the selection criteria that will form the basis for the development of new varieties in the future are given in Table 2. In

TABLE 2

CHARACTERISTICS OF CROP IDEOTYPES

1. Hybrid vigour or additive gene action.
2. Early Maturity.
3. High photosynthetic ability.
4. Low photorespiration.
5. Photo-insensitivity.
6. High response to nutrients.
7. Multiple resistance to insects and diseases.
8. Better protein quantity and quality.
9. Synchronised development of inflorescences.
10. Crop canopies that can retain and fix a maximum of CO_2.

our country endowed with abundant sunlight, a major criterion of new varieties should be improved phytosynthetic capability, which can be achieved through selection of plants having better light-receiving systems, leaf surface characteristics most conducive to CO_2 uptake, low perogisome or CO_2—phororespiration and low CO_2 compensation points. The ideotypes drawn up for wheat by Donald (1968) and Asana (1970) are given in Fig. 1.

How high can be the yield of high-yielding varieties?

During a 12-hour day length, about 500 calories/Cm^2 of radiation are received on earth. Of this, only 222 Calories/Cm^2 are in the visible part of the light spectrum and thus useful for photosynthesis. If all this energy is converted into dry matter by plants, 77 g/m^2/day can be obtained, which is equivalent to 770 Kg/ha/day (Loomis, Williams & Duncan 1967). Theoretically, therefore, there is a possibility of producing 281.0 tonnes/ha. of dry matter during a year, provided the photosynthetic rate is not limited by other factors like carbon dioxide, water and nutrition. If a harvest index of 0.5 can be reached, we can get an economic yield of about 140·5 tonnes per hectare per year. The potential yield per day, the highest yield obtained in any National demonstration or trial and the average yield of some of the major cereals, millets, pulses, oilseeds and tuber crops are indicated in Figs. 2 to 4. The data used for constructing these figures are given in Table 3. It would be obvious from this data that while we work towards realising the theoretical potential, we have a long way to go before our average yield attains a respectable relation-

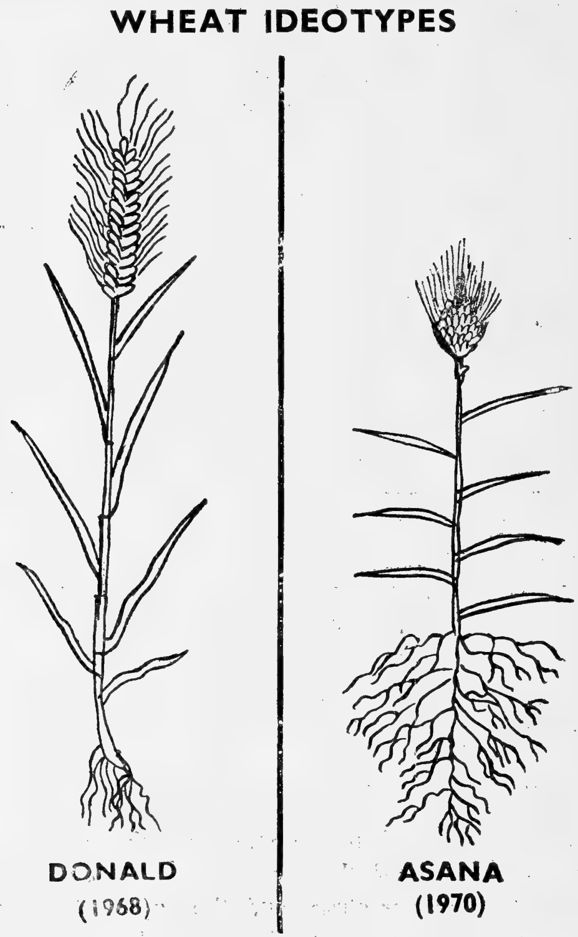

FIG. 1. Conceptual models of the wheat plant developed by Donald (1968) for maximum production and by Asana (1970) for unirrigated conditions. Donald has suggested a uniculm habit with leaves which will not shade each other, while Asana has proposed horizontal leaves for intercepting and retaining dew, a branched ear and a deep root system. Such ideotypes are based on considerable research in production physiology.

ship with the highest yield already reached in the country. The potential for the future is immense, since the maximum yield of the economic product obtained so far in any multiple cropping system is only about 20 tonnes per hectare per year in contrast to the theoretical possibility of about 140 tonnes/ha/year. The scope for research on enhancing the production potential is particularly great in pulses, oilseeds and tuber crops (Figs. 3 & 4).

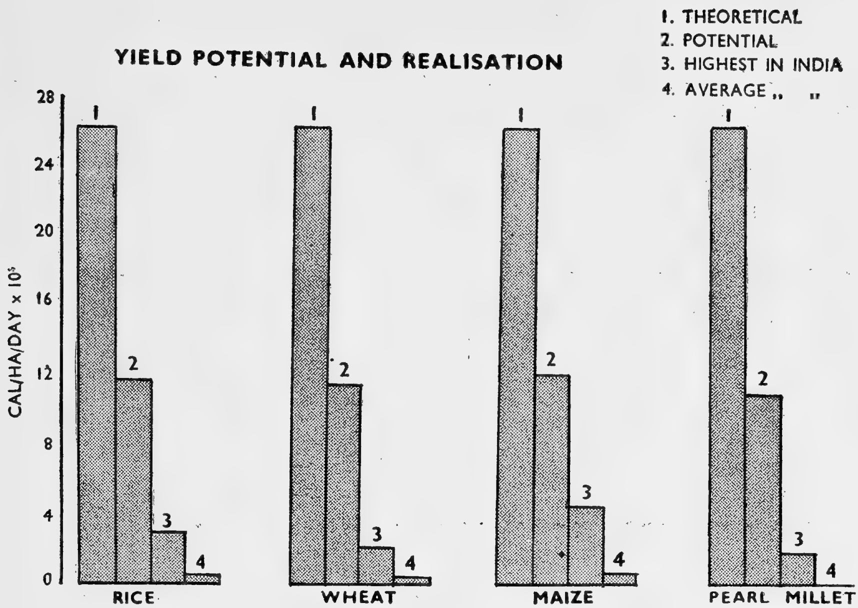

FIG. 2. The actual and potential yields in rice, wheat, maize and pearl millet.

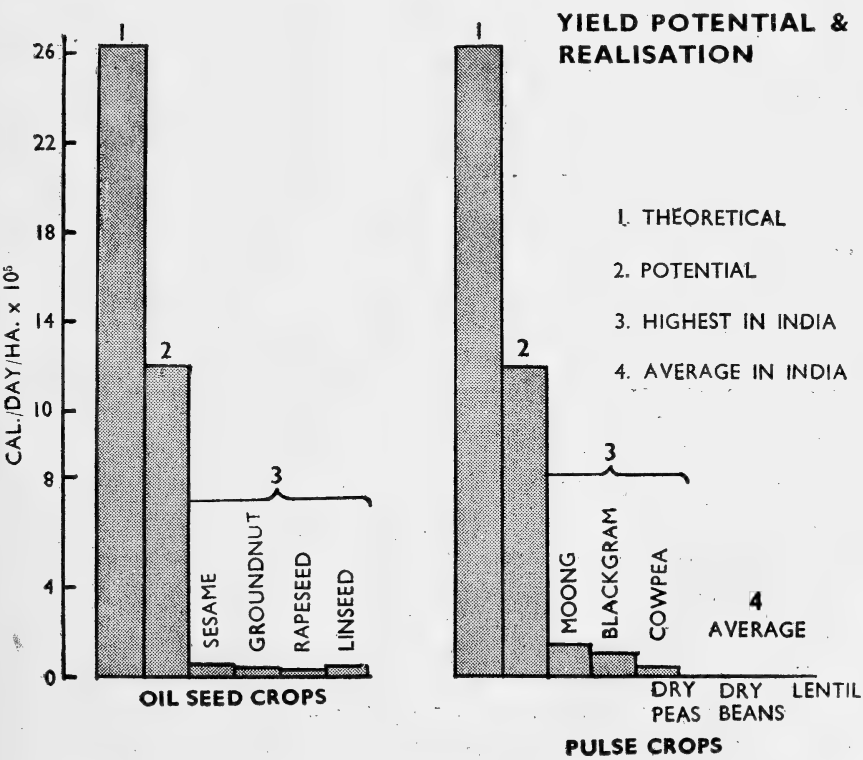

FIG. 3. The actual and potential yields in oilseeds and pulse crops. Note the enormous scope for improvement.

AGRONOMY FOR HIGH YIELDS

The agronomic practices adopted will determine whether or not the yield potential of a variety will be realised. Some of the new

TABLE 3

AVERAGE & HIGHEST PRODUCTIVITY REPORTED IN INDIA
CEREALS & MILLETS

Crops	Average	Q/Ha. Highest	Cal/Kg.	Vegetation Period	Cal/ Ha × 10^6	Cal/ Ha/day × 10^5
Rice ..	16·0	100·00	3520	120	35·20	2·93
Maize ..	11·3	110·00	3630	90	39·93	4·43
Wheat ..	11·7	71·63	3440	120	24·64	2·05
Sorghum ..	5·2	98·00	3550	130	34·79	2·67
Bajra ..	3·8	67·10	3270	130	21·94	1·68

TUBER & ROOT CROPS

Crops	Av.	Q/Ha. Highest	Cal/Kg.	Veg. Period	Cal/Ha × 10^6	Edible	Cal/Ha Day × 10^5
Potato ..	80·0	411·00	840	120	34·52	95%	2·62
Tapioca ..	130·0	480·00	1530	300	73·44	85%	2·44
Sweet-Potato ..	58·0	372·00	1140	135	42·40	85%	3·14
Yam ..	58·0	190·00	1130	135	21·47	85%	1·59

trends in agronomy are listed in Table 4. The photo-insensitive nature of the new varieties makes it possible to think and plan *de*

TABLE 4

RECENT TRENDS IN AGRONOMIC RESEARCH

1. High plant density.
2. Weed-free environments.
3. Minimum tillage.
4. Controlled release of fertilizer and bacterial fertilizers.
5. Foliar feeding.
6. Use of low cost anhydrous ammonia as a nitrogen fertilizer.
7. Soil moisture control through irrigation and alteration of structure and permeability.
8. CO_2 fertilisation.
9. Co-ordinated pest and disease control.
10. Aerial application of fertilizer, pesticides and agricultural chemicals.

novo on such problems as sowing dates and seasons. For example, the new hybrids of maize give much higher yield during the *rabi* season than during *kharif*, wherever the temperatures during *rabi* are not too low for maize (Table 5).

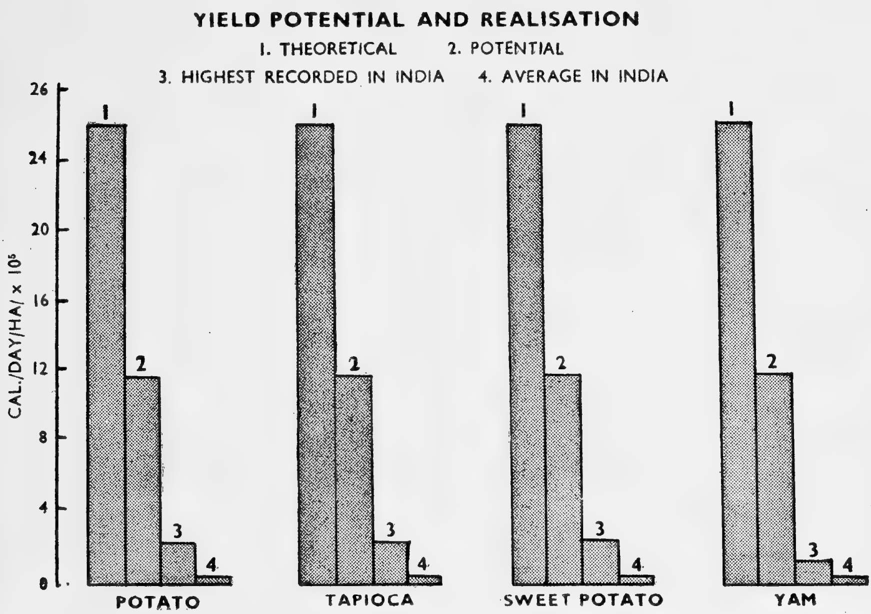

FIG. 4. Actual and potential yields in some tuber crops. The potential for improvement is very great in these crops also.

TABLE 5

MEAN PERFORMANCE OF CERTAIN MAIZE VARIETIES DURING RABI & KHARIF SEASON OF 1965, 1966 AND 1968 AT HYDERABAD

Variety	Mean Grain Yield *Kharif*	Kg./Ha *Rabi*	Percentage of Kharif	
Local ..	5359	5181	96·7	
Deccan ..	5624	7848	139·5	
Ganga-3 ..	5745	7169	124·7	
Ganga-2 ..	5642	5937	105·2	Based on one year data
Ganga 101 ..	4632	5872	126·8	Based on two years Data
Amber ..	4881	8577	175·7	Based on two years Data
Jawahar ..	5219	8280	158·7	Based on two years Data

An important aspect of the agronomic practices should be the 'breeding' of soils suited for sustained high productivity. This would involve simultaneous attention to the physical, biological, chemical and topographical facets of soil fertility. Intensive agriculture based on modern plant breeding without coincident steps in soil breeding would result ultimately in agricultural disaster than agricultural progress. Unfortunately, there has been little realisation of this position so far.

PEST AND DISEASE CONTROL

It is practically impossible to breed a variety possessing resistance to all pests and diseases as well as high yield and quality. This is both due to the wide variability occurring within the pest and pathogen populations as well as due to various forms of negative relationships existing in the plant with regard to mechanisms of resistance. For example, rusts of wheat survive best in the host plant when the cells contain high sugar. In contrast, pathogens like *Alternaria* and *Helminthosporium* grow better when the level of sugar in the cell is low. Hence, what is needed in every crop plant is the development of a co-ordinated strategy of control, involving an appropriate admixture of genetic, chemical and agronomic approaches. Diseases and pests, which can be avoided by simple agronomic procedures such as a change in the date of sowing, are best eradicated in this manner. With the rapid development of the seed industry, seed-borne diseases can be controlled through seed treatments. Genetic control will be the method of choice, where usable sources of resistance are readily available and where a disease or pest is very widespread in its occurrence. The approaches likely to give the best

TABLE 6

CO-ORDINATED DISEASE & PEST CONTROL IN *Sorghum vulgare*

Disease/pest	Casual Agent	Strategy of Control: Genetic	Chemical	Agronomic
Sugary disease	*Sphacelia sorghi*	—	+	+
Downy mildew	*Sclerospora sorghi*	+	—	+
Grain smut	*Sphacelotheca sorghi*	—	+	—
Loose smut	*Sphacelotheca cruenta*	—	+	—
Leaf rust	*Puccinia purpuria*	+	+	—
Leaf blight	*Helminthosporium turcicum*	+	—	—
Shoot fly	*Atherigona varia soccata*	—	+	+
Stemborer	*Chilo zonellus*	+	+	—
Midge	*Contarinia sorghicola*	—	+	+

results in *Sorghum* are indicated in Table 6. Such exercises will have to be done in each crop.

Development of an ecology-cum-economics based multiple cropping 'Cafeteria' system

Multiple or relay cropping would help to increase the income and employment potential of holdings of small size. However, the intensive exploitation of land and unscientific crop rotations could lead to very undesirable consequences. There should, therefore, be some ground rules in the introduction of multiple cropping patterns. Among these are:

(1) No two crops sharing in common the same pests and diseases should be grown in succession.

(2) One crop should be deep rooted and another with more shallow roots, so that different layers of the soil can be tapped for nutrients. Varieties of crops also differ in rooting pattern and if a deep-rooted crop like cotton is grown during *kharif*, a wheat variety like Sonalika or Sharbati Sonora suffers less from micro-nutrient deficiency than Kalyan Sona which also taps nutrients from the lower layers of the soil.

(3) Attention to the restoration of soil fertility through the cultivation of at least one leguminous crop should find place in the rotation. If the stalks of maize are not needed for feeding cattle, their incorporation in the soil helps to improve soil structure. On the above lines we should evolve for each agro-climatic areas, a multiple cropping 'Cafeteria' with a wide choice of alternative crops from which the farmer can choose an appropriate combination suited to his needs and input-mobilizing potential and the demands of the market (Table 7).

Table 7

Breeding varieties for a multiple cropping 'cafetaria' at Delhi

Mid-April/Mid-June	Late June-Sept.	October-December	Late December/ Mid-April
Green Gram (Pusa Baisakhi)	*Maize* (Ganga-5 Jawahar Hi-Starch)	*Potato* (Kufri Alankar Kufri Chamatkar)	*Wheat* (Sharbati Sonora, Sonalika)
Cow Pea (Phalaguni)	*Sorghum* (C.S.H.1)	*Vegetables* *Mustard* (Suphala DS-17 M)	*Barley* (K 15/96-1, BDH-4)
	Pearl Millet (H.B.1, H.B.4)		*Oats* (Kent Early Russian)
	Cotton, Fodder Crops Rice (B.C.5 and B.C.6)		*Vegetables*

Multiple cropping is a very potent instrument for improving the economic position of a farmer with a small holding and for banishing under-employment and unemployment. Studies in the Agricultural Economics Department of the Punjab Agricultural University have clearly shown that the employment potential of agriculture can be greatly enhanced by double cropping in lands with irrigation facilities. Studies have also revealed that in the Ludhiana District, there has been an appreciable increase in real income among all classes of farmers, big, medium and small, as well as among landless labour. This is not true in many other I.A.D.P. districts where the farming technology has not become as advanced as in the Punjab. In as much as 69 per cent of our work-force will depend upon agriculture for employment even by 1981, the social significance of a technological upgrading of the employment potential of our cropping systems is obvious.

In addition to the economic and sociological advantages of multiple cropping in irrigated areas this tool, if deployed scientifically, can also become a powerful method of minimising the incidence of pests and diseases. Examples of a multiple cropping system based only on economic considerations and of one on the ecology-cum-economics concept and analyse their biological implications follow. With water becoming available in many of the River Valley Projects, there is a great temptation to grow two or three crops of rice one after the other. Even in summer, paddy cultivation is becoming popular but already it is clear that where summer paddy is grown pests like jassids become serious in the succeeding *kharif* paddy crop, as was observed in parts of Bihar last year. Conversely, in some parts of Bihar where a mono-culture of tobacco was formerly adopted there was a serious incidence of *orabanche*. When tobacco was introduced into a multiple cropping system involving crops like wheat and maize, the *orabanche* menace began to reccede.

Enhancing the yield and income of unirrigated agriculture

Recent research has shown that apart from the limitations imposed by low and uncertain moisture levels, the missing links in elevating and stabilizing yields of rainfed agriculture have been the non-availability of crop varieties of suitable duration and growth rhythm, poor plant population, absence of attention to rectifying the defects in soil structure, improper tillage, lack of application of nutrients and plant protection procedures and poor storage and marketing. In addition, problems like fragmentation of holdings and lack of organised supply of inputs made the few steps taken in the past in the field of soil and moisture conservation even less effective than they might have otherwise been.

Much progress can be achieved in rainfed farming if a new technology is introduced, comprising of the following components: (1) land consolidation and soil conservation, (2) improvements in tillage leading to better soil structure and root penetration, (3) addition of organic matter in the form of plant residues with a view to improving the physical and biological characteristics of the soil, (4) adoption of water-harvesting procedures resulting in storing as much of the precipitation as possible for the use of crops, (5) addition of plant nutrients through deep placement of fertilizers and foliar feeding, if necessary by aircraft, (6) improving the biological fixation of nitrogen through the use of efficient strains of rhizobia, particularly those which are tolerant to salt and use of pelleted bacterial cultures for buffering the bacteria against acidity and alkalinity, (7) the introduction of photo-insensitive and quick maturing crops which are less affected by drought, (8) replacement of a single long duration crop with a series of double and mixed crop rotations from which the farmer can be advised to adopt the one which is most suited to the likely weather pattern during a season and to giving him the maximum income, (9) popularisation of crops like Soyabean, high-protein maize, macaroni wheat, short-duration varieties of castor and cotton and perennial crops like cashewnut, oil palm and dates which can form the base for small scale food industries and export earnings, (10) popularisation of high-yielding fodder grasses and high protein bajra, and (11) genetic upgrading of the non-descript cattle population by an extensive programme of artificial insemination using superior breeds particularly European breeds, acclimatised in the tropical parts of Australia. While the above would constitute the major ingredients of an immediate action plan, a systematic survey and development of ground water resources should be continued so as to further increase the income potential of agriculture in the dry areas. A book entitled A NEW TECHNOLOGY FOR DRY LAND FARMING has been published recently by the Indian Agricultural Research Institute, which gives details of the research carried out in this field.

Banishing malnutrition

The major contributions of agricultural research in this field are the following:

(a) *Genetic upgrading of protein quality in staple grains:*

It is now possible to upgrade the quality of proteins in cereals, millets and other food crops very considerably by genetic techniques.

Composite varieties of maize possessing protein properties nearly similar to that of milk are now under multiplication (Table 8). High protein varieties of rice and wheat as well as a highly nutritive new cereal, *Triticale*, are under development. A great merit of this approach is that a dent on the malnutrition problem can be easily made without any special educational effort.

TABLE 8

IMPROVEMENT OF THE AMINO-ACID COMPOSITION OF MAIZE BY THE INCORPORATION OF OPAQUE-2 & FLOURY-2 GENES OF AMINO-ACID/100g. PROTEIN

	Ganga-3	Yellow Opaque-2	Yellow Floury-2	White Opaque-2
Protein% ..	10·3	10·6	11·6	11·5
Glutamic Acid ..	23·3	20·6	19·9	18·3
Lysine ..	1·6	3·5	4·1	4·2
Leucine ..	17·2	11·4	11·6	10·7
Isoleucine ..	3·9	4·0	3·6	4·3

(b) *Increasing the production of pulse crops:*

New short-duration and high-yielding varieties of the major pulse crops such as *Cajanus cajan, Phaseolus aureus* and *Phaseolus mungo* have been developed, so that pulse crops can find a place in the rotations in irrigated areas. Much of the area under pulses is rainfed and for these areas both better varieties and suitable methods of applying rhizobial cultures have been developed.

(c) *Increasing vegetable and fruit production:*

These crops have received very little scientific attention so far. In recent years, several new varieties and hybrids have been developed and released in vegetable crops. If these are grown with an integrated schedule of pest control, the production can go up substantially. Research on fruit tree improvement through the development of good rootstock, new varieties and better management practices is now receiving serious attention. The new mango varieties developed at IARI offer great promise. A Demonstration orchard with plants raised on dwarfing root stocks and dwarf hybrid varieties is being developed at the IARI to show how the new plant type can facilitate good orchard management. Though the demonstration plot has been named 'Orchard of the 21st Century', it is hoped that such orchards will become common in our country by 1980.

(d) *Increasing animal production:*

It is well known that India is the largest reservoir of under-utilised cows in the world. The problem of improving animal productivity has two aspects, one relating to increasing the production of fodder and feed and the other to the genetic upgrading of the milk-yielding potential of our breeds and more particularly of non-descript cows and buffaloes. With regard to the fodder problem, the main emphasis should be on the development of high-yielding-cum-high quality fodder crops, so that the supply of concentrates to animals, becomes unnecessary. Maize and millets should also be increasingly used as animal feeds.

A new approach to the rapid genetic upgrading of the milk yielding potential of cows is the use of 'tropicalised' versions of European breeds in our artificial insemination programmes. The value of this approach has become apparent from the results of the cross-breeding experiments carried out at IARI between Sahiwals and Friesians from Australia. India should sponsor a Collecting Team of Animal Genetics to the tropical parts of Australia, Latin America and Africa, for collecting European breeds introduced 2 to 3 centuries ago and which have undergone selection for adaptation to tropical climate. The expense involved in sending such a 'Tropicalised European breed Collecting Expedition' will result in a big pay-off.

Need for exploiting synergetic interactions

If agricultural research is to be effective in canalising the powerful tools of modern science for eradicating hunger and poverty, the most important need is achieving synergetic interactions among scientists working in different disciplines on the one hand and among scientists, extension workers and political and administrative leaders on the other. Synergy or the mechanism which makes the whole something very much more than the sum of the parts, has been the most potent principle involved in evolutionary advance and is the only mechanism which can help a poor Nation to realise its economic aspirations. To cite one example of the use of this principle in evolution, our important cereal, breed wheat, has three parents, *Triticum monococcum*, *Aegilops speltoides* and *Aegilops squarrosa* which are individually poor plants but collectively make the king of cereals. Harnessing and maximising such synergetic effects should be the primary goals of our agricultural research and development policies.

ACKNOWLEDGEMENTS

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REFERENCES

ASANA, R. D. (1970) : A New Technology for Dry Land Farming—*Indian Agricultural Research Institute, New Delhi*. pp. 55-63.

DONALD, C. M. (1968) : The design of a wheat ideotype. *Proc. 3rd International Wheat Genetics Symposium, Canberra*. pp. 377-387.

LOOMIS, R. S., WILLIAMS, A. W. & DUNCAN, W. G. (1967) : Community Architecture and the productivity of terrestrial plant communities. In harvesting the Sun, Photosynthesis in Plant Life. pp. 291-308.

WITWER, S. H. (1969) : Agriculture for the 21st Century. Proc. 19th Annual National Potato Utilization Conference, Michigan. (In Press).

Trends in intraspecific sex-limited variations in some mycophagous Tubulifera (Thysanoptera)

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(*With six text-figures and three graphs*)

The saprophytic fungus habitat forms an important ecological niche inhabited by a proportionately large number of thrips species, more predominantly the Tubulifera, which appear to have established themselves quite successfully in this zone. Seldom are they found alone, but are mostly gregarious, providing an unique opportunity to study species associations, in particular their dynamics, often revealing an unbelievably large degree of intraspecific diversity. In order to be able to recognise and interpret these variations which are more often confined to only the male sex, consistent field work coupled with years of experience are vital, in particular to avoid the risk of adding to our already long list of synonyms. Variations are magnified to a very large extent by the high incidence of heterogony or allomorphosis or absolute size allometry of adults, making the morphological definition of the species very difficult. A finely intergraded series is more often noticeable in populations of such species and the two extremes are often referred to as the minor or gynaecoid males and the major or oedymerous males. Oedymerism as defined earlier (Ananthakrishnan 1966) involves the development of bizarre forms with strikingly enlarged parts affecting mostly the structure and armature of the forelegs and incident changes in thoracic structure, while gynæcoidism results in opposite traits, with weakly developed forelegs having armature highly reduced and wanting and resembling the females in general make up. This does not result in reproductive incompatability as it has been observed in the rearing of *Tiarothrips subramanii* (Ramakrishna) and *Kleothrips gigans* Schmutz in the laboratory, that the gynæcoid males were freely engaged in copulation as much as the normal and œdymerous males.

The possibility that an odd gynaecoid or an œdymerous male on which a species is based, might only be one of the morphs of the highly variant males cannot be ignored. Many Oriental and African species of the genus *Elaphrothrips* Buffa have been described on such uniques. The most striking heterogonic character in this genus is the nature of the foreleg armature, in particular the sickle-like bristle, absent in the gynæcoid males. In some species as *Elaphrothrips mucronatus* Priesner and *E. productus* Priesner further heterogony is shown in the degree of development of the 7th and 8th abdominal segments which may be as long as wide in the gynæcoid males and to more than twice as long in the œdymerous males. Again, examination of large series of *Dinothrips sumatrensis* Bagnall has confirmed Priesner's earlier suggestion (1959) that *D. jacobsoni* Karny, *D. celebensis* Bagnall and *D. sumatrensis* Bagnall are only the gynæcoid, intermediate and œdymerous forms of one species

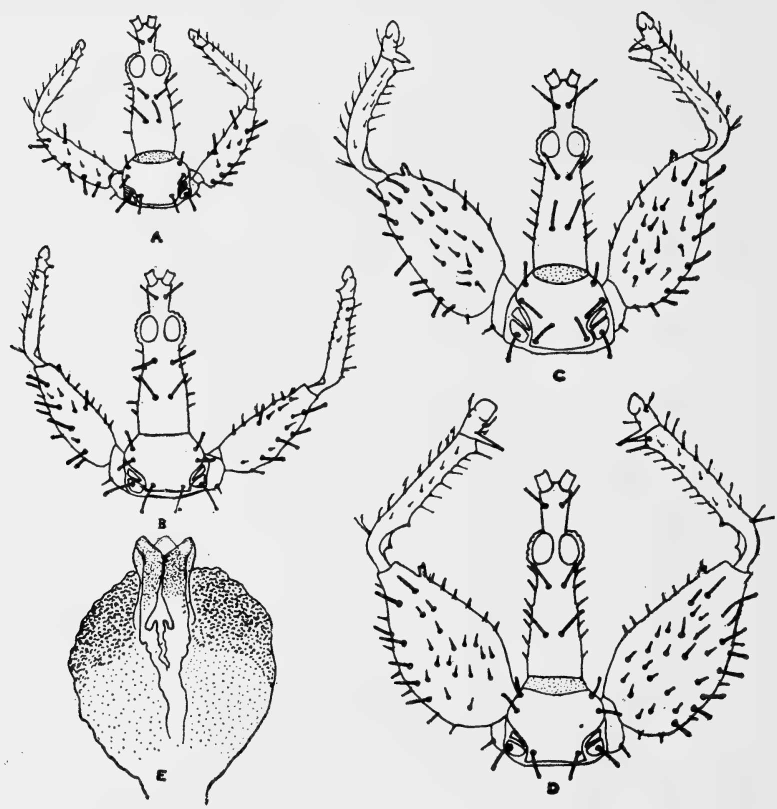
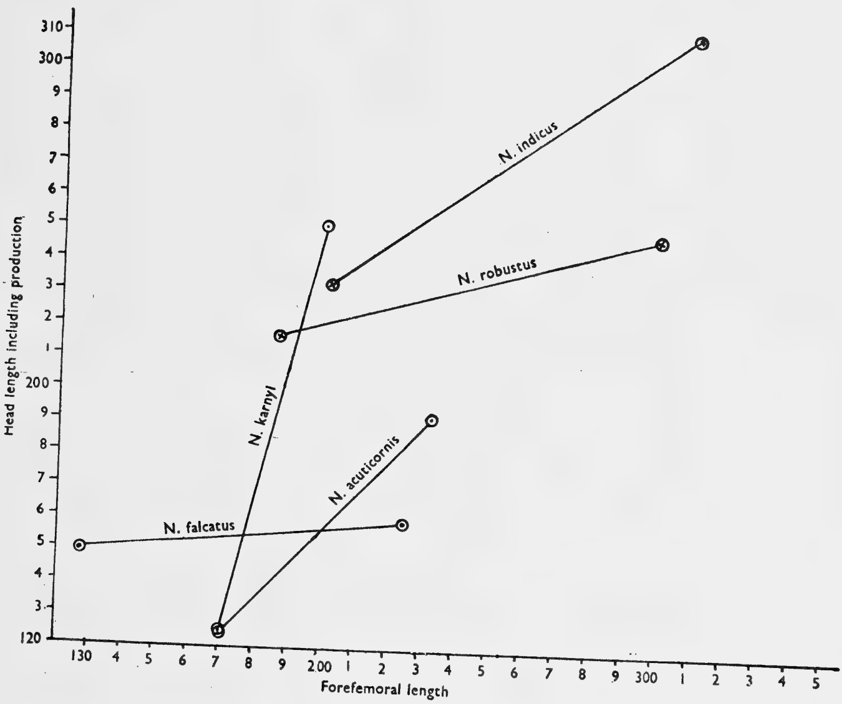


FIG. 1. The gynæcoid, œdymerous and intermediate forms of *Kleothrips gigans*. *A*. Gynæcoid male, *B*. Normal male, *C*. agama phase, *D*. Oedymerous male, *E*. Male genitalia.

D. sumatrensis (Fig. 2). Similarly Ananthakrishnan (1961) working with large populations of *Ecacanthothrips sanguineus* Bagnall concluded that several species mostly based on uniques or a few isolated specimens are all synonymous with *E. sanguineus*. Characters adopted in the erection of such species based on body colour, proportions of the head, the structure of the forefemora and tibia, the coxal prolongations in the males, the number and position of the foretibial tubercles and even the number of sense cones on antennal segment 3, as well as the number of accessory setae on the forewings, were found to be very inconsistent in view of the enormous range of variation exhibited by individuals of a population. Again Ananthakrishnan (1969) on the basis of examination of large populations of *Kleothrips gigans* Schmutz, has indicated that *K. simplex* (Bagnall) may be the gynæcoid form, while *K. agama* Priesner hitherto considered to be distinct is only a phase in œdymerism of the species (Fig. 1 & Graph 1). This is also the case observed in *Elaph-*



GRAPH 1. Relation between forefemoral length and head length in the males of some species of *Nesothrips*.

rothrips mucronatus, E. productus, etc. where also two distinct phases exist in œdymerism, viz. one with foretarsal tooth thin and straight and the other where it is more stout and beak-like. The fact that the males of a species show maximum œdymerism need not imply the development of a strong armature as in *Pygothrips* Hood, some species of *Nesothrips* Kirkaldy as *N. indicus* Ananthakrishnan, & *N. robustus* Ananthakrishnan. On the contrary the œdymerous males of several species like *Nesothrips falcatus* Ananthakrishnan, *N. acuticornis* (Hood), *Ecacanthothrips sanguineus, Hoplothrips fungosus* Moulton, *H. transvaalensis*, etc., reveal a wide variety of structures like coxal spines, forefemoral teeth and spines, foretibial teeth, excessively developed foretarsal teeth, lateral or median meso- or metanotal processes and tooth-like prolongations on cheeks below eyes totally unknown in the gynæcoid forms, leaving therefore an enormous gap between the two extremes (Fig. 3). Naturally the patterns of development differ in the males of different species or species groups. Two closely allied species may possess almost similar characteristics among the females, but the pattern of œdymerism will vary as in *Nesothrips falcatus* and *N. acuticornis*, *N. indicus*, *N. robustus* and *N. formosensis karnyi* Priesner. Ananthakrishnan (1968) indicates that in the assessment of allomorphosis three indices may appear significant for species comparison in relation to growth diversity, viz. HL/FL, HW/FW, TL/FL and only in cases lacking of specialisation of the forelegs there are very close similarities between the two sexes, whereas in those mycophagous species showing sex limited diversity, not only are the allomorphic indices substantially different in the two sexes, but also very much different among the two extreme variants (Table 1). Inciden-

TABLE 1

ALLOMORPHIC INDICES

Species	HL/FL		HW/FW		TL/FL	
	G	O	G	O	G	O
Azaleothrips amabilis ..	1·2	1·2	2·4	2·4	0·66	0·7
Hoplandrothrips indicus ..	1·0	0·63	2·5	2·44	0·9	0·73
Hoplandrothrips graminis ..	1·3	1·0	2·5	1·4	0·8	0·6
Ecacanthothrips sanguineus ..	1·2	0·8	1·9	0·6	0·8	0·65
Hoplothrips fungosus ..	0·9	0·45	1·4	1·0	0·6	0·4
Hoplothrips transvaalensis ..	1·1	0·6	2·4	1·4	0·66	0·4
Hoplothrips orientalis ..	1·2	0·7	2·0	1·0	0·8	0·45
Sophiothrips parviceps ..	1·25	0·85	2·3	1·5	0·6	0·45
Strepterothrips orientalis ..	1·8	1·0	3·0	1·6	0·8	0·5
Idiothrips ficus ..	1·2	0·66	2·2	1·9	0·6	0·6
Stictothrips orientalis ..	1·4	1·5	2·0	2·2	0·8	0·6
Neurothrips indicus ..	0·6	0·75	2·2	1·7	0·5	0·38
Polyphemothrips cracens ..	1·1	0·8	1·0	1·25	0·65	0·45
Allothripsb icolor ..	1·7	1·1	3·0	1·4	0·85	0·6
Nesothrips falcatus ..	1·0	0·73	2·5	1·9	1·5	0·53
Nesothrips acuticornis ..	1·0	0·66	2·5	1·4	0·63	0·5
Nesothrips indicus ..	1·1	1·15	2·5	2·1	0·79	0·8
Nesothrips robustus ..	1·25	0·82	2·6	1·4	0·8	0·52
Nesothrips formosensis karnyi ..	1·0	0·62	2·3	1·6	0·75	0·65
Kleothrips gigans ..	1·5	1·0	1·45	0·45	0·9	0·8
Tiarothrips subramanii ..	2·0	1·9	1·8	1·0	0·8	0·66
Priesneriana kabandha ..	1·1	1·0	2·2	1·7	0·75	0·6
Dinothrips sumatrensis ..	0·95	0·9	1·3	0·92	0·9	0·82
Pygothrips amplus ..	0·6	0·7	1·7	1·25	0·4	0·5
Elaphrothrips dallatorensis ..	1·4	1·23	2·5	1·15	1·2	0·73
Elaphrothrips mucronatus ..	1·3	1·2	1·66	0·9	1·9	1·0
Elaphrothrips productus ..	1·5	1·25	1·75	0·65	0·8	0·6

Note : HL/FL—Head length/Forefemoral length ; HW/FW Head width/Forefemoral width ; TL/FL—Foretibial length/Forefemoral length ; G—Gynæcoid ; O—Oedymerous.

The index refers to the ' Maximum ' *viz.* between the Gynæcoid and Maximum Oedymerous forms so far known.

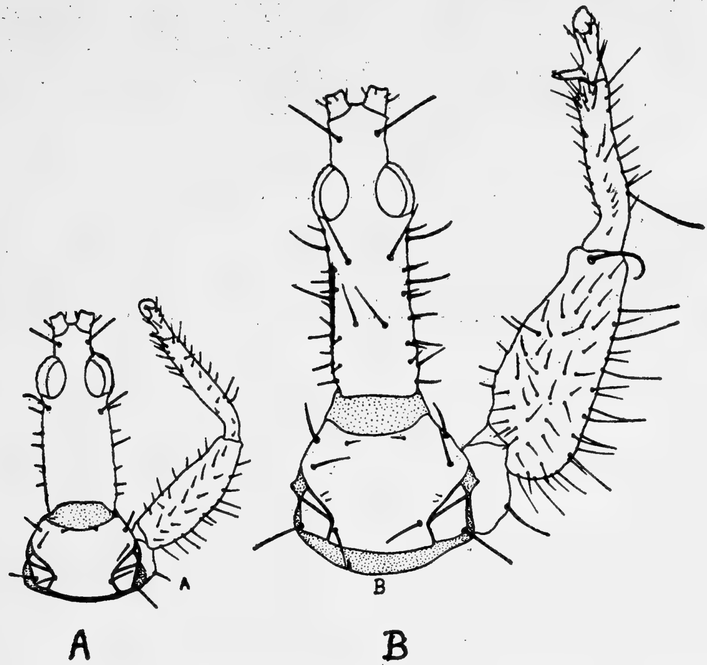
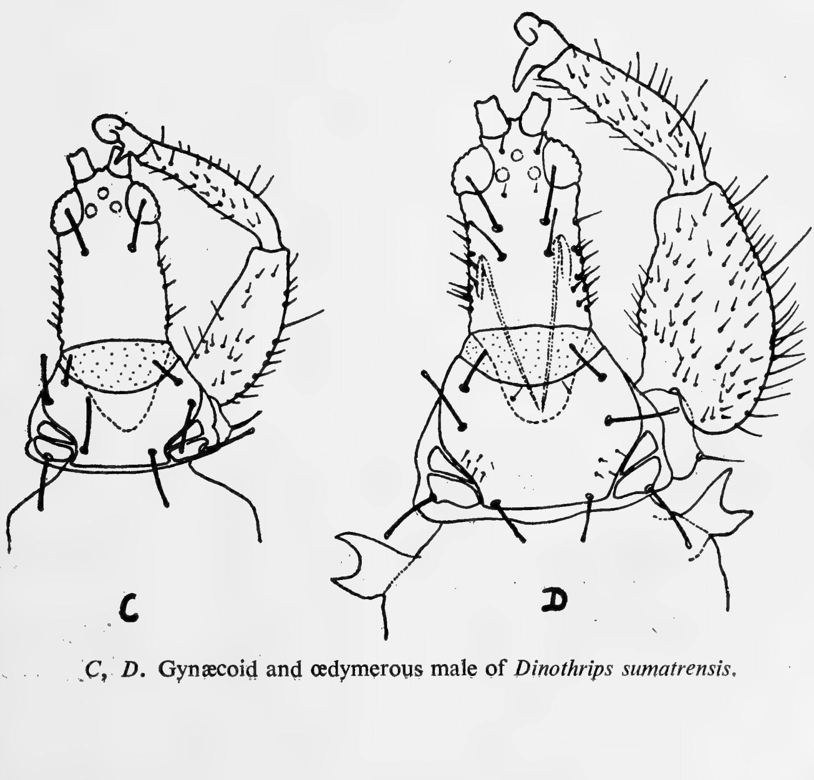


FIG. 2. *A*, *B* Gynæcoid and œdymerous male of *Elaphrothrips mucronatus*.

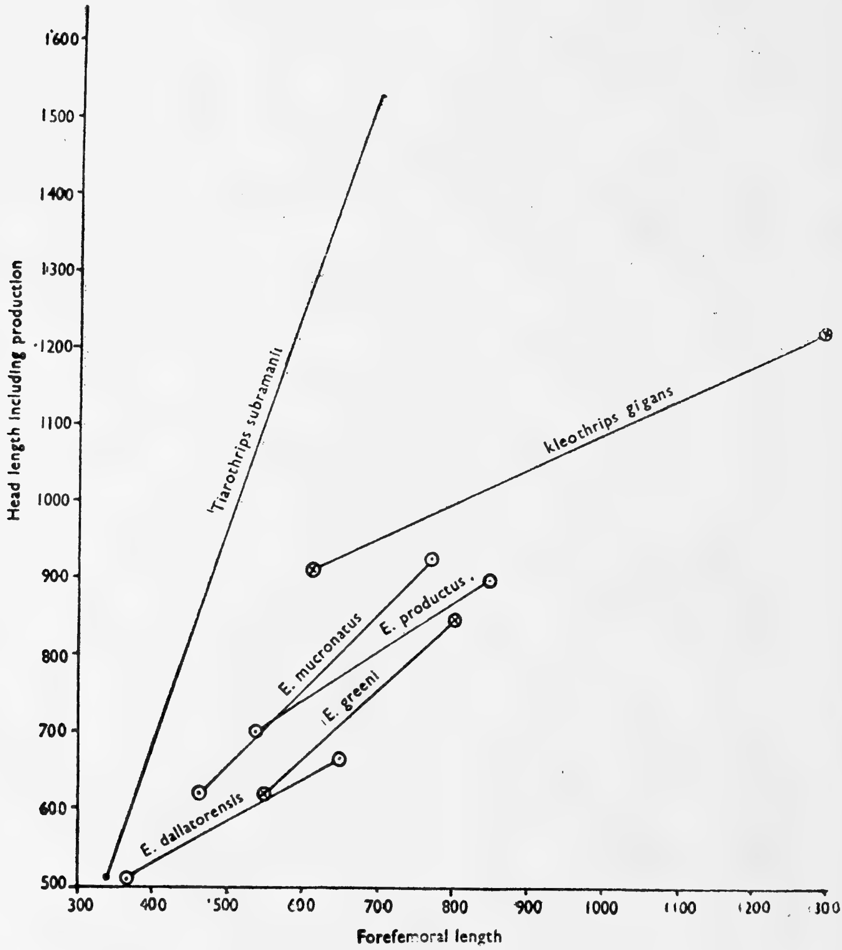


C, *D*. Gynæcoid and œdymerous male of *Dinothrips sumatrensis*.

tally mention may also be made of mycophagous Tubulifera wherein such recognisable and significant variations are absent as in several Urothripids, species of *Adraneothrips* Hood, *Stigmothrips* Ananthakrishnan, *Malacothrips* Hinds, *Meiothrips* Priesner etc.

Thrips fauna of the Saprophytic fungal zone

Among the Phlaeothripini some species of *Hoplandrothrips* Hood, *Azaleothrips* Ananthakrishnan, *Phlaeothrips* Haliday, *Malacothrips* Hinds, *Ecacanthothrips* Bagnall, *Pygmaeothrips* Karny, etc. frequently occur, but



Graph 2. Relation between the forefemoral length and the head length in the males of *Tiarothrips*, *Kleothrips* and some species of *Elaphrothrips*.

species of *Phlaeothrips* Haliday, *Malacothrips* Hinds, *Mystrothrips* Priesner, *Adraneothrips* Hood, *Stigmothrips* Ananthakrishnan and *Pygmaeo-*

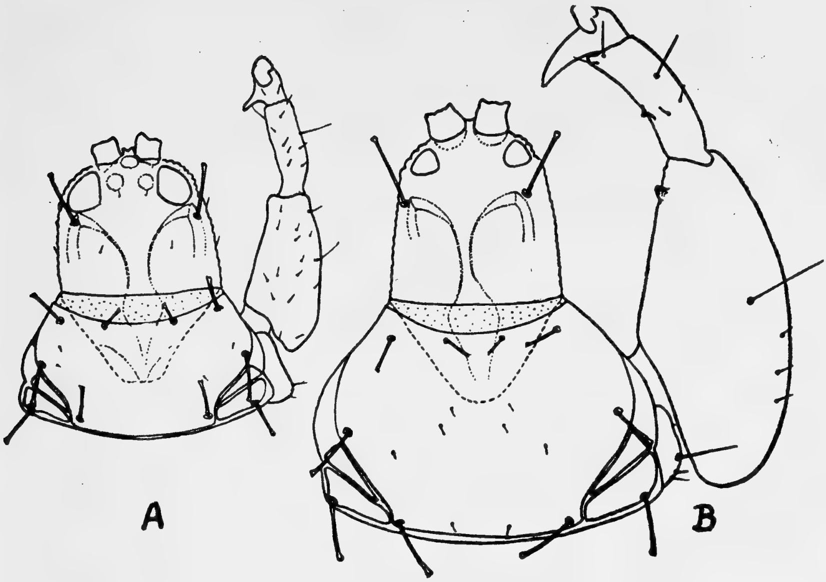
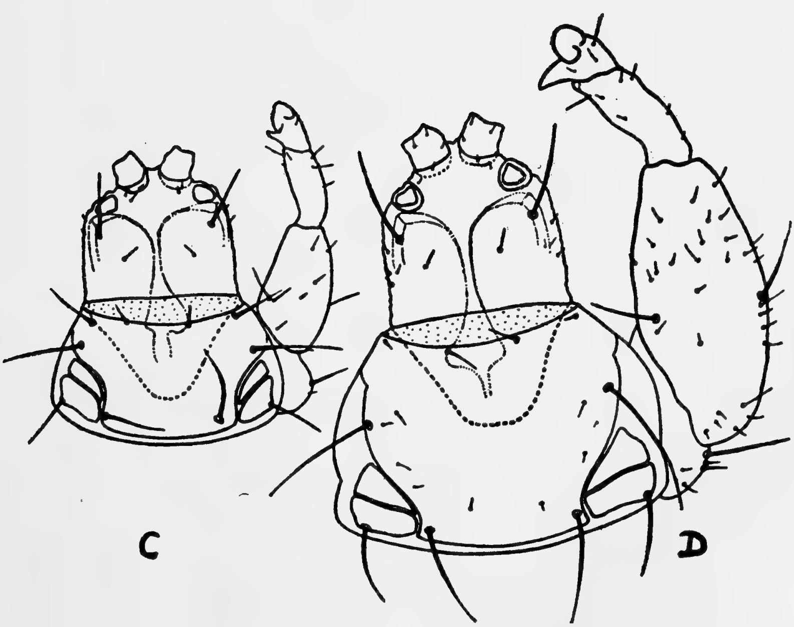


FIG. 3 *A, B.* Gynæcoid and œdymerous male of *Hoplothrips fungosus.*



C, D. Gynæcoid and œdymerous male of *Hoplothrips transvaalensis.*

thrips Karny do not present remarkable sex-limited diversities as the foretarsi are usually unarmed in both sexes, *Hoplandrothrips* Hood, *Ecacanthothrips* Bagnall and to a limited extent *Strepterothrips* Hood, *Neurothrips* Hood and *Idiothrips* Faure exhibit profound variation. The Plectrothripini appears exceptional in having females of the major and minor types, differing very significantly. The Hoplothripini also include such genera as *Hoplothrips* Serville, *Sophiothrips* Hood, frequently abounding in the fungal niches, with extreme specialisation shown by the males of many species of *Hoplothrips* Serville. The best examples of such structural diversity are met with among the Megathripinae including in it a welter of species, showing variants of many types. Species of *Elaphrothrips* Buffa, *Dinothrips* Bagnall, *Paxillothrips* Ananthakrishnan, *Tiarothrips* Priesner, *Kleothrips* Schmutz, *Nesothrips* frequently reveal such remarkable diversities, while others like *Allothrips* Hood, *Loyolaia* Ananthakrishnan, *Priesneriana* Ananthakrishnan, *Diceratothrip* Bagnall, *Diaphorothrips* Karny and *Uredothrips* Ananthakrishnan show this feature to a restricted degree. Among the Diceratothripina the genus *Machatothrips* Karny shows more diversity in the females in view of this sex possessing the heavily armed forefemora. *Bunothrips cruralis* Ananthakrishnan, a Hoplothripine species also shows more diversity in the females. It may be emphasised that all the species in a genus say like *Nesothrips* need not necessarily develop identical patterns of diversity, requiring therefore absolute caution before concluding on the identity of the species.

Coming to the nature of species associations in this zone, field studies show that monophagous species among saprophytic fungus feeders are rare and *Tiarothrips subramanii* feeding in large numbers on the dried fungus infested leaves of *Borassus flabellifer* is a typical example. *Kleothrips gigans* Schmutz may be said to be oligophagous in the restricted sense as it abounds invariably in the decaying sheaths and leaves of *Areca catechu* in the company of swarms of *Stigmothrips limpidus* Ananthakrishnan and *Meiothrips menoni* Ananthakrishnan as well as in the dried leaves of *Mangifera indica* especially in forest areas, being found along with *Meiothrips menoni* and *Stigmothrips consimilis* Ananthakrishnan. Frequently associated with the polyporous fungi (*Poria* sp.) usually on the dry fungus infested twigs of *Barleria* sp. are *Polyphemothrips cracens* Ananthakrishnan, *P. indicus* (Ananthakrishnan) and *Hoplothrips fungosus* Moulton, while similarly infested jasmine twigs yield considerable material of *Sophiothrips parviceps* Hood and *Hoplothrips fungosus*. *Polyalthia longifolia* twigs have yielded *Uredothrips indicus* Ananthakrishnan, *Pygothrips amplus* Faure, *Priesneriana kabandha* (Ramakrishna) and *Hoplothrips transvaalensis* (Hood); twigs of *Lantana* harbour plenty of *Nesothrips formosensis karnyi* Priesner and Urothripids while the dry twigs of *Smilax* offer plenty of material of *Nesothrips falcatus*

Ananthakrishnan, *Elaphrothrips crassiceps* Bagnall, *Stephanothrips occidentalis* Hood & Williams, *Diceratothrips brevisetosus* Ananthakrishnan & Jagadish, etc.

KEY TO MALES OF MYCOPHAGOUS TUBULIFERA BASED ON GYNÆCOID-ŒDYMEROUS TRAITS

1.	Maxillary stylets slender, thinner than labial palps, rarely moderately thickened as in *Polyphemothrips*; B2 of abdominal segment IX short (Phlaeothripinae)	2
	Maxillary stylets broad, band-like thicker than labial palps; B2 of IX abdominal segment mostly subequal with the rest (Megathripinae)	12
2.	Forewings Stictothripine, œdymerous males without profound modification. Body strongly reticulate	3
	Wings not Stictothripine, usually parallel-sided. Oedymerous males often showing profound diversity	6
3.	Antenna 7-segmented	4
	Antenna 8-segmented	5
4.	Head elongate; œdymerous males with forefemora much elongate and stout, foretibia at apex with a strong tooth, foretarsal tooth strong and curved and mesonotum with distinct lateral spines. Antenna 7-segmented, segment 3, short, flat.	*Strepterothrips* Hood (*S. orientalis* Ananthakrishnan)
	Head about as long as wide; œdymerous males with simple forelegs and tibial tooth and mesothoracic spur absent. Antennal 7 much smaller than 6; 3 and 5 whitish.	*Idiothrips* Faure (*I. fici* Bhatti)
5.	Abdominal segment X long and cylindrical, anal setae several times longer than tube. Forefemora of œdymerous males, long and stout i.e. heavy, foretarsal tooth strongly developed. Wings not reticulate	*Neurothrips* Hood (*N. indicus* Anan.)
	Tube and anal setae normal; forelegs of œdymerous males not long and heavy as in *Neurothrips*, almost showing slight enlargement of forefemur. Wings clearly reticulate.	*Stictothrips* Hood *S. fimbriata* (Anan.)
6.	Wings comparatively narrow, with a feeble constriction at middle	7
	Wings not narrow, uniformly parallel-sided	9

7. Cheeks smooth, head reticulate, body setae short, expanded. Oedymerous males with forefemora heavy as in *Neurothrips* and foretarsal tooth strong. — *Azaleothrips* Anan. (*A. amabilis* Anan.)

   Cheeks with strong spines often on warts; weakly reticulate. Oedymerous males with strongly developed pronotum and forelegs strongly armed — 8

8. Sense cones on antennal segment 3 arranged in a ring. Forefemora of œdymerous males very much wider than head, with a strong tooth at base and apex; outer margin concave, with numerous long hairs. Forecoxae considerably prolonged in the œdymerous. — *Ecacanthothrips* Bagnall (*E. sanguineus* Bagnall)

   Sense cones on 3 normal. Forefemora in œdymerous males with 2 or more subapical teeth, foretibia with a tooth at base of inner margin and one at apex. Foretarsal tooth strong. — *Hoplandrothrips* Hood [*H. indicus* (Ramk. & Marg.) *H. graminis* Anan.]

9. Head dorsally not convex, without cheek pouches, antenna 8-segmented — 10

   Head dorsally convex, with cheek pouches, antenna 7-segmented — 11

10. Small forms, with œdymerous males having excessively enlarged pronotum, head more elongate and cheeks with concavity, forefemora very long, foretibia short and foretarsal tooth strong. — *Sophiothrips* Hood *S. parviceps* (Hood)

    Small and large forms showing several degrees of œdymerism. Pronotum heavy in œdymerous males with forefemora moderately to exceedingly long, foretibia short, foretarsal tooth strong; forefemora at apex rarely and foretibia with one or more teeth at middle or apex; sometimes cheeks prolonged sidewards tooth-like; evidence of negative allometry in some species, relating to anteroangulars. — *Hoplothrips* Serville *H. fungosus* Moulton *H. transvaalensis* Hood *H. orientalis* (Anan.)

11. Maxillary stylets moderately thick, œdymerous males with forefemora carrying a posterior prolongation and with 2 large humps one at base and apex of inner margin. Foretibia with a strong tubercle at apex. — *Polyphemothrips* Schmutz (*P. cracens* Anan.)

12.	Antenna 7-segmented	13
	Antenna 8-segmented	14
13.	Males invariably, apterous; antennal 3 without sub-basal ring. Oedymerous males with moderately enlarged forelegs. Maxillary stylets not 'V' like.	*Allothrips* Hood (*A. bicolor* Anan.)
	Antennal 3 with a distinct subbasal ring; maxillary stylets V like. Forelegs in œdymerous males, heavier.	*Percnothrips* Anan. (*P. turbinatus* Anan.)
14.	Head not or very little produced	15
	Head distinctly produced	19
15.	Head slightly produced, cheeks incut behind eyes; œdymerous males with heavy, elongate forefemora. Tube heavy.	*Loyolaia* Anan. (*L. indica* Anan.)
	Cheeks normal. Head not produced	16
16.	Head dorsally convex. Antennal 3 with a distinct sub-basal ring. Forefemora of œdymerous males, concave along inner margin.	*Priesneriana* Anan. [*P. kabandha* (Ramk. & Marg.)]
	Head normal, segment 3 of antenna without sub-basal ring. Forefemora of œdymerous males not concave at inner margin.	17
17.	Maxillary stylets distinctly 'V' like, œdymerous males with diverse patterns; with the development of coxal and femoral strong chitinous spines, foretibial teeth and excessively long foretarsal tooth and metanotal process (*N. falcatus*) or less specialised but with lateral mesothoracic spurs, and metanotum at base with numerous teeth (*N. acuticornis*) or more simple, only with heavy forefemora, often concave at inner margin in œdymerous males (*N. indicus*, *N. robustus* and *N. formosensis karnyi*)	*Nesothrips* Kirkaldy
	Maxillary stylets not 'V' like and œdymerous males more simple[1].	18
18.	Foretibia at apex with a strongly developed tooth in normal and œdymerous males and reduced to a hardly recognised tubercle in gynæcoid males. Tube longer than head.	*Diaphorothrips* Karny (*D. unguipes* Karny)

[1] The genus *Machatothrips* Karny has forefemora with a series of 4-5 dark chitinous teeth, absent in the males.

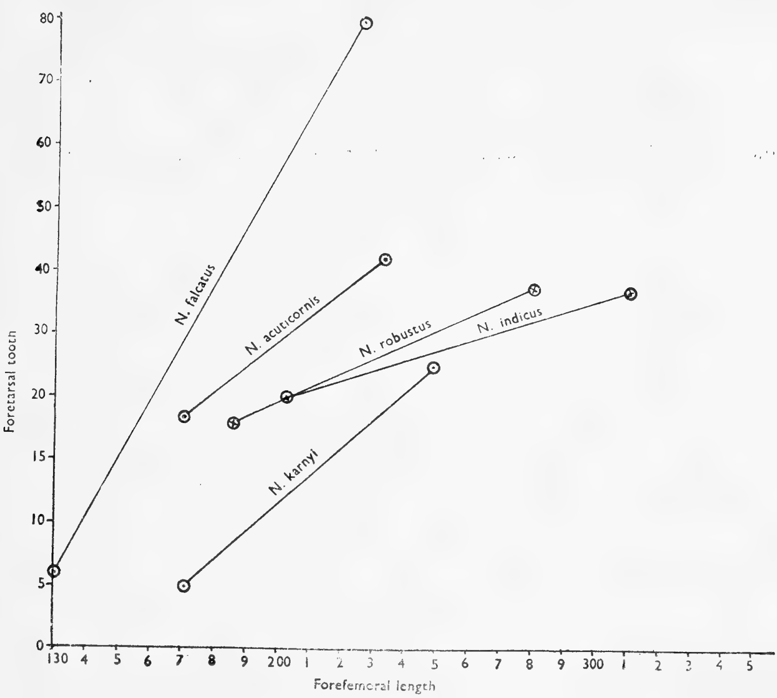
	Tube shorter than head, more parallel-sided, not heavy ; setæ on abdominal segment IX normal ; foretibia unarmed. Oedymerous males with heavy forefemora, postocellar setae distinct.	*Diceratothrips* Bagnall
19.	Mesothorax at sides with a fork or peg	20
	Mesothorax without lateral processes	21
20.	Mesothorax with a distinct fork, wanting in gynæcoid males. Oedymerous males with very strongly developed forefemora with strong spines ; foretibia with numerous denticles on inner margin and foretarsal tooth very strong.	*Dinothrips* Bagnall (*D. sumatrensis* Bagnall)
	Mesothorax with a strong peg in the œdymerous males, hardly recognisable in gynæcoid males. Otherwise œdymerous males as in Dinothrips	*Paxillothrips* Anan. (*P. longicaudus* Anan.)
21.	Head production in œdymerous males excessively developed, 4·5–5 times as long as in gynæcoid males and as long or a little longer than head. Antennal segment 3 very long, sides strongly and asymmetrically sinuate, with deep concavities and carrying strong setae at apex. Forefemora stout, strongly armed with spines and foretarsal tooth very long and strong ; gynæcoid males with short head production, often shorter than head ; 3rd antennal segment weak, sides not sinuate and without strong setae at apex. Forefemora weak as also the foretarsal tooth.	*Tiarothrips* Priesner *T. subramanii* (Ramk.)
	Head production in œdymerous males not excessively developed, much shorter than head	22
22.	Head production not parallel-sided, broader in front ; antennal 3 with clubbed apex. Forefemora in œdymerous males excessively enlarged and with a forked chitinous tooth at apex of inner margin ; foretarsal tooth strongly developed ; forefemoral and foretarsal teeth absent in gynæcoid males.	*Kleothrips* Schmutz [*K. gigans* (Schmutz)]
	Head production usually parallel-sided, antennal segment 3 not clubbed at apex ; forefemora at apex in œdymerous males with a sickle-like bristle; genal bristles and those on forelegs very strongly	

developed; gynæcoid males with weak forefemora, thin foretarsal tooth and without sickle-like bristle. . . *Elaphrothrips* Buffa
(*E. dallatorrensis* Bagnall
E. mucronatus Priesner)
E. productus Priesner

[Since sending the note for publication, the megathripine genus *Bactridothrips* has been discovered, with the males bearing a pair of long processes on the VI abdominal segment and the VII & VIII segments with a tooth on either side.]

Patterns of diversity among males

The simplest type occurs in such species as *Nesothrips indicus*, *N. robustus*, *Priesneriana kabandha*, *Pygothrips amplus*, *Uredothrips indicus* etc. with minimal effects on the morphs where the œdymerous males



Graph 3. Relation between forefemoral length and foretarsal tooth in the males of some species of *Nesothrips*.

develop strong forelegs, with stout forefemora and a moderately stout foretarsal tooth, without developing any other structural complexities. This pattern has been referred to by Ananthakrishnan (1968) as simple, monophasic or unitary. When, however, such œdymerous traits as above are coupled with the development of additional features such as

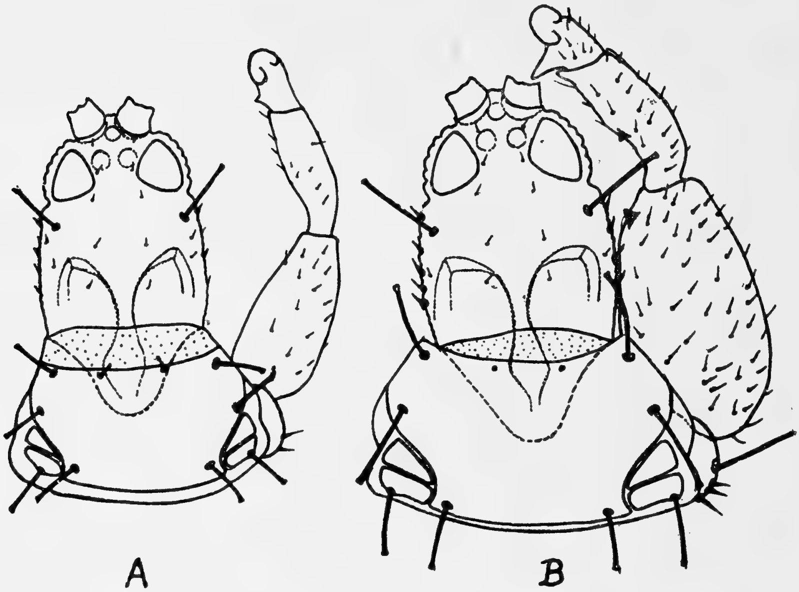
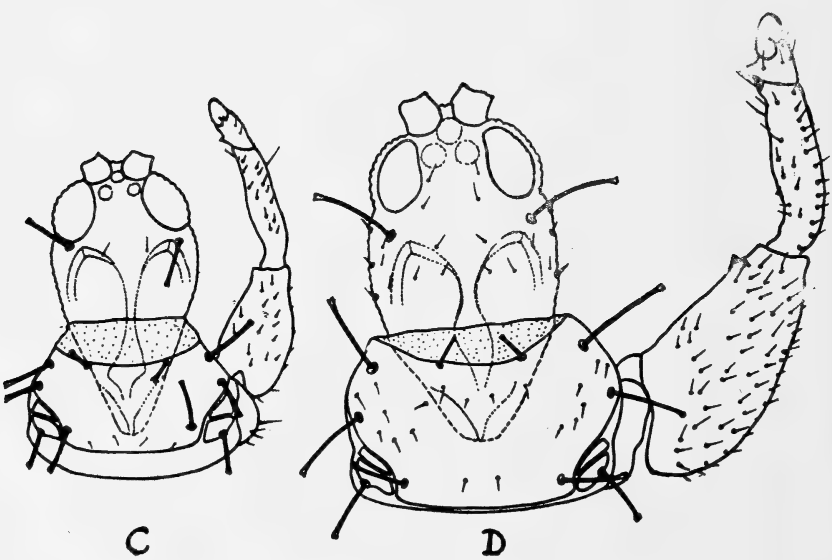


FIG. 4 *A*, *B*. Gynæcoid and œdymerous male of *Hoplandrothrips graminis*.



C, *D*. Gynæcoid and œdymerous male of *Hoplandrothrips indicus*.

forefemoral or tibial teeth, or horns on the head below eyes, or lateral or median meso- or metanotal processes, the pattern of œdymerism is referred to as *multiple* or *polyphasic*. Not all the known œdymerous forms of species develop this complete multiple pattern, enabling a further division of the multiple type into unidirectional and multidirectional categories. Multiple or polyphasic patterns therefore involve not only pronounced development of several parts and varying with species or species groups, it also results in the development of certain additional structures only in the extreme œdymerous individuals not known in the normal males. Typical examples of Indian species known to develop the multi-directional patterns—*Ecacanthothrips sanguineus, Hoplandrothrips graminis, H. indicus, Tiarothrips subramanii, Dinothrips sumatrensis, Paxillothrips longicaudus, Nesothrips acuticornis* and *Nesothrips falcatus*, the latter species showing the maximum degree of œdymerism and its effects in spite of its smaller size. In *Hoplandrothrips* as seen in *H. indicus* and *H. graminis* (Fig. 4), the œdymerous males develop very strong forefemora, with 2 or 3 subapical teeth, a basal or apical foretibial teeth, longer prothoracic bristles, in particular the anteroangulars as well as strong cheek setae. *Ecacanthothrips sanguineus* closely related to *Hoplandrothrips* shows a profound gap between the gynæcoid and œdymerous forms, the gynæcoids being exceedingly feeble in general make up, lacking a strong pronotum, cheek setae, strong femora and teeth, weak tarsal tooth and absence of coxal prolongation. Further they develop tibial tubercles beyond middle of foretibia, a feature lacking in normal and œdymerous males and present only in the females. In the œdymerous males the outer margin of the forefemora at base, tends to be clearly concave and is fringed with a cluster of fine hairs. This concavity becomes progressively reduced, along with the size and number of the fringing hairs as we proceed down the series to the gynæcoid. Striking variations between the various forms are also confined to the distribution of the red pigment, the number of sense cones, the size of antennal segments and in the number of double fringes. *Strepterothrips orientalis* and *Polyphemothrips cracens* also appear to show the multidirectional patterns to a limited extent (Fig. 5).

A further feature of importance is the degree of diversity in the macropterous, brachypterous and apterous males co-existing in a population and which to an untrained eye is liable to lead to misidentification of the species when recorded independently from different habitats. In species of *Hoplothrips* such as *H. fungosus, H. transvaalensis, H. orientalis* and others, the prothorax is smaller in the winged forms, their ocelli and eyes enlarged and the sense cones also much longer. The head may be variable in form in apterous males, with diversity in the degree of development of horn-like projections below eyes. They are wanting in the gynæcoid males where the head may be a little longer than

TABLE 2

INTRASPECIFIC DIVERSITY IN THE MALES OF SOME MYCOPHAGOUS TUBULIFERA

Characters	*Elaphrothrips productus*	*E. mucronatus*	*E. procer dallatorensis*	*E. greeni* (=*E. bouvierii*)	*Tiarothrips subramanii*	*Kleothrips gigans*	*Dinothrips sumatrensis*
Total body length (in mm.)	4·8–8·37	3·6–8·5	3·7–6·0	4·9–7·9	4·57–6·98	7·04–10·5	6·05–7·60
Total head length	496–775	481–775	450–589	558–713	330–720	592–960	543–651
Total production length	108–217	86–186	55–93	62–171	176–768	176–320	176–768
Width across eyes	202–295	241–326	210–264	248–326	233–279	240–336	341–434
Width across cheeks	171–233	217–264	202–217	233–248	233–264	176–240	310–388
Width at base	202–248	225–264	217–248	248–264	279–326	240–336	310–388
Eyes length (width)	93–154	93–155	93–124	108–140	108–124	171–202	140–155
	(63–78)	(70–93)	(62–78)	(70–78)	(78–93)	(93–124)	(108–140)
Postoculars	143–188	100–195	125–133	150–233	45–70	93–155	140–155
Production setae	150–188	73–200	100–138	150–186	Nil	108–202	—
Cheek setae	25–124	78–132	28–88	40–124	47–78	62–93	78–108
Antennal segments length (width)							
3	217–371	186–372	171–233	194–341	320–960	288–480	279–341
	(35–47)	(40–58)	(35–38)	(43–50)	(35–47)	(47–62)	(47–62)
4	202–318	186–326	140–202	171–310	158–268	256–416	202–248
	(31–35)	(38–47)	(38–40)	(43–50)	(31–47)	(55–62)	(55–62)
5	155–263	171–264	124–171	155–248	125–218	216–320	202–248
	(31–35)	(38–47)	(35–38)	(38–40)	(31–47)	(47–55)	(47–55)
6	108–155	108–171	93–116	101–155	99–140	155–217	155–186
	(23–25)	(28–31)	(28–30)	(28–31)	(31–39)	(31–35)	(47–49)
7	78–93	70–93	62–78	70–93	55–70	93–101	108–124
	(20–23)	(24–25)	(23–25)	(24–25)	(24–31)	(23–26)	(31–34)
8	62–78	62–78	55–62	62–86	78–82	78–93	78–93
	(15–16)	(16–18)	(15–16)	(15–18)	(16–18)	(16–19)	(15–18)
Longest seta on 3 (antennal segment)	68–155	63–223	48–75	88–202	34–260	60–70	78–108
,, on 4	75–140	63–194	53–63	50–163	62–140	60–70	78–108

Length of sense cones on 3	55–65	65–68	40–45	43–63	24–31	78–93	47–62
Length of mouth cone	171–233	208–248	171–217	171–264	186–264	233–264	248–295
Width at base (apex)	171–217	286–233	186–202	233–248	263–310	230–330	310–357
	(62–93)	(62–78)	(78–93)	(85–108)		(108–155)	(155–202)
Prothorax length	203–372	233–465	217–357	248–388	217–341	240–434	326–527
Width (anterior)	214–310	248–326	233–379	279–295	310–357	264–388	357–465
Width (posterior)	341–496	388–558	372–527	419–558	388–512	434–620	527–806
Anteroangulars	65–75	55–120	63–70	60–108	18–33	72–144	76–93
Midlaterals	80–85	78–130	75–90	100–113	47–78	78–108	141–124
Postangulars	63–75	100–113	88–103	88–125	47–78	93–108	186–233
Epimerals	113–135	113–188	80–120	125–163	100–113	88–176	202–233
Prothorax length	558–853	589–1007	496–775	651–961	217–341	240–434	791–930
Mesothorax, width	465–721	527–899	496–667	605–853	496–698	620–930	744–1100
Metathorax, width	465–713	504–899	481–713	605–853	496–698	620–930	729–1115
Forefemora length (width)	403–698	419–791	403–667	465–791	388–713	512–1280	481–806
	(108–326)	(124–310)	(124–310)	(124–310)	(140–279)	(144–224)	(171–419)
Foretarsal tooth length	25–124	33–108	25–70	55–116	70–155	–192	47–148
Forewings, length	1504–2279	1519–2557	1318–1442	1612–2434	1318–1860	2077–2945	2062–2634
Basal wing bristles	93–135	48–171	58–88	100–160	43–58	86–220	108–155
	85–124	83–132	63–75	88–125	43–70	86–242	155–202
	150–178	153–233	158–200	170–250	55–85	127–239	202–310
Double fringes	24–38	30–46	25–29	45–52	27–30	40–77	42–56
Abdomen width at base	434–574	450–682	481–651	574–698	512–677	496–698	651–960
at middle	327–481	341–434	388–527	403–589	357–574	403–620	574–868
across VII	210–295	217–327	233–310	295–310	264–326	264–388	526–403
across IX	171–233	171–279	170–233	148–264	186–233	202–326	248–310
Setae on IX B1	388–636	388–558	341–388	465–574	233–310	465–543	775–853
B2	496–690	419–605	310–341	419–589	233–341	465–543	775–853
B3	388–590	388–558	336–388	388–465	233–310	465–543	775–853
Tube, length	388–620	403–698	357–496	419–620	388–589	510–880	589–790
Width at base	93–108	93–155	93–124	140–155	93–124	140–171	155–202
at middle	78–108	78–108	62–108	93–108	70–93	108–140	108–155
at apex	47–78	62–78	47–70	78–82	55–62	78–93	78–93
Anal setae, length	124-540	295–512	248–310	311–512	233–310	465–543	465–512

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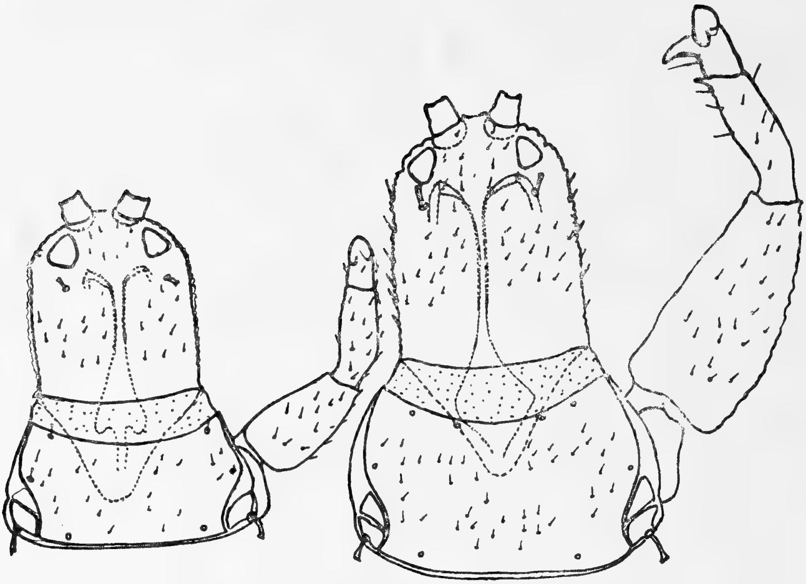
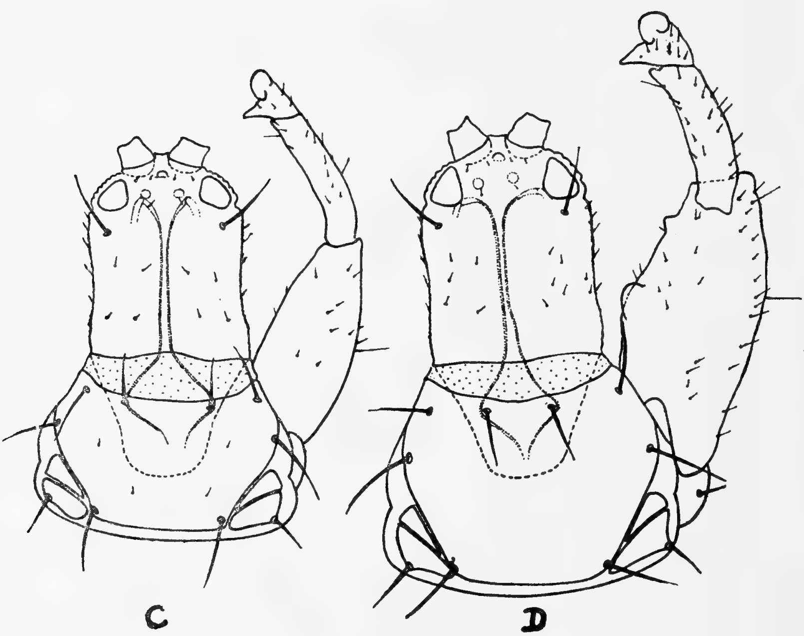
INTRASPECIFIC DIVERSITY IN THE MALES OF SOME MYCOPHAGOUS TUBULIFERA

Characters	*Elaphrothrips productus*	*E. mucronatus*	*E. procer dallatorensis*	*E. greeni* (=*E. bouvierii*)	*Tiarothrips subramanii*	*Kleothrips gigans*	*Dinothrips sumatrensis*
Total body length (in mm.)	4·8–8·37	3·6–8·5	3·7–6·0	4·9–7·9	4·57–6·98	7·04–10·5	6·05–7·60
Total head length	496–775	481–775	450–589	558–713	330–720	592–960	543–651
Total production length	108–217	86–186	55–93	62–171	176–768	176–320	176–768
Width across eyes	202–295	241–326	210–264	248–326	233–279	240–336	341–434
Width across cheeks	171–233	217–264	202–217	233–248	233–264	176–240	310–388
Width at base	202–248	225–264	217–248	248–264	279–326	240–336	310–388
Eyes length (width)	93–154 (63 78)	93–155 (70–93)	93–124 (62–78)	108–140 (70–78)	108–124 (78–93)	171–202 (93–124)	140–155 (108–140)
Postoculars	143–188	100–195	125–133	150–233	45–70	93–155	140–155
Production setae	150–188	73–200	100–138	150–186	Nil	108–202	—
Cheek setae	25 124	78–132	28–88	40–124	47–78	62–93	78–108
Antennal segments length (width)							
3	217–371 (35–47)	186–372 (40–58)	171–233 (35–38)	194–341 (43–50)	320–960 (35–47)	288–480 (47–62)	279–341 (47–62)
4	202–318 (31–35)	186–326 (38–47)	140–202 (38–40)	171–310 (43–50)	158–268 (31–47)	256–416 (55–62)	202–248 (55–62)
5	155–263 (31–35)	171–264 (38–47)	124–171 (35–38)	155–248 (38–40)	125–218 (31–47)	216–320 (47–55)	202–248 (47–55)
6	108–155 (23–25)	108–171 (28–31)	93–116 (28–30)	101–155 (28–31)	99–140 (31–39)	155–217 (31–35)	155–186 (47–49)
7	78–93 (20–23)	70–93 (24–25)	62–78 (23–25)	70–93 (24–25)	55–70 (24–31)	93–101 (23–26)	108–124 (31–34)
8	62–78 (15–16)	62–78 (16–18)	55–62 (15–16)	62–86 (15–18)	78–82 (16–18)	78–93 (16–19)	78–93 (15–18)
Longest seta on 3 (antennal segment)	68–155	63–223	48–75	88–202	34–260	60–70	78–108
,, ,, on 4	75–140	63–194	53–63	50–163	62–140	60–70	78–108
Length of sense cones on 3	55–65	65 68	40–45	43–63	24–31	78–93	47–62
Length of mouth cone	171–233	208 248	171 217	171 264	186 264	233 264	248–295
Width at base (apex)	171–217 (62 93)	286–233 (62–78)	186–202 (78–93)	233–248 (85–108)	263–310	230 330 (108 155)	310–357 (155–202)
Prothorax length	203–372	233–465	217–357	248–388	217–341	240–434	326–527
Width (anterior)	214–310	248–326	233–379	279–295	310–357	264–388	357–465
Width (posterior)	341–496	388–558	372–527	419–558	388–512	434–620	527–806
Anteroangulars	65–75	55–120	63–70	60–108	18–33	72–144	76–93
Midlaterals	80–85	78–130	75–90	100–113	47–78	78–108	141–124
Postangulars	63–75	100–113	88–103	88–125	47–78	93–108	186–233
Epimerals	113–135	113–188	80–120	125–163	100–113	88–176	202–233
Prothorax length	558–853	589–1007	496–775	651–961	217–341	240–434	791–930
Mesothorax, width	465–721	527–899	496–667	605–853	496–698	620–930	744–1100
Metathorax, width	465–713	504–899	481–713	605–853	496–698	620–930	729–1115
Forefemora length (width)	403–698 (108–326)	419–791 (124–310)	403–667 (124–310)	465–791 (124–310)	388–713 (140–279)	512–1280 (144–224)	481–806 (171–419)
Foretarsal tooth length	25–124	33–108	25–70	55–116	70–155	–192	47–148
Forewings, length	1504–2279	1519–2557	1318–1442	1612–2434	1318–1860	2077–2945	2062–2634
Basal wing bristles	93–135 85–124 150–178	48–171 83–132 153–233	58–88 63–75 158–200	100–160 88–125 170–250	43–58 43–70 55–85	86–220 86–242 127–239	108–155 155–202 202–310
Double fringes	24–38	30–46	25–29	45–52	27–30	40–77	42–56
Abdomen width at base	434–574	450–682	481–651	574–698	512–677	496–698	651–960
at middle	327–481	341–434	388–527	403–589	357–574	403–620	574–868
across VII	210–295	217–327	233–310	295–310	264–326	264–388	526–403
across IX	171–233	171–279	170–233	148–264	186–233	202–326	248–310
Setae on IX B1	388–636	388–558	341–388	465–574	233–310	465–543	775–853
B2	496–690	419–605	310–341	419–589	233–341	465–543	775–853
B3	388–590	388–558	336–388	388–465	233–310	465–543	775–853
Tube, length	388–620	403–698	357–496	419–620	388–589	510–880	589–790
Width at base	93–108	93–155	93–124	140–155	93–124	140–171	155–202
at middle	78–108	78–108	62–108	93–108	70–93	108–140	108–155
at apex	47–78	62–78	47–70	78–82	55–62	78–93	78–93
Anal setae, length	124–540	295–512	248–310	311–512	233–310	465–543	465–512



A B

FIG. 5 *A*, *B*. Gynæcoid and œdymercus male of *Strepterothrips orientalis*.



C D

C, *D*. Gynæcoid and œdymerous male of *Polyphemothrips cracens*.

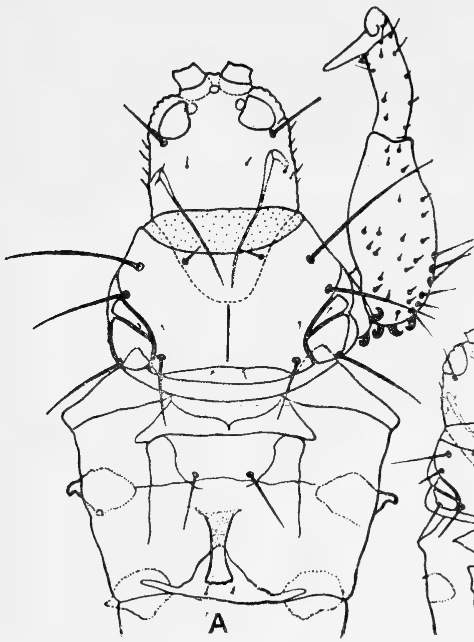
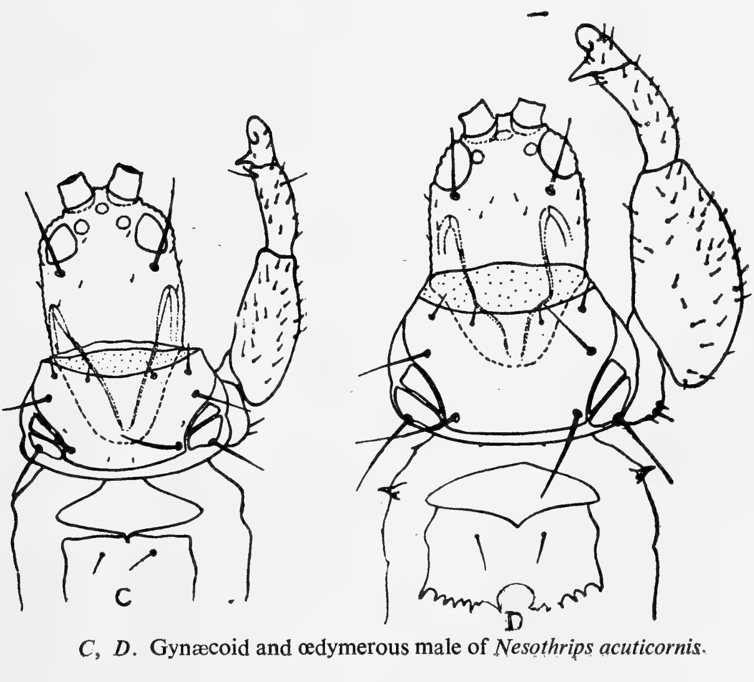


FIG. 6 *A*, *B*. Gynæcoid and œdymerous male of *Nesothrips falcatus*



C, *D*. Gynæcoid and œdymerous male of *Nesothrips acuticornis*.

its greatest width near the middle of the cheeks, while in the œdymerous males the head may be 1·6-1·8 times as long as wide as in *H. bradleyi* Hood. So also the median apodeme of the prothorax in the gynæcoid males is short and weak and long and heavy in the œdymerous forms. It may also be stated that the shape of the pelta differs considerably both in the apterous and macropterous males as well as in gynæcoid and oedymerous males and hence is apt to be misleading when only one of the variants is taken into consideration.

The species of the genus *Nesothrips*, however, present a combination of simple growth patterns and multiple unidirectional and multidirectional patterns. The spectacular examples is *N. falcatus* where the œdymerous males develop (1) highly elongate and broadened forefemur, forecoxa and forefemora with very strong curved chitinous hook-like structures, mid-coxae also with a chitinous tooth, foretibia very short and with an apical strong tooth and foretarsal tooth excessively long as compared with the gynæcoid, (2) anteroangulars extremely long, (3) development of a median metanotal process reaching the pelta. Next in complexity is *N. acuticornis* where the forefemora is moderately enlarged but comparatively larger than the gynæcoid, sides of mesothorax with well developed spurs and most important of all is the development of a strongly dentate posterior margin of metanotum not known in gynæcoid (Fig. 6). The other species of *Nesothrips* like *N. robustus*, *N. indicus*, etc. show only a simple pattern with the development of only a heavy forefemora and stronger tarsal tooth in œdymerous males (Graphs 1 & 2). Hood (1935) refers to *Nesothrips anolis* with the excessively massive pronotum with downwardly pointing coxal prolongations and stout cheek setae in the œdymerous males.

Ananthakrishnan (1967-68) has indicated the multiple trends involved in the development of the œdymerous males in *Kleothrips gigans* and *Tiarothrips subramanii* wherein significant differences exist with regard to the nature of the head process and 3rd antennal segment in the œdymerous forms. While in *Kleothrips gigans* the 3rd antennal segment and the head process do not keep pace with each other during the transition from the gynæcoid to the œdymerous, a remarkable change is noticed in *Tiarothrips subramanii* wherein both the 3rd antennal segment and head process grow at various rates, in most cases go hand in hand. The 3rd antennal segment is normally as long as head process passes from a weak, straight-sided condition to an almost monstrous proportion double the head length and strongly corrugated, asymmetrical sides strongly armed with long bristles.

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References

Ananthakrishnan, T. N. (1961) : Allometry and speciation in *Ecacanthothrips* Bagnall. *Proc. Biol. Soc. Wash.* **74** : 275-280.

———— (1965) : Polymorphism and the Taxonomy of Thysanoptera. *Bull. Ent.* **6** : 57-61.

———— (1967) : Structural diversity and variation range in Thrips populations. *Bull. Nat. Inst. Sci. India* **34** : 371-374.

———— (1967) : Allomorphic growth patterns in some Tubulifera (Thysanoptera). *Indian J. Ent.* **29** (1) : 61-64.

———— (1967) : On the multiple effects of œdymerism in *Nesothrips falcatus* Ananthakrishnan. *Curr. Sci. Bangalore* **36** (22) : 610-611.

———— (1968) : Patterns of structural diversity in the males of some Phlaeophilous Tubulifera (Thysanoptera). *Ann. Soc. Ent. Fr.* (*N.S.*) **4**(2) : 413-418.

———— (1968) : Allomorphic growth patterns in relation to sex-limited polymorphism in some mycophagous Tubulifera (Thysanoptera). *Curr. Sci. Bangalore* **37**(20) : 577-578.

———— (1969) : Indian Thysanoptera CSIR Zoological Monograph—**1** : 102-117.

———— : *Kleothrips gigans* Schmutz —A study in intraspecific diversity. *Bull. Ent.* (in press).

Hood, J. D. (1935) : Some new or little known Thysanoptera of the family Phlaeothripidae. *Rev. de. Ent.* **5**(2) : 175-187.

———— (1937) : Studies in Neotropical Thysanoptera—V. *Rev. de. Ent.* **7**: 498-506.

———— (1950) : A new *Hoplothrips* from Cuba. *Proc. Biol. Soc. Wash.* **63** : 139-146.

———— (1952) : Brazilian Thysanoptera—VI. *Proc. Biol. Soc. Wash.* **65** : 77-80.

———— (1955) : A new *Hoplothrips* (Thysanoptera) from Florida. *Florida Ent.* **XXXVIII** (1) : 27-32.

Priesner, H. (1959) : On the genus *Dinothrips* Bagnall. *IDEA*. **12** : 53.

The Flowering of the Strobilanth (Acanthaceae)

(Strobilanthinae *sensu* Bremekamp)

BY

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'Strobilanthes' popularly refers to a large group of gregarious shrubs characterized by outbursts of profuse flowering at fairly regular intervals of 3 to 14 years, mostly of 4 to 7 years, and the plants (with some exceptions) dying off after dispersal of the seeds. Bremekamp (1944) used the term 'plietesials' for such monocarpic plants that take several years to reach maturity before flowering. This growth form is not rare in the tropics and subtropics.

In India this group occurs on the hills and at the foothills; more abundantly in the south, especially on the Nilgiris and Palnis. This noteworthy group of plants attracted the special attention of the first explorers of the Indian flora. The plants grew so densely that the seedlings of the forest trees could hardly survive under them. Schemes of organized eradication of these plants were considered imperative for efficient forestry (Gamble 1888; Osmaston 1904). As to their occurrence in India, Clarke (1888) refers to 146 species, and Gamble (1924) to 46. Fyson (1932) refers to only 19, but all occurring above 1500 m. on the south Indian hills. Several of the species have been illustrated by Wight (1838-53; 1840-50; 1846-51), Beddome (1869-74), Fyson (1932) and Robinson (1935).

The present paper deals with: (1) a survey of published data regarding the periodicity of flowering; (2) the possible cause of the special manner of flowering; (3) the taxonomy of the group. An exhaustive bibliography is given since the main purpose of this paper is to stimulate research on this plant group.

The best known in south India is *Strobilanthes kunthianus* (Nees) T. And. (=*Phlebophyllum kunthianum* Nees) famous for the copious, fragrant blue flowers (ranging from pale lilac blue to deep purplish blue) at regular intervals of 12 years. These flowerings were such a landmark in the lives of the hill tribes in former days that they used to recall the main events of their lives with reference to the flowerings they had witnessed. The *kurinjimalar* ('flower of the hills') of the Tamil classics probably refers to this plant. The recent flowerings provoked more than usual interest on account of publicity through newspapers and radio, and drew crowds to the hills.

Nine consecutive flowerings at regular intervals of 12 years between 1838 and 1934 on the Nilgiris are mentioned by Robinson (1935) ; as for the Palnis, Matthew (1959) has recorded five such flowerings between 1910 and 1958. With the general flowering of 1970, there is an impressive record of 12 consecutive flowerings at regular intervals of 12 years for south India.

Formerly when large tracts of land were covered by this plant, the years of flowering attracted numerous swarms of honey bees. The rock bee (*Apis dorsata*) and the common honey bee (*Apis indica*) used to migrate in large numbers to regions of flowering ; Robinson (1935) has recorded certain interesting facts and figures regarding the number of hives of bees seen at Kodaikanal. The season of dispersal of seeds was reported to have caused mass migration of jungle fowls from the foothills on the Nilgiris. These, however, are a memory of the past, with the area under the plant fast diminishing owing to denudation of virgin land for cultivation. The flowering of 1958, and more so that of 1970, was conspicuous for the absence of such visitors.

In 1970, the mass flowering at Kodaikanal started about February with the close of winter and came to a peak in April-May. Though confined largely to isolated patches, the flowering was still impressive in the Shembaganur, Poombarai, Vembadi and Berijam areas. Robust specimens exceeded 2 m. tall (*Matthew* 11457) ; plants in flower as small as 9 cm. tall were recorded too (*Matthew* 11459 a). Stunted plants are the rule at altitude above 2000 m. exposed to incessant wind. *Matthew* 11458 had completely white flowers.

Among the other species with published data are *S. rufescens* T. And. (C. W. A. B. 1895) ; *S. sessilis* Nees (J. L. L. McG. 1895 ; Murray 1896) ; *S. wallichii* Nees (A. S. 1895 ; Osmaston 1904) ; *S. callosus* Nees (Fagan 1896 ; Santapau 1944, 1950a, b , 1951 ; Murray 1896) ; *S. pectinatus* T. And. and *S. helictus* T. And. (Osmaston 1904) ; and *S. neilgherrensis* Bedd. (Bowden 1950).

There are several questions that need to be answered as regards these plants. Even in the case of *S. kunthianus* (Nees) T. And. where the evidence for the 12-year cycle of flowering is fairly certain, there are discordant data that should be considered. Among many such reports, Gamble (1888) speaks of intervals of 4-6 years ; Fyson (1932) of 7-12 years. The present author himself has noted stray flowers of *S. kunthianus* (Nees) T. And. almost every year between two mass flowerings ; these stray blossoms being more abundant in the year preceding the mass flowering. In fact the undue publicity given to the flowering of 1969 on the Palnis was of such a one ! Much of the published data on the flowering seem to be uncritical especially in the case of species other than *S.*

kunthianus (Nees) T. And. where the correct identity of plants itself might have been uncertain. Such data should be carefully sifted in the light of ample and accurate field study.

Another source of error could be that such reports of mass flowerings pertain only to small areas. The following is such a one that the present author studied. On September 17, 1960 (1958 was the year of the previous mass flowering), he observed a region between milestones 38-4 and 37-2 of the Goschen Road near the Astrophysical Observatory, Kodaikanal, when many plants were in flower. There seemed to have been plants of at least four different stages of development here : (1) those in flower then ; (2) an equal number of plants not going into flower that year ; (3) those that had flowered in 1958 and preserved as dry twigs ; (4) some plants 10-15 cm. tall, uniform in size with seedlings from the seeds of the 1958 mass flowering abundant in places where general flowering occurred in 1958. Among those in flower, there was a notable degree of variation in size : the biggest were up to 3 m. tall with a maximum internodal diameter of 2 cm. (*Matthew* 1693) ; a few plants as small as 20 cm. tall with just 3-4 flowers each (*Matthew* 1691) ; the majority of plants of intermediate size, 1-1.5 m. tall (*Matthew* 1692).

Cases like this, probably caused by special ecological factors, may not be rare, and might account for reports of aberrant flowerings.

There has been little study on the possible causes of this type of flowering. The study of the physiology over the maturing years of these plants may throw light on the long intervals of flowering. Why and how is the flowering hormone released in such abundance ? Why do the plants die after flowering ? How is their nutritional physiology affected ? Is the report of the production of large number of tyloses generally verified, and if so, has it anything to do with the death of the plants ? Do all the viable seeds germinate simultaneously during the year following their dispersal ? Can seeds be kept viable for several years, so that if some of these could be germinated and planted out every year for 11 consecutive years, flowering thereafter should occur every year ?

Careful field studies with special reference to factors like rainfall, temperature, exposure, etc. and in the laboratory over a period of several years on the hills are necessary to answer these questions ; may be this is one of the problems to be studied in a future botanical laboratory on the hills.

Finally, the taxonomy of the group should be worked out in the light of answers to these questions. Data from cytology, anatomy, histology, embryology and biochemistry are yet to come ; pollen morphology has proved diagnostic and has been effectively used by Bremekamp (1944), probably after Radlkofer (1883). Whereas Indian floras treat '*Strobilanthes*' in a broad sense, Bremekamp (1944) has split the subtribe Strobilanthinae into 54 genera. In this sense, the genus *Strobilanthes* does not occur in India.

A comprehensive Indian monograph on the group is an urgent need, especially since Bremekamp (1944) had not sufficiently studied Indian material. Such a work will be difficult but prove to be a landmark in Indian botany.

In conclusion it should be pointed out that this type of gregarious and periodic flowering so much talked of in the Strobilanthinae is after all not so rare in nature. Bamboos flower gregariously and only once in their lifetime ; several forest trees, as certain members of Dipterocarpaceae, do not seem to flower regularly every year. For an observant botanist. our forest trees may prove to be matter for fruitful study.

Whereas laboratory studies are essential in knowing our plants better, careful field studies are equally important. Maybe a plea for intensified and improved field studies is truly appropriate to commemorate Fr. Santapau whose death occurred in a year of mass flowering.

The author thanks Prof. B. G. L. Swamy for useful suggestions.

References

Anderson, T. (1867) : An enumeration of the Indian species of Acanthaceae. *J. Linn. Soc.* **9** : 465-475.

A. S. (1896) : Flowering of Strobilanthes in Jaunsar. *Ind. For.* **22** : 182.

Beddome, R. H. (1868-74) : Icones Plantarum Indiae Orientalis. Madras.

Bentham, G. & Hooker, J. D. (1876) : Genera Plantarum **2**(2) : 1065.

Bowden, E. (1950) : The flowering of *Strobilanthes*. *J. Bombay nat. Hist. Soc.* **49** : 576.

Bremekamp, C. E. B. (1944) : Materials for a monograph of the Strobilanthinae (Acanthaceae). *Verh. Nederl. Akad. Wet.* 11 **40** (1) : 1-306, tt. i-iv.

Clarke, C. B. (1884): in Hooker, J. D. Flora of British India **4** : 429-477.

C. W. A. B. (1895) : Flowering of *Strobilanthes* in Burma. *Ind. For.* **21** : 47-48.

Fagan, R. S. (1896) : Flowering of *Strobilanthes* in Bombay. *Ind. For.* **22** : 182.

Fyson, P. F. (1932): The Flora of the South Indian Hill Stations. Madras, pp. 443 - 453.

Gamble, J. S. (1888) : The Nilgiri '*Strobilanthes*'. *Ind. For.* **14** : 153-158.

——— (1924) : Flora of the Presidency of Madras, **6** : 720-732.

J. L. L.-McG. (1895) : Flowering of *Strobilanthes*. *Ind. For.* **21** : 462.

Kapadia, G. A. (1950) : *Strobilanthes callosus* Nees at Junagadh in Saurashtra. *J. Bombay nat. Hist. Soc.* **49** : 321-322.

Lindau (in Engler & Prantl 1895) : Die Naturlichen Pflanzenfamilien **4**(3b) : 300.

Matthew, K. M. (1959) : The vegetation of Kodaikanal grassy slopes. *J. Bombay nat. Hist. Soc.* **56** : 387-422.

Morris, R. C. (1958) : Flowering of *Strobilanthes*. *J. Bombay nat. Hist. Soc.* **55** : 185.

Murray, H. (1896) : Flowering of *Strobilanthes* in Bombay. *Ind. For.* **22** : 262.

Nees, C. G. von E. (1847) in Wallich, N. Plantae Asiaticae Rariores **3** : 84-89, 1832, & in Candolle, A. P. de Prodromus systematis naturalis regni vegetabilis **11** : 177-196.

Osmaston, B. B. (1904) : *Strobilanthes* and natural reproduction. *Ind. For.* **30** : 195-196.

R. M. (1894) : Seeding of *Strobilanthes* on the Nilgiris. *Ind. For.* **20** : 130.

Radlkofer, L. (1883) : Ueber den systematichen werth der pollen-beschaffenheir bei den Acanthaceen. *Sitz. K. Bayer. Akad. Wiss.* **13**(2) : 256-314.

Robinson, M. E. (1935) : The flowering of *Strobilanthes* in 1934. *J. Bombay nat. Hist. Soc.* **38** : 117-122, tt. 1-8.

Santapau, H. (1944) : The flowering of *Strobilanthes*. *J. Bombay nat. Hist. Soc.* **44** : 605-606.

——— (1950a) : The flowering of *Strobilanthes*. *J. Bombay nat. Hist. Soc.* **49** : 320-321.
——— (1950b) : Further remarks on the flowering of *Strobilanthes*. *J. Bombay. nat. Hist. Soc.* **49** : 575-576.
——— (1951) : The Acanthaceae of Bombay. *Bot. Mem. Univ. Bombay*, **2** : 36-50.
——— (1952) : The flowering of *Strobilanthes* in Khandala *J. Bombay nat. Hist. Soc.* **50** : 430-431.
——— (1960a) : Notes on the flowering of *Carvia callosa* Bremek. ibid. **56** : 676–677.
——— (1960b) : The flowering of *Strobilanthes* ibid. **56** : 677, t. 1.
——— (1960c) : The Carvi plant *St. Trans. Rev. Bombay* **10** (11) : 38-40, t. 1.
——— (1962) Gregarious flowering of *Strobilanthes* and Bamboos. *J. Bombay nat. Hist. Soc.* **59** : 688-695.
WIGHT, R. (1838-53) : Icones Plantarum Indiae Orientalis. Madras.
——— (1840-50) : Illustrations of Indian Botany Madras.
——— (1846-51) : Spicilegium neilgherrense. Madras.

Aplanospore formation or outcome of Parasitic Attack ?

BY

Ella A. Gonzalves and G. R. Sonnad[1]

(With a plate)

The formation of ovoid, ellipsoid or irregularly-shaped aplanospores by the protoplast of the cells of several of the larger species of *Oedogonium*, and occasionally in *Bulbochaete*, has been mentioned by Tiffany (1930) in his monograph on the Oedogoniales (p. 21). Earlier, he (Tiffany 1926) had stated that when filaments are attacked by fungal parasites, single aplanospore-like structures might be observable in the cells. Handa (1928), too, noticed what he called 'akinetes' in *Oedogonium*, due to withdrawal of the protoplast from the cell wall and its rounding in two masses within a cell, each mass having a wall around it. As the material was collected from the Southern Shan States of Burma at an elevation of 4615 ft., Handa inferred that a high altitude, with its accompanying low temperature, might have been conducive to the production of such akinetes in *Oedogonium*. Fritsch (1935) in a footnote on p. 301 opined that Handa's record of such stages was questionable, owing to the possibility of the presence of a parasite.

A phenomenon similar to the one recorded by Handa (1928) was seen by Randhawa (1937) in the cells of a fertile species of *Oedogonium*, except that in Randhawa's material, the protoplast aggregated in a single obovoid mass within the cell and not in two masses. The mass was usually surrounded by a thick wall, but in recently divided cells the wall was thin.

According to Randhawa (1937), it is incorrect to refer to these accumulations of protoplasm as akinetes, for the latter, as he states, 'are usually produced by the transformation of whole cells by the secondary thickening of the cell wall' and not, as in these cases, within the parent cell. He rightly maintained that as his specimens were collected from the plains of the Punjab, the formation of such masses could not be attributed either to high altitude or to low temperature conditions. Moreover, as he did not find any fungus parasitizing the

[1] The junior author has, unfortunately, not lived to see the publication of this paper, his untimely death having occurred a short time ago.

alga, he held that the masses were, in all probability, zoospores, which, for some reason, had been unable to escape from the cells and had lost their flagella and developed thick walls around themselves. He, therefore, regarded them as aplanospores. Islam & Sarma (1963) also found such spore-like structures in the cells of two terrestrial species of *Oedogonium*. They, too, regarded them as aplanospores, as they did not observe any evidence of fungal attack.

During a survey of the Oedogoniales of the Karnatak, the authors collected specimens of *Oedogonium crassum* [(Has.) Wittr.] Hirn, from Narendra Tank, Dharwar. Examination showed that the alga was growing vigorously, but in the cells of a few filaments, the protoplast had withdrawn from the cell wall and had assembled in the centre of the cell (Fig. 1, a). Some cells had, however, two, or even three, such masses (Fig. 1, b, c). The masses were globose or somewhat oblong, each being surrounded by a thin or a fairly prominent membrane. They varied in size, the globose ones being 28-38 μ in diameter, the oblong ones being 28-37 μ by 40-50 μ. To observe the condition of these filaments more closely, the material was grown in a trough in the laboratory. Lapse of a brief period showed a large percentage of the filaments manifesting this condition, while vegetative growth had slowed down considerably.

The manner in which two masses arose in a cell was either by division of the original protoplast into two, followed by rounding of the daughter protoplasts, or by the migration of the contracted protoplast of a cell through a central pore in the transverse wall into an adjacent cell in which massing of the protoplast had already occurred (Figs. 1, 2, m). The cell containing two masses would thus be flanked by an empty cell on one side (Fig. 1, b). Occasionally, the two masses in a cell moved into adjoining cells to the right and left of them respectively.

Occurrence of three masses was due either to a cell containing two masses becoming the recipient of the contracted protoplast of a neighbouring cell or to a cell with one mass receiving the contents of the cells on either side of it.

Treatment with iodine revealed the presence of starch in some of the masses, but most of them had little or no starch; instead, such masses assumed a reddish-orange colour. The nucleus, too, was undetectable and in many of the masses, several scattered vacuoles or one large central vacuole appeared.

The condition observed here appears to be similar to that recorded by Handa (1928) and by Randhawa (1937), but it is possible that massing of the protoplast in this instance is due to the attack of an endophytic chytrid. Sparrow (1943) described the Olpidium type of

Ella A. Gonzalves : *Oedogonium*

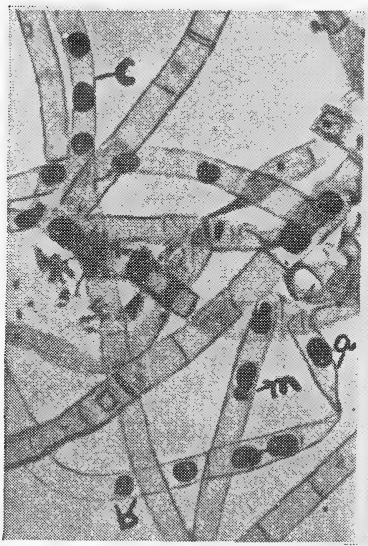

FIG. 1. Aggregationof protoplasts in one (*a*), two (*b*) and three (*c*) masses within a cell.

FIG. 2. Migration (m) of protoplast from one cell into an adjoining cell through an opening in the transverse wall.

thallus in the Chytridiales to be spherical or ellipsoidal and capable of being carried away over distances as the result of cytoplasmic movement of the host. Moreover, transparency of the vegetative part of its thallus may render unsuspect the presence of the parasite within the cells of the host.

The movements of the protoplasmic masses could thus be due to the presence of a fungal thallus within the contracted protoplast. Scherffel (1925) records that *Tribonema*, attacked by *Chytridium confervae*, reacted by concentration of the plasma in the region of the infection tube, while the host nucleus travelled from its original position to the point of infection. Wall material was then secreted in order to check the attack of the parasite. It is likely that the occurrences here are similar. When the tube formed by the encysted zoospore of the chytrid penetrated into the algal cell, the protoplast probably separated from the wall and secreted a membrane around itself to stop, perhaps, the incursion of the parasite. However, after the parasite established itself within the protoplast, it attacked and destroyed the nucleus. It also utilized the stored food material, viz. starch, which, as infection proceeded, was reduced in the cell.

Thus, the adscription of the term 'aplanospores' to such structures as have been described here, and by previous investigators, will be open to question, unless convincing supporting evidence of the liberation, germination and further development of these spore-like structures is forthcoming

References

Handa, M. R. (1928) : Akinetes in a species of *Oedogonium*. *J. Indian bot. Soc.* **7** : 15-16.

Randhawa, M. S. (1937) : A note on aplanospores in a species of *Oedogonium*. *Proc. Indian Acad. Sci.* **4** : 97-107.

Scherffel, A. (1925) : Beiträge zur Kenntnis der Chytridineen I. *Arch. Protistenk.* **53** : 1-58.

Sparrow, F. K. (1943) : Aquatic Phycomycetes. Waverley Press, Baltimore M. D., 785 pp.

Tiffany, L. H. (1926) : The filamentous algae of northwestern Iowa, with special reference to the Oedogoniaceae. *Trans. Amer. micr. Soc.* **45** : 69-132.

——— (1930) : The Oedogoniceae, a monograph including all the known species of the genera Bulbochaete, Oedocladium and Oedogonium. Columbus Ohio, 253 pp.

Spawning habits, eggs and early development of Deccan Mahseer, *Tor khudree* (Sykes)

BY

C. V. Kulkarni

(With five text-figures)

Introduction

Mahseers, a group of large Indian carps, are well known as excellent game fish in India, comparable to similar sport fish elsewhere in the world. They had attracted the attention of angler naturalists like Thomas (1897) Skene-Dhu (1918) Macdonald (1948) etc., who wrote on the natural history and the special traits of the fish from the anglers' point of view. Hora (1939, 1941, 1942) wrote several articles on the taxonomy, distinguishing characters of the species, races and colour varieties of Mahseers of India and Burma. Hora & Nazir Ahmed (1946) described the spawning habits of Katli Mahseer of Assam and Nazir Ahmed (1948) described the early stages of the Copper Mahseer, *Lissochilus hexagonolepis*. David (1953) dealt with the bionomics and some early stages of the Mahanadi Mahseer, *Barbus* (*Tor*) *mosal mahanadicus*. Recently Karamchandani *et al.* (1967) gave an account of fishery and biology of *Tor tor* (Hamilton) from Narmada River, Madhya Pradesh. Several other notes on Mahseers are also available, nevertheless, very little is known about the breeding habits and early development of the Deccan Mahseer, *Tor khudree* (Sykes). I had recently an opportunity to study the breeding habits and early development of this fish (*T. khudree*) at lake Walwhan of the Tata Hydro-Electric Power Supply Co., near Lonavla, Dist. Poona. The lake has a water spread of about 800 ha. and a maximum depth of 17 m. Despite the usual difficulties of obtaining mature brood fish at the right time, eggs and early stages were obtained by stripping ripe males and females and by fertilising the eggs artificially. A descriptive account of this work is given.

Breeding Season of *Tor khudree*

It is well known that the breeding season of Indian carps is, but for slight variations, more or less common namely during the early part of the monsoon season. Mahseers, though belonging to the same family, appear to have, according to published accounts, a varied breeding season. Day (1872), Beavan (1871) & Skene-Dhu (loc. cit.) believed that Mahseers breed several times in a year including monsoon months. Thomas (1897) recorded their breeding at intervals during post-monsoon months. Macdonald (1948) states that 'the Putitor Mahseer is said to spawn three times in the year. In the Punjab, the three spawning seasons are (1) January-February (2) May & June (3) July to September.' Nazir Ahmed (loc. cit.) observed the breeding season of Assam Mahseer to extend from April to October with a peak in August and September; whereas David (loc. cit.) states that the Mahanadi Mahseer breeds after the monsoon between November and January. He adds that 'in *Barbus* (*Tor*) *khudree* and *Barbus* (*Tor*) *mussuallah* spawning takes place in November in the Cauvery system'. Karamchandani (loc. cit.) records that breeding season of *Tor tor* commences in July-August and continues up to December. From the above records, it would be seen that there are different observations largely indicating that the spawning season is not limited to a short period of one or two months like in other major carps but is a prolonged one. However, the observations made at Lonavla (Walwhan Lake) during July and August 1970 indicate that these two months, or more precisely a period of a month or so in these two months represents the spawning period. Records of fish caught from the above lake with the help of gillnets operated in the spawning area are as under:—

Date	No. of fish caught	♂♂	♀♀	Condition of fish
31-VII-70	30	20		Oozing—18 spent—2
			10	Oozing—nil full—9 spent—1
3-VIII-70	9	5		All ripe
			4	3 ripe (loaded) 1 spent
8-VIII-70	17	11		7 ripe 4 spent
			6	2 half spent 4 spent
21-VIII-70	21	17		15 spent 2 half spent
			4	2 spent 2 half spent
27-VIII-70	26	22		12 spent 10 half spent
			4	3 spent 1 half spent

It will be seen from the above catch details that the last few days of July and the first week or ten days of August was the spawning period for the year 1970. Connecting this with the meteorological conditions such as rainfall and the resulting changes in the lake levels, it would be seen that out of the yearly (monsoon season) rainfall of 4285 mm. (160 in.) about 1825 mm. (73 in.) fell up to July 31, 1970, when the spawning activity appears to have set in. At this time the lake level rose from 6·62 m. (21·7 ft.) on 3-vi-70 to 8·5 m. (27·89 ft.) and the temperature of water fell to 24°C. This rise in the level enabled the mature fish to approach some of the streams which flow into the lake. Level areas at the confluence of these streams with the lake were inundated and provided spawning beds, though the actual spawning activity with the usual commotion could not be seen. Rainfall in the lake area commenced from 4-vi-70. The stimulus of rainfall and dilution of lake water can therefore be said to have commenced from that day and to have activated the gonadotropic hormone secretions stage by stage. Actual flooding and low temperature of water triggered the spawning activity. Early part of monsoon of 1970 was rather weak at Lonavla and this might have delayed the normal onset of breeding activity at the lake. Even then from the number of ripe fish caught on 31-vii-70, it can be surmised that the activity had already started. The area where netting was done receives water from three hill streams expected to attract breeding fish. Though the number of fish caught appears to be small, taking into consideration the depth and extent of the main lake, the shallow small area of water fished and the length of the net used, the catch indicates fairly enhanced activity of the Mahseers. On 8-viii-70 large females (3 Kg.) in half spent condition were obtained. It is probable that the half spent condition may be due to their being caught in a gillnet where they usually struggle for their life before they are removed and kept in a conditioning net. During this struggle they may have shed their eggs. Half spent condition after removal from the net is, therefore, considered as ripe and full. However, the catches in the second fortnight of August 1970 indicate that although adult fish were caught, most of them were spent. The spent condition indicated that spawning was over. Whether the same fish has another spell of spawning has to be examined in future. However, from the details gathered so far, a fortnight or two between late July and early August seem to be the peak breeding period of Mahseer in Walwhan and also its adjoining Shirawta Lake.

Two of the females caught on 8-viii-70 which were in ripe condition, though actually half spent, were stripped and the eggs fertilised with the help of milt of the males caught with them. About 10,000 eggs were thus obtained, the fertilization being about 90%. It was probably for the first time in India that such a large number of eggs of Mahseer were obtained by stripping, fertilised successfully and grown to fry and fingerling stage excepting Nazir Ahmed's (loc. cit.) initial effort with the Copper Mahseer of Assam on a smaller scale. For the Deccan Mahseer, this is the first time that the eggs, post larvae and fry, are obtained and described.

DISTINGUISHING CHARACTERS OF MALE AND FEMALE MAHSEERS

Sexual differentiation of Mahseers is not quite apparent to an untrained eye. Coloration in all fins is uniformly bluish in both sexes and the body pale golden yellow and abdomen white. However, the pectoral fin of the male is comparatively longer, reaching the seventh scale below the lateral line. Its outer ray is pointed, straight and its inner margin also almost straight. The pectoral fin of the female is short, reaching below the fifth or sixth scale of the lateral line and its inner margin is concave. Its fin membrane is thicker than in the male and its outer ray is bent inwards. Apart from the bulkiness of the abdomen giving rise to an arched ventral profile, another distinguishing feature of the female is that the base of the anal fin projects out of the profile line, while the profile is comparatively straight or less arched and the base of the anal fin does not very much project out of the profile line in the male. Fine tubercles are sometimes present on the gill cover below the eyes in the male but this character is not always reliable. Similarly the roughness of the pectorals in the males is only slightly felt and requires considerable experience.

DEVELOPMENT OF THE DECCAN MAHSEER, *Tor khudree* (SYKES)

Egg & Embryo :

The eggs of *Tor khudree* are distinctive in as much as they are not colourless like those of Catla, Rohu, etc. but are bright lemon yellow verging on golden brown. They resemble eggs of *Puntius kolus* but are larger than the latter. The perivitelline space is small and they absorb only a small quantity of water. The egg is about 2·5 mm. in diameter when freshly laid and increases in size to 3·2 mm. after absorption of water. Unlike egg of other carps, they are comparatively heavy and demersal, and they are also not soft and smooth like other carp eggs but tough and somewhat rough to touch. They resemble trout eggs but are smaller in size and comparatively lighter in weight. Figure 1a illustrates a freshly laid egg, heavily yolked and without oil globules. Figure 1b indicates an egg three hours after fertilization.

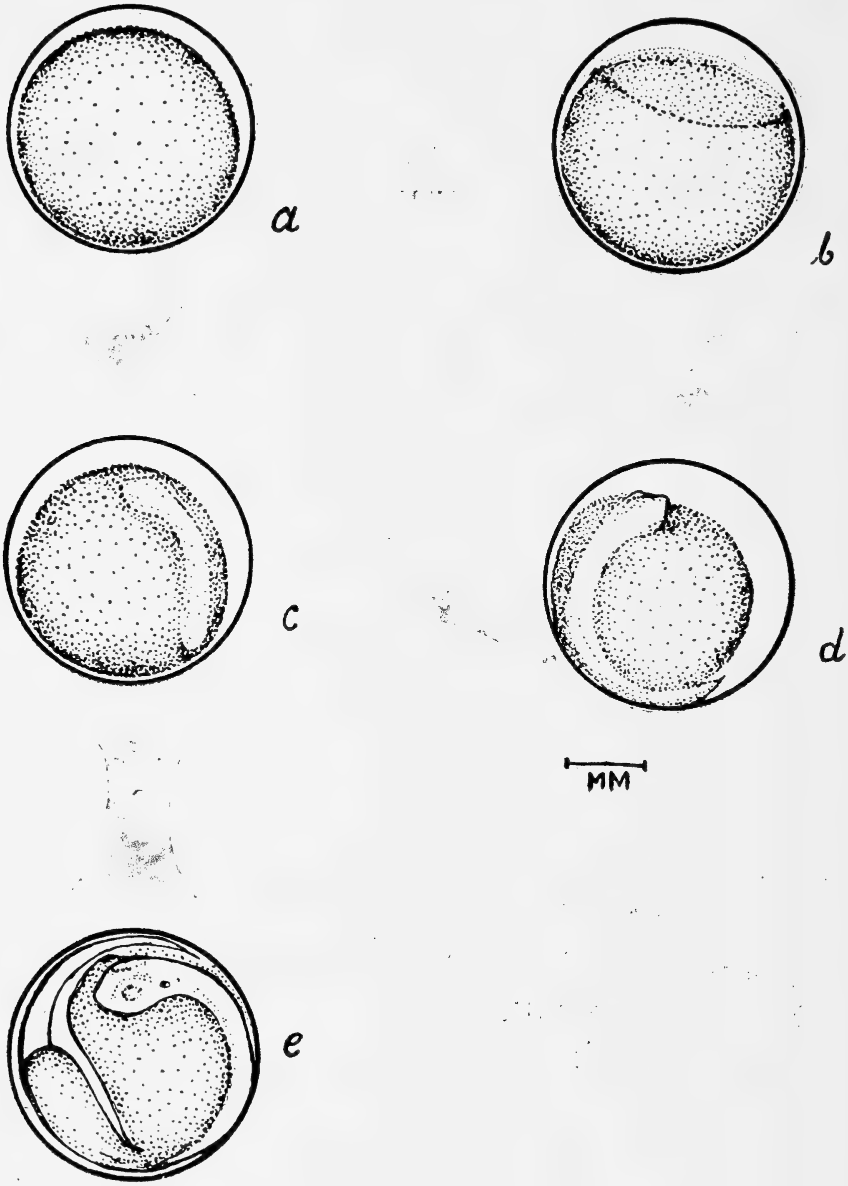

Fig. 1: Eggs of Mahseer, *Tor khudree* (Sykes)

a: Newly laid egg. b: Egg, three hour after fertilization. c: Egg, 24 hours after fertilization. d: Egg, 48 hours after fertilization. e: Egg, 58 hours after fertilization.

It shows a cap of protoplasm gathered at one pole of the egg forming a blastodisc.

After 24 hours (Fig. 1c), the embryo develops further and becomes comma shaped; the cephalic portion can be distinguished but the optic lobes are not clear. The head as well as body of the embryo are closely attached to the yolk. There is no visible movement of the embryo.

After 48 hours (Fig. 1d), the head as well as the tail portion of the embryo are prolonged and they are distinctly seen raised on the surface of the yolk which is now comparatively reduced in size. Twitching movements of the embryo are seen but they are slow and occur after an interval of two or three minutes. The movements at this stage are not jerky as in the Rohu or Catla eggs. Outline of the eyes and the lens are seen but no pigment in the eyes is yet visible.

After about 58 hours, there is not much apparent change in the embryo but the body becomes more defined and clearer, and the head well-defined. The sclerotic ring and the lens are seen but without pigment. Movement of the embryo within the egg has now become more frequent and vigorous than in the previous stage. This movement is so forceful that it makes the egg roll if kept in a flat petrie dish.

After 60 hours the eggs hatch and at the time of hatching, the actual rupture of the egg membrane takes place by the lashing movements of the tail, which bends below the abdomen and then straightens out. Out of the three eggs watched in this way, two hatchlings came out normally and without difficulty but the third had its large yolk sac and head entangled in the egg membrane. This is due to the relatively large yolk sac which may prove to be a handicap leading to a sizeable mortality in natural hatching.

The second batch of 14 eggs observed hatched out between 60 and 72 hours and the third batch of 16 eggs between 72 and 80 hours. It can be thus assumed that under laboratory conditions where water is aerated and changed occasionally and the ambient temperature is largely constant at 29°C, and water temperature 27°C. the hatching period is 60 to 80 hours. In nature, if the conditions are more favourable, the period may be shorter, but in all probability this may not be the case, with the variations in day and night temperatures, depending on whether the eggs are deposited in shallow or deep waters and whether they are lumped together or spread out.

Hatchling :

The first post-larva or the earliest hatchling of the Mahseer (Fig. 2) is about 9 mm. in total length and has a large, prominent, yellow, yolk sac divided into two lobes. Its anterior part is larger (*c*. 2.8 mm. in length) and more rounded than the posterior (*c*. 2·5 mm. in length) which is elongated. The eyes are formed, the eyeball and the outer

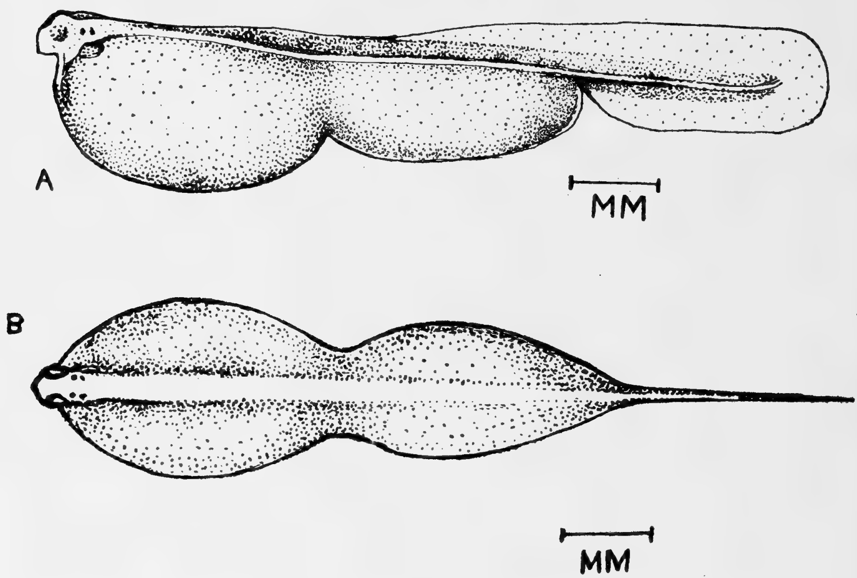

Fig. 2. a: Lateral view of a newly hatched post-larva (hatchling) of *T. khudree* (Sykes). b: Dorsal view of the same.

ring can be seen but there is no pigment. The otocysts can be seen in live specimens. The heart pulsates at about 100 to 105 beats per minute. A few colourless blood corpuscles could be seen. The aorta is also formed. Except for the colour of the yolk sac, the post-larva is colourless. A continuous embryonic fin fold starts dorsally from the middle of the two lobes of the yolk sac and proceeding backwards round the caudal portion, ends ventrally near the posterior margin of the yolk sac. Pectoral is seen as a minute bud. No traces of fin rays are seen at this stage in any fin area.

The post-larva remained quiescent on its side at the bottom of the tray and moved in jerky manner, vibrating its tail only when slightly disturbed.

Three day old post-larva:

Total length 11 mm. Rests on its yolk sac ventrally and with the dorsal finfold pointing upwards (Fig. 3). Towards the end of the third day, it moved more frequently than before but remained at the bottom, though a few occasionally swam momentarily upwards in the usual jerky manner and again settled on the bottom.

A significant development at this stage is the appearance of pigment in the eyeball and melanophores on the dorsal side of the eye. On

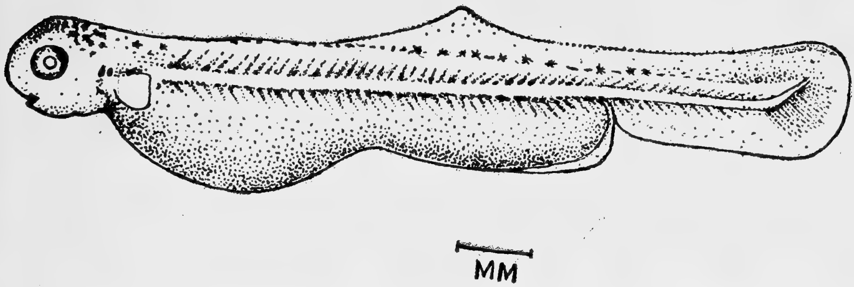

Fig. 3. Three-day-old hatchling of *T. khudree* (Sykes).

both sides of the dorsal fin fold there are black chromatophores. The pectoral fin now develops. Gill covers are well defined and gill filaments are seen. The jaws are formed. In living specimens, the black eyeball has a golden ring surrounded by black chromatophores. Otocysts are clearly marked. The pulsating heart can be clearly seen and the blood corpuscles have become distinctly red in colour. The two portions of the yolk sac appear to be losing their distinctness by reduction of the constriction between them and merge into a long but anteriorly enlarged yolk sac. The dorsal finfold is extended or produced upwards at the place of origin of the dorsal fin. Fin rays on the lower lobe of the caudal fin make their appearance. The anal opening develops.

Six day old post-larva :

Total length of fry 12 mm. (Fig. 4). Though there is not much increase in total length, the structural development has gone fairly

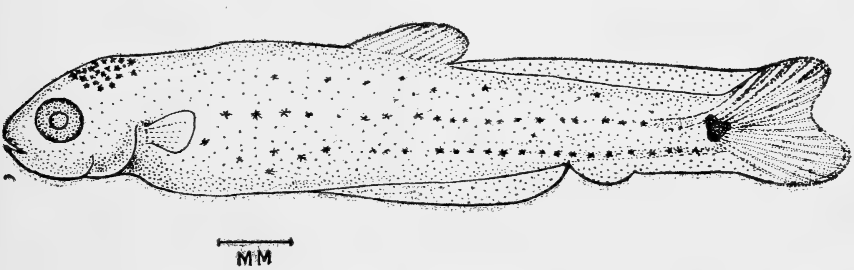

Fig. 4. Six-day-old hatchling of *T. khudree* (Sykes).

apace. In addition to the pectorals, the dorsal fin is clearly demarcated from the original fin fold and as many as ten rays in the formative stage are visible. The caudal fin lobes are marked out and full 19 fin rays could be counted. The anal fin lobe is discernible but without fin rays. Anal opening and a part of the anal track is visible. A fin fold has developed on the posterior portion of the yolk sac but anterior to the anal opening. The constriction between the anterior and posterior portions of the yolk sac had completely disappeared and the latter becomes a continuous fusiform structure.

The eyes have become prominent and bright. Chromatophores have appeared on the head and slightly behind the eyes. A double row of small pigment spots is seen on either side of the dorsal fin, between the lateral line and dorsal profile line. Small chromatophores occur on the body also. A distinct congregation of chromatophores forming a black spot or a blotch is seen on the base of the caudal fin. Anterior to and above the yolk sac and below the vertebral column, an air bladder develops which when viewed from above, appears oval. This is seen only in living specimens. The jaws are constantly in motion.

The fry at this stage (12 mm.) is erect but not free swimming and prefers to remain at the bottom when not disturbed. In a net, they prefer to remain huddled together. This habit may lead to heavy mortality either due to lack of oxygen in the corners where they congregate or to a prowling predator getting a large number of motionless fry settled in one place at a time.

On the 8th day, the fry commenced swimming but they preferred to move on the side walls of the net, probably simulating the adult habit of browsing on submerged rocks. The behaviour could also be interpreted as disinclination or inability to swim freely in the open waters. The sedantary habit accompanied by occassional jerky movements for about 8 days may make the fry an easy prey to predators who may be attracted by the movements and the comparatively large size of the fry.

Eleven day old fry:

At eleven days, the fry becomes a free swimming individual and feeds on Moina, small Daphnia and Cyclops. It has not progressed much as far as its length is concerned, it being only 13.5 mm. in total length. In addition to the concentration of chromatophores on the head, a row of elongated or dash-like chromatophores are seen along the lateral line and also on the caudal rays and the ventral line between the anal opening and the caudal fin. The caudal blotch is distinct and somewhat triradiate when viewed under a microscope. The yolk sac is not yet fully absorbed. The air bladder continues to grow in size. About 38 vertebrae could be counted in a living specimen.

Further progress in fin formation is seen in the appearance of a small bud representing the pelvic fin, a small finfold yet continuing on its anterior and posterior side. A finfold at the base of the caudal is also persistent. The caudal is now distinctly forked and anal fin has developed seven rays. Dorsal has ten fin rays and is situated almost midway between the base of the caudal and the top of the snout, but slightly in advance of the pelvic fin bud. The dorsal profile is rounded; the ventral being almost straight except at the yolk sac portion.

Twenty day old fry:

The 20-day old fry (Fig, 5). is an actively moving individual about 26 mm. in total length. It continues to feed on Moina, Daphnia, etc. The body is covered with small chromatophores but as they are sparse

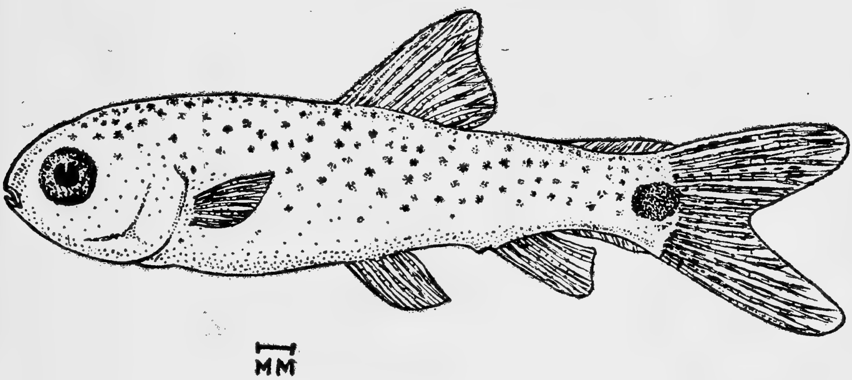

Fig. 5. 20 days old fry of *T. khudree* (Sykes).

and small, the general colour of the fry appears yellowish. No chromatophores are seen on the abdomen and below the head, the area appearing clear white. Small elongated chromatophores are formed on the caudal and dorsal fin rays but in the case of the anal, they are situated on the basal portion of the first two branched rays only. They are absent on the pelvic and pectoral fins. The caudal blotch is quite prominent and its triradiate form has changed into somewhat oblong form with broken margin.

The yolk sac has disappeared and the ventral profile is almost straight The dorsal profile continues to be arched. It becomes more prominently arched on fixation in formalin. Along with other fins, the pelvics are also well developed. The anal has 8 fin rays. They are simple but branched only at the terminal portion. Dorsal has eleven rays. The first undivided ray is just developing, the second and third undivided rays are clearly seen. Other rays are branched only at their terminal portion. In the pelvics also, the first ray is rudimentary the second undivided and the rest branched terminally.

The fry is thus well developed in all respects. In an unhealthy or ill fed fry, the chromatophores are more dense and consequently the fry looks blackish in colour and not yellowish as in the case of healthy ones. Similarly the rate of development may also change in unfavourable conditions.

Piscicultural possibilities

The present observations indicate that if ripe males and females could be obtained at the right time, stripping and artificial fertilization are not difficult. The eggs being tough and hard and the hatching period being long, (60 to 80 hours), transportation of eggs over long distances is feasible in properly designed trays or boxes as in the case of trout eggs. Compared to Catla, Rohu etc. there is less mortality in the eggs after fertilization. Similarly the hatchlings and fry seem to be hardy. Although the critical quiescent period is very long, nearly 7 to 8 days after hatching, mortality is fairly low if proper care is taken and hatchlings are not allowed to lie or rest on muddy surfaces. Further, as the quantity of yolk is fairly large, the hatchlings at the time they become free swimming, are large enough to take Moina, small Daphnia, etc. The hatchlings being more than 12 mm., when they become free swimming, there is hardly any spawn stage. They can be said to emerge as fry only. After four days, they take finely macerated hard boiled egg albumen. Thus raising of fry is not difficult, but the long hatching and quiescent period is not conducive to large output unless a lot of space and other facilities are available.

Apart from the unquestionable utility of Mahseer for lakes in which angling is practised, the fish being good eating, it can be grown in ponds and may add to the list of culturable species in tropical and especially sub-tropical waters where other species of Mahseer are known to thrive. It is reported that large numbers of Mahseer fry can be collected from rivers and streams of Himachal Pradesh. From Narmada also fry are collected in Madhya Pradesh. David (loc. cit.) reports occurrence of large number of fry in Mahanadi and records a growth of 170 to 200 mm., in natural ponds in four months. However, further observations on the food of juveniles and their rate of growth are necessary.

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REFERENCES

AHMED, NAZIR (1948): On the spawning habits and early development of the Copper Mahseer, *Barbus* (*Lissochilus*) *hexagonolapis* McClelland. *Proc. Nat. Inst. Sci. India.* **14**: 21-28.

BEAVAN, R. (1877): Handbook of fresh water fishes of India.

DAVID, A. (1953): Notes on the bionomics and some early states of the Mahanadi Mahseer. *Journ. Asia. Soc. Sci.* **19**(2): 197-209.

DAY, F. (1873): Report of fresh water fish and fisheries of India and Burma.

HORA, S. L. (1939): The game fishes of India. VIII. The Mahseers or the large scaled barbels of India. *J. Bombay nat. Hist. Soc.* **41**: 272-285.

————. (1941): The game fishes of India XIV. The black Mahseer with notes on other colour varieties. ibid. **42**: 803-815.

————. (1942): The game fishes of India XV. On the specific identity of Sykes' species of *Barbus* from the Deccan. ibid. **43**: 163-169

——— & MISRA, K. S. (1938): Fish of Deolali, Part III, ibid. **40**: 20-38.

——— & NAZIR AHMED (1946): Culture of Katli, *Barbus* (*Lissochilus*) *hexagonolapis* McClelland in Darjeeling, Himalayas, *Fish Dev. Pamphlet* No. 3, Directorate of Fisheries, West Bengal.

KARAMCHANDANI, S. J. *et al.* (1967): Biological investigations on the fish and fisheries of the Narbada river, Bulletin 10. Central Inland Fisheries Research Institute, Barrackpore, West Bengal.

MACDONALD, A. ST. J. (1948): Circumventing the Mahseer and other sporting fish of India and Burma. Bombay nat. Hist. Soc. Bombay.

SKENE-DHU (1918): The angler in Northern India, Allahabad.

THOMAS, H. S. (1897): The Rod in India.

Aspects of the Flora, and Ecology of Savannas of the South Indian Hills

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Two biological criteria enable us to characterise the high plateaux of south India above an altitude of 1700-1900 m. : the floristic peculiarities and the different types of savannas.

These high plateaux are essentially covered with savannas, generally shrubby or bushy, fundamentally different from those of lower elevation. These are grassy formations, usually dense and low, often traversed by fire. Their physiognomy, floristic composition and dynamism are determined by the biotic factors and different types of soils and climates.

Their climate may be classified amongst the tropical humid or sub-humid types, locally sub-dry (< 1000 mm. rainfall, 3 to 4 months dry), with a moderately cool season (mean temperature of the coldest month between 10 and 15°C) with some days of frost per year (from December to March). These winter months are either dry or only slightly humid. At this altitude all the soils form part of the group of leached ferrallitic soils.

At least four types of altitudinal savannas developing on firm ground may be recognised. They are described.

ASPECTS OF THE FLORA

At these altitudes I have encountered 356 indigenous and spontaneous species which are not found at lower altitude. Most of these are endemic because 223 *species are known only in the 'montane stage' of south India ;* 17 are also known in northern India, particularly in the Himalayas ; 52 are also reported in Ceylon whereas 36 extend to different countries of Asia. *Therefore, most of the typical species of the 'montane stage' have a limited geographic distribution because* 275 *species out of* 380 *are localised in the hills of south India and Ceylon.*

Another peculiarity is that this typical flora is herbaceous. Out of 380 species, 201 are endemic herbs, 44 are undershrubs. Out of 223 endemic species, 92 are herbaceous and 37 undershrubs or *hemixyles.* Many of these are savanna species. In this article I have limited myself to the montane flora of the Nilgiris and Palni.

(a) *Species probably endemic in the montane stage of the Nilgiris*

Taking into account the multiplicity of the dispersal mechanisms of the species (*see* Razi 1950, 1954) and the proximity of the Palni and Anaimalai, the abundance of the endemic in the montane domain of the Nilgiris is surprising even without counting varieties and subspecies. 82 species (66 Dicots and 16 Monocots) are exclusively confined to this region. All of these are cited below to enable future research workers to bring further precision.

Dicotyledons

ACANTHACEAE

Andrographis lawsoni Gamb.
A. lobelioides W.
A. stellulata Cl.
Leptacanthus amabilis (Cl.) Brem.
Phlebophyllum lanatum (Nees) Brem.
Nilgirianthus papillosus (T. And.) Brem.
Pleocanthus sessilis (Nees) Brem.
Mackenziea violacea (Bedd.) Brem.
Nilgirianthus wightianus (Nees) Brem.

ARALIACEAE

Schefflera rostrata Harms

ASCLEPIADACEAE

Brachylepis nervosa W. & A.

CAPRIFOLIACEAE

Viburnum hebanthum W. & A.

CELASTRACEAE

Microtropis ovalifolia W.

GERANIACEAE

Biophytum polyphyllum Munro
Impatiens beddomei Hk. f.
I. debilis Turcz.
I. laticornis C. Fisch.
I. lawsoni Hk. f.
I. neo-barnesii C. Fisch.
I. nilgirica C. Fisch.
I. orchioides Bedd.
I. rufescens Benth.
I. tenella Heyne

LABIATAE

Leucas rosmarinifolia Benth.
Orthosiphon rubicundus Benth. var. *hohenackeri* Hk. f.
Pogostemon nilagiricus Gamb.
P. paludosus Benth.
Teucrium wightii Hk. f.

BERBERIDACEAE

Berberis nilghiriensis Ahrendt.

COMPOSITAE

Anaphalis neelgherryana DC.
A. notoniana DC.
Helichrysum wightii Cl.
Senecio kundaicus Fisch.
S. lawsoni Gamb.
S. lessingianus Cl.
S. polycephalus Cl.
Yungia nilgirriensis Bab.

Convolvulaceae

Argyreia nellygherya Choisy.

Euphorbiaceae

Dalechampia velutina W.

Gentianaceae

Swertia trichotoma Wall.

Papilionaceae

Alysicarpus beddomei Schindl.
Crotalaria barbata Grah.
C. candicans W. & A.
C. formosa Grah.
Dalbergia gardneriana Benth.

Piperaceae

Piper pikarhense C.DC.
P. ootacamundse C.DC.

Hypericaceae

Hypericum japonicum Thunb. var. *major* Fys.

Rutaceae

Melicope indica W.

Symplocaceae

Symplocos microphylla W.

Umbelliferae

Bupleurum plantaginifolium W.
Heracleum hookerianum W. & A.

Lauraceae

Cinnamomum perrottetii Meissn.

Rosaceae

Pygeum sisparense Gamb.
Rubus rugosus Sm. var. *thwaitesii* Focke

Rubiaceae

Oldenlandia hirsutissima O. Kze.
O. sisaparensis Gamb.
Ophiorrhiza pykarensis Gamb.
Pavetta breviflora DC. var. *ciliolata* Gamb.
P. hohenackeri Brem.

Loranthaceae

Dendrophthoe neelgherrensis Van. Tieghem. var. *clarkei* Hk. f.
Loranthus recurvus Wall.
Viscum orbiculatum W.

Melastomaceae

Memecylon flavescens Gamb.

Mimosaceae

Acacia hohenackeri Craib.

Myrtaceae

Syzygium montanum Gamb.

Monocotyledons

Aroideae

Arisaema tuberculatum C. Fisch.
A. tylophorum C. Fisch.

CYPERACEAE

Ascopholis gamblei C. Fisch.
Carex pseudo-aperta Boeck

ERIOCAULACEAE

Eriocaulon pectinatum Ruhl
E. robustum Steud.

GRAMINEAE

Arundinaria wightiana Nees var. *hispida* Gamb.
Helictotrichon asperum (Munro) Bor var. *polyneuron* C. Fisch.
Eriochrysis rangacharii C. Fisch.
Garnotia geniculata Santos
Isachne deccanensis Bor
Poa gamblei Bor

ORCHIDACEAE

Cirrhopetalum acutiflorum A. Rich.
Coelogyne odoratissima Lindl. var. *angustifolia* Lindl.
Habenaria fimbriata W.
Liparis biloba W.

The Nilgiris appear as an important centre of speciation in south India, next only to Travancore and Tirunelveli.

(b) *Species probably endemic in the montane stage of the Palni*

I have counted 18 species, 15 Dicots, 3 Monocots :

Two trees : *Actinodaphne bourneae* Gamb., *Pittosporum undulatum* Vent ; seven small ligneous species: *Crotalaria conferta* Fys., *C. kodaiensis* Deb and Biswas, *Rubus fairholmianus* Gardn., *Vernonia pulneyensis* Gamb., *V. fysonii* Cald., *Anaphalis beddomei* Hk. f., *Anisochilus argenteus* Gamb. ; eight herbs : *Acrocephalus palniensis* Muk., *Anotis longiflora* Hutch., *Emilia zeylanica* Cl. var. *paludosa* Gamb., *Pimpinella pulneyensis* Gamb., *Christisonia saulierei* Dunn., *Garnotia palniensis* Santos, *Carex raphidocarpa* Nees and *Habenaria elliptica* W. ; and one climber : *Melothria angulata* Chak.

Endemism in the montane stage of the Palni (18 species) and Anaimalai (13 species) is therefore very low compared to that of the Nilgiris. This leads us to the conclusion that many of the species formed in the Nilgiris have not left this massif.

The explanation seems to be that the *anemochores* appearing on the Nilgiris have only a very slight chance of reaching the hills lying further south as the dominant winds blow from the south-west. It is also probable that there are among them neo-endemics which have not yet migrated southwards. As a matter of fact there is no ecological barrier between different localities in the montane stage of south India and Ceylon (Legris & Blasco 1969). A number of trees, mostly *zoochore*, are known from all these hills and high altitude of Ceylon ; examples are *Ilex wightiana* Wall., *I. denticulata* Wall., *Microtropis ramiflora* Wt., *Casearia coriacea* Thw., *Syzygium calophyllifolium* Walp., *Viburnum erubescens* Wall., *Vaccinium leschenaultii* Wt., *Rapanea wightiana* Mez., *Olea poly-*

gama Wt., *Symplocos obtusa* Wt., *Excoecaria crenulata* Wt., *Pittosporum tetraspermum* W. & A., *Meliosma wightii* Planch., *Michelia nilagirica* Zenk. etc. . . .

None of these extend up to the Himalayas.

(c) *Asiatic and Himalayan species known only in the montane domain (or stage) of south India.*

The classical example is that of *Rhododendron*, the geographic races of which, sub-species or species of south India and Ceylon (*R. nilagiricum* Zenk. and *R. zeylanicum* Hort. ex Loud.) differ slightly from the Himalayan type (*R. arboreum* Sm.).

The other ligneous species *Berberis tinctoria* Lesch. and *Cotoneaster buxifolia* Wall., have ecology and distribution similar to that of *Rhododendron*. For the herbaceous species, the distribution is yet wider. *Fragaria indica* Andr., *Potentilla kleiniana* W. & A. *Viola patrinii* DC., *V. serpens* Wall., *Thalictrum javanicum* Bl. are the Asian *orophytes* occurring beyond the limits of Indian territory.

Origin of species in south India

I shall only mention those species like *Eurya japonica* Thunb., *Evodia lunu-ankenda* Merr., *Ternstroemia japonica* L. encountered in different countries of Asia which have a sufficiently vast ecological amplitude to reach the montane stage in south India. As they also occur at lower altitude, they are not characteristic of montane stage.

On the other hand, some Asiatic trees and shrubs not large in number (*Glochidion fagifolium* Hk. f., *Daphniphyllum neilgherrense* Ros., *Pentapanax leschenaultii* Seem., *Rhodomyrtus tomentosa* Wt.) are typical of the montane stage.

The theories proposed till now to explain the presence of these species requiring cool climate in south India envisage large topographic or climatic changes which to this author do not appear indispensable for the explanation.

It is tempting to think that the Pleistocene glaciation, probably felt in the Himalayan region, favoured the North-South migration of a part of the subtropical flora. It has also been pointed out that ' the various stations at which a particular species is found at present, once formed part of a continuous range of distribution of the species . . . . In the regions in between the stations it has died out due to topographical changes leading to climatological variations ' (Hora in Croizat 1968, p. 544).

These two hypotheses do not easily apply to the species considered here. Firstly because the continuity of the Eastern Ghats if at all it existed, dates from the Tertiary. Beyond a few million years many species of Angiosperms would have evolved or disappeared. In this hypothesis (Zeuner 1958, p. 392; Kremp 1969) the theory of physical continuity cannot be retained for the species presently common to south India and Himalayas.

As for the recent large thermic fluctuations (less than 100,000 years) if they took place, why should the southward migration of *Rhododendron* and *Berberis* have been permitted and not of Fagaceæ and Conifers? This remark is as much valid for *Quercus incana* Roxb., and *Pinus roxburghii* Sargent, for example, which occur side by side in the same zone in Western Himalayas. One may add other important instances, particularly the genus *Pieris* (Ericaceae) totally absent in the south. If the Himalayan Fagaceae, Betulaceae and Conifers do not occur spontaneously on the south Indian hills it is because they never came there. Their recent introduction by man shows that the habitat is well suited to these species.

In the regions where the physical continuity of the mountains really existed, the Conifers, Fagaceae, Betulaceae, Ericaceae etc . . . are very abundant at equal latitude. This is the case of the southern extremity of the Annamitic Range in South Viet Nam.

Finally, concerning the land connections between India and Ceylon it is the belief to-day that the last separation is recent (about 10,000 years) but the real disappearance of the Gulf of Mannar would date from the commencement of the Pleistocene and there is nothing to prove that there was in its place a high mountain. Anyway neither the paleoclimatology nor the present ecological conditions explain the presence of the Ceylonese species in the Nilgiris having jumped over all the other hills of south India including the Palnis; such is the case of *Oldenlandia verticillaris* O. Kze., *Vernonia pectiniformis* DC., *Crepis fuscipappa* Benth., *Olea polygama* Wt., *Tylophora iphisia* Dcne., *Ceropegia decaisneana* Wt., *Scutellaria wightiana* Benth., *Sarcococca brevifolia* Stapf etc. (I shall not raise the question of *polytopism* here. In spite of appearance, the Himalayan *milieu* beyond 27°N is very different from that of the Ceylon mountains near the equator so that the genesis of identical species in the two cases should be an uncommon phenomenon).

The argument that cites the mammals presently common to Nilgiris southern Hills and Himalayas does not seem conclusive. *Martes gwatkinsi* Horsfield, the Nilgiri marten, is a species capable of moving down to 900 m. and even lower elevations. The same is the case with *Hemitragus hylocrius* Ogilby, the Nilgiri Tahr.

Under such conditions it seems logical to explain the presence of species common to Ceylon, south India and Himalayas by their actual means of dispersal rather than by palaeogeographic hypotheses. A more likely explanation may be given by examining the means of dispersal of south Indian species having definite Himalayan affinities.

Seeds of *Rhododendron arboreum* Sm. are remarkably adapted to vast displacements. Extremely numerous, minute, flattened, oblong, provided with a tuft of hairs at each extremity, they are susceptible to long transport thanks to wind and birds.

In *Berberis tinctoria* Lesch. much appreciated by the hill thrushes (*Zoothera*) and in *Cotoneaster buxifolia* Wall. the dispersal of the seeds is usually of *endozoic* type as in most of the species of *Fragaria, Potentilla, Viola, Thalictrum, Eurya, Osyris, Passiflora, Gaultheria* etc.[1] In *Crepis* and *Dicrocephala* the means is essentially *epizoic*.

All these species and almost all the plant species common to south India and Himalayas behave as vigorous pioneers, particularly apt to colonise the deforested lands of the montane domain. This characteristic behaviour of the species recently naturalised in a habitat quite different from that of their origin weakens the hypothesis of vestigeal species.

(d) *Conclusion*

The typical species of the montane stage of south India are essentially herbaceous endemics or are known in Ceylon also. A less important group comprises species extending up to the Himalayas. As a matter of fact these are the herbaceous *orophytes* known in different countries of S.E. Asia. In spite of vast discontinuities in areas, this group probably does not represent a vestige of an ancient epoch having completed their migration step by step. An examination of the possible mechanisms of dispersal of these species shows the floristic exchanges between the Himalayas and the Nilgiris as recent or sub-contemporary. Unfortunately, we yet know very little about the seasonal movements of some 350 species of migratory birds actually known in India. The migration study project undertaken in March 1970 at Srinagar by the Bombay Natural History Society may help to bring to light new explanations towards the modern flora of the mountains of Peninsular India.

Main Savanna types and their ecology

These hill plateaux may be characterised by their vegetation types, both ligneous and herbaceous. I shall deal with principal herbaceous types which by far occupy the largest area.

(1) **Chrysopogon zeylanicus—Arundinella** spp. type

This formation is characterised and easily recognised by the dominance of *Chrysopogon zeylanicus* Thw. It is a voluminous Gramineæ, with narrow, rigid leaves left ungrazed by the cattle. Its development in south India and Ceylon is linked to the working of the soil by man. Presently, these savannas essentially cover all the areas of old plantations of *Eucalyptus, Acacia* or other vegetable crops.

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[1] Ridley (1930) and Olson (1968) give data on this type of dispersal.

In the Nilgiris, they are well represented on the Wenlock Downs. Vast stretches are encountered in the Mukurti region. *Arundinella fuscata* Nees of low size is often abundant.

In the Palnis, the valleys around Kodaikanal (Gundar, Koniar, Kumbar etc.) include good examples of this savanna. Here *Arundinella vaginata* Bor is co-dominant with *Chrysopogon zeylanicus* Thw.

In Ceylon, particularly on the Horton Plains, the type grows under a climate more humid than that of south India notably from December to April. Principal grasses are *C. zeylanicus* Thw. and *A. villosa* Arn.

Grasses generally common to all these savannas but rarely dominant are *Eulalia phaeothrix* (Hack.) O. Ktze., *Themeda triandra* Forsk., *Andropogon lividus* Thw., *Ischaemum aristatum* L. etc. In depressions, with increasing hydromorphy of the soils, *Helictotrichon asperum* (Munro) Bor becomes very common, especially in the Palnis ; in Ceylon it is *Garnotia mutica* Fanowsky.

Marked floristic differences are noted according to the regions. For the Nilgiris I have enumerated 60 endemic Dicots and 13 endemic Monocots above 1800 m. The floristic wealth of this hill reflects also in the flora of the savanna. *Pleocanthus sessilis* (Nees) Brem., *Leucas rosmarinifolia* Benth., *Heracleum hookerianum* W. & A., *Senecio polycephalus* Cl., *Anaphalis neelgherryana* DC. etc. impart a floristic character unknown in the Palnis. Besides, many of the savanna species of the Nilgiris tolerate hydromorphic soils. Examples are *Anemone rivularis* Ham., *Impatiens chinensis* L., *Serpicula hirsuta* W. & A., *Dipsacus leschenaultii* Coult. frequent in the savannas of Avalanche in the Nilgiris but practically unknown in the same savanna type of the Palnis.

The abundance of hygrophytic species is yet more marked in Ceylon where one notes numerous *Carex*, *Fimbristylis*, *Ranunculus sagittifolius* Hk., *Osbeckia cupularis* Don, *Oldenlandia verticillaris* O. Kze. etc.

Bioclimate : The temperature conditions vary little from one place to the other in all savannas of high plateaux. Therefore it is not the temperature factor that plays the role determining the main formations.

Low temperatures, varying between –1 to –9°C, were registered under savannas for some days during the period December to March at sunrise. The diurnal thermic amplitude between 6 a.m. and 2 p.m. is very high in winter, often above 35°C.

The high annual rainfall of Ceylon (> 2000 mm.) and Nilgiris (> 1800 mm.) permits the development of hygrophytes even on the slopes. On the other hand, in the Palnis where rainfall in these savannas is of the order of 1400 mm., hygrophytes are rare or absent.

Soils : Table 1 gives the results of chemical analysis of a soil collected under *Chrysopogon zeylanicus* Thw. from the Palnis.

TABLE 1

Depth cm.	Horizons	Pebbles & Gravel %	Mechanical analysis				pH H_2O 1/2, 5	pH KCl	Exchangeable cations m. e./100 gm.				Total exchangeable cations m. e./100 gm.	Exchange capacity m. e./100 gm.	Si $0_2/Al_2O_3$	Organic matter	
			Clay 0 to 2μ	Fine silt 2 to 20μ	Coarse silt 20 to 50μ	Sand 0, 05 to 2 mm.			Ca	Mg	K	Na				C %o	C/N
—20	A1	7·3	19·8	7·9	2·6	58·2	5·5	4·6	0·7	0·4	0·3	0·1	1·5	5·3	1	49·9	19
—20 to 60	AB	34·6	14·5	7·5	2·5	71	5·6	4·9	0·2	0	0·1	0·2	0·5	2·4	1	18·6	13
<—60	B	9·8	14·6	13·5	6	66·1	5·71	5·8	0·2	0	0·1	0·1	0·4	—	1	2·3	2

A1 = surface organic horizon, dark brown (7, 5 YR 1/1), fine, gritty structure. Very porous. Contains numerous roots without preferential orientation.

AB = Gravelly horizon, containing organic material but more or less concretionary rocky material represents 35% of air-dry soil.

B = Sandy clayey horizon, light orange (7, 5 YR 5/1) constantly humid. There are practically no living roots at this level.

(2) **Eulalia phaeothrix—Arundinella fuscata** low savanna type

Dense and continuous grassy formation without trees or shrubs particularly well represented in the Pulavachiar valley in the Palnis. *Eulalia phaeothrix* (Hack.) O. Ktze. and *Arundinella fuscata* Nees are the dominating species of this type which differs from the preceding type essentially by the absence of working of the soil by man (which explains why *Chrysopogon zeylanicus* Thw. has not been able to penetrate) and by higher number of foggy days (probably 180 per year at least).

Moreover, soil profiles usually show under A1 horizon a A12 layer of bulky structure in a wet state.

The absence of plantations till recent years is an indication that fire runs through these savannas almost every year. Shrubs have disappeared except *Rhododendron nilagiricum* Zenk. and *Gaultheria fragrantissima* Wall. in the hollows. *Hypericum mysorense* Heyne, *Vaccinium leschenaultii* W. so common in the *Chrysopogon* savannas are totally absent.

The atmospheric humidity and the presence of A12 soil horizon with high water retentive capacity may explain the presence of species usually seen in humid depressions: *Ranunculus reniformis* Wall., *Impatiens tomentosa* Heyne., *Heracleum rigens* Wall. Gard., *Carex lindleyana* Nees etc....

These savannas are among the most stable types of the plateaux. No distinct trace of dynamism has been noted in the sense that no ligneous element has been observed.

(3) **Heteropogon contortus—Arundinella mesophylla** type

These are the formations on highly eroded soils well developed under a sub-dry climate of the interior depressions of the Palnis. Good examples are those of Mannavanur.

Characterised by a high density of the tufts of *Heteropogon contortus* (L.) Beauv. and *Arundinella mesophylla* Nees closely mixed together, these savannas are rich in species having a large range of distribution: *Coleus forskohlii* (Poir.) Briq., *Polygonum chinense* L., *Micromeria biflora* Benth., *Sopubia trifida* Ham., *Striga lutea* Lour., *Polycarpaea spicata* W. & A., *Borreria ocymoides* DC. etc.

In spite of its awns, *H. contortus* (L.) Beauv. is easily browsed by cattle. If the grazing rotation is very short and if the cutting is followed by sheep grazing then there is considerable deterioration of the pasture marked by a rapid development of wooly Compositæ like *Anaphalis lawii* Gamb. and *Laggera alata* Sch. Bip. which are not grazed by cattle. It is necessary to maintain a strict check on the rational use of the pastures of this region where cattle-breeding is gaining importance.

The bioclimates of these regions may be characterised by annual rainfall of 1000 mm. with 2 to 3 months dry (December to February or January to March.)

The soils unlike those previously described have a thin surface horizon, littered with fragments of altered rock. The following Table 2 gives its essential characteristics.

(4) High rainfall savannas

These are encountered only in the southern and western parts of the Nilgiris which are extremely windy and rainy during the S.W. monsoon. The Western Catchment for example at 2400 m. altitude is one of the most rainy regions of S.E. Asia and probably also of the tropical mountains. Mean annual rainfall usually exceeds 5000 mm. ; figures of 2000 to 4000 mm. in one single month—July or August—are not rare. In the Upper Bhavani and Arikayampuzha, fall of 6056 mm. was recorded between June 1st and July 31st 1959 and 5200 mm. during the same period in 1961. Fundamental trait of this climate is the extreme violence of winds and summer rains, the erosive power of which are considerable.

Soils of the regions are often reduced to lithosols in which the finer fraction is that which remains imprisoned within the network of the roots of grasses. These soils become very dry after the cessation of rains.

The vegetation is characterised by a herbaceous cover, more or less discontinuous because of rocky outcrops. Three woody species are met with in a stunted form : *Rhododendron nilagiricum* Zenk., *Ligustrum perrottetii* A.DC. and *Syzygium calophyllifolium* Walp. A number of small shrubs or *chamaephytes* are encountered which are absent in the Palnis : *Strobilanthes wightianus* Nees, *S. lawsonii* Gamb., *Teucrium wightii* Hk.f., *Leucas suffruticosa* Benth., *Anaphalis neelgherryana* DC., *A. wightiana* DC., *Andrographis lawsoni* Gamb. etc....

The grasses well adapted to maintain themselves in these regions are *Themeda triandra* Forsk. and *Isachne kunthiana* Miq. During the rainy season a number of *Impatiens* spp. may be collected : *I. tomentosa* Heyne, *I. crenata* Bedd., *I. acaulis* Arn., *I. clavicornu* Turcz., *I. pusilla* Heyne, *I. scapiflora* Heyne, etc....

The ecology of this type of savanna is not conducive to the growth of trees. Low winter temperatures, violence of winds and rains resulting in soils poor in fine materials render the working and afforestation of this part of the Nilgiris a difficult task.

Under similar ecological conditions I have located at Sispara in the Nilgiris, another savanna type where *Andropogon lividus* Thw. is very abundant. However this type occupies a small area.

Such are the general characteristics cf the main savanna types of these hills. Every study concerning the dynamism of the indigenous

TABLE 2

Depth cm	Horizons	Pebbles & Gravel %	Mechanical analysis				pH H_2O 1/2, 5	pH KCl	Exchangeable cations m. e./100 gm.				Total exchangeable cations m. e./100 gm.	Exchange capacity m. e./100 gm.	Si O_2/Al_2O_3	Organic matter	
			Clay o to 2μ	Fine silt 2 to 20μ	Coarse silt 20 to 50μ	Sand 0, 05 to 2 mm.			Ca	Mg	K	Na				C ‰	C/N
—8	A1	27·3	18·1	6·6	1·3	64.4	5·7	4·8	4·1	2·3	0·6	0·3	7.3	8	1·9	32·1	17
—8 —35	AB	62·6	22·2	9·2	0·5	59·1	5·5	4·5	2·1	1·3	0·3	0·2	3·9	7·7	1·9	28·7	15
—35 —60	(B)	14·1	15·6	8	1·3	71·12	5·4	4·5	0.8	0·8	0.3	0.2	2.1	4·1	2	12·4	14
<—60	C′	0	26·3	23·2	8·09	41·3	5·6	4·5	0·3	1·1	0·1	0·3	1·8	·4	1·3	1·9	

trees and shrubs, distribution of flora, land-use etc. must take into account the sub-divisions of the savannas of the high plateaux into four groups, described above.

References

Agrawal, S. C., & Madan, U. S. *et al.* (1961) : Ecological studies in the Nilgiris. *Indian Forester* **87**(6) : 376-389.

Blasco, F. (1970) : L'étage montagnard tropical dans le Sud de l'Inde. *C.R. Acad. Sc. Paris.* t. 270, 496-497.

Bor, N. L. (1938) : The vegetation of the Nilgiris. *Indian Forester* **64** : 600-609.

Cowan, J. M. (1936) : The Rhododendrons of Ceylon, South India and Manipur. *Notes of the R. Bot. Garden Edinburgh*, **19** : 157.

Croizat, L. (1968) : The biogeography of India : a note of some of its fundamentals. *Proc. Symp. Recent Adv. Trop. Ecology*. Varanasi, India. Part II, pp. 544-590.

Domros, M. (1970) : Frost in Ceylon. *Arch. Met. Geoph. Biokl.*; Ser **B**, **18** : 43-52.

Gupta, R. K. (1960) : Ecological notes on the vegetation of Kodaikanal. *J. Indian Bot. Soc.* **39** : 601-607.

Holmes, C. H. (1951) : The grass, fern and savanna of Ceylon. *Imp. For. Inst. Oxford.* Paper 28, N° 95.

Legris, P. (1963) : La végétation de l'Inde : Ecologie et Flore. *Trav. Sect. Sci. et Tech. Inst. fr. Pondichéry.* **6** : 590 pages.

——— & Blasco, F. (1969) : Variabilité des facteurs du climat. *Inst. fr. Pondichéry. Trav. Sect. Sci. Tech.* **7** : fasc. 1, 94 p. 18 figures.

Mathew, K. M. (1969) : The exotic flora of Kodaikanal, Palni Hills. *Records of the Botanical Survey of India* **20** : n° 1, 241 p.

Meher-Homji, V. M. (1965) : Ecological status of the montane grasslands of South Indian Hills. A phytogeographical reassessment. *Indian Forester* **91**(4) : 210-215.

——— (1967) : Phytogeography of South Indian Hill stations. *Bull. Torrey Bot. Club* **94**(4) : 230-242.

Olson, S. & Blum, K. E. (1968) : Avial dispersal of plants in Panama. *Ecology*, **49**, n° (3) : 565-566.

Ranganathan, C. R. (1938) : Studies in the ecology of the shola grassland vegetation of the Nilgiri Plateau. *Indian Forester*, vol. **64** : 523-541.

Razi, B. A. (1950) : A contribution towards the study of the dispersal mechanisms in flowering plants of Mysore. *Ecology*, **31** n° (2) : 282-286.

——— (1954) ; Some observations on the plants of the south Indian hill tops and their distribution. *Proc. Nat. Inst. Sci. India* **21** : 79-89.

Ridley, H. N. (1930) : The dispersal of plants throughout the world. 744 p. Ashford, Kent.

Whyte, R. O. (1964) : Grassland and fodder resources of India. 553 p. *ICAR*, New Delhi.

Zeuner, F. E. (1958) : Dating the past. 516 p. 4th edition. Methuen and Co. London.

The Nilgiri Tahr, *Hemitragus hylocrius* Ogilby, in the High Range, Kerala and the southern hills of the Western Ghats

BY

J. C. DANIEL

INTRODUCTION

Reports in the press that the Kerala Government was considering the possibility of nationalising the tea industry in the State, and the fact that amendments to the Kerala Land Reforms Act of 1963, permitted the State Government to take over all privately owned, uncultivated land, for distribution to settlers caused considerable anxiety about the future of the Nilgiri Tahr in the Eravikulam area of the Kanan Devan Hills Produce Co. Ltd's concession in the High Range of Kerala.

The World Wildlife Fund, Indian National Appeal, and Bombay Natural History Society, deputed me to visit the High Range to discuss the situation with the Tea interests and others concerned in the management of the area and to submit a report on the latest position Accordingly, I visited the High Range in the 2nd week of April, 1970, and also took the opportunity of doing a rapid spot survey of the position of the species in the hills in the extreme south of the Western Ghats.

THE NILGIRI TAHR IN THE HIGH RANGE, KERALA

The road from Cochin to Munnar in the High Range of Kerala gives an instructive illustration to what happens to fertile primary forests in densely populated areas. One can hold no illusion that any forested area will survive up to the 4,000 ft. contour or perhaps even higher elevations. The major traffic is timber trucks taking the spoils to the lowlands. The denuded hills are planted over with tapioca by the new settlers and the ground deprived of its cover is so burned by the scorching sun that to travel through is to experience furnace heat till one gets well up on to the hills. We reached Munnar on the evening of the 12th.

On 13th morning, Mr. M. R. P. Lappin, a member of the High Range Game Preservation Association took me to the Eravikulam Sanctuary on Hamilton's Plateau. The road to the Sanctuary becomes a track when it leaves the highest level of tea, and climbs up by numerous hairpin bends till it reaches the plateau. It has to be negotiated either on foot or more excitingly on motor-cycle as we did. Once on the plateau the track runs over gently rolling hills covered with grass and with sholas of varying size in their folds. En route Mr. Lappin fished for trout at a newly made impoundment. Introduced trout which thrive at these elevations is one of the successes of the High Range Game Preservation Association, and trout fishing is an attractive feature of the Sanctuary. Our first sighting of Tahr was unexpected, a herd of 80+ grazing into view over a hill as we reclined on the grass waiting for the bike to cool down. Later by careful stalking Mr. Lappin was able to get a part of the herd to graze to within about 40 ft. of us. A female then saw us, stamped and whistled an alarm which took the herd to the top of the hill before it stopped to look back.

The Eravikulam hut of the Association is situated in a valley almost near the centre of the sanctuary and overlooks a sluggish stream plentifully stocked with trout. The hut had been damaged some time earlier by elephants and the repaired hut is now surrounded by an elephant moat. Accompanied by a Muduvan watcher I walked to the western boundary of the Sanctuary which overlooks a deep valley, densely clothed with forest, silent except for the booming call of the Nilgiri Langur. On our way to the boundary we saw three more herds of Tahr 50+, 30+ and 30+ in strength. On the way back to the hut, we saw two elephants feeding near a pool in a narrow valley of the Sanctuary. Almost all the dropping of jackals seen contained tightly packed, shiny, elytra of a beetle. A casual search in the shola behind the hut while Mr. Lappin angled, yielded a small specimen of *Xylophis perroteti*, Perrotet's Dwarf Snake. The genus is endemic to the hills of south India and the species is said to be common above 5,000 ft. Birds were not much in evidence in the shola, though many Palni Hills Laughing Thrush [*Garrulax jerdoni fairbanki* (Blanford)] were heard. We drove back in the evening, and the last and the most impressive sighting I had of the tahr, was of a phalanx of them seen through swirling mist as they lined the skyline on the crest of a hill.

On 14th morning we visited the Rajamallay Sanctuary area and within a quarter of a mile from the Sanctuary gate saw a fairly large herd of females and young on the hill side. The herd ignored our vehicle and while some rested, others continued to graze desultorily until a dog accompanying its master to town, chased them over the hill. At Rajamallay as in other parts of the tahr habitat excellent views of the valleys are obtained from certain points on the escarpment and with luck one may be able to see gaur or elephant feeding in the valleys. One forest plantation practice of the Kanan Devan Hills Produce Co. Ltd., which can be usefully copied elsewhere (at least in forests which still hold wildlife) is the planting of eucalyptus with adequate spacing between trees to permit undergrowth. All plantations of eucalyptus that I saw in the Company's land in the High Range had fairly dense undergrowth of lantana which I understand provides good cover for sambar and other animals. If this planting policy is adopted one would not have the sterile plantations of eucalyptus seen in Government forests.

The status and habits of the species in the Eravikulam area of the High Range in Kerala have been excellently described by George Schaller (see pp. 365-389 of this *Journal*). This report is limited to consideration of the present position, and the future of the Eravikulam area which holds in a well protected and administered setting not less than one-third but probably half the total world population of the Nilgiri Tahr. In view of the difficulty of protecting the tahr in other areas of its distribution this is the only population which can be expected to survive if continuity of the protection it now receives is assured.

Eravikulam where the majority of the tahr live is approximately 32 sq. ml. in area forming about 1/7th of the total concession area of 215 sq. ml. of the Kanan Devan Hills Produce Co. Ltd. It is largely a plateau above 6,500 ft. elevation and has within its boundaries Anaimudi (8841 ft.) the highest point in the subcontinent south of the Himalayas. The area is largely isolated from the surrounding country on all sides by precipices. The rainfall is extremely heavy during the south-west monsoon averaging about 300 inches. During this season the whole area is swathed in dense fog and gale force winds are usual. Some sections of the plateau receive rains from the north-west monsoon also. From November to February heavy frost occurs and most areas of the plateau experience drought from February to May. The soil is poor and the plateau is predominantly under a coarse variety of grass with a few sholas in well protected folds of the hills. There is no evidence of human colonisation at any time.

From the time the concession was obtained over 70 years ago the area has been retained as a game preserve by the Company and is a unique example of the geography of the High Range before it was commercially exploited. The Company pays an annual tax of about Rs. 40,000 on this land which is of commercially no interest to it and the Company deserves the highest commendation for practising a policy of conservation and being prepared to pay for it.

The administration of the area is in the hands of the High Range Game Preservation Association whose membership is restricted to the managerial cadre of the Company but includes some senior Government officials of the district as honorary members. The Association appoints and pays the game watchers at Eravikulam and other areas within the company's concession. The members of the Association police the sanctuary and other game areas. The funds for the Association are from membership subscriptions and donations, mainly from the Company. Shooting is very strictly controlled and has been negligible over the past few years. Since 1936 the Rajamallay part of Eravikulam which includes Anaimudi Peak has been a sanctuary.

The advantages of the present arrangement is that the executive functions and the whole organisation are controlled by a single authority, the Company. For the past 70 years this arrangement has worked successfully and the 500 odd tahr which live at Eravikulam and the untouched sholas are sufficient evidence of its success.

The major flaw in the arrangement which could be fatal as far as the tahr is concerned, is that the organisation depends entirely on the existence of the Company. If there is a radical change in the management and its policies or if the industry is nationalised, the whole organisation would collapse. The executive authority, the High Range Game Preservation Association is so much an arm of the Company from which it obtains its members and its funds that it would immediately become impotent if company support is withdrawn.

The Company is quite aware of this position and at the meeting of the High Range Preservation Association at Munnar on 14th April which I attended, the Senior Manager of the Company expressed the opinion that the Company may agree to the suggestion mooted at the meeting that the Company present the Eravikulam area to the Indian Nation in the form of a trust for the preservation of the Tahr and its habitat. The Indian Board for Wild Life, the State Board for Wild Life, the World Wildlife Fund—Indian National Appeal, and the Bombay Natural History Society to be represented on the Board of Trustees in addition to the nominees of the Company. The High Range Game Preservation Association to continue as Executive authority. Such an arrangement was considered as the best long term solution. Every effort should be made to process this arrangement as early as possible to ensure abiding permanency to the area and the tahr.

The most urgent need is publicity. Once the Sanctuary area becomes well known and is visited by people it will be difficult if not impossible for the area to be used for any other purpose. A film of the Sanctuary and its animals should therefore have the highest priority.

As conditions are at the moment, the Eravikulam area should be considered as a strict wildlife Reserve and maintained as such. However it may be necessary in the future to open the area to the genuinely interested tourist.

The available and necessary facilities are:

Access: The Sanctuary is open from December to April which is also fortunately the main tourist season. Munnar is about 90 miles from Cochin Airport or approximately 3½ hrs. drive from Cochin and a tourist planning to visit Periyar can easily visit the High Range en route to Periyar a 60 mile drive through the Cardamom Hills. Those who have limited time can visit the Rajamallay area of the Sanctuary where sighting of the tahr is more or less certain.

The Eravikulam area needs to be seen more leisurely and requires a minimum of two days. The track from Upper Vagavurai Tea Estate is not wide enough for 4-wheeled vehicles and must be kept as it is to preserve the primeval wildness of the Sanctuary. I would stress that it would not be to the advantage of the Sanctuary to widen this path. The alternative to walking the eight miles to the hut is to ride a horse or a motor-cycle. From all aspects three-wheeler motor-cycles prepared out of fairly powerful machines and capable of taking two persons in addition to the driver would be the most economical.

One of the points which would need careful consideration if a trust is formed is permanent access facilities to the Sanctuary through Upper Vagavurai Estate.

Accommodation: At Eravikulam, the beautifully situated hut can accommodate six people. A glassed-in sun porch would be a welcome addition. Other items which could make life more pleasant are windmills to run a pump for filling the overhead tank for existing and to be built toilet facilities and to run a dynamo for charging batteries for the lighting.

Wildlife Viewing: While there is little or no difficulty in seeing tahr when with the expert local guides, the other animals which live in the Sanctuary such as the gaur, elephant, sambar, barking deer, wild boar and the occasional tiger or panther shelter in the sholas and are not easily seen. It may be possible to entice the ungulates to the edge of the shola with properly situated saltlicks and to watch from hides.

Staff: The Eravikulam Sanctuary has the unique advantage over other Indian Sanctuaries in that it has available for employment, the Muduvans who are expert woodsmen. As the original inhabitants of the High Range and on account of their reliability and honesty they deserve every opportunity for employment that the Sanctuary offers.

The Sanctuary has so far had the dedicated services of the members of the High Range Game Preservation Association but if the proposals that have been made in this note are to be successfully implemented a full time warden and a small permanent establishment would be necessary.

On 16 April, I attended by invitation, the meeting of the State Board for Wild Life which was held at Periyar Wild Life Sanctuary, with the State Minister for Forests, Shri Ravindran in the Chair. Mr. J. C. Gouldsbury, Chairman, High Range Game Association, very ably presented the case for retaining the Eravikulam area for its present objectives, and he was unanimously supported. The Minister and C.C.F. were also extremely co-operative and the former stated that he would immediately take up the matter with the departments concerned.

I met His Excellency the Governor of Kerala on the 18th and conveyed the Society's and the World Wildlife Fund's (Indian National Appeal) thanks for his interest and assistance.

The Nilgiri Tahr in the Southern Hills of the Western Ghats

The first part of my objectives in the south was completed on the 18th. From the 19th to 25th, I travelled north through the towns at the foot of the hills along the eastern face of the Ghats from the Aramboly Gap to Srivilliputur and, omitting the Palni Hills, to Pollachi east of the Anaimalais. I collected information on the occurrence of the tahr and wherever possible visited the hills for a personal check.

The status of the tahr in the extreme south of its range, unlike its position in the Nilgiris (Tamil Nadu), and the High Range (Kerala), is little known. There are no Wild Life Associations and hardly any organised hunting. Earlier reports (Webb-Peploe 1947; *JBNHS* **46:** 642) mention the animal as common on the grassy slopes of the higher hills in the extreme south of the Peninsula. I had planned to enquire at villages at the foots of the hills, starting from the southern tip of the Ghat and moving north along the eastern face of the hills, checking wherever possible the correctness of the data. I was however unable in most cases to verify the information obtained owing to the limited time of six days available to me. Almost all the tahr grounds are (fortunately for them), away from roads and require at least a three-day stay for a 24-hour visit.

Rising precipitously from the plains and reaching heights of over 3,000 ft. within 3 to 4 miles of the plains, the eastern face of the Ghats with its escarpments with nearly vertical drops of 1000 to 2000 ft. and grass-covered tops make ideal tahr country. The watershed ridge rarely falls below 4000 ft. The information received covers the area of hills lying between *c.* 8° 20′ and 9° 35′ latitude. The number of localities of the hill forest divisions within this area where tahr are definitely said to occur are: Mahendragiri Hills (*c.* 8° 20′ to 8° 25′ N., highest elevation 5427 ft.) **3**; Kalakkadu Hills (*c.* 8° 25′ to 8° 32′ N., highest elevation 6002 ft.) **2**; Singamapatti and Papanasam Hills (*c.* 8° 32′ to 8° 50′, highest elevation 6132 ft.) **3**; Kuttalam Hills (*c.* 8° 50′ to 8° 57′, highest elevation 5237 ft.) **2**; Kadayanellur Hills (*c.* 9° 5′ to 9° 15′, highest elevation 5876 ft.) **2**; Sivagiri Hills (*c.* 9° 15′ to 9° 25′, highest elevation 5385 ft.) ?; Srivilliputur Hills (*c.* 9° 25′ to 9° 35′, highest elevation 6624 ft.) **2**.

For reasons mentioned earlier, I was able to check personally only two out of the 14 localities. However I believe the information is correct and also that the tahr occurs in many more areas than are listed. For a thorough survey, a stay of at least a fortnight in each area is necessary. From the information I obtained and from personal observation it was evident that as long as the tahr areas remained isolated and inaccessible, the tahr survived but once roads were laid they were exterminated. The Kalakkad Hills are an excellent example of an undisturbed area and have the potential of becoming a fine sanctuary. In addition to the tahr, all the larger mammals are fairly common. It is also the area in which the Lion-tailed Macaque (*Macaca silenus*) is still found in some numbers. I would strongly recommend that this area be converted into a Sanctuary. However, if it is to retain its present wealth of wildlife, roads should not be laid and the sanctuary named and retained as a primary wilderness.

I feel that immediate efforts should be made to protect the tahr of Varaiaddu Mottai above the Upper Kodayar Dam in Tirunelveli Dt., Tamil Nadu. The area holds the remnant of the herds which had lived in the locality. The facilities now available if utilised properly will make the area famous for the viewing of tahr, an animal usually very unlikely to be seen by visitors owing to the precipitous nature of its habitat. At Kodayar, the road overlooks the tahr habitat and if the animals are left undisturbed, seeing them from the road can be more certain. If full protection can be assured they can be habituated to stay in easily seen areas by baiting them with salt licks. At the moment the road is used for poaching and the animals are also poached by people coming up from the base of the hill. The twelve animals, (10 ♀ and 2 kids) that we saw were very nervous and fled as soon as they saw us. Development activities on all sides have more or less isolated the tahr on the hill and unless steps are taken without any delay they will be exterminated.

For obvious reasons I have not given specific details of tahr localities. I would be glad to give them to anyone who can find the time, and the money to do a thorough Survey of the tahr in the Kanyakumari and Tirunelveli and other districts of Tamil Nadu. The High wavys, Palnis, and other hills to the north should also be immediately surveyed. It may be that about half the tahr population is found outside the Nilgiris and the High Range.

Acknowledgements

I am very grateful to His Excellency the Governor of Kerala for giving me a patient hearing; to the Minister of Forests, and the Chief Conservator of Forests, Kerala, for the invitation to attend the meeting of the State Wild Life Board; to Mr. M. R. P. Lappin and Mr. J. C. Gouldsbury for their generous assistance during my visit to the high range; and to the State Wild Life Officer, Tamil Nadu, for various assistance.

I am indebted to Mr. J. J. Bland who very generously helped me during my visit to Manjolai. Finally I would thank Mr. S. A. Hussain, Research Assistant at the Society, who drove the vehicle under most trying conditions and was always willing and helpful.

The financial assistance of the WWF, Indian National Appeal which made this visit possible is gratefully acknowledged.

Reviews

1. ENJOYING ORNITHOLOGY. By David Lack. pp. 264 (21×13.5 cm.). London, 1965. Methuen & Co. Ltd. Price in U.K. 30*s*. net.

This is a collection of radio talks and articles written from time to time for the author's own enjoyment and for those with a general interest in natural history but without the leisure or facilities for keeping abreast with significant trends and developments in the field of scientific ornithology. Of the four parts comprising the book the first, dealing with Migration is perhaps the most fascinating. It describes in a way that a layman can understand, Dr. Lack's pioneering studies of bird migration by means of high power radar. While it is not yet possible to identify with absolute certainty the species of bird moving across a radar screen, its identity can be determined with tolerable accuracy by an integrated analysis of the size of the image, its speed of travel, the composition of a flock (whether densely packed or straggly) and so on, co-ordinated with weather reports from different points along the direction of travel and visual observations from the ground. Radar studies of migrating birds have helped to reveal a number of facts hitherto unknown and unsuspected, which would be impossible to learn by any of the orthodox methods of migration study. Even at a height of 2000-4000 ft. birds are often out of sight of an observer on the shore or on a ship, and thus a major part of the movement is missed when relying solely on vision. On the other hand when, due to abnormal weather conditions, the birds are forced to fly low a misleading picture of their abundance or of what is really taking place is apt to be projected. Radar confirms that in fine weather migrants head in a constant direction over the sea (without any landmarks as guide) supporting the experimentally established finding that they navigate by the sun and stars. In bad weather, with strong cross winds, the migrants often get drifted off course, but here again radar has shown that such drifted birds somehow manage to re-orientate themselves; recoveries of ringed birds prove that they eventually succeed in reaching their goals. How this is achieved is not known at present, but radar lends support to the experimentally deduced hypothesis that migrants possess an innate sense of direction; the mechanism of this sense is as yet not understood. True, ring-recovery evidence is so far lacking that drifted juvenile birds on their first autumn migration can re-determine their course towards the normal winter quarters of the population, and it is perhaps too much to assume that they are able to locate an area where they have never been before purely by this innate sense of direction. Nevertheless, as the author points out, 'One must beware of rejecting a hypothesis because it seems to ask too much of a biological mechanism'. The chapters concerned with migration study by radar indicate the vast advances made and the almost limitless possibilities of this technique for probing ever deeper into the mysteries of bird migration aided by the increasing refinements and sophistication in the design of radar equipments. Radar data properly analysed and co-ordinated with weather reports, visual records, ring recoveries and laboratory experiments promise to unravel a number of the pervading mysteries, or at least to bring the solutions considerably nearer.

The chapter 'Swifts at Home' is a broadcast résumé of the intensive studies of the author and his wife on swifts nesting in the tower of Oxford University Museum, earlier published in *The Ibis* and elsewhere. It reveals many aspects of swift biology not known, suspected or described before, e.g. that in bad weather when the parents cannot procure a sufficiency of aerial insects, the nestlings are capable of surviving for several days without food. This they can do because of a number of special adaptations—ability to store up fat when food is plentiful, and to lie cold and torpid in an unattended nest (virtually hibernate) for several days without dying. Lack also deduces that when on their long migrational journeys—up to 6000 miles between N. Europe and Africa—swifts must roost on the wing, especially over the sea. This would seem a unique achievement for any bird, particularly for one with the swift's long narrow wings totally unsuited for motionless soaring. One cannot help wishing for some direct confirmation of this seemingly impossible feat.

There is a chapter on Darwin's Finches of the Galapagos, the birds which provide the classical example of the way in which Natural Selection works to evolve new species and subspecies in isolation. Included among this differentially adapted group is the unique tool-using finch which skewers out grubs from within holes and crannies in trees by means of a cactus spine or twig held in the bill.

Other topics include illuminating accounts of British Pioneers in Ornithological Research, Bird Artists and The Edward Grey Institute, Oxford. The last part of the book has an amusing Ornithological Examination Paper (with answers in an Appendix) and a clever and amusing skit on the intrepid and all-too-ready tribe of species-makers entitled An Undiscovered Species of Swift—a bird which the inspired reader may recognize as clearly belonging to the Hoodwink family!

All the chapters are highly readable and informative as one has learnt to associate with the writings of this versatile author.

Though becoming somewhat of a hotch potch in the latter part, the book fulfils its purpose admirably—making ornithology more enjoyable.

S.A.

2. THE LIVES OF WASPS AND BEES. By Christopher Andrewes. pp. 204 (22·5×13·5 cm.). 16 half-tone plates. London, 1969. Chatto & Windus Ltd. Price 35*s.*

This book is intended to interest the general reader in the study and observation of wasps and bees as an alternative to that of the lepidoptera. A conscious effort has therefore been made to avoid technical language and to keep the narrative as simple as possible. In the main, species which occur in Europe and North America are dealt with. There are references, however, to tropical species, e.g. *Sphex œgyptica* parasite of the migratory locust. The females of this species accompany the migrating hosts, during periods of halt hurriedly make, store, and complete as many burrows as they can and then, leaving their work as it stands at the moment, move on with the locusts to carry on their work elsewhere. Strange to say, the males of this species have not yet been found, giving rise to speculation whether the species is parthenogenetic.

In a series of short chapters a brief account is given of the life of these insects, with special emphasis on differences in behaviour and habits between different species and even between populations of the same species in different regions. The literature on the subject is freely drawn upon and a large number of interesting observations and deductions are brought together in the book. For instance, one usually thinks of the male wasp's duty as completed when he has mated, but we read here of an American species in which the male does household chores and guards the home in the absence of his mate—it must be admitted, however, not very efficiently! And it is intriguing to read about the *Ammophila* which has learnt the use of tools. She uses a stone as a hammer to make a secure closure of her burrow, unlike the *Sphex* who pounds with her head to seal the entrance and *Bembix sayi* who uses the tip of her abdomen for the purpose. The accompanying photograph shows a stone several times bigger than the wasp's head and, evidently, much more effective as a hammer. Or, take the spider-hunting wasps. One drags her victim long distances and takes the risk of having it stolen while she is engaged in making the burrow to receive it. Another avoids the danger by first finding a burrow it can rifle and then making her own burrow to put the stolen victim into. A third enters the spider's hole, overcomes and paralyses the spider, places her egg on it, and walks out to search for her next victim. And a fourth places her egg on a temporarily paralysed spider and leaves it to develop on the body of the spider, which recovers from its temporary paralysis and lives long enough to see the development through. As an instance of insect industriousness when the urge is on may be cited the *Crabro stirpicola* which is said to have been observed digging continuously at its burrow for forty-two hours on end with only one ten-minute break.

A short bibliography and an index complete the book.

D.E.R.

3. SUPPLEMENT TO THE GLOSSARY OF INDIAN MEDICINAL PLANTS. By R. N. Chopra, I. C. Chopra and B. S. Varma. pp. xii+119 (25·5×16 cm.). New Delhi, 1969. Publications and Information Directorate. Price Rs. 14.00; 28*s*.; $ 4.50.

The authors must be complimented for bringing out this volume, which, though small in size, is replete with a great deal of useful information and references on Indian Medicinal Plants. The plants have been arranged in an alphabetical order according to their generic names for ease of reference. Most of the plants mentioned here have been already included in the Glossary of Indian Medicinal Plants published in 1956, but the present volume deals with all the work done on them from that time till 1964. The reviewer feels that references upto 1968 at least could have been included particularly because this volume has been published in 1969. It would have served to make the work more up-to-date.

The supplement enumerates, in addition to those in the older Glossary, a number of plant species which were not described before. These are marked with an asterisk and can therefore be easily spotted. An index of Regional, Trade and Language Names and an index of Chemical Constituents at the end of the book further enhances its usefulness.

It is seen from page iv that the 1932 edition of THE MEDICINAL AND POISONOUS PLANTS OF SOUTH AFRICA by Watt and Breyer-Brandwijk was consulted by the authors, whereas a new, revised and enlarged edition of the same has been in circulation since 1962.

The price of the volume, which is available in hard cover, is encouragingly low at Rs. 14 per copy and no one interested in the subject of Indian Medicinal Plants should be without one.

S. R. AMLADI

4. THE WILD MAMMALS OF MALAYA AND OFFSHORE ISLANDS INCLUDING SINGAPORE. By Lord Medway. pp. xix+127 (19×26·5 cm.). With fifteen coloured plates by Mazli Matsom and Hamidah Suhaimi. London, 1969. Oxford University Press. Price M. $ 30.

Ever since Wallace's classic THE MALAY ARCHIPELAGO (1883) the mention of Malaya immediately arouses interest among zoologists and naturalists. Though this book covers only the Malay Peninsula and the islands immediately offshore, excluding those further east, it is an extremely useful book for anybody interested in the mammals of South Eastern Asia.

117 of the 200 species recorded from Malaya are illustrated on 15 plates. The pictures are not particularly attractive, but are clear and diagnostic enough to identify most, except perhaps the bats and rats. Out of 78 species of bats, only 38 have been illustrated.

The naturalist in India, while noting the absence of some of our common forms like the antelope and the jackal will be struck by the fact that in contrast to single forms in Penisular India, Malaya with its much smaller area has in several instances more than one species in the same genus or family, e.g. two pig, two bison, two porcupines, two moonrats, two mousedeer, two rhinoceros, etc.

Each species is separately referred to and, in addition to details for identification, a summary of whatever other information is available regarding habits, breeding season, food, etc. is given.

I think this a very useful book addressed to the layman and at the same time containing most of the information that is available for the scientific worker. It is evident that as in India, the animal life has been little studied and it is hoped that this book by a very versatile naturalist will arouse more interest and help to fill in the many gaps in our knowledge.

H.A.

5. WARNE'S NATURAL HISTORY ATLAS OF GREAT BRITAIN. By Arnold Darlington. pp. 112 (25×19 cm.). With many illustrations by Charles King. London, 1969. Frederick Warne & Co. Ltd. Price 35*s*. of £ 1.75 net.

This is another superb natural history book which is aimed at intelligent children but would be equally rewarding for adults. The book describes in order the main habitats of Great Britain, namely, sand dunes, sandy heathlands, acid moorlands, chalklands, limestones, and clays. In each section there is first a simple but informative write-up which covers, at a simple level, and helped out by diagrams the entire ecology of the habitat, i.e. the relationship between the soil, the creation of the soil, the plants, the insects and finally the birds. Reading these sections will give any child a close and vivid understanding of the interrelation between all natural forms. The next also describes changes in environment over a historical time—what did the Romans find in these areas? The book, therefore, unassumingly promotes *ecological understanding* rather than just 'love of nature', and this is why it would be a good idea for Indian children though it deals with Britain. The written pages are followed by attractive colour illustrations on the common plants, insects and birds of the particular habitat, to aid identification on picnics.

At the end of the book are a series of coloured maps of England denoting habitat. There is a bibliography and a final section which aims to make a conservationist of the young reader, by giving advice on field study and experiments.

S.F.

6. INDIAN FOSSIL PTERIDOPHYTES. By K. R. Surange. pp. viii+209 (24·5×15·5 cm.), with 1 coloured plate and 101 figures. New Delhi, 1966. Council of Scientific and Industrial Research. Price Rs. 23; 46*s*.; $8.

This is the fourth botanical monograph published by the CSIR, New Delhi. In this highly useful publication, Dr. K. R. Surange, Director, Birbal Sahni Institute of Palaeobotany, Lucknow, has collated information on Indian Pteridophyte fossils known since 1828. The monograph has indeed many points of excellence which are worthy of emulation by authors of botanical papers. The language is precise and free from unnecessary verbosity and the facts are presented in a very lucid and unbiased manner, The last chapter gives a valuable comparative account of the Indian fossil pteridophytes with those of the southern hemisphere, and adds to the utility of the publication. The quite extensive bibliography will prove useful to research workers in Palaeobotany. The photographs and illustrations are excellent for which the technicians concerned deserve compliments. There can be little doubt that this handy monograph with its very high production values will be a great boon to palaeobotanists in India and elsewhere. It is sincerely hoped that many similar monographs will emerge from the CSIR in the service of Indian Botany.

P.V.B.

7. A DICTIONARY OF BOTANY. By George Usher. pp. v+404 (21·5×14 cm.). London, 1966. Constable and Company Ltd. Price 50*s*.

Mr. George Usher, who is the senior Biology Master at Bedstone School, Bucknell, Shropshire, U.K., has compiled this dictionary to meet the needs of University students and Grammar School pupils in Botany. He has taken a broad view of the subject and has incorporated terms used in soil sciences. biochemistry and statistics.

This work should certainly fulfil the needs of students for whom it is meant and is indeed useful for all those who are interested in the study of Botany. Considerable amount of modern as well as the classical data are incorporated.

The problems of Plant-taxonomy as the author has pointed out in the preface, are so immense that in a work of this type the information cannot be completely given. Even so, the author has given the views of important authorities.

As the author had anticipated, quite a few slips have crept in this great undertaking but it would be futile to mention them in a review as they are not of great consequence. These slips are of the nature of repetitions, missing the correct sequence, mis-spellings during composition etc. In a dictionary, these slips may appear unpardonable to some, but they do not really impair the value of the work. It is hoped that the next edition will be more carefully proof-read.

But for its high price, the dictionary is a commendable reference work for the Indian students of Botany. There is no doubt that it will find a place in all college libraries teaching courses in Biology and general liberal education.

P.V.B.

Miscellaneous Notes

1. ABNORMALITY IN THE BREEDING BEHAVIOUR OF THE INDIAN FRUIT BAT, *PTEROPUS GIGANTEUS GIGANTEUS* (BRUNNICH)

Earlier authors (Marshall 1947; Moghe 1951), who studied the reproductive activities of the Indian fruit bat, *Pteropus giganteus giganteus* recorded that this species has a sharply defined breeding season. In Ceylon this species conceives from early December until early January, and the young ones are delivered in May or early in June (Marshall op. cit.). In Central India copulation occurs some time in September, and pregnancies in progressively advanced stages occur up to about the end of January or early February (Moghe op. cit.). Evidently there seems to be a slight variation in the breeding habits of this species in different geographical localities.

While making collections of the specimens of this species for embryological studies I noted the following peculiarities so far not recorded for this bat. Among the four pregnant females collected on January 31, 1968 one was in very late pregnancy, one in mid-pregnancy and two in very early pregnancy carrying just implanted embryos. Among the five females collected on January 22, 1970 four were in late stages of pregnancy, and one was in very early pregnancy with an unimplanted blastocyst in the uterus. These facts indicate that the different females in the same colony copulate at different times in the year, and hence, they carry different stages of pregnancy on a given date. One pertinent fact needs mentioning. In the specimens of this species reared in captivity in the London Zoo, births were recorded on the following dates—January 14, January 31, February 6, February 14, March 18, March 24, May 8, June 14, December 4, and December 19, (Baker & Baker 1936). The present observations show that even in nature *Pteropus giganteus giganteus* may not have as sharply defined a breeding season as mentioned by earlier authors.

DEPARTMENT OF ZOOLOGY,
INSTITUTE OF SCIENCE,
NAGPUR,
June 14, 1970.

J. D. SAHASRABUDHE

References

Baker, J. R. & Baker, Z. (1936): The seasons in a tropical rain forest (New Hebrides). Part III—Fruit bats (Pteropidae). *J. Linn. Soc. London* **40**: 123-141.

Marshall, A. J. (1947): The breeding cycle of an equatorial bat (*Pteropus giganteus*) of Ceylon. *Proc. Linn. Soc. London* **159**: 103-111.

Moghe, M. A. (1951): Development and placentation of the Indian fruit bat, *Pteropus giganteus giganteus* (Brunnich). *Proc. Zool. Soc. London* **121**: 703-721.

2. THE WHITE TIGER

Mohan, the grand patriach of white tigers died on the night of 18 December, 1969, at the age of 19 years.

First seen by the Maharaja of Rewa in May, 1951 in Rewa forests as one of four cubs. He was captured on 27 May 1951 when he was about 9 months old.

When Mohan attained maturity he was mated to an ordinary coloured tigress 'Begum' of the same age captured on 28 November 1952 from the same forests. The first litter produced on 10 April 1955, had normal coloured cubs. One of these cubs 'Radha' was mated with Mohan and gave birth to four white cubs on 30 October 1958, initiating the race of white tigers. Today there are 33 white tigers in the world—11 of which are in Delhi Zoo alone and six at Govindgarh Palace, Rewa.

Director,
Delhi Zoological Park,
New Delhi,
December 22, 1969.

J. H. DESAI

3. THE BREEDING OF THE INDIAN GIANT SQUIRREL (*RATUFA INDICA*) IN CAPTIVITY

In 1966, His Highness the Chhatrapati Maharajasaheb acquired from the North Kanara jungles for his private Zoo a pair of young Indian Giant Squirrel [*Ratufa indica* (Erxleben)] commonly known in these parts as Malabar Squirrel and in Marathi 'Shekra'. The squirrels have thrived in captivity since then and after three years they bred for the first time on the 1st of August 1969 and gave birth to one young (male). The squirrels are kept in a semi-circular cage with a radius of 21 ft. and root height 10 ft. They made a nest of dried grass (hay) in a wooden box 1′ 6″ × 1′ 6″

×1′8″), which had been installed in the cage. The young one is alive and has grown up well.

The same pair has again given birth to another young (male) in the same cage and box this year on 22-iv-1970. This time mating was also observed between 7th to 10th February 1970. This young is also growing up satisfactorily.

The breeding of these squirrels in captivity is we think an unusual occurrence.

OFFICER-IN-CHARGE, V. G. SURVE
NEW PALACE ZOO,
KOLHAPUR,
September 11, 1970.

4. BREEDING BEHAVIOUR AND DEVELOPMENT OF *RATTUS RATTUS WROUGHTONI* HINTON, 1919 (RODENTIA: MURIDAE) IN THE LABORATORY

(*With a text-figure*)

Rattus rattus wroughtoni was the commonest species of rat found in trapping operations in the moist deciduous forests of Sagar and Sorab Taluks of Shimoga District, Mysore State (Boshell & Rajagopalan 1968[1]). A colony of these rats was maintained in the laboratory in connection with the studies on the natural cycle of Kyasanur Forest Disease virus and the observations made, during these studies, on the breeding behaviour and development of this rat, are recorded in this communication.

MATERIAL AND METHOD

Rodents were trapped in the forest using 'Sherman' traps (aluminium folding traps, 9″×3½″×3″) and 'pakoda' (a mixture of gram flour and onion fried in oil), as bait and brought to the field laboratory. Adult female rats were kept in individual cages made of thick GI wire mesh (12″×18″×24″) with straw bedding. The standard laboratory mouse boxes (10″×7″×5″) with paddy husk bedding were also found satisfactory. Wild caught males with scrotal testes were provided one

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[1] BOSHELL, M. J. & RAJAGOPALAN, P. K. (1968): Small rodents and shrews in the Sagar-Sorab area, Mysore State, India. Population studies: 1961-1964. *Ind. J. Med. Res.* **56** (4): 527-540.

for each female. Whenever fighting was noticed, the male partner was changed for another male. Apparently pregnant females were separated in individual boxes for daily observation. The female and the babies when born were weighed once a week. The rats were fed on a commercial animal diet and water was provided from a dripping bottle with a nozzle. The cages (or boxes) were changed every three or four days and provided with fresh bedding.

Observations

A great variation in the behaviour of the individual rats was observed. In all cases, the male partner was not readily accepted by the female and fighting ensued, the female being the aggressive one. Out of 44 females kept under observation, only 17 littered. Laboratory breeding was more successful when the same female and male, which had copulated once, were used. Only in two instances, the female accepted a fresh male. It seems probable that there is a selection of individuals among the wild population which can readily breed in captivity. Actual process of copulation or littering was not observed, though the pairs were seen in a huddled posture inside the cage.

Breeding performance and litter size:

As stated above, only 17 females of the 44, littered in captivity. The others did not, even though the males were changed periodically. Eight females littered only once, two females twice, three females thrice, two females five times, one female seven times and another female eight times (Table 1). There appeared to be no seasonal variation in the breeding of these rats in the laboratory, as litters were born in all months of the year. The number of babies in a litter varied from one to five, though three or four babies in a litter are most common. (Of the 46 litters observed, 22 had three babies and 14 had four babies). There were more males than females among the babies born in the laboratory. In nine cases, all the babies in the litter were males and only in three cases all were females. Of the 145 babies born, 23 were either eaten up by the mother or died and hence could not be weighed or sexed. Of the remaining 122 babies, 66 were males and 56 were females. During the first week after littering, the babies were invariably protected by the mother. The mother became agitated when disturbed and in some cases ate up the babies.

Oestrus cycle and gestation period:

From Table 1, which gives the data on the littering of 17 rats, it was possible to calculate the gestation period. The normal procedure followed was to isolate the female after pregnancy was observed. In one case (Rat no. 26) the male partner was removed only on the day

TABLE 1

BREEDING OF *Rattus rattus wroughtoni* IN LABORATORY—LITTER SIZE, SEX COMPOSITION AND BIRTH WEIGHT OF BABIES BORN

Sl. No.	Rat	Litter No.	Date delivered	Litter size	Sex of babies		Average birth weight in gm.
					M	F	
1.	2	1	28-V-1965	3	3	0	9·5
2.	3	1	3-II-1965	3	1	2	4·5
3.	,,	2	14-IX-1965	4	2	2	4·3
4.	,,	3	19-I-1966	3	1	2	5·2
5.	,,	4	15-IV-1966	4	3	1	5·2
6.	,,	5	23-VIII-1966	4	2	2	5·1
7.	9	1	27-IX-1965	3	2	1	7·6
8.	12	1	21-I-1965	3	1	2	4·4
9.	,,	2	6-V-1965	3	2	1	5·5
10.	16	1	8-IV-1965	3	3	1	5·3
11.	,,	2	29-IX-1965	4	2	2	4·9
12.	17	1	25-VIII-1965	3	2	1	9·9
13.	18	1	29-IV-1965	5	3	2	4·4
14.	,,	2	9-VIII-1965	1	1	1	6·0
15.	,,	3	24-X-1965	4	1	3	5·0
16.	,,	4	3-I-1966	4	2	2	6·0
17.	,,	5	1-III-1966	3	2	1	5·0
18.	,,	6	30-V-1966	1	1	—	6·0
19.	,,	7	3-VII-1966	4	1	3	6·2
20.	21	1	25-I-1965	3	2	1	6·8
21.	,,	2	21-IX-1965	3	1	2	4·8
22.	,,	3	13-XII-1965	4	2	2	5·0
23.	26	1	28-VIII-1965	4	2	2	4·6
24.	,,	2	16-XII-1966	2	2	—	5·0
25.	,,	3	17-I-1966	5	3	2	4·6
26.	,,	4	24-II-1966	4*	—	—	4·6
27.	,,	5	26-III-1966	1*	—	—	10·6
28.	,,	6	20-IV-1966	3*	—	—	4·6
29.	,,	7	8-VI-1966	3*	—	—	6·6
30.	,,	8	21-VII-1966	4*	—	—	5·2
31.	27	1	22-VIII-1965	3*	—	—	4·9
32.	,,	2	17-XI-1965	3*	—		5·0
33.	,,	3	27-I-1966	3	1	2	3·4
34.	,,	4	29-III-1966	3	1	2	6·5
35.	,,	5	9-IX-1966	2	2	—	7·5
36.	34	1	22-XII-1965	3	—	3	6·6
37.	37	1	10-VIII-1965	5	2	3	5·0
38.	,,	2	31-I-1966	3	2	1	5·2
39.	,,	3	6-VII-1966	3	3	—	6·8
40.	38	1	17-VIII-1965	2	—	2	4·5
41.	40	1	24-II-1966	4	2	2	5·8
42.	,,	2	28-III-1966	2*	—	—	6·0
43.	,,	3	25-IV-1965	3	3	—	5·6
44.	41	1	1-III-1966	4	—	4	6·0
45.	42	1	15-IV-1966	1	1	—	6·0
46.	43	1	7-VI-1966	3	2	1	4·3

* Babies eaten up by mother 1-3 days afterwards ; hence not sexed. Mean weight of a new-born baby=5·1 gm., Median=5·4 gm., Standard deviation=1·46.

the female had littered (on 26 March 1966). On 20 April 1966, the same rat littered again, though no male was provided in between this period. It appears that copulation must have taken place on 26 March immediately postpartum and almost at the same time with parturition. The gestation period is therefore calculated as 25 days.

Early growth and development:

The information on growth and development was based on the observations made on 136 rats born in the laboratory. At birth, the babies weighed between 4·3 and 10·6 grams. The mean weight of the new-born baby was 5.1 gm. $\pm$ 1·46. Only one baby weighed 10·6 gms., and was the only individual in the litter. The babies were naked at birth with eyes closed and sexing was possible after weaning only. The weaning time varied from 4 to 10 weeks though the majority were weaned when they were 6-7 weeks old (Table 2). The majority of the rats were weaned when they attained a weight of 30-50 gms.

TABLE 2

AGE AND THE WEIGHT AT THE TIME OF WEANING OF *Rattus rattus wroughtoni* YOUNG ONES

Age in weeks at the time of weaning	*No. of rats*
4	2
5	3
6	24
7	34
8	16
9	3
10	4
	86
Weight range in gm. at the time of weaning	
20-25	9
25·1-30	4
30·1-35	22
35·1-40	15
40·1-45	19
45·1-50	10
50·1-55	0
55·1-60	4
60·1-65	0
65·1-70	3
	86

Maximum weight at weaning—65·6 gm.
Minimum weight at weaning=20·2 gm.

TABLE 3

WEIGHT AND SURVIVAL OF *Rattus rattus wroughtoni* BORN IN CAPTIVITY

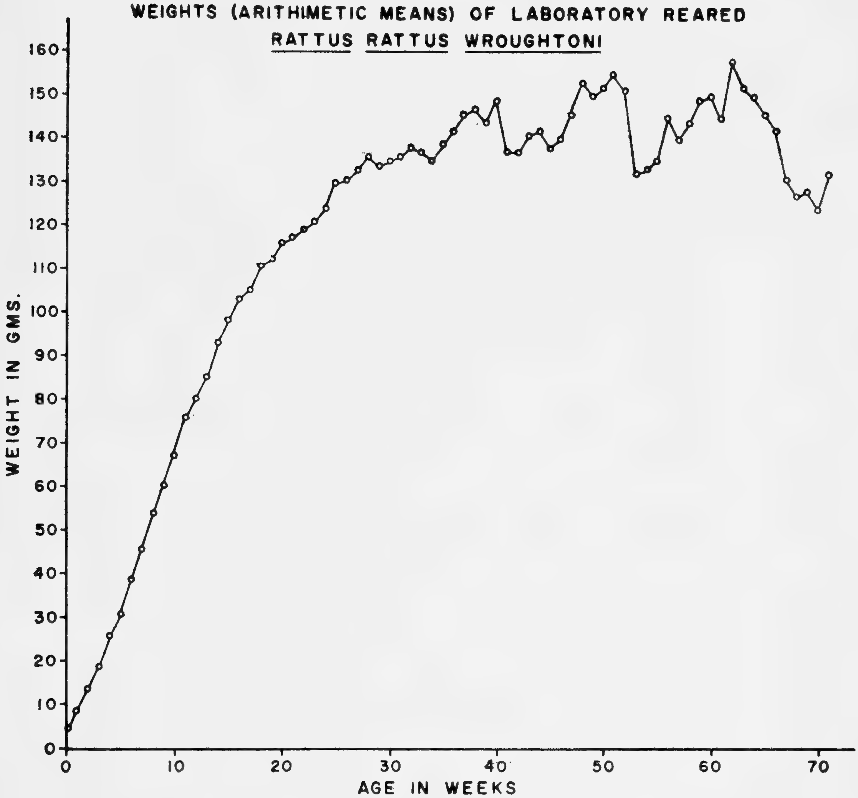
Age in weeks	Wt. range in Gm.	No. of rats	Mean wt. in Gm.	Age in weeks	Wt range in Gm.	No. of rats	Mean wt. in Gm.
0	4·3-10·6	136	4·5	36	91·0-210·0	28	142·1
1	4·7-18·6	119	8·7	37	100·0-210·0	28	146·1
2	8·8-31·7	104	13·9	38	104·0-221·0	25	147·0
3	9·8-43·5	95	19·8	39	103·0-220·5	23	144·4
4	13·8-60·4	89	25·7	40	93·0-219·7	18	149·2
5	18·0-76·4	89	30·8	41	78·0-220·0	18	137·9
6	22·2-90·0	88	38·9	42	110·0-196·0	14	137·3
7	24·2-97·8	86	45·6	43	121·5-191·3	12	141·2
8	28·6-104·8	84	54·1	44	115·1-184·6	12	142·8
9	30·0-115·2	78	60·5	45	115·0-180·0	11	138·4
10	42·5-135·6	78	67·4	46	113·2-178·0	11	140·7
11	49·0-140·0	76	75·1	47	115·2-175·0	4	146·2
12	55·0-145·6	75	80·1	48	140·0-170·0	3	153·3
13	63·4-155·0	73	85·5	49	140·0-163·0	3	150·3
14	62·5-160·1	69	93·3	50	147·5-160·0	3	152·5
15	65·4-163·0	65	98·6	51	146·9-164·5	3	155·9
16	66·0-158·2	62	103·2	52	148·0-154·0	2	151·1
17	73·0-159·9	61	105·0	53	128·0-136·0	2	132·0
18	80·0-164·7	61	111·7	54		1	133·0
19	77·0-167·0	57	112·9	55		1	135·0
20	79·0-177·7	55	116·2	56		1	145·5
21	81·0-179·5	52	117·6	57		1	140·0
22	80·5-181·8	49	119·9	58		1	144·5
23	77·0-184·3	46	121·1	59		1	149·5
24	74·0-185·0	45	124·0	60		1	150·5
25	78·0-191·3	45	130·4	61		1	145·0
26	82·0-196·0	44	130·6	62		1	158·0
27	92·0-195·1	42	133·2	63		1	152·0
28	95·8-195·6	40	136·6	64		1	150·0
29	95·0-194·6	40	134·2	65		1	146·0
30	94·5-198·5	39	135·4	66		1	142·5
31	100·0-205·1	38	136·0	67		1	131·0
32	98·0-203·8	35	138·2	68		1	127·0
33	98·0-209·5	34	137·7	69		1	128·0
34	87·0-210·1	34	135·7	70		1	124·7
35	78·0-213·0	33	139·5	71		1	132·0

Nine babies weaned when they weighed between 20-25 gms. and three of them when they weighed over 65 gms.

Table 3 presents the data on weight and survival of rats at different age intervals. It is possible that under laboratory conditions, though no malformations were noticed the rate of growth may not approximate what actually happens in nature. In the laboratory, the birth weight of the newborn baby nearly doubled within a week. Until the rats were 35 weeks of age, the weight gradually increased and became stationary after that (Figure 1). After the 50th week the

FIG. 1

WEIGHTS (ARITHIMETIC MEANS) OF LABORATORY REARED RATTUS RATTUS WROUGHTONI



rats started losing weight and only one rat was alive at the end of 53rd week and this survived for another 18 weeks. While no precise information is available on the life span of these rats in nature, in another field study, two wild caught females (whose ages were not known at the time of capture) were kept alive for 710 days and 562 days in the laboratory. Even though factors like predators and competition are eliminated in the case of a laboratory reared rat, other artificial conditions like restriction of their movements inside a cage and a probable physiological fatigue resulting from captivity conditions and an artificial diet have to be considered.

VIRUS RESEARCH CENTRE, P. K. RAJAGOPALAN
POONA-1,
April 24, 1970.

5. AN ATTEMPT TO DETERMINE THE FOOD HABITS OF THE INDIAN RHINOCEROS

The great Indian one-horned rhinoceros, *Rhinoceros unicornis* has been noted to feed chiefly on grass but no exact record is available. It was therefore attempted to actually observe the grass species nibbled by rhino at Jaldapara National Park, North Bengal and to identify the remains of vegetable material in the dung with the help of microscope slides, a technique proposed by Drs. Skoog and Gogan[1] at Serengeti for studying zebra.

Our study was carried out during a fortnight in the pre-monsoon season (last part of May) in 1970.

It was very difficult to approach the rhino and observe exactly what it was eating. The small number of animals and the nature of the vegetation at Jaldapara render direct observation difficult. Much of the forest area even in this season was covered by 10-20 feet tall grass. However, it was at last possible to observe two rhinos at different places while actually feeding on *Polytoca digitata,* locally known as Bhutta (maize) grass. Both tender (thin stemmed) and bigger, thick stemmed (diameter 6-7 mm. when dried) plants were eaten. Moreover, following the regular tracks of rhinos, spots were found where the animals had extensively grazed. On one or two occasions we reached spots apparently immediately after the rhino had passed by, for the cropped grasses lying about were very fresh. The absence of other grazers such as deer, gaur, buffalo etc. in the vicinity renders it almost certain that these feedings were by the rhino. It was also likewise evident that the rhino does not feed on fern. Twelve undigested stems from 4 different dung heaps of rhino were collected. The length of these was in the range 2·5-4·8 cm. When brought to the laboratory, 8 of these were in a stage permitting sectioning after a 24 hour treatment with NaOH. These sections stained with saffranin were compared with similar sections of grass samples collected. The most important result of the whole study is the discovery that this method is quite workable and as such it should be extremely useful to collect a large number of such undigested stems. This is indeed a simple matter in the field because dung heaps are easily reached and hundreds of samples may be collected from a single heap.

Of the 8 stems studied microscopically, two were *Polytoca* and 5 were identical, (a dicotyledonous species) while one was not very clearly recognizable. It is most interesting that a substantial part of the remains point at a non-grass species. In the Calcutta Zoo, however, the rhinos are frequently given *Ficus religiosa* and *F. bengalensis* and other leaves which the animals consume. Some of the local people at Jaldapara maintain that occasionally the rhinos eat non-grass species. The following table sums up the findings.

FOOD PLANTS OF THE INDIAN RHINOCEROS

Sample	Observed actual feeding	Observed traces of feeding	Microscopic examination of remains of dung	Alleged by local people
Polytoca digitata	+		+	
Digitaria granularis		+		
Imperata cylindrica		+		+
Setaria pallide-fusca		+		
Fimbristylis junciformis		+		
Unidentified		+		+
Unidentified Dicot species			+	
Mychenia				+
Dalbergia sissoo				+

Polytoca digitata and *Imperata cylindrica* are found in extensive areas of the Jaldapara. The former has been recorded as a fodder grass[2], while *Imperata cylindrica* (Locally known as 'Ulu' or 'ilu') is very well known as thatch grass and also as a common fodder grass and very extensive, though indirect, evidence for feeding on this by rhino were available. *Digitaria granularis* is a very short grass which generally does not grow in dense forest or in taller grasses[3]. Within this limited growth area (as we also verified) it was extensively consumed. (A related species *D. criantha* imported from S. Africa contains HCN when drying up and may form a source of danger for the browser). The other species mentioned were also of minor importance because of their limited distribution. Of these *Setaria pallide-fusca* is known to make good pastures near Bombay[3]. *F. junciformis* (*Bindi Muthi* in Santali language[4]) is a non-grass (*Cyperaceae*) though monocot sample.

The most interesting finding is the occurrence of a dicot or non-grass species in the dung. This might be identified by sectioning the common flora samples of the area such as *Dalbergia* which were not collected in this study.

In conclusion, it has been proved that our attempt, especially the microscopic identification of faecal remains, was in the right direction and a second, more comprehensive attempt covering Kaziranga, the great stronghold of the Indian Rhino is likely to enable us to learn the food habits of this endangered species.

Another phase of work will be the estimation of protein contents and certain other chemical tests of the important food sample.

Now that the Baradabari area of the former National Park has been taken over by the Military, the sanctuary should be compensated by acquiring another block of equivalent area to be chosen after a survey of the ecological needs, such as the requisite vegetation for food and shelter. The effect of fire on vegetation should be carefully studied. Stringent measures should be taken to check poaching.

There also arises the question of competition with other species for food. The tame elephants were observed to feed on *Polytoca* and *Setaria* but there is no sizeable resident herd of wild elephant. *Imperata* or thatch grass is likely to be a coveted item for the various herbivores including domestic buffalo in adjacent villages. *Mychenia* was observed to be eaten by local deer species. The number of domestic buffalo and deer in the area observed by us did not seem to us to be a potential source of danger as competitors for a limited food supply.

We thank the Forestry Department, West Bengal for co-operation at all levels and the staff of Botanical Survey of India, Calcutta for identifying the grass.

INDIAN STATISTICAL INSTITUTE,
CALCUTTA,
August 11, 1970.

R. L. BRAHMACHARY
(MISS) B. MALLIK
B. RAKSHIT

REFERENCES

[1] SKOOG, R. O. & GOGAN, P. JR. (1969): Annual Report of Serengeti Research Institute, E. Africa.

[2] NIRODI, NALINI (1955): Studies on Asiatic Relatives of Maize. *Ann. of Missouri Bot. Gard.* **42**: 103.

[3] BOR, N. L. (1960): The Grasses of Burma, Ceylon, India and Pakistan. Pergamon Press.

[4] PRAIN, D. (1963): Bengal Plants II. Botanical Survey of India.

6. REPRODUCTIVE BEHAVIOUR OF BROW-ANTLERED DEER

Introduction

Thamin deer or Browantlered deer, *Cervus eldi eldi* (McClleland), is found only in a small area of Manipur in eastern India. It is estimated that only about one hundred of these deer now exist in nature in Keibul Lamjao Wild Life Sanctuary of Manipur (Gee 1960) It is one of the threatened species of the sub-continent (Talbot 1960).

Published records on breeding pattern of this deer in nature are almost non-existent. The secretive nature of the deer and the fact that the animal lives in floating islands in swamps in nature makes it very difficult to collect information on its breeding behaviour in the wild. It may be mentioned that Browantlered deer have done well in captivity in various parts of the world. Gee (1960) states that several fawns were born at Woburn, Abbey, U.K.; four fawns were born during 1922-25 in the Regents Park Zoological Garden, U.K., nine fawns were born in Vincennes Zoological Garden of Paris and many fawns were born in Alipore Zoological Garden, Calcutta.

According to Asdell (1946), Cervidae are seasonally monestrous. Cheatum & Morton (1942) state that the length of estrous cycle is about 28 days. The same authors conclude that the estrous period lasts a maximum of thirty-six hours and the period, a female will receive a stag, lasts only about a day. Prater (1965) indicates that the stags shed their antlers in mid-August and are clear of velvet by the end of December, the rut develops between March-April and after a gestation period of 239 to 256 days, usually one fawn is born in October. Gee (1960) mentions that the stags shed their antlers in late June, the rutting season is between February and March and the fawns are born in October and November.

The paper presents the results of the study of breeding pattern of the Browantlered deer conducted in Delhi Zoo from 1962 to 1969. It is hoped that the reproductive data will enhance the biological knowledge about the species and help in its preservation.

Discussion and conclusion

The Delhi Zoological Park received a pair of Browantlered deer in August, 1962 as a present from Manipur State, India. The deer were kept in an open moated and grassed enclosure of about 1·5 acres. The deer were given one kilogram of concentrates daily and five kilograms of green fodder. In addition, they had an access to the green grass in the enclosure. The stag had complete access to the doe for mating all the year round. The deer were watched regularly. A total of eight fawns were born during 1963 and 1968.

The stags drop their antlers in late June and beginning of new antlers in velvet take place within three to four days (Table 1). The stags are in full velvet during the month of July. The antlers become clear of velvet in late November. The antlers are very handsome and characteristic of the species. In profile, they seem almost circular. The antlers sweep in one continuous graceful curve from the tip of the browtine to the point of the beam. The number of terminal tines varies from two or three to as many as eight or ten (Prater 1965). The antlers at the maximum measure 102 cm. (42 inches) (Gee 1960). In the Delhi Zoological Park, the shed antlers were measured each year and recorded. The number of tines varied from three to five on each antler (Table 1).

TABLE 1

ANTLER SEQUENCE OF BROWANTLERED DEER

S. No.	Date of dropping of antlers	Measurement of antlers	No. of tines	Beginning of velvet	Completion of velvet	Antlers cleared of velvet	Chasing female or mating
1	26-vi-65	91 cm.	3+3	30-vi-65	3-vii-65	23-xi-65	3-iii-65
2	25-vi-66	97 ,,	3+3	28-vi-66	1-vii-66	21-xi-66	2-iii-66
3	28-vi-67	118 ,,	4+4	2-vii-67	3-vii-67	22-xi-67	1-iii-67
4	28-vi-67	96 ,,	3+3	1-vii-68	4-vii-68	23-xi-68	2-iii-67* 10-iv-68
5	29-vi-68	98 ,,	3+3	2-vii-68	6-vii-68	24-xi-68	
6	26-vi-69	112 ,,	5+5	29-viii-69	1-vii-69		

A peculiar behaviour of the stag which came to the Zoo in 1962 is during rut, it chases the females and even injures them (two females on 1.3.1967 and 2.3.1967).

Due to the secretive nature of the deer, out of eight successful matings that took place during 1963 and 1968, only one mating on 10.4.1968 was actually observed. Four other mating dates were estimated from the behaviour of the dominant male and the females. On two occasions the females were injured by the male during chase and on other two occasions the male was observed chasing the female throughout the day and it was ascertained that the mating would take place on that day. The gestation period were calculated from the estimated date of breeding and the date of parturition. The average gestation period was found to be 240·4 days with a minimum of 236 days and a maximum of 244 days.

TABLE 2

BREEDING, FAWNING AND GESTATION PERIOD OF BROWANTLERED DEER IN DELHI ZOOLOGICAL PARK

S. No.	Estimated date of mating	Date of parturition	Gestation period in days	No. of Fawns born	Composition of herd		Remarks.
					M	F	
1	..	18-x-63	..	1	1	2	
2	..	12-xi-64	..	1	1	3	
3	3-iii-65	29-x-65	240	1	1	3	One male died on 2-xii-65 due to injuries.
4	2-iii-66	26-x-66	238	1	2	3	
5	..	27-x-66	..	1	2	4	
6	1-iii-67	23-x-67	236	1	3	4	
7	2-iii-67	1-xi-67	244	1	3	5	
8	10-iv-68 (Actual mating observed)	10-xii-68	244	1	3	5	One female died on 13-i-1968.
	Average		240·4	Present herd composition	2	3.5	One female died on 2-vi-1969.

In all the eight cases, the does dropped single fawn. Eight fawning dates were recorded with the earliest fawn dropping on 18.x.1963 and the latest on 10.xii.1968.

On an average the fawn of the browantlered deer were observed to be slightly larger than those of the Axis deer (*Axis axis*), Sika deer (*Cervus nippon*) and smaller than those of nilgai (*Boselaphus tragocamelus*) (Tables 3 & 4.)

DELHI ZOOLOGICAL PARK,
NEW DELHI,
November 3, 1969.

K S. SANKHALA
J. H. DESAI

TABLE 3

MEASUREMENT OF FAWNS (IN CM.) AT BIRTH

S. No.	Date of parturition	Sex	Weight in kg.	Lengths				Age of doe at fawning	Remarks
				Total	Forefoot	tail	ear		
1	18-x-63	F	4·65	71·5	35·1	9·1	9·5	3-4 Years	
2	12-x-64	F	4·54	73·7	34·3	9·1	9·5	3½ ,,	Ten cms. growth of antlers observed on 27-iii-1967. For the past two years only pedicels were observed.
3	29-x-65	M	6·00	73·1	38·1	10·8	10·1	4-5 years	
4	26-x-66	M	6·00	75·0	37·0	9·0	10·0	6 years approximately.	
					Weaned 2-xii-1966. Pedicels of two cms. observed on 18-v-1967.				
5	27-x-66	F	4·85	72·8	35·5	9·2	9·5	3 years	
6	23-x-67	M	6·10	73·0	37·05	9·1	9·5	4-5 ,,	
7	1-xi-67	F	4·90	72·0	36·0	9·0	9·3	3 years	
8	10-xii-68	F	4·60	73·2	33·8	9·2	9·5	3 years	Completely weaned on 14-i-1969.

TABLE 4

COMPARATIVE MEASUREMENT OF FAWNS OF AXIS DEER, SIKA DEER AND NILGAI AT BIRTH

S. N.	Species	Date of birth	Sex	Weight in Kg.	Length in cm.				
					Total	forefoot	Tail	ear	Girth
1	Axis deer	31-i-64	M	3·63	77·0	30·5	17·8	8·3	..
2	,,	7-v-66	M	4·50	74·0	31·0	17·5	8·2	..
3	Sika deer	1-v-66	F	1·5	56·5	26·7	7·0	6·3	.. } *
4	,,	5-v-66	F	3·0	58·5	30·5	7·6	6·3	.. } *
5	Nilgai	7-ii-67	M	6·25	86·0	38·0	21·5	8·75	43·0
6	,,	18-iii-67	F	5·50	82·0	38·0	20·0	9·0	..

* Exotic species with great difference in size of male and female.

REFERENCES

ASDELL, S. A. (1946): Patterns of mammalian reproduction. Comstock Publishing Company. Ithaca: 314, 338.

CHEATUM, E. L. & GLENT MORTON (1942): Technique used in determining the period of rut among white-tailed deer of New York State. *Trans. Seventh N. Amer. Wildlife Conf.* 334-342.

GEE, E. P. (1960): Report on the status of the Browantlered deer of Manipur. *J. Bombay nat. Hist. Soc.* **57**: 597-617.

PRATER, S. H. (1965): The book of Indian Animals. Bombay Natural History Society, pp. 316.

TALBOT, L. M. (1960): A look at threatened species. *Oryx* **5** (4 & 5); 147-326.

7. 'WHITE BISON' OF MANJAMPATTI

The 'White bison' of Manjampatti have intrigued me right from the time I first heard of them. But first hand news eluded me, until I met early this year when he visited India, Mr. J. L. H. Williams who was the first to report on the occurrence of this ash coloured gaur in the Manjampatti Valley in the journal (vide *JBNHS* **66**: 605).

He had seen a fair number of them in his day and my talks with him rekindled my interest in them to the extent of making a trip to the 'White bison' country in an effort to obtain coloured photographs of the animal.

My talks with Mr. J. Wilson, the District Forest Officer, Coimbatore South within whose jurisdiction Manjampatti falls was not very encouraging and gave me a hint of what to expect. He said he had toured the area extensively as forest working plan Officer between 1962 and 1964 and never came across a single abnormal coloured gaur. He also told me that even after assuming charge of the district earlier this year he had not seen one. So much so he said that he even contemplated writing a note titled '"White bison", fact or fiction?'.

But by then my plans had been made and I decided to go ahead with my trip. When I reached Amaravathi Nagar just over 5 Km., off the Udumalpet-Munnar road I met Mr. Arumugham, the forester in charge of the Manjampatti and adjoining forest beats with a note from the D.F.O. and explained to him my mission. During his 2 years or so in the area, he said he had never seen an off coloured gaur and confessed that he had not heard of the existence of one within his jurisdiction. He lined up his guards and watchers and questioned then closely. They were positive that they had not come across a gaur other than a normal coloured one and much less a white one.

The non-officials in the area proved to be more observant. Mr. M. A. S. M. Muthuswamy, a leading agriculturist and well known sportsman of Udumalpet, who has a small holding off the Udumalpet-Munnar Road on the Kerala side of the border and who uses the Ghat road frequently told me that he had seen a herd of 4 'White bison', which he described as greenish grey in colour, on several occasions some years previously. He also told me that he saw a fine, greenish grey bull in a herd of normal coloured gaur at Kamanuthu, just off the Munnar ghat road in the Kombu beat on the Tamil Nadu side of the border last winter. His brother, Mr. Padmanabhan whom I questioned separately said he had also seen a herd of 5. Even without my asking him he pointed at a very pale green window in his house and said 'That colour mixed with a bit of grey'. At Amaravathi Nagar, a dhoby who goes to the Kamanuthu area to collect firewood said that he had also seen an ash coloured bull there, the previous winter, confirming Mr. Muthuswamy's story. Mr. A. J. Packianathan a senior master of the Sainik School at Amaravathi Nagar said he saw in the same area four ash coloured gaur by themselves some distance away from the road in 1965. He has been taking his school boys on long treks through the jungles, twice a year, annually from 1962 onwards and had never seen an ash coloured gaur before or since. Koolayan (Shorty) a cattleman of the Malasar tribe who keeps cattle at Kumulam Patti overlooking the northern slopes of Manjamalai and part of the northern slopes of Mudian Malai and who has a grandstand view of all gaur movement in the area said he saw only one strange coloured gaur in January last year among the thousands he had seen. When I questioned him about the colour of the animal he jerked his thumb at my greying G.I. provision tin and said 'Like that'. H. H. The Raja of Pudukottai who is familiar with the Madurai or Kodaikanal side of the Palni hills wrote to say that he saw one 'White' bull gaur beyond Kukal in a place called Koilan Alai this year and that in the past 30 years he had seen about half a dozen of them, in normal coloured gaur herds. From these descriptions I guess that the colour of the animal may be best described as 'wet ash'. Enquiries on the Kerala side showed that the forest staff and others there had not even heard of such an animal.

As the jungle around Kamanuthu being more open in June (when I paid my visit) and do not hold gaur then, we decided to concentrate on the more thickly wooded Mudian Malai—Manjamalai—Varavandi area.

Local guides and porters to transport our stuff were recruited from Talinji (locally, Dhalinji). They met us at the Pambar settlement on the Kerala side of the border, a distance of a little over 2 Km. from the Chinnar check post, up the Munnar ghat road. We crossed the Pambar at this point and were in the 'white bison' country of Williams. We found out that two of the guides were in Williams' party and had guided other Europeans to see the 'White bison'. They told us that they had not seen a 'White bison' in the last 15 or 20 years. They admitted quite frankly that this was partly due to the fact that there was no occasion for them to go looking for gaur.

The place has changed considerable since Williams set foot there. Administratively the whole valley, generally referred to as the Manjampatti valley, has been brought under the jurisdiction of the Coimbatore South forest division with the transfer of Kukkal and Kudiraiyar blocks from the Madurai forest division. The Pulayar of Talinji, of whom there are about 80 families, with a head count of about 400, or at least the bulk of them are no longer living in thatched huts but have been settled by the tribal 'Welfare' department of Government in horrid lines with cracked bulging walls, topped with undulating illfitting tiled roofs.

The hand of the Tamil Nadu Electricity Board is in evidence everywhere. They are blasting and drilling all around Talinji to determine the best locations for the several, tunnels, dams and power houses which are expected to be built under the upper Amaravathi Hydroelectric Scheme. Some parts of the jungle are said to hold Naxalites and others, rice smugglers. Except for some deer and elephants during the agricultural season there is nothing there.

Manjampatti is only a place name today, the Pulayars there having abandoned their homes because of malaria and trouble from elephants and have moved to Talinji and other places. Instead, there is a small 2 man station of the hydrometric survey. The area between Manjampatti and Talinji is disturbed and it is only beyond Manjampatti that wild life occur. The senior laskar at Manjampatti told me that he has been there for nearly 4 years except for short breaks and that although he has seen quite a few gaur during his stay there he is yet to see one which could be described as odd.

I had taken with me from the Nilgiris an experienced shikari (guide) well versed in the use of field glasses. At every camp we split, and each taking a local guide combed every bit of the area around. There was a fine drizzle almost throughout our stay which encouraged animal movement throughout the day. Manjampatti was a dismal failure. Although we searched the slopes of the high mountains which ringed the valley and the lesser valleys and gullies thoroughly we failed to locate a single gaur.

The Mudian Malai slopes were more productive. In two days we saw 111 gaur in 7 herds and 1 was a young solitary bull. In a large herd I had a glimpse of a young reddish brown cow and two more light coloured young animals as they stampeded after getting my scent.

The locals call these 'sevelais' or reds. My attempts to make further contact with this herd proved futile.

At our last camp at Mukuttu we had three parties out searching the northern slopes of Manjamalai and Mudian Malai and the thick jungles below. We saw altogether 67 gaur—3 solitaries and 5 herds and signs of many more in the jungle. While we were there Koolayan took me to a popular salt lick where we spent an evening. As dusk fell a small herd of 5 gaur, a young bull and 4 cows visited the salt lick. One young cow was a 'sevelai'. It was rich chestnut, the colour of a barking deer, on the sides and the rest of the exposed parts of the body were slightly darker. Koolayan said that 'sevelais' are not as rare as the ash coloured ones and several are seen in those parts.

One possible reason for the depletion of the 'White bison' stock is the foot and mouth disease which, I believe, makes regular rounds of these jungles and proves fatal in the case of the gaur. Apparently the incidence of the disease was greater on the smaller number of 'White bison'. The occurrence of the 'sevelais' (Reds) would go to show that there is definitely a tendency for colour variation among the gaur of the Manjampatti valley. Therefore the appearance of an ash coloured bison now and then should not be a cause for surprise. But whether they would continue to patronise the valley once the upper Amaravathi Project gets going is doubtful.

All camping in this elephant infested area is appropriately done in caves. There are half a dozen of them situated at convenient intervals.

At Mudian Malai we camped at Puli Alai (tiger cave), the cave Williams refers to in his note. It is so placed half way up a deep gully that to reach it an elephant would have to be an acrobat. The approaches to the alai or cave at Mukuttu is barred by precipitous rocks on two sides and smoothly worn slippery slide rocks guard the other two. The ones at Duvanam, where the Amaravathi tumbles into the reservoir in an impressive fall and at Manjampatti are so low and deep that even if an elephant lay on its side it cannot reach the occupants.

As regards other forms of wild life, spotted deer seem to favour the light jungle around Talinji and Manjampatti, unmindful of the disturbance. Sambar occur in fair numbers on the slopes. Pigs are plentiful. Barking deer could be heard now and then. After a lapse of some years there is news of tigers—some were seen crossing the Munnar Ghat road recently. Panthers and bears are not so scarce, but they are by no means common. Strangely, there are no wild dogs.

It is understood that the Tamil Nadu forest department is planning to build an expensive rest house at Manjampatti to enable visitors to see the 'White bison'. They would be well advised to locate the bungalow on the Mudian Malai slopes well away from the din and bustle of the hydroelectric project area, where people could go and relax and see at least some of the other forms of wild life of the Valley.

At least in the matter of opening up of roads and the building of rest houses better co-ordination between the Forest Department and the Electricity Board is essential. It is but proper that the Electricity Board should submit the immediate as well as long range plans of their projects to the concerned Forest authorities in whose areas they operate.

It is ironical that I who went to the Manjampatti Valley to be enlightened about the 'White bison' had the unenviable task of trying to convince the incredulous locals that such an animal shares their valley with them. My object in going there was to make survey and if possible, obtain photographic record of the 'White bison'. And I had to return without positive proof. My only consolation is that in a survey of this nature a negative report is better than none.

I am indebted to the Bombay Natural History Society and the Dorabji Tata Trust for sponsoring the trip. I acknowledge with gratitude the assistance rendered by Mr. J. Wilson, the district forest Officer and his helpful staff.

'CANOWIE', E. R. C. DAVIDAR
COONOOR-1,
NILGIRIS,
July 18, 1970.

8. OCCURRENCE OF LEAST FRIGATE BIRD (*FREGATA ARIEL IREDALEI* MATHEWS) IN BOMBAY

On 4 June, 1970, a Least Frigate Bird, *Fregata ariel*, in juvenile plumage was found exhausted on a beach north of Bombay, 18° 55′N., 72° 50′E. On its wings were two plastic wing-tags bearing the serial number A-04.

Information now received from the British Trust for Ornithology indicates that this bird was tagged as a nestling on Aldabra Island, Indian Ocean (09° 22′S., 46° 28′E.) on the 18th April 1969. It was present there up to 29th August 1969.

This is the third record of this species from India, the first being of Ferguson from Trivandrum, 1904, and the second of Humayun Abdulali from Bombay 1960 (*J. Bombay nat. Hist. Soc.* **57**: 668) though at least six examples have been taken on the west coast of Ceylon, also during the monsoon months (INDIAN HANDBOOK **1**:49).

The map distance between the points of ringing and recovery in this case is *c.* 4400 km.

The bird is at present in the private aviaries of the Maharaja of Jamnagar. It is still rather weak, and it is proposed to release it out at sea when it recovers, after marking it with the Society's ring.

PALI HILL, BANDRA, RAUF ALI
BOMBAY 50-AS,
August 25, 1970.

9. THE OCCURRENCE OF THE SANDERLING (*CALIDRIS ALBUS*) IN KERALA

The Sanderling does not so far seem to have been recorded from anywhere in Kerala State (see Sálim Ali BIRDS OF KERALA, 1969:126).

I am sending you one wing of a sanderling shot on Dharmadam beach (11°45′N., 75°30′E.) on 24th November, 1968. Unfortunately, the specimen could not be skinned or sexed.

This bird was with two others of the same species in the midst of a large flock of Sandplovers (most probably *Charadrius mongolus*), paddling in the receding waves and feeding busily. Even from a distance the little group of Sanderlings stood out, because of their strikingly pale coloration, in that large gathering of Sandplovers. In their feeding movements they were more active than the Sandplovers.

On our next visit to the beach (21-xii-68), we saw four Sanderlings, again in the midst of a very large flock of Sandplovers.

I found that the black shoulder-patch, mentioned in some books as an important field mark, did not show up at all when the birds ran about feeding. Only when they stretched their wings did the black patch become evident.

I am grateful to my friend and colleague, Sri N. P. Vijayaraghavan for shooting the Sanderling for closer scrutiny.

PRINCIPAL, K. K. NEELAKANTAN
GOVT. BRENNEN COLLEGE,
DHARMADAM,
KERALA,
May 25, 1969.

10. OCCURRENCE OF THE INDIAN SKIMMER OR SCISSORBILL (*RYNCHOPS ALBICOLLIS* SWAINSON) IN SALSETTE ISLAND

At just on sunrise on 29th August 1970, I was watching egrets and herons on an open expanse of water of the Chedda Salt Pans along the Bombay Eastern Expressway when I saw two Skimmers (*Rynchops albicollis* Swainson) flying low and ploughing their lower mandibles through the placid water. I watched these birds for over ten minutes before they departed over the Expressway in the direction of Trombay. I again watched two Skimmers on the evening of 30th August over the same stretch of water and next morning, just at day-break and for about twenty minutes thereafter, there were three Skimmers there.

On the evening of 31st August I was accompanied by Mr. Humayun Abdulali and we watched two Skimmers in precisely the same area keeping together and working up and down, quite close to the road. On the evening of 6th September I noted three Skimmers at the same place.

IND. HANDBOOK Vol. 3 indicates that this bird is usually found on large rivers but has also been recorded on 'estuaries and inshore coastal waters (Bombay once)'. I understand that 'Bombay' in this instance refers to Alibag, Kolaba District, where one was obtained in March 1890. From Mr. Abdulali I learn that on 16th November 1940 he observed several flocks ranging from 10/50 birds flighting up Dharamtar Creek, Kolaba District, across the harbour, in the manner of gulls, and on the following day saw several flocks working up one of the smaller creeks. He was also informed by Mr. A. R. Haselet, then a member of the Society and a keen fisherman, that he had seen some in Dharamtar Creek in November 1950.

My records appear to be the first from Salsette Island and the few observations confirmed that the birds are most active, at least visible in this particular place, at dawn and dusk.

CARE MERCANTILE BANK LTD., D. A. STAIRMAND
52/60 M. G. ROAD,
BOMBAY-1,
September 8, 1970.

11. THE BLACKBIRD *TURDUS MERULA MAXIMUS* IN NEPAL

While searching the literature on Himalayan birds, it came as a surprise to me to find out that the Blackbird *Turdus merula maximus* had never been recorded in Nepal. Its nearest occurrence to this country is Chini in the Sutlej Valley (Waite, H. W., 1962, *JBNHS*

59: 962) and Garhwal (Whymper, S. L. 1911, ibid, **20**: 1158), thus leaving a gap of about 1000 km. between the latter locality and Sikkim whence reported by Meinertzhagen (*Ibis* 1927: 578). The species has also been recorded at Karta (Tibet), 40 km. east of Mt. Everest (Kinnear, N.B., *Ibis* 1922: 507 and Hingston, R.W. 1927, JBNHS **32**: 322). As early as 1911 Whymper (loc. cit.) remarked: 'It is curious that the existence of this bird should have been overlooked in these parts, as it is fairly common and much in evidence, both from its frequenting the open and from its rattling alarm call.'

In central Nepal I observed this unmistakable species on two occasions in 1964: on 14 June at the headwaters of the Tadi Khola River at *c.* 4200 m. before reaching the Gosainkund Pass, and on 16 June near one of the Gosainkund lakes at *c.* 4300 m. in boulder-strewn alpine meadows. In both instances the birds (two males) were feeding on mud and sand by a stream. They were quite shy, the flight distance being some 40 or 50 metres, and disappeared by flying low and fast over the ground and plunging behind a cliff. The species was mentioned incidentally by me in the *Ibis* 1965: 400. The scarcity of the Blackbird in the central Himalayas seems to be attributable to its preference for a drier biotope; it is common both in Kashmir and in south western Tibet.

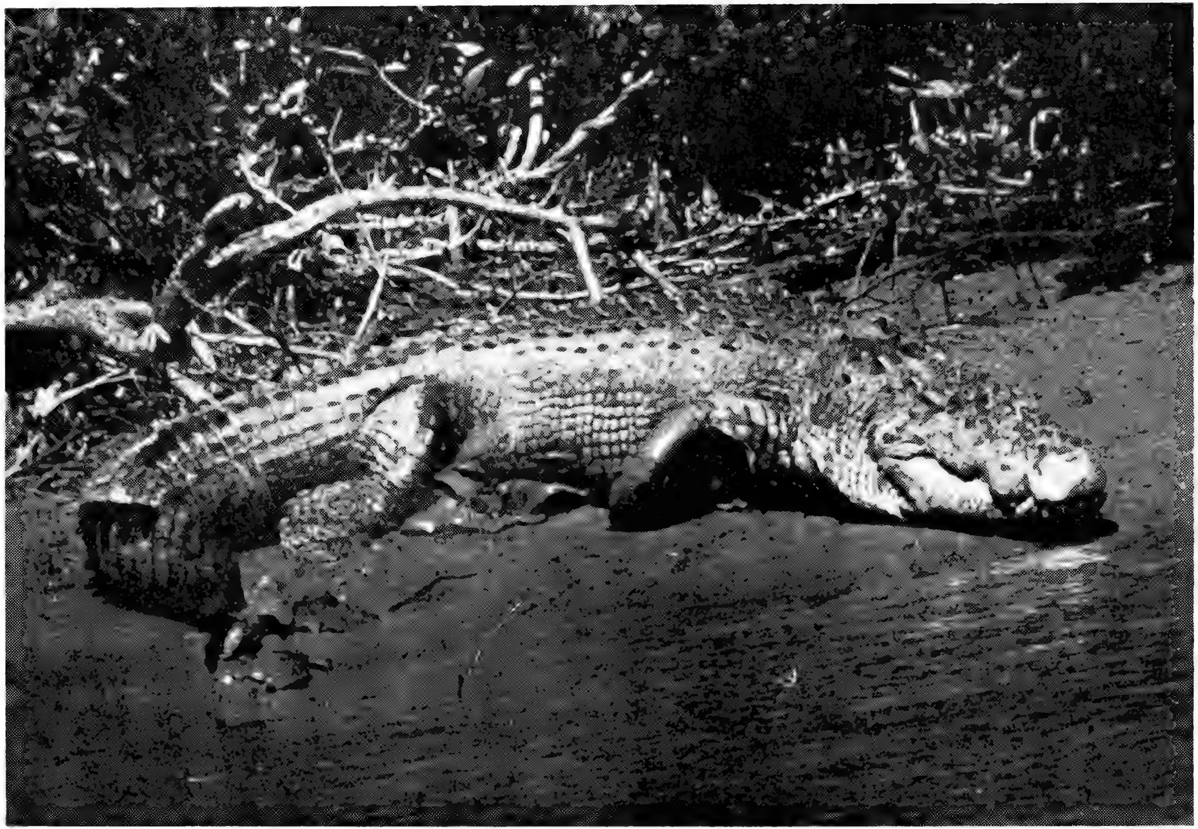
SMITHSONIAN INSTITUTION,
WASHINGTON, D.C. 20560,
U.S.A.,
August 19, 1970.

MICHEL DESFAYES

12. BIRDS AND MAMMALS EATING THE FRUITS OF YELLOW OLEANDER (*THEVETIA PERUVIANA*)

Previous records of birds and mammals eating the fruits of Yellow Oleander (*Thevetia peruviana*), published in this *Journal* are, Koel (**50**: 943-944), Grey Hornbill (**51**: 738), Common Myna (**52**: 207), Brahminy Myna, Redwhiskered Bulbul (**60**: 457), Bat (**58**: 808) and Rat (**59**: 947).

In this paper we record that goats and domestic fowls also eat the fleshy mesocarp of the unripe and the ripe fruits of Yellow Oleander (*Thevetia peruviana*) fallen on the ground. More than half a dozen goats daily feed on the leaves and the fruits of the Yellow Oleander in the compound of our house without showing any ill effect. The goats usually spit the seeds, but occasionally a few seeds are swallowed but these seeds are spat out during regurgitation (It is an effective



The Estuarine Crocodile (*Crocodilus porosus*) on Vhitarkanika Island

(*Photo : M. Krishnan*)

method of dispersal of seeds). Only a few individuals and not all domestic fowls in this area have the habit of eating this fruit. The unripe fruits with latex do not poison them.

Koel (*Eudynamys scolopacea*) is the only bird which is addicted to this fruit. In all other cases the occasional individuals observed to eat this fruit shows that they had developed this habit accidentally. Many more stray instances of birds and mammals eating this fruit are likely to come to our notice in future.

DEPARTMENT OF ZOOLOGY, SIMON G. RAJASINGH
MADRAS CHRISTIAN COLLEGE,
TAMBARAM, MADRAS-59.

'LALGUDI COTTAGE', IRENE V. RAJASINGH
S/8, STAFF COLONY,
TAMBARAM. MADRAS-59,
July 20, 1970.

[Dr. S.R. Amladi, M.D. of the Topiwalla National Medical College, comments—

'The note by Mr. Simon Rajasingh and Irene V. Rajasingh is very interesting since it reveals that there may be a species difference in withstanding the effects of the glycosides of the plant.

The references available to me certainly assert that the plant is poisonous especially to human beings. Mody in his TEXTBOOK OF MEDICAL JURISPRUDENCE AND TOXICOLOGY (1969) states 'The plant is highly poisonous & contains as active principles two glycosides: *thevetin* and *cerberin*. Both these glycosides reside in the milky juice which exudes from all parts of the plant.'

In large doses they are heart poisons, but in minute amounts they are heart tonics; in fact, *thevetin* has been used successfully in the treatment of heart disease in man. Species difference in the actions of these glycosides is not surprising as the Rat (*Rattus norvegicus*), which is a common animal used in our laboratories, is highly resistant to their actions, and requires nearly fifty times the fatal dosage for man.—Eds.]

13. THE ESTUARINE CROCODILE, *CROCODILUS POROSUS* SCHNEIDER OFF THE ORISSA COAST

(*With a plate*)

Vhitarkanika is an island in the Bay of Bengal, off the Chandbali coast in Orissa and originally belonged to the Raja of Kanika, who introduced sambar, chital and other wild animals into the island long ago. I understand that steps are being taken to proclaim this a sanctuary. If this is done, it will be the only estuarine sanctuary of its kind in the country, for I understand that it is distinct in flora, fauna and terrain from the mangrove forests of the Sunderbans.

I had, in the course of two trips in a motor-boat (a huge vessel —no slim launch) mere glimpses of two crocs basking on the bank and a longer look at the largest of them, of which I took 2 photographs. I thought the big one was at least 16 feet long. Having no authority on reptiles with me, I looked up *Crocodilus porosus* in Methuen's REPTILES AND AMPHIBIANS OF THE WORLD by Hans Hvass. In it I find this note on the creature: '12-14 ft., exceptionally to 20 ft. Found from the east coast of India and Ceylon, through Indonesia and Northern Australia to the Fiji Islands . . . more marine than any of the other crocodiles . . . one of the most dangerous of all the crocodilians.' The illustration by Wilhelm Eigener shows a crocodile that is less broad-snouted than the one in my picture in a top view—as in my picture but otherwise very similar. This means nothing as the artist probably had never seen the animal.

I stick to my estimate of 16 feet. I have, long ago, seen some crocodiles (*Crocodilus palustris*) in the Cauvery around Srirangapatna in Mysore which were probably as long or even may be a few inches longer, but they were slim by comparison. What impressed me greatly about this animal in my pictures was its tremendous bulk, rather than its length. Even one of the smaller crocs seen (may be about 10 ft. long) was bulky. I could not see the third one clearly enough to estimate size, as it was in the water.

The pictures, taken from a boat going fast and vibrating fearfully, are not sharp. To get a good picture of the estuarine crocodile at Vhitarkanika, one needs a well camouflaged and seaworthy sail-boat and a week of patrolling the narrow canals between the islands.

Vhitarkanika should certainly be a valuable sanctuary for crocodiles and water monitors if their hunting here can be effectively stopped—both are getting steadily rarer.

PERUNKULAM HOUSE, M. KRISHNAN
EDWARD ELLIOT ROAD,
MYLAPORE, MADRAS-4,
October 14, 1970.

14. THE OCCURRENCE OF THE DOG-FACED WATER-SNAKE, *CERBERUS RHYNCHOPS* (SCHNEIDER) (SERPENTES: COLUBRIDAE) AROUND MADRAS

Further to the localities recorded by Whitaker (1969)[1] for this snake around Bombay, it may be noted that this species is equally abundant on the Madras coast and in estuaries around the city.

[1] WHITAKER, R. (1969): The Dog-Faced watersnake (*C. rhynchops*) in the Bombay area & Notes on its habits. *J. Bombay nat. Hist. Soc.* **66** (2): 386.

In the course of local collection trips about 10 examples of this species were collected from various localities as Adayar and Ennore estuaries, Cooum River and Kovelong beach.

The records of this species around Bombay and Madras indicate its wide distribution along the Indian coast.

ACKNOWLEDGEMENTS

I am thankful to Dr. A. P. Kapur, Director and Dr. K. Reddiah, Supdg. Zoologist of Zoological Survey of India for providing the necessary facilities for this work.

ZOOLOGICAL SURVEY OF INDIA,
SOUTHERN REGIONAL STATION,
MADRAS-4, TAMIL NADU,
August 31, 1970.

T. S. N. MURTHY

15. THE OCCURRENCE OF *PENNAHIA MACROCEPHALUS* (TANG) (PISCES: SCIAENIDAE) IN INDIAN SEAS

During our studies on the taxonomy of Sciaenids of the Hooghly estuary, two specimens of *Pennahia macrocephalus* (Tang), hitherto unreported from Indian Seas, were determined. This species has been previously reported only from South and East China Sea (Chu, Lo & Wu 1963). Subsequently, we came across five more examples of this species from the Orissa and Madras coast in the collections of Zoological Survey of India.

Tang (1937) described the species under *Pseudosciaena* Bleeker. Subsequent workers (Lin 1940; Chu, Lo & Wu 1963) assigned it to *Argyrosomus* de la Pylaie. The assignment of this species to either of these genera is considered inappropriate sinct *Pseudosciaena* is a junior synonym of *Argyrosomus* (Trewaves 1965) and the air bladder appendages in this species are not divided into a dorsal and a ventral limb as in the type species of *Argyrosomus*. Tht species is, therefore, treated under the genus *Pennahia* Fowler, 1926. As the present report is the first record of occurrence of *Pennahia macrocephalus* (Tang) in Indian waters, a description of the species is given below:

Pennahia macrocephalus (Tang)

Johnius aneus Fowler, 1933, p. 376.
Pseudosciaena macrocephalus Tang, 1937, p. 70, pl. 1, fig. 2.
Argyrosomus macrocephalus Lin, 1940, p. 250, fig. 4; Chu, Lo & Wu, 1963, p. 59 fig. 34.
Dx. 1+24-25; A. 11+7; P. 15-17; L. I. 50-52; L. tr. 7-8/11-12; G.R. 6-7+12.

In percentage of standard length: depth of body 33·3-41·1; head length 33·6-37·5; snout length 7·7-11·3; eye diameter 10·5-12·2; interorbital distance 9·5-11·3; postorbital distance 16·3-19·7; length of lower jaw 13·3-15·6; length of maxilla 16·1-19·2; pectoral fin length 25·2-30·2; pelvic fin length 20·0-22·0 and length of second anal spine 10·3-12·2.

Body oblong, compressed. Mouth terminal, oblique; maxilla extends to hind edge of pupil. Pores: snout with 3 pores; lower jaw with 3 pairs of pores at symphysis, anterior and posterior pairs inconspicuous. Teeth: Villiform in both jaws; outer row of upper jaw and inner row of lower jaw of distantly placed enlarged teeth. Scales: on head and anterior part of body cycloid; on posterior part of body weakly ctenoid. Fins: Dorsal shallowly incised, 3rd spine the longest. Second anal spine stout, 2/3rd of first anal ray. Caudal cuneate. Air bladder: Carrot shaped Otolithini type with 18 pairs of arborescent diverticula. Sonific muscles absent in the two male specimens examined.

Colour in alcohol:

Grayish on back and upper half of body, lower half silvery. Tips of spinous dorsal, upper half of soft dorsal and caudal dusky. Opercle with a bluish blotch; pectoral axil dark.

MATERIAL

No. 11371, 1·88 mm. S.L.; Hooghly; 18.12.1885; J. Barnett.
No. 6061/2. 1, 126 mm. S.L.; Hooghly; 5.11.27; Capt. Park.
No. 12107. No. 12108, No. 12110, No. 12128 - 4, 90-115 mm. S. L.; Orissa; Marine Survey.
No. F 1136/2, 1, 182 mm. S.L.; Portonovo; 22.1.57; A. G. K. Menon. (Madras).

Remarks:

Our specimens agree well with Lin's (1940) and Chu, Lo & Wu's (1963) description of this species except in having a lower dorsal count (X.1.24 vs. X.1.27).

The authors are thankful to Dr. A. P. Kapur, Director, for his encouragement and to Dr. A. G. K. Menon, Superintending Zoologist, Zoological Survey of India, Calcutta for helpful suggestions in the preparation of this note.

ZOOLOGICAL SURVEY OF INDIA,
27, JAWAHARLAL NEHRU ROAD,
CALCUTTA-13,
July 23, 1969.

ASHA JOGLEKAR
P. K. TALWAR

REFERENCES

CHU, Y. T., LO, Y. L. & WU, H. L. (1963): A study on the classification of Sciaenoid fishes of China, with description of new genera and species. Shanghai Fisheries Institute China : 59-60.

FOWLER, H. W. (1933): Contribution to the biology of Philippine Archipelago and adjacent regions. *Bull. U.S. Nat. Mus.* (100) **12**: 376.

LIN, S. Y. (1940): Croakers of the South China Sea. *J. Hong Kong Fish. Res. Sta.* **1** (2): 250.

*TANG, D. S. (1937): A study of Sciaenoid fishes of China. *Amoy Mar. biol. Bull.* **2** (2): 70, pl. 1, fig. 2.

TREWAVAS, E. (1965): Review of the article by Chu, Lo & Wu (1963). 'A study on the Sciaenoid fishes of China, with description of new genera and species.' *Copeia* **2**: 253-254.

* Not consulted in original.

16. OBSERVATIONS ON THE BREEDING GROUND AND DEVELOPMENT OF THE CHILKA MULLET *LIZA MACROLEPIS* (SMITH)

Liza macrolepis, known locally as 'Dangla', forms a commercial fishery in Chilka Lake. In growth and size the fish can be grouped among the larger mullets. The present observations on the breeding ground of 'Dangla' would therefore be of interest from the point of view of both conservation and development of the fishery of this species.

The occurrence of 'Dangla' eggs was first noted in the tow net collections made on 27th November 1964 at about 10.30 hrs. on the right bank of the outer channel near lakemouth. An examination of the eggs revealed the characteristic large oil globule and unsegmented yolk. Since these are important features of mullet eggs and as mature specimens of *L. macrolepis* and *M. cephalus* occurred predominantly in the catches of outer channel during this period an attempt was made to collect the running ovary of these species.

On 28.xi.64 at about 04.00 hours it was possible to collect the oozing ova from a specimen of *L. macrolepis* captured at lakemouth. The oil globule was already formed in the oozing ova and they resembled in appearance and other details the eggs in tow net collections made on 27.xi.64. The eggs appeared to swell very little after fertilisation. There is, thus, little doubt that the 'tow net eggs' belonged to *L. macrolepis*. As eggs in the early and late stages of development occurred at lakemouth as well as up to 2 miles interior of outer channel it may be assumed that lakemouth and inshore areas of sea proximal of lakemouth form the breeding zone of this species. The findings of Jhingran (1958) and Jhingran *et al.* (1963) on the seaward migration of 'Dangla' and its likely breeding ground near lakemouth were thus confirmed.

The present findings indicate that 'Dangla' spawn at about midnight. The total period of embryonic development may be around 26 or 27 hours. The hatching, like spawning, appears to be from a couple of hours before midnight to two or three hours after midnight. The developing eggs collected from plankton were straw coloured and unsculptured, with the characteristic single, large oil globule. The egg measured 0·677 to 0·732 mm. and the oil globule 0·292 to 0·347 mm. The newly hatched larva measures 1·519 to 1·556 mm. The myotomes are 24, the trunk myotomes forming 11 and tail myotomes 13 including the unsegmented terminal mesoderm. The larvae survived up to six days in the laboratory and the six-day old larva measured 2·342 mm.

The 'Dangla' fishery of Chilka Lake showed considerable fluctuations in the range 27-299 m. tonnes (Jhingran & Natarajan 1965) during 1957-1965 period and this is, in no small measure, due to vagaries in recruitment. As recruitment and egg production are related and as the breeding of 'Dangla' is around the lakemouth and inshore areas of sea proximal to lakemouth, it is to be emphasized that breeders should not be unduly exploited, as done now, particularly in the outer channel during November-January.

We are grateful to Dr. B. S. Bhimachar for evincing keen interest in these investigations and Dr. V. G. Jhingran for his valuable suggestions.

CENTRAL INLAND FISHERIES RESEARCH SUB-STATION[1], HAZARIBAGH,
January 4, 1969.

A. V. NATARAJAN
S. PATNAIK

REFERENCES

JHINGRAN, V. G. (1958): Observations on the seaward migration of *Mugil cephalus* Linnaeus from Chilka lake for breeding. *Curr. Science* **27**: 181-182.

——— (1963): Report on the fisheries of Chilka Lake (1957-1960). Bull. No. 1, Central Inl. Fish. Res. Inst., Barrackpore (India).

——— & NATARAJAN, A. V. (1965): Final Report on the fisheries of the Chilka Lake (1957-1965). Bull. No. 8 Central. Inl. Fish. Res. Inst., Barrackpore (India).

17. OBSERVATIONS ON THE FOOD OF YOUNG *HILSA ILISHA* (HAM.) OF THE HOOGHLY ESTUARINE SYSTEM

(With a text-figure)

INTRODUCTION

The 'Indian Shad' *Hilsa ilisha* (Hamilton), forms a rich commercial fishery in the Hooghly estuary. Although considerable knowledge has been gained by various workers on the different aspects of the biology

[1]The investigations were carried out under the auspices of the Chilka Investigation Unit of Central Inland Fisheries Research Institute, Balugaon, Puri (Dist.), Orissa.

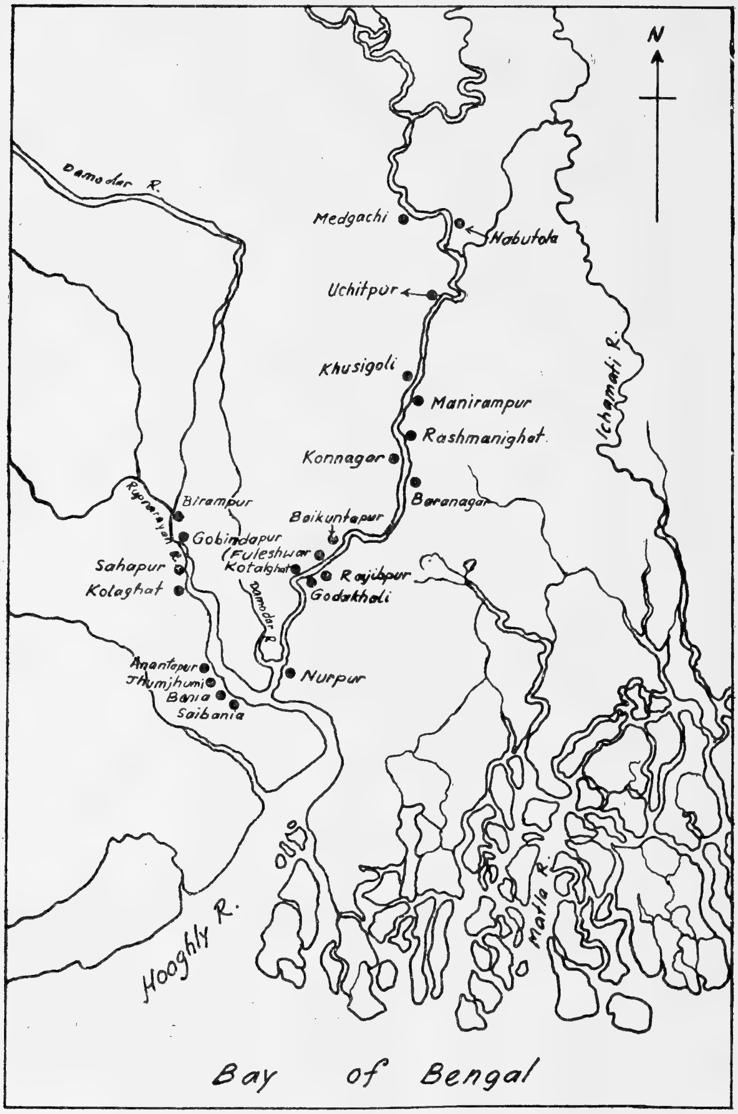
and fishery of the species (Pillay & Rosa 1963). Little work has been done on the food and feeding habits of juveniles of the species. Chacko and Ganapati (1949) have listed the different organisms that occurred in the stomach of the adult specimens of Hilsa from the coastal waters of East Godavari District (Andhra Pradesh). They found the stomach of 150 specimens, examined from the Godavari River, to be empty. Hora & Nair (1940 a, b), Pillay & Rao (1962) and Halder (1968) have worked on the food of young *Hilsa ilisha*. This study was undertaken with a view to ascertain the variations in the intensity of feeding as well as in the composition of food among the different size groups in different zones and in different seasons.

Material and Methods

The material for the present investigations was obtained from the River Hooghly and its tributary, the Rupnarayan. Regular fortnightly random samples were collected from 22 sampling centres (Text-fig. 1) for a period of three years, 1962-64. A total of 1640 specimens of *Hilsa ilisha*, in the size range of, 20 to 200 mm. total length were analysed. Total length was taken from the tip of the snout to the end of the lower lobe of the caudal fin. The fish, in fresh condition, were either directly obtained from Shore-seines (Chatberjal) and bag nets (Behundijal) or from local fish market. The specimens were preserved in 5% formaldehyde, and the stomach contents were analysed by the numerical method, i e the total number of each food items was expressed as percentage of the total number of organisms present in the stomach (Hynes 1950 and Pillay 1952) for different years, zones and lengths. This method is considered as an improvement over other numerical method. In order to improve the accuracy of the analysis, a Sedgwick—Rafters' plankton counting cell was also used. From the gut contents, 1 cc. of random sample was uniformly taken in a sedgwick—Rafters' plankton counting cell, and individual species were identified and counted. When sand, debris and other unidentifiable materials (digested and semidigested) occurred in the guts, their respective percentages were recorded by eye-estimation method. The quantities of debris and unidentifiable matter were grouped in one as miscellaneous items.

Food Habits

As will be seen from Table 1, the young *hilsa* measuring 20-120 mm. in total length were observed to feed actively on zooplankton maximum 68% followed by average 50% phytoplankton in addition to appreciable quantities of decaying organic matter and sand particles. Whereas, in fishes measuring 120-160 mm. in length, the food was



TEXT-FIG-1.

MAP OF THE HOOGHLY ESTUARINE SYSTEM ALONG WITH ITS TRIBUTARY THE RUPNARAYAN, SHOWING AREA OF INVESTIGATION AND COLLECTION CENTRES

mainly constituted by phytoplankton followed by zooplankton, decaying matter and sand particles. In specimens measuring 160-180 mm., neither zooplankton nor phytoplankton were encountered. But, since

TABLE 1

PERCENTAGE PREVALENCE OF VARIOUS FOOD ITEMS IN DIFFERENT CLASSES OR GROUPS

	2-4 cm. %	4-6 cm. %	6-8 cm. %	8-10 cm. %	10-12 cm. %	12-14 cm. %	14-16 cm. %	16-18 cm. %	18-20 cm. %
Zooplankton	68·18	44·65	54·26	55·65	52·54	19·32	20·00	..	48·20
Phytoplankton	10·78	24·24	5·83	6·39	12·80	27·10	42·73	..	15·90
Sand	6·99	12·22	3·98	6·91	4·75	7·00	4·32	50·00	..
Miscellaneous	14·05	18·89	35·93	31·05	29·91	46·58	32·95	50·00	35·90

TABLE 2

FLUCTUATIONS IN THE INTENSITY OF FEEDING IN DIFFERENT YEARS AND IN DIFFERENT ZONES

	1962			1963			1964		
	Zone I %	Zone II %	Zone IV %	Zone I %	Zone II %	Zone IV %	Zone I %	Zone II %	Zone IV %
Gorged	1·11	2·70	..	1·52	..	..	1·59	..	0·63
Full	1·82	12·68	..	6·64	1·82	1·09	1·93	..	0·74
$\frac{3}{4}$ full	30·13	28·33	20·91	9·20	5·45	2·73	5·10	..	1·37
$\frac{1}{2}$ full	33·06	26·43	29·22	14·37	5·45	22·95	8·37	..	1·90
$\frac{1}{4}$ full	9·12	12·12	24·94	16·05	2·22	3·28	11·13	12·50	9·36
Traces	7·94	8·06	8·31	16·41	6·67	50·55	8·45	..	4·45
Empty	16·82	9·67	16·62	35·81	78·39	19·40	63·43	87·50	81.54

in both the bordering classes (14-16 cm. and 18-20 cm.) zooplankton and phytoplankton were noticed in the guts, it is likely that their non-occurrence in this middle class (16-18 cm.) may be due to inadequate sampling. In the length range 180-200 mm., zooplankton formed the main food followed by debris and phytoplankton.

The zooplanktons encountered in the gut contents, in the order of their dominance, were copepods (*Calanus* and *Cyclops*), cladocerans (*Bosmina, Daphnia* and other *Cladoceran* eggs) rotifer (*Keratella, Monostyla* and *Keratella* eggs) and ostracods.

The following phytoplankters were encountered, mentioned in the order of their dominance: diatoms (*Coscinodiscus, Synedra, Cyclotella, Melosira, Pleunosigma, Gyrosigma, Surirell*), bluegreen algae (*Microcystis, Aphanocapsa, Oscillatoria*) and green algae (*Spirogyra, Pediastrum* and *Eudorina*).

The fluctuation in the intensity of feeding of the fishes (expressed as % of fullness of the gut) during the different years and different zones is shown in Table 2.

The peak intensity of feeding was noticed during the year 1962 in all the zones and the same pattern was observed to a certain extent in 1963 also. However, feeding was very poor during the year 1964, as the stomach was found empty in 77·82% and food materials in traces in 4·30% cases.

Discussion

Hora & Nair (1940 a, b), concluded that young *Hilsa* feed at the bottom as sand grains were encountered in the stomachs. Pillay & Rao (1962), inferred from their studies on *Hilsa* from Godavari estuary that the species is a bottom feeder during the entire period of its life, especially from 43 mm. stage onwards and they have also assumed that *Hilsa* feeds at all depths. Halder (1968), concluded from his studies on the food habits of young *Hilsa ilisha* in the freshwater zone (around Nabadwip) of the Hooghly estuary that the young ones of the species feed at all depths. The present study further confirms this observation not only in the freshwater zone but also in the tidal zone (up to Diamond Harbour) of the estuary where the young *Hilsa* feed at all depths.

It is evident from the above studies that the young of *Hilsa* is dominantly a zooplankton feeder up to 120 mm. in length followed by a dominance of phytoplankton in the next two size groups i.e. (120-160 mm.) and vice versa in size groups (180-200 mm.).

ACKNOWLEDGEMENTS

I am greatly indebted to Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute, and Dr. V. R. Pantulu for their guidance and encouragement during the course of this investigation. My grateful thanks are also due to Shri P. Datta for valuable suggestions and Dr. V. Gopalakrishnan for critically going through the manuscript and Shrimati Surya Kumari Raju for analysing the gut contents.

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE,
BARRACKPORE,
August 2, 1969.

D. D. HALDER

REFERENCES

CHACKO, P. I. & GANAPATI, S. V. (1949): On the bionomics of *Hilsa ilisha* (Ham.) in the Godavari. *Madras Univ. J.* **18**: 16-22.

HALDER, D. D. (1968): Observations on the food of young *Hilsa ilisha* (Ham.) around Nabadwip, in the Hooghly estuary. *J. Bombay nat. Hist. Soc.* **65** (3): 796-798.

HYNES, H. B. N. (1950): The food of the freshwater sticklebacks (*Gasterosteus aculestus* and *Pygosteus pungitius*), with a review of methods used in the studies of the food of fishes. *J. anim. Ecol.* **19** (1): 36-58.

HORA, S. L. & NAIR, K. K. (1940a): Further observations on the bionomics and fishery of Indian Shad, *Hilsa ilisha* (Ham.) in Bengal Waters. *Rec. Indian Mus.* **42** (1): 35-50.

——— (1940b): The jatka fish of Eastern Bengal and its significance in the Fishery of the so-called Indian Shad, *Hilsa ilisha* (Ham.) *Rec. Indian Mus.* **42** (4): 553-555.

PILLAY, T. V. R. (1952): A critique of the methods of study of food of fishes. *J. Zool. Soc. India*, **1** (2): 185-200.

PILLAY, S. R. & ROSA, JR. (1953): Synopsis for biological data on the hilsa, *Hilsa ilisha* (Ham.) 1822. *Fao. Fish. Bio. Synops.* **25**: 64.

——— & RAO, K. V. (1962): Observations on the biology and fishery of the Hilsa, *Hilsa ilisha* (Ham.) of River Godavari. *Proc. Indo-Pacific. Fish. Coun.* **10** (2): 37-61.

18. THE FECUNDITY OF *HETEROPNUESTES FOSSILIS* (BLOCH)

(*With three text-figures*)

INTRODUCTION

Fecundity or the reproductive potential can be defined as the number of ova shed during a particular spawning season (Pillay 1954). The study of fecundity is important in the fishery exploitation, especially in freshwater fishes which are now bred artificially in impounded waters by injecting pituitary hormone. Since fecundity bears a definite relationship with total length, body-weight and ovary-weight of fishes, its knowledge can be utilized for the selection of female breeders and thereafter for the estimation of survival of eggs also.

Heteropnuestes fossilis (Bloch) is a common freshwater fish. The mature specimens for investigation were collected from Killa Fish Farm at Cuttack (Orissa) during the years 1962-63. In all 35 mature ovaries were studied. The ovary of *H. fossilis* is brown in colour and the ova are green and round. The diameter of ova varies from 0·4545 mm. to 1·3635 mm. In a mature fish the ovary occupies about three-fourth of the body cavity. The ovaries from freshly killed specimens were preserved in 5% formalin for a few days. The formalin hardened ovaries were weighed after wiping them with a filter paper and from each ovary three samples of 1 gm. each from different regions were taken, teased on a slide and the mature ova thus liberated were counted. A mean of the three samples was taken for estimating the number of ova which was then computed for the whole ovary. In one fish the total number of ova of a complete ovary was counted for testing the accuracy of the method employed and gave a close approximation. The observed fecundity varied from 2,843 to 44,724 in fishes ranging from 164 mm. to 307 mm. in length examined during the present study. In *Clarius batrachus*, another catfish, the average number of ova is 11,612 approximately for a fish of average length 31·5 cm. and weight 251·6 gm. (Mookerjee & Mazumdar 1950).

The fecundity was studied in relation to three parameters viz. (1) Total length of fish (2) Body weight of fish and (3) Ovary weight. The method of least squares was followed for all the calculations.

Result and Discussion

A. *Fecundity—Total length relationship:*

Fig. 1 shows the relationship between fecundity and total length of fish. The fish were grouped in the range of 10 mm. and the equation followed was $F = CL^n$ where F, C and L represent the fecundity, a constant and the length respectively while *n* is an exponent showing the relation between the two variables. In *H. fossilis* the equation comes to be— $F = 10^{-6} \times 9647^{L2\cdot65681}$

This relationship seems to be of a cubic nature as indicated by the parabolic curve (Fig. 1) which means that the fecundity increases at the rate less than the third power of the total length (2·65681) as suggested by Simpson (1951).

The correlation-coefficient 'r' between the two parameters was 0·9569,

B. *Fecundity—Body weight relationship:*

The relationship between these two variables is linear as observed from the graph in Fig. 2. To consider this relationship the fishes were grouped in the range of 10 gm. and the equation followed was F=a+bW where F is the fecundity and W is the mean body weight

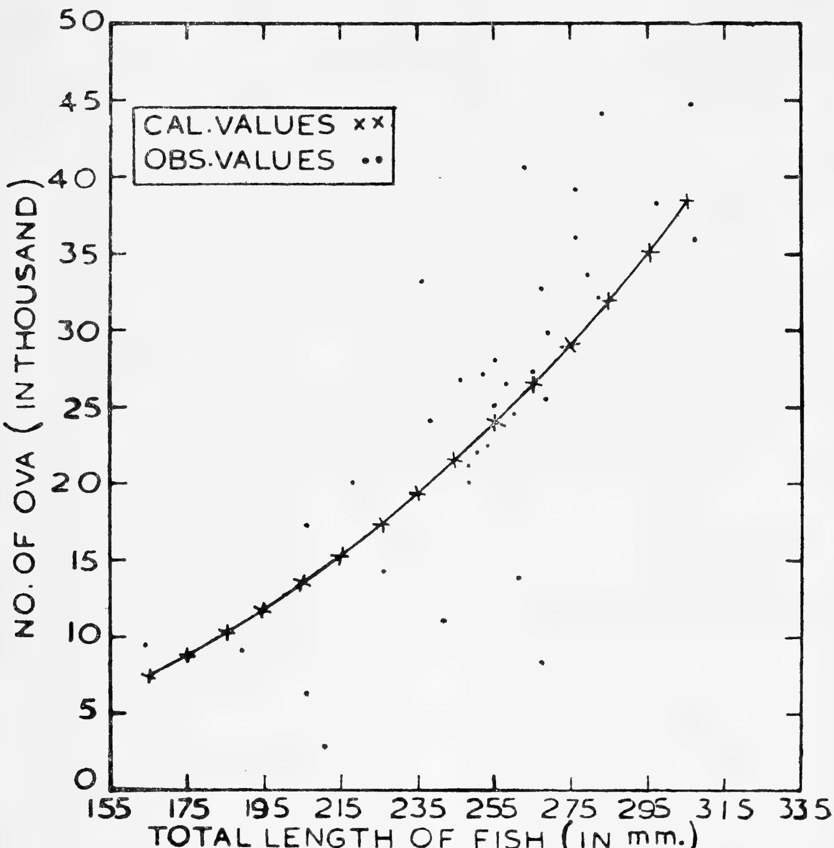


FIG. 1.

of fish in gm. A similar method was followed by Varghese (1961) while calculating the fecundity of *Raconda russeliana* (Gray). By substituting the values of the constants *a* and *b* the equation can be written as—

F=1040·49149+207·27833 W.

The value of 'r' was found to be 0·96536.

C. *Fecundity—Ovary weight relationship:*

In this case the ovary weights were grouped at an interval of

5 gm. The equation F=a+bW′ was used and after substituting the values of the constants the equation obtained was—

F=4117·7915+1298·1000 W′.

The graph in Fig. 3 indicates a linear relationship similar to that obtained by Qasim & Qayyum (1963) in some freshwater fishes.

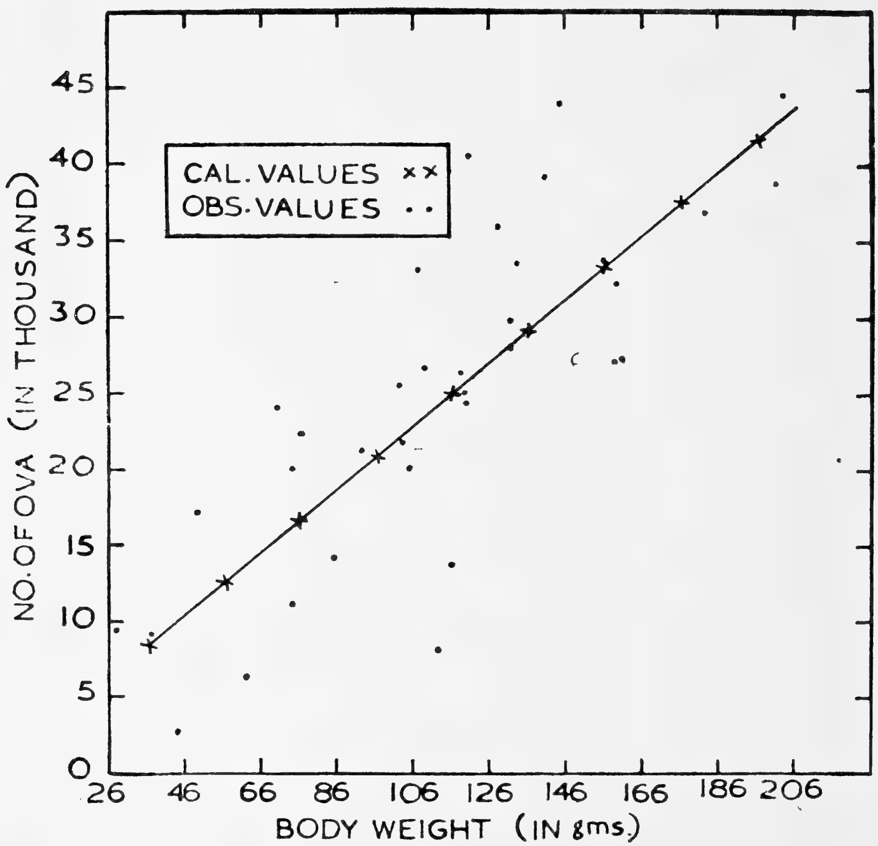


FIG. 2.

The value of 'r' was 0·9925.

In *H. fossilis,* therefore, the relationship of fecundity was found to be curvilinear with total length and linear with body weight and ovary weight for which the values of correlation coefficient 'r' were 0·9569, 0·96536 and 0·9925 respectively. It seems that ovary weight of fish is more accurate in estimating the fecundity than the other two parameters discussed above. However, it is not practicable to consider the ovary weight in live specimens, therefore, the body weight ('r'=0·96536) could be taken as the next best index. Qasim & Qayyum (op. cit.) also drew the same conclusion.

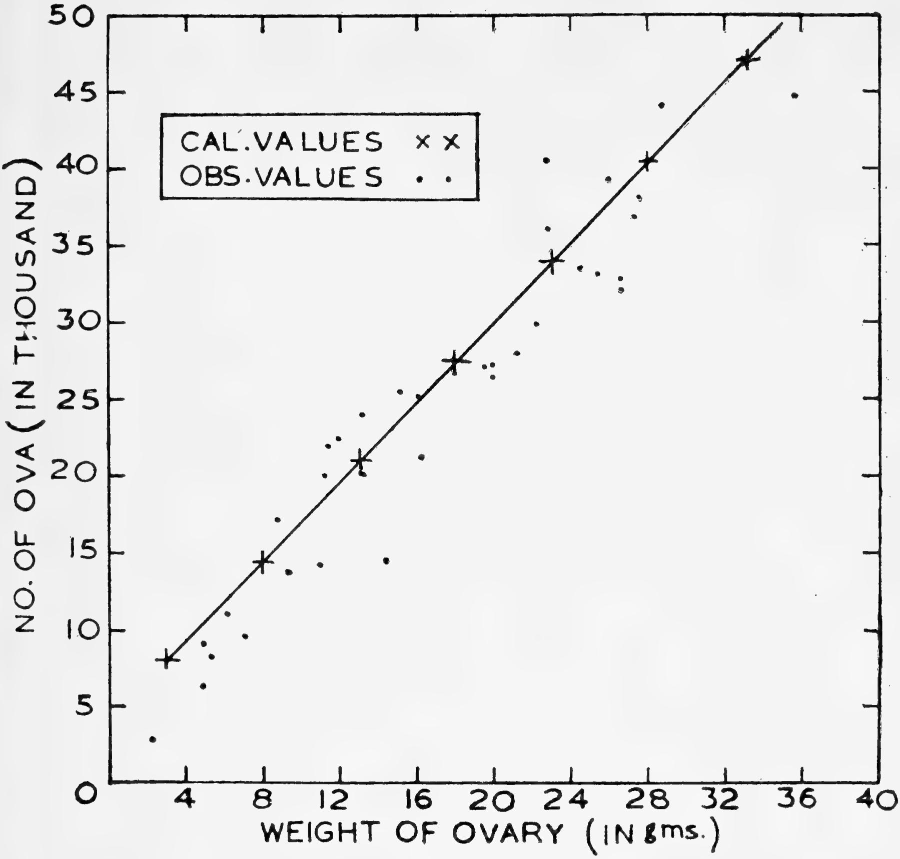


FIG. 3.

ACKNOWLEDGEMENTS

The author wishes to express his gratitude to Shri K. H. Alikunhi, now Director, Central Institute of Fisheries Education, Bombay for his guidance and to Dr. S. Z. Qasim, Scientist, National Institute of Oceanography, Ernakulam, Cochin for critically going through the manuscript.

CENTRAL INLAND FISHERIES, RESEARCH SUB-STATION, CUTTACK,
August 5, 1970.

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REFERENCES

MOOKERJEE, H. K. & MAZUMDAR, S. R. (1950): Some aspects of the life history of *Clarius batrachus* (Linn.) *Proc. Zool. Soc. Bengal* 3 (1) 71–84.

PILLAY, T. V. R. (1954): The biology of the Grey Mullet, *Mugil tade* (Forskål) with notes on its fishery. *Proc. Nat. Inst. Sci. India* **20**: 187-217.

QASIM, S. Z. & QAYYUM, A. (1963): Fecundities of some freshwater fishes. *Proc. Nat. Inst. Sci. India* **29**: 373-382.

SIMPSON, A. C. (1951): The fecundity of Plaice Fish. Invest. Series II. **17** (5).

VARGHESE, T. J. (1961): Observations on the biology of *Raconda russelliana* (Gray). *Ind. J. Fish.* **8** (1): 96-106.

19. OCCURRENCE OF THE SNAIL *LYMNAEA* (*GALBA*) *TRUNCATULA* (MÜLLER) (MOLLUSCA: PULMONATA) AT MALAD, BOMBAY CITY—A NEW RECORD FOR PENINSULAR INDIA

The pulmonate snail *Lymnaea* (*Galba*) *truncatula* (Müller) is a palaearctic species, distributed all over Europe including Iceland and extending through Asia to Kamchatka. Except Kashmir, it has not been reported from any other part of India.

The material studied consists of two examples of *L. truncatula* collected from S. K. P. A. Talaw at Malad, North Bombay (19° 12′N; 72° 50′E).

Although according to Hubendick (1951)[1] the distribution of this species in Africa seems to be the result of transportation by migrating birds, regarding the present record, further studies will be necessary to determine what factors are responsible for its occurrence at Malad, North-West Bombay. The present find is of interest as a new locality record for the species, being reported for the first time from Peninsular India, extending the southern limit of the range of the species in Asia to lat. 19° 12′N.

ACKNOWLEDGEMENTS

I am thankful to the Director, Zoological Survey of India, for affording facilities. My thanks are also due to Dr. K. K. Tiwari, Deputy Director, and Dr. A. Daniel, Superintending Zoologist, Zoological Survey of India, for many useful suggestions and to Dr. K. Manohar, Mulund, Bombay, for sending the specimens for identification, with the necessary collection data.

ZOOLOGICAL SURVEY OF INDIA, A. S. RAJAGOPAL
CALCUTTA,
June 2, 1969.

[1] HUBENDICK, B. (1951): Recent Lymnaeidae. Their variation, taxmonoy, nomenclature and distribution. Kungl. Svenska Vetens. Akad. Handl., Stockholm. **3**: 6-225.

20. THE SPIDER *LYCOSA CARMICHAELI* GRAVELEY AS A PREDATOR OF SMALL FROGS

During my field trips in connection with studies on Amphibian Fauna of Dehra Dun District, I have observed on several occasions the interesting case of predation of small frogs, *Microhyla ornata* Dum. & Bibr., and juvenile *Rana cyanophlyctis* Schn. by the spider *Lycosa carmichaeli* Graveley. Spiders have not so far been recorded as predators of amphibians rather the reverse.

Both the frogs and the spider are common around stony banks of rivers, road side ditches and pools. The spider is fairly large and is quite capable of hunting small frogs. *Rana cyanophlyctis* Schn. when mature starts eating its previous predator, but *Microhyla ornata* Dum. & Bibr. adults have not so far been observed feeding on the spider.

I am grateful to Dr. B. K. Tikader of Zoological Survey of India, for identifying the spider and to Dr. Asket Singh for providing the facilities etc.

NORTHERN REGIONAL STATION,
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13 SUBHASH ROAD,
DEHRA DUN,
September 1, 1970.

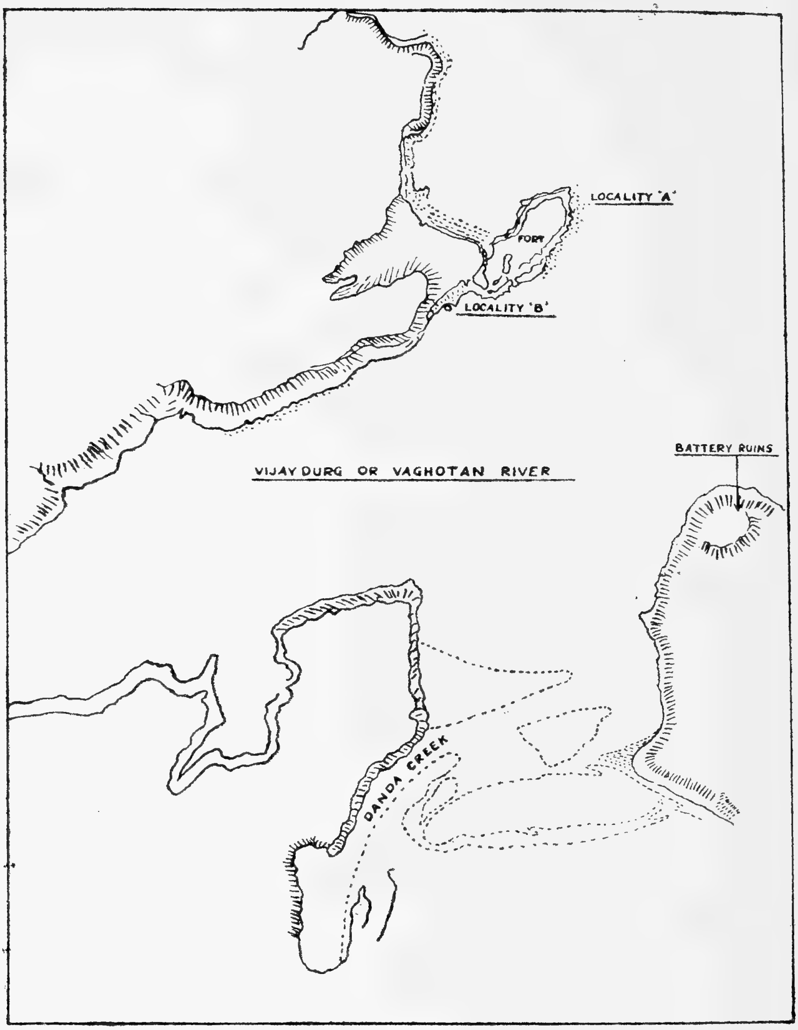
R. K. BHATNAGAR
Assistant Zoologist

21. DIAMETRICALLY OPPOSITE RESULT OF HUMAN ACTIVITY ON BARNACLE POPULATIONS

(*With a text-figure*)

There are quite a few instances in environmental research studies, of barnacle populations in intertidal region being affected due to human activity or pollution (Mileikovsky 1968; Naylor 1965; Persoone & de Pauw 1968; Rzhepishevsky 1963; and Smyth 1968). This note communicates one more instance of similar type. The peculiarity of this record, however, is that the ecological factor altered as a result of dredging activity, has different, almost diametrically opposite, effect on two populations of sessile balanomorphs.

During the survey of the west coast of India (Maharashtra region) made in the period 1962-1965, Station Vijaydurg (16° 34′N., 73° 20·5′E.) could be visited on two occasions. During the first survey in 1962, locality 'A' (Fig. 1) had populations of *Chthamalus malayensis* Pilsbry and *Balanus tintinnabulum* L. whereas locality 'B' had a population of moderate-sized *B. amphitrite* Darwin forms.



In 1963, as a part of the port development project of the Government, work was initiated to construct a landing jetty at locality 'B' and to dredge the bottom between localities 'A' and 'B'. The dredged material was being deposited in the area that was lying opposite to locality 'A'. As a result, at least apparently, of this double activity the balanid fauna of both these localities presented an altogether different picture when they were visited again in 1964. The locality which had fairly good population of large shelled *B. tintinnabulum* was completely devoid of it. There were only a few empty shells. Similarly, the population of *Ch. malayensis* had shifted position from sea-facing to land-facing surfaces of the rocks. The density of the population had also become poor.

As compared to this, the piers of the landing jetty that was under construction had abundant population of *B. amphitrite* with the basal diameter of their shells admeasuring more than 15 mm. (average diameter at other localities being 6-10 mm.).

The probable explanation that can be offered to explain this phenomenon under the situation when all physico-chemical factors except the suspended matter in the water, are apparently unchanged, is that it must have resulted due to dredging of the harbour and subsequent abrupt increase in the suspended matter in water. Locality 'A', that falls under the category of highly-exposed, so far as wave-action is concerned, must have had the maximum effect, especially the shearing effect of waves. As a result, entire population of *B. tintinnabulum* must have been eradicated and displacement of *Ch. malayensis* population must have taken place.

Paradoxically, as it may appear, the population of *B. amphitrite* situated at site 'B' that falls under the category of sheltered locality due to its disposition, had this ecological change to its advantage. The increased amount of suspended matter has provided abundant food material for these forms without any harmful effect of wave action, unlike those of locality 'A'. The resultant effect was the abundance of *B. amphitrite* forms with large-sized shells.

This explanation, though tentative, appears to be the only plausible one, that can explain the variation in the abundance of barnacle populations. It will certainly be interesting to pursue similar faunstic studies and the variation in their populations. It should prove helpful in better understanding of the population dynamics of the respective biotic region and the ecology of near-shore waters as a whole.

We are grateful to Dr. N. K. Panikkar, Director, Indian Programme of the International Indian Ocean Expedition (presently Director, National Institute of Oceanography, Panaji-Goa) for his keen interest and constant encouragement in the investigations. One of us (ABW) gratefully acknowledges the award of fellowship by the Indian National Committee on Oceanic Research, C.S.I.R., New Delhi.

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REFERENCES

MILEIKOVSKY, S. A. (1968): The influence of human activities on breeding and spawning of littoral marine bottom invertebrates. *Helgolander wiss. Meeresunters.* **17**: 200-208.

NAYLOR, E. (1965): Effects of heated effluents upon marine and estuarine organisms. *Adv. Mar. Biol.* **3**: 63-104.

PERSOONE, G. & DE PAUW, N. (1968): Pollution in the harbour of Ostend (Belgium) Biological and hydrographical consequences. *Helgolander wiss. Meeresunters.* **17**: 302-320.

*RZHEPISHEVSKY, I. K. (1963): Propagation of barnacles-balanides on the east Murman Coast. (Russ.). Diss. Dalnie Zelentzi, Murman, Institute of Marine Biology Academy of Sciences of the USSR, Murmansk.

SMYTH, J. C. (1968): The fauna of a polluted shore in the Firth of Forth. *Helgolander wiss. Meeresunters.* **17**: 216-223.

22. STUDIES ON THE LARVAE OF DECAPODA BRACHYURA 1. *XENOPHTHALMUS GARTHII* SANKARANKUTTY

(*With two text-figures*)

INTRODUCTION

The Indo-Pacific region is known for its faunistic richness and a recent assessment by Serene (1968) has put the total number of species of Brachyura at 2500, of which, according to him, more than 1000, may be found within the Indo-Malayan region. However, the larval stages of a great majority of these have not been studied and with the available information, one may not be able to proceed very far in the identification of brachyuran larvae from plankton samples. This was very evident when I made a preliminary examination of the brachyuran larvae from the International Indian Ocean Expedition which contains a large number of zoeae and megalopae collected from different parts of the Indian Ocean. As has already been advocated by Provenzano (1967), only a long term rearing programme of larvae from known parents, as is currently being pursued in the laboratories of the United States, can assist in the identification of larvae from the plankton samples. It was with this objective that the present work was initiated and further studies along similar lines is contemplated as and when ovigerous specimens become available. This paper describes the first zoeal stage of *Xenophthalmus garthii* Sankarankutty obtained through laboratory rearing. For the first time, the description of the first zoeal stage of an interesting and rare genus, *Xenophthalmus* White, is given here.

* Not referred in original.

Material and methods

An ovigerous female of *X. garthii* was collected on 23 October 1968 from Cochin backwater and kept alive in an aerated sea water aquarium. The eggs when examined soon after collection revealed advanced stage of development of larvae within the egg case. The larvae were released on 28th October and a sample of larvae was preserved in 5% neutralised formalin. Description of first zoeal stage is given below.

Description of Zoea I

(Figs. 1 & 2)

Larvae measure about 0·9 mm. in length and 0·7 mm. between tips of dorsal and rostral spines. Carapace (Fig. 1, A) with dorsal,

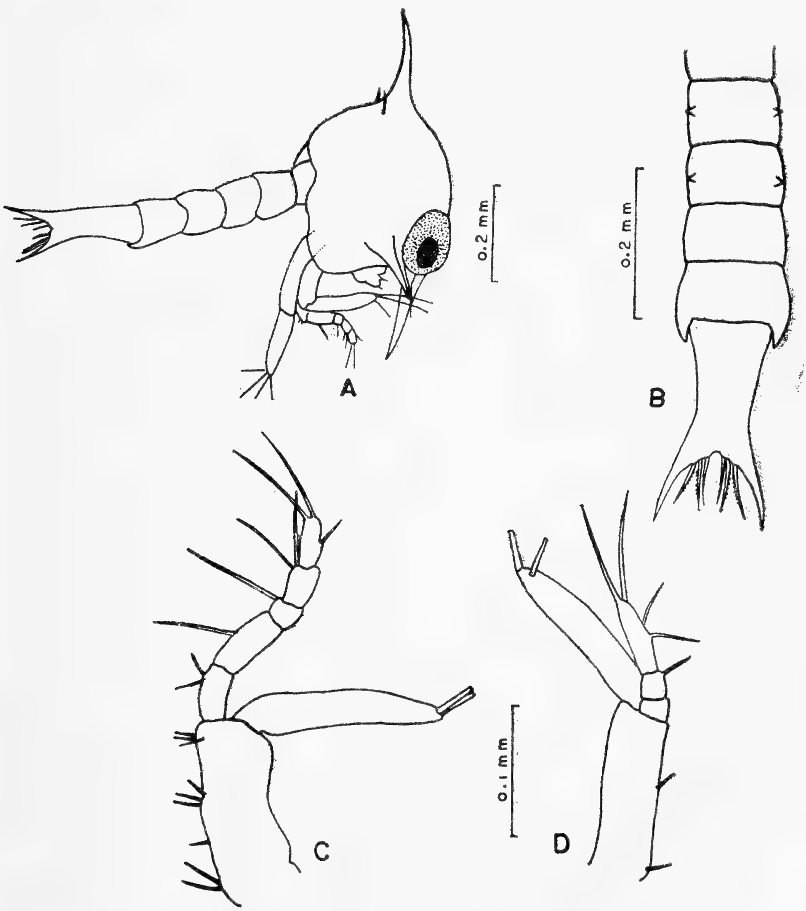

Fig. 1. Zoea I of *Xenophthalmus garthii*:—A. Zoea in lateral view. B. Abdomen in dorsal view. C. Maxilliped I. D. Maxilliped II.

rostral and lateral spines; rostral and dorsal spines subequal and longer than lateral; dorsal only slightly curved; lateral projecting laterally and slightly downwards, its base broad and compressed dorso-laterally. Eyes not free from carapace. Carapace with a pair of hairs, one on either side slightly behind dorsal spine. Abdomen (Fig. 1, B) of five segments and telson; second and third segments with a pair of triangular lateral projections in the middle; second, third and fourth segments of same length and width; fifth segment as long as preceding ones but widening towards the distal end and its lateral distal end in the form of incurved lobe with pointed tip. Telson very long (more than twice the basal width), bicornate, its basal part broad, middle part constricted and distal end wide formed by the long tapering fork enclosing three pairs of setae between the fork, innermost pair of setae being smooth and slightly shorter than outer subequal pairs. Antennule

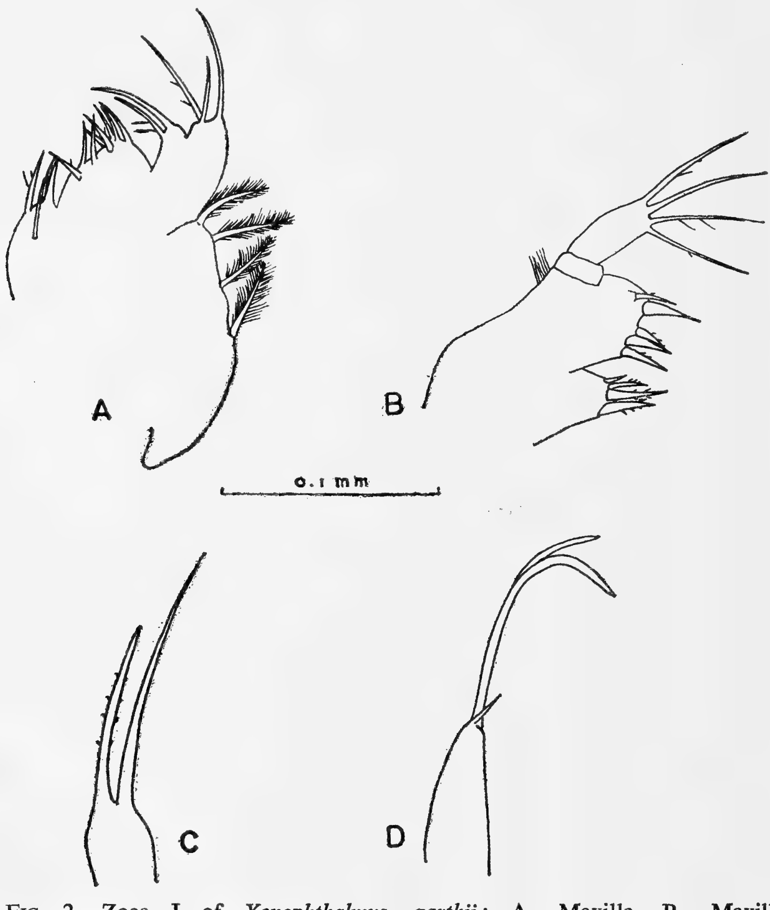

FIG. 2. Zoea I of *Xenophthalmus garthii*:—A. Maxilla. B. Maxillule. C. Antenna. D. Antennule.

and antenna shorter than rostral spine. Antennule (Fig. 2, D) having a narrow fairly long basal lobe bearing a short spinule and two long subequal aesthetes. Protopodite of antenna (Fig. 2, C) prickly and shorter than pointed exopodite. Endopodite of maxillule (Fig. 2, B) bearing four subequal terminal setae, its basal segment unarmed; basal endite having five setae of varying size and coxal endite carrying four dissimilar setae. Scaphocerite of maxilla (Fig. 2, A) having four feathery setae; endopodite bearing three dissimilar setae on its distal part and two dissimilar setae on its basal part; coxal endite with four and basal endite with eight setae. First and second maxillipeds biramous and functional, each carrying four swimming setae on its exopodite. Endopodite of first maxilliped (Fig. 1, C) five-segmented, second segment longest, first longer than rest, third shortest and terminal longer than fourth; first segment bearing two setae, second and third with one long seta and terminal segment with two distal setae and another in the middle. Endopodite of second maxilliped (Fig 1, D) three-segmented; first and second segments subequal, latter bearing a seta, third segment almost three times as long as first two and having four setae. Third maxilliped and pereiopods not represented.

As the larvae described here were examined after preservation, the pattern of distribution of chromatophores is not given.

Discussion

The description shows that the larva of *X. garthii* is of a generalised brachyuran type having all the spines of carapace, a well developed antenna, abdominal armature and forked telson. Larvae of the family Pinnotheridae so far described are known to have either all the spines of carapace or the lateral spines may be absent or all the spines of carapace may be absent (Costlow & Bookhout 1966). The shape of telson is also a variable character, for example, telson may be forked or trilobed (Gurney 1942). Although the larvae of *X. garthii* can be included among those in the family Pinnotheridae on account of the different types of larvae encountered within the family, the better developed antenna, the characteristic shape of fifth abdominal segment and telson are sufficiently diagnostic of the larva described here.

ACKNOWLEDGEMENT

I am grateful to Dr. N. K. Panikkar for the guidance and encouragement I received from him.

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REFERENCES

COSTLOW, J. D. JR. & BOOKHOUT, C. G. (1966): Larval stages of the crab, *Pinnotheres maculatus* under laboratory conditions. *Chesapeake Sci.* 7: 157-163.

GURNEY, R. (1942): Larvae of decapod Crustacea. *Ray Soc. London.*, pp. 306.

PROVENZANO, A. J. JR. (1967): Recent advances in the laboratory culture of decapod larvae. *Symposium on Crustacea*, Pt. II, *Marine Bio. Ass. India.*, pp. 940-945.

SERENE, R. (1968): The Brachyura of the Indo-West Pacific region. UNESCO—Singapore (Mimeograph).

23. STERILITY AND ABNORMAL COPULATION BEHAVIOUR IN *AGROTIS INFUSA* (BOISD) (AGROTIDAE: LEPIDOPTERA) IN RELATION TO HIGH TEMPERATURE

While studying the biology of *Agrotis infusa* (Boisd), the famous 'Bogong moth' (an important cutworm pest in South-eastern Australia) to determine the effect of temperature on fecundity and fertility of moths, many pairs were found unable to mate successfully and to lay fertile eggs when they were reared or were kept (with 20% sucrose solution as food) at temperatures of 29·8°C and above. The high temperature during imaginal life had more influence than that during rearing in producing sterility and abnormal copulation. In the former case, most of the males were sterile, being unable to complete spermatogenesis. In many cases copulation failed to occur. In some cases copulation started but the male was unable to transfer the spermatophore fully into the bursa copulatrix of the female and usually remained attached to the female by the partly everted spermatophore. In some cases, when the male did separate itself from the female, part of the tubular neck remained permanently everted out of the female genitalia. Such females laid only a few infertile eggs because of the failure of sperms to reach the spermatheca from the bursa-copulatrix. Exceptionally, however, when more than one spermatophore were inserted in the female during copulation and at-least one was deposited completely in the bursa, fertile eggs were laid by such a female. The highest number of spermatophores found in a female was three, normally, however, a fertilized female contained only one spermatophore.

Out of the four females each confined with two males at 34°C, none laid any eggs. Mating failed to occur at this temperature and dissection of females after death showed that the ovaries contained only a few degenerate eggs and there was no fat body. Out of the nine females, each kept with two males at 29·8°C, two failed to oviposit and the remaining seven laid only a few infertile eggs. In some of these mating was unsuccessful as seen by the partly everted spermatophore through the female genitalia; in all others, mating failed to occur as revealed by the absence of spermatophores in the bursae of the dead females.

When the earlier stages of the pest were reared at different temperatures and the adults were kept in pairs at an optimum temperature of 22°C with food, all females that developed at 16°C and 22°C laid fertile eggs but those which developed at higher temperatures of 26°C and 29·8°C laid 30% and 66% infertile eggs, respectively.

High temperatures during rearing and particularly during imaginal life have been found to produce sterility and to result in increased percentage of infertile eggs in other Lepidoptera and this has been explained as due to degeneration of eggs and exhaustion of fat bodies in females and retardation of spermatogenesis in males.

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August 17, 1970.

24. STUDIES ON THE BIOLOGY OF *PHYTOMYZA ATRICORNIS* MEIGEN (AGROMYZIDAE: DIPTERA)

Taskhir Ahmed & Gupta (1941)[1] have reported *Phytomyza atricornis* Mg. as a polyphagous pest feeding on over 72 species from 13 plant families.

During the first week of December 1966 large number of leaves of the Pea crop were found infested by the leaf miners, *Phytomyza*

[1]AHMED, T. & GUPTA, R. L. (1941): The Pea leaf miner, *Phytomyza atricornis* (Meigen) in India. *Indian J. Ent.* 3: 37-49.

atricornis M., and *Liriomyza brassicae* Riley at the central Research farm, Gwalior. This opportunity was availed of to study the biology of *P. atricornis* in detail.

Nature and extent of damage:

The first indication of damage seen on the leaves was numerous punctures made by the female with her ovipositor. These punctures later changed into prominent protuberances. In some cases the intensity of these punctures was so high that the tender leaves in freshly sprouted plants etiolated, while in plants growing in dry areas they withered. The larvae mined the leaves by eating through the mesophyll, leaving the two epidermal layers intact. In case of severe infestation the leaves withered away while flowering and fruiting was considerably reduced.

The intensity of attack was noted on fifty leaves at a time during February and March 1967. The data collected during four observations on the number of punctures and larvae and pupae per leaf revealed that they varied from 12 to 18 and 6 to 8 respectively. Percentage infestation varied from 40 to 74.

Mating:

Mating occurred 3 to 5 days after emergence of adults. During copulation the female remained stationery, while the male with its wings closed, sat lightly over the female holding her first abdominal segment with the first pair of legs and the mid-abdomen with the last pair of legs. A single act of copulation took a maximum of 90 minutes and a minimum of 15 minutes.

Pre-oviposition and oviposition:

The female made punctures with her ovipositor by tilting her abdomen over the hind legs, turning the abdomen tip downwards, and bringing the ovipositor vertically on to the leaf surface. It then pierced the leaf tissues, stretched the ovipositor obliquely, revolved it under the epidermis by thrusting it repeatedly forming a triangular blotch at the point of entry of ovipositor. The eggs were deposited singly.

From the second week of January to the middle of March, 6 pairs of adults were kept under observation for studying the pre-copulation and oviposition periods and fecundity per female. The precopulation period ranged from 3 to 5 days. The female started laying eggs soon after copulation. The oviposition period varied from 3 to 6 days, the maximum being in the fourth week of January. It decreased to 3 days during March due to rise in temperature. The number of eggs per female varied from 87 to 203.

Incubation period and hatching:

From about the middle of January to middle of March, 6 batches of 50 eggs were kept under observation and 86 to 94% of them hatched. There seemed to be a slight decrease in hatching as the temperature rose. Similarly the incubation period varied between 3 and 7, increase in the atmospheric temperature decreasing the incubation period. During hatching the chorion was broken at the side by the thrusting movement of the head of the larva inside the egg.

Larval and pupal periods:

The larval and pupal periods recorded in 6 cases from third week of January to third week of March varied from 6 to 10 and 5 to 12 days respectively.

Life cycle and longevity of adults:

The period required for one life cycle varied from 15 to 28 days. The longevity of male and female varied from 2 to 8 days and 4 to 18 days respectively. The males lived longer when kept with the females.

Sex ratio:

On examining 20 laboratory bred specimens in each month from January to March for their sex it was found that in January males and females were equal in number while the males outnumbered the females in February and March.

Stages of Growth

Egg:

Average of 10 eggs—Length 0·36 mm., breadth 0·15 mm., oval, colourless, somewhat translucent, surface smooth, sensitive to drought as it is laid in leaf tissues.

Maggot:

FIRST INSTAR: Average of 10 maggots—Length 1·33 mm., breadth 0·35 mm., Metapneustic, white, smoothly cylindrical tapering at the anterior end. Cephalic region with circular pits (sense organs), pair of antennae and maxillary palpi, mouth hooks each with two teeth. Body eleven-segmented.

SECOND INSTAR: Average of 10 maggots—Length 1·78 mm., breadth 0·58 mm. Amphepneustic, pale yellowish, chitinized ventral plate bearing smoky brown trophic organs.

TABLE 1

LIFE CYCLE PERIOD AND LONGEVITY OF ADULTS *P. atricornis*

Date of egg laying	Date of hatching	Incubation period (in days)	Date of pupation	Larval period (in days)	Date of emergence of adults	Pupal period (in days)	Pre-imaginal period (in days) Co · 3+5+7	Date of death	Longevity ♂	Longevity ♀
13-i-67	19-i-67	6	29-i-67	10	7-ii-67	9	25	♂ 15-ii-67 ♀ 25-ii-67	8	18
24-i-67	31-i-67	7	9-ii-67	9	21-ii-67	12	28	♂ 27-ii-67 ♀ 8-iii-67	6	15
9-ii-67	15-ii-67	6	22-ii-67	7	4-iii-67	10	23	♂ 9-iii-67 ♀ 13-iii-67	5	9
15-ii-67	20-ii-67	5	28-ii-67	8	7-iii-67	7	20	♂ 10-iii-67 ♀ 13-iii-67	3	6
8-iii-67	12-iii-67	4	18-iii-67	6	24-iii-67	6	16	♂ 28-iii-67 ♀ 29-iii-67	4	5
14-iii-67	17-iii-67	3	24-iii-67	7	29-iii-67	5	15	♂ 31-iii-67 ♀ 2-iv-67	2	4

THIRD INSTAR: Average of 10 maggots—Length 3·25 mm., breadth 0·90 mm., colour somewhat brown. Enteroventral surface of head divided into two plates, each bearing antennae and maxillary palpi, the latter with ten sensory papillae, terminal three much longer than the rest. Chitinous labial plate light brown.

Pupa:

Average of 10 pupae—Length 2·09 mm., breadth 0·9 mm. Long oval and pale yellow when fresh, attains reddish brown or dark brown colour at the time of emergence of adult. Segments well defined, both the anterior and posterior spiracles prominent.

Adult:

Average of 10 adults of each sex—Length 3·2 mm. and 2·8 mm., breadth 9·0 mm. and 8·7 mm. of male and female respectively. Inter-orbital space and ventral region of face yellow, two sub-equal superior and one to two inferior orbital setae, third segment of antenna quadrate, slightly longer, colour black. Mesonotum black with a light grey bloom; pleural sutures narrowly yellow; femora, tibiae and tarsi dull black; wings hyaline, halteres yellow.

Natural enemies:

During the course of the study a larval eulophid parasite, *Neochrysocharis* sp. and a pupal braconid parasite, *Opius* sp. were recorded. The extent of parasitisation by these parasites were 2 to 84% and 40% respectively.

ACKNOWLEDGEMENTS

The authors record their grateful acknowledgement to the Director, Commonwealth Institute of Entomology, London, for the identification of the parasites. We are also grateful to Dr. R. S. Bhat, the then Principal, Agriculture College, Gwalior, M.P. for providing facilities.

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25. A NEW HOST OF THE BRINJAL SHOOT AND FRUIT BORER *LEUCINODES ORBONALIS* GUEN, AND ITS BIOLOGY

Leucinodes orbonalis Guen. is generally considered a serious pest of brinjal (*Solanum melongena* L.) in which it bores the shoots and fruits. It has also been recorded attacking many other plants.

We observed the pest boring the shoots and fruits of tomato (*Lycopersicum esculentum* Miller) in Bhubaneswar. The infestation of the winter crop in 1964 was 5 to 10%. As it was the first record of *Leucinodes orbonalis* on tomato, it was thought worthy to study the life history of the insect, and to compare its biology and life history with that on the weed *Solanum nigrum* and on brinjal.

A large number of larvae of *Leucinodes orbonalis* were collected from the field and reared to adult stage in the laboratory, in specially designed breeding cages, containing potted brinjal plants. After mating, the female moth laid eggs on the plant inside the cage. The newly hatched larvae were taken from the plant by a camel hair brush and reared on fruits of brinjal, tomato and *Solanum nigrum*. Newly hatched larvae when released on the fruits, hide below the calyx by webbing externally and then bore into the fruits to develop inside. As the larvae grows, it cannot accomodate itself in the fruit of *Solanum nigrum*. Therefore it comes out and webs 3-4 such fruits together and feeds on them by remaining inside the web. Damaged fruits were replaced from time to time, by fresh ones.

When full grown, the larvae come out of the fruit to search for a suitable site for pupation. Such larvae were released inside 4″ diameter petri dishes loosely fitted with a plain paper base and covered with a lid. The larvae moved below the paper base and spun cocoons and pupated. The moths which emerged remained confined inside the petri dish.

Newly hatched larvae bore into brinjal, tomato and *Solanum nigrum* fruits in 30, 13 and 3 minutes respectively. The average length of larval period was 12, 13 and 15 days and pupal period was 11, 11 and 10 days respectively. Variations in the growth of the insect on the three hosts was noticed while rearing. The respective full grown larvae measured 16·0-20·0 mm., 16·0-20·0 mm. and 10·0-13·0 mm. in length and 2·5-4·0 mm., 2·5-3·5 mm. and 2·0-2·5 mm. in breadth. Cocoons spun by the full grown larvae reared on brinjal and tomato were of the same size 16·0-20·0 mm., 6·0-8·0 mm., but Cocoons from *Solanum nigrum* were 8·0-10·0 mm., 3·5-4·0 mm. The length of the pupae formed inside the respective Cocoons was 8·0-13·0 mm., 8·0-13·0 mm. and 8·0-10·0 mm. and breadth 2·5-3·5 mm., 2·5-3·0 mm., and 2·0-2·5 mm. Colour and texture of the Cocoons of *Leucinodes orbonalis* is black and leathery on brinjal, dull black, thin and papery on tomato, and ashy, thin and papery on *Solanum nigrum*. Average wing expansion of the moths from brinjal and tomato was equal — 18·0-22·0 mm. in the male and 20·0-24·0 mm. in the female. Male and female moths from *Solanum nigrum* had a wing expansion of 17·0-19·0 mm. and 17·0-20·0 mm. respectively. A difference in the fecundity of the moths was also noticed. Female moths reared from brinjal, tomato and *Solanum nigrum* laid on an average 152, 113 and 38 eggs. All the eggs were equally viable and hatched after an incubation period of 6 days. The total life cycle of *Leucinodes orbonalis* Guen. on the respective hosts was 27, 28 and 29 days. During the course of the study the average minimum and maximum laboratory temperatures were 79·5°F and 82·0°F and the relative humidity was 89%.

Tomato and *Solanum nigrum* are thus suitable alternate hosts of the brinjal shoot and fruit borer *Leucinodes orbonalis* Guen. Though the growth of the borer on *Solanum nigrum* is poor. However, it completes its life cycle on this host also. Moths from *Solanum nigrum* which were smaller in size with reduced wing spread laid far less eggs in comparision to the moths from the two other hosts. This shows that the size and vigour of the moths are correlated with their fecundity.

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July 12, 1968.

26. CHAFER BEETLE, *ADORETUS* SP. (COLEOPTERA: SCARABAEIDAE) A NEW PEST ON GUAVA IN INDIA

Guava (*Psidium guajava* L.) is an important fruit crop in India, the State of Uttar Pradesh being the largest grower with approximately 9,840 hectares under it and accounting roughly for over one-third of the entire guava crop of the country (Hayes 1961). Adult Chafer beetles *Adoretus* sp. (Coleoptera: Scarabaeidae) were recorded feeding on its leaves in the Himalayan foothills in Uttar Pradesh. The infestation was mainly during the monsoon season and thereafter and the damage was fairly serious. We presume that this is the first record of the pest on guava in India.

The adult *Adoretus* sp. is about 11 mm. long and light greenish-brown in colour. They are strictly nocturnal and usually solitary. They feed on the foliage, causing in the beginning small irregular holes, usually starting from the middle of the infested lamina and extending outwards towards the margin. A large number of irregular holes 2 to 4 mm. in diameter is thus formed on the guava leaves. Depending upon the degree of damage to the foliage, the pest reduces the yield, and in serious cases the number of fruits is substantially lowered.

Control Measures:

Spraying with 0·02 per cent endrin at the rate of 5 litres per mature tree, in the early hours of the night, effectively controls the pest. This application is recommended particularly for trees which are not bearing. For trees bearing fruits, spraying 0·05 per cent DDVP, i.e. 1 ml. of Nuvan 100, mixed in 2 litres of water at the same rate is recommended.

Acknowledgements

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Central Indian Medicinal Plants Organization (CSIR), Haldwani, Nainital (U. P.), — RAJENDRA GUPTA

October 15, 1968.

27. PLIETESIAL SPECIES OF STROBILANTHINAE (ACANTHACEAE) IN THE WESTERN GHATS (INDIA)

Biennial or perennial plant species flowering or fruiting only once in their life-cycle are usually termed 'Monocarpic', as for instance, Agave & Yucca. If such monocarpic species form compact communities in a homogenous habitat with a synchronous and mass flowering followed by fruiting and simultaneous termination of life-cycle on a mass scale such species are usually termed as 'Plietesials'.

Various species of bamboos are well known for their gregarious flowering only once at the end of their life-cycle ranging from 40 years or more. A similar plietesial habit characterises certain members of the family Acanthaceae. The term 'plantae plietesiae' was coined by Bremekamp (1944) specially to describe certain species of 'Strobilanthinae' of the Acanthaceae. Clarifying the term, he writes of these plants as follows: 'A majority of the Strobilanthinae are monocarpic i.e., they flower but once and die when they have ripened their fruits. Several of these are known to grow gregariously, often covering large tracts in the undergrowth of the forest with uniform mantle of foliage and flowering after intervals of several years simultaneously and in profusion. Already at the time of flowering the leaves are shed and during the comparatively long period required for the ripening of the capsules, the naked shoots lend the site a peculiar wintry aspect, and as the forest so long as the plants were in flower was filled with the humming of the bees, it is now the scene of the depredations of the numerous frugivorous birds'. 'As the term "perennial" is usually reserved for polycarpic plants whose aerial parts regularly die down and as there exists apparently no name for monocarpic plants of the kind most often met with in the Strobilanthinae, I have introduced for them in my latin descriptions the term "plantae plietesiae" i.e., plants living several years. As it seems desirable to have also a common name for plants showing this growth form, which in tropical and sub-tropical regions are by no means rare, I propose to call them in future "Plietesials".'

The flowering rhythm' in the plietesial members is set in the following way: the species have a vegetative phase of a fixed number of years, characteristic to individual species. At the end of this phase, the members of a species in a compact community flower simultaneously. This is followed by fruit setting and dispersal of seed. All the plants in the community then perish *en masse*. The seed shed by these plants germinate during the next monsoon and start the vegetative phase, thus completing the cycle.

Some members of the tribe Strobilanthinae are almost endemic in Peninsular India and Ceylon and are extensively distributed in the Western Ghats in India. The available literature, however, presents a very scanty information as regards the life-cycles of individual species of this group. Bremekamp (loc. cit.) states with regard to the flowering periods of these plietesial species, that the available literature is either incomplete or unreliable, particularly in case of genera like *Nilgiri-anthus*.

The Central Bee Research Institute with the help of its regional Agricultural Laboratory, Mahabaleshwar (Maharashtra), has been studying some of the local members of the Strobilanthinae, since 1952. Recently these studies have been extended to its regional stations in Castle Rock (Mysore State) and Nilgiri and Palni (Tamilnadu) areas. All these laboratories are fortunately located in the Western Ghats, where a number of the plietesial Strobilanthinae are endemic. It has been thus possible to record and confirm in successive years the flowering

TABLE
FLOWERING OF STROBILANTHINAE

Species (flowering Period)	Earlier Reports			Field Observations recorded at this Institute (1952-69)		
	Authors	Flowering Years	Reported Interval	Recorded Mass Flowering	Locations	Recorded mass flowering interval
1. *Carvia callosa* Brem. (August-October)	Talbot (1911), Cooke (1905), Santapau (1951, 1959), McCann, (1943).	1878, 1881, 1885, **1887**, 1891, **1895**, 1917, 1918, 1926, **1927**, **1928**, 1942-1946, **1944**, 1949, 1950-1951, 1959-**1960**	6, 7, 8, 9, 10, 7-12 or 15 years.	**1952**, **1960**, **1968** **1967**	Mahabaleshwar (17° 56′N; 73° 40′E) and Khandala (18° 46′N; 73° 22′E) Castle Rock (15° 24′N; 74° 20′E)	8 years*** 8 years*
2. *Thelepaepale ixiocephala* Brem. (November-January)	Talbot (1911), Cooke (1905), Santapau (1943, 1951, 1962)	1849, 1852, 1884, 1889, **1896**, 1918, **1919**, **1920**, **1928**, 1942-1946, **1944**, 1951-**1952**, **1960**.	1, 7, or 8 years.	**1952**, **1960**, **1968**	Mahabaleshwar and Khandala.	8 years***
3. *Mackenziea integrifolia* Brem. (February-March)	Talbot (1911), Cooke (1905), Santapau (1951, 1967)	1866, 1885, 1886, 1887, 1889, 1918, 1919, 1925, 1943, **1944**, 1945.	3 or 7 years.	**1967** **1968**	Castle Rock. Khandala	8 years* 8 years*
4. *Nilgirianthus reticulatus* Brem. (November-December)	Santapau (1951, 1962)	1892, 1909, 1918, 1920, 1924, 1950, **1958**	7 years.	**1958**	Mahabaleshwar	12 years*
5. *Phlebophyllum kunthianum* Nees (August-October)	Gamble (1924), Fyson (1915) Robinson (1935), Santapau (1962)	**1826-1934** at 12 year intervals, 1847, **1850**, 1851, 1852, **1898**, **1910**, 1948, **1958**	2 or 7-12 years.	1969-**1970**: expected general peak.	Nilgiri and Palni hills (10° 1′-11° 40′N; 76° 14′-77° 52′E).	12 years*
6. *Strobilanthes scrobiculata* Dalz. ex Clarke (October-December)	Talbot (1911, 1949), Santapau (1951)	**1888**, 1889, 1924.	1 year.	**1952**, **1968**	Mahabaleshwar	16 years**

Earlier reported flowering years, which correspond to observed intervals in column 7, are in bold type.
*First observation of mass flowering in the particular locality, intervals estimated from earlier reports;
**2 serial flowerings observed and 1 interval recorded;
***3 serial flowerings observed and 2 intervals confirmed.

rhythms of several of these species. The information from earlier reports by various botanists, augmented by actual field observations made by this Institute from 1952 to 1969 have been summarised in the Table.

It will be seen from the table that in so far as it concerns the Mahabaleshwar Plateau, the intervals between successive flowerings are as indicated above. Though such intervals between successive flowerings of the species seem to be fixed, it appears that the compact communities of the same species may flower about an year eariler or later in different localities, while preserving, at the same time, the fixed intervals as above. For instance, *Carvia callosa* and *Thelepaepale ixiocephala* have flowered in Mahabaleshwar in 1968, but the same species have flowered in 1967 at Castle Rock[1]. This situation possibly explains the earlier reports of flowering of these species during consecutive years in spite of their plietesial habit. In fact Talbot (1911, 1949) does refer to some of the above species as annually flowering.

In the course of his observations on some of the above species distributed in Khandala and Mahabaleshwar, Santapau (1943, 1950, 1951, 1952, 1959, 1960, 1962 and 1967) has inferred that there might not be any fixed rhythm with definite intervals in these species, or when they showed such intervals, the reasons for such flowering behaviour were obscure. He had observed more or less stray flowering of isolated plants in successive years. Quite apart from the stray cases, repeated observations at the Mahabaleshwar Laboratory do suggest a remarkable tendency for general, synchronous, mass flowering at fairly fixed intervals as indicated in the table.

ACKNOWLEDGEMENTS

I am grateful to Dr. G. B. Deodikar, Director, Maharashtra Association for the Cultivation of Science Research Institute, Poona-4 and Shri C. V. Thakar, Dy. Director, Central Bee Research Institute, K. & V.I. Commission, Poona-4, for guidance, encouragement and help; to Shri R. P. Phadke and Shri K. K. Kshirsagar of this Institute, for their valuable information and help and to Shri. C. S. Bhambure, Apiculture Institute, Mahabaleshwar, and Shri M. C. Mittal of this Institute for help in the field.

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POONA-4,
December 18, 1969.

[1]Earlier records of flowering which tally with the year 1967 in the 8-year sequence as indicated in the table, were found to be from the same region : North Kanara (Talbot 1911).

REFERENCES

Bremekamp, C. E. B. (1944): Materials for a Monograph of the Strobilanthinae (Acanthaceae). *Verh. neder. Akad. Wetensch. Afd. Nat. Tweede Sec.* **41** (1): 1-306.

Cooke, Th. (1905): The Flora of the Bombay Presidency. vol. 2, pp. 442-449. Rep. Govt. of India, Calcutta.

Fyson, P. F. (1915): The Flora of the Nilgiri and Pulney Hill Tops (above 6,500 ft.). vol. 1, pp. 310-314.

Gamble, J. S. (1924): Flora of the Presidency of Madras. vol. 2, p. 726. Rep. Govt. of India, Calcutta.

McCann, C. (1943): The flowering of *Strobilanthes callosus* Nees. *J. Bombay nat. Hist. Soc.* **44**: 143-144.

Robinson, M. E. (1935): The flowering of *Strobilanthes* in 1934. ibid. **38**: 117-122.

Santapau, H. (1943): The flowering of *Strobilanthes*. ibid **44**: 605-606.

——— (1950): The flowering of *Strobilanthes*. ibid **49**: 320-321.

——— (1951): The Acanthaceae of Bombay. *Univ. Bombay bot. Mem.* **2**.

——— (1952): The flowering of *Strobilanthes* in Khandala. *J. Bombay nat. Hist. Soc.* **50**: 430-431.

——— (1959): The flowering of *Strobilanthes*. ibid. **56**: 677.

——— (1962): Gregarious flowering of *Strobilanthes* and Bamboos. ibid. **59**: 688-695.

——— (1967): The Flora of Khandala on the Western Ghats of India. *Rec. Bot. Surv. India* **15** (1): 197-199.

Talbot, W. A. (1911): Forest Flora of Bombay Presidency and Sind. vol. 2 Govt. of Bombay, Poona.

——— (1949): The trees, shrubs and woody climbers of the Bombay Presidency. 3rd edn. Govt. Photozincographic Press, Poona.

28. A NOTE ON THE TOAD RUSH, *JUNCUS BUFONIUS* L. FROM INDIA

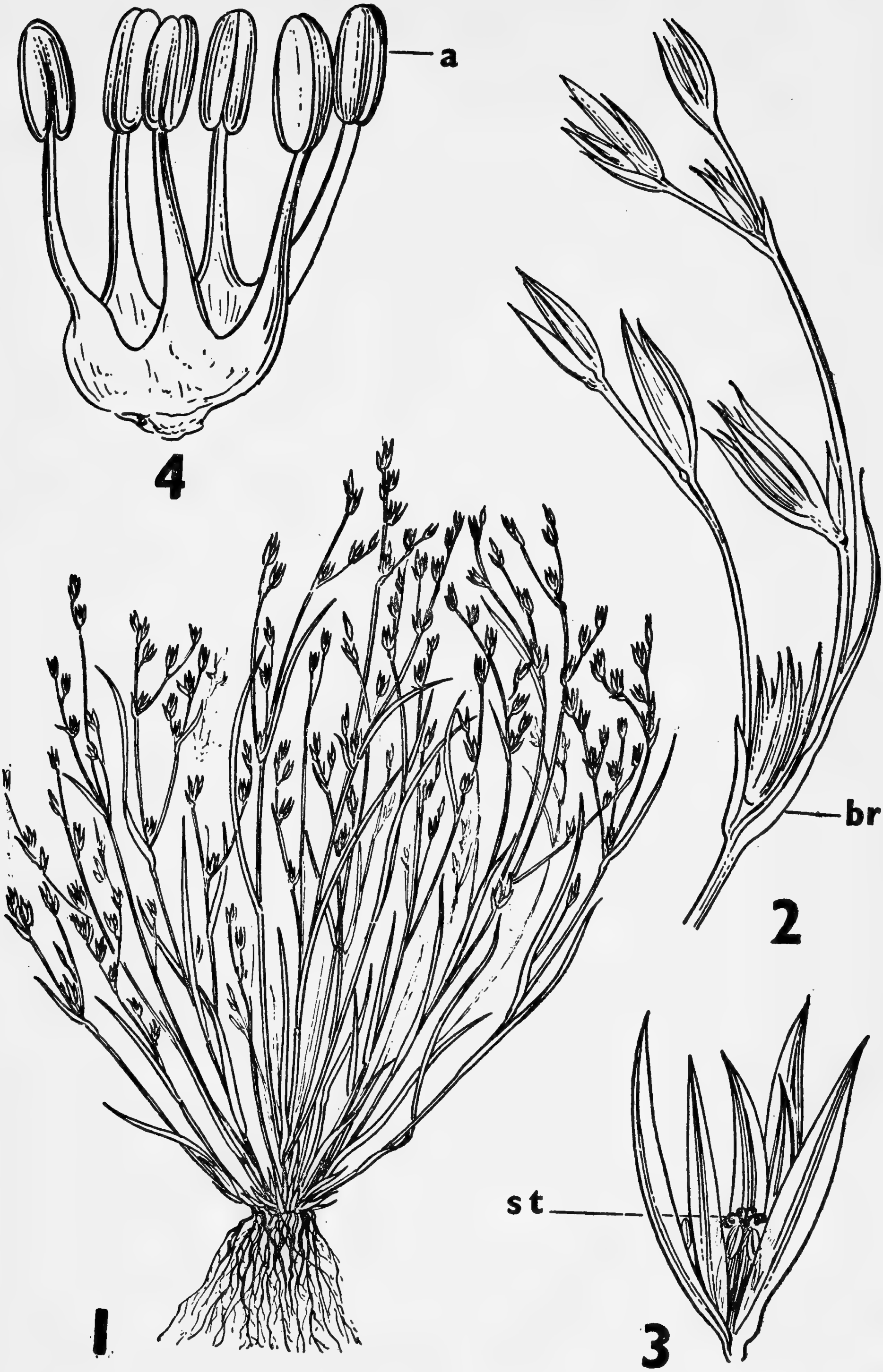
(*With a plate*)

Hooker (1894) described 26 species of the genus *Juncus* from India. Most of them are from alpine and sub-alpine Himalayas and Assam and a few from drier parts of India. *Juncus bufonius* L. has been reported in northern India from the plains to 13,000 ft. in the Himalayas and in the south from Madras (Gamble & Fischer 1956). There is no report of its occurrence in any part of Western India.

The plant was recently collected by my students J. N. Patel, K. S. Sobti and I. A. Patel from the different sites ranging from Sadra to Sarkhej from the saline bed of River Sabarmati (Herbarium sheet numbers 1518 dated March 2, 1970 and 659 dated February 11, 1970). The description and figures will familiarize botanical collectors with its identity.

Juncus bufonius L.

Slender, dwarf, elegant. (Fig. 1) annual with tufts of leafy branched fertile stems from a fibrous root-stock. Flowers markedly protandrous, in small cymes (Fig. 2). The partial inflorescence is an



Figs. 1-4. *Juncus bufonius* L. External morphology. Fig. 1. Plant body ×1. Fig. 2. Part of inflorescence ×4. Fig. 3. Diagram of an open flower ×8. Fig. 4. Monadelphous stamens ×25. (a, anther; br. bract ; st. stigma).

axillary raceme. Each flower subtended by a membranous bract and two bracteoles. Perianth six lobed, the three outer lanceolate and the three inner broadly ovate with hyaline margins. Anthers six, two-celled, basifixed and introrse, opening lengthwise and arising exactly opposite the perianth lobes. Filament with a single reduced vascular bundle and radially arranged air spaces. The cells contain abundant starch grains. The filaments fuse at the base to form a united structure, enabling all six anthers to be removed in one bunch. The stamens are thus monadelphous (Fig. 4). Gynoecium tri-carpellary. The ovary is unilocular with three parietal placentae, each bearing an indefinite number of ovules arranged in several irregular rows. The placentae are fertile only at the sides but in some preparations, it develops ovules all round. The ovarian chamber does not show a transition from axile to parietal placentation as reported by Buchenau (1892). The placental epidermis is glandular and consists of radially elongated cells. The rudimentary style is capped by six stigmatic lobes which are beset with thickly studded papillae (Fig. 3). Some instances with only three stamens in a flower and four parietal placentae are also met with. The fruit is a loculicidal dehiscing capsule. The perianth segments appear glumaceous and surround the capsule.

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April 20, 1970.

REFERENCES

BUCHENAU, F. (1892): Über die Bestaubungs-Verhaltinisse bei den Juncaceen. *Jb. Wiss. Bot.* **24**: 363-424.

GAMBLE, J. S. & FISCHER, C. E. C. (1956): Flora of the Presidency of Madras, 3 Vols. Reprinted, Ed. Calcutta.

HOOKER, J.D. (1894): Flora of British India, VI, London.

29. THE IDENTITY OF *SOLANUM KHASIANUM* CL. VAR. *CHATTERJEEANUM* SEN GUPTA (SOLANACEAE)

Sen Gupta (Bull. Bot. Surv. Ind. 3:412-415. 1961) established a variety, *chatterjeeanum*, based on the material collected by Subramanyam (10413) from Nilgiris in Madras State, under *Solanum khasianum* Cl., a species described from Khasia Hills in Assam, but, now known to be distributed also in Burma and China (Sen Gupta, loc. cit. 413); distinguished from the typical variety by not less than eight characters which are more or less constant; and stated further that intermediates often do occur.

In the course of studies on the flora of Dehra Dun, I collected specimens of a *Solanum* from plants growing in waste places near habitational sites, which are rightly comparable to the specimens identified and described as *Solanum khasianum* Cl. var. *chatterjeeanum* Sen Gupta. But a critical study of the specimens with the help of Dunal's monographic account of the genus (in DC. Prodr. 13:240-241. 1852), however, reveals that these specimens belong to a species of southern Brazil, namely *Solanum viarum* Dunal, the identity of which was confirmed by Mr. C. V. Morton of Smithsonian Institution, Washington, D.C. (personal communication). Further study on the type of *Solanum khasianum* Cl. var. *chatterjeeanum* Sen Gupta proves beyond doubt that *S. khasianum* var. *chatterjeeanum* is nothing but *S. viarum* Dunal, which might have been accidentally introduced into India during late thirties or early forties of this century. Therefore, *S. khasianum* Cl. var. *chatterjeeanum* Sen Gupta should be treated as a synonym of *S. viarum* Dunal, the correct name for this S. American species now naturalized in various parts of India. The relevant synonymy and references are as follows:

Solanum viarum Dunal in DC. Prodr. 13:240. 1852.

S. khasianum Cl. var. *chatterjeeanum* Sen Gupta in Bull. Bot. Surv. Ind. 3:412-415. 1961, syn. nov.; Maity in Journ. Bomb. nat. Hist. Soc. 62:323-327. 1965.

Sen Gupta (loc. cit.) was right in ascertaining its affinity to *S. khasianum* Cl. among the Indian species, though distinguished from *S. khasianum* by eight characters. There is no doubt that among the Indian species of *Solanum*, *S. viarum* Dunal is very closely allied to *S. khasianum* Cl. which is also probably of S. American origin, but the two taxa can be distinguished by the following differences which are tabulated below:

S. viarum Dunal	*S. khasianum* Cl.
1. Stem, petioles, pedicels and calyces patently short-hairy with dirty white or greyish-white 0·03-0·04 (-0.05) cm. long, gland-hairs mixed with a smaller number of 0·01 cm. long glandular hairs.	Stem, petioles, pedicels and calyces patently long-hairy with yellowish-brown or greyish-brown 0·3-0·5 cm. long glandular hairs mixed with a few 0·15 cm. long gland hairs.
2. Stem aculeate with stout compressed hooked or strongly recurved 0·4-0·5 (-0·7) cm. long prickles mixed with short straight slender 0·2-0·25 cm. long prickles.	Stem aculeate with straight or slightly curved unequal prickles.
3. Leaves sinuate—lobed with ovate triangular subobtuse or subacute lobes, softly glandular—tomentose mixed with a smaller number of stellate hairs on the lower surface.	Leaves pinnatilobed to-fid with ovate—lanceolate, acute lobes, pilose with long simple hairs on the upper surface, pubescent beneath with long simple hairs mixed with a smaller number of stellate hairs.

4. Calyx aculeate, lobes 0·17-0·2 (-0·25) cm. long during anthesis.	Calyx unarmed or aculeate, lobes 0·7-0·8 cm. long during anthesis.
5. Corolla-lobes lanceolate, acuminate.	Corolla—lobes ovate lanceolate, sub-acute.
6. Ovary pubescent.	Ovary glabrous.
7. Seeds 0·22-0·25 cm. across.	Seeds 0·3-0·32 cm. across.

It is very difficult to ascertain how, where and when it gained foothold on Indian Soil, but the fact that it has not been included in any of the standard Indian floras coupled with the non-existence of collections prior to 1938, suggests its introduction during World War II, probably along with some imported articles. As far as I am aware, this plant has not been reported from Asia and, hence this may be the first record of its appearance in Asiatic mainland. It is now widely naturalized in Assam, W. Bengal, Bihar, Orissa, Madras and Uttar Pradesh in India and also in Sikkim.

Specimens examined:

INDIA: Madras. Nilgiri Dt., Devarshola, alt. 1075 m., *Subramanyam* 10413 (A-holotype of *S. khasianum* Cl. var. *chatterjeeanum* Sen Gupta —(CAL). Uttar Pradesh. Dehra Dun, Hathibarkla near Bindal-bridge, *C. R. Babu* 34694 (BSD, CAL).

ACKNOWLEDGEMENTS

The author wishes to express his grateful thanks to Mr. C. V. Morton, Smithsonian Institution, Washington, D.C. for confirming the identity of this plant and to Dr. S. K. Mukherjee for his encouragement and valuable suggestion in the preparation of this paper.

CENTRAL NATIONAL HERBARIUM, C. R. BABU
HOWRAH-3,
December 29, 1969.

30. *LINDERNIA ANGUSTIFOLIA* (BENTH.) WETTST. (SCROPHULARIACEAE)—A NEW RECORD FOR SOUTH INDIA

(*With a plate*)

Lindernia Allioni, at present containing, as currently accepted, the genera *Vandellia* L., *Bonnaya* Link and Otto. and *Ilysanthes* Rafin. was hitherto known to have only twenty representative species in south India. *Lindernia angustifolia* (Benth.) Wettst., found by the author to occur widely in paddy fields at Punalur, Kerala State, is an addition to the south Indian representatives of *Lindernia* All. Though Rev. Dr. Cecil J. Saldanha of St. Joseph's College, Bangalore, has collected this plant from Puttur, South Kanara, Mysore and Ettakote, Cannanore, Kerala and described it in his Ph.D thesis entitled 'Taxonomic Revision of the Scrophulariaceae of the Western Peninsular India' (Vol. I, Pages 40, 165, 193-195; Vol. II, Part II, Plate 33) submitted to the University of Bombay in 1963, there is no published record of this plant for south India. This species has so far been reported in India only from the subtropical Himalayas, Kumaon, Sikkim, Chota Nagpur, Assam, Bengal and the Khasia mts. (Hooker, FLORA OF BRITISH INDIA 4:282-283. 1885 and S. K. Mukherjee: 'A Revision of the Indo-Burmese species of *Lindernia* Allioni' in Journ. Indian. Bot. Soc. 24:127-134. 1945).

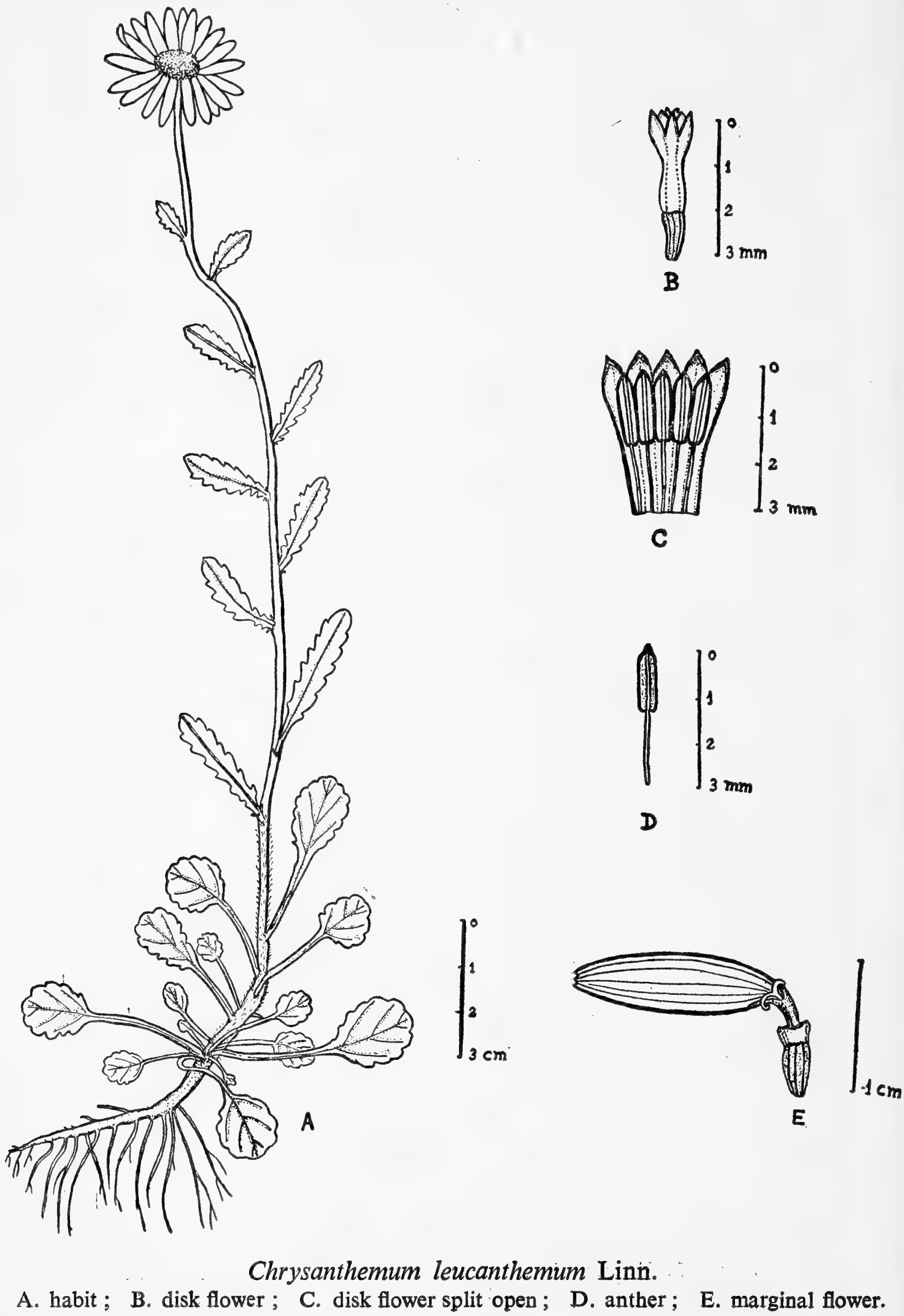
Fresh specimens of *Lindernia angustifolia* (Benth.) Wettst, were first collected by the author from Punalur in November 1968 and preserved in the Herbarium, Sree Narayana College, Quilon, Kerala State. It was found growing in paddy fields along with other species of *Lindernia* namely *L. pusilla* (Willd.) Boldingh., *L. anagallis* (Burm. f.) Pennell. and *L. hyssopioides* (L.) Haines. Description and sketches given here are based on fresh specimens.

Lindernia angustifolia (Benth.) Wettst. Diffuse or sparsely branched glabrous annual aquatic herbs. Stem erect, sometimes rooting at the lower nodes, succulent or slender, 4 gonous, up to 55 cm. long. Leaves opposite, sessile, exstipulate, linear-oblong to linear-lanceolate with a retuse tip, glabrous, rather thick, entire or obscurely toothed, mid vein impressed above, lateral veins obscure, to 3·5 cm. long and 8 mm. broad. Flowers solitary, axillary, long pedicelled and ebracteolate; sepals 5, free to the base, linear-lanceolate, glabrous with obscurely toothed margin, 3 to 5 mm. long; fruiting sepals about 1/3 as long as the capsule; corolla 2 lipped, 8 to 12 mm. long, 3·5 to 5 mm. wide at the mouth, yellow towards the base, pink brown in the middle, white towards the lobes, with an yellow round blotch on the palate, glandular hairy outside, glabrous within; tube cylindric; upper lip 2 fid lower larger, broader, spreading and 3 lobed, lobes imbricate; stamens 4, all perfect, 2 posterior with appendaged anthers inside the tube, 2 anterior in the throat of the corolla, the glabrous filament having a linear blunt appendage towards the base, anthers divergent, connivent in pairs; ovary $\pm$ 2 mm. long, $\pm$ 1 mm. broad glabrous with a small yellowish cupular gland mostly waiting on the posterior side, ovules many, style slender, glabrous $\pm$ 3 mm. long, stigma prominent, 2 lamellate. Capsule linear, septicidal, 1 to 1·5 cm. long

Ravi : *Lindernia angustifolia*

1. Plant. 2. Flower. 3. Sepal. 4. Corolla cut open showing stamens.
5. Gynoecium. 6. Fruit. 7. Seed.

Das & Pramanik: *Chrysanthemum leucanthemum*



Chrysanthemum leucanthemum Linn.

A. habit; B. disk flower; C. disk flower split open; D. anther; E. marginal flower.

and 2·5 mm. wide with the pedicel equalling or exceeding the leaves. Seeds many, small and rugose.

Lindernia angustifolia (Benth.) Wettst. is very similar to *L. anagallis* (Burm. f) Pennell. in floral structure, the flowers being quite indistinguishable. But the latter can be easily identified by its procumbent stem, rooting at nodes and shortly petiolate, ovate, obscurely crenate, toothed, leaves.

I am grateful to Rev. Dr. Cecil J. Saldanha who helped in preparing this note. I thank the Regional Botanist, Southern Circle, Botanical Survey of India, Coimbatore, for information on the south Indian species of *Lindernia* All.

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31. A NOTE ON *CHRYSANTHEMUM LEUCANTHEMUM* LINN. (ASTERACEAE)

(*With a plate*)

During the floristic survey of Darjeeling district in May, 1966, we came across some specimens of *Chrysanthemum leucanthemum* Linn. (Compositae), growing in Senchal lake area. The original habitat of this species as recorded by Linnaeus (1753) is Europe; A. Gray (1884) noted in from North America, which was corroborated by Gleason (1963). Raizada (1959) first listed this species from Mussoorie in the Indian sub-continent, followed by Gupta (1967). Our collection from Darjeeling district extends its distributional area to Eastern Himalayas. As the description of this plant is not available in Indian Floras, the diagnostic characters and a plate is provided to facilitate identification.

Chrysanthemum leucanthemum Linn. Sp. Pl. 2:888. 1753; Gray, Synopt. Fl. North America 1:2:365. 1884; Raizada in Indian For. 85:679. 1959; Gleason, Illus. Fl. North. U.S. & Adj. Canada 3:385. 1963; Gupta, Seasn. Fl. Ind. Summ. Res. Mussoorie Hills 137. 1967.

Erect or decumbent, ascending, perennial herbs, with a rhizomatous root-stock, 30-60 cm. tall. Stems simple or branched. Basal leaves long-petioled, obovate-spathulate, rounded or obtuse at apex, higher ones sessile with a narrowed, semi-amplexicaul base, ovate-oblanceolate or lanceolate-oblong, obtuse or rounded at apex, dentate to pinnati lobed-pinnatifid, glabrate or glandular-hairy, becoming smaller upwards. Heads terminal, solitary, on 3-5 cm. long peduncles; involucral bracts 3-seriate, membranous, lanceolate-oblong, scarious-margined, often suffused with reddish-brown, obtuse, 0·3-0·5 cm. long; marginal flowers ♀, 1-seriate, with white, entire or obscurely 3-dentate, 1·5-2 cm. long ligules; disk flowers ⚥ 0.4-0.5 cm. long, with yellow, 3-lobed, tubular corollas; achenes terete, 10-ribbed, glabrous; pappus wanting or of a crown-like membranous rim in marginal achenes; receptacle flat, slightly raised, pitted, glabrous, 0·5-0·6 cm. across.

Specimens examined:

West Bengal, Darjeeling, Senchal Lake, 22.5.66, *D. Das* 135 (CAL); N.W. Himalayas, Mussoorie, Happy valley, 17.5.58, *J. C. Sen Gupta* 2012, (CAL).

ACKNOWLEDGEMENT

We are grateful to Sri S. P. Banerjee, Botanist, Central National Herbarium, for his valuable advice.

CENTRAL NATIONAL HERBARIUM,
HOWRAH-3,
August 11, 1969.

(MISS) DEBIKA DAS
BHABESH PRAMANIK

32. NEW DISTRIBUTIONAL RECORDS FOR COASTAL PLANTS FROM ANDHRA PRADESH

During ecological studies on the vegetation of coastal Andhra Pradesh, *Aeluropus lagopoides* (L.) Trin. ex Thw., *Ipomoea tuba* (Schlt.) G. Don and *Trianthema triquetra* Rottl. ex Willd. were collected which have not been recorded earlier from Andhra Pradesh. The specimens cited below are deposited in CAL.

Aeluropus lagopoides (L.) Trin. ex Thw.

Gamble (Fl. Madras Pres. 3 : 1276, repr. ed. 1957) reports the occurrence of this species along both the coasts, without mentioning precise localities. Recently, Rao & Mukherjee (1965) reported this species as a new record from Midnapore and Kakadwip coasts in West Bengal. The occurrence of this species in alkaline area in the backshore of Kakinada and Uppada in the coastal Andhra Pradesh is of interest. These collections from the eastern coast of India indicate that this saline grass is now more widespread in eastern coast than previously recorded.

It thus points out the earlier range of distribution of this species along the eastern coast of India.

Kakinada: 2.10.69, *T. A. Rao* 7266; Uppada: 5.10.69, *T. A. Rao* 7324.

Ipomoea tuba (Schlecht.) G. Don

The occurrence of this species in south India was first recorded from Rameshwaram Island (Rao 1964). The present report of this species from Coringa tidal forests in A.P. not only extends the range of distribution of this species further north along the east coast, but also links up its distribution between Sundarbans and Rameshwaram Island, suggesting its possible occurrence in the tidal forests of Mahanadi estuaries in Orissa State.

Coringa tidal forest: 3.10.69, *T. A. Rao* 7287.

An extensive climber in the tidal forest; usually abundant where the brackish water influence is less.

Trianthema triquetra Rottl. ex Willd.

Gamble (Fl. Madras Pres. 1 : 389, repr. ed. 1957) records the occurrence of this species in the coastal districts of Carnatic from Sriharikota (near Pulicat Lake) southwards, and inland up to Coimbatore. Rao *et al.* (1967), reported this species as a new record for Kakadwip, in West Bengal. The present report of this species from coastal Andhra Pradesh extends its distributional range into a new area.

Uppada: 5.10.69, *T. A. Rao* 7316.

A fairly common herb with many prostrate branches growing on loamy soil in the backshore.

BOTANICAL SURVEY OF INDIA,
76, ACHARYA JAGADISH BOSE ROAD,
CALCUTTA-14,
May 18, 1970.

T. ANANDA RAO
A. R. K. SASTRY

REFERENCES

RAO, T. A. (1964): *Ipomoea tuba* (Schlecht) G. Don from Rameswaram Island—a new distributional record for South India. *Bull. bot. Surv. India* **6** : 307.

——— & MUKHERJEE, A. K. (1965): Distribution of some plants along Midnapur coast in West Bengal State. *Curr. Sci.* **34** : 589-590.

———, BANERJEE, L. K. & MUKHERJEE, A. K. (1967): Some plant records for West Bengal. *Sci. & Cult.* **23** : 125.

33. FAMILY COMMELINACEAE IN KOLHAPUR AND ITS ENVIRONS

In spite of the luxuriant vegetation of Kolhapur and its environs only stray references are found to the plants of this region in the regional and Indian floras and hence it was decided to revise the different flowering plant families of this region. The work was initiated in 1967 and by now members of Commelinaceae, Eriocaulaceae and Cyperaceae have been fully revised and others are under investigation.

This note gives an account of the family Commelinaceae found in Kolhapur and surrounding places like Pahnala, Gagan bavada, Radhanagari and Katyayani. The different species collected are being grown in the departmental garden to follow the morphological changes if any, undergone by these under uniform conditions of cultivation. The identification and nomenclatural changes are confirmed by consulting herbarium of B.S.I., Western circle, Poona. The herbarium specimens and carpological collections are deposited in the herbarium of Shivaji University, Botany Department, Kolhapur.

The family is represented by 17 taxa belonging to four genera and 15 species in this region. The details of the species collected are as follows. (numbers given in brackets refer to herbarium specimens deposited in the University herbarium).

Cyanotis tuberosa (Roxb.) Schult. f. Common in grasslands of Kolhapur (256), Pahnala (500) and Gagan bavada (670). June-October.

C. concanensis Hassk.. (*C. sahyadrica* Blatter) Gagan bavada (675, 676), along slopes of fort. July-September.

C. cristata (L.). Don. Marshy places in Kolhapur (259) and Pahnala (510). July-September.

C. fasciculata (Heyne ex Roth.) Schult. f. On moist rocks in Kolhapur (261), Pahnala (512) and Radhanagari (710). August-September.

C. fasciculata (Heyne ex Roth.) Schult.f. var. **glabrescens** C.B. Cl. Pahnala (514) on moist rocks. August-September.

Amischophacelus axillaris (Linn.) Rolla Rao et Kammathy (*Cyanotis axillaris* (L.) Roem. and Schultz.) Common in moist black soils and rice fields in Kolhapur (265) and Kagal (268). July-October.

A. cucullata (Roth.) Rolla Rao et Kammathy (*Cyanotis cucullata* (Roth.) Kunth.). Moist shady places in Kolhapur (271, 275). July-October.

Murdannia semiteres (Dalz.) Santapau. Along road sides and moist places in Kolhapur (278), Katyayani (280) and Pahnala (520). July-September.

M. nudiflora (L.) Brenan. Common in moist places and marshy areas of Kolhapur (282), Pahnala (516) and Gagan bavada (678). July-September.

M. nudiflora var. **compressa** C.B.Cl. Flowers rose coloured. Gagan bavada (679, 680), along with *M. nudiflora.*

M. spirata (L.) Bruckn. Common in moist soils of Kolhapur (284), Katyayani (286), Pahnala (518), Gagan bavada (685, 686) and Phonda ghats (850). July-September.

M. loriformis (Hassk.) Rolla Rao et Kammathy. An undergrowth in forests and grass lands of Radhanagari (712, 715). August-September.

Commelina benghalensis Linn. Common in fields, along canals and bundhs in Kolhapur (289), Katyayani (291), Kagal (293) and Pahnala (520). June-October.

C. forskalaei Vahl. Weed in fields. Kolhapur (295), Katyayani (297) and Pahnala (522). July-October.

C. hasskarlii C.B. Cl. Common in marshes of pools, ponds and lakes of Kolhapur (300) and Kagal Lake (305). June-March.

C. subulata Roth. Weed of rice fields and other marshes. Kolhapur (310, 312). July-August.

C. undulata R. Br. (*C. Kurzii* C.B. Cl.) Pahnala (525, 527), in grass-lands and forest floors along with grasses. July-October.

During this study along with the normal blue flowered plants of *Murdannia spirata* those bearing scarlet coloured flowers (petals) were also collected from Gagan bavada. The two populations of this species grew together at Gagan bavada. The two types are being cultivated separately for the last three years and they have maintained the distinctness in their flower colour. Plants with blue flowers have all the filaments bearded, whereas those with scarlet flowers have filaments of only fertile stamens bearded.

Underground cleistogamous flowers are recorded in *Commelina forskalaei* by Barnes (1946) and Maheshwari & Maheshwari (1955). Repeated collections of the plants of this species from different localities of Kolhapur did not reveal the presence of such flowers. Probably, as Maheshwari & Baldev (1958) have pointed out, a number of external factors, particularly the water content of the soil in which the plants grow, might be determining the production of cleistogamous flowers in this species.

The authors are thankful to Rolla Seshagiri Rao, Regional Botanist, B.S.I., Western circle, Poona for his help in confirmation of the identification of many species.

BOTANY DEPARTMENT,
SHIVAJI UNIVERSITY,
KOLHAPUR,
March 30, 1970.

A. R. KULKARNI
P. V. MUDGAL

REFERENCES

BARNES, E. (1946) : Some observations on South Indian Commelinas ; Two new species of *Commelina* from South India. *J. Bombay nat. Hist. Soc.* **46** (1) : 70-89.

MAHESHWARI, P. & MAHESHWARI, J. K. (1955): Floral dimorphism in *Commelina forskalaei* Vahl and *C. benghalensis* L. *Phytomorphology* **5** (4) : 413-422.

MAHESHWARI, S. C. & BALDEV, B. (1958) : A contribution to the morphology and embryology of *Commelina forskalaei* Vahl. *Phytomorphology* **8** (3, 4) : 277-297.

34. SOME INTERESTING PLANTS FROM LUCKNOW AND ITS NEIGHBOURHOOD

Kapoor (1962) published a comprehensive list of plants of Lucknow District in an endeavour to revise Anderson's (1859) catalogue. Later Sharma (1964) supplemented Kapoor's list by recording 13 more plants. The present paper includes some more species gathered at Lucknow or its neighbourhood. A few of these, like *Ambrosia artemisifolia* Linn. and *Dichrocephala latifolia* DC. are particularly noteworthy from their distribution and occurrence in the Upper Gangetic Plain. The specimens are lodged in the herbarium of the National Botanic Gardens, Lucknow.

1. **Acanthospermum australe** (Linn.) O. Kuntze (*A. hispidum* DC.). Compositae.

Butler Palace Compound, *Ram Singh* 2286 ; University, *D. D. Awasthi* 2929.

It was reported as a new record for Upper Gangetic Plain from Ajmer-Merwara by Raizada & Sharma (1962) and one of our sheets (*Awasthi* 2929) was incidentally cited by them. It is now being observed to be getting more and more frequent within this area and has perfectly established itself.

The identity and nomenclature of this plant needs correction. The plant is *Acanthospermum hispidum* DC. Prodr. 5 : 522, 1836 ; but this is not *A. hispidum* auct. e.g. Blake in Contrib. U.S. Nat. Herb. 1921, which is identical with *A. australe* (L.) O. Kuntze. The plant found in many parts of India is *A. hispidum* DC., and not *A australe* (L.) O.K.—EDS.

2. **Amaranthus hybridus** Linn. subsp. **cruentus** (L.) Thell. var. **paniculatus** (L.) Thellung (*A. paniculatus* Linn.). Amaranthaceae.

Lucknow, *Hira Lal* 9596 ; Near garden Well, *S. L. Kapoor* 20461.

It is commonly cultivated in gardens, parks and private houses and is seen frequently as an escape.

3. **Ambrosia artemisifolia** Linn. Compositae.

Daliganj, *Hira Lal* 99050.

Panigrahi & Kar (1966) recorded it as a new find for India from Khasi & Jaintia Hills, Assam. As far as the authors know it has not so far been recorded for the Upper Gangetic Plain.

4. **Atylosia platycarpa** Benth. Papilionaceae.

Kursi Road, *U.S. Misra* 4848 ; Garden compound, *Ram Nath* 51492.

Duthie (1903, Vol. 1, p. 213) recorded it only from Saharanpur and Saugor.

5. **Centaurium roxburghii** (G. Don) Druce (*Erythraea roxburghii* G. Don). Gentianaceae.

Reported by Anderson (1859), excluded by Kapoor (1962). This collection confirms its occurrence.

6. **Clerodendrum inerme** Gaertn. Verbenaceae.

Lucknow, *P. C. Kanjilal s.n.*

It is cultivated and is occasionally an escape.

7. **Dichrocephala latifolia** DC. Compositae.

Kursi, *K.M. Balapure & Party* 89120.

Our specimen was collected just outside the administrative boundary of Lucknow District ; it is included here as Duthie recorded it only from Dehra Dun.

8. **Glossogyne bidens** (Retz.) Alst. (*G. pinnatifida* DC.). Compositae.

Barkhurdarpur Tehrwa, *S. L. Kapoor & Party* 42358. This was reported by Anderson (1859) but was kept as doubtful by Kapoor (1962).

9. **Leucas urticaefolia** R. Br. Labiatae.

Banthra, *U.S. Misra* 2828.

It is rare in our area.

10. **Lindernia anagallis** (Burm.) Penn. (*Bonnaya veronicaefolia* Spr.). Scrophulariaceae.

Near Kukrail Reserved Forests, *Hira Lal & Janki Prasad* 24281.

Anderson (1859) recorded it from Lucknow but Kapoor (1962) kept it as doubtful. It does occur here in moist situations.

11. **Swietenia mahagoni** Jacq. Meliaceae.

Shivaji Marg, *S. Ibrahim Husain* 65698 ; Trilok Nath Marg, *S. Ibrahim Husain* 76687.

Cultivated on roadsides.

12. **Trifolium alexandrinum** Linn. Papilionaceae.

Near Bhadruk, *Ram Singh* 399.

It is cultivated in the suburbs of Lucknow and is frequently seen as an escape near cultivated area.

ACKNOWLEDGEMENTS

We are thankful to the Director, National Botanic Gardens, Lucknow for herbarium facilities and to Dr. L. D. Kapoor for going through the manuscript.

NATIONAL BOTANIC GARDENS,
LUCKNOW,
November 4, 1969.

S. IBRAHIM HUSAIN
S. L. KAPOOR

REFERENCES

ANDERSON, T. (1859) : Notes on the flora of Lucknow with catalogues of the cultivated and indigenous plants. *J. As. Soc. Bengal* **28** (2) : 89-120.

DUTHIE, J. F. (1903-1911) : Flora of the Upper Gangetic Plain and of the adjacent Siwalik and Sub-Himalayan Tracts. Calcutta.

KAPOOR, S. L. (1962) : On the botany of Lucknow District. *J. Bombay nat. Hist. Soc.* **59** : 862-896.

PANIGRAHI, G. &. KAR, S. K. (1966) : The family Compositae in Assam and North East Frontier Agency. *Bull. bot. Surv. India* **8** : 229.

RAIZADA, M. B. & SHARMA, V. S. (1962) : New plant records for the Upper Gangetic Plain from Ajmer-Merwara. *Indian For.* **88** : 364.

SHARMA, P. C. (1964) : A note on the flora of Lucknow District. *Bull. bot. Surv. India.* **6** : 101.

35. A RICH, BUT LITTLE KNOWN COLLECTION OF INDIAN PLANTS IN U.S.S.R.

During a recent visit to the U.S.S.R., I visited the Botanical Institute of the Academy of Sciences of Ukrainian Soviet Socialist Republic, at Kiev. There is a large herbarium (KW) attached to this institute, with about one million sheets and believed to be one of the biggest herbaria in U.S.S.R.

The herbarium is rich in Ukrainian plants. In addition to the general herbarium, there are some old collections which have, so far, been kept separate as special herbaria. Notable among these are the herbaria of N. S. Turczaninow, I. F. Schmalhausen, A. S. Rogowicz, W. S. J. G. Besser and J. E. Gilibert.

Turczaninow's (1796-1864) herbarium is very rich in Indian plants, and I believe, it is the second biggest collection of Indian plants in the U.S.S.R.; next only to the herbarium of the Komarov Botanical Institute at Leningrad (LE).

The Turczaninow herbarium is reported to have about 52,000 specimens, comprising several thousand species.

The collections in this herbarium are mostly of the nineteenth century. They are listed in a catalogue which runs into three bound volumes. It was prepared about 100 years ago, and much of it was written by Turczaninow himself. The species are listed more or less according to De Candolle's system of classification. The grasses are listed in volume 3, pages 194-277. The catalogue, however, seems to be incomplete.

The collection is remarkably rich in Wallichian specimens; and for some genera examined by me, more or less complete series was present. As I had only limited time at my disposal, I could consult material of only a few grass genera of the Rottboellineae, Maydeae, and Chlorideae. The following Wallichian specimens were present in the tribe Rottboellineae :—

Wallichian Catalogue numbers: 8868, 8869, (A, B), 8870 (C), 8871 (D, E, F), 8872, 8873 (B), 8874 (B, C), 8875 (E, F, G), 8876, 8877 (B, C), 8879 (B, E, F, H), 8880 (B, C). That is, except 8878, all numbers from 8868 to 8880 were present. In the Maydeae, I found 8623 (A, E, F, G, H and K), 8624 (C, E, F, G), 8625, 8627 (A), and 8630 (D).

This abundance of Wallichian sheets suggests that the set was perhaps received here from an institution where the Wallichian material was first made into sets and distributed.

Other collectors, whose material seems to be present in large numbers are: W. Griffith, (Assam, etc.), B. Heyne (India orientalis), R. F. Hohenacker (Pl. India Or., S. India-Nilgiris), J. D. Hooker (Khasia, etc.), G. S. Perrottet (Nilgiris), T. Thomson (Punjab, Mysore, Carnatic, Nilgiris) and R. Wight (India Or., Bihar, etc.).

These are all unmounted specimens, kept loose on sheets or between blotting sheets with their labels lying loose on sheets. All the folders, that I saw, had material of one species within one folder; but in several cases, collections of one species from different localities, (even from different countries) were kept within one folder. As the specimens are unmounted, and the labels are loose in the folders, there is a chance of error by mixing of labels. The folders are about 60×45 cm., i.e. much larger than usual species or genus covers (which are about 44×28 cm.). The sheets inside the folders vary from normal size ($\pm 41 \times 26$ cm.) to very large ($\pm$ 56×40 cm.). The specimens are generally in good condition.

Turczaninow was a senior officer in Siberia and held administrative posts. He travelled very widely, and also sent his junior officers on tours to different parts of the country, and obtained plant specimens through them. Turczaninow had wide exchange relations and received specimens from different parts of the world, and in exchange, he sent plants of Siberia, Ukraine, and other regions of Russia. He was a keen naturalist and had published many botanical works, among them the 'Flora of Baikal' is well known in the U.S.S.R. and outside. He had described many new taxa of plants, some of these occur in India, namely *Zizania latifolia* Turcz. and *Stipa mongholica* Turcz.

After retirement, Turczaninow went to Kharkhov, and gave all his collections to the herbarium there. He spent all his pension in purchase and exchange of specimens.

Dr. A. I. Barbarycz who is in charge of the herbarium said that in 1943, during the Second World War, the Nazi armies took away the entire herbaria from various institutions in Ukraine to some place in east Germany and that after the war, they were recovered from Poznan, in Poland. When the material was located, much of it was in very bad condition, even soaked in water and about one hundred bundles were so wet that they had to be abandoned. These were mostly Ukrainian plants. The material was brought to Kiev, and since then, it has stayed there.

The collection is very valuable to Indian botanists and the material has remained practically untouched for more than a century. The Russian scientist Prof. Bobrovto offered to try to arrange to send specimens on study loan if desired.

The scientists at the institute at Kiev are busy with the preparation of Flora of the Republic, and other routine work, and have not been able to give attention to the Indian material. They plan to mount those specimens and if possible keep a separate Indian section in the herbarium.

ACKNOWLEDGEMENTS

I am grateful to Dr. A. I. Barbarycz for facilities of working in the Kiev herbarium, and to other botanists who made themselves available for discussion. I am grateful to the Academy of Sciences of U.S.S.R.; Director, Botanical Survey of India; and the Ministry of Education, Government of India, for giving me the opportunity of visiting the U.S.S.R. under the Indo-Soviet Scientific and Cultural Exchange Programme.

BOTANICAL SURVEY OF INDIA,
CALCUTTA,
December 4, 1969.

S. K. JAIN

AN APPEAL

WORLD WILDLIFE FUND

Indian National Appeal

Perhaps one of the most conspicuous lacks of the conservation set-up of this country has been that there was no channel, so far, through which a layman could involve himself in the conservation movement, even if he wanted to. The most he could do was to persuade a friend to subscribe to the Journal. As a result, we have had a growing body of people (including members of the Society) who have an urgent concern for natural life, and would like to help in its preservation, but are powerless to do so, short of becoming ecologists themselves.

The Indian National Appeal of the World Wildlife Fund offers an opportunity to the layman for more personal involvement in the country's conservation programmes. The WWF which is *primarily* concerned with raising money, for specific conservation projects, has its headquarters at Morges, Switzerland, and operates through ' National Appeals ' (fund-raising organisations) in various countries. National Appeals are already in operation in Britain, U.S., Germany, Austria, Italy, S. Africa and some other countries. The money raised by these Appeals is largely used for wildlife projects in the country of origin. The projects can be anything from ecological surveys and park management to setting up a chair for conservation in a university. From 1962 to 1967, over $79,500 were raised by the WWF altogether, to support 183 different projects, the world over.

The Indian National Appeal was launched in New Delhi in November 1969 at the occasion of the IUCN General Assembly. His Highness the Maharaja of Baroda is the International Trustee, and Zafar Futehally is the Honorary Secretary.

Our object, of course, is only to raise money and then try to make sure that we grant it to the most urgent causes in the nature conservation field. Our first project is a survey of the Great Indian Bustard by Shri R. S. Dharmakumarsinhji, which should lead to the creation of a sanctuary for this bird by the Gujarat Govt. We have already produced a pamphlet on the bird written by Shri Dharmakumarsinhji, which is available on request.

Examples of other projects supported by WWF International or the Indian Appeal are: a breeding programme for the Swamp Deer in Kanha National Park; a study of the White-Winged Wood Duck in Assam, which would lead to protection measures; a similar study of the Nilgiri Tahr; a snake park for Madras; and a bridge for a Sanctuary in Nepal.

The response from business houses to the Appeal, so far, has been most encouraging. The Tata Group has given us Rs. 30,000 guaranteed for two years, Godrej and Co. have furnished our office at Hornbill House free of charge, Imperial Chemicals (India) have donated Rs. 10,000 a year for five years, and Selvel have donated hoardings. Various other companies have sponsored literature etc.

We are of course anxious for individual donations, which can be sent to the World Wildlife Fund, Hornbill House, Shahid Bhagat Singh Road, Bombay 1. You can also help greatly becoming a Member of the Appeal. The fee is Rs. 10 annually and it entitles you to receive our Newsletter and other literature regularly.

HONORARY SECRETARY

World Wildlife Fund

Indian National Appeal.

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1969-70

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HONORARY SECRETARY'S REPORT FOR THE YEAR 1969

Membership

The total of the Ordinary Membership which had shown a tendency to remain more or less static near 700 showed a small but encouraging increase during the year. The total membership in good standing on our Register as on 31st December 1969 compared to the membership as on December 1968 is given below :

	1968	1969
Life Members	151	163
Ordinary members	677	823
Forest Department Nominees ..	63	68
Student Members	1	4
Honorary Members	2	2
	894	1060

In addition, we have to receive subscription from 148 ordinary members. Efforts are being made to persuade them to continue their membership. The meagre membership of the Society is perhaps a reflection of the general apathy towards nature in this country. The Society's membership is in effect a barometer of the interest it has been able to create among educated people, and there is large scope for enrolling new members. Our existing members must play a part in this sphere. During the year 102 members joined as against 23 resignations and 5 deaths.

The Society's Publications

Journal : Three numbers of the Journal were published during the year: Vol. 65(3) and Vol. 66 Nos. 1 and 2. The 717 pages include 8 articles each on birds and botany, 10 on invertebrates other than insects, 6 on mammals, 4 on insects, 2 on fishes and one on wildlife. The 90 Miscellaneous Notes covered all aspects of Natural History.

Among the articles, it is difficult to pick out any as particularly outstanding. However, some from the subjects which they discussed, were of unusual interest. Instances are: 'The Birds of Sind' by J. O. Wright & D. A. Holmes which reviews the status of the birds of the plains of Sind 45 years after the publication of the first comprehensive account of the avifauna. Fr. A. E. Bean's investigation of the 'Occurrence of *Spindasis abnormis* on the Western Ghats' is an excellent example of contributions made by the devoted amateur to any discipline of Natural History. The Society's continuing interest and anxiety on the status of wildlife in India is reflected in the wildlife survey reports by Spillett which draw attention to the failure in the management of a national asset. The report by Schaller on the status of the Kashmir Stag highlights the important and urgent problems threatening the survival of the species. Other articles of particular interest are ' The Elephant (*Elephas maximus*) in U.P.' which describes a census of the population, 'The Spider Fauna of India' which is the first collation and systematic catalogue of Indian spiders and the ' Food-habits of Water birds of the Sundarbans, 24 Parganas, W. Bengal, India ' a detailed study of the food habits of water-birds.

Books : The year saw three more of our popular publications THE BOOK OF INDIAN ANIMALS, BUTTERFLIES OF THE INDIAN REGION and INDIAN MOLLUSCS going out of print. A third edition of the BOOK OF INDIAN ANIMALS will appear in 1970. However, reprinting of the other two books in the near future appears unlikely as the Society is unable to lock up a considerable amount of its capital in slow selling publications.

The publication of the 2nd and 3rd volumes of the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, a publication which is sponsored by the Society, adds two more volumes to the definitive literature on Indian avifauna. Excellent progress is being maintained and the subsequent volumes are expected at short intervals of time. The manuscript of FAUNA VOLUME for the Maharashtra Gazetteer was completed and handed over. Its publication is expected shortly.

The Society with financial assistance from the Rockefeller Foundation published ' The Ecology of the Lesser Bandicoot Rat in Calcutta ' by Juan Spillett. The book records 15 months observation on the Bandicoot rat which is apparently the dominant species among the destructive rodents in the Calcutta environs.

The Society's Journal is an indispensable reference Volume for any study of the Oriental fauna and the unavailability of many of the earlier issues is a constant source of frustration to serious researchers. Arrangements have now been completed with M/s. Swets Zeitlinger of the Netherlands for printing photo-offset editions of the out-of-print volumes.

Under the nature education scheme of the Society, and with financial assistance received from the Seth Purshotamdas Thakurdas & Divaliba Charitable Trust, the Society published a booklet on nature (MAZE MITRA) prepared by its Nature Education Organiser. The booklet which is printed in Marathi and Gujarathi is for free distribution to school children in Maharashtra and Gujarat.

GENERAL

Bird Migration Study : As we reported last year, the bird ringing camps are now organised on an all year basis. During the migratory season camps were held at Bharatpur in Rajasthan and Point Calimere and camps were run at Mahableshwar and Daulatabad during the non-migratory season for ringing resident species.

Satisfactory results were obtained and in summary the camps ringed 38,594 birds of over 150 species, and recoveries gave an overall picture of the area of origin of the migrants. Much information was also obtained on the movements and habits of resident birds. We are grateful to the MAPS Organisation and the Smithsonian Institution for their generous financial support.

Conservation : An effort was made to obtain information on the status of Crocodile species in various parts of the country. The attempt produced very little constructive information apart from drawing attention to the fact that crocodiles have disappeared or have not been noticed in a large part of their former habitat.

A similar enquiry on the status of the Tiger indicated an alarming decline in their number.

The Society was instrumental in arranging an expert to advise the Government of Maharashtra on the planning of the proposed National Park at Borivli in the Bombay suburban area.

The Indian Board for Wildlife which met after 4 years at Delhi under the Chairmanship of Dr. Karan Singh, the Minister for Tourism, is now taking a more active approach to conservation problems than in the past. In this connection we would also refer to the concern and interest of the Prime Minister in the conservation programmes of the Government.

The IUCN General Assembly at Delhi between 24 November and 1 December was the major conservation activity during the year. Many useful resolutions and projects relating to Indian conservation needs were formulated and the Society is pressing for the speedy implementation of the resolutions and action on the projects.

DONATIONS

Sálim Ali-Loke Ornithological Research Fund : During the year we received donations from :

N. H. Wadia Charity Fund ..	Rs.	1,000·00
Dr. Sálim Ali	Rs.	6,000·00
	Rs.	7,000·00

Appeals were sent to many trusts and persons who were thought to be in a position to contribute to the Corpus of the fund. There was only a single response. The contributions received so far are mainly from a few donors.

Lady Peng McNiece	..	Rs. 20,939·40
Dr. Sálim Ali	..	Rs. 19,000·00
Executive Committee		
Members (2)	..	Rs. 2,500·00
Members (5)	..	Rs. 1,021·96
Others	..	Rs. 1,416·62
Interest earned	..	Rs. 4,211·52
		Rs. 49,089·50

Auditorium : The Cactus Club donated a chair for the auditorium.

Research Studies

Gir Project : Members may recall that last year we had reported on the plans for a Wildlife and Ecology research station in the Gir. The project received the Government of India's approval, and research is now in progress.

Andaman Islands : A further trip was made to the Andaman Islands in February 1969, the object being to visit the isolated Narcondam Island and observe the rare Narcondam Hornbill. This was achieved though the period of stay at Narcondam was less than 24 hours.

University Department : The recognition of the Society as an institute for field Ornithology was renewed for a further period of three years. We have three research students, two registered for M.Sc. and one for Ph.D.

Nature Education Scheme

The scheme now in its 22nd year, continues its activities in Bombay, Poona and adjacent areas for creating interest in nature among school children.

Library

During the year 319 books were added to the Library. Among these 34 were received for review, 12 purchased and 273 donated by members and others. Our thanks are due to the donors and to the publishers who have sent us review copies.

Meetings & Exhibitions

January :	Photos by Morarji[1], P.R. & Films of Thakore[2]. Exhibition[1] of 'Fish on Stamps'.
February :	Peter Jackson[3]—Wildlife of Africa. Kenworthy, J. B.[3]—Fire and the balance of Nature.
March :	Peter Jordan[3]—The Ecology of Timberwolf in North America and some suggestions for Ecological Studies in the Gir Sanctuary.
April :	P. J. Deoras[3]—Rat Problem in Bombay. Film[2]—No Room for Wild Animals. Exhibition of flowering Orchids[1].
June :	Film[2]—Serengeti shall not die.
September :	G. B. Schaller[3]—Some Observations on Indian Wildlife.
November :	Ranjitsinh[3]—Indian Wild Life. Weldon Gratton[3]—Planning a National Park.
December :	O. A. Hoeg[3]—Birds of Norway.

Revenue Accounts

The financial position of the Society continues to be difficult as will be evident from the statements of accounts.

Additions to the Collections

During the year 415 specimens were added to the collections :

Mammals ..	9
Birds	346
Reptiles	41
Amphibians ..	19

Staff

The Committee wishes to record its appreciation of the willing co-operation of the entire staff in the activities of the Society.

Acknowledgement

The Committee's thanks are due to Mr. M. J. Dickins who continues to look after the Society's interests in the United Kingdom.

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[1] Exhibition.
[2] Film Show.
[3] Talk.

Registered No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT, 1950

SCHEDULE VIII [VIDE RULE 17(1)]

BALANCE SHEET AS AT 31 *DECEMBER* 1969

FUNDS AND LIABILITIES	Rs. P	Rs. P.
Trust Funds or Corpus :		
Life Membership Fund :		
Balance as per last Balance Sheet ..	51,543·00	
Add : Amount received during the year	1,899·46	
	53,442·46	
Add : Amounts written back in respect of Life Members confirmed to be alive, previously transferred to General Reserve Fund ..	2,750·00	56,192·46
Fixed Assets Fund :		
Balance as per last Balance Sheet ..	76,009·12	
Add : Grants and donations received ..	28,604·39	
	1,04,613·51	
Less : Transferred to Income and Expenditure Account on account of Depreciation	15,099·36	89,514·15
Carried forward ..		1,45,706·61

ASSETS	Rs. P.	Rs. P.
Immovable Properties :		
Motor Cars :		
Balance as per last Balance Sheet ..	25,506·75	
Additions during the year ..	28,434·95	
	53,941·70	
Less : Depreciation during the year ..	7,944·84	45,996·86
Furniture, Fixtures and Equipment :		
Balance as per last Balance Sheet ..	55,619·03	
Additions during the year ..	1,617·15	
	57,236·18	
Less : Depreciation during the year ..	7,154·52	50,081·66
Investments: (At cost)		
Shares—Quoted		
107 'A' Equity Shares of Rs. 50 each in Bank of India, fully paid ..	7,541·00	
95 Equity Shares of Rs. 100 each in Bank of India, Rs. 50 per Share paid up ..	6,669·00	14,210·00
Carried forward ..		1,10,288·52

BALANCE SHEET AS AT 31 *DECEMBER*, 1969—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.
Brought forward ..		1,45,706·61
Provision for Capital Losses : Balance as per last Balance Sheet ..	3,390·88	
Add : Transferred from Income and Expenditure Account ..	1,137,50	4,528·38
General Reserve Fund : Balance as per last Balance Sheet..	36,765·40	
Less : Amounts transferred to Life Membership Fund in respect of members confirmed to be alive ..	2,750·00	34,015·40
Building Fund : Balance as per last Balance Sheet ..		19,150·76
Publication Fund : Balance as per last Balance Sheet ..		30,725·00
Other Earmarked Funds : (As per Schedule 'A') ..		3,45,629·47
Carried forward ..		5,79,755·62

ASSETS	Rs. P.	Rs. P.
Brought forward ..		1,10,288·52
Investments: (At cost) Brought forward *Government Securities*—Quoted		
Rs. 25,000 3% Conversion Loan 1946/86. ..	25,000·00	
Rs. 2,000 3% 1st Development Loan 1970/75 ..	1,948·75	
Market value Rs. 30,972·40, please refer to Note 5)	26,948·75	
Unquoted :		
Rs. 3,000 12 Year National Defence Certificates due 22-10-1975	3,000·00	
	29,948·75	
Less : Provision for Depreciation ..	6,750·00	23,198·75
Loans : (Unsecured, considered good)		
Loan Scholarships ..	—	
Other Loans (to staff) ..	210·00	210·00
Carried forward ..		1,33,697·27

BALANCE SHEET AS AT 31 *DECEMBER* 1969—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.
Brought forward ..		5,79,755·62
Liabilities		
For Expenses	36,356·12	
,, Advance Subscriptions ..	1,224·10	
,, Sundry Credit Balances ..	13,222·13	50,802·35
Notes.—		
(1) Included in the Fixed Assets is a Jeep Station Wagon amounting to Rs. 28,434·95 which has been purchased out of the Grants from the Smithsonian Institution, U.S.A., for Bird Migration Study during 1969.		
(2) All expenses incurred on the various activities for which grants and donations are received have been directly debited to the relevant Fund Account.		
(3) Annual subscriptions are accounted for on a cash basis. The amount due as at 31st December, 1969, from Members is not ascertainable.		
Carried forward ..		6,30,557·97

ASSETS	Rs. P.	Rs. P.
Brought forward ..		1,33,697·27
Advances: (Unsecured, considered good)		
To Trustees ..	—	
,, Employees (for camp expenses)	7,592·96	
,, Others ..	36,047·38	43,640·34
Stocks: (At cost or under)		38,440·17
Income Outstanding:		
Rent	—	
Interest (Accrued)	3,169·77	
Other Income:		
Supplies and Services ..		
(including Rs. 3,215, considered doubtful) ..	30,624·56	
Government of India		
Grant for Journal Expenses 1969-70.	8,000·00	
National Institute of Sciences of India:		
Grant for Journal Expenses 1969-70.	1,000·00	42,794·33
Cash and Bank Balances:		
(*a*) In Current Account with:		
National & Grindlays Bank Ltd., Bombay. ..	2,46,549·72	
National & Grindlays Bank Ltd., London (£346-11-9) ..	6,238·57	
Chartered Bank, Bombay ..	8,548·26	
Carried forward ..	2,61,336·55	2,58,572·11

BALANCE SHEET AS AT 31 *DECEMBER*, 1969—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward ..		6,30,557·97	Brought forward ..	2,61,336·55	2,58,572·11
(4) There is a contingent liability for calls on partly paid share Rs. 4,750.			*Cash and Bank Balances*: (Contd.)		
(5) The market value of the shares in the Bank of India as at 31st December 1969 as per the Stock Exchange Quotations was Rs. 44 for the 'A' Equity Shares and Rs. 44·52 for the Equity Shares, ex. instalment. However, as these shares have been purchased cum instalment, the market value for Balance Sheet purposes as at 31st December 1969 has been taken at Rs. 69 for 'A' Equity Shares and Rs. 69·52 for Equity Shares.			*In fixed Deposit with*:		
			Bank of India Ltd., Bombay (including Rs. 36,000 for Sálim Ali/Loke Wan Tho Ornithological Research Fund and Rs. 3,000 for Col. Burton's Nature Conservation Fund) ..	39,000·00	
			Bank of Bhutan, Phuntsholing ..	10,550·00	
			M/s. Mukund Iron & Steel Co. Ltd., Bombay	10,000·00	
			(*b*) With the Trustees	—	
			(*c*) With the Cashier	—	
					3,20,886·55
			Income and Expenditure Account		
			Balance as per last Balance Sheet ..	46,735·60	
			Add: Deficit from Income and Expenditure Account ..	4,363·71	
					51,099·31
Total ..		6,30,557·97	Total ..		6,30,557·97

The above Balance Sheet to the best of my belief contains a true account of the Funds and Liabilities and of the Property and Assets of the Trust.

(Sd.) J. D. KAPADIA,
Trustee

BOMBAY, 26*th August*, 1970

As per our report of even date.
(Sd.) A. F. FERGUSON & Co.,
Chartered Accountants

Registered No. F. 244 (BOM)

THE BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT, 1950

SCHEDULE IX [VIDE RULE 17(1)]

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 *DECEMBER* 1969

Expenditure	Rs. P.	Rs. P.
To Expenses in respect of properties :		
Rates, Taxes & Cesses ..		nil
Repairs and Maintenance ..		nil
Salaries		nil
Insurance		nil
Depreciation (by way of provision or adjustments)		nil
,, *Expenditure from Grants, Government of Maharashtra :*		
For 1968-69 : Salaries, including Dearness Allowance (Per contra) ..	8,040·98	
For 1969-70 : Salaries, including Dearness Allowance (Per contra) ..	26,036·87	
For 1968-69 : Building Maintenance (Per contra)	2,762·40	
For 1969-70 : Building Maintenance (per contra)	4,205·29	41,045·54
Carried forward ..		41,045·54

Income	Rs. P.	Rs. P.
By Rent :		
Accrued	nil	
Realized	nil	nil
,, *Interest* (Accrued and Realized) (excluding items directly credited to grants)		
On Securities	1,006·67	
On Bank Account (Fixed Deposits) ..	1,603·93	2,610·60
,, *Dividends :*		nil
,, *Donations :*		
In cash	nil	
In kind—Coloured transparencies, Library books, Photographs etc. received from the Estate of Late E. P. Gee not valued ..	nil	nil
,, *Grants :*		
Government of Maharashtra :		
For 1968-69 (Expended as per contra)	8,040·98	
For 1969-70 (Expended as per contra)	26,036·87	
For 1968-69 (Expended as per contra)	2,762·40	
Carried forward	36,840·25	2,610·60

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER 1969—(continued)

EXPENDITURE	Rs. P.	Rs. P.
To Brought forward ..		41,045·54
Establishment Expenses :		
Salaries including Dearness Allowance	51,931·73	
Society's contribution to Staff Provident Fund	2,576·04	
Postages	1,935·04	
Printing and Stationery	2,138·39	
Advertisements	106·43	
Telephone Charges	1,019·75	
Bank Charges	542·19	
Meeting Expenses	1,289·50	
Motor Car Charges (after adjusting donation received in cash Rs. 1,000).	522·32	
Conveyance and Travelling Expenses	120·25	
Rent	1·00	
Interest on overdraft	1·92	
		62,184·56
To Miscellaneous Expenses :		
General Charges	1,952·03	
Fire and Equipment Insurance ..	72·90	
Repairs to Furniture	197·85	
I.U.C.N. Conference Expenses ..	1,105·50	
		3,328·28
,, Remuneration to Trustees ..	nil	
Remuneration (In the case of Math)	nil	
Legal Expenses	nil	
Audit Fees	1,000·00	
Contribution and Fees	nil	
		1,000·00
Carried forward ..		1,07,558·38

INCOME	Rs. P.	Rs. P.
Brought forward ..		2,610·60
By Grants: (contd.)	36,840·25	
For 1969-70 (Expended as per contra)	4,205·29	
Educational Activity Grant 1969-70..	4,000·00	
Government of India :		
For Journal Publication Expenses 1969-70	8,000·00	
National Institute of Sciences of India :		
For Journal Publication Expenses 1969-70	1,000·00	
		54,045·54
,, *Income from Other Sources :*		
Membership Subscriptions ..	31,671·26	
Entrance Fees	510·00	32,181·26
,, *Publications :*		
Journal Sales	9,360·45	
,, *Profit on sale of Books :*		
Book of Indian Birds ..	7,795·40	
Butterflies of the Indian Region ..	1,935·96	
Book of Indian Animals ..	5,490·00	
Indian Molluscs	246·98	
Identification of Poisonous snake charts	279·50	
Other Publications	1,892·92	
Nature Calendars	3,609·70	
Carried forward ..	30,610·91	88,837·40

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER 1969—(continued)

Expenditure		Rs. P.	Rs. P.
Brought forward ..			1,07,558·38
To Amounts Written off:			
(*a*) Bad Debts		nil	
(*b*) Loan Scholarships		nil	
(*c*) Irrecoverable Rent		nil	
(*d*) Other Items		nil	
			nil
,, *Depreciation:*			
On Investments		nil	
On Furniture		7,154·52	
On Motor Cars		7,944·84	
			15,099·36
,, *Expenditure on Objects of the Trust:*			
(*a*) Religious		nil	
(*b*) Educational—Journal Expenses		28,678·67	
,, *Library Account:*			
Subscription to other Societies ..	1,578·51		
Purchase of Books ..	318·40		
Periodicals and binding charges	597·00		
		2,493·91	31,172·58
,, *Maintenance of Reference Collections* ..			1,644·06
Total ..			1,55,474·38

Income	Rs. P.	Rs. P.
Brought forward ..		88,837·40
Profit on sale of Books (contd.)	30,610·91	
Add: Profit on packing and forwarding charges ..	305·38	
		30,916·29
By Miscellaneous Receipts: (including 5% administrative charges on the expenses of various grants handled during the year)		16,257·62
,, Profit made on Investments matured	1,137·50	
Less: Transferred to Provision for Capital losses ..	1,137·50	
		nil
,, *Transfers*:		
From Fixed Assets Fund on account of Depreciation (as per contra)		15,099·36
,, Deficit for the year carried to Balance Sheet		4,363·71
Total ..		1,55,474·38

As per our report of even date.

(Sd.) A. F. Ferguson & Co.,
Chartered Accountants

Bombay, 26*th August*, 1970

(Sd.) J. D. Kapadia,
Trustee

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF THE BALANCE SHEET AS AT 31 *DECEMBER* 1969

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Additions/ Amounts received during the year* (3)	*Transfers from other Funds* (4)	*Total of columns 2, 3, & 4* (5)	*Spent/ Refunded* during the year* (6)	*Transfers to other Funds* (7)	*Total of columns 6 & 7* (8)	*Balance as at 31st December 1969 (minus) (5-8)* (9)
(1) Field Work Fund ..	1,039·64	2,000·00	..	3,039·64	250·00	2,000·00	2,250·00	789·64
(2) Staff Welfare Fund ..	500·00	..	..	500·00	..	..	..	500·00
(3) Dr. Sálim Ali/Loke Wan Tho Ornithological Research Fund	39,822·90	9,266·60 (including interest Rs. 2,266·60)	..	49,089·50	..	..	..	49,089·50
(4) Col. Burton's Nature Conservation Fund ..	3,622·88	189·00 (interest)	..	3,811·88	..	..	..	3,811·88
(5) Grant from California Academy of Sciences for Herpetological Survey ..	1,851·44	..	..	1,851·44	464·61	..	464·61	1,386·83
(6) Vertebrate Zoology Field Work Fund (By Shri Humayun Abdulali) ..	11,011·82	911·47 (interest)	2,000·00	13,923·29	4,816·08	..	4,816·08	9,107·21
(7) Grant from Smithsonian Institution for the Secretarial Assistance to Dr. Sálim Ali on the Publication of Handbook of the Birds of India and Pakistan in Ten Volumes ..	..	25,969·20	..	25,969·20	13,301·99	..	13,301·99	12,667·21
(8) Grant from Seth Purushottamdas Thakurdas and Divaliba Charitable Trust for the Publication of Nature Study booklets for Free Distribution ..	2,802·16	400·00 (being excess provision in 1968 now written back)	..	3,202·16	1,858·00	..	1,858·00	1,344·16
Carried forward ..	60,650·84	38,736·27	2,000·00	101,387·11	20,690·68	2,000·00	22,690·68	78,696·43

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Additions/ Amounts received during the year* (3)	*Transfers from other Funds* (4)	*Total of columns 2, 3, & 4* (5)	*Spent/ Refunded* during the year* (6)	*Transfer to other Funds* (7)	*Total of columns 6 & 7* (8)	*Balance as at 31st December, 1969 (minus) (5-8)* (9)
Brought forward Rs. ..	60,650·84	38,736·27	2,000·00	101,387·11	20,690·68	2,000·00	22,690·68	78,696·43
(9) Grant from Smithsonian Institution for the Bird Migration Study Survey ..	303·06	54,750·00	25,367·11	80,420·17	80,195·71 224·46	..	80,420·17	..
(10) Grant from U.S. Government (Army) for Migratory Animal Pathological Survey ..	2,888·32	34,200·00	..	37,088·32	37,088·32	..	37,088·32	..
(11) Grant Supplementary from U.S. Government (Army) for Migratory Animal Pathological Survey in Eastern India ..	..	7,600·00	..	7,600·00	1,556·93	..	1,556·93	6,043·07
(12) Grant from M/s. Satyajit Machinery Stores for the Himalayan Survey of Mr. Lavkumar ..	..	1,000·00	..	1,000·00	1,000·00	..	1,000·00	..
(13) Grant from His Majesty King of Bhutan for the publication of Birds of Bhutan by Dr. Sálim Ali ..	..	10,637·43 (including interest Rs. 637·43)	..	10,637·43	..	..	..	10,637·43
(14) Grant from Smithsonian Institution for Gir Forest Ecological Research Programme ..	..	86,032·00	..	86,032·00	..	..	..	86,032·00
(15) Grant from Yale School of Forestry for Gir Forest Ecological Research Programme.	..	133,212·80	..	1,33,212·80	514·10	..	514·10	1,32,698·70
(16) Grant from World Wildlife Fund for the publication of Booklet on Conservation for distribution to Schools ..	..	20,000·00	..	20,000·00	..	..	..	20,000·00
Carried forward ..	63,842·22	3,86,168·50	27,367·11	4,77,377·83	1,41,270·20	2,000·00	1,43,270·20	3,34,107·63

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Brought forward Rs. ..	63,842·22	3,86,168·50	27,367·11	4,77,377·83	1,41,270·20	2,000·00	1,43,270·20	3,34,107·63
(13) Grant from Government of Maharashtra :								
(1) Grant of 1968-69 :								
(*a*) For Establishment expenses ..	11,335·36	..	..	11,335·36	8,040·98 *3,294·38	..	11,335·36	..
(*b*) For Building Maintenance ..	2,763·38	..	..	2,763·38	2,762·40 *0·98	..	2,763·38	..
(2) Grant for the year 1969-70 :								
(*a*) For Establishment expenses ..	..	35,764·00	..	35,764·00	26,036·87	..	26,036·87	9,727·13
(*b*) For Building Maintenance. ..	..	6,000·00	..	6,000·00	4,205·29	..	4,205·29	1,794·71
Total ..	77,940·96	4,27,932·50	27,367·11	5,33,240·57	1,85,611·10	2,000·00	1,87,611·10	3,45,629·47

*The above amounts being unspent have been refunded to the relevant Grantee/Government Authorities.
**Includes amount spent by Bombay Natural History Society, since recovered from the Smithsonian Institution.
***Including Rs. 28,446, being the cost of a Jeep with trailer & accessories transferred to Fixed Assets Fund.

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the Year ended 31 *December* 1969

RECEIPTS	Rs. P.	Rs. P.	PAYMENTS	Rs. P.	Rs. P.
To Balance as at 1st January, 1969 brought forward :			By Salary of Nature Education Organiser		6,906·00
Cash with Cashier	42·40		,, Printing and Stationery ..		476·54
Balance with National & Grindlays Bank Ltd., Bombay, on Current Account	9,034·49		,, General Charges		1,052·11
Balance with Bombay Natural History Society	58·79	9,135·68	,, Postages		175·05
,, Grant from Government of Maharashtra :			,, Balance as at 31st December, 1969		
for 1969-70		9,236·00	With National & Grindlays Bank Ltd., Bombay on Current Account		10,018·05
,, Sales of Nature Study Booklets ..		256·07			
Total ..		18,627·75	Total ..		18,627·75

BOMBAY, 26*th August*, 1970

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants.

(Sd.) J. D. KAPADIA,
Trustee.

BOMBAY NATURAL HISTORY SOCIETY

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH GRANT-IN-AID

Receipts and Payments Account for the Year ended 31 *December* 1969

RECEIPTS		Rs. P.	PAYMENTS	Rs. P.	Rs. P.
To Balance as at 1st January, 1969, brought forward :			By Grant for Study of Sea-anemones of Maharashtra 1969 :		
(*a*) With National & Grindlays Bank Ltd., Bombay, on Savings Account	705·24		Salaries	500·00	
(*b*) With Junior Fellow (Mr. D. N. Mathew) ..	500·00		Miscellaneous	457·90	
		1,205·24			957·90
,, Grant for Study of Sea-anemones of Maharashtra 1969		2,017·85	,, Grant for Study of the Ecology of Avian Species of importance to Indian Agricultural Economics 1969-70 :		
,, Grant for Study of the Ecology of Avian Species of importance to Indian Agricultural Economics 1969-70		5,907·24	Salaries	3,600·00	
,, Interest on Bank Account		39·00	Miscellaneous	2,189·84	5,789·84
			,, Balance as at 31st December, 1969 :		
			With National & Grindlays Bank Ltd., Bombay, on Savings Account	1,921·59	
			With Junior Fellow (Mr. D. N. Mathew) ..	500.00	2,421·59
Total ..		9,169·33	Total ..		9,169·33

BOMBAY, 26*th August*, 1970

(Sd.) A. F. FERGUSON & Co.,
Chartered Accountants.

(Sd.) J. D. KAPADIA,
Trustee.

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD AT HORNBILL HOUSE, SHAHID BHAGAT SINGH ROAD, BOMBAY 1, ON FRIDAY, 18TH SEPTEMBER, 1970, AT 6-30 P.M., WITH MR. R. E. HAWKINS IN THE CHAIR. APPROXIMATELY 30 MEMBERS WERE PRESENT

Before the meeting commenced, the Chairman referred to the sad death of Fr. Santapau, and said that in his death the Bombay Natural History Society has suffered an irreparable loss. Apart from his eminence in botany, Fr. Santapau took the keenest interest in the activities of the Society, and was closely associated with it for the last 20 years.

The Chairman said that the Society was trying to establish a small floristic sanctuary in the Khandala Ravine, an area where Fr. Santapau had done much botanical work. It was hoped that the Government of Maharashtra would accept the recommendation made by the Society for the creation of this sanctuary.

Members stood in silence for a minute as a mark of respect to Fr. Santapau.

The Chairman then asked the Honorary Secretary to make any comments he wished on the Annual Report before any questions were asked about it. The Honorary Secretary said that there had been a small though welcome increase in the membership from 894 to 1060. Of the 148 members who had paid their subscription in 1968, but had not done so in 1969, a few were expected to pay. Regarding the 23 resignations, it was unfortunate that even institutions like the Marathwada University, the Salar Jung Museum and other institutions of learning had discontinued their membership. The Society would try and have these memberships reinstated.

The Honorary Secretary stated that he would like to make a comment on the Borivli National Park established by the Government of Maharashtra in Bombay. This was a most imaginative step, and one which would be of the greatest benefit to the citizens. However, it was unfortunate that a film city was being built up in a portion of the Park, and this would detract from the park values. Representation had been made in this connection to the Government but apparently it was not possible at this stage to go back on this scheme. Government, however, had indicated that they were acquiring further forest land on the southern side of the Bassein Creek, and this would add a large area of forest to the Park. The Honorary Secretary said that at the present time when the resources of Government were limited, and when there were so many demands on them it was natural that only those schemes were put through which provoked strong public support. It was, therefore, most important for members of the Bombay Natural History Society and others to get more vocal, and put forward their demands more vigorously.

The Chairman then asked the meeting if there were any questions to be asked on the report. No questions were asked, and Mr. G. V. Bedekar proposed and Mr. D. E. Reuben seconded that the report be adopted. The report was unanimously adopted.

The Chairman then asked the Honorary Treasurer to present the accounts for the year. The Honorary Treasurer answered the questions that were asked and Mrs. Khan proposed and Prof. Bole seconded that the accounts be unanimously adopted. The accounts were unanimously adopted.

The Chairman then stated that the panel of names proposed by the Executive Committee for 1970-71 for election may be taken as approved by the meeting since no alternative names had been suggested.

EXECUTIVE COMMITTEE

President

Nawab Ali Yavar Jung, *Governor of Maharashtra*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S. (Retd.)
Dr. Sálim Ali, D.SC., F.N.I.
Mr. R. E. Hawkins

Hon. Secretary

Mr. Zafar Futehally

Hon. Treasurer

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The meeting then formally terminated with a vote of thanks to the Chair.

After the meeting there was a slide-show of the colour transparencies of Mr. Ranjit Sinh, Mr. E. P. Gee and others. The slide show was followed by a display of two films by Mr. E. P. Gee—on the Kanha National Park and on the Manas Sanctuary.

ERRATA

"Volume **67** (2), August 1970, page 362, add : '*cristata* L. (Fig. 16). *Crossandra undulaefolia* Salisb. (Fig. 17 & 17A).' between 5th and 7th lines below the photograph."

Field Work Grant

The Society is in a position to financially assist individual projects in field work in Vertebrate Zoology, including collecting, and would be glad to consider applications for specific proposals. Apply in detail to the Honorary Secretary.

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