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CONTENTS

CONTENTS

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IMPACT OF PESTICIDAL POLLUTION IN THE ENVIRONMENT[1], [2]

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(*With two text-figures*)

The ubiquitous presence of residues of persistent pesticides in abiotic and biotic components of the environment is a matter of serious public concern. A brief review of the impact of pesticidal pollution on the ecosystem is given. Data obtained from Indus Basin (India) revealed widespread contamination of milk and wheat flour with DDT and HCH residues. Human adipose tissues also showed invariably the presence of DDT and HCH, the level of beta-HCH as high as 30 ppm was found in a sample. Potato and soil samples were found to be contaminated with negligible levels of insecticide residues. The possible implications of these residues have been discussed. Research and legislative needs to control the pesticidal contamination with particular reference to India have been outlined. It is concluded that the situation on the pesticidal contamination in certain components of the environment in India is quite serious and demands immediate action.

INTRODUCTION

During the past three decades, organic pesticides have become increasingly important in controlling pests of crops, animals and man. These chemicals have greatly increased agricultural yields and saved millions of lives from insect-borne diseases. Unfortunately, the use of certain persistent pesticides has resulted in the pollution of the environment. The main reasons for environmental pollution and serious ecological problems with pesticides are: 1. pesticides are biological poisons; 2. large quantities are applied to the ecosystem; 3. poor application technology is used which results in large amounts of pesticides being widely spread in non-target areas; 4. little pesticide (probably less than 1 per cent) ever hits the target pests and 5. persistence in the environment for periods longer than required or intended.

[1] Accepted August 1979.

[2] Presented at the National Symposium on Land and Water Management in the Indus Basin, held at Ludhiana, November 9-11, 1978.

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When a pesticide is introduced into the environment, it enters a dynamic ecosystem and immediately begins to be moved from one part of the system to another, degraded *in situ* or move out of the system to other systems. Figure 1 portrays the various pathways by which pesticides cycle through the environment. Pesticides could conceivably have a biological impact throughout all parts of the environment since there is a continuous movement of these chemicals between soil, living organisms, water and air.

Pesticides Residues and their Effects

Soil : Large proportion of pesticides applied reach the soil, which acts as a reservoir for these chemicals. Their persistence in soil is very variable and depends upon complex interacting factors such as the characteristics of a pesticide, soil type, environmental factors, etc. (Lichtenstein 1972, Edwards 1975). The chemical structure of a pesticide and its resultant intrinsic stability is the most basic single factor. Factors that are next in importance are the adsorption of pesticide on to clay or organic fraction, precipitation, temperature and microbial activity. Amongst the organochlorine insecticides, DDT and dieldrin persist longest in soil, followed by endrin, lindane, chlordane, heptachlor and aldrin in order of decreasing persistence.

Persistent pesticides in soil may create a variety of hazards. Their residues concentrate into the bodies of the invertebrates and arthropods that live in soil, and from these they can be transported into the bodies of the higher organisms (Edwards 1970, 1973). Starting with DDT at a level of 9.9 ppm in soil, it reached a level of 141 ppm in the earthworms and 444 ppm in the brains of adult robins (Hunt 1965). This high concentration in the robins was toxic to some birds. Soil invertebrates also take up some of the organophosphorus and carbamate pesticides. Recently, Edwards (1976) found that slugs concentrate large amount of diazinon and phorate from soil and considered that this may constitute a serious danger to birds and mammals which feed on them, even if slugs were unaffected, because of the high toxicity of these insecticides to vertebrates.

Soil micro-organisms which cause or contribute to the breakdown of cellulose, nitrification, turn over of organic material and other biological materials may be adversely influenced by pesticides. For example, EPTC (herbicide) at normal dosage impaired cellulose decomposition in soil. Another herbicide (TCA) reduced soil nitrification (Pimentel and Goodman 1974). Earthworms and arthropods have been severely reduced by insecticides and herbicides. Simazine at a normal dosage caused a reduction in a number of soil invertebrates by 33 to 50 per cent (Edwards 1964). Predatory mites, hemeidaphic Collembola and particularly the Isotomidae were most affected by Simazine. DDT and some of the organophosphorus insecticides increased many species of spring tails and some species of non-predatory mites even to the extent of increasing the total biomass. The duration of ecological imbalance following the application of pesticides, however, was found to depend upon the persistence of chemical and its absolute toxicity. A general consensus is that most pesticides do not affect microbial population if applied at the recommended dosage but may cause serious ecological problems if their dosages are exceeded.

Fortunately residues of persistent organochlorine insecticides do not concentrate from soil into plant tissues but nevertheless the small quantities in plant tissues which are used for human food may be undesirable. A further hazard is the development of resistance in soil pests due to their continuous exposure to persistent pesticides present in the soil.

Aquatic systems : There are many routes by which pesticides can reach the aquatic environment such as rivers, lakes, oceans and ponds. These routes are (*a*) surface run-off and transport from treated soil ; (*b*) industrial wastes discharge and factory effluents ; (*c*) direct application as aerial sprays or granules to control water-inhabiting pests ; (*d*) spray drift from normal agricultural practices; (*e*) atmospheric transports ; (*f*) municipal water discharged into sewage effluents ; (*g*) agricultural wastes and (*h*) accidental spillage (Kilgore and Li 1976, Edwards 1977). It is considered that run-off from agricultural land is the main source of gradual pollution, with direct application to water and discharge of effluent into aquatic systems causing more serious but localized contamination. The pesticides that cause maximum pollution are the organochlorine insecticides and certain persistent herbicides. Pesticide residues have been found to be the largest in rivers, less in estuaries and least in the ocean.

Pesticides in the aquatic environment constitute both direct and indirect hazards to man as well as to aquatic animals. Of particular concern, is the phenomenon of ' bioconcentration ' of persistent organochlorine insecticides like DDT, dieldrin, DDD, etc. One of the first studies of build-up of organochlorine insecticides in an aquatic ecosystem was conducted in California in 1958 by Hunt and Bischoff (1960). DDD insecticide was applied several times to clear lake to control gnats. The level of insecticide in water immediately following the last application was calculated to be 0.02 ppm. Residue levels of DDD in samples taken from the lake 13 months after treatment were 10 ppm in plankton, 903 ppm in fat of plankton-eating fish, 2690 ppm in fat of carnivorous fish, and 2134 ppm in fat of fish-eating birds. These residues represent about a 500-fold increase in levels in plankton and a 100,000-fold increase in fish-eating birds over levels occurring in lake water after treatment. The high levels of pesticide residues, thus, acquired by the birds caused mortality in Western grebes. This process of ' bioconcentration ' is sometimes confused with that of ' biological magnification ' which can be defined as the accumulation of a pesticide in an animal in any particular trophic level of a concentration greater than that in its food or the preceding trophic level so that eventually, animals at the top of food chain accumulate the largest residues. The food chain concept is particularly questionable in aquatic system, because, although there is a marked tendency for the organisms in the higher trophic levels to accumulate larger amounts of persistent organic pesticides, there is a good evidence that these organisms can obtain these residues as readily from the water in which they live as from their food (Moriarty 1973).

Many fish kills attributable to pesticides have been reported. Such events frequently result from accidents and ignorance. Dramatic fish kill becomes immediately obvious, there is considerable public outcry and the causes are usually eliminated or controlled. Gradual contamination, however, carries greater potential environmental hazards. Observations on sublethal effects of pesticides are accumulating and there are indications that indirect effects on the ecosystem, such as the disturbance of population dynamics, changed food requirements, reproductive behaviour and photosynthesis may be quite important.

Air and Atmosphere : Pesticides enter the atmosphere by a variety of routes, particularly from spray drift or volatilization from soil or water. Other routes of entry include wind erosion and agricultural burning. The use of aircraft for pesticidal application undoubtedly contributes greatly to the air contamination. Many studies have revealed the presence of residues of pesticides in air and rain samples. Risebrough *et al.* (1968) suggested that insecticides can be transported long distances by

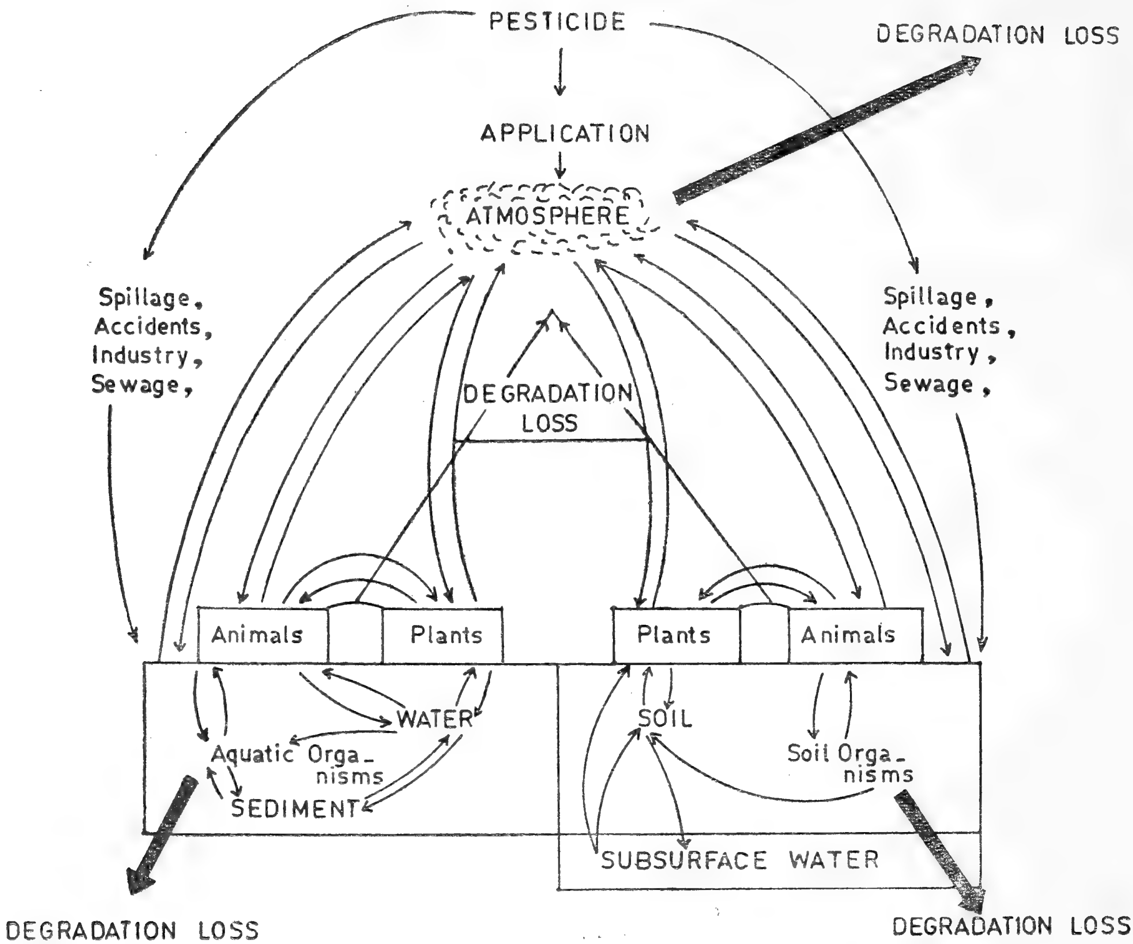

Fig. 1. Pesticide cycle in the environment.

global air currents in the same way as occurs with radio isotopes such as Strontium-90 and Cesium-177 and then fall out on to land or water in pattern dependent upon local precipitation. The significance of this route for the unexpected contamination of untreated soil and water situated far off from the places of application is still to be ascertained. Current evidence indicates that hazards from pollution of the atmosphere by pesticides are still small, particularly when compared with those from pollution of air by other materials. The amounts of pesticides in air are unlikely to be harmful to general public breathing air because the concentrations found have been quite small. *Agricultural crops and other food commodities* : Pesticides residues in food are often a matter of major concern to the public. Nevertheless, it is very difficult to produce crops that contain no insecticide residues without serious losses due to pests. Domestic animals are also continuously exposed when they eat insecticide contaminated feed. This results in the contamination of milk and meat. It is important that food commodities for man should not contain pesticides residues at levels hazardous to human health. In many countries, pesticide residue tolerances have been fixed for the maximum amounts of residues that may occur in plant tissues or other food commodities after taking into considerations the legitimate need of agriculture and the acceptable daily intake (ADI).[4] As a result of these requirements, there have been extensive studies of insecticide residues in food commodities in many countries of the world. It is reassuring to find that in most countries, the daily intake of these pesticides through well-balanced diets have been only a small fraction of the 'ADI' (Corneliussen 1970, Duggan and Corneliussen 1972, Abbot *et al.* 1969, Carassco *et al.* 1976).

Birds and wild life : The residues of organochlorine insecticides have been reported to occur in the tissues and eggs of many species of birds. The concentrations varied greatly and the quantities found were associated with the habits and food of the birds. Generally, there were much more insecticides residues in raptorial and fish-eating birds than in herbivorous birds ; particularly large amounts have been found in Herons and Great-crested Grebes and their eggs. The population of several of the bird species is declining such as the bald eagle, Osprey, peregrine falcon and brown pelicans, whereas it is increasing in other species such as the black bird or starling, quail, pheasant and robin. Pesticides probably are a contributing factor to this decline. Research has produced evidence that pesticides have and are affecting the reproduction in some species, both in egg laying and in the thickness of the egg shell (Wiemeyer and Porter 1970, Bitman *et al.* 1970). However, not all members of the particular family show the same reproductive failure. The egg shell effects are generally attributed to the pesticide causing a change in calcium metabolism. It is very difficult to assess the hazards of pesticidal pollution on birds and other wild life as only a small proportion of the total species have been investigated.

Man : The intake of pesticides through food and other sources result in their accumulation in the body tissues of human beings. The most common insecticide found in the general population was DDT. Aldrin, dieldrin, BHC, heptachlor and its epoxide etc. were the other insecticides detected. Residents of different countries have been found to contain different mean levels of DDT, for example, Germany 2.3, Netherlands 2.0, Denmark 3.1, Great Britain 3.0, Czechoslovakia 9.2, Italy 10.1, Hungary 12.4, Poland 13.4, Israel 18.1 and India 28 ppm (Matsumura 1975). The high levels of DDT residues in the general population in India was further confirmed by Ramachandran *et al.* (1974) and Vir (1977). It has been shown that these chemicals can be transferred from the mother to the foetus so that babies may be born with insecticides in their tissues. Another susceptible reproduction-related system is the mother-child transfer of pesticides via milk. The most likely effects of low-level residues of persistent organochlorine insecticides in man are the 'induction effects' on the hepatic microsome enzyme systems. The significance of this phenomenon on human health is not fully understood as yet. Data presently available do not suggest that man is being harmed by the small quantities of the pesticides present in his tissues. The long-term and delayed effects of these pesticides are, however, quite difficult to assess.

The consumption of methyl mercury derived from sea food resulted in the outbreak of

[4] The daily dose of a chemical which appears to be without appreciable risk to man on the basis of all facts known at that time.

Minamata disease in Japan. This occurrence was of course localised in areas of mercuric pesticide usage but do emphasize the possibility of development of serious situation if timely proper precautions are not taken in the use of pesticides.

Ecosystem effects : Pesticides impinge at all levels of organisation—at levels of the cell and the organs and at levels of the individual, the population and the ecosystem. Since each species in a community is affected differently by an introduced toxicant, the entire community organisation changes often resulting in outbreaks and the general instability of the ecosystem (Moore 1967 ; Pimentel 1971; Pimentel and Goodman 1974). For example, when predaceous coccinellid beetles and other predator and parasite populations were unintentionally eliminated in areas treated with DDT, chlordane and other chemicals, outbreak of mites (Helle 1965), aphids (Pimentel 1961) and scale insects (De Bach 1947) occurred. The densities of these plant pests increased 20-fold above the control levels usually achieved through their natural enemies. There has been an increase of green leaf hoppers on rice in areas of intensive use of BHC and of white flies on cotton after the introduction of DDT in the Sudan Gezira. According to FAO/WHO (1975), such pesticides induced disturbances may be more severe in tropical countries where ecological conditions tend to favour control by natural enemies. The use of pesticides has also been reported to alter the natural habitat (Pimentel and Goodman 1974). Plants, humans and other animals are all parts of the same system or ' establishment '. If the life system is altered, it may have serious repercussions on the nature and functions of the ecosystem and ultimately on man.

One of the more serious long-term effects on populations has been the evolution of resistant strains of pests to pesticides (Perry 1974). The effect of this pesticide resistance on the ecosystem is varied. Species with large amounts of genetic variability can evolve a high degree of tolerance and become the dominant species in the pesticide-stressed ecosystem. The possibility of the alteration in the dynamic equilibrium of the whole biotic community cannot be overlooked through such changes in the dominance by some species. In addition to pests, pesticide-tolerant or resistant populations of fish have been shown to exist in areas subjected to sustained pesticide usage. No top carnivores were found in nearly 100 hours' collecting in this area, suggesting that the resistance may involve increased ability to store toxic residues to the deteriment of animals higher in food chain (Ferguson *et al.* 1964).

Pesticides contamination levels in the Indus-Basin (India)

The information on the nature and levels of pesticidal contamination in various components of the environment in the Indus-Basin (India) is available only from the Punjab State and that too is as yet fragmentary.

According to the estimates made by the Ministry of Agriculture, Govt. of India, the consumption of pesticides in the Punjab is about 3600 metric tonnes per year (Anon. 1976). Most of these are insecticides, the important being HCH, carbaryl, malathion, DDT, fenitrothion and endosulfan. The total use of these six insecticides is about 2350 metric tonnes. However, these figures do not seem to have taken into account the use of insecticides for the control of malaria. DDT and HCH are the two main insecticides being used for malaria control. About 700 metric tonnes of DDT per year are being sprayed for this purpose in the Punjab. Cotton, vegetable, oilseed etc. are the major crops being sprayed with these insecticides. However, it is apparent from the data given below that the present use of insecticides is still not very extensive on most crops except for vegetables (Sidhu, A. S.,—personal communication).

Crop	Total area (ooo ha)	Per cent area covered
Cotton ..	240	25
Rape and mustard	180	25
Maize ..	560	10
Sugarcane ..	100	10
Potato ..	22	50
Other vegetables ..	38	75

Soil, human adipose tissues and a few food commodities have so far been analysed for insecticides residues (Table 1). Residues of both DDT and HCH were detected in most of the 250 samples of wheat flour collected from different cities in the Punjab (Joia *et al.* 1978). About 20 per cent of the samples contained DDT residues at a level above 1 ppm while a single sample contained even more than 5 ppm DDT. HCH residues exceeding 1 and 5 ppm were found in about 30 and 4 per cent samples respectively. Indications were obtained that the contamination of wheat with DDT at low levels could also occur through sources other than their direct admixture. Earlier Bindra *et al.* (1973) reported the results of analysis of 54 samples of wheat collected from the farmers' households and grain markets. Of the 40 per cent samples contaminated, 17 contained DDT alone while 4 contained HCH.

The overall mean level of DDT and HCH residues in wheat flour in the Punjab was found to be about 0.4 and 1 ppm respectively. As most of DDT and HCH residues were retained intact even during *chapati* preparation (Chawla *et al.* 1979), the daily intake of DDT and HCH by an adult comes to about 208 and 519 μg respectively (Table 2). Thus, the daily intake of DDT through cereal alone is about 69 per cent of the prescribed safe level (ADI) of 0.005 mg/kg/day (FAO/WHO, 1975) and is much higher than the total dietary intake of DDT in USA (55 μg), England (34 μg) and Spain (70.4 μg), (Carassco *et al.* 1976). Similarly, the calculated daily intake of HCH (519 μg) through wheat flour in the state was found to be much higher than that in the U.K. (17 μg) (Brooks 1972).

The contamination of milk with DDT was fairly widespread in the Punjab (Dhaliwal and Kalra 1977, Kalra *et al.* 1978). The residue level of DDT in most of the samples collected from the rural areas and the depots of Punjab Dairy Development Corporation, situated in Ludhiana, Chandigarh, Bhatinda and Amritsar was more than the maximum permitted level. Some samples even showed as high as 10-17 times the permitted level of DDT residues. HCH-residues mostly in the form of alpha-and beta-isomers were also detected. Butter and baby milk food also showed the presence of DDT and HCH residues (Dhaliwal and Kalra 1978, Kalra *et al.* 1979). The contamination of milk is to be viewed with concern as it is consumed in substantial quantities by infants and the sick. The contaminated milk, if taken by a 3 month child weighing 5 kg at the rate of 875 ml (5 feeds of 175 ml each) per day could result in a daily intake of 225 μg of DDT (Table 2). This is 9 times higher than the 'ADI' of 0.005 mg/kg/day. The consumption of baby milk food is also likely to result in the intake of DDT at levels higher than the levels accepted to be safe. As children are considered to be more susceptible than adults, they are at a much greater risk. The major portion of DDT residues was found in the form of p, p′-TDE. The high level of TDE in milk suggests that the intake of DDT in cattle probably occurs through the contaminated cattle feed (Witt *et al.* 1966). As limited amount of DDT is being used in agriculture, the contamination of cattle feed with excessive DDT

TABLE 1

PESTICIDE RESIDUES IN THE PUNJAB ENVIRONMENT

Matrix	Period of sampling	Samples examined	Samples found contaminated	Insecticide detected	Range (ppm)
Wheat grain ..	1970	54	17	DDT	4 to > 6
			4	HCH	> 4
Wheat flour ..	1974-76	250*	210	DDT	Tr. - 10
	1976	140	112	HCH	Tr. - 12
Bread ..	1977	9	9	DDT	Tr. - 0.15
			9	HCH	Tr. - 0.1
Pulse ..	1976	10	6	DDT	Tr. - 1.02
			5	HCH	Tr. - 0.05
Milk ..	1976	102	102	DDT	Tr. - 1.02
		42	25	HCH	Tr. - 0.05
Butter ..	1977	6	6	DDT	3.11-5.86
	1978	15	15	DDT	2.61-8.19
			15	HCH	0.51-5.35
Infant food ..	1977	1	1	DDT	2.72 (fat basis)
Poultry egg	1976	20	20	DDT	0.05-0.97
			14	HCH	0.07-0.62
Potato ..	1974	20	20	DDT, aldrin, HCH, heptachlor and dieldrin	Tr.-0.05
Okra ..	1967-68	6	6	Endrin	0.06-0.38
Brinjal ..	1964	10	4	DDT	0.08-8.0
Tomato ..	1964	10	1	DDT	0.08
Animal Feed Straw ..	1975-78	35	29	DDT	Tr. -0.75
			24	HCH	Tr. -0.6
Fodder	,,	13	10	DDT	0.02-0.5
			8	HCH	0.1-0.2
Concentrate ..	,,	12	12	DDT	0.07-0.89
			12	HCH	Tr. -2.0
Human Adipose Tissues ..	1976-78	51	51	DDT	0.7-31.34
			50	HCH	Tr. -30.05
			4	Dieldrin	Tr. -1.20
Soil ..	1976-77	106	89	DDT	0.07 (1.63)**
			1	HCH	0.5
			1	Endrin	0.1
Water ..	1976	2	2	DDT	Tr.

* These include the 140 samples examined for HCH also.

** Arithmetic mean (Maximum value).
Tr. indicates traces.

TABLE 2

ESTIMATES OF DIETARY INTAKE OF DDT AND HCH THROUGH CONTAMINATED FOOD COMMODITIES IN THE PUNJAB

Adult/ Infant and weight (kg)	Food commodity	Estimated mean consumption* (g or ml/day)		Insecticide and mean level of contamination (ppm)	Calculated daily intake (μg)		Proportion of the acceptable daily intake (%)	
		Actual diet	Balanced diet		Actual diet	Balanced diet	Actual diet	Balanced diet
Adult, 60	Cereals	519	370	DDT, 0.4	208	148	69	49
-do-	-do-	-do-	-do-	HCH, 1.0	519	317	**	**
-do-	Milk	317	180	DDT, 0.26	82	47	27	16
Infant, 5	-do-	875	—	DDT, 0.26	225	—	900	—
-do-	Baby milk food	135	—	DDT, 0.35	47	—	190	—

* The estimated mean consumption of food items for the adult is from ' Diet Atlas of India ' by Gopalan, C., Bala Subramanian, S. C., Ramsastri, B. V. and Visweswara Rao, K. (1971), Indian Council of Medical Research.

** The ADI for HCH has not been established so far. The ADI for gamma isomer is 0.0125 mg/kg/day.

residues is rather unexpected. Butter samples obtained from Haryana and Rajasthan also showed excessive DDT and HCH residues indicating concentration of the residues from contaminated milk (Dhaliwal and Kalra 1978 ; Kalra *et al.*, 1979).

DDT and HCH residues were also present in the samples of poultry eggs collected from Ludhiana but their levels rarely exceeded the maximum permitted residue limits. Market samples of potatoes collected from the different cities in the Punjab showed invariably the presence of DDT, HCH, aldrin, heptachlor and dieldrin. However, their levels in most of the samples were negligible (Kalra *et al.* 1978). DDT residues were detected in the market samples of brinjal (Jaglan and Chopra 1970) while endrin was detected in the samples of okra (Bhalla *et al.* 1970).

Biopsy samples (51) of the adipose tissues of human being collected from the Daya Nand Medical College, Ludhiana, when analysed invariably showed the presence of DDT and HCH. The residues of HCH in few samples were found to be quite excessive. As high as 30 ppm of beta-HCH, which is known to accumulate in human body, was found in a female fat sample (Chawla *et al.* 1978).

Recently, the soils of Punjab and Chandigarh were surveyed for insecticide residues (Singh 1977). A total of 106 surface soil samples were collected at random from all over the constituent districts of the Punjab and Union Territory, Chandigarh. More than 80 per cent of the samples were contaminated with DDT. The mean level of total DDT-R was found to be 0.03 ppm whereas the maximum level found was 1.73 ppm. These values were much lower than those found in countries like USA and Canada. This could be attributed to the relatively faster rate of loss of DDT under subtropical conditions as observed by Agnihotri and Jain (1977) in Delhi and Talekar *et al.* (1977) in Taiwan. Interestingly, Vir (1977) found a much higher level of DDT (4.2 ppm) in surface soil in areas located around the DDT factory in Delhi.

The presence of DDT and BHC residues in wheat, milk and eggs is a matter of concern particularly in view of the fact that practically no usage of these insecticides is directly related to the production of these commodities. However it is reassuring to find that potatoes for which aldrin and heptachlor have been recommended, contained only negligible amount of organochlorine insecticides.

Research and Legislative needs

Although considerable amount of work is being done on the development of non-chemical methods of pest control, yet the general consensus is that these methods have not reached a stage that they can supplant the use of chemicals in the foreseeable future. Our needs to use pesticides will, therefore, continue to increase. Nevertheless, we cannot ignore the potential risks. In the use of pesticides, we must, therefore, be keenly aware of, and concerned, and knowledgeable about their effects on man's total environment. The prime objectives of research and regulatory programmes are the achievement of pest control without injury to man, animals, plants, soil, fish, or wild life and other values in man's total environment. Determining the effect of pesticides on environmental quality is extremely complex problem and our understanding is far from complete. Winteringham *et al.* (1974) suggested ' integrated and comparative approach ' to the problem of environmental contamination at scientific level. This approach is system-analysis type and there are significant information flows in both directions between any two kinds (Fig. 2). It is considered that this approach would provide rational basis for the development of necessary counter measures, regulatory action control and would also help to identify priorities.

In order to gain a better perspective about the potential for pesticide contamination in the environment, the amount of pesticides used now and in the past must be known (Box II). The environmental impact may depend not only on a country's total consumption but also on the kinds and rates of application on crops. Although some figures on the total consumption of pesticides in India are available, the data on the pattern of their usage are scanty. Realizing the importance of such data, USA and many countries in the European Common Market have initiated extensive programmes for its collection. It hardly needs any emphasis that such an information will help in the identification of problems resulting through the actual use of pesticides.

Wide-scale and intensive monitoring investigations to estimate the levels of pesticides in the biotic and abiotic component of environment are being carried out in the western countries, with the aim to detect any undesirable concentration of a pollutant as and when it arises so that an appropriate action may be taken before any detrimental effect occurs (Box III). In India, no national monitoring programme for pesticides residues has so far been initiated. Limited and scattered surveys have only been done to find out the extent of pesticidal contamination in food material (Bindra and Kalra 1973, Lakshminarayana and Krishna Menon 1975, Agnihotri *et al.* 1974a & b), soil (Singh 1977, Vir 1977) and human adipose tissues (Ramachandran *et al.* 1974). Monitoring is defined as ' the process of repetitive observing, for defined purpose, of one or more elements or indicators of the environment according to pre-arranged schedules in space and time, and using comparable methodologies for environmental sensing and data collection '. Thus, monitoring is normally of long-term nature and differs from a survey, which is

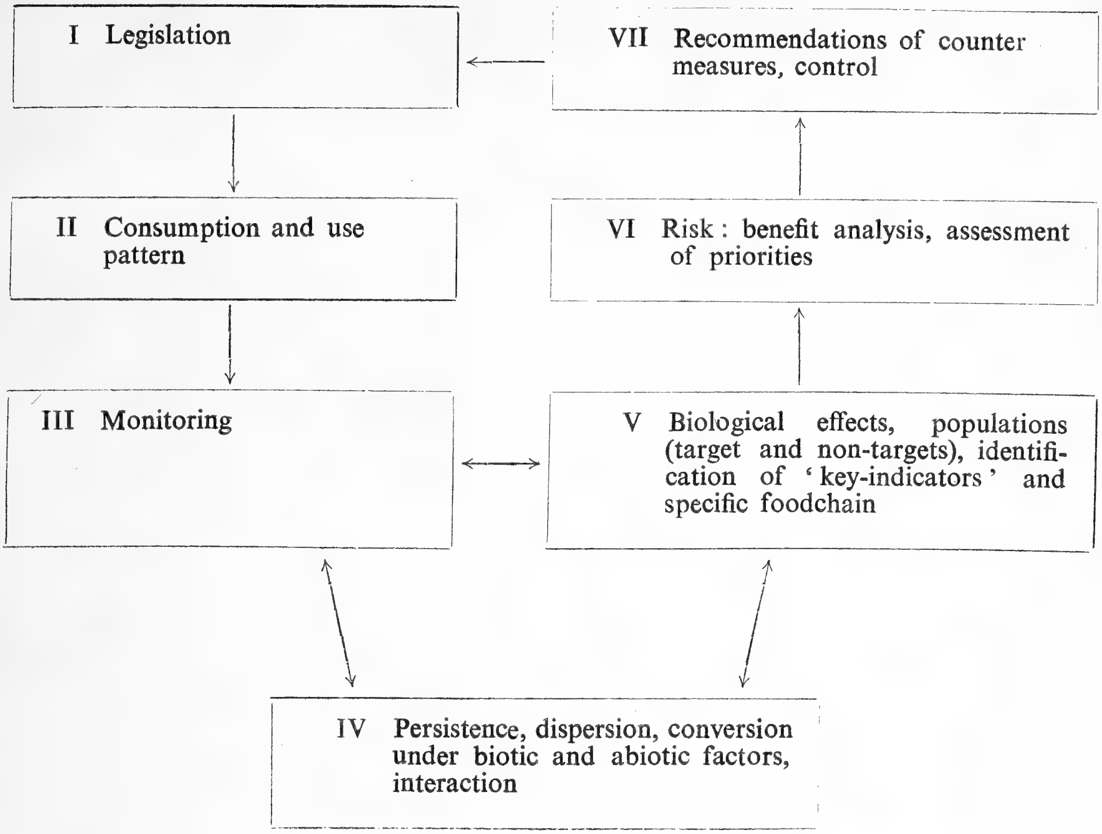

Fig. 2. Integrated and comparative approach to pesticide residues in biosphere (Winteringham *et al.* 1974 with modification).

usually short-term and often comprises only one period of sampling at each sampling site (Holden 1975). Obviously, there is an immediate need for initiation of monitoring programme for pesticides residues in India.

Sufficient information on the fate of pesticides from relevant uses must be acquired (Box IV). Microbial action, volatilization, adsorption, leaching, chemical/biochemical reactions, photodecomposition and absorption by plants, etc. are the key processes that influence the behaviour of pesticides in soil, water, plants and other living organisms as also their movement in the ecosystem. Although considerable progress has been made in understanding these phenomena in temperate region, there is a little information available in sub-tropical countries like ours (Bindra and Kalra 1973, Kalra 1977, Agnihotrudu and Mithyantha 1978). These studies are essential for the judicious use of pesticides and might help in the identification of the sources of the known occurrence of environmental contamination.

Some species populations in the life system, either because of their known susceptibility to pesticides or as they are particularly vulnerable due to their position in the particular ecosystem, may serve valuable role of 'key indicators', They will 'tell us' when pollutant level may be reaching dangerous level in the environment. 'Key indicator species' that readily take up and concentrate residues may be identified in the aquatic and terrestrial ecosystem. It is also important to study the transfer of pesticides through specific food chains and their magnification in humans, animals and wild life. Such studies will enable early detection of the problem situations so that remedial action may be taken (Box V). Practically no work has been done on this aspect in India excepting that of Vir (1977) who found that the local species of earthworm, *Pheretima posthuma*, concentrate DDT residues from soil.

It is becoming increasingly apparent that the benefits of using pesticides must be considered in the context of present and potential risks of pesticide usage (Box VI). Both risks and benefits could vary significantly from country to country, or even from one period of time to another in the same geographical area. For example, persistent organochlorine insecticides like DDT and HCH which have been restricted from use in the western countries are still used in large quantities (about 85 per cent of the total pesticides consumption) in India. However, sound and objective judgements can only be made by the decision-making bodies if systematic information is available both on the benefits and risks. One could appreciate that it will not be possible to have any assessment of risks in the absence of data on the fate and significance of foreign chemical residues, the susceptibility of the exposed plant or animal species (both target and non-target species) or which significant food chain is involved under the particular local conditions. There is serious doubt that the correct assessment of the benefits through pest control programmes is even being made in India. The cases of malaria are showing a steady increase in spite of extensive use of DDT for its control. It may be noted that the malaria vectors have become resistant to DDT almost all over the country. The present-day emphasis is that the use of any pesticide in pest control programmes must be assessed on the basis of three important criteria, economics, public health, and environmental pollution. All three are important and a serious deficiency in any one of these would prevent the pesticide from being used. Unfortunately, no attempt is being made in India to assess even the important pest control programmes such as the use of pesticides for public health purposes and for the protection of crops like cotton, rice, etc. on the basis of these criteria.

Although most of the dangers from unregulated and indiscriminate use of pesticides were known quite early, it was only in 1968 that the comprehensive 'Insecticides Act, 1968' was passed. The Act provides to regulate the import, manufacture, sale, transport, distribution and use of pesticides with a view to prevent risks to human beings or animals and for other matters connected therewith. In addition, we have Prevention of Food Adulteration Act, 1954 under which the provision exists for prescribing the pesticides residues tolerances in food commodities. The registration of pesticide is done under the Insecticides Act, 1968. The burden of proving that a pesticide is safe within the requirement of a scheme lies with the manufacturers. However, most of the manufacturers of pesticides in the country do not have facilities for generating the required data for the purpose of registration. Although the Prevention of Food Adulteration Act is on the statute for about the last 25 years, it does not seem to have been implemented at all to regulate the pesticides residue in the nation's food supply. If such a law is to be effective, it would require very effective machinery which may not be provided for many more years to come. However, it must be realised that most of the problems in controlling pesticides arise from the lack of appreciation that they are product of a technological society. The law may prescribe, proscribe, or regulate anything so long as those requiring the control can explain exactly what they want and the criteria which they wish to apply in order to achieve the end. The important input for the success of pesticides legislation is, therefore, knowledge in the form of scientific data (Box I).

Conclusions

Pesticides are indispensable and invaluable inputs for increased agricultural production. However, this considered indispensability does not justify their use in an irresponsible manner. As is apparent from the foregoing account, the intelligent utilization of pesticides would depend on the fundamental knowledge of the behaviour and effects of pesticides in the ecosystem. Clearly, the pesticidal contamination of the environment in India needs immediate attention in view of the following evidence :

First. The high levels of DDT residues in the adipose tissues of the Indian population.

Second. The widespread contamination of milk with excessive DDT residues.

Third. The estimated dietary intake of DDT in India exceeds the ADI.

The pollution with pesticides is not easy to perceive. Changes in the ecosystem take place so slowly that the problem may become visible only after it has taken a serious turn making it difficult to reverse the trend of negative effects. Therefore, any further complacency may have serious consequences.

Substantial monetary gains in the form of increased agricultural production are obtained through the use of pesticides. In India, pesticides worth 100 crores of rupees are being used every year. The conservative net gain through their consumption may be put at 400-500 crores of rupees. Appropriations of at least 2 per cent of this net gain should be diverted to research so as to develop strategies in the rationale of pesticide use.

Each and every law has an element of assurance for the general public. Pesticides legislations are supposed to provide assurance to the people against the possible harmful effects of pesticides on man and his environment. However, both the Insecticides Act and the Prevention of Food Adulteration Act (PFA rules) have remained practically unimplemented with respect to the contamination of the environment. The literature being issued by the firms, mainly based on the data collected in western countries, contains recommendations on the use of pesticides which are likely to leave residues more than the prescribed maximum limit under certain situations. One wonders on whom the onus for the presence of residues above tolerances under the PFA rules will lie when the sources of contamination of food commodities like wheat, milk, etc. remain obscure. We should not feel shy to accept the realities of the situation. It is suggested that an ' Expert Working Group on Pesticides Residues ' may be constituted to take stock of the present situation, decide priorities, suggest an action plan for immediate implementation through the co-operative efforts of the Government, Industry and related organisations, and help the Government in rationalization of its policy.

It is well recognized that many of the hazards result through the improper usage of the pesticides. If we are to maintain a satisfactory cost/benefit/risk ratio, we must select pesticides carefully and use them correctly and safely. Education on the safe and proper usage of pesticides can go a long way to achieve this.

In the end, it is not inappropriate to state that the use of pesticides is not an ecological sin. Rather, the pesticides are capable of improving the quality of life and environment provided their use is based on sound scientific principles.

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FLORA OF RAJGIR HILLS, BIHAR [1]

S. R. PAUL [2]

(*With a map*)

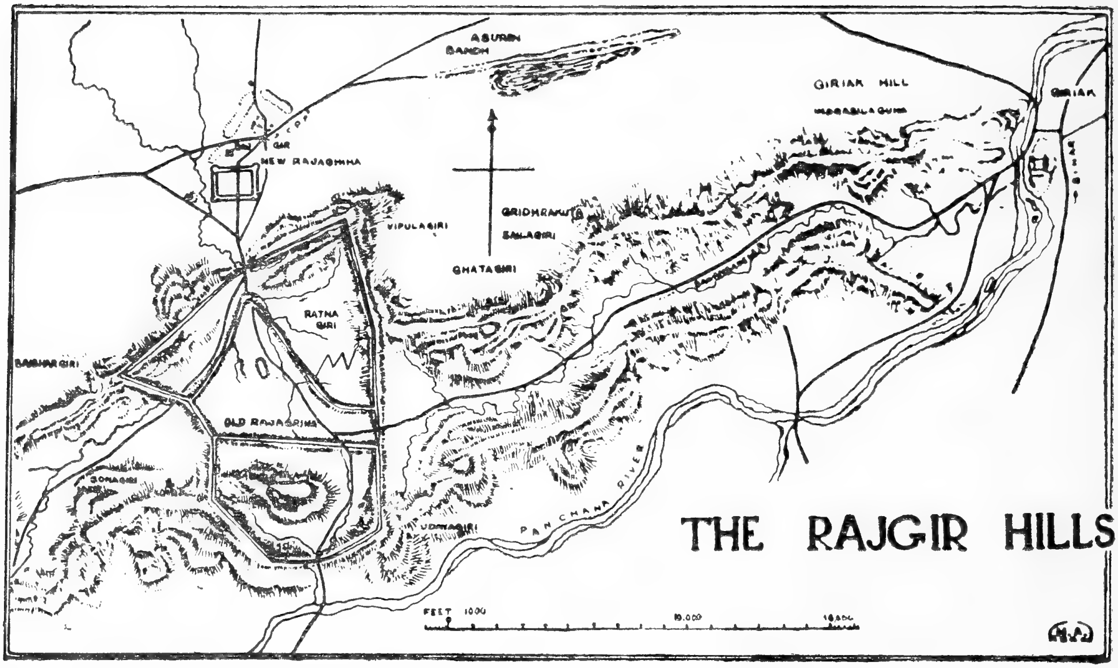
INTRODUCTION

Rajgir, the capital of ancient Magadha was first known and identified by Dr. Buchanan Hamilton as Rajagriha or Giribraja, the residence of Buddha. The city is surrounded by five hills which is mentioned in the Mahabharata and in the Pali annals. The Rajgir hills are a part of a range running north-east near Bodh-Gaya and the main hills are two parallel ranges between Rajgir and Giraik, situated at 25° 1′ 45″ N, 85° 28′ E (Map 1). Ratnagiri which is about 305 m is the highest peak among the five hills. The soil layer is thin, coarse and just below it lie rocks. Rajgir has a monsoon type of climate with an annual rainfall of approx. 113 cm, with the maximum rainfall in July-August.

Rajgir hills remained unexplored botanically and there is no detailed catalogue of the flowering plants of the area except a very short account by Srivastava (1956) who gave a list of about forty-eight angiosperms. This study gives a comprehensive list of 399 vascular plants in the flora of the area based mainly on the col-

[1] Accepted March 1980.

[2] Division of Plant Taxonomy & Herbarium, National Botanic Gardens, Lucknow, India.



Map 1

lections made by the parties of the National Botanic Gardens, Lucknow (LWG) and Central Drug Research Institute (CDRI) supplemented by my personnel collections. The frequency of occurrence based on visual estimation, flowering and fruiting period and field numbers are provided for each species.

According to Haines (1921-25) no specimens of *Trachyspermum strictocarpum* (Cl.) Wolf has ever been collected from the province, although he surmised that it probably enters the province. It is found throughout Higher Vindhyan range from Pachmari, through the Balaghat plateau to the mountains of Bilaspur and its occurrence on Rajgir hills is interesting phyto-geographically. Mooney (Suppl. 68.1950) recorded it from Kalahandi (Orissa) and the present report is an addition to the Bihar flora. *Galactia tenuiflora* (Klein ex Willd.) Wt. & Arn., *Acacia gageana* Craib. and *Lolium perenne* L. are recorded for the first time from Bihar.

RANUNCULACEAE

Ranunculus scleratus L.

Common in open, moist places. *Fl.* : Feb., *Paul* 2523.

DILLENIACEAE

Dillenia pentagyna Roxb.

Frequent in scrub jungles. *Fl.* : April. *Paul* 2505.

ANNONACEAE

Miliusa tomentosa (Roxb.) Sinclair

Common in open grounds. *Fl.* : April. *Srivastava & Party* 20658.

MENISPERMACEAE

Cissampelos pareira L.

Frequent in village hedges. *Fl.* : Sept. *Fr.* Dec. *Saran & Party* 25847.

Cocculus hirsutus (L.) Diels.

Rare in waste land. *Fr.* : April. *Srivastava & Party* 46683.

Stephania japonica (Thunb.) Miers

Not common in villages. *Fl.* : Aug. *Paul* 2512.

NYMPHAEACEAE

Nymphaea stellata Willd.

Rare in paddy-fields. *Fl.* : Oct.

PAPAVERACEAE

Argemone mexicana L.

Common weed of waste land. *Fl.* : April. *Saran & Party* 25864.

FUMARIACEAE

Fumaria parviflora Lamk.

Not common in cultivated fields. *Fl.* : Oct.-Nov. *Srivastava & Party* 46659.

CRUCIFERAE

Brassica campestris L. var. **sarson** Prain

Found as an escape from cultivation.

Cochlearia flava Buch.-Ham.

Rare in cultivated fields. *Fl.* : Nov. *Saran & Party* 25648.

Rorippa indica (L.) Bailey

Not common along banks of streams. *Fl.* : Jan. *Paul* 2537.

CAPPARACEAE

Capparis sepiaria L.

Large climber. Common. *Fl.* : March-May. *Srivastava & Party* 20623 ; *Singh & Party* 2388 (CDRI).

C. zeylanica L.

Frequent in hedges. *Fl.* : April. *Saran & Party* 25869.

CLEOMACEAE

Cleome gynandra L.

Common weed of waste places. *Fl.* : July-Sept. *Paul* 2520.

C. viscosa L.

Common in open waste grounds. *Fl.* : Aug.-Oct. *Paul* 2538.

VIOLACEAE

Ionidium enneaspermus (L.) F. Muell

Not common. *Fl.* : Nov.-Dec. *Paul* 2540.

FLACOURTIACEAE

Flacourtia indica (Burm.) Merr.

Rare in open places. *Fl.* : Dec.-Feb. *Paul* 2503.

F. sepiaria Roxb.

Frequent in open waste lands. *Fr.* : March. *Srivastava & Party* 20626.

COCHLOSPERMACEAE

Cochlospermum religiosum (L.) Alst.

Frequent. *Fl.* : Feb.-April. *Fr.* : May-June. *Saran & Party* 25831.

POLYGALACEAE

Polygala chinensis L.

Common in waste places among grass. *Fl.* : Aug.-Oct. *Chandra & Party* 37023.

P. erioptera DC.

Frequent among grass. *Fl.* : Dec.-Jan. *Chandra & Party* 37022 ; *Saran & Party* 25849 ; *Srivastava & Party* 46520.

CARYOPHYLLACEAE

Polycarpon prostratum (Forsk.) Aschers & Schweinf.

In moist, waste land. Rare. *Fl.* : Oct.-Dec. *Saran & Party* 25021.

PORTULACACEAE

Portulaca oleracea L.

Common in waste places. *Fl.* : Aug. *Chandra & Party* 29340.

P. quadrifida L.

Frequent. *Fl.* : Sept., *Srivastava & Party* 46737.

MALVACEAE

Abutilon indicum (L.) Sweet

Not common in hedges. *Fl.* : Aug. *Saran & Party* 25690.

Abelmoschus manihot (L.) Medic.

Frequent in undergrowth of forest. *Fl.* : Oct.-Nov. *Paul* 2549.

Azanza lampas (Cav.) Alef.

Frequent on hilly slopes. *Fl.* : Sept. *Saran & Party* 25888.

Hibiscus lobatus (Murr.) O. Kuntze

Rare near streams. *Fl.* : Sept.-Oct.

H. ovalifolius (Forsk.) Vahl

Frequent in waste ground. *Fl.* : April. *Srivastava & Party* 20617.

H. vitifolius L.

Fairly common on hilly paths. *Fl.* : Nov. *Saran & Party* 25683.

Kydia calycina Roxb.

Not common in forest. *Fl.* : Oct. *Paul* 2534.

Malvastrum coromandelianum (L.) Garcke

Common in moist, waste land. *Fl.* : Aug.-Oct. *Saran & Party* 25610.

Sida acuta Burm. f.

Common weed of waste places. *Fl.* : Aug.-Oct. *Saran & Party* 25691.

S. cordifolia DC.

Not common. *Fl.* : Aug.-Sept. *Paul* 2515.

S. rhombifolia L. subsp. **rhombifolia.**

Frequent in waste land. *Fl.* : Sept. *Paul* 2526.

S. spinosa L.

Fairly common on the edge of forests. *Fl.* : Oct.-Nov. *Saran & Party* 25681.

S. veronicaefolia Lamk.

Frequent along roadsides. *Fl.* & *Fr.* : Sept.-Feb. *Chandra & Party* 36932.

Urena lobata L. subsp. **sinuata** var. **sinuata** (L.) Borss.

Common in waste land and along streams. *Fl.* & *Fr.* : Sept.- Jan. *Srivastava & Party* 46598.

BOMBACACEAE

Bombax ceiba L.

Not common in valleys. *Fl.* : Feb. *Fr.* : April-May.

STERCULIACEAE

Helicteres isora L.

Common in the forest. *Fl.* : March-April. *Srivastava & Party* 46529.

Melochia corchorifolia L.

Rare in the plains near villages. *Fl.* & *Fr.* : Sept. *Chandra & Party* 37017.

Sterculia urens Roxb.

A few trees noted in scrub jungles. *Fl.* : Jan.-Feb. *Srivastava & Party* 20644.

Waltheria indica L.

Not common in open lands near foothills. *Fl.* Aug.-Sept. *Srivastava & Party* 20647 ; *Saran & Party* 46527.

TILIACEAE

Corchorus aestuans L.

Not common on hilly slopes. *Fl.* : Feb.-March. *Srivastava & Party* 46627.

C. capsularis L.

Rare near ditches. *Fl.* : July-Aug. *Paul* 2530.

C. trilocularis L.

Frequent in moist places. *Fl.* : June-July. *Srivastava & Party* 20194.

Grewia disperma Rottl. ex Spreng.

Rare in forest. *Fl.* : July-Oct. *Srivastava, s.n.*

G. hirsuta Vanb.

Occasional in forests. *Fl.* : Sept. *Chandra & Party* 36994.

G. tiliifolia Vahl

Common in open lands. *Fl.* : Oct.-Nov. *Srivastava & Party* 20639, 20645.

Triumfetta neglecta W. & A.

Frequent in valleys. *Fl.* : Oct.-Dec. *Saran & Party* 25694.

T. rhomboidea Jacq.

Frequent in waste places. *Fl.* : Nov.-Dec. *Chandra & Party, s.n.*

LINACEAE

Linum usitatissimum L.

Not common. Found as an escape along road sides. *Fl. & Fr.* : Nov.-Jan. *Saran & Party* 25928.

OXALIDACEAE

Biophytum sensitivum DC.

Not common among grasses. *Fl. & Fr.* : July-Sept. *Srivastava, s.n.*

B. reinwardtii (Zucc.) Klotz.

Frequent in moist, shady grounds. *Fl.* : Aug.-Oct. *Saran & Party* 46562.

Oxalis corniculata L.

Common in open, wastelands. *Fl. & Fr.* : March-Oct. *Saran & Party* 25693.

O. latifolia H.B. & K.

Not common in moist, shady places near cultivated fields. *Fl.* : Aug. *Srivastava & Party* 21134.

RUTACEAE

Atalantia monophylla (Roxb.) DC.

Not common. *Fl. & Fr.* : Nov.-March. *Saran & Party* 25650.

Murraya paniculata (L.) Jacq.

Frequent in valleys. *Fl. & Fr.* : April-June. *Saran & Party* 25624 ; *Srivastava & Party* 25625.

SIMAROUBACEAE

Balanites roxburghii Planch.

Frequent in scrub jungles. *Fl. & Fr.* : Feb.-May. *Chandra & Party* 37027.

BURSERACEAE

Boswellia serrata Roxb.

Local name : Salai.

Occasional in forest. *Fl. & Fr.* : Feb.-May. *Srivastava & Party* 20653, 46518.

Garuga pinnata Roxb.

Local name : Kekar.

Not common in the Forest. *Fl. & Fr.* : March-July. *Paul* 2502.

MELIACEAE

Soymeda febrifuga A. Juss.

Local name : Rohini.

Occasional. *Fl.* : March-April. *Fr.* : June. *Paul* 2541.

Walsura piscidia Roxb.

Common inside the forest. *Fl. & Fr.* : Feb.-April. *Srivastava & Party* 20661 ; *Saran & Party* 25813, 46513.

OLACINACEAE

Olax scandens Roxb.

Local name : Ramilbari.

Common in forest. *Fl. & Fr.* : April-July. *Srivastava & Party* 20620, 46538 ; *Saran & Party* 25899.

OPILIACEAE

Cansjera rheedii Gmel.

Rare in open places. *Fl. & Fr.* : Dec.-March. *Paul* 2550.

CELASTRACEAE

Celastrus paniculata Willd.

Frequent. Conspicuous from the colour of its aril. *Fl. & Fr.* : April-Sept. *Paul* 2524.

Elaeodendron glaucum Pers.

Occasional. *Fl.* & *Fr.* : Oct.-Dec. *Paul* 2510.

RHAMNACEAE

Ventilago denticulata Willd.

Frequently climbing over large bushes. *Fl.* & *Fr.* : Oct.-Jan. *Saran* & *Party* 25844 ; *Srivastava* & *Party* 46539.

Zizyphus mauritiana Lamk.

Common in dry places. *Fl.* & *Fr.* : Feb.-March. *Chandra* & *Party* 37029. Paul 2501.

Z. oenoplia Mill.

Rare in waste places. *Fl.* : July-Aug. Paul 2528.

Z. xylopyra (Retz.) Willd.

Frequent in forest. *Fl.* & *Fr.* : March-April. *Saran* & *Party* 46555, 25866 ; *Srivastava* & *Party* 20651.

VITACEAE

Ampelocissus latifolia (Roxb.) Planch.

Occasional. *Fl.* & *Fr.* : April-Aug. *Paul* 2517.

Cayratia trifolia (L.) Domin

Common. *Fl.* & *Fr.* : March-Nov. *Chandra* & *Party* 29343.

Leea edgeworthii Sant.

Not common. *Fl.* & *Fr.* : May-Oct. *Paul* 2539.

SAPINDACEAE

Cardiospermum halicacabum L.

Fairly common in Villages. *Fl.* : April-May. *Saran* & *Party* 25674.

Schleichera oleosa (Lour.) Oken.

Occasional in forest. *Fl.* & *Fr.* : March-Aug. *Srivastava* & *Party* 46540.

ANACARDIACEAE

Buchanania lanzan Spreng.

Frequent along roadsides. *Fl.* & *Fr.* : April-May. *Srivastava* & *Party* 20652.

Lannea coromandelica (Houtt.) Merr.

Frequent. *Fl.* & *Fr.* : April-June. *Saran* & *Party* 25633.

Semecarpus anacardium L.f.

Rare near forest edges. *Fl.* & *Fr.* : May-Oct. *Saran* & *Party* 25867.

PAPILIONACEAE

Abrus precatorius L.

Not common. *Fl.* & *Fr.* : Sept.-Feb. *Saran* & *Party* 25661.

Alhagi pseudalhagi (M.B.) Desv.

Not common in Plains. *Fl.* : Feb.-April. *Paul* 2543.

Alysicarpus bupleurifolius (L.) DC.

Frequent in grasslands. *Fl.* & *Fr.* : Aug.-Nov. *Paul* 2504.

A. monilifer (L.) DC.

Common in waste places. *Fl.* & *Fr.* : Sept.-Dec. *Srivastava* & *Party*, *s.n.*

A. vaginalis (L.) DC.

Frequent among grasses on moist grounds. *Fl.* & *Fr.* : Oct.-Jan. *Paul* 2513.

Butea monosperma (Lam.) Taub.

Local name : Palas. Rare. *Fl.* & *Fr.* : Feb.-June. *Saran* & *Party*, *s.n.*

Crotalaria calycina Sch.

Rare in waste lands. *Fl.* : July-Sept. *Paul* 2547.

C. chinensis L.

Frequent in forest. *Fl. & Fr.* : Sept.-Dec. *Srivastava & Party* 46632.

C. evolvuloides Wight

Frequent in shady places. *Fl. & Fr.* : Aug.-Jan. *Srivastava & Party* 21552.

C. prostrata Rottl. ex Willd.

Frequent in forest. *Fl. & Fr.* : Aug.-Oct. *Paul* 2531.

C. sericea Retz.

Rare in grasslands. *Fl. & Fr.* : Aug.-Jan. *Paul* 2511.

Dalbergia latifolia Roxb.

Frequent in open places. *Fl. & Fr.* : Sept.-Feb. *Srivastava & Party* 46547, 46535.

D. paniculata Roxb.

Occasional in forest. *Fl. & Fr.* : July-Oct. *Saran & Party* 25870.

Desmodium gangeticum (L.) DC.

Fairly common. *Fl. & Fr.* : April-Oct. *Srivastava & Party* 46551.

D. latifolium DC.

Rare in waste grounds. *Fl. & Fr.* : Sept.-Nov. *Paul* 2506.

D. motorium (Hout.) Merr.

Not common among grasses. *Fl. & Fr.* : April-Sept. *Paul* 2525.

D. pulchellum Benth.

Frequent. *Fl. & Fr.* : Sept.-Dec. *Paul* 2636.

D. triangulare (Retz.) Merr.

Not common in moist places. *Fl. & Fr.* : Aug.-Jan. *Paul* 2516.

D. triflorum (L.) DC.

Common in wastelands. *Fl. & Fr.* : Sept.-Feb. *Srivastava & Party* 46594.

Galactia tenuiflora (Klein ex Willd.) Wt. & Arn.

Frequent. *Fl. & Fr.* : July-Feb. *Saran & Party* 25898.

(This is the only record for the province).

Indigofera hamiltoni Grah.

Frequent in forest. *Fl. & Fr.* : March-June. *Saran & Party* 25895.

I. hirsuta L.

Common in moist places. *Fl. & Fr.* : Sept.-Nov. *Srivastava & Party* 46507.

I. linifolia (L.) Retz.

Common. *Fl. & Fr.* : July-Dec. *Srivastava & Party* 46522 ; *Saran & Party* 25881.

I. linnaei Ali

Frequent. *Fl.* : Aug. *Chandra & Party* 37000.

I. pulchella Roxb.

Frequent. *Fl.* : Dec.-Feb. *Srivastava & Party* 20656, 20635.

I. tinctoria L.

Not common in forest. *Fl. & Fr.* : Aug.-Nov. *Saran & Party* 46579.

Lathyrus sativus L.

Escape from cultivation. *Fr.* : Oct. *Srivastava & Party* 46615.

Medicago denticulata Willd.

Rare among grasses. *Fl. & Fr.* : Aug.-Dec. *Paul* 2027.

Melilotus alba Desr.

Common weed of cultivation. *Fl. & Fr.* : Feb.-April. *Saran & Party* 25936.

M. indica (L.) All.

In cultivated fields. *Fl.* & *Fr.* : Oct.-Dec. *Paul* 2508.

Milletia auriculata Baker ex Brand.

Rare in forest. *Fl.* & *Fr.* : Aug.-Feb. *Paul* 2532.

Mucuna pruriens (L.) DC.

Local name : Kanwach.

Occasional in forest. *Fr.* : Oct.-Dec. *Paul* 2514.

Ougenia oojeinensis (Roxb.) Hoch.

Rare in open places. *Fr.* : Feb.

Phaseolus calcaratus Roxb.

Not common in forest. *Fl.* & *Fr.* : Oct.-Jan. *Chandra* & *Party* 29299.

Pterocarpus marsupium Roxb.

Not common. *Fl.* & *Fr.* : Oct.-Feb. *Srivastava* & *Party* 20643.

Rhynchosia minima DC.

Frequent in waste places. *Fl.* & *Fr.* : Aug.-Nov. *Srivastava* & *Party* 46681.

Tephrosia purpurea Pers.

Frequent on dry soils. *Fl.* & *Fr.* : Oct.-Feb. *Srivastava* & *Party* 20629.

Teramnus labialis (L.f.) Spreng.

Occasional in forest. *Fl.* & *Fr.* : Sept.-Dec. *Paul* 2518.

Uraria picta Desv.

Rare in forest. *Fl.* & *Fr.* : Aug.-Oct. *Paul* 2544.

Vicia hirsuta Gray

Frequent in cultivated fields. *Fl.* & *Fr.* : Sept.-Dec. *Paul* 2507.

Zornia gibbosa Spanoghe

Common in dry paddy fields, *Fl.* : Nov. *Paul* 2536.

Caesalpiniaceae

Bauhinia malabarica Roxb.

Frequent. *Fl.* : March-Oct. *Srivastava* & *Party* 20657.

B. vahlii Wt. & Arn.

Not common. *Fl.* & *Fr.* : July-Jan. *Paul* 2509.

B. variegata L.

Occasional. *Fl.* : Feb.-March. *Saran* & *Party* 25621.

Cassia fistula L.

Not common. *Fl.* & *Fr.* : June-Nov. *Srivastava* & *Party* 20644.

C. occidentalis L.

Common in waste places. *Fl.* & *Fr.* : Aug.-Oct. *Saran* & *Party* 25675.

C. sophora L.

Frequent. *Fl.* & *Fr.* : Sept.-Nov. *Srivastava* & *Party* 26491.

C. tora L.

Frequent in waste grounds. *Fl.* & *Fr.* : Oct.-Feb. *Paul* 2535

Mimosaceae

Acacia catechu (L.f.) Willd.

Not common along forest edges. *Fl.* & *Fr.* : March-May. *Paul* 2546.

A. gageana Craib. in Kew Bull. 1915 : 409, 1915.

Rare in forest. *Fl.* : April. *Srivastava* & *Party* 46516.

New record for Bihar & Orissa. *Distr.* : W. Pakistan ; Jammu.

A. nilotica (L.) Delile subsp. **indica** (Benth.) Brenan

Frequent. *Fr.* : Oct.-Nov. *Saran & Party* 25660.

A. torta (Roxb.) Craib.

Not common. *Fl.* : Oct.-Nov. *Srivastava & Party* 20634, 46516.

Albizzia lebbek (L.) Benth.

Not common in valleys. *Fr.* : Oct.-Nov. *Srivastava & Party* 20633.

A. odoratissima (L.f.) Benth.

Occasional. *Fl.* : March-April. *Paul* 2639.

Mimosa himalayana Gamble

Common. *Fl.* & *Fr.* : April-June. *Srivastava & Party* 20627.

M. pudica L.

Rare in waste grounds. *Fl.* & *Fr.* : Aug.-Oct. *Paul* 2521.

Neptunia oleracea Lour.

Not common in streams. *Fl.* & *Fr.* : Oct.-Nov. *Srivastava & Party* 21497.

ROSACEAE

Potentilla supina L.

Frequent. *Fl.* : April-May. *Saran & Party* 25930.

Rosa macrophylla Lindl.

Some plants were noted as escape from cultivation. *Fl.* : Oct. *Saran & Party* 25929.

DROSERACEAE

Drosera burmanni Vahl

Rare in Swampy fields. *Fl.* : April-June. *Paul* 2548.

COMBRETACEAE

Combretum decandrum Roxb.

Not common. *Fl.* : Oct.-Feb. *Saran & Party* 25823, 46526.

C. nanum Ham.

Rare. *Fl.* : March-May. *Saran & Party* 25671.

Terminalia bellirica (Gaertn.) Roxb.

Not common. *Fr.* : Jan.-Feb. *Paul* 2522.

T. tomentosa Wt. & Arn.

Frequent. *Fr.* : April-June. *Chandra & Party* 28141.

MYRTACEAE

Syzygium jambos (L.) Alston

Frequent. *Fl.* & *Fr.* : April-July. *Paul* 2545.

LYTHRACEAE

Ammannia baccifera L.

Occasional near streams. *Fl.* & *Fr.* : Sept.-Dec. *Saran & Party* 25577.

Rotala indica (Willd.) Koehne

Frequent in marshy places. *Fl.* : Oct.-Nov. *Paul* 2554.

R. rotundifolia (Buch.-Ham.) Koehne

Common aquatic. *Fl.* : March-June. *Paul* 2519.

Woodfordia fruticosa (L.) Kurz

Local name : Dhaki.

Frequent in open, dry places in the forest. *Fl.* & *Fr.* : Feb.-May. *Saran & Party* 25829, 46557.

ONAGRACEAE

Ludwigia octovalvis (Jacq.) Raven subsp. **octovalvis**

Common in moist grounds. *Fl.* : Nov. *Saran & Party* 25678.

L. perennis L.

Frequent in rice-fields. *Fl.* : Sept.-Oct. *Saran & Party* 25695.

CUCURBITACEAE

Bryonopsis amplexicaulis Lamk.

Common climber. *Fr.* : Oct.-Nov. *Srivastava & Party* 25631.

Coccinia grandis (L.) Voight

Frequent in village hedges. *Fr.* : Oct.-Nov. *Srivastava & Party* 46585.

Momordica dioica Roxb.

Frequent in waste grounds. *Fl. & Fr.* : Sept.-Nov. *Paul* 2533.

Trichosanthes dioica Roxb.

Occasional. *Fr.* : Feb.-March. *Srivastava & Party* 46561.

FICOIDACEAE

Mollugo nudicaulis Lamk.

Frequent. *Fl. & Fr.* : Feb.-Sept. *Srivastava & Party* 21492.

M. pentaphylla L.

Not common in open fields. *Fl.* : July-Oct. *Paul* 2551.

Trianthema portulacastrum L.

Fairly common. *Fl. & Fr.* : Sept.-Jan. *Chandra & Party* 29356, 29352 ; *Srivastava & Party* 46661.

UMBELLIFERAE

Centella asiatica (L.) Urban

Frequent along roadsides. *Fr.* : Oct. *Saran & Party* 25696.

Seseli indicum W. & A.

Common. *Fl.* : Jan.-March. *Srivastava & Party* 21550.

Trachyspermum strictocarpum (Cl.) Wolf

Not common. *Fl. & Fr.* : Sept.-Feb. *Saran & Party* 25923 ; *Singh & Party* 2384 (CDRI).

ALANGIACEAE

Alangium salviifolium (L.f.) Wang.

Common on hills. *Fl* : Feb.-April. *Saran & Party* 25817.

RUBIACEAE

Anthocephalus cadamba (Roxb.) Miq.

Occasional. *Fl.* : April-July. *Srivastava & Party* 20650.

Borreria stricta (L.f.) C.F.W. Mey

Frequent along way side and waste lands. *Fl.* : Sept.-Nov. *Paul* 2529.

Gardenia latifolia Aiton

Occasional in forest. *Fl.* : April-June. *Paul* 2553.

G. turgida Roxb.

Frequent. *Fl. & Fr.* : March-April. *Srivastava & Party* 20649 ; *Saran & Party* 25842.

Hedyotis hispida Retz.

Occasional. *Fr.* : Jan.-Feb. *Saran & Party* 25927.

Hymenodictyon exselsum Wall.

Not common. *Fl.* : Oct.-Feb. *Saran & Party* 25895.

Ixora arborea Roxb. ex Smith

Frequent. *Fl.* : March-April. *Saran & Party* 25824.

Oldenlandia affinis (R. & S.) DC.

Occasional near river banks. *Fr.* : Oct.- Dec. *Paul* 2542.

O. corymbosa L.

Frequent. *Fl.* : Oct. *Paul* 1500.

O. ovatifolia (Cav.) DC.

Frequent. *Fl.* : Nov.-Feb. *Paul* 2573.

Pavetta indica L.

Frequent. *Fl.* : June. *Srivastava & Party* 46553. *Saran & Party* 25886.

P. tomentosa (Haines) Bremek.

Not common along footpaths. *Fl.* : Nov.-Jan. *Srivastava & Party* 20640.

Xeromphis spinosa (Thunb.) Poir.

Occasional. *Fl.* : Feb.-June. *Paul* 2555.

COMPOSITAE

Ageratum conyzoides L.

Very Common everywhere. *Fl.* : Dec. *Paul* 2552.

Blumea jacquemontii Hook. f.

Frequent. *Fl.* : Feb. *Srivastava & Party* 46517.

B. lacera DC.

Occasional in sheltered places. *Fl.* : Jan.-Feb. *Paul* 2560.

B. laciniata DC.

Occasional in wastelands. *Fl.* : March. *Saran & Party* 25699.

B. mollis (D. Don) Merrill

Not common in cultivated fields. *Fl.* : Nov.-Dec. *Paul* 2562.

B. oxyodonta DC.

Frequent along roadsides. *Fl.* : Jan.-March. *Paul* 2568.

Caesulia axillaris Roxb.

Common in rice-fields. *Fl.* : Oct.-Nov. *Paul* 2578.

Eclipta prostrata (L.) Linn.

Common in rice-fields. *Fl.* : Sept.-Dec. *Paul* 2570.

Elephantopus scaber L.

Not common in grassland. *Fl.* : & *Fr.* : Aug.-Oct. *Paul* 2557.

Emilia sonchifolia DC.

Occasional in waste places. *Fl.* : Oct.-Nov. *Paul* 2569.

Gnaphalium indicum L.

Frequent along muddy banks of streams. *Fl.* : Oct.-Jan. *Paul* 2571.

G. purpurium L.

Not common in wet ground. *Fl.* : Feb. *Paul* 2566.

Grangea maderaspatana Poir.

Common. *Fl. & Fr.* : April-July. *Saran & Party* 25685.

Laggera alata Sch.-Bip.

Rare. *Fl.* : Sept.-Nov. *Paul* 2556.

Launaea procumbens (Roxb.) Ramayya & Rajagopal

Frequent among grasses. *Fl.* : April. *Paul* 2580.

Senecio nudicaulis Buch.-Ham.

Frequent. *Fl.* : Sept. *Paul* 2561.

Sonchus brachyotus DC.

Common. *Fl.* : Oct.-Dec.

S. oleraceus L.

Frequent. *Fl.* : July. *Srivastava & Party, s. n.*

Sphaeranthus indicus L.

Common in marshy places. *Fl.* : Feb.-Oct. *Paul* 2574.

Tridax procumbens L.

Very Common. *Fl.* : Aug.-Nov. *Paul* 2579.

Vernonia cinerea Less.

Common in waste, open places. *Fl.* : Feb. *Paul* 2583.

Vicoa indica (Willd.) DC.

Common. *Fl.* : Feb.-Nov. *Srivastava & Party* 46548.

Xanthium indicum Koenig

Common. *Fr.* : Oct.-Dec. *Paul* 2594.

CAMPANULACEAE

Campanula benthamii Wall. ex Kitamura

Rare. *Fl.* : Feb.-March. *Paul* 2575.

PRIMULACEAE

Anagallis arvensis L.

Not common in moist ground. *Fl.* : Oct.-Dec. *Paul* 2590.

MYRSINACEAE

Ardisia solanacea (Poir.) Roxb.

Occasional in valleys. *Fl. & Fr.* : Feb.-July. *Paul* 2558.

SAPOTACEAE

Madhuca longifolia (Koenig) MacBride var. **longifolia**

Rare. *Fl. & Fr.* : May-Jan. *Saran & Party, s.n.*

EBENACEAE

Diospyros melanoxylon Roxb.

Frequent. *Fr.* : April-June. *Paul* 2577.

D. montana Roxb.

Occasional. *Fr.* : June. *Saran & Party* 25816.

D. tomentosa Roxb.

Frequent. *Fr.* : April-May. *Srivastava & Party* 20656.

NYCTANTHACEAE

Nyctanthus arbor—tristis L.

Occasional. *Fl.* : April. *Srivastava & Party* 46532.

APOCYNACEAE

Carissa opaca Stapf ex Haines

Frequently met with on hilly slopes. *Fl. & Fr.* : Feb.-April. *Saran & Party* 25808.

C. paucinervia A. DC.

Not common. *Fl. & Fr.* : Oct. Dec. *Saran & Party* 25808.

Ichnocarpus frutescens (L.) Ait. & Ait.

Common climber in shady localities. *Fl.* Oct.-Jan. *Saran & Party* 25827.

Wrightia tomentosa Roem. & Sch.

Frequent. *Fl. & Fr.* : April-Dec. *Saran & Party* 25884 ; *Srivastava & Party* 46514.

Asclepiadaceae

Calotropis procera R. Br.

Frequent along roadsides. *Fl.* : March-April. *Saran & Party* 25862.

Cryptolepis buchanani Roem. & Sch.

Not common. *Fl.* & *Fr.* : May-Dec. *Srivastava & Party, s. n.*

Dragea volubilis (L.f.) Benth. ex Hook. f.

Frequent. *Fr.* : April. *Chandra & Party, s. n.*

Gymnema sylvestris R. Br.

Common. *Fl.* & *Fr.* : Aug.-Feb. *Saran & Party* 25809 ; *Srivastava & Party* 20901.

Hemidesmus indicus (L.) Sch.

Common. *Fl.* & *Fr.* : Sept.-Nov. *Srivastava & Party* 46558.

Gentianaceae

Canscora diffusa (Vahl) R. Br.

Common in moist, shady places. *Fl.* & *Fr.* : Oct.-March. *Saran & Party* 25944.

Exacum tetragonum Roxb.

Not common among grasses. *Fl.* : Sept.-Nov. *Srivastava & Party, s. n.*

Nymphoides indicum (L.) O. Kuntze.

Rare aquatic. *Fl.* : May-Oct. *Paul* 2592.

Boraginaceae

Cordia dichotoma Forst. f.

Rare. *Fl.* & *Fr.* : March-April. *Paul* 2559.

Cynoglossum lanceolatum Forsk.

Not common in waste grounds and along roadsides. *Fl.* April-Nov. *Paul* 2584.

Heliotropium indicum L.

Frequent. *Fl.* : Aug.-Sept. *Saran & Party* 25679.

H. ovalifolium Forsk.

Occasional. *Fl.* : Feb.-March. *Saran & Party* 25932.

H. supinum L.

Frequent. *Fl.* & *Fr.* : Jan.-Feb. *Saran & Party* 25937.

Trichodesma indicum R. Br.

Occasional. *Fl.* : Oct.-Nov. *Paul* 2563.

Convolvulaceae

Cuscuta reflexa Roxb.

Occasional. *Fl.* : Oct.-Nov. *Chandra & Party, s. n.*

Convolvulus arvensis Sieb. ex Spreng.

Rare in cultivated fields. *Fl.* : Feb.- April. *Paul* 2572.

Erycibe paniculata Roxb.

Frequent. *Fl.* & *Fr.* : April-June. *Srivastava & Party* 46552.

Evolvulus alsinoides L.

Common. *Fl.* & *Fr.*: July-Oct. *Saran & Party* 25901.

E. nummularius L.

Not common. *Fl.* : Oct.-Dec. *Saran & Party, s. n.*

Ipomoea aquatica Forsk.

Abundant. *Fl.* & *Fr.* : March-Oct. *Paul* 2576.

I. nil (L.) Roth

Occasional in waste lands. *Fl.* & *Fr.* ; March-June. *Paul* 2585.

I. pestigridis L.

Frequent in cultivated fields. *Fl.* : Aug.-Sept. *Paul* 2593.

Merremia emarginata (Burm. f.) Hallier f.

Frequent in paddy-fields. *Fl.* : Oct.-Dec. *Saran & Party* 25915.

Porana paniculata Roxb.

Frequent on hedges in scrub-jungles. *Fl.* : Oct.- Dec. *Paul* 2567.

Rivea ornata Choisy

Not common in waste lands. *Fl.* : Aug.-Sept. *Saran & Party* 25868.

SOLANACEAE

Capsicum annuum L.

Occasional near houses. *Fl.* : Aug. *Saran & Party* 25835.

Datura metel L.

Frequent in low-lying fields near villages. *Fl.* : April-May. *Srivastava & Party* 46711.

Nicotiana plumbaginifolia Viv.

A weed introduced from Mexico ; naturalized in waste, moist places. *Fl.* : March-June. *Saran & Party* 25912.

Solanum nigrum L.

Common in cultivated fields. *Fr.* : July-Sept. *Paul* 2591.

S. surattense Burm. f.

Frequent in waste lands. *Fl.* : Nov.-Jan. *Saran & Party* 25804.

SCROPHULARIACEAE

Limnophila indica (L.) Druce

Not common in muddy places. *Fl.* : Sept.-Nov. *Paul* 2564.

Lindenbergia muraria (Roxb.) Bruhl

Occasional. *Fl.* : Oct.-Dec. *Saran & Party* 25664.

Lindernia crustacea (L.) F. Muell.

Common in moist, shady places. *Fl.* : July-Sept. *Paul* 2595.

L. parviflora (Roxb.) Haines

Frequent in marshy places. *Fl.* : Aug.-Sept. *Paul* 2565.

L. sessiliflora (Benth.) Wettst.

Frequent. *Fl.* : July-Aug. *Paul* 2581.

Scoparia dulcis L.

Common in cultivated fields. *Fl.* : Aug.-Sept. *Paul* 2600.

OROBANCHACEAE

Orobanche aegyptiaca Pers.

Common parasite on roots of cultivated plants. *Fl.* : Oct.-Feb. *Paul* 2588.

LENTIBULARIACEAE

Utricularia inflexa Forsk. var. **stellaris** (L.f.) Taylor

Occasional in swamps, paddy fields, etc. *Fl.* & *Fr.* : Oct.-Nov. *Paul* 2610.

BIGNONIACEAE

Stereospermum chelonoides (L.f.) DC.

Occasional in forest. *Fl.* & *Fr.* : Feb.-April. *Paul* 2586.

PEDALIACEAE

Martynia annua L.

Not common among grasses. *Fl.* : Aug. *Paul* 2599.

Sesamum indicum L.

Frequent in cultivated fields. *Fl.* & *Fr.* : July-Oct. *Srivastava & Party* 21520.

ACANTHACEAE

Adhatoda vasica Nees

Occasional. *Fl. & Fr.* : Nov.-Jan. *Saran & Party* 25854.

Andrographis paniculata Nees

Frequent in moist places. *Fl.* : Aug.-Oct. *Srivastava & Party* 46630.

Barleria cristata L.

Frequent in swampy places. *Fl.* : Nov. *Paul* 2587.

B. prionitis L.

Not common in open places. *Fl.* : Oct.-Nov. *Paul* 2605.

Blepharis maderaspatensis (L.) Heyne ex Roth

Common in hedges and open, moist places. *Fl.* : Nov. *Saran & Party* 25904.

Dicliptera micranthes Nees

Occasional in forest. *Fl.* : Feb. *Saran & Party* 25625.

Eranthemum purpurascens Nees

Frequent in forest. *Fl.* : March-April. *Srivastava & Party* 46625.

Hemigraphis hirta T. Anders

Frequent along hill slopes. *Fl.* : March-April. *Saran & Party* 25619.

Hygrophila auriculata (Sch.) Heyne

Occasional along water courses. *Fl.* : Aug.-Oct. *Saran & Party* 25676.

Indoneesiella echioides (L.) Sreem.

Frequent in waste lands. *Fl.* : Nov. *Saran & Party* 25907.

Justicia diffusa Willd.

Common in cultivated fields. *Fl.* : Dec.-Feb. *Paul* 2597.

J. quinqueangularis Koen. ex Roxb.

Frequent in fields and waste grounds. *Fl.* : Feb. *Srivastava & Party* 46690.

Peristrophe bicalyculata Nees

Common in hedges. *Fl.* : Nov. *Saran & Party* 25850.

Rungia pectinata (L.) Nees

Common in dry sandy soils and in open fields. *Fl.* : Oct.-Dec. *Srivastava & Party* 20621.

R. repens (L.) Nees

Frequent in moist places and in cultivated fields. *Fl.* : Nov.-Dec. *Paul* 2589.

VERBENACEAE

Gmelina arborea Roxb.

Frequent in scrub jungles. *Fl.* : March-April. *Saran & Party* 25865.

Lantana camara L. var. **aculeata** (L.) Mold.

Common in villages. *Fl.* : Feb. *Saran & Party* 25558.

Lippia javanica (Burm. f.) Spreng.

Not common in marshy waste lands. *Fl.* : July-Sept. *Paul* 2598.

Phyla nodiflora (L.) Green

Frequent in marshy places. *Fl.* : Oct.-Dec. *Srivastava & Party* 25677.

Pygnacopremna herbacea (Roxb.) Moldenke

Occasional in forest. *Fl.* : June. *Paul* 2609.

Verbena officinalis L.

Rare in paddy fields. *Fl.* : Dec.-Jan. *Paul* 2582.

Vitex negundo L.

Along roadsides near the villages. *Fl.* : July-Oct. *Paul* 2596.

Labiatae

Anisochilus carnosus Wall.

Frequent in paddy fields. *Fl.* : Nov.-Dec. *Paul* 2612.

Anisomeles indica (L.) Kuntze

In open country along hedges. *Fl.* : Oct. *Srivastava & Party* 46675.

Hyptis suaveolens Poit.

Frequent. *Fl.* : Nov. *Srivastava & Party* 46508.

Leucas cephalotes Spreng.

Frequent in cultivated fields. *Fl.* : Sept.-Dec. *Paul* 2601.

L. montana Spreng.

Occasional in forest. *Fl.* : Feb. *Srivastava & Party* 46560.

Nepeta hindostana (Roth) Haines

Rare in marshy waste lands. *Fl.* : Nov. *Paul* 2617.

Ocimum sanctum L.

Frequent near garden beds. *Fl.* : Oct.-Nov. *Srivastava & Party* 46570.

Nyctaginaceae

Boerhavia diffusa L.

Common near villages in waste grounds. *Fl.* : June-Oct. *Saran & Party* 25861.

Amaranthaceae

Achyranthes aspera L.

Frequent in waste places. *Fl. & Fr.* : Sept.-Nov. *Srivastava & Party* 46651.

Aerva lanata (L.) Juss.

Common. *Fl.* : Nov.-Dec. *Srivastava & Party* 46714.

A. sanguinolenta (L.) Bl.

Not common among grasses. *Fl.* : Sept.-Dec. *Srivastava & Party* 46523.

Alternanthera paronychioides St. Hil.

Frequent in marshy places. *Fl.* : Aug.-Oct. *Srivastava & Party* 46490.

A. sessilis (L.) DC.

Common in cultivated fields and moist places. *Fl.* : May-Sept. *Paul* 2606.

Amaranthus gracilis Desf.

Common in cultivated fields and dry, waste land. *Fl. & Fr.* : Sept.-Oct. *Saran & Party* 25860.

A. spinosus L.

Common in waste lands. *Fl. & Fr.* : Oct.-Jan. *Saran & Party* 25672.

A. tricolor L.

Frequent in waste lands and in cultivated grounds. *Fl. & Fr.* : Nov.-Jan. *Chandra & Party* 29349.

Celosia argentea L.

Not common in shady places. *Fl.* : Sept.-Nov. *Srivastava & Party* 46559.

Gomphrena celosioides Mart.

Occasional in cultivated grounds. *Fl.* : March-April. *Paul* 2608.

Chenopodiaceae

Chenopodium album L.

Common weed. *Fl.* : April. *Saran & Party* 25934.

C. murale L.

Frequent in cultivated fields. *Fl.* : Jan.-April. *Saran & Party* 25548.

POLYGONACEAE

Polygonum barbatum L.

Frequent along stream banks. *Fl.* : Nov.-Dec. *Paul* 2614.

P. limbatum Meissn.

Not common. *Fl.* : Dec.-April. *Paul* 2602.

P. plebeium R. Br.

Common in moist places, cultivated fields, dried ditches etc. *Fl.* : March-April. *Saran & Party* 25920.

P. stagnium Buch.-Ham.

Not common. *Fl.* : Dec.-Feb. *Paul* 2624.

Rumex maritimus L.

Common in waste places. *Fl.* : March-April. *Saran & Party* 25935.

LORANTHACEAE

Dendrophthoe falcata (L.f.) Etting

Common parasite on trees. *Fl.* : Dec.-Feb. *Paul* 2607.

EUPHORBIACEAE

Acalypha indica L.

Frequent weed in waste places. *Fl. & Fr.* : Nov.-Jan. *Saran & Party* 25857.

Bridelia montana Willd.

Occasional in forest. *Fl.* : Aug. *Srivastava & Party* 20660.

B. retusa Spreng.

Frequent. *Fl. & Fr.* : Aug.-Oct. *Srivastava & Party* 20638.

B. stipularis (L.) Bl.

Not common. *Fl. & Fr.* : April-Nov. *Srivastava & Party, s.n.*

B. tomentosa Bl.

Not common. *Fl. & Fr.* : Oct.-Feb. *Saran & Party, s.n.*

Croton bonplandianum Baill.

Very common in waste places. *Fl. & Fr.* : Feb.-April. *Saran & Party* 25673.

Cleistanthus collinus Benth.

Frequent in forest. *Fl.* : March-April. *Srivastava & Party, s.n.*

Euphorbia dracunculoides Lamk.

Frequent in waste ground. *Fl. & Fr.* : Oct.-Jan. *Srivastava & Party* 20021.

E. granulata Forsk.

Frequent on dry, fallow fields. *Fl.* : Sept.-Feb. *Chandra & Party* 29300.

E. hirta L.

Fairly common weed. *Fl.* : Aug.-Oct. *Paul* 2613.

E. microphylla Heyne

Frequently met with among grasses. *Fl.* : Aug.-Dec. *Saran & Party* 25914.

E. nivulia Buch.-Ham.

Occasional in rocky places. *Fl.* : March-April. *Saran & Party* 25832.

E. perbracteata Gage

Not common. *Fl.* : Jan.-March. *Chandra & Party* 29281.

Phyllanthus fraternus Webster

Common in waste places. *Fl.* : July-Sept. *Paul* 2604.

P. urinaria L.

Occasional along roadsides and in waste places. *Fl. & Fr.* : May-Nov. *Paul* 2620.

Securinega virosa (Roxb. ex Willd.) Pax & Hoffm.

Frequent in forest. *Fl.* : June-Aug. *Srivastava & Party* 20648.

Tragia involucrata L.

Common in hedges. *Fl.* : Nov.-Jan. *Saran & Party* 25833.

T. gagei Haines

Rare in hedges. *Fl.* : Feb.-April. *Sri-Vastava & Party, s.n.*

Trewia polycarpa Benth.

Frequent in waste places. *Fl.* : Feb.-April. *Saran & Party* 25954.

ULMACEAE

Trema orientalis (L.) Bl.

Occasional near villages. *Fl.* : Oct.-Dec. *Paul* 2611.

MORACEAE

Ficus glabella Bl.

Common in scrub jungles. *Fr.* : April-May. *Srivastava & Party, s.n.*

F. lacor Buch.-Ham.

Frequent in forest. *Fr.* : April. *Paul* 2619.

F. mollis Vahl

Frequent near villages. *Fr.* : March-May. *Paul* 2603.

F. racemosa L.

Common. *Fr.* : May-June. *Paul* 2621.

CERATOPHYLLACEAE

Ceratophyllum demersum L.

Frequent in marshy places. *Fl.* : Aug.-Oct. *Paul* 2623.

MONOCOTYLEDONS

HYDROCHARITACEAE

Hydrilla verticillata (L.f.) Royle

Common aquatic herb. *Fl.* : Aug.-Sept. *Srivastava & Party* 46493.

Vallisneria spiralis L.

Scarce in streams. *Fl.* : Feb.-March. *Paul* 2616.

ORCHIDACEAE

Vanda parviflora Lindl.

Frequent epiphyte. *Fl.* : March-April. *Paul* 2625.

HYPOXIDACEAE

Curculigo orchioides Gaertn.

Not common in forest. *Fl.* : Oct.-Dec. *Paul* 2615.

DIOSCOREACEAE

Dioscorea bulbifera L.

Rare in hedges. *Fr.* : July-Aug. *Paul* 2631.

LILIACEAE

Asparagus racemosus Willd.

Not common. *Fl.* : Nov.-Jan. *Paul* 2618.

Asphodelus tenuifolius Cav.

Frequently met with as a weed of cultivated fields. *Fl.* & *Fr.* : April-Oct. *Paul* 2640.

PONTEDERIACEAE

Eichhornia crassipes (Mart.) Solms.

Not common in ditches below the hill. *Fl.* : March-April. *Paul* 2622.

COMMELINACEAE

Commelina benghalensis L.

Fairly common weed. *Fl.* : July-Aug. *Chandra & Party* 29336.

C. forskalii Vahl

Common in marshy places. *Fl.* : Sept.-Oct. *Saran & Party* 25698.

Cyanotis cristata (L.) D. Don

Common in marshy places, among grasses and in crevices of rocks. *Fl.* : Oct.-Nov. *Paul* 2629.

Murdannia nudiflora (L.) Brenan

Common along streams, river banks and in moist grassy places. *Fl.* : Aug.-Sept. *Paul* 2638.

PALMAE

Phoenix acaulis Buch.-Ham.

Occasional in forest undergrowth.

ALISMATACEAE

Sagittaria guayanensis H.B. & K. subsp. **lappula** (D. Don) Bogin

Not common in muddy banks. *Fl.* : Sept.-Oct. *Paul* 2626.

POTAMOGETONACEAE

Potamogeton crispus L.

Frequent in shallow ditches. *Fl.* : Jan.-March. *Srivastava & Party* 46762.

ERIOCAULACEAE

Eriocaulon cinereum R. Br.

Frequent in paddy fields. *Fl.* : Oct. *Paul* 2634.

CYPERACEAE

Bulbostylis barbata (Rottb.) Cl.

Occasional in forest. *Fl.* : Sept.-Nov. *Chandra & Party* 37049.

Cyperus amabilis Vahl

Frequent. *Fl.* : April-Sept. *Chandra & Party* 36969.

C. brevifolius (Rottb.) Hassk.

Common in moist places. *Fl.* : June-Sept. *Saran & Party* 25697.

C. compressus L.

Common in rice-fields. *Fl.* : June-Aug. *Chandra & Party* 37013.

C. exaltatus Retz.

Common along streams. *Fl* : Aug.-Oct. *Srivastava & Party* 21933.

C. iria L.

Common in rice fields. *Fl.* : Sept.-Jan. *Chandra & Party* 37004.

C. kyllingia Endl.

Frequent along streams in marshy places. *Fl.* : June-Aug. *Srivastava & Party* 21473.

C. malaccensis Lamk.

Not common among grasslands. *Fl.* : Sept.-Jan. *Saran & Party* 25946.

C. pygmaeus Rottb.

Not common in paddy-fields. *Fl.* : April-June. *Paul* 2633.

C. rotundus L.

Common in cultivated fields. *Fl.* : Aug.-Nov. *Chandra & Party* 29293.

Eleocharis plantaginea R. Br.

Frequent along margins of shallow ditches. *Fl.* : Oct.-Nov. *Srivastava & Party* 21478.

Fimbristylis junciformis Kunth

Common among grasses. *Fl.* : April-Aug. *Srivastava & Party* 21102.

F. monostachya Hassk.

Frequent near hot springs. *Fl.* : Aug.-Sept. *Srivastava & Party* 21121.

F. miliaceae (L.f.) Vahl (= **S. quinquangularis** Vahl)

Frequent in marshy places. *Fl.* : Oct.-Dec. *Srivastava & Party* 21475.

Scirpus maritimus L.

Common along streams. *Fl.* : March-April. *Saran & Party* 25922.

Scleria levis Retz.
(= *S. hebecarpa* Nees)

Not common. *Fl.* : Aug.-Oct. *Srivastava & Party* 20611.

Poaceae

Andropogon pumilus Roxb.

Frequent in forest. *Fl.* : Nov.-Dec. *Srivastava & Party* 20630.

Apluda mutica L.

Common on marshy banks of paddy fields. *Fl.* : Aug.-Sept. *Srivastava & Party* 20655.

Aristida adscensionis Lour.

Occasional in dry fields. *Fl.* : July. *Srivastava & Party* 20659.

Arthraxon lancifolius (Trin.) Hochst.

Common in open waste places. *Fl.* : Oct.-Nov. *Srivastava & Party* 20622.

Arundinella benghalensis Druce

Frequent in grasslands. *Fl.* : Aug.-Sept. *Srivastava & Party* 22636.

A. pumila (Hochst.) Steud.

Common on hill sides. *Fl.* : July-Aug. *Srivastava & Party* 21173.

Arundo donax L.

Frequent in forest. *Fl.* : Nov.-Dec. *Srivastava & Party* 21458.

Brachiaria ramosa (L.) Stapf

Occasional in waste places *Fl.* : April-May. *Srivastava & Party* 21470.

B. reptans (L.) Gard. et Hubb.

Not common in paddy fields. *Fl.* : Oct.-Nov. *Paul* 2627.

Bothriochloa glabra Stapf

Occasional. *Fl.* : April. *Srivastava & Party* 20603.

B. pertusa (Willd.) A. Camus

Frequent in grasslands. *Fl.* : Nov.-Dec. *Srivastava & Party* 20615.

Chrysopogon fulvus (Spreng.) Chiov.

Common in open, moist, waste places. *Fl.* : Oct.-Nov. *Srivastava & Party* 20628.

Crypsis schoenoides Lamk.

Not common in waste places. *Fl.* : Sept.-Oct. *Srivastava & Party* 21465.

Cymbopogon caesius (Nees) Stapf

Rare in forest. *Fl.* : Nov. *Srivastava & Party* 20654.

C. martini (Roxb.) Wats.

Frequent in forest. *Fl.* : Oct.-Dec. *Srivastava & Party* 20200.

Cynodon dactylon (L.) Pers.

Very common everywhere. *Fl.* : Aug. *Paul* 2635.

Dendrocalamus strictus (Roxb.) Nees

Frequent in outskirts of forests. *Srivastava & Party* 20625.

Dicanthium annulatum (L.) A. Camus

Common on hilly slopes. *Fl.* : July-Aug. *Srivastava & Party* 46618.

Digitaria adscendens (H.B. & K.) Henr. subsp. **adscendens**

Common in waste places. *Fl.*: Oct.-Nov. *Paul* 2628.

D. marginata Link.

Frequent among grasses. *Fl.*: Sept. *Srivastava & Party* 21093.

Echinochloa colona (L.) Link.

Common in marshy places and in paddy fields. *Fl.*: Oct.-Dec. *Chandra & Party* 29287.

Eleusine indica (L.) Gaertn.

Common along roadsides, waste places and in cultivated fields. *Fl.*: July-Aug. *Srivastava & Party* 21459.

Eragrostiella bifaria (Vahl) Bor

Occasional in moist grounds. *Fl.*: Aug. *Srivastava & Party* 20632.

Eragrostis pilosa (L.) Beauv.

Common in waste grounds. *Fl.*: July. *Srivastava & Party* 21127.

E. tenella (L.) Beauv. ex Roem. & Sch.

Frequent in grasslands. *Fl.*: Dec.-Jan. *Paul* 2637.

Eulalia trispicata (Sch.) Henr.

Frequent in open, waste grounds. *Fl.*: Oct.-Nov. *Chandra & Party* 33637.

Hackelochloa granularis (L.) O. Kuntze

Occasional in marshy places. *Fl.*: Nov.-Dec. *Srivastava & Party* 20641.

Heteropogon contortus (L.) Beauv. ex R. & S.

Common in forest. *Fl.*: March-April. *Srivastava & Party* 20619.

Imperata cylindrica (L.) P. Beauv.

Frequent in open grasslands. *Fl.*: Nov. *Srivastava & Party* 21136.

Leptochloa chinensis (L.) Nees

Frequent near hot springs. *Fl.*: April. *Srivastava & Party* 21133.

Lolium perenne L.

Occasional in the forest. *Fl.*: April-July. *Srivastava & Party* 21467.

Microchloa setacea R. Br.

Frequent on old walls of the fort. *Fl.*: Aug.-Sept. *Srivastava & Party* 20896.

Oplismenus burmanni (Retz.) P. Beauv.

Common along roadsides in the forest. *Fl.*: Oct.-Nov. *Srivastava & Party* 20631.

Ophiurus monostachyus Presl.

Not common. *Fl.*: Sept. *Srivastava & Party* 20642.

Panicum paludosum Roxb.

Occasional. *Fl.*: Oct. *Srivastava & Party* 21463.

P. psilopodium Trin.

Occasional in rice fields. *Fl.*: Nov. *Srivastava & Party* 21119.

Paspalidium flavidum (Retz.) A. Camus

Frequent in moist places. *Fl.*: Oct.-Nov. *Paul* 2632.

Pennisetum pedicillatum Trin.

Occasional in forest. *Fl.*: Sept.-Oct. *Srivastava & Party* 20618.

Saccharum spontaneum L.

Common in grasslands. *Fl.*: Aug.-Sept. *Srivastava & Party* 20198.

Schizachyrium brevifolium (Sw.) Nees

Frequent in dry, waste lands. *Fl.*: Nov.-Jan. *Srivastava & Party* 20616.

S. exile Stapf

Occasional. *Fl.* : Nov. *Srivastava & Party* 20624.

Setaria glauca (L.) Beauv.

Very common. *Fl.* : Aug.-Sept. *Srivastava & Party* 20674.

Sporobolus diander (Retz.) Beauv.

Occasional in moist places and in cultivated fields. *Fl.* : Sept. *Chandra & Party* 27908.

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MATURATION AND SPAWNING OF *RASBORA DANICONIUS* (HAM.-BUCH.)[1]

V. Y. THAKRE AND S. S. BAPAT[2]

(*With two text-figures*)

The present paper deals with the study on the gonadal maturation, sex ratio, minimum size at maturity, spawning season and spawning periodicity in a cyprinid fish, *Rasbora daniconius*.

INTRODUCTION

The maturation and spawning study is important as a factor with significant correlations with other biological activities, since this study is useful in various applied aspects of fishery, its management and industries.

Oviparous fishes exhibit various types of spawning tendencies which can be studied from the development of the intra-ovarian eggs. Walford (1932), Clark (1934), and Hickling & Rutenberg (1936) studied various spawning behaviours based on the size distribution of the intra-ovarian eggs in different fishes.

MATERIAL AND METHODS

3085 specimens of *Rasbora daniconius* were collected from August 1973 to July 1974 from river Kham near Aurangabad. The total length and weight of each fish were accurately measured in mm and mg respectively and the lengths and weights of the gonads were also noted. The ovaries were then preserved in 5% formalin for ova-diameter measurements of the intra-ovarian eggs. Since the distribution of ova in anterior, middle and posterior regions was uniform, the ova-diameter measurements from only the middle region of each ovary were taken. The range of ova in each ovary was then divided into several groups with a class interval of three micrometer divisions and the percentage of the ova present in each size group was calculated and presented in graphs (Figs. 1 & 2).

Growth of ova in different stages of maturity : The ova-diameter frequency polygons exhibited in Fig. 1, show size distribution of ova in the ovaries of different stages of maturity. On the basis of the gonadal appearance, the size of the intra-ovarian eggs and the extent of the yolk present in the ova, the ovaries have been classified into seven maturity stages (Wood 1930). Stage V again has been sub-classified into V_1, V_2 and V_3 sub-stages on the basis of the modes shown by the ovaries in stage V.

Sex ratio : Sex composition for different months and different size groups is shown in Tables 1 and 2 respectively. The Chi-square test (Snedecor 1961), used in each case confirms whether the observed ratio agrees to the expected 1 : 1 ratio between the two sexes. The X^2 values significant at 5% level are shown with one asterisk and those significant at both 5% and 1% levels are shown with two asterisks.

Minimum size at maturity : 2152 females specimens ranging between 36 and 160 mm in total length were examined for their maturity stages. The number and percentage of females in different maturity states, such as immature, maturing, mature and spent were recorded

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TABLE 1

SEX COMPOSITION AND ITS CHI-SQUARE TEST FOR DIFFERENT MONTHS IN *R. daniconius*

Months		Total No. of specimens examined	Females		Males		X^2	D.F.
			Number	Percentage	Number	Percentage		
1973								
August	..	192	155	80.73	37	19.27	72.5**	1
September	..	559	322	57.60	237	42.40	12.925**	1
October	..	320	173	54.06	147	45.94	2.113	1
November	..	268	178	66.42	90	33.58	29.895**	1
December	..	372	272	73.12	100	26.88	79.527**	1
1974								
January	..	311	262	84.24	49	15.76	145.881**	1
February	..	238	197	82.77	41	17.23	102.252**	1
March	..	188	136	72.34	52	27.66	37.531**	1
April	..	201	131	65.17	70	34.83	18.512**	1
May	..	93	75	80.65	18	19.35	34.936**	1
June	..	137	100	72.99	37	27.01	28.971**	1
July	..	206	151	73.30	55	26.70	44.738**	1
Pooled	..	3,085	2,152	69.76	933	30.24	481.673**	1

TABLE 2

SEX COMPOSITION AND ITS CHI-SQUARE TEST FOR DIFFERENT 10 MM SIZE GROUPS IN *R. daniconius*

Length groups in mm.		Total No. of specimens examined	Females		Males		X^2	D.F.
			Number	Percentage	Number	Percentage		
36-45	..	235	135	57.45	100	42.55	5.213*	1
46-55	..	371	212	57.14	159	42.86	7.571**	1
56-65	..	349	213	61.03	136	38.97	16.989**	1
66-75	..	604	373	61.75	231	38.25	33.384**	1
76-85	..	550	362	65.82	188	34.18	55.047**	1
86-95	..	486	431	88.68	55	11.32	290.897**	1
96-105	..	268	241	89.93	27	10.07	170.881**	1
106-115	..	104	83	79.81	21	20.19	36.962**	1
116-125	..	55	39	70.91	16	29.09	9.618**	
126-135	..	35	35	100.00	..	..	..	..
136-145	..	19	19	100.00	..	..	..	..
146-155	..	7	7	100.00	..	..	..	..
156-165	..	2	2	100.00	..	..	..	..
Pooled	..	3,085	2,152	69.76	933	30.24	481.673**	1

for each size group as shown in Table 3. The Table indicates that mature females appear for the first time in 66-75 mm size group in 4.29%. In the next size group 76-85 mm these females occur in 22.1%. As the percentage 4.29 in the 66-75 mm size group is too insignificant, the minimum size of maturity can be fixed between 76 and 85 mm or 80 mm, the average size of the length group. The occurrence of spent females in the same size group may be due to the wide range of the size group.

Spawning season : Out of 2152 females examined during one year, only 1219 females—all above the minimum size of maturity (i.e. above 75 mm total length), were taken into consideration in this observation. The data of 1219 females collected in different months were analysed into different maturity stages as represented in Table 4. The Table indicates total absence of ripe females in May and their presence from June to November. The small percentage (4.23) of spent females in June may be due to spawners shedding their eggs in early June. In November only two ripe females (4.65%) were caught and there was total absence of spent females in December. This

TABLE 3

PERCENTAGE DISTRIBUTION OF IMMATURE, MATURING, MATURE AND SPENT SPECIMENS IN EACH 10 MM SIZE GROUP

Length groups in mm.	No. of females examined	Immature No. and %	Maturing No. and %	Mature No. and %	Spent No. %
36-45 ..	135	135 (100.00)	..	..	..
46-55 ..	212	166 (78.30)	46 (21.70)	..	..
56-65 ..	213	136 (63.85)	77 (36.15)	..	..
66-75 ..	373	224 (60.05)	133 (35.66)	16 (4.29)	..
76-85 ..	362	179 (49.44)	54 (14.91)	80 (22.10)	49 (13.54)
86-95 ..	431	159 (36.89)	82 (19.03)	122 (28.30)	68 (15.78)
96-105 ..	241	54 (22.41)	73 (30.29)	74 (30.71)	50 (16.60)
106-115 ..	83	13 (15.66)	25 (30.12)	30 (36.14)	15 (18.07)
116-125 ..	39	2 (5.13)	12 (30.77)	16 (41.03)	9 (23.08)
126-135 ..	35	1 (2.86)	7 (20.00)	17 (48.57)	10 (28.57)
136-145 ..	19	..	2 (10.52)	11 (57.90)	6 (31.58)
146-155 ..	7	..	..	5 (71.43)	2 (28.57)
156-165 ..	2	..	..	2 (100.00)	..

(Figures in brackets indicate percentage)

TABLE 4

NUMBER AND PERCENTAGE OF FEMALES (ABOVE 75 MM TOTAL LENGTH) IN DIFFERENT STAGES OF MATURITY

Month	Total No. of females examined	I	II	III	IV	V	VI	VII
1973								
August ..	122	..	..	..	1 (0.82)	38 (31.15)	45 (36.89)	38 (31.15)
September ..	122	..	..	..	1 (0.82)	28 (22.95)	49 (40.16)	44 (36.07)
October ..	105	12 (11.43)	..	..	..	11 (10.48)	36 (34.29)	46 (43.81)
November ..	43	20 (46.51)	..	..	..	..	2 (4.65)	21 (48.84)
December ..	112	76 (67.86)	36 (32.14)	..	..	..	..	..
1974								
January ..	130	7 (5.38)	112 (86.15)	11 (8.46)	..	..	..	..
February ..	120	..	84 (70.00)	35 (29.17)	1 (0.83)	..	..	..
March ..	107	..	39 (36.45)	59 (55.14)	9 (8.41)	..	..	..
April ..	78	..	16 (20.51)	30 (38.46)	27 (34.62)	5 (6.41)	..	..
May ..	64	..	6 (9.38)	21 (32.81)	23 (35.94)	14 (21.88)	..	..
June ..	71	..	..	4 (5.63)	26 (36.62)	16 (22.54)	22 (30.99)	3 (4.23)
July ..	145	..	..	..	7 (4.83)	43 (29.66)	48 (33.10)	47 (32.41)

(Figures in brackets indicate percentages)

suggests that there was no spawning in November, the two ripe females thereat belonged to the late spawners. The data, therefore, indicate that *R. daniconius* spawns from early June to late October, lasting for a period of five months.

Spawning periodicity: Ova-diameter measurement method was adopted for this purpose. Mature ovaries in Vth and VIth stages were obtained from mature females collected in breeding season and fixed in 5% formalin. Eleven such ovaries were selected and the ova-diameter measurements from the middle region of each of the ovaries were taken. From the number of ova and their percentage in each ova-diameter size group, frequency distribution graph for each of the ovaries was drawn as shown in Fig. 2.

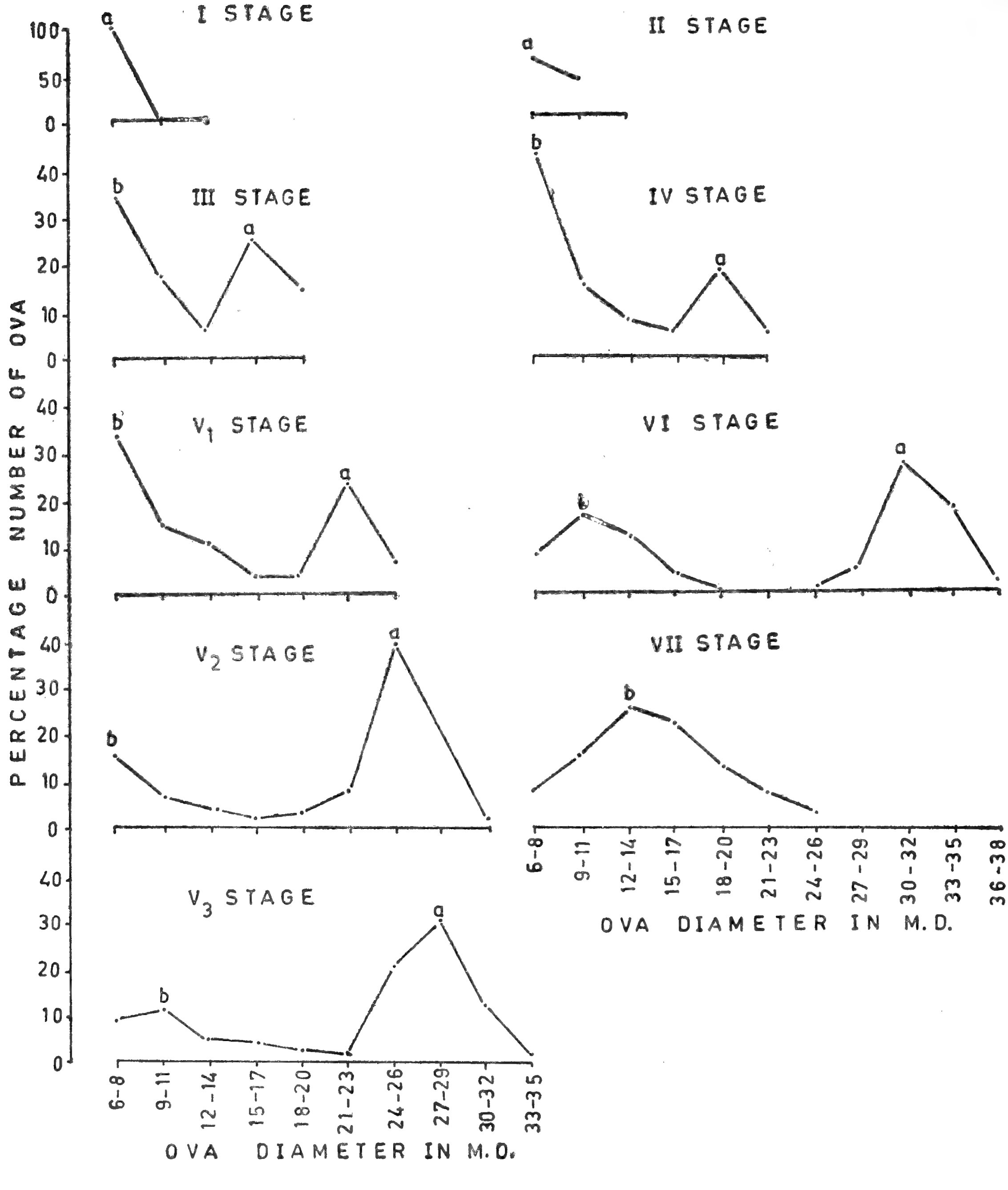

Fig. 1. Ova-diameter frequency polygons showing the growth of the ova in different stages of maturity.

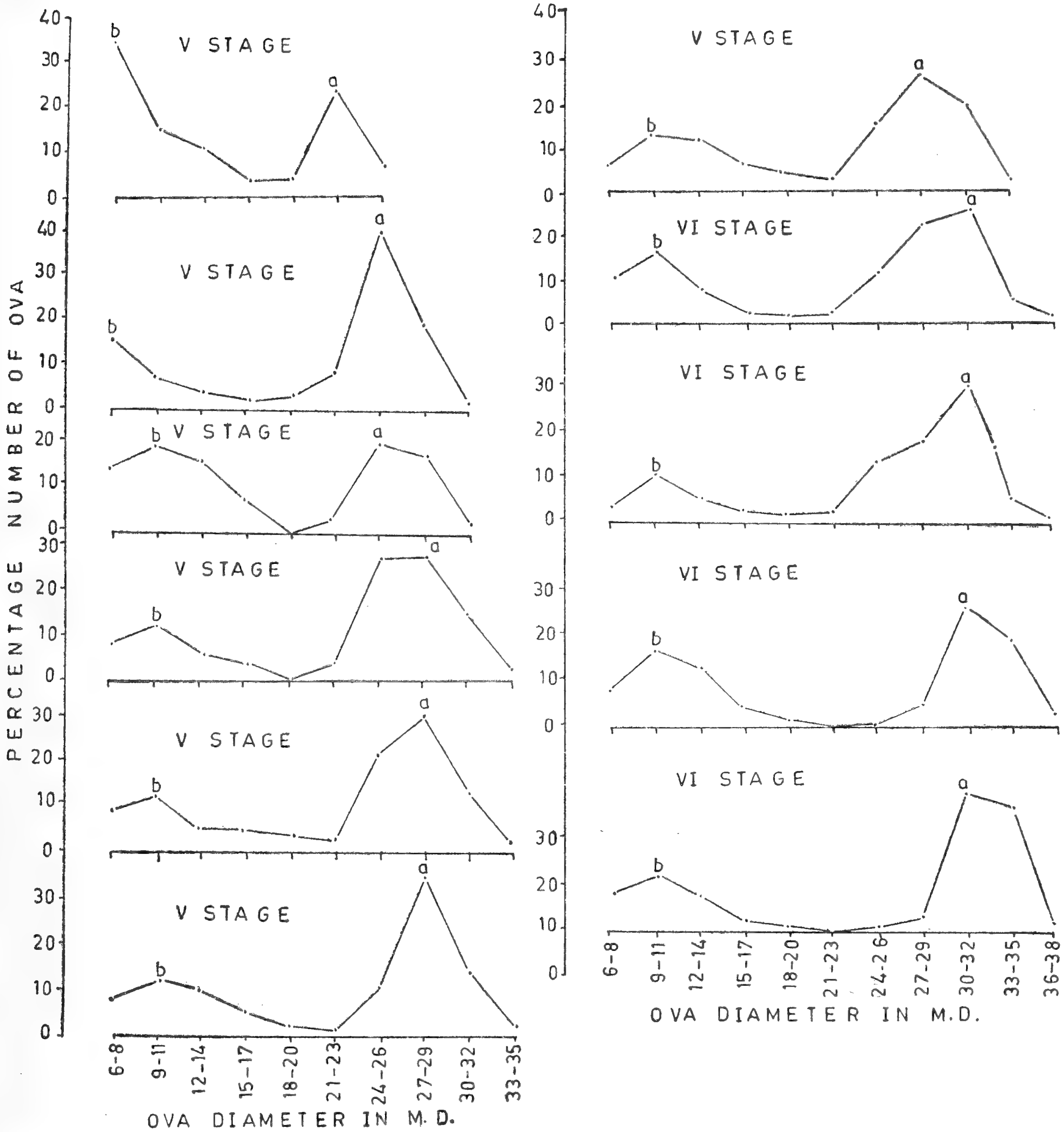

Fig. 2. Size frequency distribution of ova in mature ovaries (Stages V and VI) of *Rasbora daniconius.*

TABLE 5

SHOWING DETAILS OF OVA-DIAMETER RANGE, MODAL TYPES AND MODAL SIZES OF OVA IN EACH MATURITY STAGE OF THE OVARY

Stage of maturiy		Range of ova diameter in m.d.	Modal type	Modal size of ova in m.d.
I	..	6-8	'a'	(6-8)
II	..	6-11	'a'	(6-8)
III	..	6-20	'a'	(15-17)
	..		'b'	(6-8)
IV	..	6-23	'a'	(18-20)
	..		'b'	(6-8)
V	..	6-35	'a'	(21-23),(24-26),(27-29)
	..		'b'	(6-8), (9-11)
VI	..	6-38	'a'	(30-32)
	..		'b'	(9-11)
VII	..	Shortened and indefinite	..	..

It is clear from Fig. 2 that each of the ova-diameter frequency polygons has two distinct modes, 'b' and 'a', the former representing the immature egg stock and the latter the mature ones. Walford (1932) observed that in a fish spawning once in a year, the mature ovary contains only two types of ova, the immature and the mature. Hence from the above observation it can be said that the fish spawns only once in a year. From Table 5 and Fig. 2 it is clear that the total range of the distribution of intra-ovarian eggs in *R. daniconius* is from 6 to 38 m.d., out of which the mature ova cover a range of 18 to 38 m.d., which is nearly half of the total range of the distribution of the intra-ovarian eggs, thereby indicating a prolonged breeding season of the species (Prabhu 1956). The fact that the mature ova are clearly differentiated from the immature ones indicates that the fish spawns in a definite spawning season (Hickling & Rutenberg 1936, De Jong 1939).

It is observed from Table 5 and Fig. 2 that the range of mature ova in the ovaries in stages V and VI is very wide. In the ovaries in Vth stage the mature ova ranged from 18-35 m.d., while those in stage VI ranged from 18-38 m.d. This shows that from Stage V to VI the ova grow from 35 to 38 m.d., i.e. 3 m.d. in diameter. The maximum size of the ova in the ovaries in Stage IV is 23 m.d. This indicates that the mature ova in stage V grow from 23 to 35 m.d., i.e. 12 m.d. in diameter, thus showing that the ovary in stage V grows through a wide range of size and also progresses through different modes showing differential maturity as shown by the sub-stages V_1, V_2 and V_3. The sub-stage V_3 can be said to be more advanced when compared to other two. The phenomenon deals with the prolonged breeding habits of the fish.

It is also clear from the above observations that in stage VI the growth of ova is only 3 m.d. in diameter, whereas, in stage V it is 12 m.d.

in diameter, indicating that the growth of the ova in stage VI is less than that in the stage V and also that the ova after attaining stage VI spawn immediately within a short duration. From this observation it can also be concluded that the ova in stage V have longer persistence in the ovary than those in stage VI.

Results and discussion

The sex ratio in different months and size groups showed dominance of one sex, the females. The Chi-square tests proved that in none of the cases except in October, the sex ratio agreed to the expected 1 : 1 ratio. Since the fish spawns in October, the above observation closely agreed with the view of Tandon (1961), who found that *Selaroides leptolepis* congregated in almost equal numbers during spawning season. The minimum size of maturity was found to be between 76 and 85 mm in total length. The spawning season extended from early June to late October, exhibiting a prolonged duration of spawning periodicity in a single spawning season.

The ovaries of *R. daniconius* were classified into seven maturity stages on the basis of ova-diameter and degree of yolk content in ova. In ova-diameter distribution graphs the mode 'a' of mature ova showed only one constant position in each of the stages except in stage V, where it showed three different positions which formed the basis to sub-classify the ovaries in stage V as V_1, V_2 and V_3, showing gradation in the maturity in one stage itself. Formation of these sub-stages in the stage V could be attributed to the wide range of ova diameter progressed in the stage. The above observation also formed the basis to find out the prolonged spawning periodicity in the fish.

Acknowledgement

We are grateful to Dr. R. Nagabhushanam, Professor and Head, Department of Zoology, Marathwada University, Aurangabad for his constant encouragement and help.

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ADDITIONAL NOTES ON ANDAMAN BIRDS[1]

HUMAYUN ABDULALI

This paper covers the notes on Andaman birds obtained during the course of my last two trips to Car and Great Nicobar which have already been reported upon (*JBNHS* 75 : 744-772).

The first two items relate to records from Battye Malve, south of Car Nicobar, and are really inadvertent omissions from the last paper.

15. **Fregetta tropica melanogaster** (Gould) (Southern Indian Ocean) Duskyvented Storm Petrel.

On 12 April 1977, a dark petrel with white underparts and in flight not unlike a whimbrel, was seen far away, off Battye Malve, and may have been of this species ?

19. **Phaethon lepturus lepturus** Daudin (Mauritius) Longtailed Tropic Bird.

On 21 March 1976, about an hour before we reached N. Cinque I., we saw a large white tropic bird in the distance with dark markings on the back which was probably this species. While talking to the sailors of M.V. *Yonge* on the return trip (after seeing the storm petrel mentioned above), they referred to a white long-tailed bird, all white, with webbed feet, a black streak through the eye and yellowish orange bill, which had taken refuge on the boat during a shower of rain, about two months ago, roughly off Battye Malve, south of Car Nicobar. The bird refused to take the food offered and was duly eaten. The tail feathers 17 inches long, had been preserved and their identity has been confirmed at the Smithsonian.

[1] Accepted April 1979.

200. **Spilornis elgini elgini** (Blyth) (S. Andaman Island) Dark Andaman Serpent Eagle.

The examination of two specimens of *Spilornis elgini abbotti* Richmond (1903) from Simalur I., off the north-west coast of Sumatra borrowed from Rijksmuseum N.H., Leiden, leaves no doubt that *elgini* is a different species from *cheela.* I had overlooked the fact that Peter's BIRDS OF THE WORLD (1931, 1 : 273) had accepted *elgini* and *minimus* as two species both separate from *cheela.*

In April 1976, I saw 2 dark *elgini* and one pale *davisoni* in the Port Blair Zoo, and have the following comparative notes :

	elgini	*davisoni*
(*a*)	Darker & smaller	Paler & larger
(*b*) *Bill :*	thicker & shorter	thinner & longer
(*c*) *Lower belly & vent :*	spotted	barred
(*d*) *Call :*	Deep short whistle & also sharp rattling *tuk-tuk-tuk*	*phui-phui-phui,* not unlike Indian *cheela* at distance
(*e*) *Legs & feet :*	yellowish & smoother	paler, less yellowish & rougher
(*f*) *Tarsus :*	central line of large scales	hexagonal scales all over
(*g*)	Head & back concolorous	head blackish & darker than rest of plumage ; traces of grey cheek patch

	elgini	*davisoni*
(*h*) sits in more owl-like posture		
(*i*) head broader		narrower

Brown 1968 (EAGLES, HAWKS & FALCONS OF THE WORLD 1 pl. 41) illustrates the immature of *elgini* as similar to the adult, only slightly paler all over, and with a whitish head. Some time back Dr. W. Meise drew my attention to Stresemann's statement that the young of *elgini* did not have white underparts as in all races of *cheela* in which this plumage is known. This acceptance of two species makes it much easier to understand *S. elgini* and *S. cheela davisoni* living side by side, though with varying habits, rather than as races of the same species. A *davisoni* obtained at Pyinmalana, South Andaman, in March 1972 contained remains of a small mammal (rat ?).

In *JBNHS* 68 (2) p. 397 I have referred to the first publication of the name being in *Ibis* for January 1863, and not in the *Journal of Asiatic Society of Bengal* for the same month, which I said, was dated February. This is not quite correct but it includes the proceeding of a meeting held on 4 February 1863. Inquiry at the British Ornithologists Union indicates that there is no reason to believe that the *Ibis* was not published in January, and the first publication would have to be accepted therein.

The same remarks would apply to the first description of the Rail (*Rallus canningi*) and the Tree Pie (*Dendrocitta bayleyi*) published under the same circumstances.

315a. **Turnix tanki albiventris** Hume (Andamans) Andaman Yellowlegged Button Quail

Hume (1873, Stray Feathers 1, p. 310) described this from the Andamans 'as close to *maculosa* with a perfectly white abdomen'. He adds that the specimen is an indifferent one and that he is provisionally suggesting the name *albiventris*. This was accepted in Sharpe's CATALOGUE OF BIRDS IN BRITISH MUSEUM (22 : 545) and Blanford's FAUNA (4 : 154), both indicating that it was much rarer in the Andamans than in the Central Nicobars. Stuart Baker (5 : 456) synonymised it with *tanki* (Bengal, later restricted to northern suburbs of Calcutta) but refers only to birds from the Nicobars. The species has not been found on Car or Great Nicobar, and the three which I obtained at Trinkut and Camorta (*JBNHS* 64 : 158) though no doubt different from those from India and Burma, can scarcely be said to have *white* bellies. A juvenile ♀ obtained by de Roepstorff at Camorta on 24 April 1876 has its wings in quill and is paler than three adults from the same area available for examination. At Camorta, it was seen feeding on the road, when the yellow of the bill, legs and feet, was very prominent.

Mr. S. V. Chatterji, I.F.S., told me that one had been caught in a house at Port Blair (1976) and died at the local zoo. Without seeing some material from the Andamans, it is not possible to comment upon the validity of *albiventris*.

383. **Charadrius placidus** J. E. Gray (Nepal), Longbilled Ringed Plover

Sp. No. 156 in Tytler collection in Lahore is marked '*Charadrius longipes* (presumably David 1854—HA). ♀ Andaman Islands', which according to the synonymy in Stuart Baker's FAUNA is *Charadrius placidus* not previously recorded from these islands. The identity of the specimen needs confirmation.

418. **Calidris subminutus** (Middendorff) (Stanovoi Mountains and mouth of Uda) Longtoed Stint

1 ♂ 1 ♀ Dhanikheri, South Andamans, 20 March 1977.

In spite of the paucity of earlier records, I obtained specimens while looking for snipe on all three recent trips out of parties of about 8/10 birds.

The 12 specimens now available for examination consist of 3 ♂♂ and 9 ♀♀. Their measurements overlap but the females are slightly larger than the males. (see Table.)

536. **Streptopelia tranquebarica humilis** (Temminck) (Bengal and Luzon) Red Turtle Dove

On 18 March 1976, they were calling everywhere at Port Blair and a female was seen on a nest 20 ft. up in a large tree (6 April).

548. **Psittacula eupatria magnirostris** (Ball) (Andaman Islands) Large Parakeet

On 6 April 1976 a female was seen bobbing her head up and down on a branch a little below a male, obviously soliciting. The male bent over with open bill and the female thrust hers inside, then withdrew. This was repeated four times before they flew away. Also seen entering a hole in a tree.

603. **Centropus (sinensis) andamanensis** Beavan's Crow Pheasant

At Port Blair, on 6 April 1976, a bird with a pale, almost white head was heard calling from an exposed position in a tree. The bill was held in front and pointed downwards, and the feathers on the head slightly raised, every time it called. Another called '*kuk*' and then rattled off a series of short *kuk-kuk-kuk* (over 20 times) and quite unlike the calls of *C. sinensis* around Bombay. After sunset, several called together from different places, the area resounding with their calls.

TABLE

		Wing	Bill	Tarsus	Tail	Middletoe without claw
♂♂	..	90-92	17.7, 18.7, 19	19, 19.6, 20	34, 37	20, 21, 21.2
♀♀	..	90-100 av. 93.2	18-20.9 av. 19.7	19-22	34-39 45	19-22
(FAUNA ♂♀		87-95	17-19	c. 20-21	34-36	-)

438. **Esacus magnirostris magnirostris** (Vieillot) (Australia) Great Stone Plover

Pairs were noted on Sir Hugh Rose and North Cinque islands and I have referred to their trusting nature in the introduction to my last para on Great Nicobar (*JBNHS* 75, p. 745).

In JBNHS 64(2) : 17 I had referred to the males, which at least in collections were scarcer than females, being smaller. Two additional males from South Andaman both have their wings only 173 mm, and tails 232, 235 mm.

One obtained on 23 April 1977 is marked as with enlarged gonads.

679. **Caprimulgus macrurus andamanicus** Hume (Jolly Boys Island, S. Andamans) Longtailed Nightjar

23809 ♀ Landfall Island

Head more heavily streaked than earlier specimens and interspaces and underparts also darker.

742. **Halcyon chloris davisoni** Sharpe (Aberdeen, S. Andamans) Andaman Whitecollared Kingfisher

♂ Landfall Island, 15 April 1972.

In my Catalogue (*JBNHS* 69, p. 546), I have measured the bills from feathers of a ♂ and 2 ♀♀ from the Andamans as 47, 43, 42 ; the present specimen measures 44.6, all being larger than indicated in INDIAN HANDBOOK (4 : 98) 38-41 mm.

764. **Upupa epops saturata** Lönnberg (Kjachta, Southern Transbaicalia) Hoopoe

The de Roepstorffe collection contains a male hoopoe said to have been obtained in South Andaman on 10 October 1876. The head is pale as in nominate *epops*, but the first primary is all black on one side and has white spots on the other. It was identified by Dr. Ripley as *saturata*. The species has not been recorded from this area before.

983. **Artamus** sp. Swallow Shrike

On North Cinque Island (19 March 1976), I noted several swallow shrikes as very similar to Bombay birds and quite different from dark, white-vented *A. leucorhynchus humei* from Port Blair. This remains unexplained.

1903. **Dicaeum concolor virescens** Hume (Neighbourhood of Port Blair) Plain-coloured Flowerpecker.

On 19 March 1976, a bird with a bright orange lower mandible was being fed by dark-billed parents. The young bird while waiting for its parents, often picked and swallowed small yellow berries after testing them with its bill.

ADDITIONS TO THE PLANTS OF CORBETT NATIONAL PARK, U.P.[1]

P. C. Pant, B. P. Uniyal and R. Prasad[2]

In the present paper 256 species are added to the list of plants of Corbett National Park.

Under the programme of working out the flora of National Parks and Game sanctuaries Northern Circle of the Botanical Survey of India undertook a project for preparing a complete floristic account of the Corbett National Park (Nainital and Garhwal District) in north western U.P. Before the final preparation of the account covering all aspects it has been felt necessary to prepare check-lists for correlating ecological and other observations.

From the initial two explorations conducted, the senior author published a list of plants of Corbett National Park comprising of 232 species. Later more collections were gathered from the area by K. P. Janardhanan in 1972. Critical study of the specimens continued and materials were gradually housed in the BSD Herbarium. As a result of subsequent exploration two notes relating to interesting distribution of species and new records were published (Janardhanan & Prasad 1975 & Janardhanan and Uniyal 1973). In addition to the earlier list 256 species reported in this paper turned out to be the additions to the previous list.

The additional plants species collected are enumerated here according to their habit.

TREES

Alangium salvifolium (L.F.) Wang
Albizzia procera Benth.
Bridelia verrucosa Haines
Buchanania lanzan Spreng.
Butea monosperma (Lamk.) Taub.
Casearia elliptica Willd.
Cassine glauca (Rottb.) Kuntze
Clausena pentaphylla DC.
Cordia dichotoma Forst. f.
C. vestita Hook. f. & Thoms.
Crataeva adansonii DC. ssp. *odora* (Buch.-Ham.) Jacobs.
Drypetes roxburghii (Wall.) Hurus.
Ehretia acuminata R. Br.
Embelia tsjeriam-cottam (Roem. & Sch.) A. DC.
Erythrina suberosa Roxb.
Ficus arnottiana Miq.
F. hispida L.f.
F. infectoria Roxb.
F. racemosa L.
F. rumphii Blume
F. semicordata Buch.-Ham.
Flacourtia indica (Burm. f.) Merr.
Garuga pinnata Roxb.
Grewia elastica Royle
Lannea coromandelica (Houtt.) Merr.
Litsea glutinosa (Lour.) C. B. Robins.
L. monopetala (Roxb) Pers.
Miliusa velutina Hook. f. et Thoms.
Morus alba L.
Nyctanthes arbor-tristis L.
Phoebe lanceolata Nees
Pongamia pinnata (L.) Pierre
Premna barbata Wall. ex Schauer
P. latifolia Roxb. var. *Mucronata* (Roxb.) Clarke
Quercus leucotrichophora A. Camus ex Bahadur
Sapium insigne Trimen
Schleichera oleosa (Lour.) Oken.
Stereospermum suaveolens DC.
Syzygium cerasioides (Roxb.) Chatt. & Kanjilal
Terminalia bellerica (Gaertn.) Roxb.
T. chebula Retz.
Toona ciliata Roem.
Wrightia tomentosa (Roxb.) R. & S.
Ziziphus glaberrima Santapau

[1] Accepted September 1979.
[2] Botanical Survey of India, Northern Circle, Dehra Dun.

SHRUBS

Acacia pseudo-eburnea J. R. Drumm.
Antidesma diandrum Roth
Ardisia humilis Vahl
Asparagus racemosus Willd.
Azanza lampas (Cav.) Alef.
Boehmeria macrophylla D. Don
Calotropis gigantea (L.) R. Br.
C. procera (Ait.) R. Br.
Caryopteris wallichiana Schauer
Coffea bengalensis Heyne ex R. & S.
Combretum nanum Buch.-Ham. ex D. Don
Datura metel L.
Debregeasia hypoleuca Wedd.
Gardenia turgida Roxb.
Grewia sapida Roxb.
Indigofera cassioides Rottl. ex. DC.
Ipomoea fistulosa Mart. ex Choisy
Jatropha curcas L.
Lantana camara L. var. *aculeata* (L.) Moldenke
Leucomeris spectabilis D. Don
Moghania macrophylla (Willd.) O. Ktze.
Phlogacanthus thyrsiflorus Nees
Rubus niveus Thunb.
Solanum indicum L.
Vitex negundo L.

HERBS

Ajuga bracteosa Wall. ex Benth.
A. macrosperma Wall. ex Benth.
Artemisia parviflora Buch.-Ham. ex Roxb.
Asystasia macrocarpa Nees
Baliospermum montanum (Willd.) Muell.-Arg.
Biophytum sensitivum (L.) DC.
Blumea fistulosa (Roxb.) Kurz.
B. laciniata (Roxb.) DC.
B. mollis (D. Don) Merr.
B. oxyodonta (Wall.) DC.
Campanula colorata Wall. ex Roxb.
Chirita pumila D. Don
Cirsium arvense (L.) Scop.
Clinopodium umbrosum (M. Bieb.) C. Koch
Costus speciosus Sm.
Cotula anthemoides L.
Crotalaria medicaginea Lamk.
C. prostrata Rottl. ex Willd.
Curcuma angustifolia Roxb.
Cynoglossum zeylanicum (Vahl) Thunb. ex Lehm.
Desmodium microphyllum (Thunb.) DC.
D. triflorum (L.) DC.
Eclipta prostrata (L.) L.
Eranthemum nervosum (Vahl) R. Br.
Erigeron asteroides Roxb.
Eulophia dabia (D. Don) Hochr.
Euphorbia geniculata Orteg.
Gnaphalium luteo-album L.
Hartmannia rosea G. Don
Hedychium ellipticum Hamilt. ex Rees
Hedyotis pinifolia Wall. ex G. Don
Heliotropium strigosum Willd.
Hemigraphis rupestris Heyne ex T. Andr.
Hypericum japonicum Thunb.
Kohautia gracilis (Wall.) DC.
Lactuca dissecta D. Don
Laggera falcata (D. Don) O. Ktze
Lepidagathis cuspidata (Wall.) Nees
Leucas hyssopifolia Benth.
Lindernia cordifolia (Colsm.) Merr.
L. crustacea (L.) F. V. Muell.
L. sessiliflora (Benth.) Wettst.
L. viscosa (Hornem.) Boldingh
Lobelia heyneana Roem. & Sch.
Mazus delavayi Bonati
Mollugo pentaphylla L.
Mosla dianthera (Buch.-Ham. ex Roxb.) Maxim.
Oldenlandia corymbosa L.
Orthosiphon rubicundus Benth.
Pachystoma senile Reichb. f.
Persicaria nepalensis (Meissn.) H. Gross.
Peucedanum dana Buch.-Ham. ex Clarke
Phyllanthus debilis Klein. ex Willd.
Physalis minima L. var. *indica* Clarke
Plumbago zeylanica L.
Polygala crotalarioides Buch.-Ham. ex DC.
Polygonum plebejum R. Br.
P. serrulatum Lagasc.
P. stagninum Buch.-Ham. ex Meissn.

Portulaca oleracea L.
Potentilla indica (Andr.) Wolf.
Psilotrichum ferrugineum (Roxb.) Moq.
Saussurea heteromalla (D. Don) Hand.-Mazz.
Senecio chrysanthemoides DC.
S. nudicaulis Buch.-Ham. ex D. Don
Sonchus arvensis L.
Sonerila tenera Royle
Sphaeranthus indicus L.
Tephrosia purpurea Pers.
Verbascum chinense (L.) Sant.
Vernonia squarrosa (D. Don) Less.
Vicoa vestita Benth. ex Hook. f.
Youngia japonica (L.) DC.
Zingiber capitatum Roxb.
Z. roseum (Roxb.) Rosc.

GRASSES

Aristida cyanantha Nees ex Steud.
Arthraxon lancifolius (Trin.) Hochst.
Arundinella bengalensis (Spreng.) Druce
A. nepalensis Trin.
A. pumila (Hochst.) Steud.
Arundo donax L.
Bothriochloa intermedia (R. Br.) A. Camus var. *punctata* (Roxb.) Keng
B. pertusa (L.) A. Camus
Brachiaria ramosa (L.) Stapf
Capillipedium assimile (Steud.) A. Camus
Chionachne koenigii (Spr.) Thw.
Chloris dolichostachya Lagasca
Chrysopogon serrulatus Trin.
Cynodon dactylon (L.) Pers.
Cyrtococcum accrescens (Trin.) Stapf
Dactyloctenium aegyptium (L.) P. Beauv.
Digitaria longiflora (Retz.) Pers.
Echinochloa colonum (L.) Link
Eragrostis atrovirens (Desf.) Trin, ex Steud.
Erianthus filifolius Nees ex Steud.
Hackelochloa granularis (L.) O. Ktze.
Heteropogon contortus (L.) P. Beauv.
H. melanocarpus (Ell.) Benth.
Isachne miliacea Roth
Microstegium ciliatum (Trin.) A. Camus
Narenga porphyrocoma (Hance) Bor
Neyraudia arundinacea (L.) Henr.
Oplismenus burmannii (Retz.) P. Beauv.
Panicum antidotale Retz.
P. austroasiaticum Ohwi.
P. montanum Roxb.
Phragmites karka (Retz.) Trin. ex Steud.
Pogonatherum paniceum (Lamk.) Hack.
Pseudosorghum fasciculare (Roxb.) A. Camus
Rottboellia exaltata L.f.
Saccharum bengalense Retz.
Setaria barbata (Lamk.) Kunth
S. geniculata (Lamk.) P. Beauv.
S. homonyma (Steud.) Chiov.
S. pallide-fusca (Schum.) Stapf et C. E. Hubb.
Themeda quadrivalvis (L.) O. Ktz.

SEDGES

Bulbostylis barbata (Rottb.) Clarke
Carex myosurus Nees
Cyperus compressus L.
C. corymbosus Rottb.
C. haspan L.
C. niveus Retz.
C. pangorei Rottb.
C. pilosus Vahl
C. pumilus L.
C. rotundus L.
Fimbristylis bisumbellata (Forsk.) Bub.
F. dichotoma (L.) Vahl
Lipocarpha chinensis (Osb.) Kern.
Scirpus mucronatus L.
Scleria parvula Steud.

AQUATIC, WET OR MARSH HERBS

Bacopa monnieri (L.) Pennell
Cardamine scutata Thunb.ssp. *flexuosa* (With.) Hara
Centella asiatica (L.) Urban
Centipeda minima (L.) A. Br. & Asch.

Cyanotis cristata (L.) D. Don
Hoppea dichotoma Willd.
Ludwigia octovalvis (Jacq.) Raven
Murdannia scapiflora (Roxb.) Royle
Phyla nodiflora (L.) Greene
Potamogeton nodosus Poir.
Ranunculus sceleratus L.
Rotala indica (Willd.) Koehne
R. mexicana Cham. & Schlecht.
R. rotundifolia Koehne
Veronica anagallis-aquatica L.

WOODY CLIMBERS

Celastrus paniculatus Willd.
Helinus lanceolatus Brand.
Hiptage benghalensis (L.) Kurz.
Jasminum arborescens Roxb.
J. roxburghianum Wall. ex DC.
Leptadenia reticulata W. & A.
Mucuna nigricans (Lour.) Steud.
Phothos cathcartii Schott
Pueraria tuberosa (Roxb. ex Willd.) DC.
Rhaphidophora glauca Schott
Sabia paniculata Edgew. ex Hook. f. et T.
Tetrastigma campylocarpum (Kurz.) Planch.
Vitis semicordata Planch.

HERBACEOUS AND SUBWOODY CLIMBERS

Atylosia mollis Benth.
Cardiospermum halicacabum L.
Dioscorea belophylla Voigt
D. bulbifera L.
Diplocyclos palmatus (L.) Jeffrey
Mucuna capitata W. & A.
Piper nigrum L.
Rhynchosia minima DC.
Smilax zeylanica L.
Trichosanthes cucumerina L.
T. dioica Roxb.

OCCASIONAL EPIPHYTES

Ficus benjamina L.
F. hederacea Roxb.
F. retusa L.

PARASITES

Viscum nepalense Spreng.

FERNS AND FERN-ALLIES

Ampelopteris prolifera (Retz.) Copel.
Ceratopteris siliguosa (L.) Copel.
Diplazium esculentum (Retz.) Sw.
D. japonicum (Thunb.) Bedd.
Dryopteris crenata (Forsk.) O. Ktze.
D. rampans (Baker) C. Chr.
Nephrodium cucullatum Baker
Psilotum nudum (L.) Griseb.
Pyrrosia flocculosa (D. Don) Ching
Riccia fluitans L.
Selaginella involvens (Sw.) Spring.
S. subdiaphana (Wall.) Spring.
Thelypteris subpubescens (Bl.) Iwats.

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COMBAT BEHAVIOUR IN *VARANUS BENGALENSIS* (SAURIA: VARANIDAE)[1]

WALTER AUFFENBERG[2]

(*With three text-figures*)

INTRODUCTION

The published information pertaining to varanid combat behaviour contains very few quantitative data. Though important because they outline the major features of varanid combat, all earlier papers were necessarily anecdotal, for they were based on very few observations (Abdoessoeki, no date ; Sterling 1912 ; Schmidt 1927 ; Lederer 1929, 1933; Smith 1931 ; Mertens 1942 ; Vogel 1954, 1979 ; Ditmars 1955 ; Deraniyagala 1958 ; Honegger and Heusser 1969 ; Hoogerwerf 1970 ; Murphy and Mitchell 1974). From these reports it becomes clear that in ritualized male-male varanid combat the most significant feature is a test of strength in which the combatants wrestle while embraced and standing on their hind legs (see Carpenter and Ferguson 1977 for review and comparison of all lizard social behaviour), similar to that known in snakes (Carpenter 1978). The most thorough analysis of the combat of any varanid species is by Carpenter *et al.* (1976), who stress that part of the combat sequence in these lizards known as body arching.

The only data pertaining to combat in the Bengal monitor, *Varanus bengalensis*, is provided in the reports of ritualized fighting seen between wild males in India (Ali 1944) and Sri Lanka (Deraniyagala 1957). The Ali report is very short and stresses the bipedal stance. Deraniyagala's observations also emphasize this phase, as well as body arching and biting attempts.

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Individuals of the same species maintained in captivity under my care in Florida showed slightly different behavioural patterns than those reported by Deraniyagala and, more important, afforded an opportunity to study the details of, and variation in, varanid combat in greater detail than had previously been possible. During the present study, data were obtained on differences in male, female, and adolescent combat, the component behavioural acts comprising each type, conditions under which combat was initiated, and the temporal factors in regard to both season and maturation. Agonistic behaviour, excluding actual fighting, has been described in this species by Auffenberg and Ganci (in press), who conclude that certain behavioural acts often previously considered as threat behaviour by other workers are best considered as part of a stress reaction, for they appear commonly in a variety of stressful contexts, including threatening ones. This paper is an additional part of an anticipated series of contributions on the behaviour of *Varanus bengalensis* in captivity (see also Auffenberg 1979).

METHODS

The results below were obtained largely by review and analysis of continuously running closed circuit TV equipment, including remote cameras appropriately mounted in two greenhouses and a time lapse VTR automatic recorder set to advance the tape at 0.3 sec intervals. This allowed for rapid review when set at a normal replay speed, yet preserved sufficient detail of the recorded social inter-

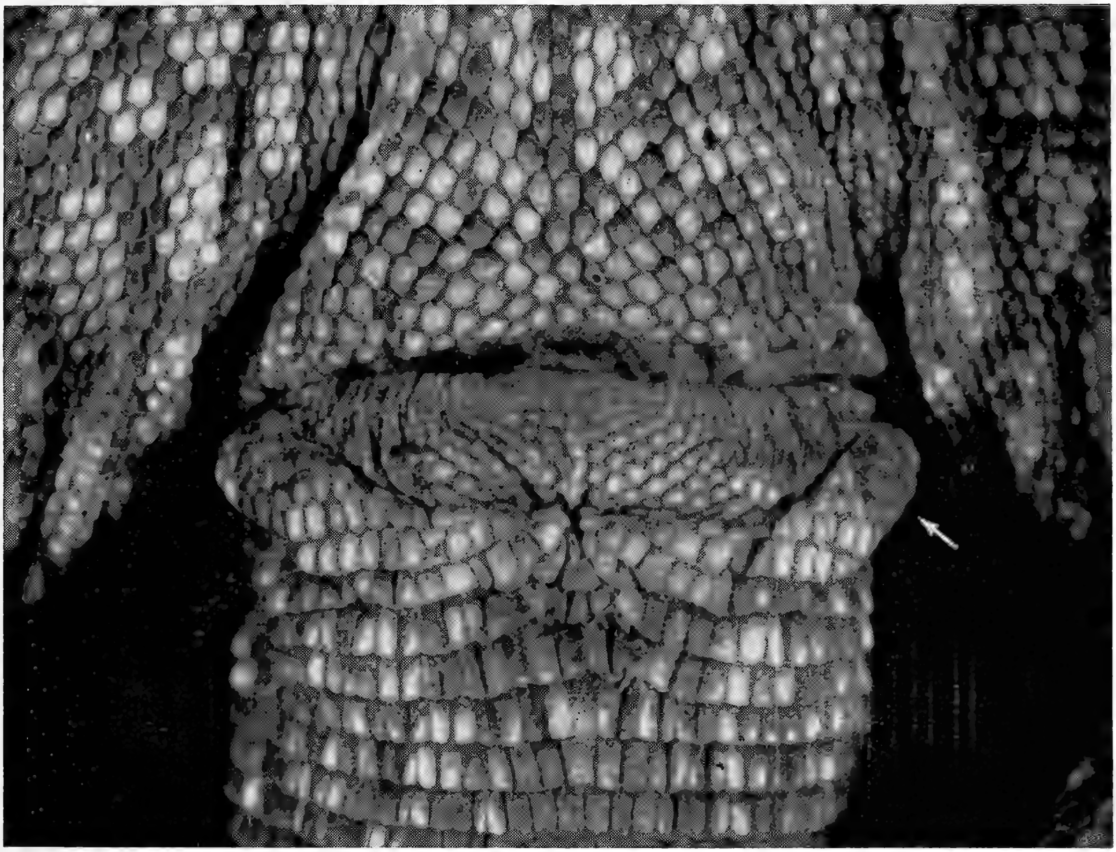


Fig. 1. Cloacal area of subadult male *Varanus bengalensis* (UF 40557), showing thickened ridges posteriolateral to the vent.

actions. In addition to this analysis system, motion pictures (Super-8) were made whenever practical, often within a 2 m range, so that details of the behavioural acts were clearly evident when reviewed by a stop-motion film projector, using a projection system similar to that described by Jenssen (1977).

Each of the two greenhouses (56 m^2 each) usually contained one adult male, several adult females, and a variable number of adolescents of both sexes. Individuals were often shifted from one greenhouse to another to encourage combative interactions among individuals being studied. Observations were carried out from June 1977 to July 1979. During this time 137 combative interactions between 25 individuals were recorded and analyzed. The origin of the individuals and the conditions under which they were kept from 1974 to the present have been described earlier (Auffenberg and Ganci, in press). During the time when the following results were obtained, the lengths and weights of the individuals used were as follows : 4 adult males, average total length 149 cm ($\bar{X}$ SVL 58.0 cm), weight 2743 gm ; 8 females, 119.3 cm ($\bar{X}$ SVL 46.3 cm), weight 1452 gm ; 13 adolescents, 89.0 cm ($\bar{X}$ SVL 38.7 cm), weight 720 gm.

Results

Monitor lizards are notoriously difficult to sex from external characters (Mertens 1946, 1958). Males attain larger size, grow faster, are generally dominant to females (Auffenberg 1979, in press), and in at least some species, more active (Auffenberg 1979). Minor scale characters separate the sexes of some species (Mertens 1958 ; Auffenberg, in press). These differences are often near the cloacal area. After studying the scalation of 89 preserved and live *Varanus bengalensis*, I found a consistent external morphological character that will separate at least 96 per cent of all adults and 47 per cent of the juveniles ; i.e. all males with a snout-vent-length of 25 cm or more possess a patch of scales on the base of the tail just posterior to each of the lateral corners of the vent. These scales form a protrusion that is very slightly flap-like in the sense that the lateral edge forms a shelf raised above the lateral surface of the tail base (Fig. 1). The edge of this shelf is provided with from 3 to 5 slightly enlarged scales, the largest 2-3 being light-coloured. The structure is much smaller in females and barely, if at all, raised above the surface of the tail base. In adults its presence or absence is usually easily seen even in individuals walking about.

Individuals were recognized on the basis of a combination of size, head shape, and colour pattern characteristics. These were easily noted on TV tape and motion picture film.

Combative interactions involving females or adolescents occur at any time of the year. However, male ritual combat is restricted to a much shorter period preceding and during extensive courtship activity of the same individuals (April through July in Florida), suggesting photoperiodic control. It was first noted in individuals known to have attained an age of three years at that time. The first courtship attempts were correlated with the appearance of the earliest signs of ritual combat, so that expression of the latter seems associated with sexual maturity.

Of the total of 137 combat encounters observed and analyzed during this study, 44.5% occurred between adult males, 32.8% between adult males and females, 6.3% between adults and adolescents, 4.7% between adult females, and 11.7% between adolescents (usually males).

Combat activity included a number of behavioural acts, some characteristically preceding or succeeding combat and others occurring only during the combat itself. These could be categorized into several contextural and functional classes (= adaptive behavioural types of Scott 1950). The most common acts were in the agonistic class and included weaponry use, warning signals, combat tactics meant to enhance the effectiveness of the actual encounter whether ritualistic or not, and acts related to social status (dominant or subordinate). Others could be classed as reproductive, for they are most often associated with varanid courtship behaviour. Still others are classed as simple investigatory tactics, and the last class comprises what I believe to be stress-related behaviours that convey the motivational level of the displayer and are used in a variety of contexts (see Auffenberg 1979, in press; Auffenberg and Ganci, in press). Operational definitions of those acts I believe to be important in agonistic behaviour in adults of this species of varanid lizard follow.

Weaponry Class

Biting : Clearly the strongest reinforcement of intent; used by both sexes in both intra- and interspecific combat. It is used more often by females than males in intraspecific fighting and is infrequently used by males during courtship (Auffenberg, MS in preparation). Most bites are on the dorsum, neck, or head, rarely the legs or tail. Deraniyagala (1957) said it occurs in *V. bengalensis.*

Tail slap : A rapid lateral swing of the tail, often, but not always, following tail coiling (see below). The tail slap usually terminates the interaction. The blow is swift and smartly delivered, usually striking the other individual on the side of its body, or less often the head. Tail slapping in combat has been reported in *V. niloticus* (Cowles 1930), *varius, spenceri, mertensi,* and *salvadori* (Murphy and Mitchell 1974).

Warning Class

Tail coil : Partially or completely coiling the tail in the horizontal plane, usually preceding and leading to a tail slap (Fig. 2B).

Gape : A strong cue directing attention to the teeth, but very rarely used in intraspecific combat.

Hiss : An auditory cue, sometimes in the form of huffing, used only in a defensive context.

Lateral compression : Compression of the body laterally so that it presents the broadest lateral view (Fig. 2 B).

Dorsal arch : A dorsal bending of the mid-body region (Fig. 2 B), usually used in a defensive context with lateral compression.

Lateral orientation : Placing the body so that it presents the least perpendicular view, often performed in conjunction with body high, lateral compression, and dorsal arch. Together these serve to increase apparent size (Fig. 2 B).

Dorsal flattening : Dorso-ventral flattening of the trunk, usually accompanied by tilting the broadened surface towards the rival (Fig. 3 G in Carpenter *et al.* 1976). This is apparently a rare act in *Varanus bengalensis.*

Head tilted : Bowing or bending the neck to place the head in a sloping position relative to the substrate (Fig. 2 B).

Combat Tactics Class

Bipedal stance : Rearing smoothly onto the hind legs, with the tail usually used as a support. In a defensive context the front legs may hang limply at the sides (Fig. 2 C), but in an offensive combat context they are used in a brachial embrace (see Fig. 2 G). The defensive form often follows a quick unexpected advance or attack by another individual. The offensive tactic has been described in varanids as follows: Fleay (1958), *V. varius* and *V. spenceri*; Johnson (1976), *V. gouldi*; Ali (1944) and Deraniyagala (1957), *V. bengalensis*; and Lederer (1933) and Vogel (1979), *V. salvator.*

Brachial embrace : Two individuals, ventral surfaces opposed, clasp one another with their

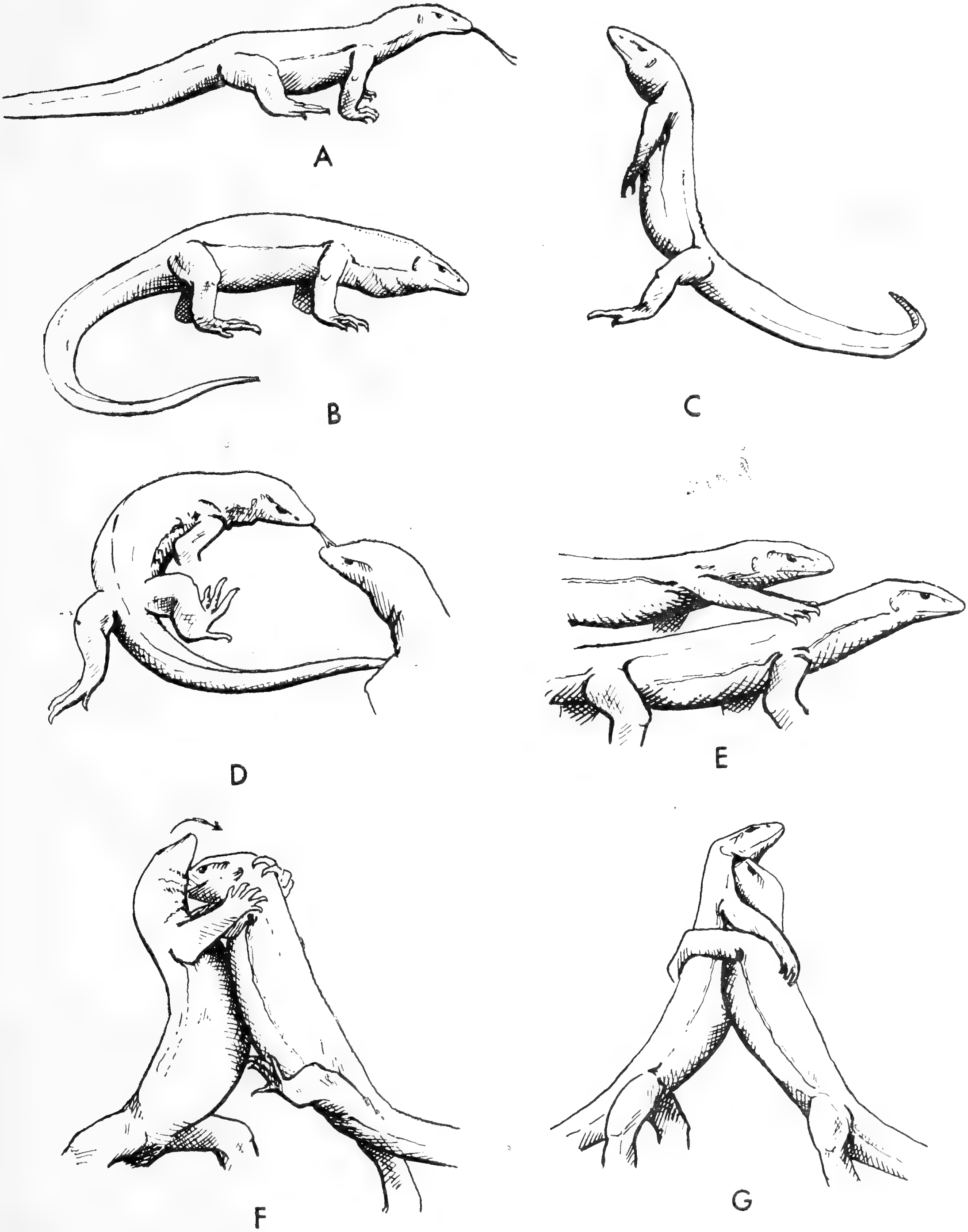
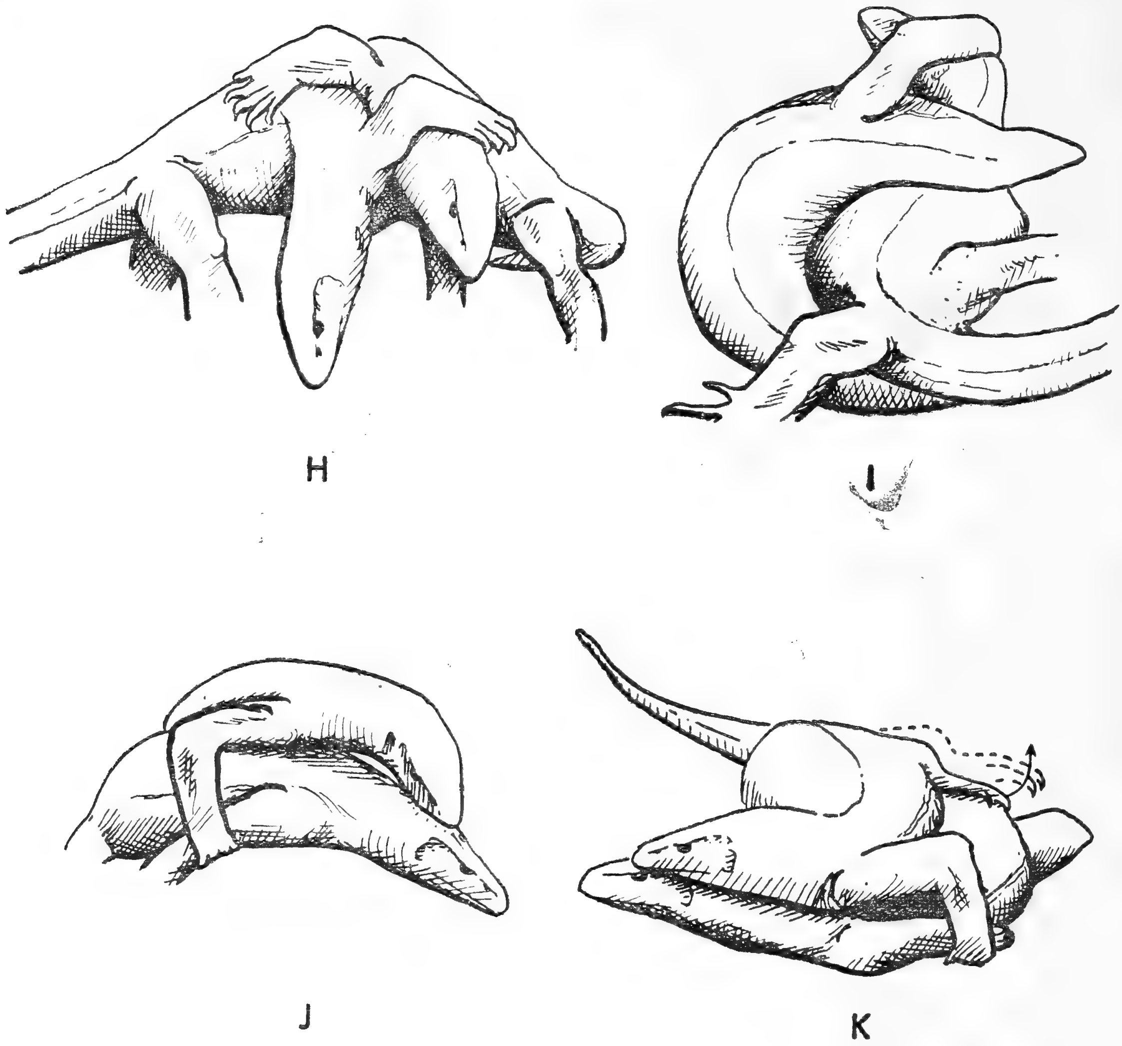


Fig. 2. Behavioural acts of *Varanus bengalensis* common in agonistic contexts, made from motion picture film. (*captions continued overleaf*)



H I J K

Fig. 2 (Contd.) :

(A) investigatory pose with no stress, *i.e.*, tail down and not bowed, no raised roach, head not greatly raised, lowered turned away or tilted, no body compression or gular expansion. Compare with (B) which illustrates a high stress pose, with bowed tail, raised roach, back arched, body compressed, gular expanded, and head tilted downward. (C) defensive bipedal position with gular expansion and head tilted. (D) licking head of potential rival prior to ritualized combat. (E) one individual placing front foot on other as a dominance act. (F) ritual bipedal male-male wrestling combat, with the individual on the right illustrating climbing behaviour—an important fighting tactic—while the other individual is using a lateral head push technique (arrow) to avoid being pushed farther backwards. (G) bipedal stance with mutual brachial embrace and with the individual on the right using a snout-in-throat tactic to lift or twist the other individual. (H) left individual moves snout to the substrate and forms a body arch as he is twisted downward by individual on the right. (I) topping behaviour by adult female on left immediately after being mounted by male on right. (J) dominance behaviour by mounted male directed to subadult male after ritual combat, including brachial embrace and neck biting—often part of the courtship sequence. (K) same, but showing chin rubbing and tail lifting (arrow) by male.

front legs (Fig. 2 G). This tactic was usually also mentioned in the reports of the several varanids listed above.

Wrestle : Twisting and turning, bipedal individuals try to push the embraced rival to the ground (Fig. 2 G). During this tactic it is apparent that the splayed hind legs of the opponents help to resist lateral movement when force is applied by the opponent (Fig. 2 F). The major tactic is thus to push forward in such a way that the weight of the opponent is shifted onto his tail base (Fig. 2 F), thereby raising his hind legs off the ground and making it easier to topple him sidewards. To help the weight transfer, opponents sometimes try to climb the other while in a bipedal stance, particularly up the other's thighs (Fig. 2 F). Wrestling has been mentioned in several of the reports listed above.

Snout thrust : One individual during the bipedal stance, and always when engaged in a brachial embrace, thrusts its snout into the space between the posterior parts of the lower jaw, thus providing a nonslip surface when the head is used to push the head of the other laterally (Fig. 2 G).

Lunge : Move rapidly towards another individual ; the distance involved less than the lizard's own length.

Head push : Pushing sidewards with the head and neck to force the other individual off balance during ritual male combat (Fig. 2 F). The necks and heads are sometimes so crossed that they appear entwined (more so in long-necked varanids, such as *V. salvator*, see Vogel 1979), reminding one of the much more highly twisted necks of snakes in ritual combat (Carpenter 1977).

Body arch : Always following bipedal wrestling, when one individual is nearly pushed to the ground by the other. It is a tactic that is apparently meant to keep the momentarily disadvantaged individual from being pushed to the ground and into a subordinant position. To accomplish this the snout of one or both individuals is used as one base of an arch produced by the neck and body, with the base or middle of the tail and one of the hind legs forming the other base of the arch (Fig. 2 H). The hind foot on the side of the body closest to the ground is used as an important supporting strut (Fig. 3), and the opposite free leg attempts to hold down the hind foot of the other individual, or is at least kept over the body of the other. This tactic makes it difficult for the arch to be broken, for the hind legs are linked over one another. The loser in this part of the combat is usually the one who allows his hind leg to be displaced from this position by having it slip under the opponent's body. This individual is then easily pushed to the substrate by the body and hind legs of the other ; the winner ending in a superior, nearly mounted position. Body arching has previously been described in ritual combat of male varanids in *V. gilleni* (Murphy and Mitchell 1974 ; Carpenter *et al.* 1976), *V. bengalensis* (Deraniyagala 1957), and *V. salvator* (Vogel 1979).

Dominant Class

Head raised : Head lifted above the trunk axis and held there (Fig. 2 A).

Topping : One individual puts one of its front feet on the back of the other (Fig. 2 E), or even climbs upon the other (Fig. 2 I), and maintains this position even as the lower individual tries to move away (= *riding* of Carpenter and Ferguson 1978).

Subordinant Class

Head down : Head dropped below trunk axis and held there.

Facing away : Head and/or body oriented away from the other individual.

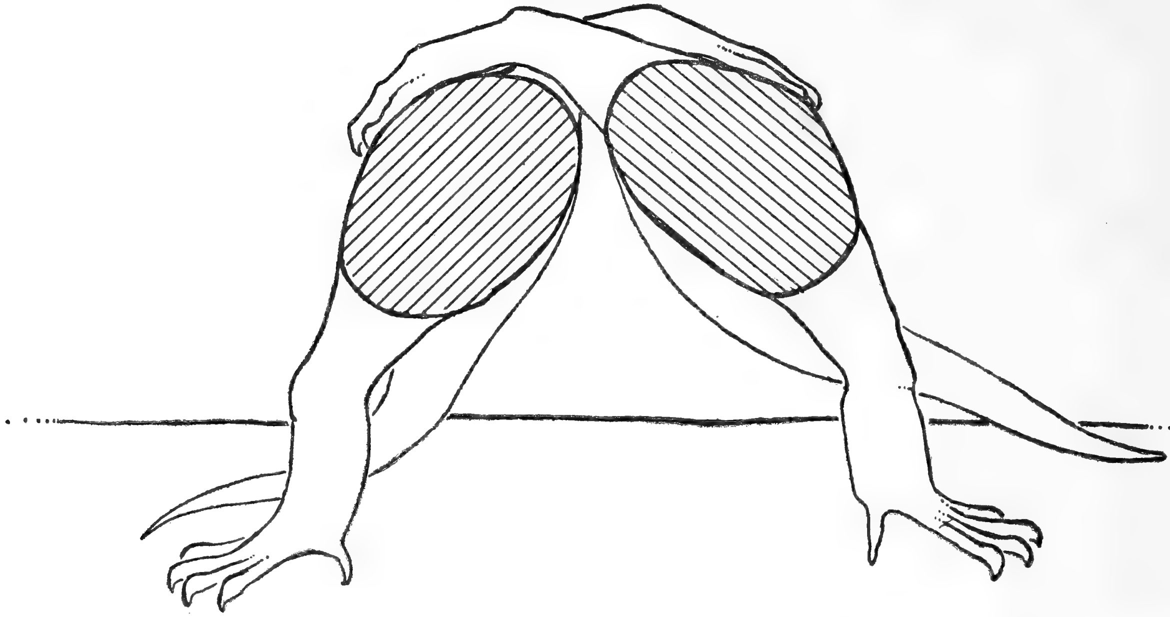


Fig. 3. Cross section through hind legs of male *Varanus bengalensis* engaged in a body arch. See text for explanation.

Eye(s) closed: Usually only the eye facing the opposing individual is closed and held so; an uncommon act in this species.

Body adpression: Entire body pressed against the substrate, probably to decrease apparent size. When intense this act may include the neck and chin pressed against the ground as well.

Moving away: Walking or running away from another individual, usually terminating the interaction.

Sexual Class

Straddle (mount): One individual assumes a superior position on another, with all four legs (or at least the front legs) positioned on opposite sides of the lower individual.

Scratching: One individual places one of its front feet on the back of the other and scratches feebly in two or three posterior movements (figured by Auffenberg 1978 for *V. komodoensis*).

Chin rubbing: Male in mounted position rubs his chin on the neck and/or head of the lower individual, usually while pressing downward (Fig. 2 K).

Neck bite: Mounted male bites neck (or head) of lower female or male (Fig. 2 J); rare in this species. Biting has been reported in the combat of *V. niloticus* (Cowles 1930) and *V. gilleni* (Murphy and Mitchell 1974; Carpenter *et al.* 1976).

Tail lift: A mounted male tries to lift the tail base of the lower individual (usually a female) with one of his hind feet by stroking upward with the claws (Fig. 2 K).

Investigative Class

Tongue flicking: Touching or directing the extended tongue to another individual (Fig.

2 D), usually on the head, neck or side of body. Concomitant pressing of the snout into tympanic, and snout areas as occurs in *V. komodoensis* (Auffenberg, in press) does not occur in this species.

Stress Reaction Class

Body high : All legs stiff and somewhat extended, raising the body maximally when in a quadrupedal position (Fig. 2 B).

Gular expansion : Enlarging the throat by both lowering the hyoid apparatus and inflation, often accompanied by a hiss or huffing (Fig. 2 B). This is, in part, the *inflated throat* of Carpenter and Ferguson (1977).

Roach raised : Tissue along the dorsal midline of part of the neck is very slightly raised ; not common in adults of this species, but frequently used by juveniles (Auffenberg and Ganci, in press).

The two following sequences are typical of those occurring between pairs of adult males (= M) and those in which a female (= F) is included in the pair, or when both are females. ' Step ' denotes the order in which the pre-combative behavioural acts occurred.

Male-Male Sequence

Step	Time Min:Sec.	Behavioural Acts
1	0 : 00	A approaches B from behind, scratching B on tail base with front foot.
2	0 : 08	A licks inguinal area of B.
3	0 : 15	A moves closer and licks neck and ear area of B, who turns head away as it slowly walks off.
4	0 : 21	A follows, B licks air with head down.
5	0 : 23	B licks A's tail, with both individuals parallel.
6	0 : 26	A licks tail base of B while both remain in same position, with B's head still down.
7	0 : 37	A straddles tail of B, then licks axillary area of B.
8	0 : 42	B turns head over shoulder, licks air, starts to coil tail.
9	0 : 45	A tilts head down, extends gular area.
10	0 : 48	A licks tail of B 5 times, moving up tail to cloacal area, when B turns to face A.
11	0 : 50	A licks head of B and latter immediately raises into bipedal position, with A doing the same.
12	0 : 51	Both individuals embrace, with front claws digging into each other's backs. The wounds produced are not deep, but bleed, tend to be parallel and are transversely oriented, with most located dorsoposteriorly to the insertion of the front legs.
13	0 : 53	Beginning of wrestling behaviours by both combatants.
14	2 : 12	A uses snout thrust on B, pushing head of B posteriorly.
15	2 : 16	B slips out of thrust and uses same technique on A, forcing latter to bend posteriorly, then wrestles A toward surface. A forms body arch and struggle continues in this position.
16	2 : 18	A slips out of arch and re-embraces B, pinning both of B's front legs to his side as they both rise to a bipedal position and continue to wrestle.
17	3 : 23	Both form body arch.
18	3 : 34	A forces B to substrate in ventral adpression posture, mounting B at same time.
19	3 : 37	A embraces B, pinning his front legs to the side of his body, and rubs neck of B with the underside of its chin.
20	3 : 39	B tries to move forward from under A, as embrace and chin rubbing by A continue.
21	3 : 43	A stands on dorsum of B (topping).
22	4 : 51	A again straddles and lays on B, chinning B while making huffing noises and trying to lift tail of B with its hind foot.
23	5 : 13	B finally slipping out from under A and running away.

Male-Female Sequence

1	0 : 00	M approaches F from behind and straddles tail as F basks.
2	0 : 03	M licks tail of F, then her hind leg, then dorsum as M moves up onto, her body.
3	0 : 11	F moves out from under M, but not far away.
4	0 : 33	M straddles tail again and scratches feebly on her dorsum with one of his front legs.
5	0 : 41	M in mounted position, licks neck of F two times.
6	0 : 42	F suddenly whirls about and places her front foot over his head and pushes down on his neck with her neck.
7	0 : 46	M slips away quickly and licks F's hind leg two times.
8	0 : 51	F whirls around, body compressed, high, roach raised, and places herself laterally, with head tilted and hissing.
9	0 : 53	F climbs onto back of M (topping) with front feet only.
10	0 : 56	M licks axillary area of F.
11	0 : 57	F whirls about and bites M on dorsum, then on side.
12	0 : 58	M lunges upward, carrying her body with him as she tries to both bite his throat and embrace him with her front feet.
13	1 : 07	M tries to slap F with tail, but she is too close.
14	1 : 09	F again leaps on M, biting his neck as she straddles him.
15	1 : 16	M walks away with her in straddled position, his gular area extended.
16	1 : 27	F slips off M and extends her gular area as they roll over and over with many tail slapping attempts (not clear if F only).
17	2 : 04	M in fully mounted position, with brachial embrace pushing her forelimbs to her sides.
18	2 : 15	Chinning starts and F's body is pushed tightly against the substrate as the combat sequence grades into courtship.

END

The most significant factors in all ritual male-male combats observed is that (1) no stereotyped display action patterns precede combat, (2) licking is a very pronounced activity, (3) combat takes the form of a ritualized wrestling match, with the mutually embraced combatant males in a bipedal position, and (4) there is no biting. Deraniyagala (1957) has briefly described all these features in *Varanus bengalensis* male-male combat, but he also reported unsuccessful biting attempts by the engaged males. In view of the fact that close analysis of film and CCTV tape of many combats in this study failed to indicate any biting attempts during combat itself, but did include similar appearing activities, such as snout thrusting, suggests to me that Deraniyagala misinterpreted some of what was seen. Vogel (1977) reported that *V. salvator* do not bite one another during ritualized combat. However, biting is part of the combat in other monitor species, for Murphy and Mitchell (1974), and later Carpenter *et al.* (1976), reported repeated biting in male-male combat of *V. gilleni*.

In the non-ritualized combat of adult males and females, or between females of *V. bengalensis* biting is common, but only by the female. Tail slapping is used by both sexes. The other major differences when compared to ritualized male-male combat are that the fighting is much more energetic on the part of at least the female, and that the combatants do not use the bipedal stance.

The total combat encounters seen during this study (137) could be divided into (1) those in which teeth and/or tail were employed at least once during the interaction, and (2) those in which weaponry was never used. The latter included male-male ritualistic combat.

Within adult male-male combat interactions, 36.5 per cent fall in the weaponry use category and 63.5 per cent in the non-weaponry use type, almost all of which are ritualistic in the sense that bipedalism was involved. In adult male-adult female combats, all were of the weaponry use type, with actual biting or tail slap *always* initiated by the females. Of combats between adult females and adolescents and between two adult females, about 45% are of the weaponry use type, and 55% are with no weapons used. Thus the most stressful combat encounters usually involve females.

On the other hand, adult male-male ritualistic (non-weaponry use) combat is of statistically much longer duration than all weaponry use types ($t = > 0.02$ in all pair comparisons), having an average length of 3.3 minutes (SD $\pm$ 0.7). Mean duration of weaponry use types is as follows : adult male-male 1.8 min, SD $\pm$ 0.7 ; adult female-female 0.3 min, SD $\pm$ 0.1 ; adult male-adult female 1.1 min, SD $\pm$ 0.6 ; adult-adolescent 0.4 min, SD $\pm$ 0.2 ; adolescent-adolescent 0.6 min, SD $\pm$ 0.2.

Of 568 interactions recorded since 1977, none resulted in combat when both interacting individuals approached one another from the front. Of the 137 instances of combat recorded, in 73.3% one of the eventual combatants approached the other from behind, and in only 26% one approached from the side. There is no significant difference in these proportions between male-male, female-male, adolescent-adolescent, or adult-adolescent interactions.

The interaction eventually leading to combat was initiated 90.1% of the time by the moving individual and only 9.9% of the time by the non-moving one. The first behavioural act of the initiating individual was either licking the other (76.5%), mounting attempts, even though feeble (17.5%), and scratching the tail, head, or back (6%). Of the licking types of initiation, 46.7% occurred on the head, 13.3% on the end and/or middle of the tail, 12.0% on the tail base and/or near the cloacal area, 9.0% on the scapular and/or axillary area, 7.1% on the hind legs, 6.0% on the dorsal part of the body, and 5.8% on the neck. The last three are not significantly different from one another ; nor were the two licked tail areas. The reminder of the categories are significantly different at the 0.01% level (*t* test).

These acts by the initiating individual result in variable responses : gular extension 16.1%, tongue licking 35.5%, topping 9.0%, mounting 10.4%, head down 6.5%, head away 3.1%, walking away 7.1%, hissing 9.3%, and scratching 3.0%. Actual weaponry use or ritualized combat was immediately preceded by the following acts on the part of the other individuals : licking 45.5%, mounting attempts 36.4%, scratch 9.1%, gular expansion 6.2%, and head down 2.8%. The number of behavioural acts preceding combat varies from 1 to 22. In general ritualistic combat is preceded by a greater number of behavioural acts ($\bar{x}$ = 12.3 steps, SD $\pm$ 3.14) than non-ritualistic combat ($\bar{x}$ = 5.8 steps, SD $\pm$ 1.03), primarily due to the quick agonistic response of particularly the females.

Table 1 shows the frequency of behavioural acts probably serving as signals (excluding combat tactics and weaponry use) for male-male, female-female, male-female, adult-adolescent, and adolescent-adolescent combat interactions. Note that for every one of these class encounters, licking represents the highest, or nearly so, of the total acts represented. The only exception is in adolescent-adolescent combative interactions, where gular expansion is slightly (but not significantly) higher. In female-female interactions topping behaviour is equally represented. The highest frequency of licking occurs among males, in which the other acts are used very little. It is apparently much less important in female interactions, where topping, head down, and even mounting is much more common. In a sense, female-female combative interactions include more acts considered typically male (mounting, chinning, and topping) than expected when

TABLE 1

FREQUENCY (IN %) OF BEHAVIOURAL ACTS PROBABLY SERVING AS SIGNALS LEADING TO, BUT EXCLUDING COMBAT TACTICS AND WEAPONRY USE

Acts	Combat Categories				
	Adult male-male	Adult female-female	Adult-adolescent	Adult male-female	Adolescent-adolescent
Licking	65.1	23.0	50.0	45.0	20.1
Tail coil	4.3	..	..	..	10.2
Gular expansion	4.3	7.7	11.1	7.5	26.2
Head down	5.4	15.4	16.7	5.3	8.1
Head away	5.8	..	10.0	..	2.1
Head up	2.2	7.0	..	2.8	1.0
Mounting	7.2	16.1	..	17.5	..
Topping	4.3	23.1	12.2	15.0	15.3
Chinning	1.4	7.7	..	2.5	..
Hissing	..	..	..	3.0	17.0

TABLE 2

FREQUENCY (IN %) OF MAJOR BEHAVIOURAL ACT CLASSES (EXCLUDING ACTUAL COMBAT ACTS) IN VARIOUS AGE AND SEX INTERACTIONS

Act Classes	Combat Categories				
	Adult male-male	Adult female-female	Adult-adolescent	Adult male-female	Adolescent-adolescent
Investigative	65.1	23.0	50.0	45.0	20.1
Sexual	8.6	23.8	..	20.0	..
Stress Reaction	4.3	7.7	11.1	7.5	26.2
Warning	4.3	..	..	3.0	27.2
Social :	10.7	45.5	38.9	23.1	26.5
Dominant	6.5	30.1	12.2	17.8	16.3
Subordinant	4.2	15.4	26.7	5.3	10.2

TABLE 3

INITIAL AND PENULTIMATE BEHAVIOURAL CLASSES (IN %) IN SEQUENCES LEADING TO AGGRESSION

Act Classes	Initial Act	Following Act	Penultimate Act
Investigative	76.5	35.5	40.1
Sexual	23.5	13.4	38.9
Stress Reaction	0.0	16.1	9.6
Warning	0.0	9.3	0.0
Weaponry use	0.0	N.A.	N.A.
Social :	0.0	25.7	11.2
Dominant	0.0	9.0	3.2
Subordinant	0.0	16.7	8.0

compared with male-male precombat acts. Adult-adolescent interactions include the least variety of acts, with several missing types being of considerable social significance, such as mounting and chinning, for they are part of the sexual class of behavioural acts.

This pattern suggests that important relationships among the major act classes (see above) may be more easily demonstrated than between the acts themselves. For this reason I have reorganized the acts in Table 1 into the major act classes of Table 2. The investigative category remains unchanged from Table 1 ; the sexual class is high in female-female and male-female categories, but absent when adolescents are involved in the encounter, even if adults are also involved. Stress reaction acts are highest in categories including adolescents ; warning acts are most often exchanged between adolescents ; dominant acts most common in female-female and least common in male-male interactions ; and subordinant acts are most common in interactions between adults and adolescents (caused almost entirely by the adolescent's behaviour).

Analysis of the major behavioural act classes in various phases of all combat categories (Table 3) shows that only investigative and sexual acts are included during the initiation of an eventually combative interaction, and that the former is three times more common than the latter. During the succeeding stages of the interaction, investigative acts remain most frequent, with sexual, stress-related, and subordinant acts being less frequent (not significantly different). Warning and dominant acts (not significantly different) are least utilized. The most common acts immediately preceding combat remain investigative and sexual (not significantly different) types, though there is a significant ($P = > 0.02$) increase in the frequency of sexual acts. Stress, warning, dominant, and subordinant acts are all significantly reduced ($P = 0.05$, 0.01, 0.02, and 0.03 respectively) from values in the intermediate phases of the interaction.

Table 4 provides the probabilities for those sequential behavioural acts leading to non-ritualized (adult male-female and adult female-female sequences ending in weaponry use) combat, and Table 5 includes the data for the same categories in a ritual combative context (male-male sequences end in bipedal posture on the part of both individuals). Weaponry use is never the initiating act, but follows some other act class 15.3% of the time. Investigative, dominant, and subordinant act classes are common (not statistically significantly different). Investigative initial acts are most often followed by particularly dominant acts, and less often subordinant ones and weaponry use. Warning following acts are rare. Dominant initial acts are most often followed by investigative ones by the respondent. Subdominant initial acts are very common, followed by either dominant or sexual ones. Stress reactions are less often initiating acts leading to dominant or sexual ones. Sexual initial acts elicit the second greatest variety of act classes (next to the investigative class), never leading to investigation by the respondent, but to particularly dominant, subordinant, stress reactions, and weaponry use. Warning is rare as an initial act, and is followed only by subordinant acts.

Table 5 provides the data for the same classes in encounters leading to ritualistic male-male combat. Investigative acts are again both common as initial acts and lead to the largest variety of reciprocal acts and most ritual combats. However, dominant acts are rare and when performed are always followed by subordinant and stress reactions only by the respondent. Dominant acts are, however, common after ritual combat (see below). As in non-ritual combat, subordinant initial acts are most commonly followed by investigative acts by the respondent, and by subordinant acts, stress reaction and by bipedalism, which was

5

TABLE 4

TWO-TUPLE SEQUENTIAL MATRIX OF BEHAVIOURAL ACT CLASS FREQUENCY (IN %) IN STEPS 1 AND 2 FOR TWO INTERACTING INDIVIDUALS DURING NON-RITUAL COMBAT (NS=$P>0.05$, *=$P \leqslant 0.05$-0-02, NO SYMBOL=$P \leqslant 0.01$).

Initial Act Class of Initiator	Reciprocal Act Class of Respondent							
	Investigative	Dominant	Subordinant	Stress	Sexual	Warning	Weaponry Use	Totals
Dominant	4.4	..	0.6	..	..	..	2.0	7.0
Subordinant	8.6	..	2.2	..	3.2	..	..	14.0
Stress Reaction	3.9	2.0	..	..	0.7	..	..	6.6
Sexual	..	6.8	4.4	4.4	0.5 NS	1.0 NS	5.0	22.1
Warning	..	..	2.2	..	..	..	..	2.2
Weaponry Use	..	..	..	..	..	..	..	0.0
Investigative	5.0 NS	15.3*	8.1*	6.5 NS	4.4 NS	0.5 NS	8.3	48.1
Totals	21.9	26.3	15.3	10.9	8.8	1.5	15.3	

TABLE 5

TWO-TUPLE SEQUENTIAL MATRIX OF BEHAVIOURAL ACT CLASS FREQUENCY (IN %) IN STEPS 1 AND 2 FOR TWO INTERACTING INDIVIDUALS DURING RITUAL COMBAT (SYMBOLS AS IN TABLE 4).

Initial Act Class Of Initiator	Reciprocal Act Class of Respondent									
		Investigative	Dominant	Subordinant	Stress	Sexual	Warning	Weaponry Use	Bipedal	Totals
Investigative	..	17.2	3.6NS	10.3	6.7NS	3.0NS	..	..	13.4	54.4
Dominant	..	..	..	3.9	3.4	..	..	..	..	7.3
Subordinant	..	6.7	..	3.0	3.4	..	..	..	3.2	16.3
Stress	..	6.9	..	..	..	..	..	..	3.6	10.5
Sexual	..	..	..	..	..	..	..	..	12.3	12.3
Warning	..	..	..	..	..	..	..	..	..	0.0
Weaponry Use	..	..	..	..	..	..	..	..	..	0.0
Totals	..	30.2	3.6	17.2	13.5	3.0	..	..	32.5	

not found in a non-ritualistic context. Stress reactions are commonly followed by investigative ones and by bipedalism. Unlike non-ritualistic combat, sexual initial acts were commonly followed only by bipedal posturing. Warning and weaponry use are never involved, as pointed out above. In general, dominant acts are not common, probably because its determination is the purpose of the interaction in the first place.

Tables 3 through 5 also show that it is extremely unlikely that the transition probabilities of the behavioural acts are stationary in the first several steps of the encounter (see Oden 1977, for discussion of stationarity). Rather, the data suggest that the acts tend to follow a pattern dependent on both time (periods between combat interactions) and the identity (initiator, respondent) of the actor.

To test this, the data in Table 5 were further analyzed to determine whether the observed number of 1-step (pair of adjacent acts, = 2-tuple sequences) behavioural transitions were significantly different from expected under the hypothesis of independence. The approach used was that for nonstationary transitions outlined by Oden (1977), but using X^2 analysis after probability estimators were calculated ($\hat{P}(A_1B_2) = n(A_1)\, nB_2/N^2$, where $n(A_1)$ = no. times A occurred in step 1, etc., and N = total number of male-male combats). Significant deviations ($P \leqslant 0.05$, binomial test) from the expected values were obtained from several data subsets. These significantly associated adjacent acts in decreasing significance ranking are : sexual-bipedal, subordinant-investigative, investigative-investigative, investigative-dominant, dominant-subordinant, dominant-stress reaction, subordinant-subordinant, investigative-bipedal, investigative-subordinant, investigative-stress reaction and investigative-sexual.

The same type of analysis was extended to include the first three adjacent behavioural acts in both ritual and non-ritual contexts (= 3-tuple sequences). There are 36 possible combinations of 3-step noncombative act sequences that can conceivably be used by two monitors, beginning with step 1 of the initial three steps of any social interaction. However, of these possibilities, only 15 actually occur in the initial three steps of interactions ending in ritual combat and 13 in interactions ending in non-ritual combat. Furthermore, the nature and frequence of these act class combinations are different in the two contexts, suggesting that only certain of the possible combinations are important in early communication between an interacting pair of *V. bengalensis*. In the ritualistic encounters only 9 of the 36 possible 3-step sequences show a statistically significant dependence (X^2 analysis, $P \leqslant 0.5$). These comprise only three behavioural classes (investigative, stress reactions, and subordinant). Ranked from greatest to least sequence dependence probability, these 3-step sequences are: investigative, steps 1, 2, 3 ; investigative for steps and 1 and 2 and stress reaction for step 3 ; investigative for first two steps and subordinant for step 3 ; stress for step 1, investigative for steps 2 and 3 ; subordinant for step 1 and investigative for steps 2 and 3 ; stress reaction for steps 1 and 3 and investigative for step 2 ; stress reaction for step 1, investigative for step 2, and subordinant for step 3 ; the reverse of 7 ; and subordinant for steps 1 and 2 and investigative for step 2. Of these, the first two are apparently most important, for they are most consistently involved in the early phases of interactions eventually leading to ritual combat.

In the non-ritualistic context mutual sequential investigative acts are not significantly higher than other sequences and never a step 2 act class of the respondent. Co-investigation is thus characteristic of ritual combat, explaining the generally smaller number of steps before combat in the ritualistic contexts. Investigative steps 1 and/or 2 are so commonly followed by subordinant acts of stress reactions that close relationship and partial dependence is very highly probable ($P = \leqslant 0.01$). This is not true in non-ritual contexts. Step 1 dominant acts lead only to ritualistic combat by the respondent, but in non-ritualistic contexts they were sequentially followed by a number of different act classes by the initiator, as well as by combative reactions by the respondent. Subordinant initiating acts were followed by investigative or particularly by dominant acts, or combat in the non-ritualistic contexts, but only by combat or reciprocal subordinant acts in ritual contexts. A step 1 stress act was followed by combat only in the ritual context. Step 2 of the respondent's stress was commonly followed by a subordinant act in step 4 within the same context. Sexual acts were never used in initiation of the behavioural sequence of either individual in the ritualistic context, but were commonly used by the initiator in Steps 1 and 3 in a non-ritual context. Warning acts are very rarely used in ritualistic contexts, but common in the respondent's step 2, who often follows this with weaponry use. The latter showed a highly significant ($P \geqslant 0.01$) dependent sequence, in which non-stationarity was particularly clear.

Therefore, while the acts preceding non-ritualistic and ritualistic combat are quite similar because the same investigative and sexual acts are most common in precipitating the combats, the *sequence* of acts is quite different. The recognition of potential male-male rivals is, however, evidently based on a combination of this sequence and the very probably important sexual scents (see Auffenberg, in press, for discussion).

Vogel's (1979) study of wild *Varanus salvator* showed that the winner in one ritualistic combat between two adult males did not necessarily remain dominant to the loser. These observations were thus at variance with those of Honegger and Heusser (1969) on captives of the same species, where dominance patterns seemed quite permanent. In the present study I found that dominance was only partly determined by size, for of the four adult males (A-D, see Table 6), A=B>C>D, and the dominance coefficient $\left(\frac{\text{No. successful bouts/total bouts} \times 100}{\text{no. interactions initiated}}\right.$, see Bergen 1977) for these individuals were 3.37, 1.83, 3.17, and 9.52 respectively. Thus A was clearly the most dominant individual, though his size equalled that of B; B and C were approximately equal socially, though the latter was smaller; D was the most subordinant and also the smallest. Table 6 also shows, however, that dominance shifts are common, especially between individuals of nearly equal size. The same individuals rarely fight more than once in the same day. However, fights between the same individuals on succeeding days is common.

There is no evidence that winning leads to a significantly high level of despotism in the winner's interactions with either the previous loser or other cage mates. There is also no evidence that winning or losing a bout significantly changes the number of times that adult female cage mates are courted. However, females engage in longer courtship with winners and frequently walk in front of them immediately after combat is concluded. Losing males frequently court females within 15 minutes after a bout, winning males tend to court even sooner. Thus, winning a ritual bout confers at least some advantage to the winner (additional data and discussion in author's MS on *V. bengalensis* courtship, now in preparation).

Discussion

From the data presented above it is clear that in *Varanus bengalensis* of all ages and sexes fight one another, but only females and subadults seem intent on damaging the rival by using

TABLE 6

SOCIOMETRIC MATRIX OF RITUALIZED COMBATS (N=61) IN FOUR MALE *Varanus bengalensis* (A-D), SHOWING FREQUENT DOMINANCE SHIFTS AMONG COMBATANT PAIRS (REVERSALS BELOW DIAGONAL).

Winner	Loser				Totals	
	B	A	C	D	Wins	Losses
B	..	25	6	2	33	13
A	10	..	8	3	21	27
C	1	2	..	2	4	14
D	2	0	0	..	2	7
No. initiated	38	12	8	3		

weaponry. A similar pattern has been noted in the field for *Varanus komodoensis* (Auffenberg 1978, in press), a species representing a distinctly different subgenus (Mertens 1957). This suggests that this pattern may be characteristic of the family Varanidae. Young *V. bengalensis* fight less than adults, but show a greater proportion of stress reactions (Auffenberg and Ganci, in press). Large adult males show the least number of aggressive acts and even in ritual combat are not as evidently stressed as females and adolescents are during their encounters.

The varanid familial characters of ritual combat are bipedalism, brachial embrace, and common lack of weaponry use. The reported biting between ritually combative male *bengalensis* by Deraniyagala (1957) is presumed to be a misinterpretation, though biting is clearly a part of this behavioural pattern in *Varanus gilleni* (Murphy and Mitchell 1974). It is apparently not part of the pattern in *V. salvator* (Vogel 1977).

Visual signals in the form of ritualised displays are not employed by either of the two potential rivals prior to ritualistic combat, or prior to any type of combat, regardless of sex or size. However, the very frequent use of tongue flicking during the initial phases of combative interaction among all ages and sexes suggests that (1) pheromones are probably important olfactory cues used to distinguish sex and sexual maturity, and (2) they are probably surface releaser types. Fecal sign-posting in and on the periphery of the activity range of *V. komodoensis* in the wild has also been reported (Auffenberg 1978), but its importance in other varanid species has not yet been demonstrated. Vogel (1977) reported that in *V. salvator* tongue flicking is a preliminary act in about half the ritual encounters in the wild.

The most common behavioural acts immediately preceding both ritual and non-ritual combat are of an epigamic type. Hierarchial acts commonly lead to combat only in non-ritualistic contexts, and are primarily important in combat-mediation. Appeasement displays serve a similar function for particularly the smaller individuals (see Auffenberg 1978, and Auffenberg and Ganci, in press) for they tend to reduce aggression.

Though minor, what occurs among adult captive male *Varanus bengalensis* is based mainly on size and less on ritualized combat outcome. It is never based on the social consequences of stereotyped modal action patterns (see Barlow 1977). Subordinant males are not excluded from courtship with available females by dominant males, though there is a suggestion of greater acceptance by females for recently dominant males. This is also suggested in wild *Varanus komodoensis*. In the latter species there may also be long-term pair formation (Auffenberg, in press), but this needs verification and may be an artifact of the naturally low adult densities of this species in the wild.

Dominance shifts are common in similar-sized male *Varanus bengalensis*, determined by rather regular ritual combat before and during the reproductive. In nature ritual combat in this species is undoubtedly a form of territorial aggression. In captivity (and undoubtedly in the wild as well) this aggression system includes submissive signals that help to keep the beaten individual from suffering further damage. An appeasement display, based largely on stress reactions, is used by especially young *V. komodoensis* when entering at least the feeding territories of larger individuals. However, this conciliatory system was not found to be conspicuously active under the high density captive conditions in the present study. However, that it exists in *V. bengalensis* is clear (Auffenberg and Ganci, in press), and that it is functionally operative in nature is reasonably certain. The territorial dominance witnessed in *V. komodoensis* in the field probably changes to the dominant aggression in captive *V. bengalensis*, and which forms the basis of this report. Special signals of either visual or olfactory type are apparently not as important in designating social rank as total size alone. As in *V. komodoensis* (Auffenberg 1978, in press), subordinates respond to large size by moving out of the way or by performing appeasement displays (Auffenberg and Ganci, in press).

The head jerking reported by Lederer (1933) in captive *V. salvator*, and by Vogel (1977) in the wild for the same species, is apparently not found in *V. bengalensis*. It may be an important visual signal in potential intraspecific combat contexts in areas of sympatry in south-eastern Asia. In *V. salvator* it is reported to be part of the warning display system and is only used in intraspecific contexts. However, it is less common and probably reflects a lower motivational level than lateral body compression, according to Vogel (1977).

A comparison of the available details of ritual combat in both *V. bengalensis* and *V. salvator* as reported by Vogel (1977) shows that they are very similar, except that the proportionately longer necks of *salvator* allow an ' entwining ' not possible in the short-necked *bengalensis*. The ritualized combat of *V. gilleni* (Murphy and Mitchell 1974, Carpenter *et al.* 1976) does not include a bipedal phase and the body arch segment of the combative sequence is greatly exaggerated and stylized.

While *V. gilleni* seems to represent a somewhat different pattern in detail, it appears that in general the varanid ritualistic combat pattern is a test of strength. It is similar in its basic components to that of snakes in that strength is not determined by head butting or pushing, or jaw fencing, etc., but by the opponents trying to push one another to the substrate with their bodies. A comparison of varanid and snake display shows that both vertical and horizontal tactics are included (= bipedal and body arch in varanids). Weapons are apparently never used in most species of both groups.

However, much remains to be learned, for the agonistic behaviours of only *V. bengalensis*, *V. komodoensis*, *V. salvator*, and *V. gilleni* are known. These represent only a few of the several subgenera recognized. Still to be explored are the behaviours of those species representing the highly specialized, arboreal types, as the subgenera *Dendrovaranus*, *Philippinosaurus*, *Papusaurus*, etc.

Table 7 summarizes the agonistic behavioural acts of *Varanus bengalensis* and the contexts in which they are performed.

TABLE 7

SUMMARY OF COMBATIVE BEHAVIOURAL ACTS OF *Varanus bengalensis* AND THE CONTEXTS IN WHICH THEY ARE USED

Behavioural Acts	Contexts		
	Ritualistic	Non-ritualistic	
		High Stress	Low Stress
Agonistic			
Weaponry Use			
Bite	No	Yes	No
Tail Slap	No	Yes	No
Warning Cues			
Tail Coil	No	Yes	Sometimes
Hissing	Sometimes	Sometimes	Sometimes
Lateral Compression	No	Yes	Sometimes
Gape	No	Rare	No
Combat Tactics			
Bipedalism	Yes	Sometimes	No
Brachial embrace	Yes	No	No
Wrestling	Yes	No	No
Body arching	Yes	No	No
Snout thrust	Yes	No	No
Dominant Cues			
Head up	Yes	Sometimes	Sometimes
Scratching	Postcombat	Sometimes	Sometimes
Topping	Postcombat	Yes	Yes
Subdominant Cues			
Head down	Postcombat	Sometimes	Sometimes
Walk away	No	Postcombat	Postcombat
Ventral adpression	Postcombat	Sometimes	Sometimes
Eyes closed	Sometimes	Sometimes	Sometimes
Reproductive			
Straddle (mount)	Pre-postcombat	Sometimes	Sometimes
Chinning	Pre-postcombat	Sometimes	Sometimes
Tail lift	Pre-postcombat	Sometimes	Rare
Stress Reaction			
Body high	No	Rare	Sometimes
Gular extension	Rare	Yes	Yes
Investigative			
Tongue flicking	Yes	Yes	Yes

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ORNITHOLOGICAL NOTES FROM PAKISTAN[1]

T. J. Roberts[2]

Compared with the growing popularity of bird watching as a hobby in neighbouring India and the valuable contributions which have been made in recent years by a new generation of enthusiastic zoologists and naturalists, the situation in Pakistan is still rather discouraging. In the past thirty years there have been very few ornithologists working in this region and regrettably most published observations have emanated from foreigners who have been temporarily working in this country. Fortunately, I know of two young Pakistani naturalists, both of whom are currently taking degrees in wildlife management and vertebrate ecology in the U.S.A. and who will undoubtedly spread their knowledge and enthusiasm after their return to this country and it is to be hoped that there will ensue interesting developments and fresh contributions to our understanding of the bird fauna of this region.

Meanwhile this note puts on record some of my own more interesting observations during the past year and to 'keep the home fires burning' so to speak.

Haliaeetus albicilla Whitetailed Sea Eagle.

This magnificent fish eagle is rare enough to warrant continued recording of its occurrence and I was interested to note the second sight record for Nepal of this species by Gooders (*JBNHS* 75 (3): 925-926). This description of the distinctive tail patterns of a sub-adult, coincides exactly with a detailed description given by us, in a note submitted ten years ago about the occurrence of this eagle in Pakistan (see Roberts & Savage *JBNHS* **66** (3) : 619-622). I believe this pattern is associated with four year old birds in the last year before they produce white tail feathers. On January 8th, 1980 a Sea Eagle was seen by myself and a group of friends on Hadiero Lake (24° 50′ N, 67° 53′ E) some sixty miles due east of Karachi. It caught a large fish basking near the surface and we watched it feeding on its prey on a nearby bare stony hillock. When disturbed (by our photographic efforts) it was mobbed by Black Kites which were wheeling around in the vicinity. My companion Kent Forssgren, a professional ornithologist from Sweden was familiar with this species from his studies in the Baltic, and though it had a completely dark-brown tail he thought that it was probably a three year old male. It was not resighted on subsequent visits to this lake. Ghauspur Jheel in Jacobabad District (28° 09′ N, 69° 05′ E) is the most likely locality in the whole of Pakistan to encounter this eagle and in November 1979 I also saw one immature specimen. The previous year during a visit to Ghauspur in early February I had failed to sight any Whitetailed Sea Eagle.

Chlidonias leucopterus Whitewinged Black Tern.

I recorded seeing individuals in breeding plumage in the vicinity of Karachi in May 1977 (*JBNHS* **75** (1): 216-219) which was apparently the first record for this region. I can now add that in May 1978 and 1979 three or four individuals of this beautiful little tern have been observed by me, both in brackish pools near the Karachi coast (Ghizri Creek)

[1] Accepted May, 1980.
[2] Post Box 3311, Malir City Post Office, Karachi-23, Pakistan.

as well as at Haleji Reservoir some fifty miles inland. It therefore appears to be a regular spring passage migrant off the Karachi coast and inland. I have always seen it in company with larger numbers of Whiskered Terns (*Chlidonias hybridus*) and I only attempted identification from individuals already clearly showing their breeding plumage.

Metopidius indicus Bronzewinged Jacana.

Again I was interested to note in the latest issue of the Society's Journal, that Shri Lalsinghbhai Raol records the first record of this species near Jamnagar on the Saurashtra peninsula (*JBNHS* **75** (3) : 923). In the Sind Gazetteer section covering the avifauna, which was compiled by Kenneth Eates after over thirty years of bird watching in the Province, he noted (page 52) that it was strange that no individual of this species had ever been sighted even in lower Sind. It is also apparently unknown from the Punjab. On February 14th, 1980 at Haleji Reservoir, (24° 49′ N, 67° 44′ E) three square mile lake which is now preserved as a wildlife sanctuary, I encountered a pair calmly feeding out in the open and not more than 200 metres from the roadside embankment. On March 1st they were still there and joined by a third individual. I was fortunate to be able to borrow a 1,000 mm telephoto lens from a friend on the day when they were encountered so was able to get a good series of photographs. The bill is distinctly heavier than that of the Pheasant-tailed Jacana which was feeding nearby and of course the latter species does not have a frontal shield extending over the forecrown. The individuals appeared to be all adults and to be mainly feeding on small crustacea or aquatic insects as I saw them peck at objects on the surface of lotus lily leaves and even pull the leaves up in their bills, but they made no attempt to eat the leaf vegetation.

Monarcha azurea Blacknaped Monarch Flycatcher.

A female suddenly arrived in my garden at Malir, just north of Karachi on December 21st, 1979 and it stayed around for seven weeks until February 10th 1980 affording many delightful hours of watching. This flycatcher was recorded by C. B. Ticehurst (*Ibis*, Oct. 1922) in his Birds of Sind as the 'merest vagrant' in winter. He collected a single specimen in February 1919. Jack Coles, a friend who worked as a newspaper correspondent in Karachi during the 1960's also found a female with a nest in Malir in April 1971, but he never saw the male and the nest was regrettably robbed shortly thereafter. This is my first observation in seven years of residence here but obviously stray individuals must be regular visitors. Our particular female had the habit of retiring at dusk to the same roosting tree and was particularly noisy at this time, hopping about in the branches and uttering its rather harsh wheezy calls.

Muscicapa rubeculoides Bluethroated Flycatcher.

This appears to be another first record for Pakistan as far as I am aware. In volume seven of Sálim Ali's HANDBOOK it is recorded as occurring westwards up to the Chenab River and is not even recorded for Kashmir.

In the Margalla Hills (33° 28′ N, 73° 03′ E) which serve as a backdrop for the new capital city of Islamabad, I heard a strange bird singing on the evening of May 26th 1979. This was in a stony ravine with non-perennial pools of water but in very thick thorny scrub including *Zizyphus mauritiana*, *Carissa opaca* and *Woodfordia floribunda*. Try as I might, and even crawling on hands and knees I could not get a glimpse of the singing bird. The next evening I had to catch a plane back to Karachi but a visit to the same spot was rewarded by a clear view of a singing male in the lower branches of a *Ficus* higher up the same ravine. Its song consisted of a rather continuous warble reminiscent of a *Hippolais*. It may have been only an odd male trying to establish a nesting territory as I did not find any trace of it during a subsequent visit in July.

Cettia brunnifrons Rufouscapped Bush Warbler.

The western subspecies of this skulking little warbler is recorded in Volume 8 of Sálim Ali's HANDBOOK (page 17) as occurring as far west as the Pir Panjal range in Kashmir but it is not recorded for Pakistan. Perhaps the Murree Hills across the Jhelum River from the Pir Panjal, do not provide a sufficiently alpine habitat as this species has never been noted from these hills which are well worked ornithologically. In the Kaghan Valley, of Hazara District further west, there is a secluded valley to the west of the Kunhar River, known as Sharan Forest (34° 43′ N., 73° 20′ E.) and during a visit to this area in 1978 I got a tantalizingly fleeting glimpse of this bird but could not identify it. On July 7th 1979, when visiting the same area, I found this Bush Warbler to be quite plentiful at the upper limit of the tree line around 10,000 feet or higher, in both scrub-willow and stunted Blue Pines. I got good recordings of its cheery little song and found that it was quite fearless of humans approaching within twenty feet as it busily foraged amongst the rocks and bushes. The bright rufous red cap contrasts with its rather olive brown back and wing coverts. There is a broad creamy supercilium, a dark eye streak and the lower mandible is yellow at the base. The throat and breast are greyish white whilst the vent is pale creamy fulvous. It is such a noisy little bird, that I do not think it would have escaped notice before, so that I suspect the Sharan population may be a somewhat isolated one. It shares its habitat at this elevation in Sharan with the Wren (*Troglodytes troglodytes*) and the Orange Flanked Bush Robin (*Erithacus cyanurus*).

Zoothera citrina Orangeheaded Ground Thrush.

Hugh Whistler in his notes on the birds of Rawalpindi and the Murree Hills (*Ibis*, January 1930, p. 91) merely lists this thrush as nesting in the Murree Hills on the basis of an earlier note published by Col. C. H. T. Marshall, who found a nest in the Murree area in 1870. This must be the only basis for the Murree Hills being included in its distributional range in Volume 9 of the HANDBOOK. Since I have lived for short periods in the Murree Hills and felt that I knew the region's ornithology pretty well, I had the temerity to write to the distinguished authors, (when Volume 9 was being compiled) and suggested that Pakistan should be deleted from the distributional range of this thrush. But in late July 1978, I went up to Islamabad particularly to try and sight the Indian Pitta in the adjoining Margalla Hills where it had been seen for the first time in Pakistan by my young friend Kamal Islam (see *JBNHS* **75** (3) : 924-925), I was unable to find the Pitta on that visit but did investigate an obviously Turdine songster (all the thrush species breeding in the Murree Hills are silent by the end of July) which to my delight and surprise turned out to be the Orangeheaded Ground Thrush. I only encountered it in one of the side ravines and at an elevation of about 1,600 feet and between 6 a.m. and 7 a.m. located three singing males. This place is some thirty miles away from Murree town and is ecologically in an area quite distinct from the Murree Hills. I was able to get good recordings of their songs which continued for four or five minutes without interruption with many mimetic phrases from the Hawk Cuckoo (*Cuculus varius*) and the Pied Crested Cuckoo (*Clamator jacobinus*). They sang from the lower branches of shady trees and allowed reasonably close observation. I also saw them again in 1979 and do not doubt that there is a small monsoon season visiting population which breeds here in Pakistan. Scores of previous visits to the Margalla Hills earlier in the summer or in winter have never produced any sightings of this thrush.

Pitta brachyura Indian Pitta.

After the disappointment of failing to find the Pitta first noticed in June 1978 (referred to above), I again visited the same ravine in the Margalla Hills in May 1979. At sunrise I was rewarded by the unmistakable 'whit-wheear' call of this jewel-like bird from a rather dry and exposed hillside. Later I found that at least five or six pairs were haunting the thickets on either side of a dry stream bed in the bottom of the ravine. They were shy and furtive and difficult to see even when heard calling from a few feet away. I twice saw males in excited courtship or aggressive flight chases. Their wings make quite a loud whirring. I have no doubt also that there is a small breeding colony in this ravine and the fact that they have escaped notice up to this time may largely be due to the fact that they are confined to rather impenetrable thorny thickets in one small valley. They shared this habitat with Rustycheeked Scimitar Babblers, Paradise Flyacatchers and Plaintive Cuckoos.

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A CHECK-LIST AND SOME NOTES CONCERNING THE MAMMALS OF THE LANGTANG NATIONAL PARK, NEPAL[1]

MICHAEL J. B. GREEN[2]

(*With two plates and a map*)

INTRODUCTION

The mammals of the Nepal Himalaya are a mixture of species derived from the Oriental (i.e. India and S.E. Asia) and Palaearctic (i.e. Eurasia excluding S.E. Asia) regions. Caughley (1969) noted that there are fewer mammalian species in the Himalaya of central Nepal, for example the Langtang area, than to the east and west. For instance, the red deer occurs in Kashmir and Bhutan and the Himalayan marmot occurs in west Nepal and Sikkim but neither species are present in the intervening range. Ibex, markhor, wild goat and urial occur in the western Himalaya of Ladakh, Kashmir and Kumaon but their distributions stop short of Nepal. Similarly, the distribution of the takin which occurs in the Bhutan Himalaya does not extend into Nepal. According to Caughley (1969) the paucity of species in the central region of Nepal may be 'the result of a forked post-pleistocene route of dispersal from the north'.

In April 1976 the Langtang area was officially established a national park. Encompassing an area of about 1,710 sq km and extending from just 32 km north of Kathmandu right up to the Chinese (Tibetan) border, it is the largest of Nepal's national parks. Altitude varies from 792 m to 7,245 m within which eight vegetation zones, ranging from upper tropical to upper alpine, are present (Dobremez *et al.* 1974).

Between April 1976 and May 1977 the Langtang National Park was surveyed by the Durham University Himalayan Expedition. Although much of the fieldwork was confined to the Langtang Valley, most of the other regions of the park were visited except for the Yangri Khola and the 'restricted' area to the north of Langtang Himal. The following account of the park's mammals is based on the DUHE's work unless otherwise acknowledged.

CHECK-LIST

The mammals which occur in the park are listed in Table 1, together with the altitudinal range and local name (if known) for each species. This check-list is incomplete because the alleged presence of some species awaits reliable confirmation. For example, the jackal (*Canis aureus*) has not been reported but may occur in the park. According to Fleming Jr (pers. comm.) the distribution of this species is extending northwards from the Terai into the Himalayan foothills. The presence of the jungle cat (*Felis chaus*) is likely but unconfirmed. Fox (1974a) mentions that the great Tibetan sheep or nayan (*Ovis ammon hodgsoni*) occurs in the upper Lende Khola in China (Tibet) and that the presence of the wolf (*Canis lupus*) is doubtful. All of these species are omitted from the check-list. Also bats have been seen in the park but no specimens have been caught for specific identification.

There is only one reliable record for the clouded leopard which was seen several years ago north of Melamchigaon (Fleming Jr

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pers. comm.). Some evidence indicates that the snow leopard occurs in the park. Near Gosainkund at 3,900 m, Fox (1974b) saw spoor which he attributed to snow leopard. In June 1977 Miller and Rice (pers. comm.) saw leopard tracks at 4,540 m in the upper Langtang Valley, about 4 km northeast of Langsisa goth[3]. This animal may have been a visitor to the park which had crossed a high pass from China (Tibet). Reference to the other larger mammals which occur in the park is made in the mammal survey section.

[3] A goth is a temporary settlement which is used by local people during the summer months when the alpine pastures are grazed by their livestock.

TABLE 1

CHECK-LIST OF MAMMALS WHICH OCCUR IN THE LANGTANG NATIONAL PARK, NEPAL

Species	Alt. range (m)
INSECTIVORA	
* *Soriculus caudatus* large clawed shrew ; chhuchundro ; ?	2,000-3,800
* *Soriculus nigrescens*	2,000-3,800
* *Suncus murinus* grey musk shrew ; ? ; ?	1,800
CHIROPTERA	
No records	
PRIMATES	
Macaca mulatta rhesus macaque ; bandar ; priou	1,520-2,440
Presbytis entellus common langur ; langur or lampuchare bandar ; praken	1,520-4,120
LAGOMORPHA	
Ochotona roylei roylei Himalayan mouse-hare or pika ; muse - kharaya ; pakpu khonjin or poo-see	2,590-5,090
RODENTIA	
Dremomys lokriah orangebellied Himalayan squirrel ; lokharke ; shimbo or rham	1,830-3,050
* *Callosciurus pygerythrus lokroides* hoarybellied Himalayan squirrel ; ? ; ?	1,800
* *Rattus rattoides* house rat ; thulo musa ; ?	1,100-3,900
* *Rattus eha eha*	3,000-4,100
* *Rattus niviventer niviventer*	1,700-2,100
* *Mus musculus homourus* house mouse ; sano musa ; piezu	3,600
* *Pitymys sikimensis* Sikkim vole ; ? ; ?	3,600-3,900
Hystrix indica Indian porcupine ; dumsi ; beederee	2,440

TABLE 1 (*Continued*)

Species	Alt. range (m)
CARNIVORA	
Vulpes vulpes red fox ; rato phauro ; wohprhakpa or wamo	.. 3,350-5,330
Cuon alpinus wild dog or dhole ; jungeli/ban kukur ; parah	.. 2,400-3,910
Selenarctos thibetanus Himalayan black bear ; bhalu ; thom	.. 1,830-2,590
Ailurus fulgens red panda ; hobrey or rato ba sano panda ; telekama	.. 2,440-3,660
Mustela sibirica subhemachalana Himalayan weasel ; daman or Himali weasel ; ringmu	.. 3,050-4,880
Mustela altaica temon pale-footed weasel ; ? ; ?	.. 4,150-4,720
Martes foina beech/stone marten ; dhunge malsappro ; kowar	.. 3,050-3,810
Martes flavigula Himalayan yellowthroated marten ; malsappro ; kukhauri or kowarken	.. 1,830-4,000
Felis bengalensis leopard-cat ; chituwa birala ; ?	.. 2,590
Neofelis nebulosa clouded leopard ; dhuwase chituwa ; ?	.. ?
Panthera pardus leopard ; chituwa ; sengen	.. 1,520-3,050
Panthera uncia snow leopard ; huen chituwa ; cerken	.. 3,900-4,540
ARTIODACTYLA	
Sus scrofa Indian wild boar ; badel or banel ; pha	.. 1,830-3,260
Moschus moschiferus moschiferus Himalayan musk deer ; kasturi mriga ; lawa	.. 3,000-4,330
Muntiacus muntjac muntjac or barking deer ; ratuwa mriga ; kesha or showa	.. 2,290-3,050
Nemorhaedus goral hodgsoni brown goral ; ghoral ; reeda or reegu	.. 1,680-3,350
Capricornis sumatraensis thar serow ; thar ; yha	.. 2,590-3,660
Hemitragus jemlahicus Himalayan tahr ; jharal ; nyang ghin	.. 2,740-5,200

Notes : (*i*) Data are based on the records of DUHE (Borradaile *et al.* 1977), except for the asterisked species which refer to Niethammer and Weisser (pers. comm.).

(*ii*) English, Nepalese (Mishra and Mierow 1976) and Tibetan names are given in sequence for each species.

(*iii*) Altitudinal ranges are based on sightings of animals and on indirect evidence from tracks and faeces.

Mammal survey

Information concerning the park's mammals was obtained from members of the expedition and tourists. As the park receives over 2,000 tourists per year (Borradaile *et al.* 1977), notices were displayed along the major trekking routes requesting visitors to report their sightings of mammals to DUHE. Tourists were also questioned whenever encountered by members of the expedition. From these data which are summarized in Table 2 it appears that, in descending order, the pika, common langur and orangebellied squirrel were the most frequently seen mammals in the park. These three species accounted for three quarters of the total number of sightings. Such data provide the visitor with a rough idea of which species he is most likely to see if he visits the Langtang National Park. However, the figures do not truly reflect the relative abundance of each species because they do not account for the relative amount of time spent by the observers in each species' habitat. Information of an anecdotal nature is given below for those species which are listed in Table 2.

Rhesus macaque

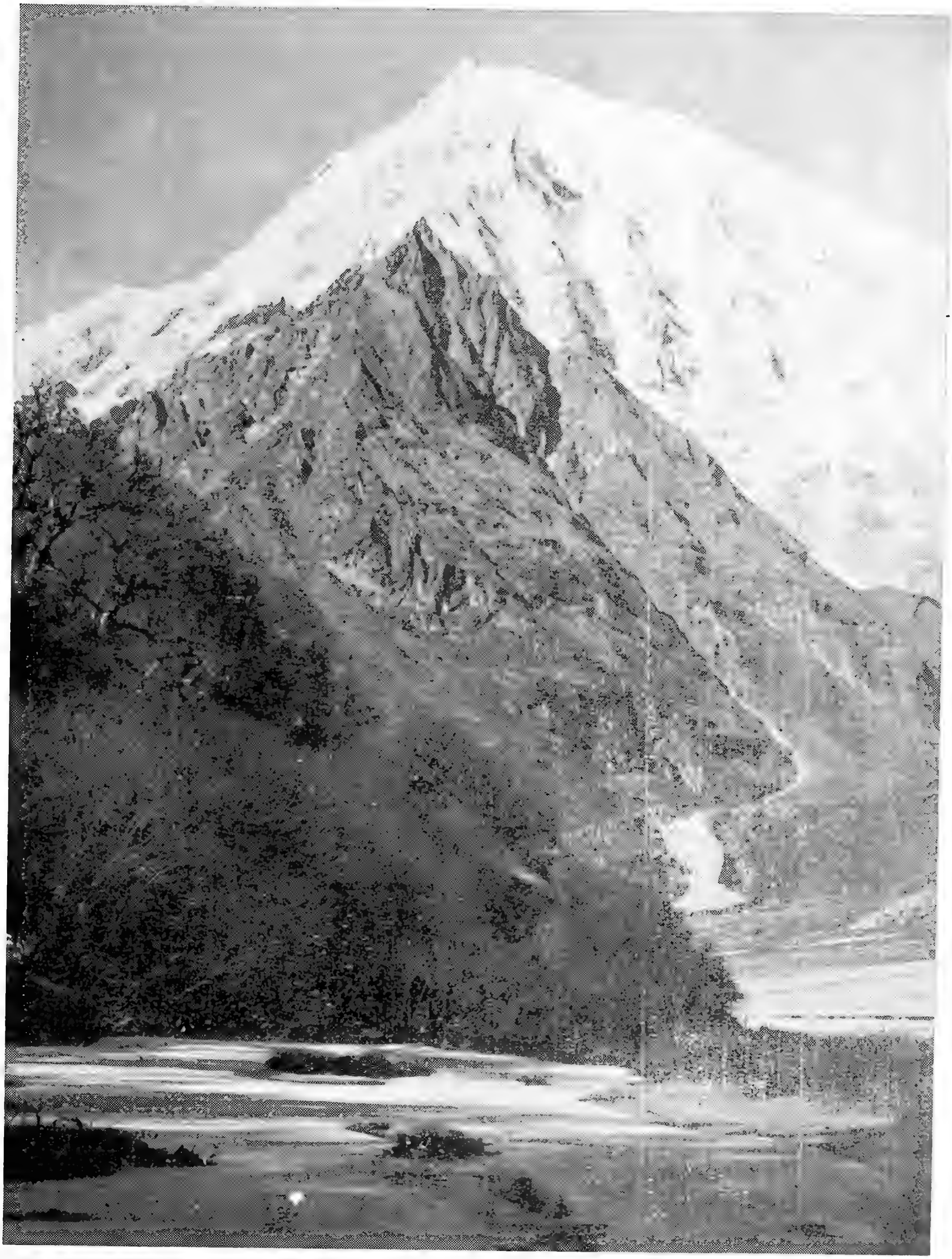
There is some confusion about the distinction between the rhesus (*M. mulatta*) and Assamese macaque (*M. assamensis*). Caughley (1969) 'saw a group of 16 rhesus monkeys (between Manigaon and Ramche) that lacked the rufous colouring on the hind quarters characteristic of the Assam rhesus' but he was not convinced that this form was anything other than a colour phase of the common rhesus. In 1971 Fleming Jr (pers. comm.) identified a group of about 16 Assamese macaques near Bhargu but this species is not mentioned by Fox (1974b). Until the issue is resolved by a detailed comparison of the two species, reference here is only made to the rhesus monkey.

The distribution of the rhesus macaque overlaps with the lower altitudinal range of the common langur but the former is much less common. Groups were seen near Dhunche, Munga, Syabru, Syabrubensi and Timure and in the lower Langtang Valley amidst a variety of vegetation types, including mixed deciduous and *Pinus roxburghii* forest and *Euphorbia royleana* heath. They were not seen in cultivated fields but according to Caughley (1969) they 'feed almost exclusively on crops when in the vicinity of villages'. The mean group size of 9.8 is underestimated because of the difficulty of counting all the members of a group in forested habitat. A lone animal was only once recorded, at 2,440 m near Chingtang; otherwise groups were seen between 1,520 m and 2,130 m. Caughley (1969) observed rhesus macaques 'at 3,800 m in winter when the snowline was then at 3,400 m.'

Common langur

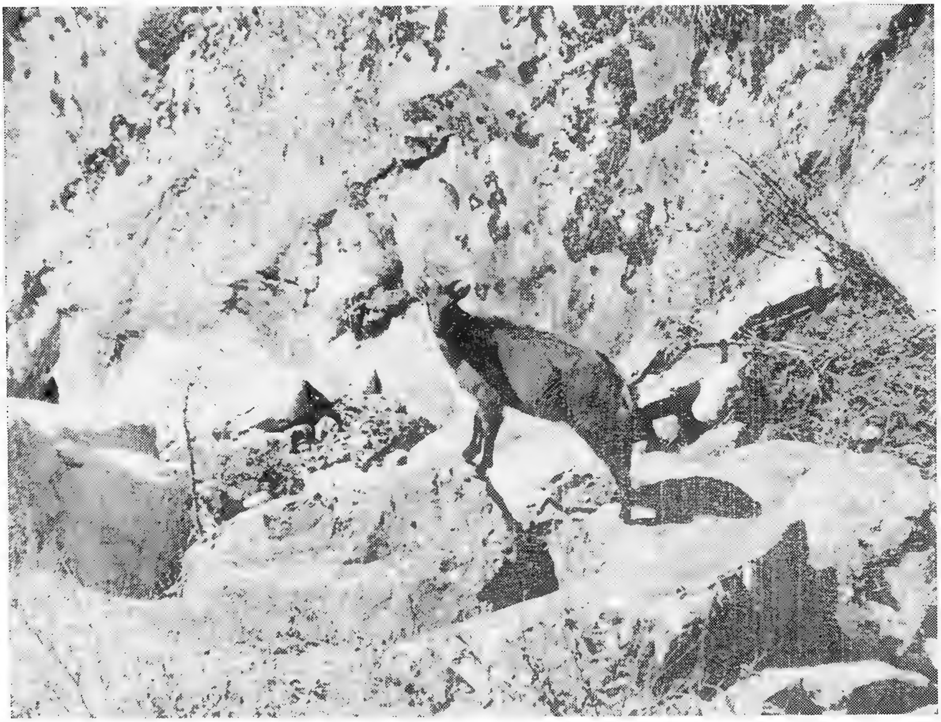
Langurs were seen in temperate forests and subalpine scrub in the Balephi, Ghatte, Langtang, Melamchi, Phalung and Trisuli Valleys. Solitary animals were seen on 42 (28%) occasions. Maximum group size was 50 but it should be mentioned that Fox (1974b) once saw over 140 langurs in fields adjacent to the Bhote Kosi, just outside the park's boundary.

In the Langtang Valley langurs were usually seen between 1,520 m and 3,510 m. Repeated sightings of one group, which numbered up to 46 animals, indicated that it ranged from below Ghora Tabela (3,050 m) to Langtang Village (3,510 m)—a distance of 17 km. Between July and December the group was often seen around Langtang Village but during the winter and spring months it remained in the vicinity of Ghora Tabela. A lone adult, which probably originated from this group, was seen above Pana goth on 28 September at 4,050 m, above Nubmathang goth on 3 October at 4,020 m

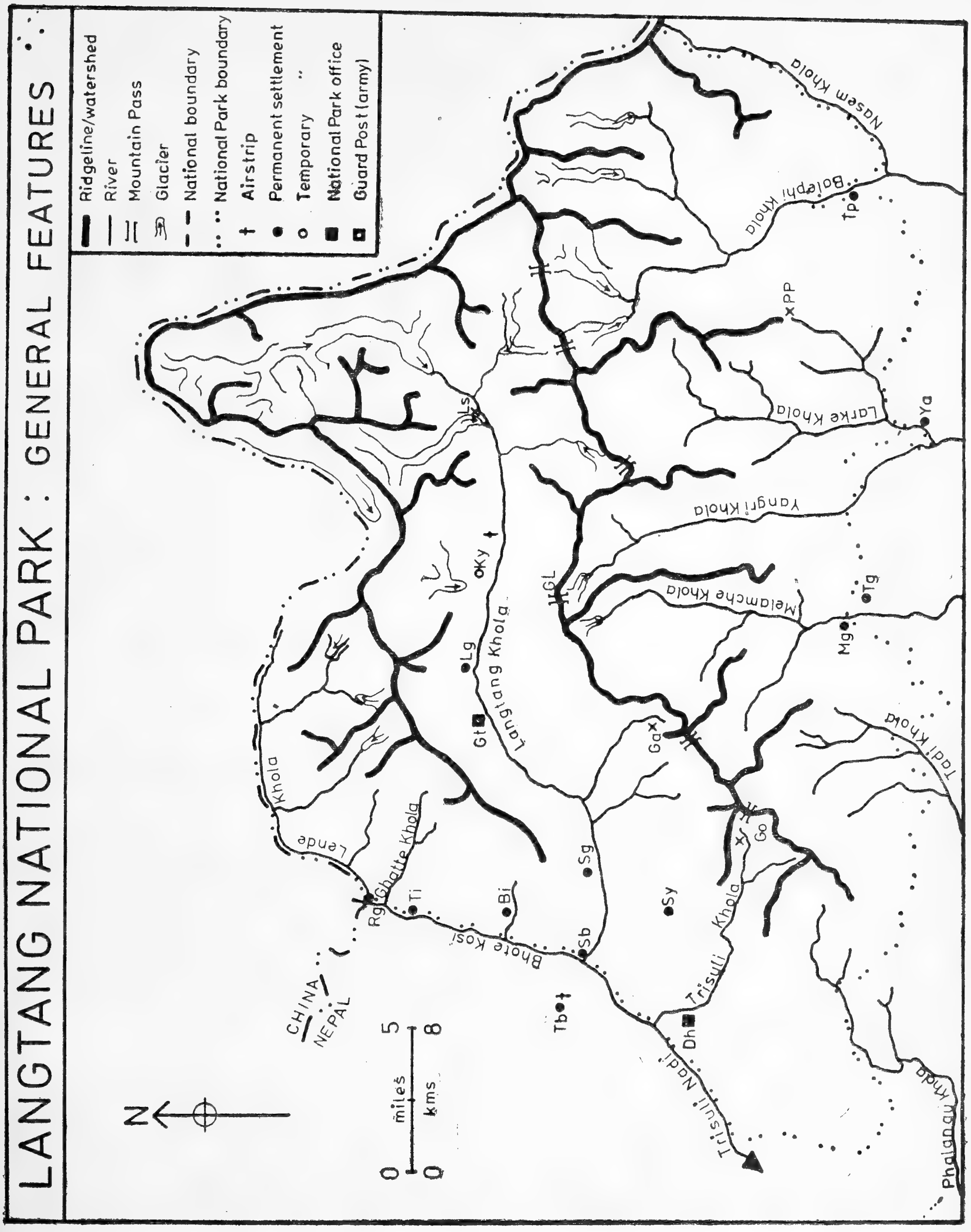


Langtang Lirung (7,245 m), the highest peak in the Langtang National Park, Nepal.
(*Photo* : Michael J. B. Green)

An adult female tahr which subsequently fell off a cliff, killing itself.



A yearling tahr, probably a male owing to its slight ruff.
(*Photos* : Michael J.B. Green)



MAP: Based on satellite photographs (Fox 1974b). Drawing by L. J. Borradaile.

6

TABLE 2

MAMMALS SEEN BY THE DUHE AND TOURISTS IN THE LANGTANG NATIONAL PARK BETWEEN APRIL 1976 AND MAY 1977

Species	Observations No.	Observations %	Animals No.	Group size Range	Group size Mean
Rhesus macaque	13	1.9	127	1-30	9.8
Common langur	153	22.2	1,490	1-50	9.7
Pika	303	44.0	311	1-3	1.0
Orangebellied Himalayan squirrel	64	9.3	69	1-2	1.1
Red fox	5	0.7	5	1	1.0
Wild dog	1	0.2	4	4	..
Himalayan black bear	11	1.6	13	1-2	1.2
Red panda	3	0.4	4	1-2	1.3
Himalayan weasel	33	4.8	33	1	1.0
Pale-footed weasel	2	0.3	2	1	1.0
Stone marten	2	0.3	2	1	..
Himalayan yellow-throated marten	29	4.2	41	1-3	1.4
Leopard-cat	1	0.2	1	1	..
Leopard	3	0.4	3	1	1.0
Indian wild boar	4	0.6	7	1-4	1.8
Himalayan musk deer	8	1.2	8	1	1.0
Muntjac	12	1.7	15	1-3	1.3
Brown goral	18	2.6	40	1-6	2.2
Serow	2	0.3	2	1	1.0
Himalayan tahr	22	3.2	296	1-40	13.5
TOTAL	689	100.1	2,473		

and above Langsisa goth on 5 October at 4,120 m. This last goth is 8 km east of Langtang Village. Some individuals may, therefore, range up to 1,070 m in altitude and 25 km in distance during the year.

The highest recorded sighting for the common langur is 4,270 m near Routang (Bishop 1977) which is also in the park. Here, according to local reports, a group of at least 50 animals forage during the summer months and then descend to 2,900 m for the winter. However, not all langur groups migrate seasonally. During a one year study of a group of 32 langurs at Melamchigaon, the same home range of 2.2 sq km was maintained within an altitudinal range of 2,439 m to 3,050 m (Bishop 1975). Migratory behaviour is probably an adaptive feature of those populations which inhabit the higher altitudes to meet their food requirements.

Langurs were seen eating *Fagopyrum dibotrys* (wild buckwheat), Umbelliferaceae, leaves of *Rosa macrophylla* and berries of *R. sericea* and *Hippophae salicifolia*. Fields of barley, buckwheat and potatoes were raided and hay and turnips, left by villagers to dry on rocks, were also taken by langurs.

Pika

Above the tree level pikas were ubiquitous among rocks, especially those comprising moraines and walls. They were also present in rocky habitat within subalpine and montane forests. Pikas were most frequently encountered between 2,590 m and 4,880 m and their faeces were found as high as 5,090 m which exceeds the altitudinal range of 3,400-4,300 m recorded by Prater (1971). Sightings were normally of solitary individuals (98%) but two and three animals were seen together on six and one occasion, respectively. Pikas were seen scurrying among rocks, in between bouts of feeding, or sunning themselves on rocks. Undoubtedly the species is an important source of food for martens, weasels, red fox and probably some raptors such as the golden eagle (*Aquila chrysaetus*) and Eurasian kestrel (*Falco tinnunculus*).

Squirrels

The orangebellied Himalayan squirrel is common within the temperate forest zone. Animals were seen singly and in twos on 59 and 5 occasions, respectively.

The presence of flying squirrels within the park is not yet confirmed but one record comes from nearby at Gatlang. Here some trekkers reported seeing locals maltreat a female and her young which had been caught. The most likely species to occur in the park are *Petaurista elegans*, *P. magnifica* and *P. petaurista* (Fleming Jr, pers. comm.).

Red fox

Above the tree line the red fox is widespread; its tracks and faeces were often found here along footpaths. Animals were seen in the upper Langtang Valley on five occasions, between 3,410 m and 4,970 m. Faeces were found up to 5,330 m and always contained the hair and bones of small rodents and on one occasion the beak of a rose finch (*Carpodacus* sp.).

Wild dog

A pack of four dogs was seen in the forest above Khangjima. Elsewhere in the Langtang Valley livestock sometimes fall prey to this species. In March 1977 two young yak were killed at Buldagaon goth (3,910 m). These calves had been ripped open at the belly which, according to local people, is characteristic of wild dog. North of Tarkeghyang spoor, probably that of wild dog, was found to contain the hair of musk deer (Fleming Jr, pers. comm.).

Bears

The Himalayan black bear was seen within the temperate forests of the lower Langtang Valley. Solitary animals were seen nine times and groups of two twice. One trekker was chased by a female, which was accompanied by a cub, and every year several villagers are mauled by bears. The species is still hunted within the park on account of the damage which it causes to crops.

A brown bear reputedly exists in the Melamchigaon area. According to Fleming Jr (pers. comm.) this form is most unlikely to be *Ursus arctos*. A brown phase, when the white collar is absent, occurs in the Himalayan black bear which could account for any confusion between the two species.

Red panda

This inhabitant of the montane forest zone is seldom encountered due to its nocturnal habits. Its presence may be detected by a distinctive call which is recognized by local people. In the lower Langtang Valley two solitary animals and one group of two were sighted between 2,440 m and 3,050 m. The faeces were easily identified on account of their size (c. 18 × 35 mm), oval shape and dark green colour. They were twice found at the base of *Abies spectabilis* trees in the Langtang and Trisuli Valleys, at 3,660 m and 3,200 m respectively.

Weasels

The Himalayan weasel (*M. sibirica subhemachalana*), with its distinctive rufous coloured pelage, dark muzzle and black-tipped tail, was often seen in stone walls in the upper Langtang Valley. Weasels in and around the expedition's house in Langtang Village accounted for 26 of the 33 sightings. Animals were only ever seen singly, indicating that they are solitary hunters.

The pale-footed weasel (*M. altaica temon*), which has a light brown body with a yellow throat and belly and white paws, was seen twice amidst alpine scrub and moraine at 4,150 m and 4,720 m, respectively.

Martens

The Himalayan yellowthroated marten was seen in a diverse range of habitats which included terraced fields and forest of the temperate zone and cliffs and scrub of the subalpine and alpine zones. Animals were seen as high as 4,000 m which is above the upper altitudinal limit cited by Prater (1971) who states that 'In the Himalayas they keep to forest limits and are not found above the treeline.' Out of 29 sightings, solitary animals were seen 18 times, groups of two 10 times and a family of three once. Such data indicate that animals often hunt in pairs, reinforcing the particular view held by local people that musk deer are chased until exhausted by pairs of martens. Animals were seen to be active at all times of the day and once around mid-night. They were observed more frequently on the ground (13 times) than in trees (5 times). This is not a true reflection of the amount of time which animals spend on and above the ground because they are more easily seen in the former habitat. Once a marten was seen catching white-capped river chats (*Chaimarrornis leucocephalis*) by the banks of the Langtang Khola. Having caught one bird in its mouth, the marten was then mobbed by three other river chats. Distracted by these mobbers, the marten briefly relinquished its prey in order to chase and jump up after them. Seconds later the prey was retrieved but then, noticing the observer, the marten dropped this and made a hasty retreat. The river chat flew away, presumably unharmed. The hair of musk deer, seeds of berries and cuticle of insects have been found in the faeces of martens.

The stone marten also occurs in the montane and subalpine zones. Solitary animals were seen twice amidst rocky habitat.

Leopards

In the lower Langtang Valley leopards were seen in open rocky habitat at 1,520 m and montane forest at 2,740 m. In the former instance the leopard was watched on the cliffs above Syabrubensi as it stalked towards where four goral had been feeding. It then took fright because of the excited crowd of spectators which had gathered in the village just below. Park guards saw a leopard in Ghatte Khola and reported another being killed near Syabru in March 1977. Leopard faeces were often found up to 3,050 m elsewhere in the park which indicates that the species is common.

The leopard-cat also occurs in the park. One was seen in the upper Balephi Valley, east of Chingtang Gompa.

Indian wild boar

Within temperate forests this species is common. Solitary animals were seen on three occasions and a group of four once. In the Trisuli Watershed area Caughley (1969) found animals as high as 4,200 m. In view of the extensive damage which this species causes to crops it is often hunted.

Himalayan musk deer

Living in birch, rhododendron and fir forests of the subalpine and alpine zones, the Himalayan musk deer is rarely seen because of its shy nature, crepuscular habits and low population density. Animals were encountered on seven occasions in the upper Langtang Valley between 3,000 m and 4,100 m and once elsewhere. Twice animals, which may have been feeding, were disturbed around midnight. Fox (1974a) estimated 20-30 animals on the south side of the Langtang Khola, between Palpal and Chhona.

Musk deer are generally solitary except during the rut. Observations of a female, which was repeatedly found within the same area of about 200 m × 400 m, suggest that the home range is small (Fleming Jr, pers. comm.). Animals defecate in certain places on a repeated basis but the role of such latrine sites is uncertain. Natural predators include the leopard, wild dog and Himalayan yellow-throated marten.

It is a well-known fact that the species is hunted for its musk which is used in medicines and cosmetics and is worth about four times its weight in gold. Musk deer populations have been drastically reduced throughout the park and poaching is still rife in the remoter areas. Suitable habitat for the species comprises 6.5% (111 sq km) of the park's area. About one fifth of this habitat was visited (e.g. Panch Pokhari and the upper Langtang, Larke, Melamchi and Balephi Valleys) of which 86% was found to have been trapped within the last three years. Trapping involves the construction of brush barricades, along which gates are placed at intervals and set with sprung nooses to ensnare the animal's head or foot. From 100 to 600 gates may be in operation in a single one kilometre section of valley. Such figures provide some idea of the intense pressures which musk deer face from poaching (Green 1978a).

Muntjac

Muntjac or barking deer occur in the temperate forest zone. In forests animals could be detected by their characteristic dog-like bark but also they were often seen grazing in clearings and cultivated fields. Along the Bhote Kosi, lower Langtang and Balephi Valleys animals were seen or heard on 15 occasions ; solitary individuals were seen eight times and groups of two and three both once.

Brown goral

On the grassy cliffs above the Bhote Kosi and lower Langtang Khola goral are common. Group size numbered up to six but solitary animals were seen on 10 (56%) occasions. A young animal, about three months old, which had been found ' abandoned ' by some Tibetans at Ghora Tabela was successfully reared on a diet of rice, tsampa (roasted barley flour) and milk.

Serow

Due to its preference for forest with impenetrable stands of bamboo and its solitary nature the serow is seldom seen. Two single animals were sighted in the lower Langtang Valley. Faeces, which can be readily distinguished from those of tahr or sheep on account of their larger size, were often found in birch, fir and rhododendron forest up to 3,660 m.

Himalayan tahr

A detailed study of the Himalayan tahr was made in the upper Langtang Valley (Green 1978b, 1979). Here, in the subalpine scrub and alpine pastures, two populations of about 170 and 46 animals each ranged over areas of 7 sq km between 3,500 m and 4,600 m. Density varied between 5 and 46 tahr per sq km depending on the habitat and the degree of competition with livestock. Mean group size was 14.8, based on a total of 239 sightings. This figure differs little from the mean of 13.5 which is separately derived from the observations of DUHE and visitors (Table 2). During the thirteen month study period 77 was the largest recorded group of tahr. Groups tended to consist of adult males or adult females and juveniles of both sexes, except in the rut when groups of mixed sex and age categories predominated. Adult females and juveniles maintained the same home ranges throughout the year, migrating about 700 m vertically on a daily basis. Adult males tended to range laterally. The rut lasted from about November until mid-February; most mating probably occurred in December. Young were born between mid-June and mid-July.

In the lower Langtang Valley about 40 tahr were seen near Buldagaon goth (Treunier, pers. comm.) which suggests a total population size of up to 300 tahr for the Langtang Valley.

Elsewhere in the park a group of 13 tahr were seen on the cliffs above Saraswatikund and 31 were sighted on the slopes above Pemasol goth in the eastern headwaters of the Balephi Khola. Also Fox (1974a) reported that tahr occur in the vicinity of Rasuwa Garhi and Ganesh Kund. The former is the border post with China (Tibet) to which access is restricted and, therefore, could not be surveyed. The latter, a lake at 4,800 m, was visited but no tahr were seen although their faeces were evident.

More recent work has shown that the tahr is exclusively neither a forest animal (Prater 1971) nor an inhabitant of the subalpine zone between 3,900 m and 5,200 m (Caughley 1969). In the present study tahr were seen between 2,700 m and 5,000 m which, together with Schaller's (1973) observations of animals between 2,500 m and 4,400 m, indicates that the species occupies a wider altitudinal range than was previously believed.

Conservation

A national park such as Langtang, within which there are a large number of residents, poses particular problems because the conservation of the wildlife must be reconciled with the needs of the local people. In view of such a dilemma it has been recommended that the park should be zoned into areas of differing conservation status (Borradaile *et al.* 1977). Certain 'protected natural areas' should be set aside for the preservation of wildlife whereas other 'cultivated landscapes' should be designated for use by residents to meet local timber, fuelwood, agricultural and pastoral requirements. 'Protected natural areas' amounting to 673 sq km (about 40% of the park's area) have been proposed in order to ensure that a representative sample of the park's wildlife will be completely protected from human pressures.

In the case of the park's mammals some five species merit particular attention because their status is 'threatened' according to the Red Data Book (IUCN 1974). These are the wild dog, leopard, clouded leopard, snow leopard and the Himalayan musk deer.

Although hunting mostly ceased after the park's establishment, it still persists in the case of certain species. However, a distinction should be made between those species which are killed because they pose a threat to crops, livestock or human life and those which are hunted for their meat, hide or other valuable assets. The former is justifiable—the latter must be curbed.

Species which fall into the first category include the rhesus macaque, common langur, Himalayan black bear, Indian wild boar and muntjac, which raid and damage crops extensively, and the wild dog and leopard which occasionally prey on livestock. In the daytime monkeys are the principal marauders. For religious reasons they are never killed but may be chased away from fields. At night cultivations are vigilantly guarded from nearby machans. Fires and noises are made to frighten away bears in particular. However, such measures may sometimes be inadequate and so the authorised killing of persistent marauders may be necessary within 'cultivated landscapes'. Such action would be difficult to justify in the case of wild dog or leopard in view of their 'threatened' status. It would be in the interests of good public relations for the park authorities to consider either a scheme of compensation to local people for livestock killed by these predators or to trap them for relocation elsewhere in the park.

The only species to fall within the second category is the Himalayan musk deer. Poaching for musk has already been discussed. Unless effective measures are taken to curb such illicit activities, populations will cease to be large enough for breeding to be viable and the species will become extinct, not only in Nepal but throughout the Himalaya.

Apart from hunting, most mammalian species are adversely affected wherever their habitat is utilized by man. For instance, the brown goral, Himalayan tahr and serow compete with livestock for fodder. Fortunately, from a conservation viewpoint, certain areas are too precipitous to be reached by domestic animals but are accessible to these more agile wild ungulates.

Generally speaking, provided that sufficient habitat can be conserved and poaching is stopped, no specific measures need to be taken to preserve the mammalian fauna because it will look after itself.

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NARORA RESERVOIR, U.P.,—A POTENTIAL BIRD SANCTUARY [1]

ASAD RAFI RAHMANI [2]

Northern India receives the major influx of migratory ducks but bird sanctuaries are few in this part of the country. With large-scale draining of jheels and swamps, the ducks now flock to the over-crowded Ghana Bird Sanctuary (Rajasthan), in the newly established Priyadarshani Bird Sanctuary (Uttar Pradesh) and in Sultanpur Bird Sanctuary (Haryana). There are still many swamps and reservoirs which if properly protected, could become ideal refuges for water birds. One such place is near Narora in Uttar Pradesh.

Narora (28° 15′N, 78° 23′E) in Bulandshahr district of Uttar Pradesh is the site of India's fourth atomic power plant. It lies on the main migratory route of the birds of Palaearctic region. Due to damming of the river Ganga, a huge reservoir is formed. During winter and summer, when the water level is low, large number of islands appear in the reservoir which provide safe resting places for the ducks. Moreover, on both sides of the reservoir, many lakes and jheels are present where the aquatic birds feed. Terns, lapwings and Indian skimmer nest during the summer months on the small islands unmolested.

I have surveyed the reservoir, from Narora to Rajghat, a distance of seven kilometres. The reservoir was visited on 16-vii-78, 27-viii-78, 17-xii-78, 6-vi-79, 18-vii-79, 19-viii-79, 23-xii-79, 13-i-80 and 3-ii-80. The area could be roughly divided into the following three zones :

(*a*) *Riverine zone :* As the reservoir is located in the Ganges, the area provides a typical habitat for all the riverine birds of northern India. Twenty-five islands, ranging from 1/2 acre to 20 acres, are present from Narora to Rajghat. Except for the one main island which is never submerged, all the remaining islands are transitory and their appearance or disappearance as well as size, depends greatly on the water level of the reservoir. In addition to these elongated islands, innumerable number of small islands also arise when the water level is extremely low.

Human disturbance in the reservoir is minimum, save for the daily water level readings taken by the U.P. Hydel Department, so the birds find a congenial habitat and during winter, hundreds of ducks and waders make their home in this reservoir. Circumstantial evidence suggests that the River tern and the Indian skimmer breed on these islands. The surrounding water around the islands is generally shallow in which spoonbill, painted and black-necked storks, sandpipers, black-winged stilt, curlew, egrets, tufted pochard, shoveller, pintail, gadwall, etc., find food. Bar-headed and greylag geese, Brahminy duck and cormorant rest on the sand banks. In deeper parts of the reservoir, tufted pochard, white-eye pochard, shoveller and wigeon are very common. In a five-square kilometre area upto 1,000 were counted on 23-xii-79.

(*b*) *Marshes and jheels :* To check erosion and siltation, 'bunds' of stone are erected on either side of the elongated reservoir. Near these 'bunds', water which has overflowed in monsoon months, accumulates resulting in marshes and jheels. Teals, pintail, coot, purple moorhen, pheasant-tailed jacana, bronzewinged jacana, painted and blacknecked storks, openbilled stork, sarus crane, spotbill,

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cormorants (large and little), grey heron, dabchick, whitebreasted waterhen, three species of kingfisher and sandpipers are found in these jheels. In the thick reedy beds, ashywren-warbler, red munia and streaked weaverbird were identified.

In the absence of suitable trees, painted stork, spoonbill, cormorants and egrets do not breed in Narora. However, pheasant-tailed jacana, sarus crane, Indian moorhen, coot, Whitebreasted waterhen, dabchick, red munia and streaked weaverbird regularly breed here.

(*c*) *Open fields :* The marshes gradually graduate into cultivated and uncultivated fields which harbour different species of birds, mostly the common ones. Noteworthy species are : grey and black partridges, quails, whitethroated munia, stone curlew, blackbellied finch lark, pied bushchat, collared bushchat, and red-start.

Among the birds of prey, the Pallas's fishing eagle is rather common around the jheels, while the blackwinged kite can be seen hovering over grasslands in search of prey. Redheaded merlin, kestrel and tawny eagle were also seen once each.

In addition to the above-mentioned birds, all the birds of the Indian plains and marshes are found in Narora. I have identified 120 species—both resident and migratory. Important ones are listed below. Rare vagrant migrants are the great crested grebe and the common shelduck. Only one specimen of each species was observed.

LIST OF SOME IMPORTANT BIRDS OBSERVED BETWEEN NARORA AND RAJGHAT

(*Based on counts in winter*)

Species	Year and approximate number 1978	1979	1980	Status
1. Barheaded Goose (*Anser indicus*)	30	45	28	Uncommon
2. Greylag Goose (*Anser anser*)	—	5	—	Rare
3. Brahminy duck (*Tadorna ferruginea*)	180	260	196	Common
4. Common shelduck (*Tadorna tadorna*)	—	1	—	Rare
5. Tufted pochard (*Aythya fuligula*)	+	+	+	Very Common
6. Wigeon (*Anas penelope*)	+	+	+	Very Common
7. White-eyed pochard (*Aythya nyroca*)	+	+	970	Very Common
8. Gadwall (*Anas strepera*)	+	+	1,700	Very Common
9. Pintail .. (*Anas acuta*)	—	+	78	Common
10. Shoveller (*Anas clypeata*)	+	+	+	Very Common

LIST OF SOME IMPORTANT BIRDS OBSERVED BETWEEN NARORA AND RAJGHAT (*Continued*)

Species	Year and approximate number 1978	1979	1980	Status
11. Combduck (*Sarkidiornis melanotos*)	—	11	—	Uncommon
12. Spotbill (*Anas poecilorhyncha*)	28	—	36	Uncommon
13. Spoonbill (*Platalea leucorodia*)	*	*	76	Common
14. Little cormorant (*Phalacrocorax niger*)	68	*	80	Common
15. Large cormorant (*Phalacrocorax carbo*)	—	74	29	Uncommon
16. Darter (*Anhinga rufa*)	—	38	46	Uncommon
17. Blacknecked stork (*Xenorhynchus asiaticus*)	—	32	54	Common
18. Painted stork (*Ibis leucocephalus*)	+	+	+	Common
19. Openbilled stork (*Anastomus oscitans*)	—	69	34	Common
20. Whitebreasted waterhen (*Amaurornis phoenicurus*)	+	+	+	Very Common
21. Purple moorhen (*Porphyrio porphyrio*)	+	+	+	Very Common
22. Coot (*Fulica atra*)	+	+	+	Very Common
23. Pheasant-tailed jacana (*Hydrophasianus chirurgus*)	+	+	+	Common
24. Blackwinged stilt (*Himantopus himantopus*)	+	+	+	Common
25. Avocet (*Recurvirostra avosetta*)	—	6	15	Uncommon
26. Curlew (*Numenius arquata*)	—	—	5	Rare
27. Redshank (*Tringa totanus*)	*	120	156	Common
28. Pallas's fishing eagle (*Haliaetus leucoryphus*)	3	*	7	Comparatively common
29. Blackwinged kite (*Elanus caeruleus*)	—	—	5	Rare
30. Kestrel (*Falco tinnunculus*)	—	1	—	Rare

— = Not seen
* = Probably present
\+ = Seen but not counted. Very common.

Potentialities of the Narora reservoir as a bird sanctuary

The main reservoir and the adjoining marshes in Narora have great potentiality for development into a bird sanctuary. Following are some of the reasons which could attract both the birds and the tourists to Narora.

1. The place is well connected by road with Delhi, Bulandshahr, Moradabad, and Aligarh.

2. The Uttar Pradesh Tourism Development Corporation has plans to develop the area into a picnic spot. The Corporation has established a beautiful Gazel Restaurant which provides a panoramic view of the reservoir. Rest houses of the U.P. Hydel Department are easily available for overnight stay. Moreover, due to the fast developing township of workers and engineers of the Narora atomic power plant, hotels and 'dharamshalas' have appeared which provide all the necessary facilities for boarding and lodging. A bird sanctuary will greatly enhance the attraction of the place.

   Thus, the infra-structure, which eats up most of the capital of any such project, is already present in Narora, so, expenditure on this account will be small.

3. Due to the deep water and absence of any private motorboat, it is very difficult for hunters to reach the islands, therefore, poaching is minimum. However, engineers in government motorboats sometimes manage to kill a few ducks. Declaring the area into a sanctuary can easily curb this activity. As Narora is a prohibited zone and armed men guard the barrage, outside poachers do not visit the reservoir.

   Dr. Sálim Ali, who visited Narora with me in December 1978, called it a 'natural sanctuary'. He suggested to the official of the U.P. Forest Department and to the Regional Tourist Officer, that 'all efforts should be made to protect this place from destruction.'

4. Fishing is the only commercial exploitation which is allowed in the Narora reservoir. And this activity does least damage to the birds because fishing is mostly done in the deeper parts of the reservoir where the birds generally do not feed. Thus fishermen and birds do not compete with each other. (This needs further confirmation).

   Due to transitory nature of the islands, cultivation is not possible on them, except in summer (watermelons is grown on a few big islands). Human pressure on the nearby marshes and jheels is minimum and most of them remain permanently occupied by birds. There is no village on the left side of the reservoir where most of the marshes are present. Thus, acquiring the surrounding land, especially on the left side, for a bird sanctuary would have negligible economic impact on the cultivators.

5. Rajghat and even Narora have religious importance. Thousands of pilgrims come every year to bathe in the Holy Ganga. Most of the temple priests and other inhabitants to whom I talked want this place to be declared a shooting-free zone.

6. Uttar Pradesh does not have any riverine bird sanctuary. The Narora Bird Sanctuary will greatly increase the tourist attraction of the State.

7. Additionally, this reservoir can also become a congenial habitat for the highly endangered gharial (*Gavialis gangeticus*). It has deep pools full of fish and undisturbed sand banks where these reptiles can lay eggs. Four years ago, the fishermen caught a five-foot mugger (*Crocodylus palustris*)

from this reservoir. (This mugger now lives in the Crocodile Rehabilitation Centre in Kukrail near Lucknow). This proves that the habitat for crocodiles in the Narora reservoir has not altered very much and with proper protection these reptiles could be easily re-introduced.

8. India's fourth atomic power plant is fast coming up, three kilometres downward of Narora. This plant will increase the importance of the town.

Conclusions

All the necessary infra-structure and facilities which are required for a bird sanctuary are already available in Narora. With a minimum expenditure, the Narora reservior could additionally become an excellent tourist attraction. In my latest visit (13-ii-80) I found that the population of birds has slightly increased since some restriction was placed on shooting. Decline in flight-distance of the wigeon, shoveller, tufted pochard and brahminy duck also proves that poaching is decreasing. With a little more imaginative planning and necessary protection, the Narora reservoir could become a haven for wildfowl.

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TAXONOMIC REVIEW OF HODGSON'S GIANT FLYING SQUIRREL, *PETAURISTA MAGNIFICUS* (HODGSON) [SCIURIDAE: RODENTIA], WITH DESCRIPTION OF A NEW SUBSPECIES FROM DARJEELING DISTRICT, WEST BENGAL, INDIA[1]

R. K. GHOSE AND S. S. SAHA[2]

(*With three text-figures*)

INTRODUCTION

The taxonomic status of the giant flying squirrels with prominent yellow shoulder patch, *Sciuropterus magnificus* Hodgson, 1836, and *Sciuropterus nobilis* Gray, 1842, have been the subject of some controversy since the publication of the 'Catalogue of the Mammalia in the Museum of the Asiatic Society of Bengal' by Blyth (1863), who treated them as conspecific. Subsequently, Jerdon (1874), Anderson (1878), Sclater (1891), Blanford (1891), Robinson and Kloss (1918), Ellerman (1940, 1947, 1949 and 1963), Ellerman and Morrison-Scott (1951, 1966) and Chakraborty (1975), followed Blyth (1863). Wroughton (1911, 1919), however, accepted *S. nobilis* Gray as a distinct species, but treated *S. magnificus* Hodgson as a subspecies of *Petaurista albiventer* (Gray).

During the last few years fresh material of giant flying squirrels has been collected by the Zoological Survey of India parties from Darjeeling District, West Bengal, and Bhutan, both in winter and summer seasons. These specimens offered an opportunity to us to study the subject afresh and evaluate the taxonomic status of the two flying squirrels. The result of this study has been presented in this paper. Opportunity has also been taken to describe a hitherto unknown subspecies of *Petaurista magnificus* (Hodgson).

All measurements have been expressed in millimetres. The colour names given with initial capital letters in the text have been recognized according to Ridgway's (1912) nomenclature.

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RESUMÉ OF THE TAXONOMY OF *Sciuropterus magnificus* HODGSON, 1836, *Sciuropterus nobilis* GRAY, 1842 AND *Sciuropterus chrysothrix* HODGSON, 1844

The giant flying squirrels, originally described as *Sciuropterus magnificus* Hodgson, 1836, *Sciuropterus nobilis* Gray, 1842, and *Sciuropterus chrysothrix* Hodgson, 1844, were studied by Blyth (1847) and Horsfield (1851). They however, used the generic name *Pteromys*, and retained *Pteromys magnificus* (Hodgson) and *Pteromys nobilis* (Gray) as distinct species, with *Sciuropterus chrysothrix* Hodgson as a synonym of *P. nobilis*. Although the paper of Hodgson (1844) giving accurate accounts of the new species, *Sciuropterus chrysothrix* and *S. senex*, was sent to the Editors of the Journal of the Asiatic Society of Bengal much earlier in 1842 (long before Gray's), due to delay in printing (of the colour plate), it came out as late as 1844 with the following note by Blyth : 'The truth is, both of them are species *already* described ; *viz.* the *Pteromys nobilis* and *P. caniceps* of Gray, and it would not be creditable to the Journal that they should be published under Mr. Hodgson's new names'. Despite that note, Blyth (1863) in his subsequent publication himself synonymized *Sciuropterus nobilis* Gray and *Sciuropterus chrysothrix* Hodgson with *Pteromys magnificus* (Hodgson), with their status designated as 'variety' in his catalogue. Jerdon (1874), Anderson (1878), Sclatar (1891) and Blanford (1891) also treated them in a similar manner. The last-named author, however, emphasized on the presence or absence of the middorsal strips, and thought that *S. nobilis* was the summer garb and *P. magnificus*, the winter garb of *Pteromys magnificus* (Hodgson).

It was Wroughton (1911) who used Link's generic name *Petaurista* for the giant flying squirrels, and correctly emphasizing on the presence of a distinct saddle unlike in any of the giant flying squirrels, considered *Petaurista nobilis* (Gray) as a distinct species. He, however, left *Sciuropterus magnificus* Hodgson under *Petaurista albiventer* (Gray) as a subspecies.

Robinson and Kloss (1918), emphasizing on the dorsal stripe, reverted to Blyth's (1863) taxonomy of the group. They had with them '*nobilis*' form with and without any dorsal stripe, thus nullifying its importance as the diagnostic character of *S. chrysothrix* [= *Petaurista nobilis* (Gray)] as stated by Hodgson (1844). They also attributed the prior name *P. magnificus* (Hodgson), to the two available forms. Ellerman (1947) and Ellerman and Morrison-Scott (1951, 1966) followed Robinson and Kloss's taxonomic treatment. Although, Ellerman (1963) admitted that '*nobilis*' is strikingly distinct from all other *Petaurista*, and '*magnificus*' is not so striking, but with the scanty material (available to him), he concluded that the two forms were seasonal variants, despite the fact that he had both summer and winter collections of both of them. Based on a study of the additional material recently obtained from Bhutan in summer and winter, Chakraborty (1975) concluded that *P. magnificus* is a distinct species with a constant pelage colour, and that *P. nobilis* and *P. chrysothrix* are nothing but its synonyms. *Petaurista magnificus* differs from all other species of the genus by having a constant dark maroon saddle on the back even in the subadult stage, which may sometimes be partly or fully divided down the spine by a yellowish buff line.

The following points may be summarized from the extant literature :—

Since the publication of Blyth's (1863) 'Catalogue', except Wroughton (1911, 1919), all other authors attributed undue importance to the middorsal stripe. They overlooked the basic colour pattern and also the original descriptions. Additional material of *P. nobilis* with or without the stripe, perhaps, put them in a dilemma. Blanford (1891) and his followers considered the two species as seasonal dimorphs. But Robinson and Kloss (1918), Ellerman (1947, 1963) and Chakraborty (1975), who had various forms of *P. nobilis* from different seasons, with or without the middorsal stripe, curiously overlooked the fact that seasonal change cannot be attributed to the two forms, and they maintained the traditional concepts about the two species. And this was perhaps due to a mislabelled specimen (skin and skull) of *P. nobilis* designated (by Robinson and Kloss 1918) as a paratype of *S. magnificus* now in the collection of the Zoological Survey of India (Reg. No. 9728).

Robinson and Kloss (1918) said that the 'Co-types' of *Petaurista magnificus* were in the British Museum and the Indian Museum. But in Sclater's (1891) catalogue of the collection in the Indian Museum, the skin marked 'a' did not have any skull. This specimen has been registered as ZSI. Reg. No. 9728 : skin and skull, after the collection of the Indian Museum was received by the Zoological Survey of India in 1916.

On examination of the alleged 'Co-type'—skin and skull, furnished with an additional label by Robinson himself and written in red ink 'probably a paratype of the species' (=*P. magnificus*), we found that the skull was typical of *P. albiventer* and certainly did not belong to the skin, and that the skin was that of *P. nobilis* with a distinct maroon saddle and the middorsal stripe broken at places. Moreover, Hodgson's specimen with the middorsal stripe, that was presented to the India Museum, London, was taken from Darjeeling, which cannot be the type-specimen of *S. magnificus*, whose type-locality is Nepal. This particular specimen belongs to the material of Hodgson's *S. chrysothrix* from Darjeeling, and on the basis of which Gray's *S. nobilis* was established. Wroughton's (1911, 1919) assertion that *S. magnificus* was a subspecies of *P. albiventer* (Gray) was due to his reliance on the basic colour pattern, namely, grizzled upper surface. But he failed to appreciate the distinct shoulder patch as an important character which isolates *P. magnificus* and *P. nobilis* from the rest of the species under the genus.

A reference to the original descriptions of the three species, namely, *S. magnificus*, *S. nobilis* and *S. chrysothrix* will show that the description were amply clear about their distinct colour-patterns (see also Text-fig. 1).

TAXONOMIC ACCOUNT

Order Rodentia

Family SCIURIDAE

Subfamily PETAURISTINAE

Petaurista nobilis (Gray)

Sciuropterus nobilis Gray, 1842, *Ann. Mag. nat. Hist.*, **10** : 263. Darjeeling.

Sciuropterus chrysothrix Hodgson, 1844, *J. Asiat. Soc. Beng.*, **13** : 67. Nepal.

For diagnosis see key (p. 101).

Petaurista nobilis nobilis (Gray)

Material examined : West Bengal ; Darjeeling District : 7♂, 4♀ ; Ghoombhanjang (alt. *c* 2117 m), 15-16 June 1974, 25-26 Feb. 1975 and 27-29 Mar. 1975 ; 2♂, 2♀ : Selimbong (alt. *c* 2250 m), 20-24 Mar. 1975, coll. R. K. Ghose. 1 unsexed : no other data, don. W. Rutledge, 1♀ : no other data, don. Zoological Garden, Alipore. 2 unsexed (1 juv.) : no other data, don. L. Mandelli.

Diagnosis : Fully agrees with the clear description of Hodgson's *Sciuropterous chrysothrix* (Text-fig. 1A).

External measurements : 9♂ : Head and body, 347-420 ; tail, 378-490 ; hind foot, 70.5-77.5 ; ear, 40-45. 6♀ : Head and body, 368-410 ; tail, 439-510 ; hind foot, 72-80 ; ear, 39-46.

Skull (Text-fig. 2) *measurements :* See Table 1.

Distribution : Known from the hills of Nepal, Sikkim and West Bengal (Darjeeling District).

Remarks : In one male (from Selimbong), one female (unknown locality), 2 unsexed and 1 juv. (1 ad. and 1 juv. from Sikkim and the other from unknown locality) the middorsal stripe and the blob on the forehead are absent, only a Buff-Yellow to Orange-Buff streak is present on the neck. In two females (from Ghoombhanjang) the dorsal stripe is obsolete and the blob on the forehead is ill defined. The middorsal stripe is of the same colour as the shoulder patch. The stripe is generally distinct, but occasionally broken at places, or obsolete, or absent altogether. The colour of the limbs, like that of the parachute, is Orange-Rufous. Sometimes the manus and/or the pes are black.

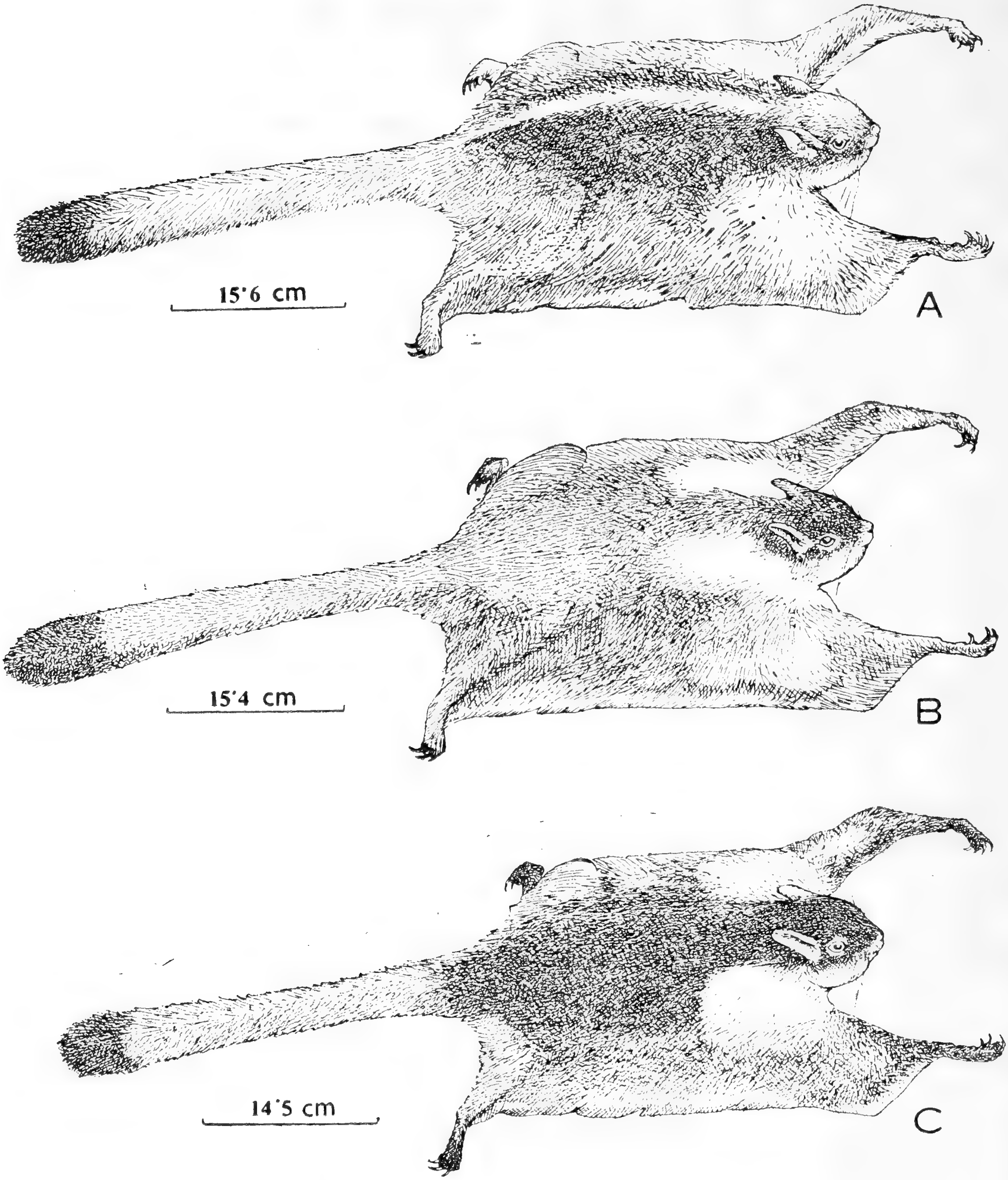

Fig. 1. Colour patterns of three giant flying squirrels in dorsal view: A. *Petaurista nobilis nobilis* (Gray); B. *Petaurista magnificus magnificus* (Hodgson), and C. *Petaurista magnificus hodgsoni* subsq. nov.

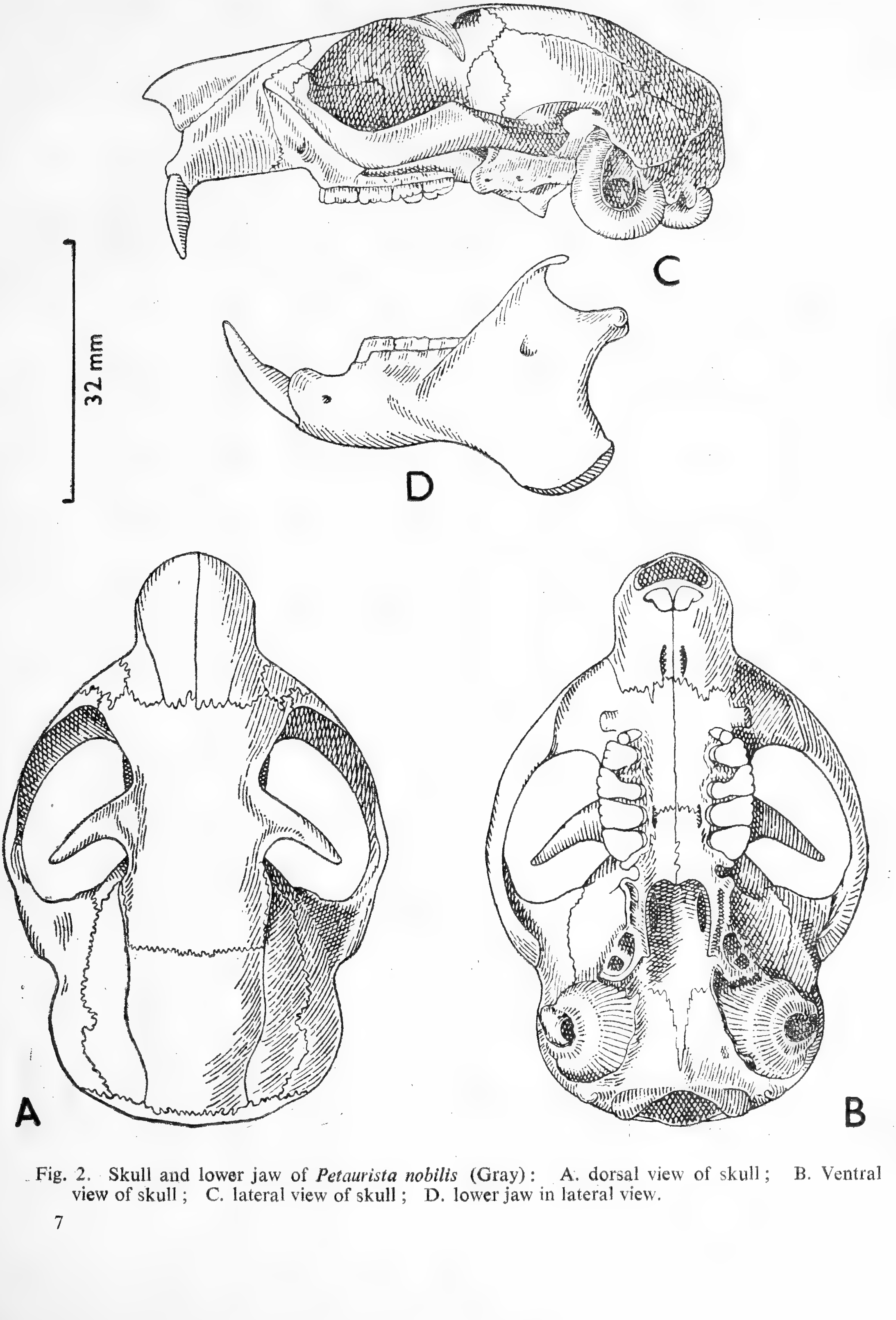

Fig. 2. Skull and lower jaw of *Petaurista nobilis* (Gray): A. dorsal view of skull; B. Ventral view of skull; C. lateral view of skull; D. lower jaw in lateral view.

TABLE 1

CRANIAL MEASUREMENTS OF *Petaurista nobilis*, *P.m. magnificus* AND *P.m. hodgsoni*

Locality & Species	Sex	Occipitonasal length	condylobasal length	Palate	Diastema	Upper toothrow	Inter orbital width	Bulla	Zygomatic width	Cranial width at auditory meatus	Nasal	Post orbital width	Maxillary width	Lower jaw
P. nobilis :														
Selimbong, Darjeeling, West Bengal ..	♂	72.8	68.8	38.0	16.5	16.0	14.7	12.3	45.0	33.3	22.6	15.8	18.4	44.1
-do-	♂	69.5	64.0	35.8	13.3	15.7	15.5	12.0	44.8	31.4	21.6	17.9	17.8	42.0
Ghoombhanjang, Darjeeling, West Bengal ..	♂	71.7	65.0	35.3	14.9	15.4	18.0	12.1	47.6	34.0	21.6	16.5	17.8	44.5
-do-	♂	70.2	66.2	36.0	14.1	16.8	17.3	11.8	45.6	34.5	22.3	17.0	18.8	43.3
-do- ..	♂	69.8	66.0	35.9	15.0	16.1	16.0	11.8	47.8	34.4	21.7	16.8	18.2	44.6
-do- ..	♂	68.5	64.5	35.2	14.7	16.0	14.6	12.0	43.0	33.5	22.4	15.5	18.0	43.7
-do- ..	♂	72.2	65.6	35.0	15.0	16.0	15.0	13.1	47.5	34.1	22.0	18.2	18.9	44.7
-do- ..	♂	67.9	63.6	34.5	14.0	15.0	15.3	12.6	44.5	32.6	20.5	17.6	17.9	43.0
Selimbong, Darjeeling, West Bengal ..	♀	74.0	69.4	37.4	16.3	16.6	16.3	12.3	48.0	35.5	22.3	17.8	19.4	44.8
-do- ..	♀	72.8	68.5	37.2	14.8	16.0	14.5	13.0	46.0	34.0	21.6	17.7	18.7	43.5
Ghoombhanjang, Darjeeling, West Bengal ..	♀	74.5	68.9	37.7	15.7	16.4	15.8	12.2	49.0	35.0	23.5	17.4	19.5	45.3
-do- ..	♀	71.1	64.0	36.0	15.2	15.6	15.0	12.6	46.6	33.2	22.3	16.9	18.0	44.4
P.m. magnificus :														
Sathat Hills, Gorkha, Nepal ..	♂	69.8	63.6	35.8	14.0	15.8	14.4	12.3	47.0	32.6	20.2	16.2	17.5	43.0
-do- ..	♀	68.4	62.6	34.0	13.9	14.9	14.7	12.2	44.5	31.6	20.8	16.8	17.0	41.1
P.m. hodgsoni :														
Ghoombhanjang, Darjeeling, West Bengal ..	♂	65.0	60.8	34.1	13.5	15.0	14.8	11.2	43.8	32.3	19.5	17.4	17.0	42.1

Three pairs of mammae (1 thoracic and 2 abdominal). One female collected in June 1974 was lactating. In two other females taken on 15 June 1974 and 26 February 1975, single embryos were found in the right horn of the uterus of both of them.

Petaurista nobilis singhei Saha

Petaurista nobilis singhei Saha, 1977, *Proc. zool. Soc., Calcutta*, 28 (1975) : 27-29. Bhutan.

Material examined : Bhutan : 1 ♂, 4 ♀ (1 ♀ bearing ZSI Reg. No. 19643 is holotype) : Gomchu (alt. *c* 2286 m), Gomchu Valley, 28 Mar. 1966 and 25 to 27 Dec. 1973 ; 1 ♂, 1 ♀ : Paro (alt. *c* 2440 m), Paro Valley, 14 Feb. 1969 ; 1 ♀ : Mithangarh (alt. *c* 1676 m), Diya Valley, 7 May 1966 ; all collected by B. Biswas and are the material of the type-series.

Diagnosis : Larger in size. Deeper and richer in coloration than the nominate subspecies. Pelage thicker, woolly and glossy. Saddle rich Maroon. Shoulder patch extends along the side of body and rich Orange-Buff. Parachute Ochraceous-Salmon. Middorsal stripe usually absent, but when present, obsolete or broken at places. Blob on forehead bright Orange-Buff and invariably present.

External measurements : 2 ♂ : Head and body, 414-490 ; tail, 495-510 ; hind foot, 80-81 ; ear, 46-51. 6 ♀ (including the holotype) : Head and body, 414-487 ; tail, 464-590 ; hind foot, 79-85 ; ear, 45-51.

Skull measurements : 1 ♂ : Occipitonasal length, 72.0 ; palate, 37.8 ; toothrow, 17.9 ; nasal, 20.4 ; frontal length, 30.1 ; orbit, 18.6, bulla, 13.1. 6 ♀ (including holotype type) : Occipitonasal length, 75.5-79.8 ; palate, 38.5-42.7 ; toothrow, 17.3-18.5 ; nasal, 21.7-24.3 ; frontal length, 29.0-31.7 ; orbit, 18.8-20.1 ; bulla, 12.7-13.2.

Distribution : So far known it is widespread in Bhutan.

Petaurista magnificus (Hodgson)

Sciuropterus magnificus Hodgson, 1836, *J. Asiat. Soc. Beng.*, **5** : 231. Nepal.

For diagnosis see key (p. 101).

Petaurista magnificus magnificus (Hodgson)

Material examined : Nepal : 1 ♂, 1 ♀ : Sathen Hills, Gorkha, 14 and 15 Jan. 1923, coll. N. A. Baptista.

Diagnosis : Upper surface with shades of reddish chestnut and whitish grizzling. Shoulder patch confined to pectorals, Saturn Red with golden hue (Text-fig. 1B). Undersurface Orange-Buff to Chestnut Orange.

External measurements : 1 ♂ : Head and body, 370 ; tail, 470 ; hind foot, 74 ; ear, 43. 1 ♀ : Head and body, 385 ; tail, 480 ; hind foot, 76 ; ear, 42.

Skull measurements : See Table 1.

Distribution : Hills of Nepal. Replaced by the following subspecies in Darjeeling District of West Bengal in the east. Its alleged occurrence in Assam, particularly to the south of the Brahmaputra, is obviously due to confusion with *P. albiventer*.

Petaurista magnificus hodgsoni subsp. nov.

Material : Holotype : 1♂ (ZSI. Reg. No. 20110) ; Ghoombhanjang (alt. *c* 2117 m), Darjeeling District, West Bengal, India ; 30 Mar. 1975 ; coll. R. K. Ghose. Deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

External measurements (holotype) : Head and body, 359 ; tail, 415 ; hind foot, 72 ; ear, 41.5.

Skull (Text-fig. 3) *measurements* (holotype) : Occipitonasal 65, condylobasal 60.8, palate 34.1, diastema 13.5, nasal 19.5, bullae 11.2, toothrow 15.

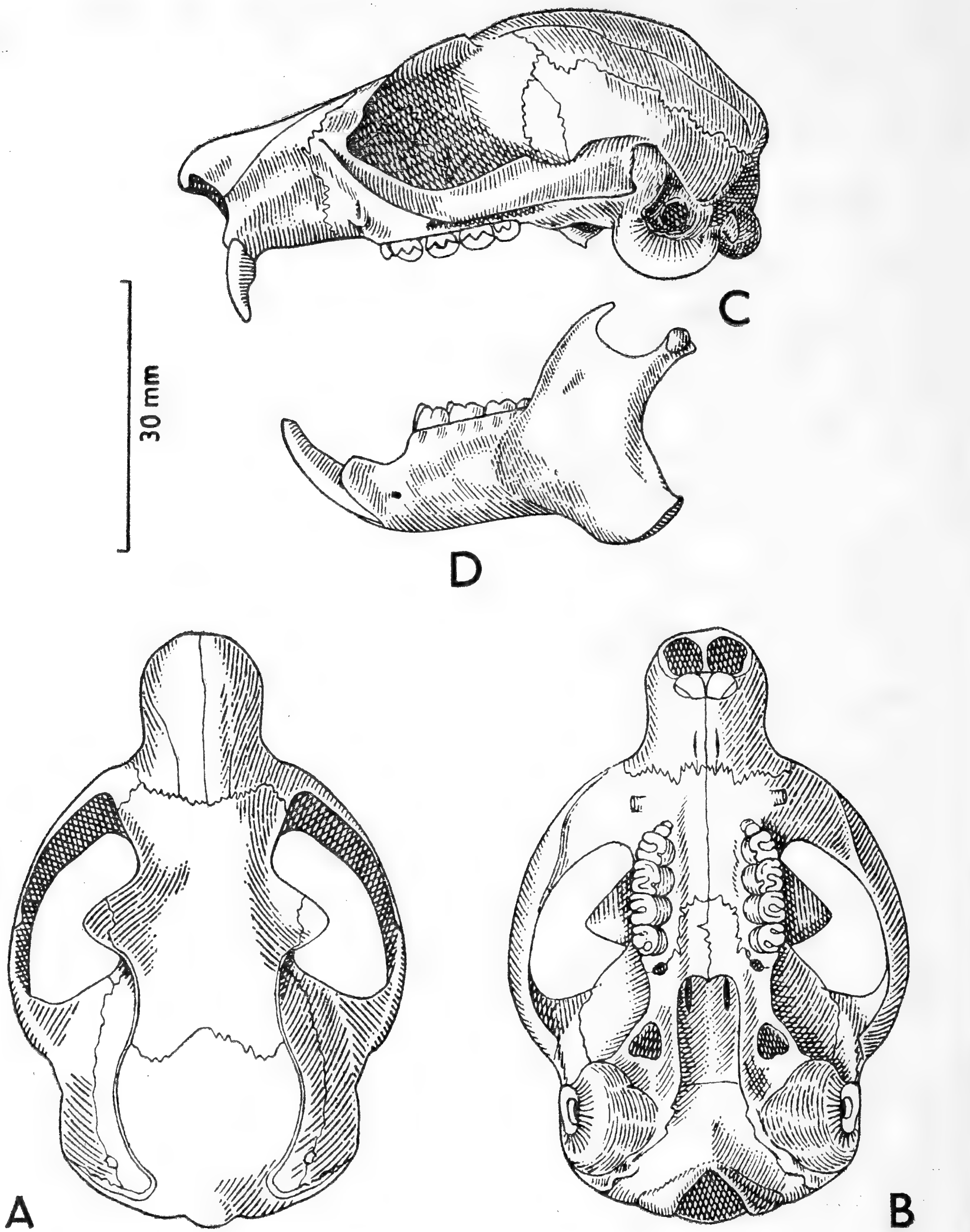

Fig. 3. Skull and lower jaw of *Petaurista magnificus hodgsoni* subsp. nov.: A. dorsal view of skull; B. ventral view of skull; C. lateral view of skull; D. lower jaw in lateral view.

Description : Upper surface chestnut mixed with some black hairs. Shoulder patch Cream-Buff to Colonial Buff. Limbs and parachute lighter than back and coloured Burnt Sienna. Tail Capuchin Orange to Xanthine Orange with a black tip (Text-fig. 1C), Undersurface Apricot Buff.

Distribution : So far known only from the type locality.

Remarks : Petaurista m. hodgsoni is smaller in size than *P. m. magnificus.* Although it is smaller in other cranial measurements, the interorbital bridge is wider than that of the nominate subspecies, and the skull is more rounded in overall aspect. Larger proportions of ear to head and body 12.5% (against 9.9-11.6%), and condylobasal 93.5% (against 91.1-91.3%), cranial width 49.3% (against 46.1-46.6%), postorbital width 28% (against 23.2-24.8%), and maxillary width 26.6% (against 24.8-25%) to occipitonasal length (Table 1) together with the strikingly different coat colour in *P. m. hodgsoni* warrants its separation from the nominate subspecies.

The new subspecies is named after the late Mr. B. H. Hodgson who is aptly known as the father of Indian vertebrate zoology.

KEY TO THE IDENTIFICATION OF THE SPECIES AND SUBSPECIES OF *P. magnificus* AND *P. nobilis*

1. Shoulder patch confined to pectorals. Rest of upper surface more or less uniformly coloured .. .. *P. magnificus* (2)

   Shoulder patch extends beyond pectorals along sides of body, isolating a distinct saddle .. .. *P. nobilis* (3)

2. Colour in general bright. Upper surface reddish chestnut, grizzled with whitish. Shoulder patch bright golden yellow. Under surface ochraceous .. .. *P. m. magnificus*

   Colour in general darker. Upper surface chestnut. Shoulder patch Cream-Buff. Under surface Apricot Buff .. .. *P. m. hodgsoni*

3. Saddle maroon. Usually a middorsal stripe present. Under surface Salmon-Buff to Flesh-Ochre. Parachute Orange-Rufous. Shoulder patch and sides of body Buff-Yellow to Orange-Buff .. .. *P. n. nobilis*

   Saddle rich glossy maroon. Middle stripe usually absent. Under surface Ochraceous-Salmon. Parachute deep Orange-Rufous. Shoulder patch including sides of body rich Orange-Buff. .. .. *P. n. singhei*

ACKNOWLEDGEMENTS

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SOME NEW PLANT RECORDS FOR WEST BENGAL FROM JALPAIGURI DISTRICT [1]

J. K. SIKDAR[2]

Jalpaiguri district has a rectangular shape, the length being from west to east and it lies at the foot of the hills south of Kalimpong division of Darjeeling district and the western part of Bhutan. The district is bounded on the east by Assam and on the south by Coochbehar district and Bangladesh. It is mainly a plain tract with the exception of Buxaduar hills which are the only mountainous tract and faces north.

The area, though visited by a number of botanists from time to time, has not yet been well explored and the floristic data specifically required for this district, is almost negligible in literature so far published.

Eight exploration trips to twenty different forest ranges under four forest divisions including the cultivated lands, waste lands, marshy areas, etc., were undertaken during the year 1975 to 1977 and about 1100 species collected and identified. On the basis of recent investigations on the flora of Jalpaiguri district, I found a good number of plants not reported previously from West Bengal (Prain 1903 & 1903a, 1905; Culshaw 1950; Mukerjee 1965; Bennet 1966; Matthew 1966; Dutta & Majumdar 1966; Vuppuluri Sharma 1969; Guha Bakshi & Naskar 1969 and others) and thus form new records for the state. A list of such plants with short diagnostic characters, flowering & fruiting, distributional notes, ecological features, etc. is given below. The herbarium sheets of the specimens examined are deposited in the Central National Herbarium (CAL).

[1] Accepted November 1979.
[2] Central National Herbarium, Botanical Survey of India, Howrah-711 103.

RUBIACEAE

Hedyotis macrophylla Wall. in Wight & Arn., Prodr. 408. 1834; FBI. 3 : 54. 1880.

An erect to suberect annual herb, young stem ± soft, 4 — angled; leaves opposite, pale-green, ovate-elliptic, acuminate, nerves distinct; flowers white in sessile axillary cymes; cocci dehiscing ventrally, the top not protruded between the calyx-teeth.

Fl. & frt.: Sept.-Oct.

Rare, usually growing as weed in waste land or among grass in rather sandy gravel soil along forest paths.

Distributed in Burma, Nicobar Islands and Assam. Prain (1903) and subsequent workers have not reported it from West Bengal and also there is not a single collection of this species in Herb. CAL from West Bengal. Hence, it is a new record for the state.

Specimen examined: Jalpaiguri district: Titi, ± 200 m (Madarihat range), *Sikdar* 681.

Hedyotis monocephala R. Br. ex Wall. in Hook. f., Fl. Brit. Ind. 3 : 63. 1880.

A prostrate or straggling stout herb with grooved branches; leaves 2-3.5 cm long, sessile, elliptic-lanceolate, acuminate, glabrous on both surfaces; stipules variable with recurved teeth; flowers in terminal capitate cymes.

Fl. & frt.: Jan.-Feb.

Rare, in swampy areas associated with *Veronica anagallis*, *Cotula hemisphaerica* and *Gnaphalium luteo-album* Linn. ssp. *affine* etc. This taxon can be easily identified by its sessile terminal capitate cymes, dark-brown leaves when dry and obscure nerves on the leaves.

Distributed in Assam and Burma. Prain (1903) and later workers, have not reported this taxon from West Bengal and there is not a single collection from the State in Herb. CAL. Hence a new record for West Bengal.

Specimen examined: Jalpaiguri district: Chilapata (Chilapata range), *Sikdar* 4300.

ACANTHACEAE

Strobilanthes anisophyllus T. Anders in Cat. Pl. Hort. Bot. Calc. 43. 1861, and in Journ. Linn. Soc. 9 : 478. 1867 ; FBI. 4 : 462. 1884.

Erect undershrub, less than a metre in height ; leaves very unequal, nearly alternate, lanceolate-acuminate, narrowed into the petiole, margin serrated ; bracts elliptic-obtuse ; bracteoles shorter than the bracts ; flowers 2-2.5 cm long, bluish or pale-purple in cymose heads.

Fl.: Nov.

Rare, restricted to the lower hills from 800 to 1000 m altitude, often growing on exposed slopes or rocky plateaus among grass, *Selaginellas*, *Begonia gigantea* and *Dicliptera roxburghiana*.

A new record for West Bengal, previously known to occur in Assam, Meghalaya (Khasi hills) and in Nagaland. There is not a single collection of this taxon from West Bengal in Herb. CAL.

Specimens examined: Jalpaiguri district: way to Buxaduars, ± 900 m (Buxaduar range), *Sikdar* 932 ; Buxaduar, ± 1000 m *Sikdar* 968.

LAMIACEAE

Pogostemon auricularius (L.) Hassk. in Tijdsch. Nat. Geschied (ed. Hoeven & de Vriese), 10 : 127. 1843 ; El-Gazzar & Watson in Taxon 16 (3) : 187. 1967. *Dysophylla auricularia* (L.) Bl., Bijdr. 825. 1826 ; FBI. 4 : 638. 1885. *Mentha auricularia* L., Mant. Pl. 81. 1767.

Erect densely hairy annual branched herb with opposite leaves and pinkish-white flowers in dense terminal spikes ; corolla tube with hairy lobes.

Fl. & frt.: Nov.-May.

Grows in open moist areas among grass, in shady moist soil along forest paths and often in the forest associated with *Hygrophila salicifolia, Phyllanthus urinaria, Ischaemum* spp. etc. A very pretty herb when in full bloom. Rare.

Distributed in Sikkim, Assam, Maharashtra (Poona), South India and East Bengal. Prain (1903) recorded this species from Chittagong (Bangladesh) only. However, this taxon is not so far reported earlier from the State except the deposition of two old sheets in Herb. CAL without valid record from the localities as stated on the herbarium sheets. It is interesting to record its distribution in West Bengal after 87 years.

Specimens examined: Jalpaiguri district: Central Moraghat (Moraghat range), *Sikdar* 415 ; Poro forest (Nimati range), *Sikdar* 757 ; Mahakalguri, Alipurduar, *E.A. Heawood* 52 (21st Sept. 1891). Darjeeling district: Siliguri, *Clarke* 26464B (31.5.1875).

Pogostemon elsholtzioides Benth. in DC., Prodr. 12 : 153. 1848 ; FBI. 4 : 634. 1885.

Erect bushy, branched, small shrub, stem brownish to pink-red ; leaves 5-9.5 × 1.2-2.5 cm, lanceolate, long-acuminate, glabrous, petiole short ; flowers pinkish with aromatic scent, in separate whorls forming interrupted upto 9 cm long spikes, often with purple tinge ; calyx whitish hoary.

Fl.: Nov.

Occasional, restricted to the Buxaduar hills upto ± 1200 m altitude, growing in dry rocky-gravel situations along the valleys in association with *Lantana camara* var. *aculeata*. It is an attractive plant when in full bloom.

Distributed in Bhutan and Meghalaya (Khasi hills). Mukerjee (1940) recorded this species from Assam and Bhutan only. After Mukerjee, it has not been reported from West Bengal.

Specimens examined: Jalpaiguri district: Buxaduar, ± 950 m (Buxaduar range), *Sikdar* 926 and ± 1050 m, *Sikdar* 970.

POLYGONACEAE

Persicaria viscosa (Ham. ex D. Don) Nakai in Rigakkai 24 : 300. 1926 ; Hara, Fl. E. Him. 24. 1971. *Polygonum viscosum* Ham. ex D. Don, Prodr. Fl. Nepal 71. 1825 ; FBI. 5 : 36. 1886.

A slender annual with ascending soft hollow stem covered with spreading bristly hairs and bearing bright red flowers in long terminal racemes.

Fl.: Feb.-Apr.

Rare. Seen growing in moist soil on high ground by the side of a rice field. Flower colour persists even after drying.

Distributed in Assam, Tripura, Meghalaya, Sikkim and Nepal. Hara (*l.c.*) reported it from Kathmundu, 1400 m. Prain (1903) recorded it from Chittagong (Bangladesh) only. There are only two specimens in Calcutta Herbarium (CAL) collected by C. R. Das (1959) and A. K. Dutta (1965) from Jalpaiguri and Burdwan respectively without its valid record from West Bengal. Since then it has not been reported from West Bengal again. So the recent collection of the plant by the author from northern Bengal is a valid record of its distribution in West Bengal.

Specimens examined: Jalpaiguri district: Chilapata, side of paddy field (Chilapata range), *Sikdar* 4396 ; Rajabhatkhawa, (Rajabhatkhawa range), *C. R. Das* 11. Burdwan district : Bhedia, *A. K. Dutta* 691.

MYRISTICACEAE

Knema erratica (Hook. f. et Thoms.) J. Sinclair in Gard. Bull. Singapore 18 : 205. 1961. *Myristica erratica* Hook. f. et Thoms., Fl. Ind. 1 : 156. 1855. *M. longifolia* Wall. ex Bl. var. *erratica* Hook. f. et Thoms., Fl. Brit. Ind. 5 : 110. 1886.

Small to moderate-sized tree, twigs with conspicuous striations and furrows ; leaves 20-28 × 3.0-5.0 cm, narrowly oblong or oblong-lanceolate, glabrous above, lower surface stellate hairy when young ; male flowers brown-tomentose, split down to half way into the perianth lobes ; fruit ellipsoid, densely covered with brownish tomentum.

Fl. & frt.: Jan.-May.

Rare. Growing wild along the hillslopes in somewhat shady situations. It is often confused with *K. linifolia* (Roxb.) Warb. but differs in shape and size of the flowers, bark and leaf-characters.

This taxon is reported so far in India from Sikkim, Assam, Manipur and Meghalaya. Prain (1903), however, recorded it from Chittagong (Bangladesh) only. This is the first report of the plant from West Bengal.

Specimens examined: Jalpaiguri district: Way to Buxaduar, ± 600 m (Buxaduar range), *Sikdar* 4594.

EUPHORBIACEAE

Claoxylon longipetiolatum Kurz in Journ. Asit. Soc. Beng. **42** (2) : 244. 1873 ; FBI. **5** : 413. 1887.

A stout shrub up to 3 m high, stem appressed-pubescent ; leaves large, elliptic to ovate-oblong with acute-obtuse base, membranous, crenate-serrate or undulate, penninerved, slightly pubescent below ; flowers white in hispid racemes ; capsule deeply 3-lobed, hirsute with soft prickles.

Fl. & frt. : Feb.-Aug.

Rare. Grows luxuriantly along the margin of the evergreen forests preferably in cold-shady localities together with *Leea gigantea* and *Viburnum colebrookianum* only in the eastern ranges of the Jalpaiguri district.

J. D. Hooker (1887) included this plant as under imperfectly known species and mentioned only Andaman Islands as the locality in India. Further studies shows that it was also reported from Assam and Meghalaya and there is deposition of 4-sheets of this species in Herb. ASSAM. On the basis of a recent enquiry, this taxon does not occur in Andaman Islands. Hence the appearance of this plant in West Bengal for the first time is of botanical interest.

Specimen examined : Jalpaiguri district : North Rajabhatkhawa (Rajabhatkhawa range), *Sikdar* 6997.

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MOVEMENTS OF *BANDICOTA BENGALENSIS AND NESOKIA INDICA* IN RICE FIELDS IN SIND[1]

G. W. Fulk,[2] A. C. Smiet[3] and
A. R. Khokhar[4]

(*With a text-figure*)

Data on the movements of four adults of *Bandicota bengalensis* and two adults of *Nesokia indica* were gathered with radio telemetry equipment in rice fields shortly before and after harvest. Before harvest, a male *Bandicota* had a large home range (105 metres in diameter) enclosing the ranges of two or more females whose burrows he occasionally visited. Female *Bandicota* had ranges 22 and 30 metres in diameter. Two *Bandicota* moved away in response to the harvest operations, one moving 590 metres, the other 240 metres. Both moved to unharvested fields. No animal stayed in its home field more than two days after the harvest. Both *Nesokia* showed a pattern of shifting their home ranges every week or two to an adjacent, but non-overlapping area.

The Bandicoot Rat, *Bandicota bengalensis*, is well adapted to exploit an ephemeral and localized supply of abundant food, such as a ricefield (Fulk *et al.* 1981 ; Chakraborty 1977). Studies of the movements of *Bandicota* are of special interest since wild populations of this species do not usually live in the same place year around and individuals must move great distances to find new food sources. Frantz (1973) found that the pattern of movements in Bandicoot Rats in Calcutta was such that it enabled individuals to find quickly godowns recently filled with grain.

Earlier (Fulk *et al.* 1979) we reported on the movements of *Bandicota bengalensis* in a fallow field. We found that many of the animals moved long distances (up to 640 metres), not as part of their daily routine, but rather as a shifting of the home site. Here, we report on another study of the movements of *Bandicota*, this one carried out in a rice field shortly before and after harvest, undertaken in order to confirm the previous results and to learn how the pattern of movements might be affected by the different environmental conditions.

We also used this opportunity to follow the movements of *Nesokia indica*, a common but rarely studied rice field rodent in Sind.

Methods

Seven rodents (3 *Nesokia* and 4 *Bandicota*) were live trapped between 25 and 29 September 1978 in a rice farm (24°40′N-60°50′E) in Badin District, Sind Province, Pakistan. At this time, the crop was flowering. These animals were fitted with radio transmitters (AVM Instrument Company, Champaign, Ill., U.S.A.) and released at their points of capture after a 24-hour recovery period. Two additional *Bandicota* were caught and fitted with transmitters in October.

We used a vehicle-mounted antenna which could pick up the signal from a distance of 500 metres when the animal was on the surface, but only from 100 to 200 metres when the

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animal was in a burrow. All final fixes (determinations of an animal's location) were made by approaching the animal with a hand-held antenna.

Starting on 1 October, we made eight trips to the farm and followed the animals on 21 mornings and evenings in October and 8 mornings and evenings in November. Fixes were made at hourly intervals from sunset to midnight or later. Whether the rat was inside or outside a burrow was recorded for each fix. Whenever a signal could not be received, traps were set around the last location site and the surroundings were searched with the vehicle-mounted antenna. More than four square kilometres had been thoroughly searched by the end of the study.

Fluorescent tubes were fixed to some transmitter collars as suggested by Taylor (personal communication) in order to permit sighting of rats at night. This technique failed, probably because of the dense cover of vegetation.

Results

Signals from one *Bandicota* were never received. Little data on two other animals (one *Bandicota* and one *Nesokia*) were gathered since their transmitters were found on the ground 25 and 52 metres from the release points soon after release. These animals were probably killed by predators. Both of the transmitters had tooth marks and one was found near pieces of fur and meat. We had live-trapped a mongoose (*Herpestes auropunctatus*) in these fields.

Data from the remaining animals are summarized in Table 1 and presented below. Figure 1 shows the home ranges and long distance movements made by some animals.

Table 1

Summary of radio-telemetry study of *Bandicota bengalensis* and *Nesokia indica* in rice fields

Animal				Days Followed	Long Distance Movement (Metres)	Observed Range Length (Metres)	Remarks
No.	Species	Sex	Weight (Grams)				
1	*N. indica*	M	140	4	—	11	Transmitter found
2	*N. indica*	M	145	27	—	37	Disappeared
7	*N. indica*	M	104	14	—	18	Disappeared
4	*B. bengalensis*	F	180	11	—	22	Disappeared
5	*B. bengalensis*	F	148	27	45	30	Disappeared
6	*B. bengalensis*	M	280	0	—	—	Transmitter found
8	*B. bengalensis*	M	140	0	—	—	Disappeared
9	*B. bengalensis*	M	250	23	240	105	Disappeared
10	*B. bengalensis*	F	200	30?	590	?	Transmitter found

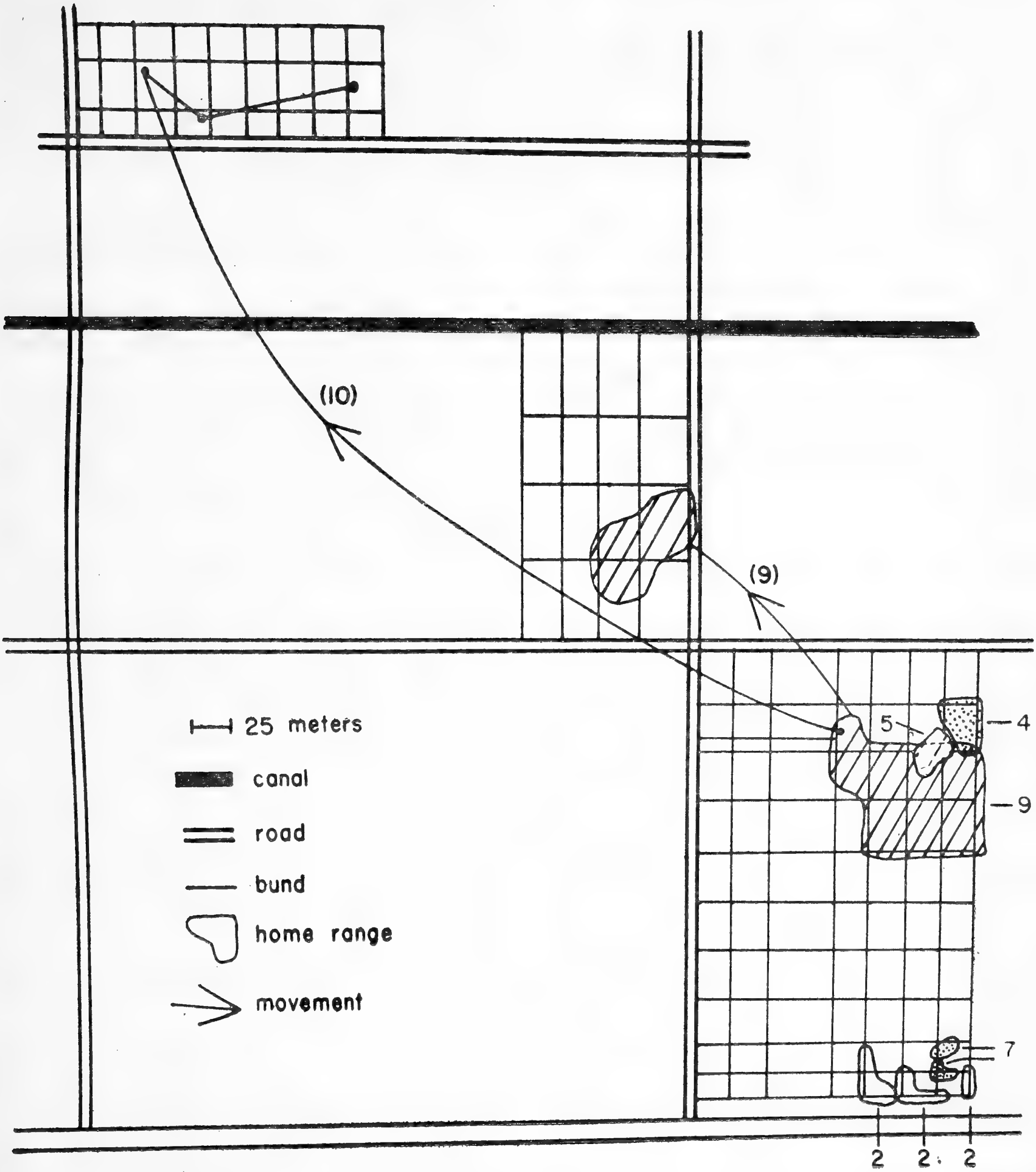

Fig. 1. Map of farm where movements of two *Nesokia indica* (numbers 2 & 7) and four *Bandicota bengalensis* (females 4, 5 & 10 and male 9) were followed with radio telemetry. The entire farm was divided into rice fields, but separate fields are shown here only for part of the farm.

NUMBER 2, *Nesokia indica*, SCROTAL MALE, 145 GRAMS.

On 2 and 3 October, this animal was located 13 times, mostly in its burrow, but sometimes moving on the surface in the rice or along the bund. Between 4 and 20 October, it shifted its home range and frequented two new burrow systems (38 fixes). Although close by, it did not appear in the former home range. Between 22 and 25 October, it again changed its home range (18 fixes) to a field about 45-50 metres away from the original home. The reason for these shifts are not known.

The Observed Range Lengths (ORL) for these three home ranges were 37, 35 and 22 metres. On the night of 25 October, this rat disappeared. These fields were harvested two days later.

NUMBER 7, *Nesokia indica*, SCROTAL MALE, 104 GRAMS.

Between 1 and 4 October, this rat was located 14 times in a small area. From 8 to 12 October, it was located 25 times in another area, nearby but not overlapping with the previous area. No disturbance apparent to us caused this shift. On the night of 16 October, this animal could not be located.

NUMBER 4, *Bandicota bengalensis*, PERFORATE FEMALE, 120 GRAMS.

This female was located 22 times between 1 and 9 October and was very active. She frequently crossed the width of the field, a distance of 19 metres, in a few minutes. During the day, we saw runways and damage in the field near her home burrow. During the night of 9 October this animal disappeared.

NUMBER 5, *Bandicota bengalensis*, PERFORATE FEMALE, 148 GRAMS.

The home range of this female was adjacent but exclusive to the range of animal Number 4. Most of the 58 fixes for Number 5 were in the home burrow, but sometimes this animal moved on the surface, one evening as far as 45 metres away, considerably beyond her previously established home range. On the night of 25 October, it disappeared and was not found again. Two days later, the fields around its burrow were harvested.

NUMBER 9, *Bandicota bengalensis*, SCROTAL MALE, 250 GRAMS.

This animal was located 34 times between 11 and 24 October. It was very active and travelled distances up to 50 to 60 metres in a few minutes. Its total home range comprised an area of 0.68 hectares. In this area, 5 burrow systems were visited 2 to 6 times each. One of these systems was used in the daytime and was situated at the edge of the home range. Out of the 4 other burrow systems, two were known to contain an adult female and juveniles. While the harvest operations were going on, this animal limited its movements to the unharvested parts of its range. On the evening of 24 October, a few days after the harvest of all fields within its home range, it moved to unharvested fields 240 metres away. Here, it established a new home range of about 0.2 hectares and remained there between 20 October and 3 November (9 fixes). When we checked on 14 November, the fields had been harvested and this rat had disappeared.

NUMBER 10, *Bandicota bengalensis*, FEMALE, 200 GRAMS.

This animal was released on 22 October. Several juveniles were also captured near the home burrow of this animal which had enlarged teats. Male Number 9 visited this burrow at least three times. On 23 and 25 October, this female was located 12 times, always inside her burrow. Two days after the harvest of the fields around her burrow, she moved away. On 30 October, after considerable searching, we

TABLE 2

PER CENT OF TOTAL RADIO-TELEMETRY FIXES THAT WERE ON THE SURFACE AS OPPOSED TO IN A BURROW FOR 6 RODENTS IN RICE FIELDS. VERTICAL LINES CONNECT VALUES THAT ARE NOT DIFFERENT AT P > .05

Individuals				Species Totals		
Animal Number		Total Fixes	% on Surface	Species	Total Fixes	% on Surface
Bandicota male	9	49	82	*Bandicota bengalensis*	164	43
Bandicota female	4	22	64	*Nesokia indica*	102	19
Bandicota female	10	16	31			
Bandicota female	5	77	14			
Nesokia male	2	68	21			
Nesokia male	7	34	15			

located this animal in a burrow in the middle of an unharvested field 590 metres away from the previous burrow. On 1 November, this field was harvested; and on the evening of 2 November, the female moved about 60 metres to a neighbouring, partly-harvested field. It stayed there only a few hours and by the next morning had moved about 100 metres to a burrow in a grassy bund. On the way, it had crossed several open fields. It stayed in this burrow, apparently without moving. We dug out this burrow on 26 November and found the radio transmitter without the animal. Probably it had been eaten by a predator.

Surface Activity

Two bandicoots, male Number 9 and female Number 4, were more likely to be found on the surface than the other animals (Table 2). Overall, 43% of the *Bandicota* fixes were on the surface compared to only 19% of the *Nesokia* fixes.

DISCUSSION

Only three of nine transmitters were recovered. Transmitter break down, caused either by predation or battery failure, could have accounted for some of the remaining six. However, we feel that most of these animals moved outside of our searching range. That bandicoot rats can and do move considerable distances was shown by female Number 10, which moved a straight-line distance of 590 metres, and male Number 9, which moved 240 metres. This result is similar to our earlier study in which several bandicoots moved long distances (Fulk *et al.* 1979).

The animals fitted with the three transmitters that were found were almost surely killed by predators. The two that were found soon after release had fluorescent tubes fixed to their collars. Perhaps these tubes made animals more susceptible to nocturnal predators.

Movements of two bandicoots were definitely affected by the harvest operation, while two others (*Nesokia* 2 and *Bandicota* 5) may have been affected. No animal remained in its home field for more than a few days after harvest. This is somewhat surprising in light of our past experience (Fulk *et al.* 1981) that *Bandicota* may remain abundant in rice fields after harvest, especially if rats store rice underground. We inspected several burrow openings after the harvest in this study and found no evidence (scattered rice pannicles) that rats had stored rice. We excavated one burrow, that of *Bandicota* Number 10, and found no stored rice. Why *Bandicota* stores rice underground on some occasions and not on others is unknown. We did feel that rat density had been unusually low in these fields.

In our previous study (Fulk *et al.* 1979) as in this study, we observed that a male *Bandicota* had a large home range encompassing ranges of two or more females.

The data we gathered on *Nesokia* showed that some individual *Nesokia* may be as active on the surface as some *Bandicota* are, at least near the time of harvest. This corresponds well to our finding (Fulk *et al.* 1981) that *Nesokia* does eat rice grain at this time, but is in contrast to the opinion of Wagle (1927) that *Nesokia indica* was 'quite innocent of damaging the rice crop'.

We observed in both individuals of *Nesokia indica* a pattern of shifting the home range to an adjacent but non-overlapping area. One can only speculate as to the cause of this behaviour. Perhaps *Nesokia* moves to a new area when its principal food, roots of certain grasses and sedges, becomes locally exhausted.

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PLANT EXPLORATION IN RALAM VALLEY, KUMAON, HIMALAYAS[1]

P. C. PANT AND B. D. NAITHANI[2]

Observations on the vegetation of Ralam Valley and Ralam glacier, in the vicinity of Tibetan border with enumeration and short notes of 145 species from collections upto an altitude of 4800 m in eastern Kumaon are recorded.

INTRODUCTION

A sound policy on resources development and environmental management in the Himalayan region has become very necessary. The role of Himalayan forests in controlling soil erosion and silting of rivers, streams and irrigation canals down in the plains is well known. Therefore up-to-date data on plant life of the whole of the Himalayan region is of utmost importance. Keeping in view, this aspect the findings of a botanical exploration to Ralam Valley are being presented here.

Topography : Ralam valley is in Malla Johar region of Pithoragarh district in the interior of Eastern Kumaon, Himalayas stretching in a system of mountains with gorges, river valleys and glaciers in altitudinal range of 1200 m to 4800 m above mean sea level. Malla Johar extends from the Tibetan border down the Gori valley as far as its junction with the Ralam river. Almost all the villages of Malla Johar lie within the narrow gorge of Gori river. Milam is the northernmost village, Laspa is further south and to the east of Laspa is Ralam, a side valley through which flows the Ralam river. Malla Johar is a snow covered mountainous and glacial range. The rising chain of peaks separates Johar from Darma which culminates in Panchachuli. The horizon to the south-west is dominated by the superb mass of Nanda Devi and Nandakot. Inhabitants of the valley move down to their winter season abode or encampments during colder months due to the heavy snow fall in the region.

Ralam valley can be approached by crossing the Gori river either at Lilam and trekking through Bui Pato-Saba Odiyar or by crossing Gori river near Burphu and trekking through Tola-Sumdu-Bazarganga. The former route is short but very difficult. The entry to the Ralam valley through the latter route is comparatively easier and this was followed during the year 1969 when we explored in Ralam valley under the auspices of Botanical Survey of India, Northern Circle, Dehra Dun. The collections cited in this paper are deposited in the herbarium of Botanical Survey of India, Dehra Dun (BSD).

Geology : Malla Johar contains Permian and Mesozoic rocks of the Tethys Himalaya lying in the region of Kiogor and Chitichun on the Tibetan frontier of Kumaon, embedded with huge masses of sediments consisting mostly of limestones of varying sizes from ordinary boulders to blocks of the dimensions of an entire hill mass.

The foreign transported blocks on the Tibetan frontier of Kumaon are known as exotic blocks of Johar, these exotic blocks are pink, red and white limestones of all ages from Permian to the Cretaceous.

Climate and rainfall : Climate in Ralam valley is austere and very close to that of Tibet.

[1] Accepted September 1979.
[2] Botanical Survey of India, 3, Laxmi Road, Dehra Dun (U.P.).

More than 50% of the precipitation falls as snow in winter months and precipitation is less than 10″. Air is excessively dry during day time when strong south wind prevails. Regarding temperature in western Himalayan region it is on record that for every 180 m rise, there is a variation of approximately 1°C.

Vegetation : Descending from Martoli and crossing Gori river, Burphu village (3000 m) is reached, which is an important halting place on the way to Ralam Valley. The vegetation around Burphu was scanty, where the dry mountain slopes support shrubby *Juniperus* spp. which are the principal source of fuel wood for the inhabitants of Burphu. The herbaceous components around Burphu consist of *Prunella vulgaris, Origanum vulgare, Euphrasia* spp., *Pedicularis* spp., *Swertia* sp., *Gentiana* sp., yellow flowered *Taraxacum* sp. and white flowered *Anaphalis* sp., *Axyris amaranthoides* and highly aromatic *Artemisia stricta* were very common on dry sandy soil and also as weeds of the cultivated level land of Burphu.

Trekking eastwards from Burphu towards Ralam Valley the narrow path leads to Tola, a small village consisting of some 4-5 houses at a distance of about 8 kms from Burphu. The section between Burphu-Tola, was somewhat dry with scanty vegetation. An interesting feature of this section was the shrubby association of *Rosa sericea-Ribes grossularia* in addition to other shrubby growth of *Cotoneaster* spp., *Berberis* sp. and *Juniperus communis* distributed in the region. Beyond Tola the vegetation was in herbal form which included *Taraxacum* sp., *Geranium* sp., *Senecio ligularia, Polygonum chinense, Stellaria* sp. and *Adenocaulon bicolor* on moist shady habitats and along streams. On mountain slopes and rock crevices *Micromeria biflora, Taraxacum* sp., *Plantago* sp. and *Stellaria* sp. were common up to Sumdu, another small village. A little distance after Sumdu the path ascends from 2900 m to 5200 m over the vast and rich meadow of Bazarganga pass facing the important Himalayan peaks of Nandakot, Nandaghunti, Trisuli and the Haldar ranges.

The vast meadow of Bazarganga was covered with clumps of *Danthonia cachemyriana* and other herbaceous elements like *Gentiana venusta, Swertia cuneata, Plantago brachyphylla, Elsholtzia eriostachya, Rumex dentatus, Oxyria digyna, Taraxacum officinale, Senecio chrysanthemoides, Aster* sp., *Impatiens* sp. and *Sibaldia parviflora* in shades of blue, yellow and pink coloured flowers thus forming thick matting of the Bazarganga. At few exposed patches where snow has melted the pretty pinkish-white, flowered herb, *Arenaria glanduligera* was of rare occurrence in the region.

Among shrubs *Gaultheria trichophylla, Rhododendron campanulatum, R. anthopogon* and *Salix lindleyana* were common. Ascending further towards Bazarganga Pass the above pattern of herbaceous vegetation was replaced by another set of alpine herbs such as *Aconitum violaceum, Delphinium cashmirianum, Picrorhiza kurooa, Pedicularis rhinanthoides, P. porrecta, Aletris pauciflora, Saussurea graminifolia, Polygonum affine, Goodyera fusca, Heracleum brunonis* and *Guldenstaedtia himalaica.* The stout rhizomatic herb *Rheum moorcroftiana* on mountain slopes was quite rare in the area.

Of the tree vegetation, *Betula utilis* formed a community with *Rhododendron campanulatum* till reaching the snow line, thence crossing the Bazarganga Pass 4800 m and trekking through the kneedeep, snow clad valley, some of the typical alpine herbs met within the terrain were *Saussurea obvallata, S. taraxicifolia, S. kunthiana, Jurinea macrocephala, Parnassia laxamannii, Orchis latifolia* and *Macrotomia benthamii* etc.

Proceeding towards Ralam village, an interesting vegetational feature of the area consists of a community of *Jurinea macrocephala*—

Anaphalis sp. intermixed with elements like *Morina coulteriana*, *Potentilla argyrophylla*, *Codonopsis ovata*, *Delphinium* sp., *Polygonum* spp. and *Allium stracheyi* amidst clumps of *Danthonia cachemyriana*.

Ralam village situated at 4000 m consists of about 30 houses. Inhabitants of Ralam are known as 'Ralamwals' in the region. The land at Ralam is quite fertile, where *Fagopyrum tataricum*, *Eleusine coracana*, *Lepidium sativum*, *Brassica tournefortii* and very tasty high altitude variety of *Solanum tuberosum* were the main items of cultivation of the 'Ralamwals'.

Elsholtzia densa, *Capsella bursa—pastoris* and *Carduus onopordioides* were observed as common weeds of the cultivated fields around Ralam village. Near some houses plants of *Saussurea lappa* 'Kuth' were also planted as it has a high repute in the indigenous system of medicine. *Nardostachys jatamansii*, *Orchis latifolia* and *Allium* spp. are exploited in large quantities by the villagers for selling down in the plains.

Sorbus aucuparia, *Rhododendron campanulatum*, *Juniperus communis* and *Betula utilis* constitute the shrubby and tree vegetation respectively around Ralam. Proceeding towards Ralam glacier at a distance of about 5 km from the village of Ralam, the following three types of herbaceous communities were recognised.

1. *Potentilla atrosanguinea—Rumex nepalensis* sheltering *Capsella bursa-pasteris*, *Nepeta spicata* and *Astragalus* sp.

2. *Potentilla atrosanguinea—Anaphalis* sp. with *Delphinium vestitum*, *Senecio chrysanthemoides* and *Arenaria* sp.

3. *Potentilla atrosanguinea—Jurinea macrocephala* with *Nepeta spicata*, *Delphinium vestitum*, *Anaphalis* sp. and *Cotoneaster* sp.

The meadows on way to Ralam glacier consist of thick clumps of *Danthonia cachemyriana* in addition to *Phleum alpinum* and *Juncus himalensis*. The noteworthy herbs of these meadows were chiefly the members of Gentinaceae and Scrophulariaceae such as *Gentiana pedunculata*, *G. stipitata*, *Swertia cuneata*, *S. ciliata*, *Pedicularis mollis*, *P. brunoniana*, *P. hoffmeisteri* and *Euphrasia* spp. respectively. Other herbaceous associates were *Geranium pratense*, *Phlomis bracteosa*, *Impatiens gigantea*, *Cynanthus lobatus*, *C. linifolius*, *Codonopsis ovata*, *Allium wallichii*, *A. stracheyi*, *Nomocharis nana*, *Hypericum monanthemum*, *Galium aparine*, *Dubyaea hispida*, *Helinium grandiflorum*, *Lactuca violaefolia*, *Astragallus candolleanus* and *Trigonella emodi*.

Of the shrubby growth *Berberis jaschkeana*, *Juniperus communis* and *Cotoneaster* sp. were of stray occurrence in the area.

In glacial moraine the herbaceous species were *Pedicularis brunoniana*, *Senecio chrysanthemoides*, *S. kunthianus*, *Dubyaea hispida*, *Anaphalis cuneifolia*, *Origanum vulgare* and *Nepeta spicata*. Amidst rocky boulders *Christolea himalayensis* with pinkish white flowers was an interesting crucifer of rare occurrence in the glacial region.

The last part explored was a particularly tough terrain, more so during the rainy season, between Ralam and Saba Odiyar having pockets of forests and long stretches of meadows. The forests were dominated by trees of *Rhododendron arboreum*, *Syringa emodi*, *Aesculus indica*, *Hippophae salicifolia*, *Acer* sp. and with shrubs of *Rhododendron lepidotum*, *Arundinaria spathiflora*, *Ribes* sp. and *Rosa* sp.

Undergrowth on meadows was comprised of herbaceous elements of Asteracea, Gentianaceae and Scrophulariaceae members, a striking element in this section during the season was the tall Liliaceous herb—*Lilium giganteum*, with fragrant white flowers, the hollow stem of which is used by village-folk for making flutes, *Circaester agrestis* near Saba Odiyar under rock crevices, *Utricularia kumaonense* amidst moss carpet from the environs of Pilti bridge and *Christolea himalayensis* from the glacial region are some of the interesting collections of the present visit to Ralam valley.

ENUMERATION OF PLANTS

GYMNOSPERMS

CUPRESSACEAE

1. **Juniperus communis** L.

Stunted woody shrub on rocky habitats, fruiting. On way to Tola 3000 m, common, 39649.

2. **J. wallichiana** Hook.f. et Thom. ex Parl

Large erect woody shrub on rocks and meadows with male cones. On way to Tola 3500 m, common, 39647.

DICOTYLEDONS

RANUNCULACEAE

3. **Aconitum deinorrhizum** Holmes ex Stapf

Tall erect herb with sky blue flowers, in *Betula-Rhododendron* forest. On way to Saba Odiyar 2500 m, rare, 39760.

4. **A. violaceum** Jacq. ex Stapf

Small erect herb with blue flowers. Bazarganga slope—Ralam valley, 4000 m, common, 39659.

5. **Delphinium cashmirianum** Royle

Medium sized erect herb with blue flowers. On way to Bazarganga Dhura 4500 m, common, 39660.

6. **D. vestitum** Wall. ex Roxb.

Medium sized erect herb with violet flowers growing on meadows. On way to Ralam glacier 4500 m, common, 39704.

7. **Ranunculus hirtellus** Royle

Tall erect herb with yellow flowers near moist places in *Betula-Rhododendron* forest. On way to Saba Odiyar 2800 m, common, 39758.

8. **Thalictrum foliolosum** DC.

Tall erect herb with fruits and white flowers in *Aluus-Rhododendron* forest. On way to Bui 1500 m, common, 39599.

MENISPERMACEAE

9. **Stephania glabra** (Roxb.) Miers

An extensive climber with fruits in *Alnus-Rhododendron* forest. On way to Bui 1500 m, common, 39587.

BEBERIDACEAE

10. **Berberis jaschkeana** Schneid.

Large shrub with red fruits, intermixed with *Rhododendron campanulatum*. Ralam valley 4000 m, common, 39749.

BRASSICACEAE

11. **Capsella bursa-pastoris** (L.) Medik.

Small erect herb with white flowers. On way to Ralam glacier 4200 m, common, 39712.

12. **Christolea himalayensis** (Camb.) Jafri

Small herb with thick root stock, flowers white with pinkish tinge, growing on glacial soil. Ralam glacier 4300 m, rare, 39684.

13. **Thlaspi arvense** L.

Herb with fruits growing as a weed of cultivated fields. Ralam 4000 m, common, 39723.

CARYOPHYLLACEAE

14. **Arenaria glanduligera** Edgew.

Small hairy herb with white flowers tinged with pink. On way to Bazarganga 4500 m, frequent, 39674.

15. **A. serpyllifolia** L.

Prostrate weak herb with fruits. On way to Ralam glacier 4500 m, common, 39719.

16. **Stellaria semivestita** Edgew. et Hook.f.

Prostrate herb with white flowers in *Alnus-Rhododendron* forest. On way to Bui 1500 m, rare 39592.

HYPERICACEAE

17. **Hypericum monanthemum** Hk.f. & Th. ex Dyer

Small erect herb with fruits on rocky habitats. Ralam valley 4000 m, rare, 39738.

GERANIACEAE

18. **Geranium pratense** L.

Large trailing herb with fruits and pink flowers, growing on meadows and rocky habitats. On way to Ralam glacier 4500 m, common, 39700.

BALSAMINACEAE

19. **Impatiens gigantea** Edgew.

Tall erect herb with pink flowers. Ralam 4000 m, common, 39745.

20. **I. scabrida** DC.

Tall erect hairy herb with yellow flowers, on way to Bui 2800 m, common, 39593.

VITACEAE

21. **Vitis jacquemontii** Parker

An extensive climber, fruiting. On way to Bui 1500 m, common, 39582.

ANACARDIACEAE

22. **Rhus wallichii** Hook. f.

Small tree with green fruits. On way to Bui 2000 m, occasional, 39577.

FABACEAE

23. **Astragalus candolleanus** Royle ex Benth.

Small tufted woody herb on meadows and moraine, fruits hairy. On way to Ralam glacier 4500 m, common, 39699.

24. **Desmodium tiliaefolium** G. Don

Tall shrub in *Aesculus-Acer* forest. Fruiting. Saba Odiyar 2500 m, common, 39770.

25. **Guldenstaedtia himalaica** Baker

Small prostrate herb as undergrowth of *Rhododendron campanulatum*, on rocky habitats and on grassy slopes. Small hairy fruiting pods. On way to Bazarganga slope 4000 m, common, 39670.

26. **Indigofera habepetala** Bth. ex Baker

Tall shrub in *Acer-Aesculus* forest. Fruiting. Saba Odiyar 2500 m, common, 39766.

27. **I. heterantha** Wall. ex Brandis

Woody shrub in *Alnus-Rhododendron* forest with fruits and pink flowers. On way to Bui 1500 m, common, 39591.

28. **Parochaetus communis** Hamilton ex D.Don

Small erect herb on moist rocky habitats, flowers blue. On way to Bui 1500 m, common, 39580.

29. **Smithia ciliata** Royle

Small tufted herb along bridle path, on open places, flowers bluish white. Around Bui 1500 m, rare, 39583.

30. **Trigonella emodi** Benth.

Prostrate herb amidst rock boulders. On way to Ralam glacier 4000 m, common, 39714.

31. **Vigna capensis** Walp

Large climber upon *Xanthoxylum* sp. with rose pink flowers. On way to Bui 1800 m, rare, 39581.

Caesalpiniaceae

32. **Cassia leschenaultiana** DC.

Tall erect herb with fruits and yellow flowers. On way to Bui 1500 m, rare, 39588.

Rosaceae

33. **Cotoneaster** sp.

Tall erect shrub on rocky habitats with pink coloured fruits. On way to Tola 3200 m, common, 39651.

34. **Cotoneaster** sp.

Large prostrate shrub on rocks, fruits red. Ralam 4000 m, common, 39750.

35. **Cotoneaster** sp.

Tall erect shrub with dull pink coloured fruits on rocky habitats. On way to Tola 3200 m, common, 39653.

36. **Potentilla ambigua** Camb.

Small tufted herb with yellow flowers on glacial soil. Ralam glacier 4500 m, common, 39687.

37. **P. argyrophylla** Wall. ex Lehm.

Tall erect herb on moraines and open meadows, fruits. On way to Ralam glacier 4500 m, common, 39716.

38. **Rosa macrophylla** Lindl.

Tall erect prickly shrub with orange coloured, prickled fruits. On way to Tola 3200 m, common, 39654.

39. **R. sericea** Lindl.

Tall erect prickly shrub with red orbicular fruits. On way to Tola 3200 m, common, 39650.

40. **Sorbus aucuparia** L.

Tall erect shrub on meadow slopes, with fruits in association with *Rhododendron* sp. On way to Bazarganga Dhura 3800 m, 39652.

41. **S. cuspidata** (Spach) Hedlund

Big tree in *Betula-Rhododendron* forest, fruiting. On way to Saba Odiyar 2500-3000 m, occasional 39763.

Saxifragaceae

42. **Deutzia staminea** R. Brown ex Wallich

Large shrub in *Alnus-Rhododendron* forest, fruiting. On way to Bui 1500 m, occasional, 39585.

43. **Parnassia laxmanii** Pallas ex Schultes

Medium sized erect herb on meadow and rocky habitats, flowers white. Ralam valley 4000 m, common, 39736.

44. **Philadelphus tomentosus** Wall. ex Royle

Small shrub with fruits in *Acer-Aesculus* forest. Saba Odiyar 2500 m, common, 39768.

45. **Saxifraga fimbriata** Wall.

Small erect herb with yellow flowers amidst moss on rocky habitats. Ralam valley 4000 m, occasional, 39735.

46. **S. flagellaris** Willd.

Small flagellate erect herb, with yellow flowers. On way to Bui 1500 m, rare, 39579.

47. **S. diversifolia** Wall. var. **parnassifolia** (D. Don) Engl.

Small erect herb with yellow flowers on big boulders. Bui 1500 m, occasional, 39586.

Crassulaceae

48. **Sedum heterodontum** Hook.f. & Thoms.

Succulent herb with yellow flowers amidst boulders. Ralam 4000 m, occasional, 39721.

49. **S. hookeri** Balakr.

Small erect herb with red fruits on rocks and meadow. Ralam valley 4000 m, rare, 39741.

50. **S. trullipetalum** Hook.f. & Thoms.

Small prostrate fleshy herb with yellow flowers. Bazarganga 5000 m, common, 39679.

APIACEAE

51. **Bupleurum longicaule** Wall. ex DC.

Tall erect herb on meadow, fruiting. On way to Ralam Glacier 4500 m, common, 39683.

52. **Cortia depressa** (Don) Norman

Small herb with thick root stock flowers white. Bazarganga slope—Ralam valley 3750 m, common, 39751.

53. **Heracleum brunonis** Benth.

Medium sized erect herb as an undergrowth of *Rhododendron campanulatum* and on open meadows, flowers white. Bazarganga slope—Ralam valley 4000 m, common, 39669.

54. **Trachydium roylei** Lindl.

Small prostrate herb on moraine and meadow with blackish green fruits. On way to Bazarganga Dhura—Ralam valley 4000 m, common, 39667.

CORNACEAE

55. **Cornus macrophyllus** Wall.

Small tree in *Alnus-Rhododendron* forest, with fruits. On way to Bui 1500 m, rare, 39584.

RUBIACEAE

56. **Galium aparine** L.

Trailing herb with hispid fruits, growing as a weed of *Solanum tuberosum* and *Fagopyrum tataricum* cultivations. Ralam 4000 m, common, 39720.

ASTERACEAE

57. **Anaphalis contorta** Hook.f.

Small erect herb with white flowers, heads on rocky habitats and meadows. On way to Ralam glacier 4000 m, common, 39694.

58. **A. cuneifolia** Hook.f.

Erect herb, with white flower heads on rocky habitats and in glacial region. Ralam 4500 m, common, 39710.

59. **A nepalensis** (Sprengel) Hand.-Maz.

Small erect herb with white flower heads. Bazarganga slopes 3800 m, common, 39657.

60. **Anaphalis** sp.

Medium sized erect herb with white flower heads. On way to Ralam 4200 m, common, 39715.

61. **Artemisia nilagirica** (CL.) Pamp.

Medium-tall, erect herb with dark brown-pink flower heads on rocks and meadows. On way to Ralam glacier 3000 m, common, 39697.

62. **A. stricta** Edgew.

Small erect herb on meadow with brownish green flower heads. Ralam valley 4000 m, common, 39728.

63. **Aster stracheyi** Hook. f.

Erect herb with runners, flower heads dark pink. On way to Tola, Ralam glacier 3000-4500 m, common, 39646 and 39707.

64. **Carduus onopordioides** Fish ex Bieb.

Tall erect prickly herb, on waste land with pink flower heads. Ralam 4000 m, common, 39729.

65. **Cicerbita cyanea** (D. Don) Beauverd

Tall erect herb in *Betula-Rhododendron* forest, fruiting. Saba Odiyar 3000 m, common, 39756.

66. **Dubyaea hispida** DC.

Medium sized erect, hispid herb with yellow flower heads on open grasslands and glacial region. On way to Ralam 4500 m, common, 39702.

67. **Erigeron multiradiatus** Benth.

Small-medium sized erect herb with pink violet flower heads on rocky habitats and open grasslands. Ralam 4000 m, common, 39725.

68. **Inula grandiflora** Willd.

Small hispid erect herb with yellow flower heads on moist rocky habitats. Ralam valley 4000 m, rare, 39739.

69. **Jurinea macrocephala** (DC.) Benth.

Robust herb with small pink flower heads on open meadows. On way to Ralam glacier 4500 m, 39698.

70. **Lactuca brunoniana** (Wall. ex DC.) Clarke

Tall erect herb with light pink flower heads in *Acer-Aesculus* forest. Saba Odiyar 2500 m, common, 39769.

71. **L. violaefolia** (Decne) Cl.

Tall erect herb with violet flower heads along bridle path. Ralam 4000 m, common, 39726.

72. **Leontopodium himalayanum** DC.

Medium sized erect woolly herb with fruiting achenes and flower heads on rocky habitats and meadows. Ralam 4000 m, common, 39688.

73. **Saussurea denticulata** Wall.

Erect shrub with pale white flower heads in *Acer-Aesculus* forest. Saba Odiyar 2500 m, common, 39767.

74. **S. graminifolia** Wall. ex Hook.f.

Small woolly herb with white woolly flower heads on moraine. Bazarganga slope—Ralam valley 4000 m, common, 39663.

75. **S. hypoleuca** Spreng ex DC.

Tall erect herb with pinkish flower heads on rocky habitats and meadows. On way to Ralam Glacier 4000 m, occasional, 39695.

76. **S. kuntheana** Cl.

Small tufted herb, with pink flower heads on moraines. Bazarganga slope—Ralam valley 4000 m, common, 39677.

77. **S. obvallata** (DC.) Clarke

Robust erect herb, with brown coloured flower heads on moraine. Bazarganga slope—Ralam valley 4000 m, common, 39752.

78. **S. taraxicifolia** Wall. ex DC.

Small tufted herb with pinkish sessile flower heads. Bazarganga slopes—Ralam valley 4000 m, common, 39678.

79. **Senecio chrysanthemoides** DC.

Tall erect herb with yellow flower heads on open meadows and moraine. On way to Ralam glacier 4500 m, common, 39706.

80. **S. graciliflorus** DC.

Tall erect herb in *Betula-Rhododendron* forest. Flower heads yellow. On way to Saba Odiyar 3000 m, common, 39757.

81. **S. kunthianus** Wall. ex DC.

Tall erect herb with yellow heads. Ralam 4500 m, common, 39708.

82. **S. ligularia** Hook.f.

Tall erect herb in *Betula-Rhododendron* forest. Flower heads yellow. On way to Saba Odiyar 3000 m, occasional, 39755.

83. **Taraxacum officinale** Weber

Herb on meadows with yellow flower heads. Bazarganga 4500 m, common, 39774.

CAMPANULACEAE

84. **Codonopsis ovata** Benth.

A trailing herb on meadows with green fruits. Ralam valley 4000 m, rare, 39740.

85. **Cynanthus linifolius** Wall. ex H.f. & Th.

Prostrate herb with blue flowers on rocks and meadows. On way to Ralam glacier 4000 m, common, 39701.

86. **C. lobatus** Wall. ex Benth.

Large trailing herb with blue flowers on meadows. Ralam valley 4000 m, common, 39746.

ERICACEAE

87. **Gaultheria trichophylla** Royle

Weak trailing herb with blue coloured fruits over moist rocks. Bazarganga slopes 4000 m, common, 39668.

88. **Rhododendron anthopogon** D. Don

Small stunted shrub on meadows intermixed with *Cassiope* sp. fruiting. Bazarganga 4000 m, common, 39775.

89. **R. campanulatum** D. Don

Large shrub with fruits. Bazarganga—Ralam valley 4000 m, common, 39676.

90. **R. lepidotum** Wall. ex Don

Small woody shrub on rocky habitat, fruits. On way to Saba Odiyar 3000 m, common, 39753.

PRIMULACEAE

91. **Androsace lanuginosa** Wall.

Small tufted herb with fruits on rocky habitat. On way to Saba Odiyar 4000 m, common, 39754.

OLEACEAE

92. **Syringa emodi** Wall. ex G. Don

Tall erect shrub in *Betula-Rhododendron* forest, fruiting. On way to Saba Odiyar 3000 m, common, 39764.

GENTIANACEAE

93. **Gentiana detonsa** Friest

Medium sized erect herb on meadows, fruiting. Ralam valley 4000 m, rare, 39743.

94. **G. pedunculata** Royle ex G. Don

Small erect herb with light blue flowers in moist habitats of meadows. On way to Ralam glacier 4000 m, common, 39691.

95. **G. stipitata** Edgew.

Small tufted herb with bluish green flowers. On way to Tola Ralam glacier 3000-4500 m, occasional, 39648, 39696.

96. **G. venusta** (Don) Griseb.

Small erect herb with blue flowers on meadows. Bazarganga slopes 3800 m, common, 39656.

97. **Swertia ciliata** (D. Don) B. L. Burtt

Tall erect herb with white pink coloured flowers on meadows. Ralam glacier 4500 m, common, 39682.

98. **S. cuneata** Wall. ex D. Don

Tall erect herb with fruits and bluish white coloured flowers on meadows. On way to Bazarganga—Ralam valley 3800-4000 m, common, 39658, 39734.

BORAGINACEAE

99. **Cynoglossum glochidiatum** Wall. ex Bth.

Small herb with sky blue flowers on rocky habitats. On way to Bui 2000 m, common, 39578.

100. **Hackelia uncinata** (Royle ex Bth.) C. E. C. Fisher.

Tall erect herb with sky blue flowers in *Betula-Rhododendron* forest. On way to Saba Odiyar 2500 m, common, 39759.

101. **Macrotomia benthami** (G. Don) DC.

Tall erect herb in *Betula-Rhododendron* forest, fruiting. On way to Saba Odiyar 3000 m, common, 39761.

SCHOPHULARIACEAE

102. **Euphrasia densiflora** Pennell

Small erect herb with white flowers on meadows. On way to Ralam glacier 4000 m, common, 39681.

103. **Pedicularis brunoniana** Wall.

Small erect herb on meadows with pink flowers. Ralam 4000 m, common, 39686, 39705.

104. **P. hoffmeisteri** Klotz

Stout erect herb with fruits and yellow coloured flowers on meadows and moraine. On way to Ralam glacier 4000 m, common, 39717.

105. **P. mollis** Wall. ex Benth.

Small erect herb on meadows and moraine, fruiting. On way to Ralam glacier 4500 m, common, 39690.

106. **P. porrecta** Wall. ex Benth.

Small erect herb with red fruits on meadows. Bazarganga slope—Ralam valley 4000 m, common, 39664.

107. **P. rhinanthoides** Schrenk

Small erect herb with pink flowers on meadows. On way to Bazarganga, 4000 m, common, 39671.

108. **Picrorhiza kurreca** Royle ex Benth.

Small prostrate herb on moist rocks in moraine, fruiting. Bazarganga slope—Ralam valley 4000 m, common, 39662.

LENTIBULARIACEAE

109. **Utricularia kumaonense** Oliver

Minute herb with white flowers in moist habitat. Near Pilti bridge (Saba Odiyar) 3000 m, rare, 39773.

LAMIACEAE

110. **Elsholtzia ciliata** (Thunb.) Hyland

Small erect herb, with white flowers in *Alnus-Rhododendron* forest. On way to Bui 1500 m, rare, 39589.

111. **E. densa** Benth.

Herb as a common weed of *Solanum tuberosum* & *Fagopyram tataricum* cultivation, flowers violet coloured. Ralam 4000 m, common, 39722.

112. **E. eriostachya** Benth.

Medium sized erect herb with greenish pink flowers on rocky habitats. Bazarganga slope 3800 m, common, 39661.

113. **Nepeta laevigata** (Don) Hand.-Maz.

Tall erect herb on open meadows and moraines with dark pink coloured flowers. On way to Ralam glacier 4500 m, common, 39709.

114. **Origanum vulgare** L.

Medium sized erect herb on meadows. Flowers pink. On way to Ralam glacier 4500 m, common, 39713.

115. **Phlonis bracteosa** Royle ex Benth.

Tall erect herb with fruits on meadows. Ralam 4000 m, common, 39727.

PLANTAGINACEAE

116. **Plantago himalaica** Pilger

Small erect herb on meadows, fruiting. Bazarganga slope 4000 m, common, 39666,

POLYGONACEAE

117. **Bistorta vaccinifolia** (Wall.) Greene

Large procumbent herb with pink flowers on rocky habitats. On way to Ralam glacier 4000 m, common, 39693.

118. **Persicaria nepalensis** (Meissn.) H. Gross

Tall erect herb on rocky habitats in *Quercus-Rhododendron* forest. Flowers greenish white. Ralam 4000 m, common, 39744.

119. **P. polystachya** (Wall. ex Meissn.) H. Gross

Tall erect herb along cultivated fields. Flowers white. Ralam 4000 m, common, 39724.

120. **Polygonum affine** D. Don

Trailing herb with pink flowers amidst boulders. On way to Bazarganga 4500 m, common, 39672.

121. **P. glaciale** Hook.f.

Small prostrate herb with white flowers on rocky habitats in shade. Ralam valley 4000 m, common, 39733.

122. **Rheum moorcroftianum** Royle

Rhizomatous herb on moist places, flowers red. Bazarganga slopes, 4000 m, rare, 39680.

123. **Rumex acetosa** L.

Tall erect herb on meadows and moraine, fruiting. On way to Ralam 4000 m, common, 39718.

124. **R. nepalensis** Spreng

Tall erect herb, fruiting. Ralam 4000 m, common, 39730.

CHLORANTHACEAE

125. **Circaester agrestis** Maxim

Small erect herb on moist places in rock crevices occasionally in association with *Leucanthus* sp. fruiting. Shamboo Odiyar, 2500 m, abundant, 39633.

URTICACEAE

126. **Pilea racemosa** (Royle) Tuyama

Large herb with rose pink flowers. On way to Bui 3000 m, occasional, 38581.

SALICACEAE

127. **Salix lindleyana** Wall. ex Anders

Large prostrate shrub on rocky habitats and amidst boulders, fruits green. Bazarganga slope 4500 m, common, 39675.

MONOCOTYLEDONS

ORCHIDACEAE

128. **Goodyera fusca** Hook.f.

Terrestrial, erect fleshy herb amidst the clumps of *Rhododendron* sp. and *Gaultheria* sp. flowers greenish white. Bazarganga 4000 m, rare, 39665.

129. **Herminium monorchis** R. Br.

Terrestrial herb on meadows, fruiting, Ralam valley 4000 m, common, 39732.

130. **Orchis latifolia** L.

Terrestrial herb on moist places, fruiting. Ralam valley 4000 m, common, 39731.

ZINZIBERACEAE

131. **Globba racemosa** Smith

Tall erect herb in *Alnus-Rhododendron* forest, flowers yellow. On way to Bui 1500 m, common, 39590.

HAEMODORACEAE

132. **Aletris pauciflora** (Klotzsch) Hand.-Maz.

Small erect herb on meadows with brownish white flower. Bazarganga slope 3800 m, 39655.

Liliaceae

133. **Allium stracheyi** Baker

Small erect herb, with light pink flowers. Ralam valley 4000 m, common, 39737.

134. **A. wallichii** Kunth.

Tall erect herb with pink flowers on meadows. On way to Ralam glacier 4500 m, occasional, 39685.

135. **Lilium giganteum** Wall.

Tall unbranched herb with hollow stem in *Acer-Aesculus* forest, fruiting. Near Lungrani 2500 m, common, 39771.

136. **Nomocharis nana** (Klotzsch) E. H. Wilson

Small erect herb on meadows, fruiting. Ralam valley 4000 m, rare, 39742.

Juncaceae

137. **Juncus himalensis** K. & G.

Tall erect herb with brown fruiting spikes. Ralam valley 4000 m, common, 39748.

Cyperaceae

138. **Scirpus setaceus** L.

Small erect tufted herb on meadows with dark brown fruiting spikes. On way to Ralam 4500 m, common, 39703.

Poaceae

139. **Chrysopogon gryllus** (L.) Trin.

Tall erect herb with flowering spikes in *Alnus-Rhododendron* forest. On way to Bui 1500 m, common, 39595.

140. **Danthonia cachemyriana** Jaub. et Spach.

Tall erect grass with fruiting spikes on meadows. On way to Ralam glacier, on way to Saba Odiyar 3000-4500 m, common, 39711, 39762.

141. **Deyeuxia** sp.

An erect grass with brown fruiting spikes on open slopes. On way to Ralam glacier 3200 m, common, 39692.

142. **Phleum alpinum** L.

Tall erect grass with dull violet spikes on moist rocks. Ralam valley 4000 m, common, 39747.

143. **Saccharum spontaneum** L.

Tall erect grass, with silvery white fruiting spikes along bridle path. On way to Bui 1500 m, common, 39594.

Ferns

Pteridaceae

144. **Pteris cretica** L.

Fern with sori amidst boulders. On way to Bui 1500 m, rare, 39596.

Cryptogramaceae

145. **Cryptogramme crispa** R. Br.

Fern with sori on rocky habitat and shade. Bazarganga 4000 m, common, 39673.

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SOCIAL BEHAVIOUR OF THE AXIS DEER DURING THE DRY SEASON IN GUINDY SANCTUARY, MADRAS[1]

Shingo Miura[2]

(*With three text-figures*)

The social behaviour of the axis deer is described. Axis deer exhibit a biomodal pattern in diurnal activity, changing their grouping behaviour and vegetative use. Several separate elements are identified in buck-buck and doe-buck interactions respectively. Axis deer make no attempt to form a harem group, nor do they establish territory. Brief comparisons are made between social behaviour of axis and certain other cervids.

Although the axis deer *Axis axis* can generally be found in moist and dry deciduous forests, practically throughout peninsular India (Prater 1971), the eco-ethological study made by Schaller (1967) was only for Kanha population, in Central India. I had an opportunity to visit Guindy Sanctuary, South India from 29th February to 2nd April, 1977 and was able to gather quantitative data concerning grouping and rutting behaviour of the axis deer. The purpose of this study is to describe social behaviour and to determine the social system of the axis deer during the dry season as it compared to other populations and to other cervids.

Study area and method

Guindy Sanctuary covers an area of 302 ha of flat terrain and is located at the outskirts of Madras City, Tamil Nadu. This small sanctuary is rich in wildlife, e.g. axis deer, blackbuck (*Antilope cervicapra*), bonnet macaque (*Macaca radiata*), and common mongoose (*Herpestes edwardsi*).

According to a direct census carried out by the Madras Wildlife Warden in May of 1976, the population of deer and blackbuck was 1360 animals (density ; 4.5 animals/ha.) and 740 animals (2.4 animals/ha.) respectively. These densities are considerably higher than other populations (see ; Sharatchandra and Gadgil 1977).

I roughly divided the vegetation of this area into three types as follows : (1) deciduous thorny forest dominated by *Acacia planifrons*, *Acacia leucophloea*, *Acacia javanica*, *Azadirachta indica* and *Derris glabra* (covering with 44% of the area), (2) mixed forest with *Ficus bengalensis*, *Atlantia monosperma*, and *Glycosmis pentaphylla* (33%), and (3) grassland (23%). Due to overbrowsing by ungulates, some malformed palatable plants, such as *Plugia leucophrus*, *Carissa spinarum*, and *Randia* spp. occurred in the area.

More than 250 hrs. of direct observations on the deer were made along standardized routes in the area. Use of 9 × 35 binoculars facilitated the identification of sex, size, and behavioural acts of the deer. Antlered bucks were classified into five antler classes as ‘ spikes ’, less than 40 cm, 41-50 cm, 51-60 cm, and more than 61 cm. Social interactions and behavioural acts were recorded in field note on a minute-by-minute basis, noting sex, antler class, and when possible, known animals. More than 30 animals of both sexes were recognized as individuals by antler configuration, and by distinctive marks such as natural notches at ear

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margins and scars in various regions. Some individuals were recorded as many as 25 times. Based upon the description by Hardin *et al.* (1977), I observed whether the deer formed a group or not. The deer were regarded as a herd when they were within view of one another and responding to each other during the entire period of observation. However, some cases, were not considered as a group as even though they were adjacent to one another, they went their separate ways after brief interactions.

Results and discussion

Out of a total number of 6318 individuals, 3789 (60.0%) were adult or juvenile does, 1425 (22.6%) were bucks including yearlings and 1101 (17.4%) fawns. The buck to doe ratio, based on above data, was 35.0 : 100.0. Most bucks (82.2%) were with hard antlers, 17.2 per cent were in velvet, and the rest had shed their antlers.

Group size and composition

Out of 2424 total observation records, 880 (36.3%) were of single animals and 1546 (63.7%) were groups of two or more or herds. The overall average group size was 2.83 (range ; 1-37 animals). The distribution of herd sizes is skewed toward small groups, with 85.6 per cent of all groups containing fewer than four deer. The percentage of all deer seen in groups of various sizes, however, is considerably larger in larger groups : 44 per cent of all deer were in groups of five or more.

Doe groups, consisting only of females with or without fawns, were observed more frequently than mixed and buck only groups. Strong social ties appeared to exist between does, and between doe and fawn. Most (89.3%) of the 1526 sightings of groups numbering two or three were doe groups. Although the composition of groups of more than four was generally mixed (56.7%), the frequency of doe groups observed should not be ignored (39.9%). Few buck groups consisting of males only were seen during this period : most bucks were seen either as solitary (26.0% of all bucks) or as members of a mixed group (63.0%).

Diurnal rhythms

Diurnal rhythms of the axis were examined from 0600 to 1900 hrs from three points of view : vegetative use, basic activities, and grouping behaviour.

Percentages of deer observed in the three vegetation types to every one hour are presented in Fig. 1A. This indicates a certain pattern of diurnal vegetative use of the deer. In the grassland which is characterized by an open habitat rich in food for grazing, there were two peaks ; in the early morning between 0600 and 0700 hrs and in the evening between 1600 and 1700 hrs, and there was one lull in the daytime between 1100 and 1200 hrs. The Deciduous forest which was dominant in the area and was characterized by relatively open habitat poor in food, was consistently used to some degree during all of the observations, but this was rather used frequently during the midday. Use of mixed forest, which was characterized by closed habitat and relatively rich in food for browsing, was the inverse of the use of grassland. There was one peak at midday of 1100-1200 hrs. These changes of vegetative use may be closely related with their diurnal activities.

I divide here the acts of the animals into four basic categories ; resting (lying on the ground), feeding (grazing and/or browsing), moving, and others (grooming, suckling, drinking, and social acts etc.). Percentages of these acts to every one hour are shown in Fig. 1B. Axis exhibit a biomodal activity pattern. There were two peaks and one lull in feeding. The morning peak between 0600 and 0700 hrs, 89 per cent of animals

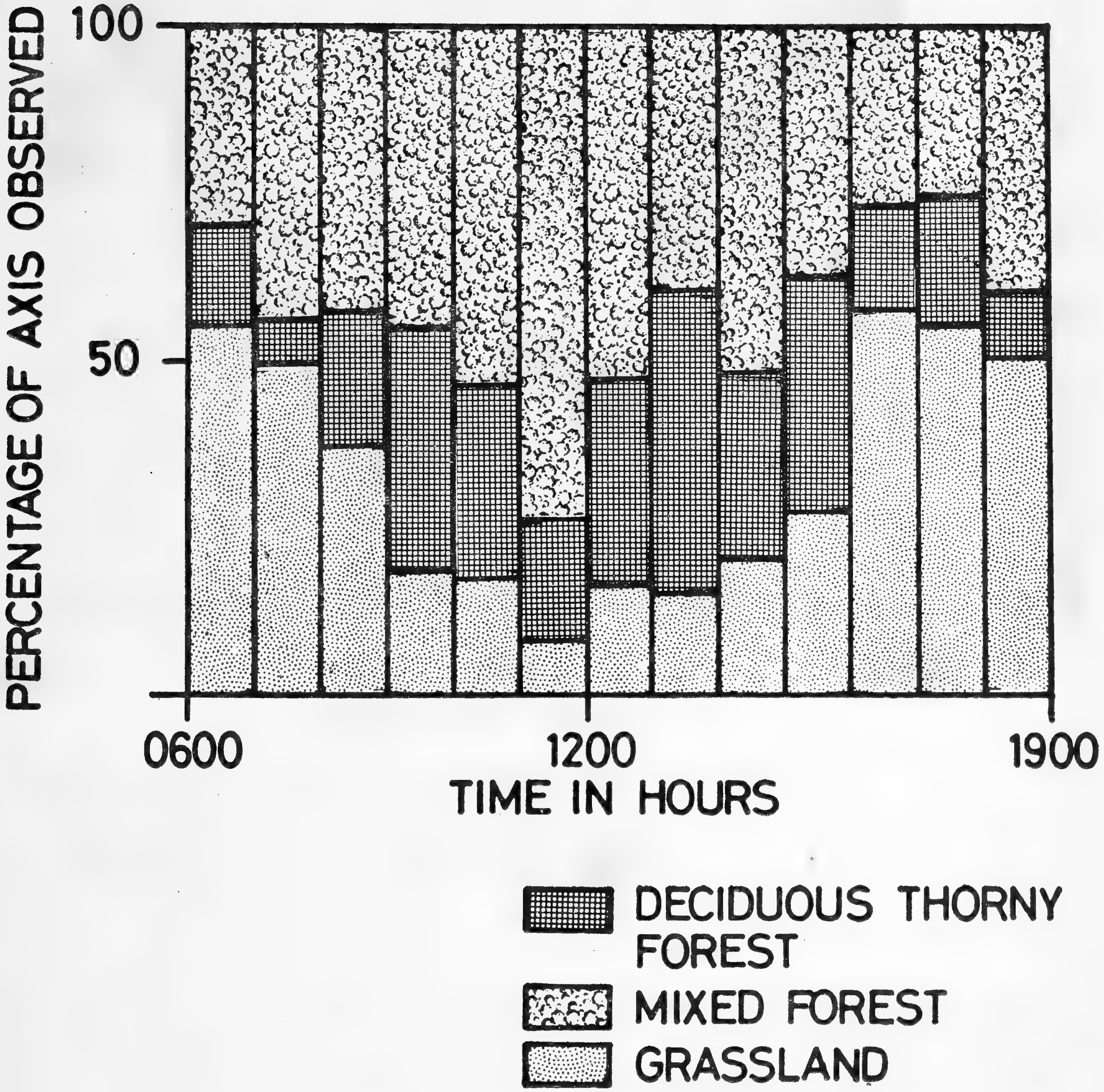

Fig. 1A. Percentages of the axis deer observed in three vegetation types per hour in Guindy Sanctuary.

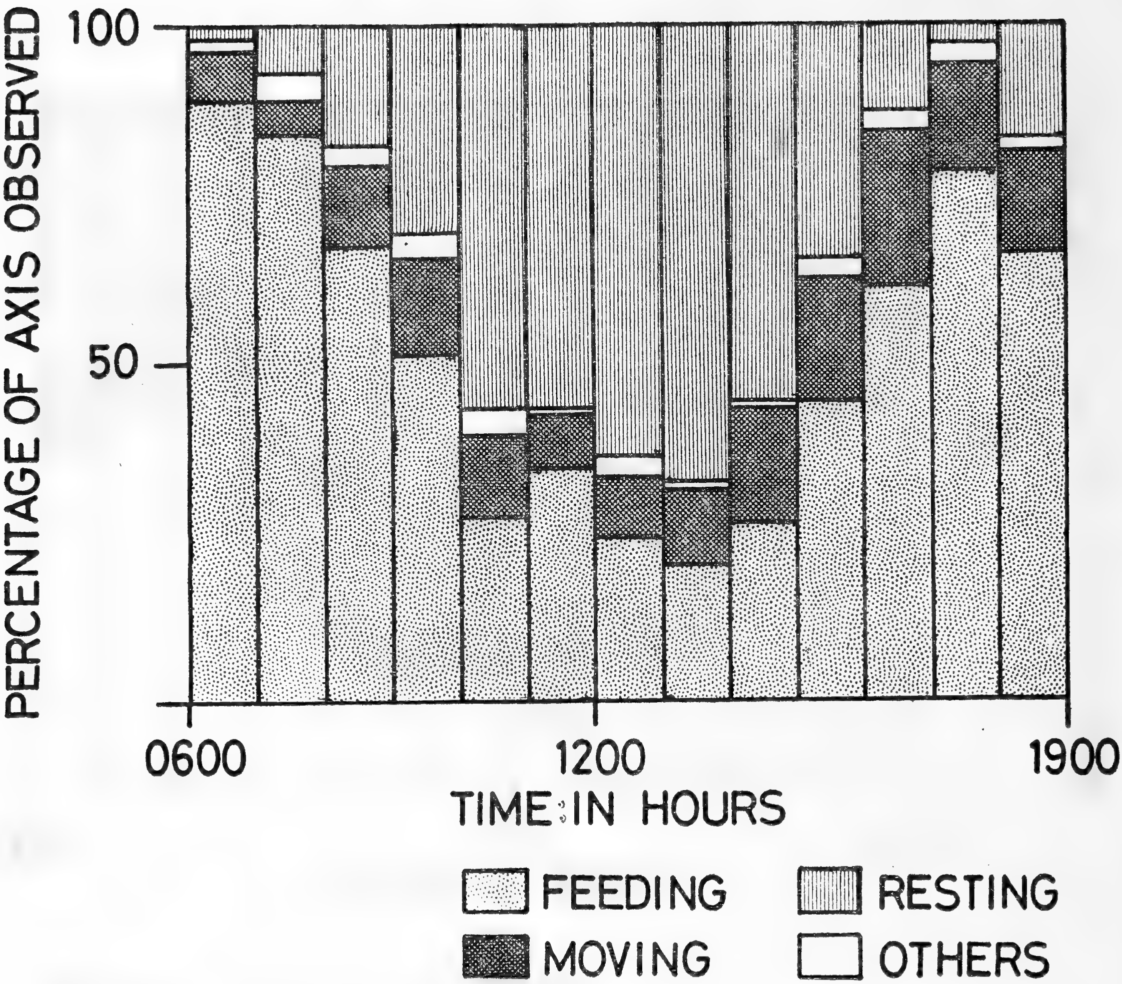

Fig. 1B. Percentages of four basic acts of the axis deer observed per hour in Guindy Sanctuary.

were engaged in feeding, and during the evening peak between 1700 and 1800 hrs, 78 per cent. The per cent of feeding was apparently inversely proportional to resting. The lull of feeding was coincident with the peak of resting. Moving was consistently observed all the time with slight increases before and after the peaks of feeding. It was noticeable that the two peaks for feeding synchronized with the peaks for the use of the grassland and the peak for resting was also roughly coincident with the peak for the use of the mixed forest. Diurnal changes of their activities may deeply influence grouping behaviour.

Percentages of various group sizes observed every hour including average group size observed every hour are presented in Fig. 1C. Single animal and groups of two animals were observed all the time with ranges of 21-49 per cent, and 20-42 per cent respectively. But, both occurred more frequently in the daytime between

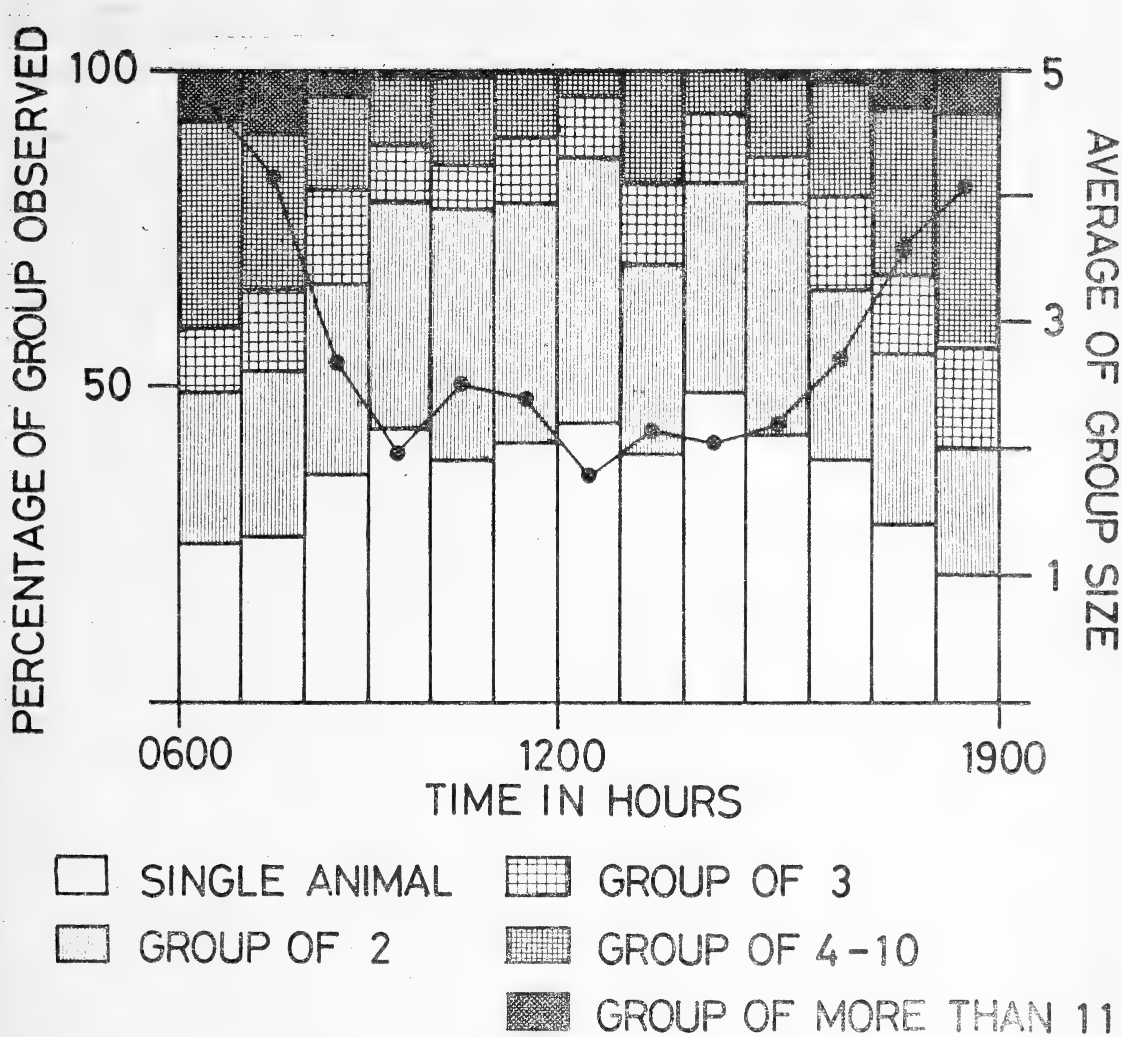

Fig. 1C. Frequencies of various sizes of groups observed per hour, including average sizes of groups, in Guindy Sanctuary.

0900 and 1600 hrs than in the early morning and in the evening. On the contrary, groups of 3-10 animals occurred more frequently in the early morning and in the evening than during the daytime. Out of 72 total sightings of large sized groups of more than 11 animals, only seven were seen during the daytime between 0900 and 1600 hrs. The largest group of 37 animals were engaged in grazing and moving in the grassland between 1608 and 1619 hrs. Changes of the average size of the groups shows a 'V' shape curve, which indicates that larger gathering tended to occur more often in the morning and in the evening than during midday. Thus, it is reasonable to infer that after the early morning the animals split up their organization into smaller groups or solitary, and in the evening they reorganized and formed into larger groups, while changing their activities and use of vegetation.

My observations after 1900 hrs indicate that almost all members (85.6%) rested, and they should be regarded as the roosting groups. Similar large roosting groups were also observed for Sika deer at Nara Park, Japan (Miura 1975). It is evident that the larger groups observed in the evening were in the process of forming roosting aggregations, and the larger groups in the morning were the breaking up of these roosting aggregations.

Stability of known individuals

The organization of the axis deer is characterized not by fixed but a rather flexible system that changes from morning till night with relation to their diurnal activities. To illustrate this aspect of the social organization I tabulated all observations of some of known individuals sighted frequently. Five selected examples of these records are given in Tables 1 and 2.

Table 1 gives data on 47 total sightings of three does. Two (F1 and F2) of them were considered as mothers rearing newborns (11 and 12) respectively from suckling behaviour. The mothers were seen in various group sizes numbering 1 to 34 individuals. There was no evidence indicating a firm bond between them and other adult or juvenile individuals except their fawns. Of the 33 total sightings of the mothers, they were seen 20 times with their fawns. Of the 11 occasions they were in groups of two animals, they almost always (90.9%) associated with their fawns. The data on mothers, therefore, indicate that the family bond, composed of a doe and her fawns must be regarded as a very stable unit (Graf and Nichols 1966, Schaller 1967, Eisenberg and Lockhart 1972). F9 was also seen in various sized groups of 1-34 animals. Does associated more often with other adult or juvenile does than with bucks, although there did not seem to exist any special ties between does.

Table 2 lists 38 total sightings of two antlered bucks (M1 and M9). They were seen in various group sizes ranging 1-30, and also in two types of groups ; buck groups and mixed groups. They were seen with mixed groups for 68.4 per cent of the observation, and with buck groups for 10.3 per cent of the observations. While they often herded with other known bucks (M6 and M14), no special contacts between them were observed : the organization among bucks became very weak once they were in rut. Presumably, they happened to join same associations is search of does in oestrus.

Normally the relation between buck and doe was transitory : the buck would try to sniff at her perineal region and then move away indifferently from her, unless she was in heat, and this contact usually lasted only a few seconds. But, if she was in heat, the buck would attempt to follow or to remain with her tenaciously, probably until mating was over. F9 was accompanied at least three days by M28 and other bucks. When she was in heat on the 22nd of March, M28 showed sexual interest towards her and escorted her throughout the observation. The next day, after they were seen in a large association, she separated from this association and entered the forest and was followed by three bucks including M28. Copulation probably occurred on this day. Afterwards, she was not followed by any of the bucks including M28, though they were observed twice in the same association.

The family bond appears to be the basic unit of the group and all other kinds of groups or aggregations observed may be made up of several family parties and solitaries which may come together temporarily, an observation which agrees with those of Graf and Nichols (1966) and Schaller (1967). Thus, although

TABLE 1

GROUPING BEHAVIOUR AND COMPOSITION: ALL OBSERVATIONS OF F1, F2, AND F9. FIGURES IN PARENTHESES INDICATE INDIVIDUAL NUMBER OF KNOWN ANIMALS

No.	Date	Adult bucks	Juvenile bucks	Adult females	Juvenile females or fawns	Group size
F 1						
1	9/3				1 (I1)	2
2	10/3			1	1 (I1)	3
3	11/3	1			1	3
4	12/3		1	2	2 (I1)	6
5	13/3					1
6	14/3					1
7	15/3				2 (I1)	3
8	16/3			1	3 (I1)	5
9	17/3				1 (I1)	2
10	18/3			2	2 (I1)	5
11	19/3	1		2	2	6
12	20/3				1 (I1)	2
13	24/3	1			1	3
14	25/3				1 (I1)	2
15	26/3				1	2
16	27/3			1	2	4
17	28/3			1	1 (I1)	3
18	29/3				1	2
19	30/3	3	1	5	2 (I1)	12
20	31/3				1 (I1)	2
21	1/4				1 (I1)	2
F 2						
1	11/3					1
2	12/3			2	2 (I2)	5
3	1/73		1	2	2	6
4	19/3				1 (I2)	2
5	20/3				1 (I2)	2
6	22/3				1 (I2)	2
7	25/3			1	1	3
8	26/3	3	1	13 (F9)	16 (I2)	34
9	27/3			1	1	3
10	28/3	2	2	5	2 (I2)	12
11	29/3			2	2 (I2)	5
12	30/3			1	1	3
F 9						
1	14/3			4	5	10
2	15/3				1	2
3	19/3				2	3
4	20/3					1
5	21/3			11	11	23
6	22/3	1 (M28)		4	6	12
7	23/3	3 (M28, M25)		13	11	28
8	24/3	1 (M28)		12	11	25
9	25/3	1 (M29)		1	1	4
10	26/3	3 (M25, M28, M29)	1	13 (F2)	16	34
11	27/3			1	1	3
12	28/3	1				2
13	29/3				1	2
14	30/3				1	2

TABLE 2

GROUPING BEHAVIOUR AND COMPOSITION : ALL OBSERVATIONS OF M1 AND M9. FIGURES IN PARENTHESES INDICATE INDIVIDUAL NUMBERS OF KNOWN ANIMALS

No.	Date	Adult bucks	Juvenile bucks	Adult females	Juvenile females or fawns	Group size
M 1						
1	8/3			2	2	3
2	9/3	2 (M11, M26)			1	4
3	10/3	1				2
4	11/3			1	4	6
5	13/3	2 (M6, M7)		2	2	7
6	14/3					1
7	15/3	1 (M11)		2		4
8	16/3	1 (M11)				2
9	20/3					1
10	22/3			3	2	6
11	23/3	1 (M6)		3	5	10
12	24/3			1	1	3
13	25/3	1 (M6)		2	1	5
14	26/3	1 (M6)		3	2	7
15	27/3	3 (M8)	2	8 (F6)	5	19
M 9						
1	8/3	2 (M3, M18)		1		4
2	9/3	4 (M10, M11)		3	4	13
3	10/3	4 (M10, M11)		2	1	8
4	11/3	7 (M10, M14, M18)	1	4 (F8)	4	17
5	12/3	1		1	2	5
6	13/3					1
7	14/3	6 (M3, M13, M14, M18, M27)	1	3	5	16
8	15/3			3	1	5
9	16/3					1
10	17/3	5 (M14, M18, M22, M27)		4	4	14
11	18/3	5 (M14, M22, M27)	1	6 (F5, F8)	6	19
12	19/3			1	1	3
13	20/3	1		4	1	7
14	22/3	11 (M2, M3, M14, M27)	1	10 (F5)	7	30
15	23/3			1	1	3
16	24/3	5 (M15)		9	7	22
17	25/3	3 (M14)		4	1	9
18	26/3					1
19	27/4					1
20	28/3	1		3 (F8)	2	7
21	29/3					1
22	30/3	1				2
23	31/3					1

grouping behaviour of the axis deer is, indeed, highly developed, the basic social trend seems to closely resemble that of other species of deer (ex; Linsdale and Tomich 1953, Severinghous and Cheatum 1956, Ito 1969).

SOCIAL INTERACTIONS

The number of behaviour patterns used by different antler class bucks are summarized in Table 3.

Buck-buck interactions

Head-up display (Schaller 1967): This aggressive act is common among many cervids though different terms have been used (Strusaker 1966, Geist 1966, Miura 1976, Kucera 1978). This display is a rapid lifting of the head and the muzzle with the showing of incisors and was often accompanied by a snort. This was used by bucks toward other bucks and does. Nineteen of the 20 head-up displays (95.0%) were given by bucks of the greater than 50 cm antler class.

Thrashing and pawing: Bucks often used their antlers to violently thrash small shrubs. Thrashing was often performed in conjunction with pawing of the forefoot. These behavioural acts were not only used as an aggressive threat between bucks signaling readiness to fight, but also performed spontaneously without contact with other bucks where an agonistic context was not evident. The former case was observed 71 times. In 14% of the cases when the bucks confronting each other were within 1-5 m, and lasted from 5 to 30 sec. In 63.4% instances it was given by a buck when others approached

TABLE 3

NUMBER OF BEHAVIOUR PATTERNS USED BY DIFFERENT ANTLER CLASS BUCKS

Behaviour Patterns	Antler Class					
	More than 61 cm	60-51 cm	50-41 cm	Less than 40 cm	Spikes	Total
Head-up display ..	13	6	1			20
Head-down display ..	3	2				5
Thrashing bush with antler ..	52	25	8	2		87
Pawing by forefoot ..	29	18	7	1		55
Rubbing antler ..	12	4	1	1		18
Rubbing forehead ..	8	3	1			12
Rubbing preorbital gland ..	9	2				11
Rubbing neck ..	3	1	1	1		6
Sparring aggressively ..	7	8	1			16
Sparring plav ..	21	17	11	9	4	62
Chasing ..	4					4
Circling ..	9	2	2	1		14
Parallel walk ..	6					6
Flehmen ..	21	8	3	2	2	36
Sniffing or muzzling ..	74	37	9	3	1	124
Following female ..	69	29	6	1		105
Erection penis ..	41	6				47
Mounting ..	23					23
Copulation ..	3					3

him within 10 m, and the rest were when other animals were 11-40 m away. The latter cases occurred fewer times (16 occasions). This act was performed by all antler class bucks, excepting yearlings during this period, however when frequency was correlated with antler class, the larger antlered bucks did it more frequently.

Wallowing was completely absent in the axis deer during the study.

Rubbing : A buck would occasionally rub his antlers, preorbital gland, or other regions of his face. The rubbing was accompanied by an erection of his penis and the expulsion of urine. This act was often interspersed in the thrashing and pawing sequence and was also performed in two contexts ; agonistic threat or not. Bucks performed this act without agonistic context in 44.4% of the observation.

Sparring : This act is typical of fighting among almost all ungulates. In this category of sparring encounters between two bucks in which they face each other with heads lowered, two bucks with antlers in contact, and two bucks pushing and occasionally clashing their antlers are included. This act, however, apparently involved different levels of aggressive intent ; ritualized and actual fight. Ritualized sparring matches had less aggressiveness and appeared as if they were playing with each others antlers, and was accompanied by grunts. Most participants in these matches were of different antler classes. Only four out of 31 matches observed involved equal size class, whereas 53.6% were of bucks one antler class apart, 28.6% of two classes apart, 10.8% of three classes apart. The greatest disparity involved two separate matches between a 65 cm antler class buck and a 30 cm buck. These matches were usually terminated when one of the participants turned and moved away and most of them showed no obvious victor. These matches lasted from 5 to 300 sec. with an average of 55.7 sec.

Actual fights were much less frequent and more violent than rirualized one, and usually of shorter duration ($\bar{X} = 7.2$ sec., $N = 8$). The loser ran away, and was chased by the victor. Seven of 16 participants in eight fights were of the greater than 61 cm antler class, the rest were of 51-60 cm class. Six of eight fights involved equal size class, and twice involved one class apart.

Chasing : Chasing was very rare in axis deer during the study, I observed such act only 4 times, all of which were preceded by actual fight and were performed by bucks of the greater than 61 cm antler class. Such scarcity of this act may be related to the fact that bucks make no attempt to establish and defend a territory.

Circling and parallel walk : These acts were observed 10 times, and almost always preceded an actual fight. In all of them one buck approached another, thrashing or rubbing its antlers on vegetation. The second buck would respond by thrashing or rubbing and the two would approach closer and continue to thrash. When near each other the animals would circle slowly around one another, or both would walk parallel within 1 to 10 m in the 'crouch' posture (Cowan and Geist 1961). Self-grooming or grazing displacement acts were also observed during such encounters.

Doe-buck interactions

Flehmen : This is a highly stereotyped act in many ungulates (Dagg and Taub 1970), and its frequency might be correlated with the rut. Most of them were accompanied by sniffing or licking doe's urine. 53 per cent of flehmens occurred during or just after urination by a doe, and the rest occurred after sniffing ground with fresh urine. Flehmen was observed in all classes of bucks, but was most commonly seen bucks of greater than 50 cm antler classes (80.5%). Spike and the less than 40 cm antler class bucks performed only twice respectively (11.2%). Mean duration of flehmen was 21 sec. (N = 36) with range of 10-30 sec.

Sniffing or muzzling: A buck would sniff or muzzle at the perineal region of does whenever he entered a group containing does or encountered a doe. The larger bucks sniffed significantly more often than the smaller bucks. A total of 124 sniffings observed, 59.7 per cent were performed by bucks of greater than 61 cm antler class, 29.8 per cent were 51-60 cm, 7.26 per cent 41-50 cm, 2.42 per cent less than 40 cm.

Following: After sniffing, bucks often followed or attempted to remain with a doe as she moved about. This acts resembles 'tending' described by McHugh (1958) for American bison. Although bucks of all antler classes, excepting spikes followed does, the frequency was significantly related to antler class. Following was performed by bucks of more than 51 cm antler classes in 93.3 per cent of the observations.

Following of does was usually performed by a single buck (95.0%), and he tried to prevent others from doing so by aggressive acts, such as head-up display, snorting, pawing, or thrashing, but on five occasions several bucks (2-5 animals) were seen following a doe. On these occasions, they rushed at a doe at full speed and they struggled for the doe by clashing with each other. It was my impression that such difference of following by bucks might be dependent on the state of receptivity of the doe, and the doe followed by several bucks seemed to be in oestrus or approaching it.

Bucks of axis deer never showed 'herding behaviour' described by Struhsaker (1967) for the elk, Lincoln *et al.* (1970) for the red deer, and Miura (1976) for the sika deer, in which they make an attempt to collect and retain a number of does. Bucks moved over a wide range and joined many groups, apparently in search of receptive does. When a buck entered a group containing does, he showed courtship behaviour toward a doe individually, and then he followed and tended her if she was in heat. As a result of such acts, they generally left the group and formed a temporary pair (tending bond ; McHugh 1958) until copulation was completed. Thus, there was no indication of a tendency by bucks to form or defend 'harem' group. Rather, tending bond system is accepted in axis deer.

Mounting and copulation: If a doe stopped moving and did not try to escape from sniffing by a buck while being followed, the buck would mount, straddling the doe's back with his hind-legs on the ground. Multiple mounts occurred during all three copulations observed, the number of mounts were three, five, and 15 respectively. All of them were performed by bucks of greater than 60 cm antler class. Copulation involved one thrust of a successful mount with the buck's feet leaving ground, the loin pushing forward, and throwing back his head for a moment. She was often forced several metres forward by his movement. Following copulation, tending by the buck ceased.

Diurnal variations of social interactions

The data on diurnal variations in frequencies of buck-buck and doe-buck interactions are summarized in Fig. 2. This figure demonstrates that there are two obvious peaks of two interactions respectively, one in the morning (0600-0700 hrs.) and one in the late afternoon. The afternoon peak of buck-buck interaction occurred earlier than that of doe-buck interaction. In spite of a slight lag of the peaks, the frequencies of two interactions which showed a biomodal pattern were very closely similar to each other.

Vocalization

Bucks would emit a variety of sounds for example, bellows (Schaller 1967), moans, barks,

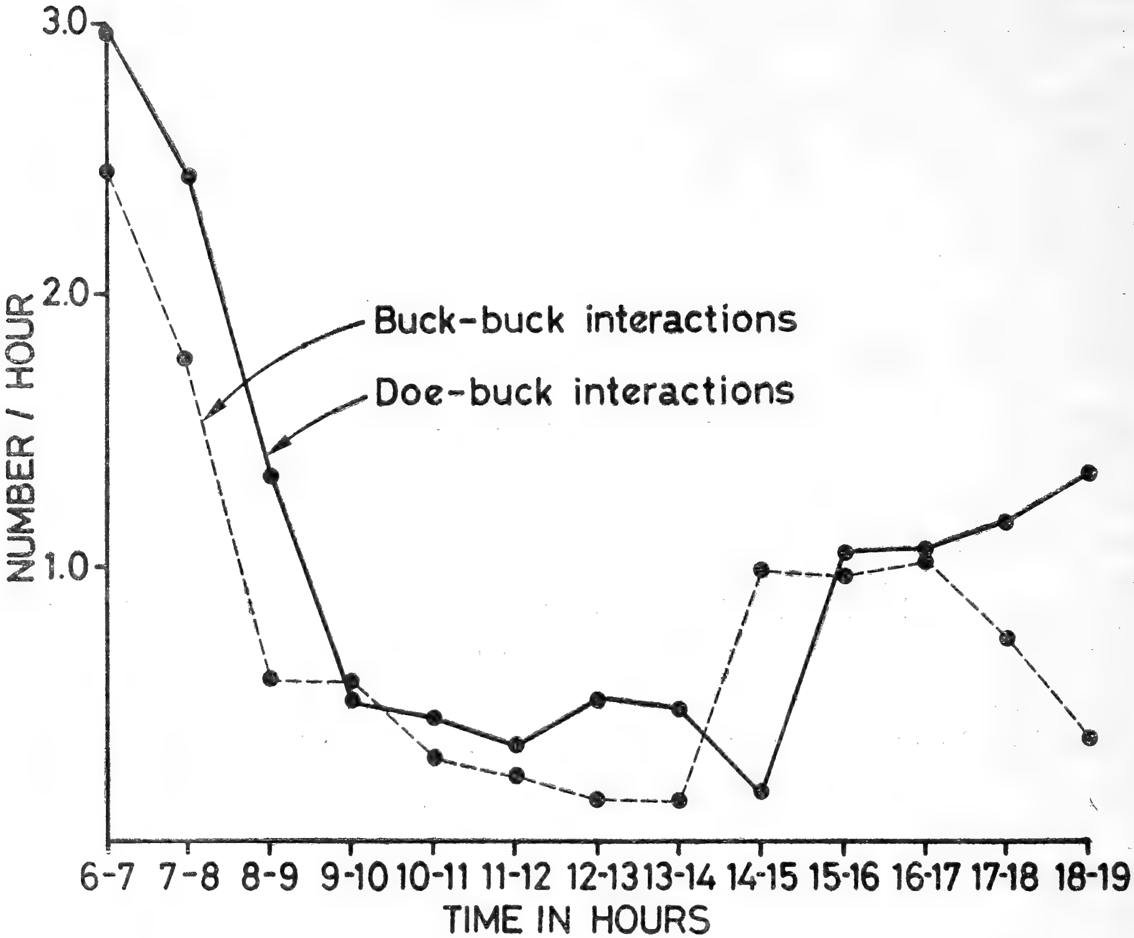

Fig. 2. Number of buck-buck and doe-buck interactions per hour of the axis deer in Guindy Sanctuary.

grunts and snorts. Bellows were the most common sound in this period and were emitted only by adult bucks. 98.0 per cent of the observations were emitted by the 51 cm antler class bucks. Every instance of this vocalization was recorded and diurnal variation was examined (Fig. 3). This sound could be heard at any time of the day, but most often in the morning and in the evening. The impression was gained that the frequency of this vocalization was deeply influenced by the number of buck-buck or doe-buck interactions.

Moans were also emitted only by adult bucks of greater than 50 cm antler class. Perhaps a production of this sound might be closely related to dominance rank among bucks. On 14 occasions mixed groups containing several known bucks of greater than 50 cm antler class were observed occupying the same areas at different times, only one of the bucks usually emits this sound, and he frequently showed sexual behaviour toward the does. This buck appeared to be the dominant among them according to the observations on aggressive

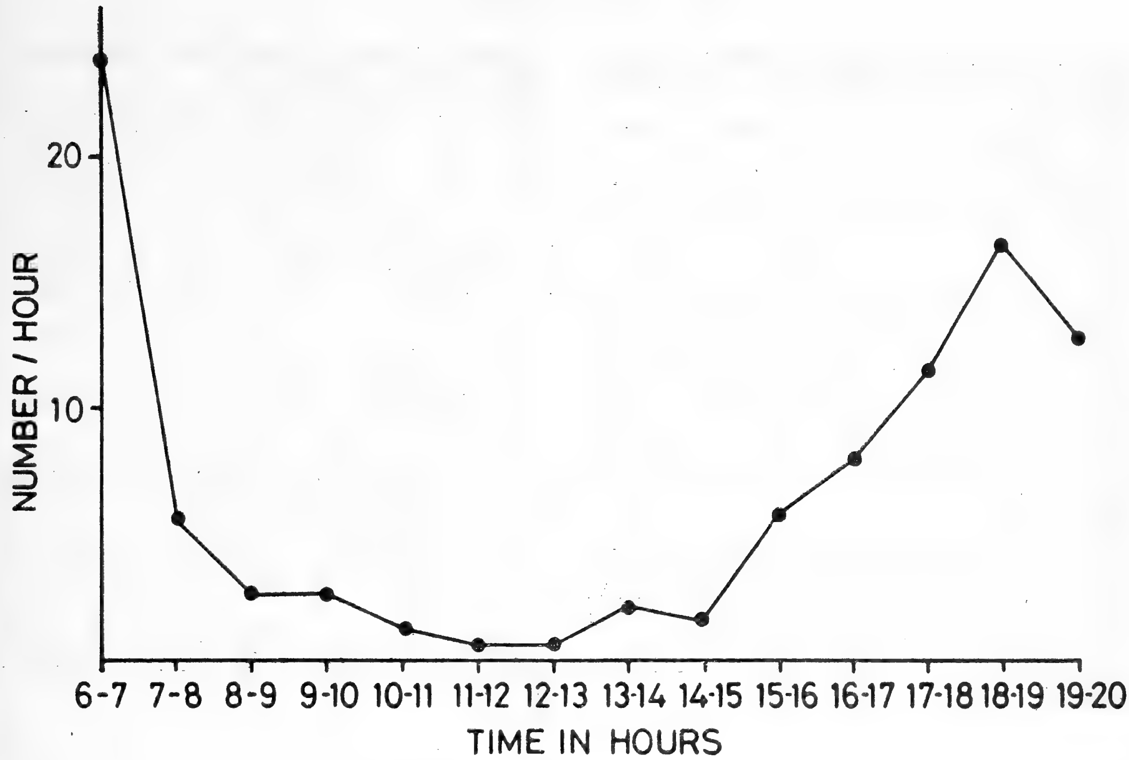

Fig. 3. Number of bellows per hour of the axis deer in Guindy Sanctuary.

interactions. Other bucks seemed to be tolerated being in the group unless they advertised themselves by emitting this sound. Other vocalizations could not be recorded quantitatively.

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NEW DESCRIPTIONS

STUDIES ON SPIDERS OF THE GENUS *LUTICA* MARX (FAMILY-ZODARIIDAE) FROM INDIA[1]

B. K. TIKADER[2]

(*With ten text-figures*)

INTRODUCTION

The family Zodariidae consists of a small number of rare and inconspicuous, ground dwelling forms. Simon (1905, 1906) and Gravely (1921) have described some species of this family from India. Very recently Tikader & Patel (1975) and Tikader & Malhotra (1976) described some new species of the genera *Storena* and *Lutica* of the family Zodariidae from India.

I have provided a key to species and illustrated epigyne and internal genitalia of two known species of the genus *Lutica* and described a new species in this paper. Type specimens of new species are deposited in the National Collections of Zoological Survey of India, Calcutta.

KEY TO THE SPECIES OF *Lutica* MARX.

1. Dorsal side of abdomen uniform deep brown in colour 2

Dorsal side of abdomen uniform brownish red in colour .... *L. deccanensis*

2. Anterior middle eyes encircled by deep brown patches. Epigyne V-shaped.......... *L. bengalensis*

Anterior area of eyes encircled by black patches. Epigyne not V-shaped................ *L. poonaensis*

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Lutica deccanensis Tikader & Malhotra

(Figs. 1-2)

1976. *Lutica deccanensis* Tikader & Malhotra, *J. Bombay nat. Hist. Soc.*, 72 (3) : 794.

Specimens examined: 2 ♀♀, Flower garden, Poona University compound, Poona, Maharashtra, India. Coll. *B. K. Tikader*, 28.4.80.

Distribution : Poona (*Type-locality*), Maharashtra, India.

Remarks : I have studied the type as well as other specimens and have given illustrations of epigyne as well as internal genitalia which were not given in the original description.

Lutica bengalensis Tikader & Patel

(Figs. 3-4)

1975. *Lutica bengalensis* Tikader & Patel, *Bull. Brit. Arach. Soc.*, 3 (5) : 138.

Specimens examined: 3 ♀♀, Flower garden, Poona University compound, Poona, Maharashtra, India. Coll. *B. K. Tikader*, 4-2-1980.

Distribution : India : Calcutta (*Type-locality*) West Bengal, Poona, Maharashtra.

Remarks : I have studied the type as well as other specimens. I have given illustrations of epigyne as well as internal genitalia which was not provided in the original descriptions.

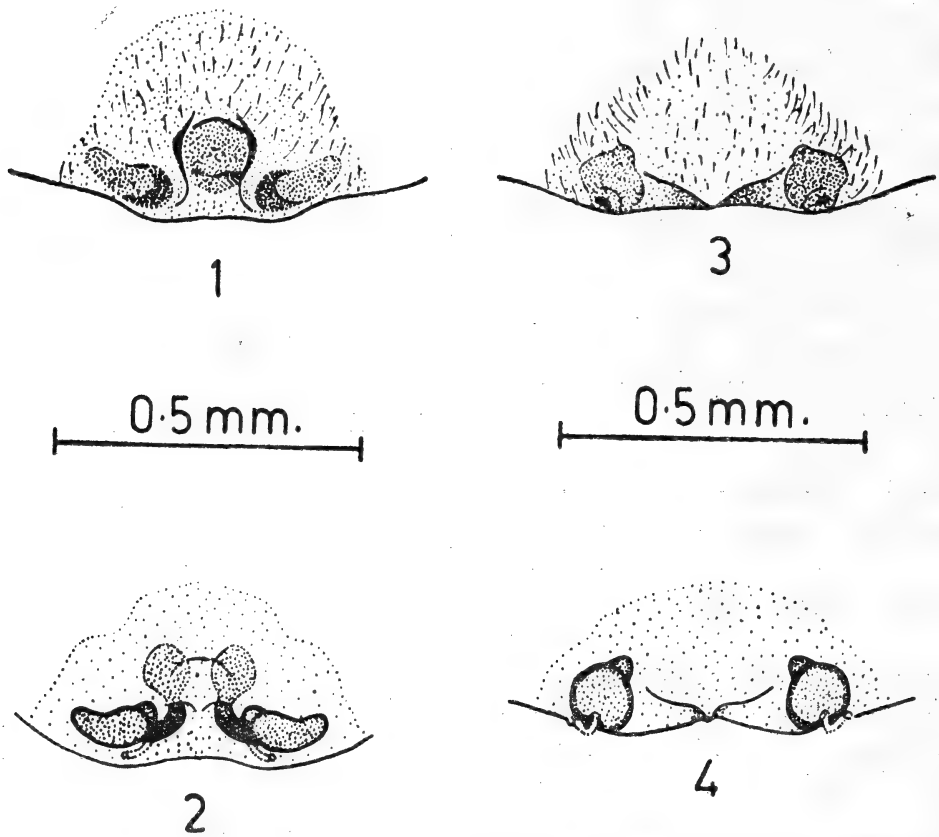
Lutica poonaensis sp. nov.

(Figs. 5-10)

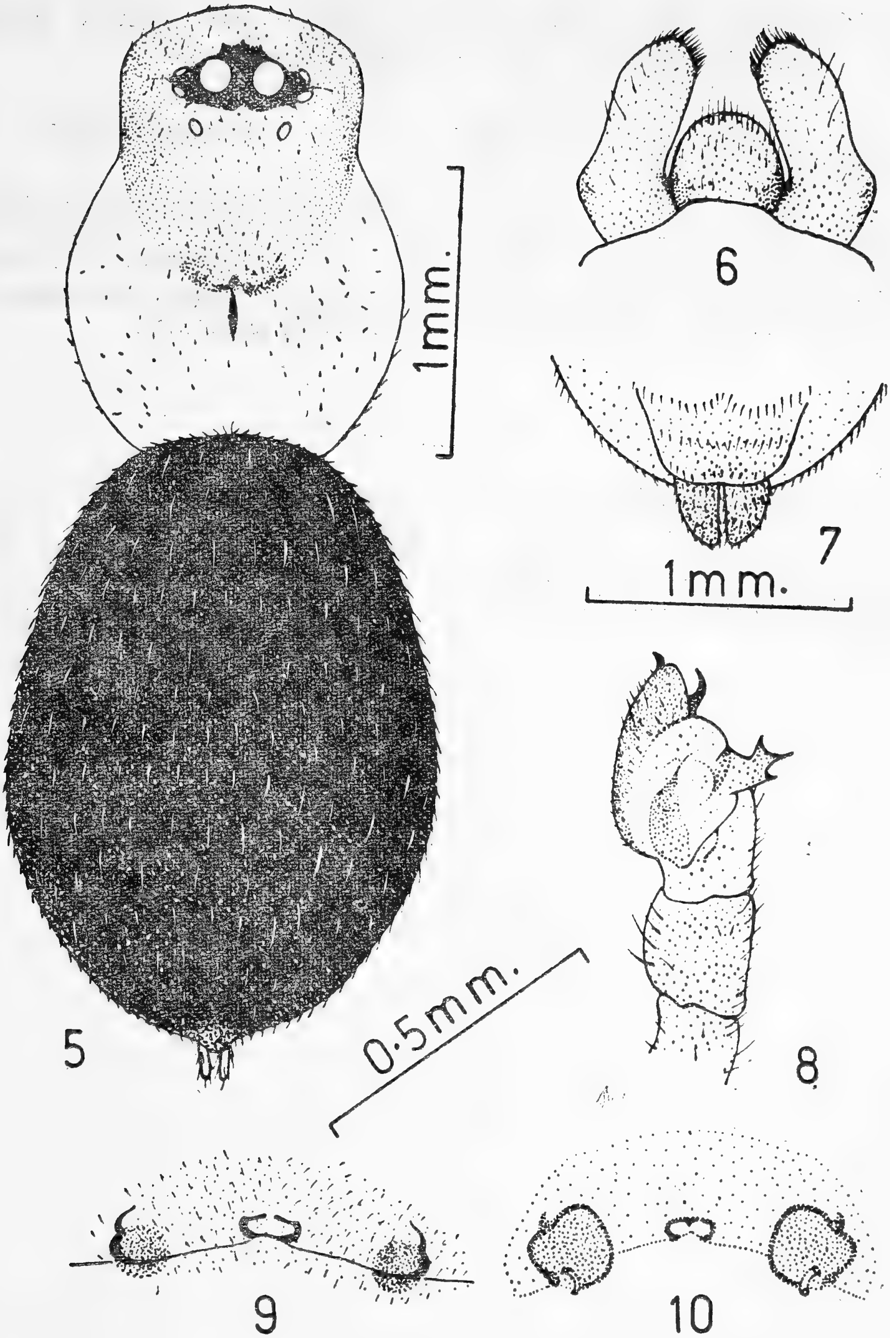
General : Cephalothorax and legs greenish-brown, abdomen deep brown to dark. Total length 3.60 mm. Cephalothorax 1.50 mm long, 1.20 mm wide; abdomen 2.10 mm long, 1.50 mm wide.

Cephalothorax: Longer than wide, cephalic region slightly high and light brown. Eyes pearly white except anterior medians. Anterior row straight or slightly procurved, anterior medians conspicuously larger than others and encircled by deep brown to dark patches. Posterior row strongly procurved and posterior medians widely separated and closer to adjacent laterals. Lateral eyes contiguous. Legs long and moderately strong, clothed with fine hairs. Legs formula 4132. Sternum heart-shaped, pointed behind, clothed with fine hairs. Labium and maxillae as in text-fig. 6. Male palp as in text-fig. 8.

Abdomen: Oval, nearly elliptical in shape, slightly overlapping cephalothorax in front. Dorsal side uniform deep brown to dark colour but ventral side uniform pale colour. Anterior pair of spinnerets conspicuously long and other two pairs not developed properly. Epigyne as in text-fig. 9. Internal genitalia as in text-fig. 10.



FIGS. 1-2. *Lutica deccanensis* Tikader & Malhotra. 1. Epigyne; 2. Internal genitalia. 3-4. *Lutica bengalensis* Tikader & Patel. 3. Epigyne; 4. Internal genitalia.



FIGS. 5-10. *Lutica poonaensis* sp. nov.
5. Dorsal view of female, legs omitted ; 6. Maxillae and labium ; 7. Spinnerets ; 8. Male palp ; 9. Epigyne ; 10. Internal genitalia.

Holotype : One female, internal genitalia in a microvial along with holotype, *paratype* six females, *allotype* four males in spirit.

Type-locality : Flower garden, Poona University compound, Poona, Maharashtra, India. Coll. *B. K. Tikader*, 28-3-1980.

This species resembles *Lutica bengalensis* Tikader and Patel but is separated as follows : (1) Cephalic region more brown to dark than the cephalic region of *L. bengalensis.* (2) Epigyne and internal genitalia also structurally different.

ACKNOWLEDGEMENTS

I am thankful to Shri P. W. Garde and Shri D. J. Kamble, Artists of this station for preparation of illustrations and to Dr. Animesh Bal, for assisting in various ways during the preparation of the manuscript.

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A NEW SPECIES OF *OPHIORRHIZA* (RUBIACEAE) FROM INDIA[1]

J. K. SIKDAR AND G. G. MAITI[2]

(*With six text-figures*)

Ophiorrhiza seshagiriana sp. nov.

O. heterostylae Dunn affinis, sed differt habitu erecto, cymis cum ramulis racemiformibus, pedicellis brevioribus, calycis lobis triangulari-ovatis, glabris, corollae tubo cylindrico non bulboso, antherarum lobisque brevioribus.

Ophiorrhiza seshagiriana sp. nov.

Plant erect, herb to undershrub, Stem woody, glabrous, younger part pruinose. Leaves in unequal opposite pair, lanceolate, 5-11 × 1.5-3 cm, base acute, either equal or unequal ends, apex narrowly acuminate, entire, glabrous, greyish beneath, secondary nerves 5-9 pairs ; petiole 5-8 mm long, glabrous. Stipules subulate-linear from a broad base, 3 mm long, caducous. Cyme mostly terminal, rarely axillary, 1.5-3.5 cm across, with short raceme-like branches having 5-10 flowers ; lateral peduncle pruinose. Flowers 5-merous, 10-11 mm long, tubular with reflexed lobes at blooming, glabrous, white ; pedicel short, about 1 mm long, pruinose ; bracts and bracteoles subulate-linear, 1-2 mm long, persistent in fruit. Calyx cupular, 1.2-1.3 mm long, 5-ribbed, lobes triangular-ovate, acute, glabrous. Corolla tubular, tube 5-6 mm long, cylindric, non-bulbous, glabrous, hairy within above anther lobes upto throat, hairs about 1 mm long ; lobes linear-oblong, 4-4.5 mm long, veins conspicuous, apex keeled inside, pruinose within but glabrous outside. Stamens 5, introse, filament attached 2 mm above from the base, about 0.7 mm long, anthers linear-oblong, about 1.2 mm long, yellowish. Ovary 2-celled, style extrose, filiform, 7-8 mm long, hairy towards base ; stigma clavate, 0.4 mm, bilobed. Capsule (immature) obcordate, about 3.5 × 2.8 mm, compressed, divaricate, glabrous. Seeds not found. (Figs. 1-6).

Flowering time : May.

West Bengal : Jalpaiguri district, Buxaduar Forest Range, on the way to Sinchu from Buxaduar, ± 1800 m, 16.5.1976, *J. K. Sikdar* 4681 A (*Holotype*) and *J. K. Sikdar* 4681 B-E, (*Isotypes*) deposited at CAL.

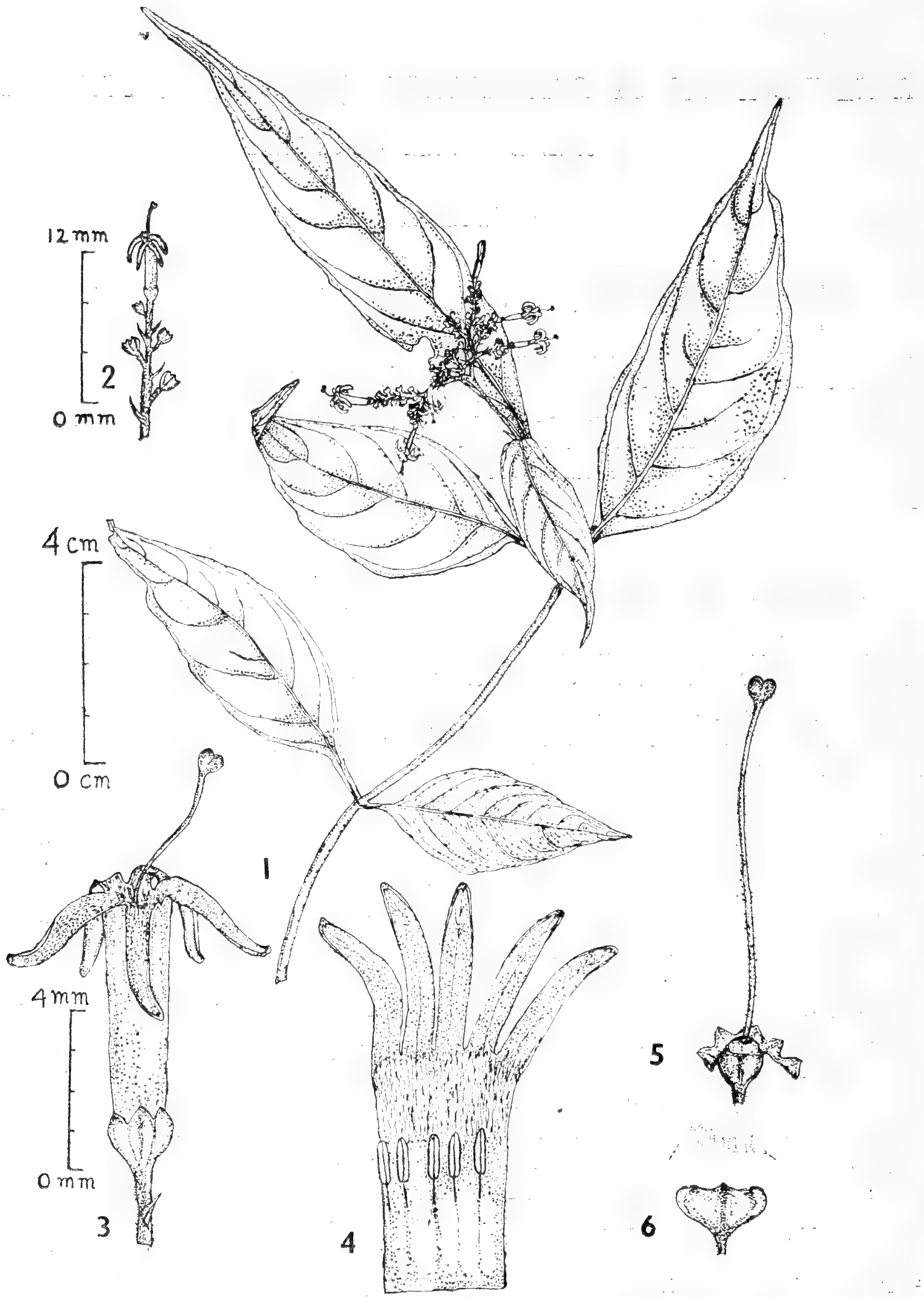
Grows in shady moist situations along rocky forest paths.

It is related to *O. heterostyla* Dunn but can be differentiated by its erect habit, cymes with short raceme-like branches, shorter pedicel, triangular-ovate, glabrous calyx lobes, cylindric non-bulbous corolla tube and shorter anther lobes.

This taxon is very easily recognisable by the presence of reflexed corolla lobes at blooming which is also seen in *O. heterostyla* Dunn, the only other representative of Indian *Ophiorrhiza*. In *O. heterostyla* Dunn heterostylous

[1] Accepted November 1980.

[2] Central National Herbarium, Botanical Survey of India, Howrah-711 103.



FIGS. 1-6 : *Ophiorrhiza seshagiriana* sp. nov.

1. Habit of the plant ; 2. Part of the peduncle ; 3. Flower ; 4. Flower split open ; 5. Pistil ; 6. Fruit (immature).

nature is of common occurrence while in this taxon it is not visible.

This species is being named in honour of Prof. Rolla Seshagiri Rao, Ex-Joint Director in-Charge, Botanical Survey of India and now Prof. and Head of the Department of Botany, Andhra University, for his valuable contributions to Indian Botany.

Acknowledgements

We wish to express our deep sense of gratitude to Prof. R. S. Rao of Andhra University for his valuable guidance and to Dr. K. Thothathri, Deputy Director, Central National Herbarium for all necessary facilities and encouragement. We are also grateful to Dr. N. C. Majumdar, C. N. H. for Latin translation.

A NEW SPECIES OF *CAPPARIS* LINN. (CAPPARACEAE) FROM SOUTH INDIA[1]

G. V. Subba Rao, G. R. Kumari and V. Chandrasekaran[2]

(*With nine text-figures*)

Capparis nilgiriensis sp. nov.

C. brevispinae DC. affinis sed ramulis glabris, foliis glabris non-coriaceis apicibus acutis marginibusque non-recurvatis, nervis haud prominentibus, petiolis canaliculatis marginibus inaequalibus, sepalis interioribus utrinque tomentosis et staminibus paucioribus differt.

Holotypus *Subbarao* 40259 A (CAL) et isotypi *Subbarao* 40259 B-F (MH) lecti apud Chinnacoonoor (950 m) Dist. Nilgiri in statu Tamil Nadu (Madras) die 16-3-1972; paratypi *Subbarao* 42492 A-H (MH) lecti apud Malappurampatti-Chinnacoonoor (950 m) Dist. Nilgiri in statu Tamil Nadu (Madras) die 18-4-1973; paratypi *Shetty* 10215 A-H (MH) lecti apud Kuridimalai (700 m) Dist. Coimbatore in statu Tamil Nadu (Madras) die 5-4-1960; paratypi *Viswanathan* 470 A-E (MH) lecti apud Anaikatty (Papamalai) (760 m) Dist. Coimbatore in statu Tamil Nadu (Madras) die 17-3-1970; paratypi *Subramanyam* 5595 A-J (MH) lecti apud Honey Falls (366 m) Courtallam, Dist. Tirunelveli in statu Tamil Nadu (Madras) die 20-3-1958; paratypi *Subramanyam* 5789 A-F (MH) lecti apud Sirumalai (1000 m) Dist. Madurai in statu Tamil Nadu (Madras) die 26-4-1958.

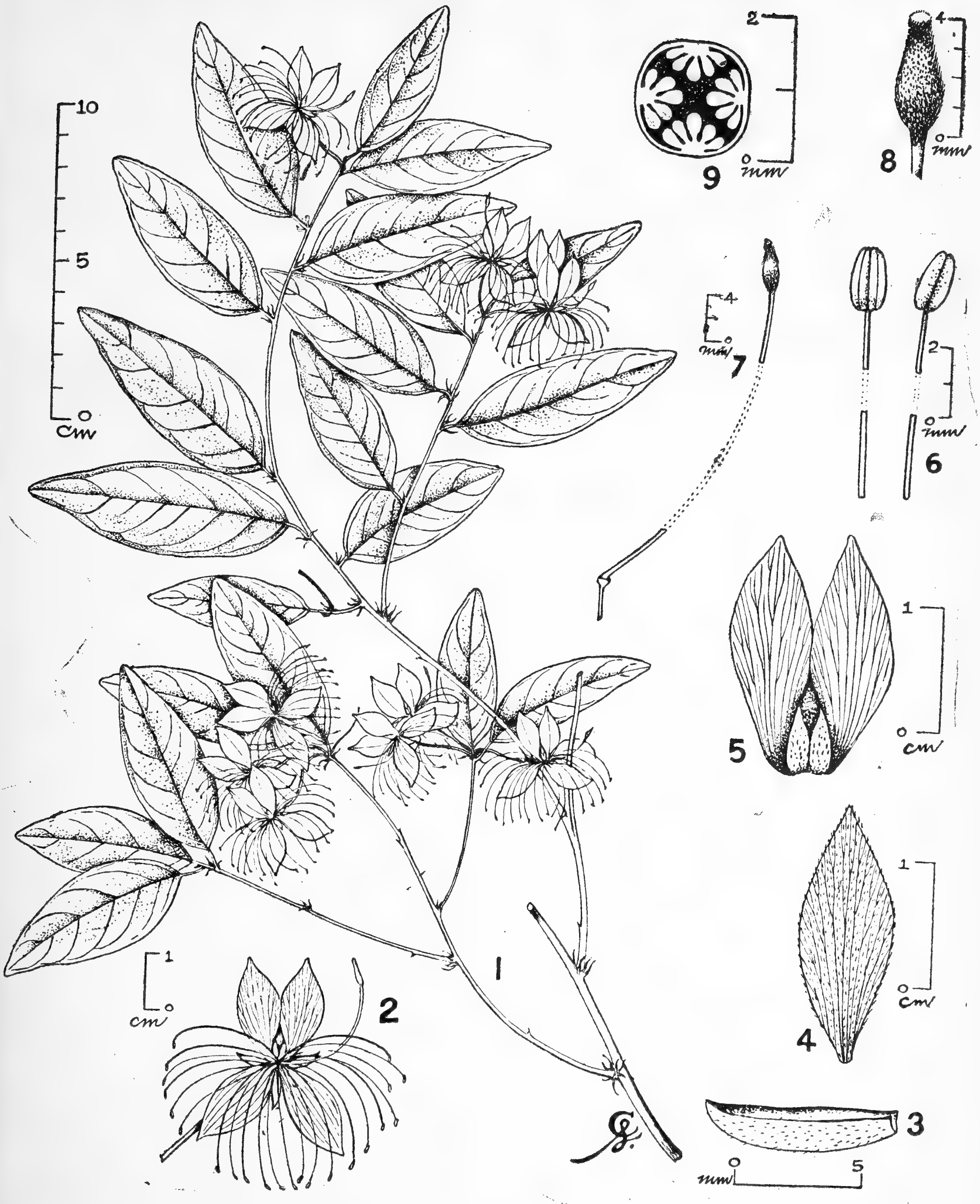
Capparis nilgiriensis sp. nov.

Allied to *Capparis brevispina* DC. but differs from it in: glabrous branchlets; glabrous and non-coriaceous leaves with obtuse tip and non-recurved margins, reticulation not prominent; deeply canaliculate petioles with uneven margins; inner sepals tomentose on both sides and less number of stamens.

Scandent shrubs ± 3 m high; branches irregularly spreading; branchlets terete, glabrous, more or less flexuosus, sparingly armed with slightly ascending small spines on few branches; cataphylls few, linear. Leaves simple, $4.0-11.3 \times 1.5-4.2$ cm, ovate or elliptic to oblong, non-coriaceous, glabrous, margins entire and non-recurved, obtuse or rarely emarginate at apex, almost round at base; nerves 5-7 pairs, looped near margins, midrib and nerves prominent underneath, reticulations not prominent; petioles 6-10 mm long, glabrous, deeply canaliculate with uneven margins. Flowers axillary, upto 4 cm across, solitary or sometimes conferted with upto 4 towards the apex of a twig, lower ones supra axillary; hypsophylls 2.5 — 4 mm long, linear, minutely puberulous, thick, incurved; pedicels 1.5-3.0 cm long, rarely more, slightly dilated at apex, ultimately glabrous. Sepals 4, subequal, concave; outer sepals $7.5-8.0 \times 4.5-5.0$ mm, ovate, obtuse, puberulous outside; inner sepals $7.5-8.0 \times 3.5-5.0$ mm, elliptic to obovate, tomentose on both sides, obtuse, narrowed towards base. Petals 4, white; two lower petals free, $2.1-2.5 \times 0.7-1.1$ cm, elliptic to obovate, tomentose, subacute at apex, narrowed towards base; upper two petals $1.9—2.3 \times 0.6-1.0$ cm, oblong-obovate, tomentose outside, obtuse to subacute, united at base forming inside a tomentose cream

[1] Accepted November 1980.

[2] Botanical Survey of India, Southern Circle, Coimbatore.



FIGS. 1-9. *Capparis nilgiriensis* sp. nov.

1. A twig; 2. Flower; 3. Sepal; 4. Lower petal; 5. Upper petals; 6. Stamens; 7. Gynophore & Ovary; 8. Ovary; 9. C. S. of ovary.

coloured callus. Stamens 16-24, exerted, filaments 2.0-3.0 cm long, glabrous; anthers ±-2 mm long, basifixed. Gynophore 2.0-2.2 cm, glabrous; ovary 3-4 mm long, ovoid or spindle shaped, furrowed, densely pubescent, slightly beaked; ovules many in 4 parietal placentas. Fruit not seen (Figs. 1-9).

The holotype *Subbarao* 40259 A (CAL) and isotype *Subbarao* 40259 B-F (MH) were collected from Chinnacoonoor (950 m), Nilgiri District, Tamil Nadu (Madras State) on 16-3-1972; paratypes *Subbarao* 42492 A-H (MH) were collected from Malappurampatti to Chinnacoonoor (950 m), Nilgiri District, Tamil Nadu (Madras State) on 18-4-1973; paratypes *Shetty* 10215 A-H (MH) were collected from Kuridimalai (700 m), Coimbatore District, Tamil Nadu (Madras State) on 5-4-1960; paratypes *Viswanathan* 470 A-E (MH) were collected from Anaikatty (Papamalai) (760 m), Coimbatore District, Tamil Nadu (Madras State) on 17-3-1970; paratypes *Subramanyam* 5595 A-J (MH) were collected from Honey Falls (366 m) Courtallam, Tirunelveli District, Tamil Nadu (Madras State) on 20-3-1958; *Subramanyam* 5789 A-F (MH) were collected from Sirumalai (1000 m), Madurai District, Tamil Nadu (Madras State) on 26-4-1958.

ACKNOWLEDGEMENTS

We wish to thank Dr. N. C. Nair, Joint Director, Botanical Survey of India, Southern Circle, Coimbatore and the Forest Department of Tamil Nadu for the facilities provided and Rev. Fr. Dr. Cecil J. Saldanha S. J., St. Joseph's College, Bangalore for rendering the diagnosis into Latin.

A NEW SPECIES OF *MAESA* FORSK. (MYRSINACEAE) FROM MEGHALAYA[1]

N. C. MAJUMDAR AND G. S. GIRI[2]

(*With five text-figures*)

Maesa kanjilalii sp. nov.

M. ramentaceae A. DC. maxime affinis sed inflorescentiis perlaxis longioribus, pedicellis usque ad 9 mm longis, floribus majoribus (3-3.5 mm longis), foliorum marginibus irregulariter undulatis statim distinguenda.

Arbor parva, ramuli graciles, glabri, teretes. Folia petiolata, lanceolata, in sicco pallide viridia, utrinque glabra, 12-16 cm longa, 3-4.5 cm lata, chartacea vel membranacea, basi breviter attenuata, apice acuminata, infra medium latissima, ad marginem recurva, parum undulata, cum glandibus albuminatis marginalibus, costa infra prominenti, nervis lateralibus 9-12 paribus, petiolis canaliculatis, glabris, 15-18 mm longis. Inflorescentia axillaris, racemosa, parce ramosa, gracilis, laxa, usque ad 24 cm longa, glabra vel apice perminute puberula. Flores 3-3.5 mm longi, bracteati, bracteae lineares, 1-1.5 mm longae, pedicellus gracilis, usque ad 9 mm longus, glaber, bracteolae 2, ovato-lanceolatae, 1 mm longae, margine parum ciliatae. Sepala 5, valvata, triangulares, 0.75 × 0.5 mm, glabra, ad marginem scariosa, ciliata ad erosa, sine punctis glandularibus. Corolla 5-loba, lobis reniformibus orbicularibusve, 1.5 mm × 1.25-1.5 mm, tubum aequantibus, marginibus undulatis chartaceis, intus glandulari-lineolatis. Stamina 5, corollae lobis opposita, filamenta intus, prope basin tubi affixa, gracilia, glabra, 1-1.5 mm longa, antherae reniformes, 0.5 mm longae, bilobatae, longitudinaliter findentes. Ovarium semi-inferius, globosum, glabrum, ca 1 mm diam., stylo brevi, stigmate tholiformi vel indistincte lobato.

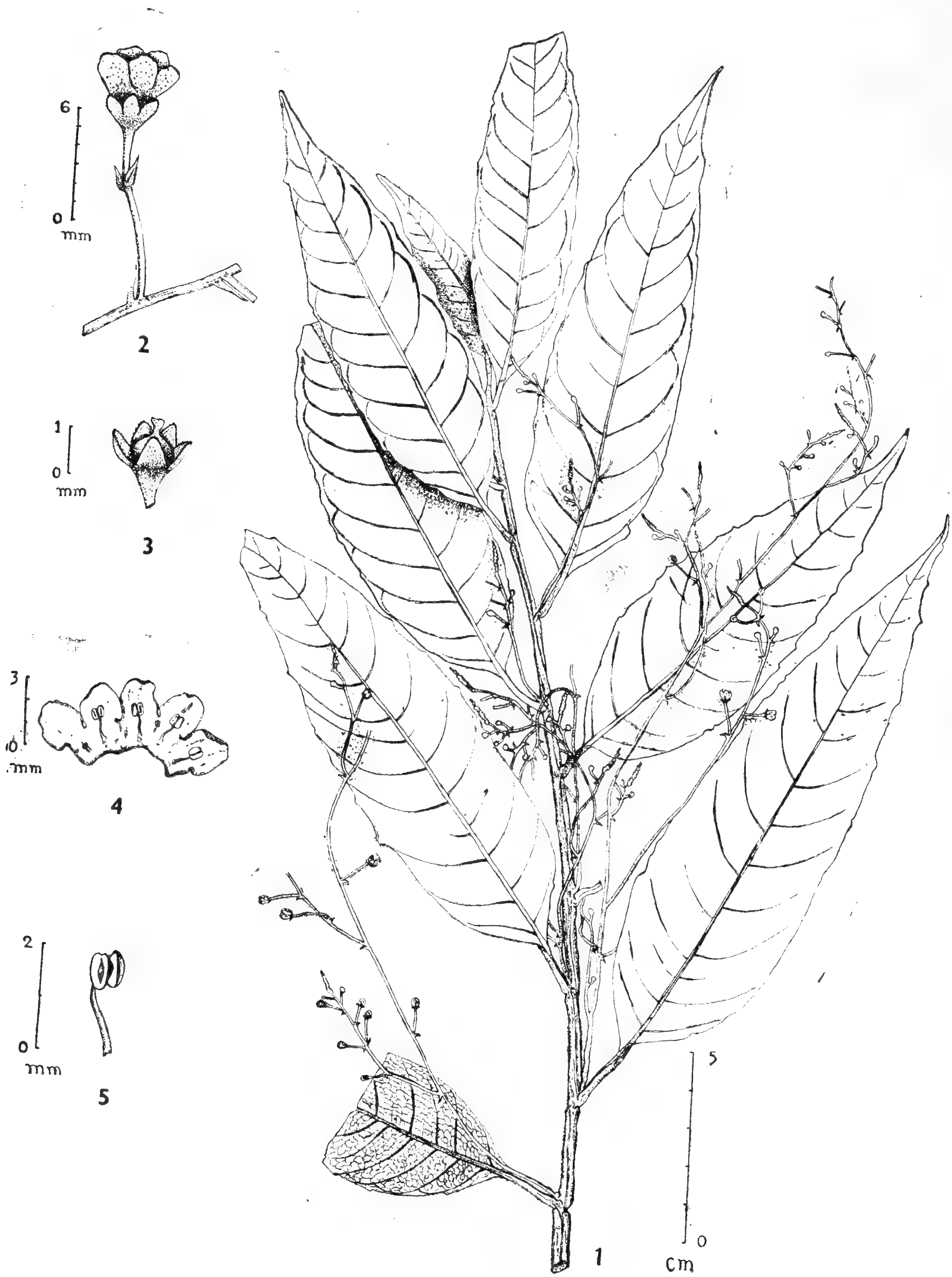
Holotypus lectus ad locum Goahati Road, prope Shillong, Assam, a *P.C. Kanjilal*, die 14-10-1930, sub numero 8684, et positus in herbario indico nationali (CAL).

Maesa kanjilalii sp. nov.

Small tree, branchlets slender, glabrous, terete. Leaves petiolate, lanceolate, pale green on drying, glabrous on both surfaces, 12-16 cm long, 3-4.5 cm broad, chartaceous or membranous, shortly attenuate at base, acuminate at apex, broadest below the middle, margin recurved, slightly undulate with albuminous marginal glands, midrib prominent beneath, lateral nerves 9-12 pairs, petiole canaliculate, glabrous, 15-18 mm long. Inflorescence axillary, racemose, sparingly branched, slender, lax, upto 24 cm long, glabrous or very minutely pubescent at the tips. Flowers 3-3.5 mm long, bracteate, bracts linear, 1-1.5 mm long, pedicel slender, upto 9 mm long, glabrous, bracteoles 2, ovate lanceolate, 1 mm long, margin slightly ciliate. Sepals 5, valvate, triangular, 0.75 × 0.5 mm, glabrous, margin scarious, ciliate to erose, without glandular dots. Corolla 5-lobed, lobes reniform, or

[1] Accepted November 1980.

[2] Botanical Survey of India, Howrah-711 103.



FIGS. 1-5. *Maesa kanjilalii* sp. nov.
1. Habit ; 2. Flower ; 3. Calyx with pistil ; 4. Corolla split open ; 5. Stamen.

orbicular, 1.5 mm × 1.25-1.5 mm, margin wavy, papery, finely glandular-lineolate inside, as long as tube. Stamens 5, opposite corolla-lobes, filaments inserted within, near the base of the tube, slender, glabrous, 1-1.5 mm long, anthers reniform 0.5 mm long, bilobed, longitudinally split. Ovary semi-inferior, globose, glabrous, nearly 1 mm diameter, style short, stigma dome-shaped, or very indistinctly lobed.

Holotype : Gauhati Road, 6 to 7 miles from Shillong, Assam, 14-10-1930, *P. C. Kanjilal* 8684 (CAL).

Distribution : India : Meghalaya.

This new species is closely allied to *M. ramentacea* A. DC. but can be easily distinguished by its longer, very lax inflorescence, long pedicels (7-9 mm), larger flowers (3-3.5 mm), and irregularly wavy leaf margins, whereas *M. ramentacea* is characterised by shorter inflorescence (nearly half as long or rarely as long as leaves), shorter pedicels (1-2 mm), smaller flowers (2 mm) and entire leaf-margins.

The species is named after its collector, *P. C. Kanjilal.* It was identified as *Maesa ramentacea* Wall. by D. Chatterjee at Kew who pointed out some difference in inflorescence and indicated the possibility that it could be a variety of that species. We, however, have discovered several other differences as pointed out above, which are adequate to distinguish it in the specific rank.

MISCELLANEOUS NOTES

1. SOCIAL CHANGES IN THE HANUMAN LANGUR, *PRESBYTIS ENTELLUS* AROUND JODHPUR

Social changes is a usual phenomenon in mammals and it is a natural process of maintaining a species specific character like group size and structure in relation to their environment. The movement of individuals between groups have been recorded in a wide variety of primate species (Itani 1972). Drickamer and Vessey (1973) suggest that age, mating season, sex ratios of adults in the social groups and geographical barriers, all affect the group change behaviour. This paper reports the various types of social changes that occurred in langur groups, *Presbytis entellus* Dufresne in a period of two years (From August, 1975 to July, 1977) at Jodhpur (26°19′N lat. and 73°8′E long.), which lies at the eastern fringe of the Great Indian Desert (*see* Mohnot 1971 for details of habitat).

Social changes can be grouped in two main headings : *gradual* and *drastic changes*. The former includes births, deaths, leadership change and movement of weaned male juveniles. The latter includes epidemics, fission and fusion of two groups and replacement of dominant male preceded and followed by infant killings. Thus groups are constantly being rearranged in a variety of ways and there are considerably social changes in this respect. The following five types of changes described here are as follows :

(*i*) *Change of leadership* (Table 1) : It is the most common process in bisexual groups and resulted by attack from neighbouring all-male bands. A total 10 such cases were recorded in 8 groups out of 15 (twice in two groups), while there was no change of leadership in 7 groups. In two groups, Kaga A and Kaga B, a second change was noted during the two year period. Of these only one change was followed by infanticides (Makwana 1979).

(*ii*) *Fission of group* : Only one such case was noted in 'Ficus' group during February to July 1977. Originally it was a bisexual unimale group of about 30 individuals in February 1977. During April 4 and 5, an all-male band of 6 (5 adults and 1 subadult) attacked this group and absorbed 6-8 adult and one subadult females and their young. The resident male was observed about 50 m away with remaining members (females and their young).

On July 14, a new male was observed with 8 adult and 1 subadult females, 2 juvenile females, one older infant female and one black coated baby. The resident male and its group was seen no longer (supposed to have shifted elsewhere).

(*iii*) *Fusion of two groups* : The two neighbouring unimale bisexual groups, SC and SH fused into one, and the following events occurred in this process :

(*a*) During first observation period (August-December 1975) these were two independent, unimale bisexual groups. The group SH was smaller in size and subordinate to the SC group (*See* Table 2 for composition).

(*b*) In Februay 1977, during second observation period, the leader of SH group (H1) was no more and the leader of SC group (C1) was visiting both the groups. One more adult male (H2) was noted twice with SC group, but it was subordinate to male C1 and fear grimaced and retreated at his approach.

TABLE 1

SOCIAL CHANGES IN LANGUR, *P. entellus* AT JODHPUR (1975 TO 1977)

S.No.	Group	Leader male in 1975 (Aug.-Dec.)	1976	1977 (Feb.-July)	Remarks
1.	Bijolai	.. M-1	?	M-2	Leader changed in February, 1977.
2.	Kailana	.. M-1	M-1	M-1	No change of leader
3.	Chopar	.. M-1		M-1	-do-
4.	Sursagar H	.. M-1	?	M-2	Leader changed in February 77, and disappeared by the end of February.
5.	Sursagar C	.. M-1		M-1	Sursagar H group fused with this group in last week of April, 77.
				M-2	Male 1 changed on 30 May, 77 (*See* Text)
6.	Kaga-S	.. M-1	?	M-2	Leader changed in March, 77.
				M-3	Male 2 also changed on 5th May, 77 and followed by infanticides.
7.	Kaga-N	.. M-1	?	M-2	Leader changed in March, 77.
				M-3	Male 2 also changed on 5th March, 77.
8.	Nagadari	.. M-1	?	M-2	Leader changed in May, 77.
9.	Nagadari A	.. M-1		M-1	No change of leadership.
10.	Rest House	.. M-1		M-1	-do-
11.	Rest House A	.. M-1	?	M-2	Leader changed in May, 77.
12.	Vidyasal-A	.. M-1 (Multimale group)	?	M-1 (Unimale (group)	Became unimale from multimale and roosting site changed.
13.	Vidyasal-B	.. M-1		M-1	No change of leadership. Roosting site changed.
14.	Kadamkandi-A	.. ..	..	M-1 M-2	Leader changed in June, 77.
15.	Ficus	.. ..	..	M-1	Original male left the area during last week of February with some females and
				M-2	their young ones. (Fission of a group, see Text).

During last week of February there was only C1 male and the other new male was supposed to have left the group.

(*c*) During March and last week of April, both the groups foraged together under leadership of C1 male but roosted differently at their original roosting sites. The male C1, roosted with SC group and SH group roosted without adult male.

Two adult females and one juvenile male disappeared from the SH group. Of these one adult female and juvenile male were observed in a neighbouring unimale bisexual group.

(*d*) During last week of April, both the groups not only foraged but also roosted together, under the leadership of male C1. Thus, the process of fusion of two neighbouring bisexual groups was completed (Table 2). The fused group was headed by male C1 for about two months (May and June 1977).

TABLE 2

P. entellus, COMPOSITION OF SC AND SH GROUPS DURING 1975 AND 1977

Period	Group SC					Group SH				
	Total	Ad. ♂	Ad. ♀♀	Ju.	Inf.	Total	Ad. ♂	Ad. ♀♀	Ju.	Inf.
October, '75	26	C1	12	5	8	11	H1	8	1	1
February, '77	24	C1	14	1	8	14	..	8	2	4
April, '77	20	C1	10	4	5	19	..	9	2	8
May, '77	33	C1	17	6	9	..	..	..	..	..
July, '77	33	C2	17	7	8	..	..	..	..	..

(*e*) In last week of June, the male C1 was replaced by a new male C2 from a neighbouring all-male group. There might have some fight between male C1 and C2, as the latter had a fresh injury at his right eye. A band of 5 adult males were also observed around the group after the take-over.

Both the groups were still mixed and roosted together with the new male. Thus the fusion of two groups, and then change in leadership occurred.

(*iv*) *Formation of unimale bisexual from multimale bisexual type* : Group Vidyasal-A, whose size was about 45 and comprised of a number of adult females, juveniles, infants, 3 adult and 2 sub-adult males during October 1975. There was linear dominance hierarchy among the males. In February 1977, the group remained unimale bisexual type with only 22 individuals (Adult male 1, adult females 15 and young ones 6).

(*v*) *Change of groups* : Mostly males in juvenile stage change or leave their original group due to high pressure or hostility of leader male. Occasionally adult females also leave their group, mainly when they are not sexually satisfied by their own leader. Two adult females in two different groups were noted to change their group in a neighbouring bisexual group. Juvenile males mostly join all-male bands or occasionally also a neighbouring bisexual group.

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2. SOME NOTES ON THE LONGEVITY OF TWO SPECIES OF INDIAN WILD CATS IN CAPTIVITY

The present communication deals with some notes on the longevity of two species of Indian Wild Cats observed at the Nandankanan Biological Park, Orissa.

Golden Cat : (*Felis temmincki*) : One full grown male of this species received in the Park on 21-7-1966 died on 18-7-1979, after remaining for 12 years, 11 months and 27 days in captivity. The estimated age at the time of death was about 15 years. It was living with one or two female specimens of the same species. It was housed in an enclosure having cemented floor space of approximately 16.5 sq. metres, height 2.80 metres. There was a two chambered cave like retiring den within the enclosure where the golden cats use to stay throughout the day. It was fed with 750 gm of goat meat and 250 gm of beef with bones six days in a week and only 375 gm of goat meat once a week. One live chicken was given once a month in place of its usual diet of goat meat and beef.

According to Crandall (1965) this species of cat has not done well at the New York Zoological Park and none survived for more than 2 years and a golden cat lived for 17 years, 8 months and 25 days at St. Louis Zoological Park. The longevity of this cat in the Zoological Gardens of London is given as 10 years, 9 months and 3 days (Flower 1931).

Clouded Leopard : (*Neofelis nebulosa*) : One full grown adult female clouded leopard received in the Park on 29-4-1966 died on 9-2-1980, after 13 years, 9 months and 12 days in captivity. The estimated age at the time of death was about 15 years. It was kept along with either one male and / or one female specimen of the same species. They were housed in a semi out-door enclosure having an area of approximately 48 sq. metres, height 2.80 metres. There were two spacious retiring cells within the enclosure. The animal maintained very good health on a diet of 1 kg goat meat and 100 gm beef with bones daily for six days in a week and only 500 gm goat meat once a week. One live chicken was given once a month instead of its usual diet of goat meat and beef.

At the New York Zoological Park none of the clouded leopards survived for long, the best record of longevity being 4 years and 8 months. A clouded leopard lived for 10 years, 8 months and 3 days in the San Diego Zoological Garden (Crandall, loc. cit). The longevity of this species in the National Zoological Park is given as 15 years, 10 months and 19 days whereas the longevity of this species in the Philadelphia Zoological Garden is given as 16 years, 11 months and 1 day (Jones 1958).

We would be interested in the longevity records of these two species of wild cats in other Indian Zoological Parks.

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3. CAUSES OF DEER MORTALITY IN INDIA

In India the information on causes of mortality in deer in free living state or captivity is very meagre. There have been reports of occasional episodes of Rinderpest (Schaller 1967, Srivastava 1957, Singh 1958, Gupta and Verma 1949, Ray and Samanta 1974), tuberculosis (Liston and Soparkar 1924, Basak *et al.* 1976); fascioliasis (Rao and Acharjyo 1972) etc. Isolated cases of parasitic infestations and other miscellaneous conditions have also been recorded (Rao and Acharjyo 1972, Rao and Acharjyo 1969, Tripathi *et al.* 1971, Patnaik and Acharjyo 1970, Sen Gupta 1974). This paper records the causes of mortality among various species of deer in Zoological Parks, National Parks, Sanctuaries and reserve forests in different parts of the country.

MATERIALS AND METHODS

In an attempt to determine the relative importance of various diseases to which members of cervidae family are prone to suffer and the causes of mortality, a countrywide survey was conducted. The mortality information for three years period (1975-1977), based on post mortem examinations was obtained from fifteen Zoological Parks (Bhillai, Bombay, Darjeeling, Delhi, Hyderabad, Junagadh, Kanpur, Kohima, Mysore, Pune, Renuka, Shillong, Silvassa, Tutikandi and Visakhapatnam); two national parks (Corbett and Shivpuri); one Sanctuary (Kinnersanni) and reserve forests in two states (West Bengal and Jammu and Kashmir). Information on the species of dead animal and date of death was also collected. Information was sought also on total populations of each species, sex and age at death of each animal, but the provided information was not complete and therefore, could not be used.

RESULTS AND DISCUSSION

During the three year period 1975-1977, a total of 243 deaths had been recorded in eleven species of deer which included 107 Chital (*Axis axis*); 29 hog deer (*A. porcinus*); 40 barking deer (*Muntiacus muntjak*); 4 musk deer (*Moschus moschiferus*); 3 fallow deer (*Dama dama*); 28 sambar (*Cervus unicolor*); 8 thamin (*C. eldi*); 2 Kashmir stag (*C. elaphus hanglu*); one swamp deer (*C. duvauceli*); 14 mouse deer (*Tragulus meminna*) and 7 Sikka deer (*Cervus nippon*). Out of these, Kashmir Stag, Musk deer, Swamp deer and Thamin deer are endangered species and hence have been included in Schedule I of Indian Wildlife Protection Act, 1972. Fallow deer (*Dama dama*) and Sikka deer (*C. nippon*) are exotic species and are being displayed in various Indian Zoos. Sikka deer has also been listed as endangered species. Out of 243, 32 deaths occurred of animals in free living state in national parks, sanctuaries and forests and the remaining among animals in the zoological gardens.

Causes of mortality :

As shown in table 1, tuberculosis was quite a frequent cause of mortality in captive chital,

TABLE 1

RECORDED CAUSES OF DEATH IN DIFFERENT SPECIES

Causes of death	Spotted deer	Barking deer	Hog deer	Sambar	Mouse deer	Sikka deer	Musk deer	Fallow deer	Thamin deer	Kashmir stag	Swamp deer	Total
1. Tuberculosis ..	16	01	—	—	—	—	—	—	—	—	—	17
2. Anthrax ..	02	02	—	—	—	01	—	—	—	—	—	05
3. Pasteurellosis ..	—	—	—	—	—	—	01	—	—	—	—	01
4. John's disease ..	—	—	—	—	—	—	—	—	—	01	—	01
5. Fascioliasis ..	12	—	02	—	—	—	—	—	—	01	—	15
6. Pneumonia ..	13	—	04	04	01	—	02	01	—	—	—	25
7. Gastroenteritis ..	03	03	—	01	01	02	—	—	—	—	—	10
8. Dystokia ..	02	01	—	01	03	—	—	—	—	—	—	07
9. General debility and anaemia ..	06	01	04	06	02	—	—	—	04	—	—	23
10. Captivity stress/heat stress ..	07	—	—	—	—	—	—	01	—	—	—	08
11. Injury ..	35	26	10	09	02	02	—	—	03	—	—	87
12. Miscellaneous ..	11	06	09	07	05	02	01	01	01	—	01	44
TOTAL ..	107	40	29	28	14	07	04	03	08	02	01	243

whereas not a single case was recorded in free living state. Out of 17 cases of tuberculosis, 16 were recorded in Chital alone, which indicates their high susceptibility to tuberculosis in captivity. It would appear that the tuberculosis in deer is directly related to the conditions of captive environment and prevalence of this disease among other animals in the zoological gardens. In many of the Zoos, cases of tuberculosis had occurred also among other zoo animals. Unfortunately, the exact typing of the tubercle bacilli associated with the disease in Chital and other zoo animals had not been done. Therefore, the type of causative organism, source and the channels of transmission of infection could not be ascertained.

Cases of Anthrax were recorded in spotted deer at Visakhapatnam Zoo (two cases), barking deer at Kohima Zoo (two cases) and Sikka Deer at Delhi Zoo (one case). Anthrax is essentially a soil borne infection. However, the infection can be transmitted through contaminated food or fodder from farms or places with a history of Anthrax. Certain birds have been found to carry spores of *Bacillus anthraxis* in their alimentary tracts, and hence can disseminate the infection.

A Kashmir stag was recorded to have died of Johne's disease. Darjeeling zoo experienced an outbreak of Pasteurellosis in 1975-76 in which eight red Pandas (*Ailurus fulgens*) and one musk deer died.

An outbreak of fascioliasis was recorded at Corbett National Park in January, 1975 in which 12 chital and two hog deer died in the vicinity of the water reservoir. Fascioliasis has been reported to occur in wild animals in areas which support snail populations.

Among the non-specific diseases, pneumonia and general debility and anaemia were responsible for 10.2 per cent and 9.8 per cent of the total deaths, respectively. The cases of general debility and anaemia were recorded in both captivity and feral state. Probably the nutrition available to the animals in forest and captivity is deficient qualitatively and or quantitatively which requires thorough investigation. Other disease conditions recorded were gastro enteritis (10 cases), dystokia (7) and Captivity stress/heat stress (8).

It has been reported that the incidence of deaths due to injuries resulting from accidents, fighting or during capture operations for treatment or managements purposes is quite high. In this survey about 35 per cent of total deaths were attributed to injuries of various origin. Frequency of these deaths can perhaps be brought down by improvement in zoo management methods by using tranquilizers.

A number of deaths due to non-specific and undetermined causes were also recorded which have been included in miscellaneous causes. The causes of death included in this category were senility (11), snake bite (2), nephritis (1), pericarditis (2), drowning (2), hepatitis (2), thrombosis (1), toxemia (1), dermatitis (2), and undetermined causes (20).

Most of the disease conditions recorded as the cause of mortality based on the post-mortem findings could be due to variety of aetiological agents. For specific aetiological diagnosis, it is highly desirable to seek laboratory support because identification of specific agents of disease will provide a more rational basis for chemotherapy and also for planning suitable measures of prevention and control in the future.

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4. REPRODUCTIVE BIOLOGY OF THE SPINY FIELD MOUSE, *MUS PLATYTHRIX*

(*With a text-figure*)

Introduction

Since the biology of *Mus* in India is poorly known, intensive study was carried out on *Mus booduga* around Tirupati (Rao 1977). A number of *Mus platythrix* were also collected and studied during the course of field work during 1975 and 1976. In this paper results of the study on reproductive biology are presented and compared with Chandrahas's (1974) results of work done at Kolar (Karnataka).

Material and Methods

Monthly collections of *Mus platythrix* were made during 1975 and 1976, in crop fields around Tirupati (13°36′ N, 79°23′ E) by excavating the burrows. The rodents were sexed and dissected for recording pregnancy, lactation, embryo numbers and number of corpora lutea. Male animals were considered to be participating in reproduction activity if they had scrotal testes (Rao 1979). The croplands had groundnut (July to November) and paddy (July to October and in part January to April also) as the major crops. The area received rainfall (mean annual = 1085 mm) during May to December. The data was pooled for both the years.

Observations and Discussion

Male fecundity :

Fecund males were found from August to April next (Fig. 1), which corresponds with the pregnancy cycle of females. Except in the month of November, the breeding rate gradually increased from August till December and then declined gradually till May. Chandrahas (1974) has reported that they breed from August to March at Kolar.

Female fertility :

Pregnant females were found from September to March next. There was also a gradual increase in the per cent pregnant females from the month of September till November declining thereafter (Fig. 1). It is interesting to observe that the numbers of fecund males and pregnant females run parallel to each other throughout the year.

Litter size:

Fifteen samples of litters yielding 57 young ones were picked up by excavating the burrows during the study period. The litter size varied from 2 to 7, the average being 3.8. Litters of large size (having 7 embryos) were collected from the fields in October and December (Table 1).

Table 1

Distribution of litters of various sizes in the monthly field-collections of *Mus platythrix* during 1975 and 1976

Month	Size of litter				Total No. of young ones	No. of lactating females	Mean young per litter
	2	3	5	7			
January	0	2	1	0	11	3	3.66
February	0	0	0	0	0	0	0
March	1	0	0	0	2	1	2.00
September	0	0	1	0	5	1	5.00
October	0	1	1	1	15	3	5.00
November	1	3	0	0	11	4	2.75
December	0	2	0	1	13	3	4.33
Total					57	15	3.80

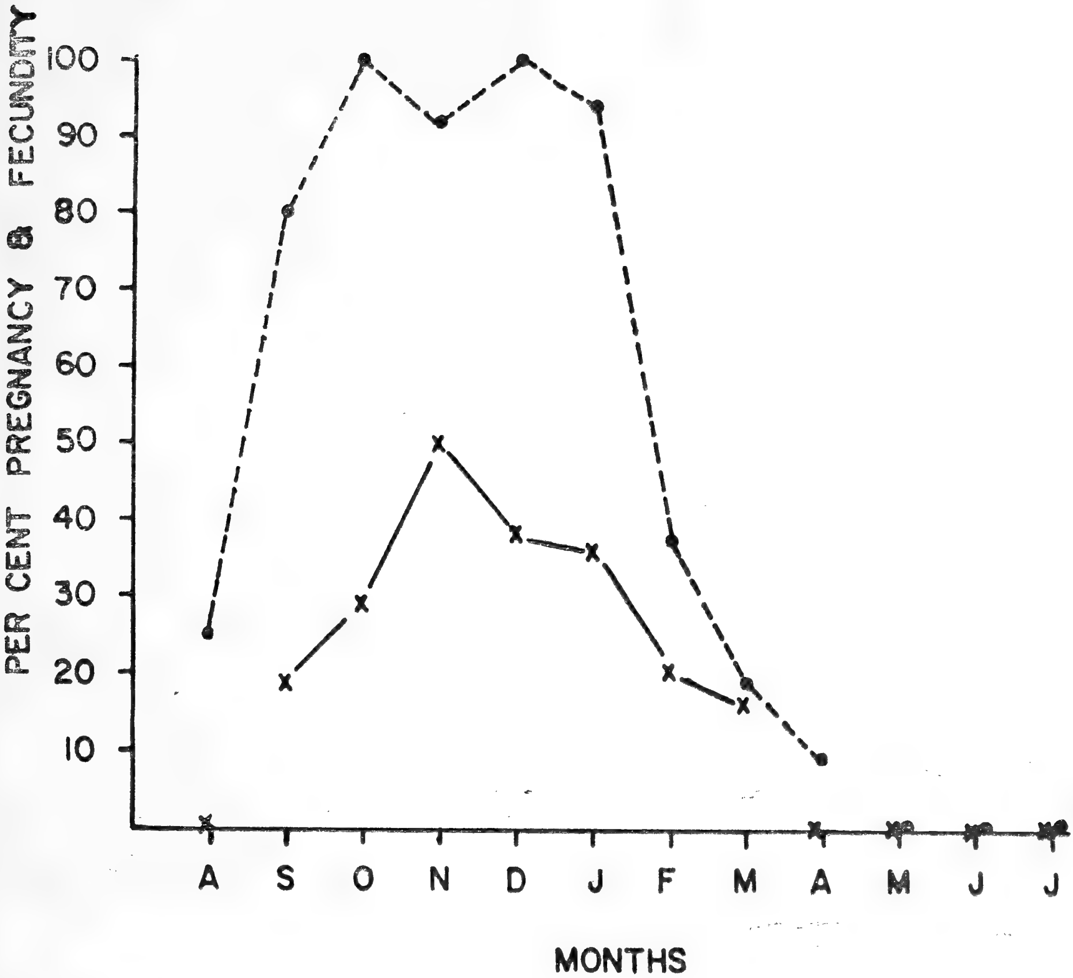

Fig. 1. Per cent female *M. platythrix* pregnant and male fecund during the year.
● - - ● Males fecund. x — x Females pregnant.

The frequency of occurrence of litters of 2 and 3 young ones was relatively common. Chandrahas (1974) has reported the litter size as ranging from 5 to 8.9, the average being 7.6. Prakash (1971) reported that the litter size in *Mus platythrix sadhu* varied from three to ten in the Rajasthan desert.

Observations on implanted embryos

Twenty two pregnant females of *M. platythrix* were examined during the course of studies with 100 visible embryos. The litter size ranged from 2 to 8, the mean being 4.54 per pregnant female. Embryos of 4 and 6 had the maximum frequency (Table 2). The litter size in the present investigation was less than the litter size of the spiny mice reported by Chandrahas (1974). In the present study right horn was found having less number of embryos (1.50±1.00) than the left uterine horn (3.05±1.13), the difference being statistically significant ($P<0.001$).

TABLE 2

DISTRIBUTION OF EMBRYOS OF VARIOUS SIZES IN THE MONTHLY COLLECTION OF *M. platythrix* DURING 1975 AND 1976

Month	Size of litter 2	4	5	6	8	No. of embryos resorbing	Total No. of implanted embryos	No. of pregnant females	Mean embryos per female
January	1	1	1	1	0	2	17	4	4.25
February	0	1	0	0	0	0	4	1	4.00
March	0	1	0	0	0	1	4	1	4.00
September	1	2	0	0	0	0	10	3	3.33
October	0	2	0	1	1	3	22	4	5.50
November	1	3	0	0	1	1	22	5	4.40
December	0	1	1	2	0	0	21	4	5.25
Total						7	100	22	4.54

Pre-natal mortality

The counting of the freshly formed corpora lutea in the ovaries of pregnant females indicated that the production of ova ranged from 5.00 to 6.50 per pregnant female, the mean being 5.98 (Table 3). There was no significant difference in the magnitude of pre-implantation mortality during various months of breeding season. Maximum loss per female was observed in September when the food is abundantly available to the mice. The intensity of loss was more in the right ovary. The post-implantation loss was maximum in October and January (Table 2). The embryos towards the cervix were always found resorbing but never the ones towards fallopian tube. The resorbing embryos were observed in female with larger litter size only. This resorption may be an intrinsic physiological mechanism regulating the mouse numbers.

Annual productivity

By applying the formula of Lechleitner (1959) the annual breeding potentiality of the spiny mouse is calculated. Considering the gestation period of *M. platythrix* as 21 days (Chandrahas 1974), a female can produce 10.09 litters in a breeding season. Correcting this figure by multiplying by the mean prevalence of pregnancy the figure is reduced to 3.03/litters/female/ breeding season. Converting it to ova produced per female the annual productivity of the female mice comes to 18.11. If pre-natal mortality (6.9% pre-implantation and 25.7% post-implantation) is accounted, the figure is corrected to 18.11—0.33=17.78 young per female per year.

Breeding season

It is interesting to observe that the scrotal males occurred in August and soon after in September pregnant females are found in the population. Thereafter the peak in the reproductive activity of both the sexes continues from October to January, during winter (Figure 1). Chandrahas (1974) also observed a similar cycle in *Mus* at Kolar. Most of the tropical mammals litter during winter months since during monsoon, possibly, due to excessive rains, marshy conditions prevail and the environment is not, therefore, conducive for the survival of litters of the terrestrial animals. It

TABLE 3

PRE-IMPLANTATION LOSSES IN *Mus platythrix*

Months	Number of embryos				Number of corpora lutea				Pre-implantation losses			
	Right horn	Left horn	Total	Mean ± S.D.	Right horn	Left horn	Total	Mean ± S.D.	Right horn	Left horn	Total	%
January	5	12	17	4.25 ± 1.71	11	13	24	6.00 ± 0.82	6	1	7	29.2
February	0	4	4	4.00 ± 0	2	4	6	6.00 ± 0	2	0	2	33.3
March	1	3	4	4.00 ± 0	1	4	5	5.00 ± 0	0	1	1	20.0
September	3	7	10	3.33 ± 1.16	7	10	17	5.66 ± 0.58	4	3	7	41.1
October	0	13	13	5.50 ± 1.92	12	15	27	6.50 ± 1.29	2	2	4	15.3
November	8	14	22	4.40 ± 2.19	13	18	31	6.20 ± 1.10	5	4	9	29.0
December	8	13	21	5.25 ± 0.96	12	14	26	6.50 ± 0.57	4	1	5	19.2
Total	25	66	91	4.54 ± 1.01	58	78	136	5.98 ± 0.62	23	12	35	25.7

appears also that the quality of the food available in post monsoon months may trigger the breeding activity. The availability of paddy and groundnut in the post monsoon months in the study area confirms this presumption. On the other hand, however, the breeding activity of the Indian desert mammals, inclusive of *Mus* species, is at the maximum during monsoon due to prevalence of favourable temperatures and availability of nutritive green food (Prakash 1960, 1971). Though Tirupati region falls under semi arid zone, yet the *Mus platythrix* breeds during winter like typical tropical mammals, which is interesting.

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5. WHITE PATCH AND ITS GENETIC CONTROL IN SOME OF THE INDIAN RODENT SPECIES

The albinism and colour variations in the rodents of the Indian sub-continent were reported earlier in some of the taxonomic literature dealing with Indian rodents. The occurrence of a diamond shaped white patch on the ventral surface of a house rat, *Rattus rattus rufescens* has also been reported recently (Joshee 1961, Deoras and Mithel 1974). But this fact was overlooked, because the stress was given more on the epidemic studies rather than on its genetical consideration. The fact that a white patch was seen, though very rarely, even in the field rats of the species of *B. indica* (Pradhan 1975), attracted my attention towards the subject. Some specimens of the species *R. r. rufescens*, possessing two white patches on the ventral side were also collected.

A pregnant female rat, *R. r. rufescens*, possessing a white patch (henceforth W.P.) on the pectoral region was caught alive and kept in a cage under observation. The female gave birth to four young ones possessing white patches. Attempts to breed and continue this generation further failed due to their premature deaths. But when the karyological studies were conducted in these true typical rats, an interesting fact came to light. Though *R. r. rufescens* (W.P.) has 2n=38 chromosomes, its karyomorphology varies from that of ordinary *R. r. rufescens*. *R. r. rufescens* (W.P.) lacks one pair of graded metacentric chromosomes and possesses one extra pair of graded telocentric chromosomes than those present in *R. r. rufescens* (Table 1).

Now it seems from the above observations that the possibility of the genetic control over the occurrence of white patch cannot be ruled out. Davis and Baker (1971) have shown that the change in the morphology of some of the rat chromosomes controls the colour variations. Besides, the white patch of similar kind has also been reported in other rodent species. Therefore we feel that the polymorphism of some typical nature in the karyomorphology may be playing some important role in controlling the expression of white patch in rodents.

TABLE 1

KARYOMORPHOLOGY OF *R. r. rufescens* WITH AND WITHOUT W.P.

Species	Diploid No.	*Large Meta-centric	*Sub-Telo-centric	*Graded Telo-centric	*Graded Meta-centric
R. r. rufescens	38	2	1	8	8
R. r. rufescens (W.P.)	38	2	1	9	7

* Figures in pairs.

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6. ON THE OCCURRENCE OF THE WHITETAILED SEA EAGLE *HALIAEETUS ALBICILLA* (LINNAEUS) AT CHILKA LAKE

We recently spent a couple of days bird watching at Chilka lake in Orissa (23rd to 25th February 1979).

While driving upto Barkul Point from Ramba Guest House, we had seen a whitetailed sea Eagle on 24th February near the Naval Establishment junction.

The visibility was near perfect and the bird was seen flying to our left against greenish mountainous background at a height of about 300 m. The prominent white and short tail and the broad wings matched perfectly with the description given in the HANDBOOK (Volume 1 : 286).

Again on 25th February one of us (KSRK) had a very clear sight record of the bird near Barkul point; perhaps the same single individual which we had seen the day before.

The HANDBOOK mentions only a single record in India from Punjab.[1] Our sighting confirms the occurrence of this bird in Orissa also.

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K. S. R. KRISHNA RAJU

VICE-CHANCELLOR,
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VISAKHAPATNAM-530 003,

M. R. APPARAO

July 1, 1979.

[1] The distribution has been updated in the 2nd edition of the HANDBOOK (1978) as extending to Rajasthan and Kutch—EDS.

7. NIGHT HERON *NYCTICORAX NYCTICORAX* (LINNAEUS) BREEDING IN SUB-ADULT PLUMAGE

I was often intrigued by buffy white-stippled, egret-like birds on nests while watching mixed heronries around Bombay, until a full-fledged juvenile fallen off a Night Heron nest was brought to the Society by a member, and its identity confirmed by reference to specimens in the Society's collection. Since then whenever I came across such birds on nests I presumed them to be full-fledged young of the species, though invariably always they were unattended by adult plumaged birds at the time of observation. That this presumption was unfounded was proved when I saw juvenile-plumaged Night Herons collecting sticks as nesting material in the company of adult-plumaged birds from a bare Copperpod tree on the morning of 26th August 1979 in the Borivli National Park, and commuting back and forth between the Copperpod and the nesting tree. It is evident therefore that juvenile-plumaged Night Herons found on nests in heronries need not necessarily be full-fledged chicks, but mature birds breeding in subadult plumage. There is, however, no referene to this breeding habit of the bird in published literature on Indian birds as far as I am aware.

The observation also partially answered a query which often posed before me : Do nocturnal birds collect nesting material during daytime hours or at night? At least the Night Heron does so during daylight hours.

C/O. BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE, S.B. SINGH ROAD,
BOMBAY-400 023,

August 30, 1979.

J. S. SERRAO

8. THE BROWNWINGED TERN (*STERNA ANAETHETUS*): AN ADDITION TO THE BIRDS OF KERALA

On the afternoon of 12-xi-1978 the fresh carcass of a Brownwinged Tern was found on the beach at Puvvar 8°24′N, 77°E, *c* 23 km south-east of Trivandrum. A fisherman took it to Dr. K. V. Sreenivasan of the Primary Health Centre, Puvvar, whose interest in birds was known to the fishermen. The bird was passed on to me, and I identified it as a Brownwinged Tern. Subspecific identification created problems, as some of the measurements did not tally with any given in the HANDBOOK under the three races of *Sterna anaethetus* included in it.

Some 36 hours after the bird was picked up, Dr. Satish Chandran Nair, Department of Zoology, Kerala University, made a valient attempt to skin and sex the specimen. But no proper skinning could be done as putrefaction had set in. Sexing, too, was not possible, and we concluded that the bird was a juvenile. The crudely prepared skin was sent to the Society.

Mr. Humayun Abdulali and Dr. Grubh examined the specimen. Mr. Abdulali wrote : 'The feathers of the upper parts are pale tipped and indicate a juvenile plumage. It is undoubtedly a Brown-winged Tern (*Sterna anaethetus*) and the nearest record which I can trace from the area are of a male and a female which 'fell on board off Cape Comorin 77°E lat., 8°N long., on 26th September 1864'....the present specimen has a 255 mm wing (bill from feathers 39.5, tarsus 19, tail 150) which is too large for *Sterna anaethetus antartica* Lesson (wing 218-239, bill 29-36) quoted from Baker in the Indian HANDBOOK (3 : 61) where it is suggested that this is a breeding form in the Laccadives and at Vengurla further northwards. When cataloguing the material in Bombay (*JBNHS* 69 : 297), I have expressed my inability to place the 16 specimens....among any of the three races accepted in Indian limits.' (See also H. Abdulali *JBNHS* 67 : 110-111.)

On 18-iii-1979 Sri V. K. Sureshkumar, Dr. K. V. Sreenivasan and I were at Puvvar, and Sri Sureshkumar found another specimen of the Brownwinged Tern. Only the two wings, the feathers of the back, one leg and the sternum with the pectoral girdle remained. This was sent to Mr. Abdulali who commented (in epist.): 'I measured the left wing 263 and the right 255 mm, the difference in size being due to the first primary being missing in the latter. In any case, the upperparts agree with specimens of *anaetheta* in the Society's collection, and single specimens in fragmentary condition are insufficient to permit any attempt at sub-specific indentification.'

The Brownwinged Tern is not included in Sálim Ali's BIRDS OF KERALA (1969) and has not been previously reported from Kerala.

24/1337, BEHIND G. P. O.,
TRIVANDRUM-695 001,
May 3, 1979.

K. K. NEELAKANTAN

9. JUNGLE CROW *CORVUS MACRORHYNCHOS* PREYING UPON GREY WAGTAIL *MOTACILLA CASPICA*

Crows are known for their omnivorous habit. I observed a jungle crow *Corvus macrorhynchos* catching a grey wagtail *Motacilla caspica* in flight and feeding on it while it was still alive.

On 16th January 1979 at 9-30 hrs. I saw a jungle crow foraging on the ground near the Tamil Nadu Inspection Bungalow at Thekkady, actively hopping around. At this time there was a grey wagtail sitting on the ground about 40 metres away. A grey wagtail, probably the same individual, was always seen in this locality for more than a month. Now the crow flew silently and landed close to the wagtail. The wagtail did not show any visible response, probably not suspecting a predator in the crow; the crow then made a swift advance towards the wagtail. The wagtail immediately flew up but the crow gave a quick chase and hit it with its beak. Now the wagtail started losing speed and in its next attempt the crow caught the bird in the air about a metre above the ground and carried it in its beak to a mango tree, about 50 m away from the spot. The crow then started plucking the victim with its beak while holding it with its toes against a branch; the wagtail was still alive and shaking its head but did not call. While the crow was removing the feathers another jungle crow (probably its mate) was sitting close by without interfering. Within 3 minutes the prey was plucked clean and then the crow started feeding on it bit by bit. At this stage the fleshy body of the wagtail dropped down and the crow immediatey went down to pick it up and flew to a house top where its 'mate' also joined the feast. The whole operation took about ten minutes.

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SHAEQUE AHMED YAHYA

10. OCCURRENCE OF *DICRURUS PARADISEUS LOPHORHINUS* (VIEILLOT) IN GOA (INDIA)—A COMMENT

While in Calcutta in February, 1979, Messrs Saha and Mukherjee kindly showed me the specimen of Ceylon Crested Black Drongo from Goa about which they wrote in their note, (*JBNHS* 77 (3): 511-2). In appearance and measurements this specimen from the Western Ghats coast of India conforms well to the distinctive form of the Greater Drongo from the evergreen, wet zone of South-west Sri Lanka (Ceylon) about which I wrote in an earlier paper (1949). This subspecies is distinctive because the outermost tail feathers, instead of developing the nude vanes and racket tips of the typical racket-tails, has the two outer tail feathers fully plumed, but narrowed and curved, partially twisted in a lyre-tail fashion.

The occurrence of this specimen and the reference in Baker (1924) to the presence of this phenotype in Kerala ('Travancore') confirms my own impression that *lophorhinus* of Sri Lanka is indeed most appropriately a subspecies of *paradiseus*, closely related, but with a single morphological character. That this tail type is perhaps confined to a minor gene shift in the population of the mainland would seem to be confirmed by the method of collecting specimens or sight records which of course represent an extremely random and haphazard sampling. More extensive field observations in western peninsular India might reveal the presence of this tail type character as a scarce recessive, while the phenotype has become localized and characteristic of the south-west Sri Lankan population. With the imminent decline of the habitat in the south-west of that island, there may be an increase of the hybrid population, now found in a hybrid zone between the *lophorhinus*-type and the *ceylonicus*-type on the margins of the wet evergreen belt.

The occurrence of a hybrid zone, and the appearance of a phenotype of one subspecies within the range of another is known in India and elsewhere. One example might be cited in the brown-backed form of flycatcher-shrike, *Hemipus picatus*, which appears in the range of the black-backed subspecies, but is locally dominant in part of the total species range. Again the occurrence of intermediate or color variants in fruit pigeons *Treron phoenicoptera* in central India, cited in the HANDBOOK (1969, vol. 3, p. 107) may refer to the same phenomenon? The Blue Goose population, now stabilized in part of the range of the Snow Goose, *Anser caerulescens*, in north-eastern Arctic Canada, has a hybrid zone in the western part of its breeding range. Occasional individual 'blues' appear in the range of the pure 'snow' population.

Bearing the above in mind it would seem that Baker's former treatment of *lophorhinus* as a separate species, or even genus (1924) is unrealistic from the point of view of speciation.

I am grateful to the staff of the Zoological Survey of India and especially to the authors of the note for showing me the specimen and inviting my comments on a recent visit to Calcutta.

S. DILLON RIPLEY

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WASHINGTON, D.C., U.S.A.,

April 23, 1979.

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11. THE REDTAILED WHEATEAR (*OENANTHE XANTHOPRYMNA*) IN THE DELHI AREA

On the morning of 23rd December, 1977, we saw at Sultanpur Jheel, a bird that we identified as a Redtailed Wheatear (*Oenanthe xanthoprymna*) from Ali and Ripley's HANDBOOK, vol. 9. We watched the bird for ten-fifteen minutes at about twenty to thirty feet. We had never seen it before in several year's bird-watching in Delhi. The bird's description was as follows: Size between sparrow and bulbul. Head and back pale sandy-brown, wings somewhat darker brown. Dull whitish supercilium, dark line through the eye. Rufous rump, chestnut tail with a black terminal band. Below, white, upright posture. So far as we can see, it can only be the Redtailed Wheatear.

Later we found from Usha Ganguli's A GUIDE TO THE BIRDS OF THE DELHI AREA that its status is accidental and that there is no subsequent record since it was recorded by Holmes in her book BIRD STUDY IN INDIA 1920. Furthermore, Abdulali and Panday's *Checklist of the Birds of Delhi, Agra and Bharatpur* places it in brackets, signifying 'erroneous or needing confirmation' and labels it S ?, S signifying 'stray, accidental and far out of normal range', ? signifying 'absence of specimen makes it impossible to determine subspecific identity.'

In the light of this, we think our sighting may be of interest to you.

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June 11, 1979.

12. A CURIOUS ACCIDENT TO THE NEST OF A SUNBIRD

On Sunday 9th September 1979 while driving through Borivli National Park with Rafia and Humayun Abdulali, we saw a nest of the Yellow-backed Sunbird (*Aethopyga siparaja*) hanging from an exposed root in a roadside cutting. We stopped and found that it was old and deserted, but another nest was seen hanging in a similar situation on the other side of the road. No entrance was visible and the nest was covered with earth, first suggesting an attack by white ants.

It was taken down and a closer examination showed that the porch over the entrance was depressed with earth. It contained three eggs, one of which was broken and the other two in a state of decay. The outside of the nest was covered with streaks of red earth in which the cutting had been made, and the only explanation appears to be that a heavy flow of rain water over the edge of the cutting brought down a lot of earth onto the nest and this, when drying closed the entrance, shutting out the bird.

The nest was washed under a tap and this produced a deluge of earth from all over the outer cover, thus corroborating the above suggestion. This does appear to be a singularly unusual disaster.

In the birds of Bombay and Salsette (1938) Sálim Ali and Humayun Abdulali said that all their records were for the winter months, and they could only quote breeding records from the Bhor Ghat (Khandala) on 17 and 21 September.

Mr. Abdulali has since seen many nests in the surrounding hills, mostly June to September, and almost always in identical facies. On 27 August 1979 he saw a ♀ visiting a nest, almost complete, at the southern end of the park, but it had been torn off a few days later.

The nest is of course very distinctive, showing much coarser material than in the other sunbirds, and lacking the cobweb covering. It is almost invariably attached to roots projecting from roadside cuttings.

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September 25, 1979.

13. FATAL MALE-MALE CONFLICT IN THE GHARIAL, *GAVIALIS GANGETICUS* (GMELIN) (REPTILIA, CROCODILIA)

(*With a text-figure*)

Three sub-adult gharial comprising one male and two females, measuring 2.58-2.78 m were liberated into a specially designed breeding pool in Nandankanan Biological Park, Orissa, on 13 February 1976. This pool, 59.5 m in length, 29.7 m in maximum breadth and with a maximum depth of 9.1 m holds 27 lakh litres and is fed with water by a 40 H.P. pump and also has a 10 H.P. recirculation pump. The layout is shown in Figure 1. To provide maximum freedom from disturbances the viewing area is restricted to 30 m and the balance of the 220 m perimeter comprises a 2.05 m high brick and mortar wall. Although courtship and presumed mating were observed in 1977 and 1978 no egg laying occurred and the resident male suffered genital prolapses on 31 January 1977 and again on 30 January 1978. In order to bring about successful breeding, attempts were initiated in 1978 to secure a second male. This male was obtained from Frankfurt Zoological Society, West Germany. This male measured 3.85 m and weighed 195 kg. A third female was obtained from Trivandrum Zoo on 20 February 1979 and three sub-adults, reared at the Tikerpada Gharial Project, District Dhenkanal, Orissa, were added to the breeding pool on 4 January 1979 when they measured 1.83-1.90 m.

The Frankfurt male had had no exposure to members of its own species for many years. It was decided to introduce this new male into the breeding pool while keeping close observation on the behaviour of the resident male. The Frankfurt male was introduced on 11 January 1980 at 2230 hours, having arrived from Hyderabad by truck (a two-day journey) one hour previously. After a lapse of 50 minutes it entered the pool. On the following day it was observed investigating the pool and moving around very close to the overflow (Figure 1). The resident male had as usual occupied his favourite location close to I_1. This is the only area in the pool where the water is sufficiently low for an animal to lie basking with part of its body out of the water without coming out of the pool.

The next day (13 January 1980) the Frankfurt

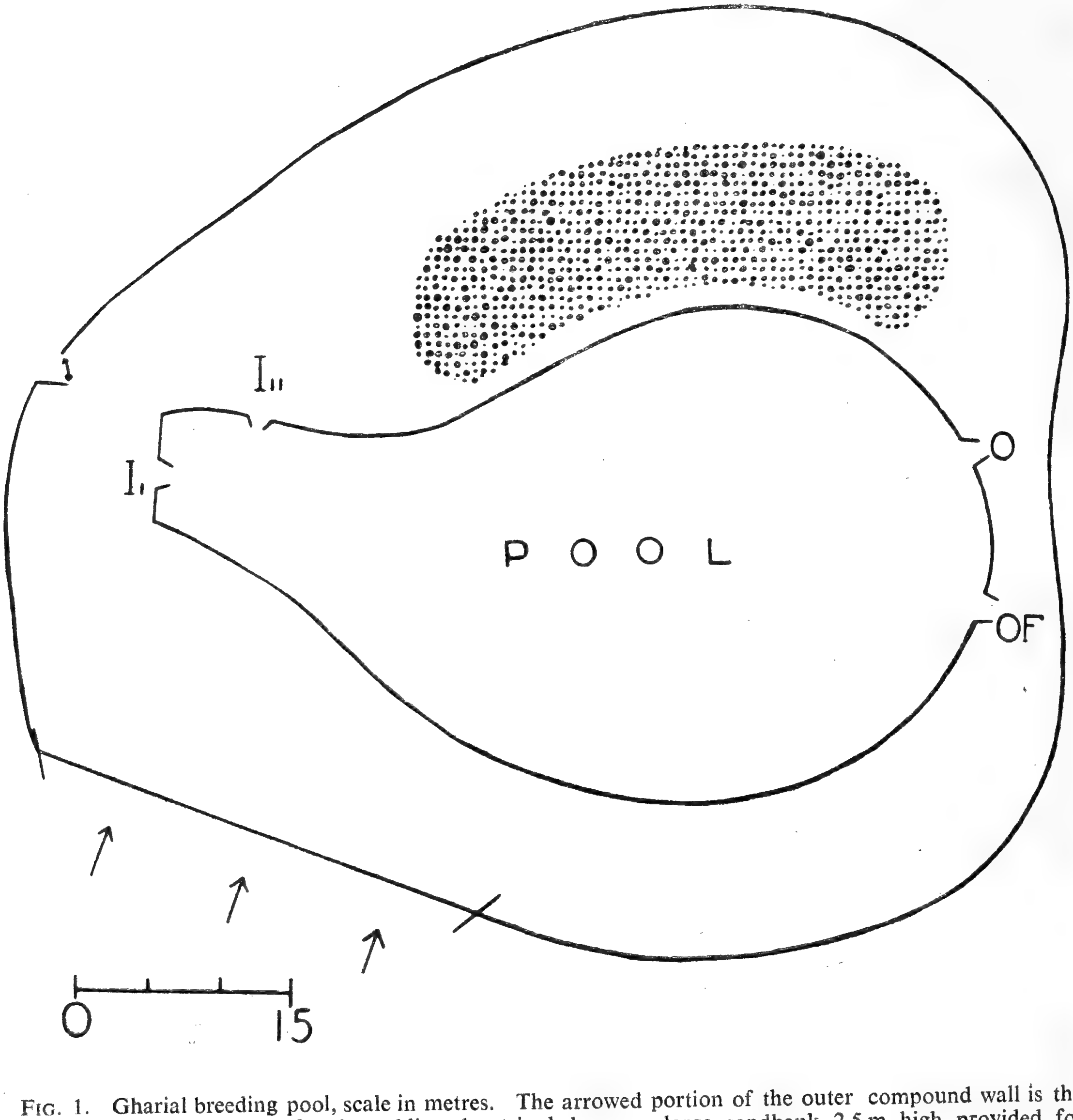

FIG. 1. Gharial breeding pool, scale in metres. The arrowed portion of the outer compound wall is the total viewing area for the public ; the strippled area a large sandbank 2.5 m high provided for nesting.

I_1—Inlet of a 40 H.P. pump

I_2—Inlet 'nalla' from 10 H.P. pump

O—Outlet for 10 H.P. pump, and

OF—Overflow used to skim off surface debris when the 10 H.P. pump is in operation.

male showed aggressive behaviour towards the resident male and attempted (successfully) to displace it from this favoured basking site which the Frankfurt male thereafter took over. Although the Frankfurt male was 95 cm longer than the resident, this successful aggressive behaviour occurring so soon after its entry into the pool is surprising when the resident had been in the pool for almost four years. One would have expected that this (ownership) would have given the resident male a psychological 'edge' over the Frankfurt male, at least for some time.

From 14 January to 31 January, the resident male attempted to come back to I_1 but was kept away by the Frankfurt male.

On 1 February, the Frankfurt male commenced courtship with the resident females. At 0950 on 1 February, the Frankfurt male was observed in the water and the resident male was basking outside the pool. When one of us (H.R.B.) frightened the resident male into the water, the Frankfurt male at once approached it and to reach it with maximum speed, dived, presumably trying to approach the resident male from below. It was not possible to observe what happened under the water but at the end of its dive the Frankfurt male leapt up vertically from the water exposing its body to the mid belly region. This was presumably the 'carry over' of the force of an attack on the resident male. The latter was not seen thereafter and was presumably skulking at the bottom of the pool.

On 2 February, it was observed that the resident male was remaining completely outside the water at all times. At this time, had the senior author been present, the resident male would have been removed from the breeding complex.

On 3 February, it was noticed that when forced to enter the pool, the resident male did so hesitatingly and that the Frankfurt male immediately swam quickly towards him and chased him out of the water.

On 4 February, the resident male was not observed between 0600 and 0900 hours (when it regularly basked) and was not observed thereafter until the morning of 8 February when the putrified carcase was observed floating in the pool.

There was no apparent external injury. The proctodaeum protruded and was in a wounded condition. The post-mortem revealed a bruised thoracic portion probably due to a stroke by the Frankfurt male either with his tail (more likely) or with his jaws.

These observations are interesting since gharial are usually extremely gentle animals very tolerant of quite small individuals (under a metre long) in their close proximity in the wild. Although the males are known to be territorial during the breeding season it was not anticipated that male-male combat with fatal consequences was likely to occur in a pool of this size. It is noteworthy, however, that the attacks took place during the mating season at a time when any male-male antagonism is likely to be at its peak. Courtship started on 31 January and lasted until 26 February.

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November 10, 1980.

14. SUSPENDED ANIMATION OF FISH OUT OF WATER FOR MANY HOURS

I give below an account of experiments carried out by me on common carp (*Cyprinus carpio*) being cultured at the Tata Hydro Electric Company's fish farm near Walwhan Lake at Lonavala.

On the 21st January, 1980 I purchased a fish (*Cyprinus carpio*) weighing about 1.25 kg and brought it home at 5.30 p.m. Since it could not be immediately cleaned it was kept in the refrigerator at 6.00 p.m. It was taken out for cleaning at about 8.00 p.m. and placed in a vessel under a tap. After about 15 minutes when its scales were being removed it was found to be alive.

When I was told about this incident, it reminded me of an article that had come in the *Reader's Digest* a few years back. It was about the bat (flying fox) which remained alive in the refrigerator for many days. So I decided to conduct some experiments on this species of fish.

Accordingly on the 25th January, 1980, a fish weighing about 250 g was brought at 5.30 p.m. and kept in a plastic bucket full of water. At 5.50 p.m. the water in the bucket was reduced to 5 litres. The temperature of the water was brought down by putting some ice cubes one by one. By 6.00 p.m. the fish was removed into a dry alluminium vessel and placed in the refrigerator. The vessel was then partially covered with a lid. For about 5 minutes the fish made efforts to jump and then quietened. At 10.00 p.m. after a period of 4 hours the vessel with the fish was taken out of the refrigerator. At this time it looked completely dead but it's eyes were very bright and its scales appeared fresh. Some water was poured into the vessel and it was watched carefully. For the first 10 minutes there was no sign of life in the fish. So two cups of warm water were added to increase the temperature of the water in the vessel. Within a few minutes two bubbles one after another were seen coming out of its gills. Later on slight movement of its gills could be seen. At this instance the fish was removed into a bucket full of fresh water. Its breathing rate went on increasing and it made efforts to move about. After half an hour the fish was swimming freely. Thus after an ordial of four hours without water in the refrigerator this fish regained its full vigour and vitality. Next day the fish was released back into the pond.

Subsequently, many experiments of similar type on the same species of fish were carried out. Every time the experiments were performed, the period of it's existence in the refrigerator was increased by half an hour. Finally it could be concluded that the common carp, (*Cyprinus carpio*) can remain without any water in the refrigerator for a period of 8 hours and survive when again released back into it's natural habitat.

I thank Mr. S. N. Ogale for his co-operation.

P. S. MUKUNDAN

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POONA DIST.,

June 23, 1980.

15. A NOTE ON THE BIOGEOGRAPHICAL RELICTNESS OF *PILLAIA INDICA* YAZDANI (PILLAIDAE : MASTACEMBELOIDEI)

(*With a text-figure*)

A species (or genus) is a relict of a region of it occurs in isolation from its main centre of distribution and if its presence can be explained by the fact that it (or its ancestral form) was left behind under different natural conditions than existing at present. A biogeographical relict is characterized by its confined area (Udvardy 1969), whereas biogeography by itself attempts to reconstruct and understand the evolutionary history of organisms both in space and time. However it is an established fact that the mode of dispersal of fishes in spite of suitable ecological niches, is largely dependent on drainage patterns, river captures and other phenomenon (Hora 1955).

In India, most, if not all work, aimed towards the distribution of fishes was primarily geographical ecology. Many workers have contributed to a large extent to this aspect but due to paucity of knowledge on fossil and stratigraphic records, historical biogeography was neither clearly explained nor analysed.

We attempted therefore, to formulate the most plausible hypothesis about the biogeography of fish fauna in N.E. India (Assam, Mehalaya, Nagaland, Manipur, Tripura, Mizoram and Arunachal Pradesh). This falls under the trans-Himalayan areas of the Indo-Chinese Subregion (89°7′ to 97°25′E longitude and 22° to 29°7′N latitude). This sub-region was the centre of origin for most freshwater fishes presently distributed in India (Jayaram 1977). It is highly stable having attained the maximum level of differentiation in relation to the available habitats (Mani 1974). The present paper deals with *Pillaia indica* Yazdani, a small eel-like mastacembeloid fish found predominantly in this region (Fig. 1).

Habitat : The habitat of the fish was peculiar, in that it was available in a small stream adjacent to a hydro-electric power station near Summer (N.E. of Shillong 21 km ; 91°56′E to 25°34′N) and also in the paddy fields where the irrigation channels had decomposing hay and other waste plant materials. *Pillaia indica* lives inside the loose mud (10-15 cm deep). We have observed the fish lifting its nose above the water level for aeration. They were collected by groping in the mud or by using iron mesh seives.

Results and Discussion : Collections were made throughout Khasi Hills for determining the distribution of *Pillaia indica* but it could be found only in Summer and its surroundings. Out of a total collection from October, 1977 to the end of April, 1978, 81 specimens of *Pillaia indica* along with 39 specimens of *Channa* spp., *Channa stewartii* (Playfair), *Channa orientalis* (Schneider) were caught. When the streams were impounded for irrigational purpose it affected the population to a large extent resulting in no fish catch for 1½ months.

Yazdani (1976) while discussing the relationships of this fish with Chaudhuriidae and Mastacembelidae opined that *Pillaia indica* might have originated in the Indo-Chinese amphitheatre and subsequently migrated westwards along the Himalayas (Menon 1973). Yazdani (op. cit.) stated that *Pillaia indica* forms a connecting link between Mastacembelidae and Chaudhuriidae, the latter being phylogenetically advanced and also represented by a single genus *Chaudhuria*.

Yazdani's hypothesis lacks support if we consider Brundin's (1966) approach because it is the location of 'sister-groups' that permits

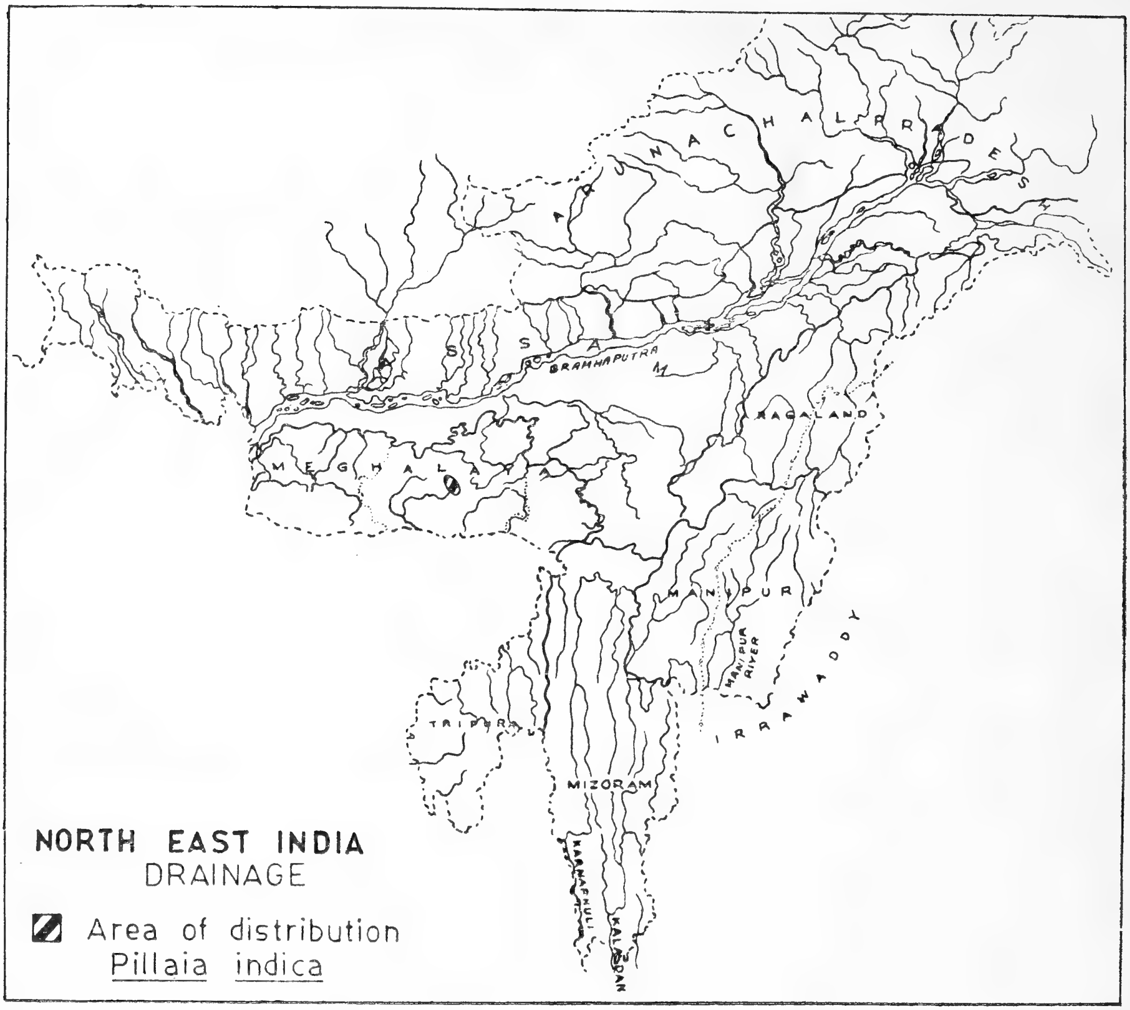

FIG. 1.

biogeographic hypothesis to be constructed. This theory implies that phyletically primitive species will generally be postulated as being nearer the centre of origin of the group under consideration, whereas phyletically more advanced or relative taxa will tend to be peripheral to it (Cracraft 1974).

If one agrees with the opinion (Menon, op. cit.) that most of the freshwater fishes originated and migrated towards the west along the Himalayas from the Indo-Chinese centre, and that Mastacembelids along with Pillaiidae have migrated and distributed themselves throughout peninsular India from the centre of origin whereas *Chaudhuria* is still available only in Burma. If so, either Mastacembelids are phylogenetically advanced than *Chaudhuria* or they have originated in some other place?

The Mastacembeloids, including Mastacembelidae of Africa and Southern Asia and the

Chaudhuriidae of Burma have relationships to the Anabantoids as suggested by gill raker evidence (Nelson 1969) but affinities with Symbranchiformes are also possible (McAllister 1969). In either case the Mastacembeloids can be considered part of the Gondwanaland Element. *Pillaia* and *Channa* sps. co-exist in this region, which shows that they still stay in the same niche which their ancestors might have shared. But Channids have diversified their habitat. Channidae, distributed in Africa and Southern Asia have some relationships with Anabantids (Gosline 1971). In North-Eastern India, Anabantids are available in similar habitats though they have not reached the altitudinal similarity with *Pillaia indica* (*c* 1000 metres).

Pillaia indica might have had a fairly good distribution along with Channidae, Anabantidae and Mastacembelidae before the Himalayas arose out of the intense squeezing of the Tethyan geosyncline between Laurasia coming from the North and Gondwana, comprising the Indian peninsula, from the south. But later it must have got confined to the present place where its niche is being shared with the Channids alone. Further, fishes of various and ecological associations can only spread if suitable environmental conditions become available in intervening areas (Hora, op. cit.).

The present-day distribution of *Pillaia indica* shows that it is reaching or has already reached relictness, either phylogenetic or biogeographic. Due to the lack of substantial record on its phylogeny it is difficult to point about its phylogenetic relictness. On the other hand, from the time of its first description (Yazdani 1972) (the specimens were collected in the year 1967), it has not expanded its distributional area and is confined to a small zone (10 km^2). This possibly reflects *Pillaia indica* being a biogeographic relict.

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16. ON THE EXTENSION OF RANGE OF TWO FRESHWATER CATFISHES, *GLYPTOTHORAX CONIROSTRE* (STEIND.) (SISORIDAE) AND *CLUPISOMA GARUA* (HAM.) (SCHILBEIDAE), TO POONCH VALLEY (JAMMU AND KASHMIR), INDIA

In the vast literature on the ichthyofauna of India there is no comprehensive report on the freshwater teleosts of Poonch Valley. As elucidated elsewhere (Das & Nath 1971) the ichthyofaunal interest of Poonch Valley lies in the unique phenomenon of 'East meets West', for this is the only region of Jammu and Kashmir State which exhibits a rare combination of the palaearctic species with fishes of Indian origin.

Das & Nath (1965) were the first investigators to report six species of teleosts from Poonch Valley. Subsequently, Das & Nath (1971), and Nath (1973) added eighteen unrecorded species to their original list. Recently Sharma & Sharma (1974) reported six more species from Poonch Valley, thereby raising the number of species of freshwater teleosts recorded from this area to thirty. As a result of extensive collections made by the present author during the period 1976-1980, it has now been possible to add some unrecorded species to the previous lists.

Glyptothorax conirostre (Steind.) is a typical torrential-stream sisorid which abounds in Kangra and other hill-streams of Punjab (Khan 1934). Day (1878) gives as its habitat the Himalayan streams of Simla and Kangra, while Hora (1923) mentions Simla, the head-waters of the Jumna River. The present report of the occurrence of this sisorid in Poonch Valley (in the Jhelum drainage system) is a new record for Jammu and Kashmir, where it abounds in Poonch River and its tributaries and shares its niche with *Glyptothorax kashmirensis* Hora—another typical torrential-stream sisorid which is endemic to Kashmir Valley—and *Glyptosternum reticulatum* McClelland which occurs in Afghanistan as well as Kashmir Valley and Ladakh and is of palaearctic origin (Das & Nath 1971 ; Das 1965, 1966 ; Talwar 1978).

Clupisoma garua (Ham.), the freshwater schilbeid cat-fish, is found throughout the larger rivers of Sind, India, Burma and Assam (Day 1878). Khan (1934) reported it from the Punjab, where it is abundant in the River Jhelum just below the Rasul Head and the River Sutlej near Ferozepur and Ropar. It has, however, not been reported from Jammu (Tawi) and the Valley of Kashmir so far and the present report of its occurrence in Poonch Valley is a new record for the State of Jammu and Kashmir. It is very common in the fast-flowing Poonch River and Betarh Nallah of Poonch Valley, with an altitude ranging between 1005 and 1065 metres above sea level and is particularly abundant during the monsoon season. *C. garua* (Ham.) is thus essentially a catfish of low altitudes, which has not been able to establish itself in Kashmir Valley in spite of the fact that Poonch River and its tributaries are a part of the Jhelum drainage system.

Recently Malhotra *et al.* (1980) extended the known range of six species of freshwater teleosts to Jammu area. The record of *Labeo calbasu* (Ham.) by the said authors is not, however, the first one, as the species was reported from Jammu (Tawi) by Das & Nath (1966) for the first time.

I am indebted to Dr. A. K. Datta of the Zoological Survey of India, Calcutta, for confirming the identification of the specimens under report.

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17. OCCURRENCE OF DIFFERENT SPECIES OF COCKROACHES AT LUDHIANA (PUNJAB)

An attempt was made to know the different species of cockroaches occurring in Ludhiana region of the Punjab State. For this purpose different species of cockroaches were collected from the kitchens of residential houses, hostels and hotels; private stores of foodgrains and food commodities at Ludhiana. One species was collected from the kitchen garden. The Zoological Survey of India, Calcutta identified the different species of cockroaches. The six species are described briefly.

Periplaneta americana (L.): Blattidae (The American cockroach)

This is the largest of all the species noticed in the region. The adults measure 30-40 mm in length. Red to chocolate brown in colour. The adult pronotum has a conspicuous yellow to buff coloured area surrounding the dark coloured patch in the centre.

Neostylopyga rhombifolia (Stoll) : Blattidae (The harlequin cockroach)

This is a medium sized cockroach. The adults measure 20-25 mm in length. It is shining blackish brown with patches of yellow colour over its body. Yellow-coloured patches are more concentrated on the thorax and submarginal area of the abdomen. Wings are vestigial in both the sexes. Males are smaller than females.

Shelfordella tartara (Sauss.) : Blattidae

This is a medium-sized cockroach with males measuring 19-23 mm in length. The wings are fully developed in males and extend beyond the end of the abdomen. The outer margin of the fore wings and the pronotum are translucent. The general body colour is lighter as compared with other species. In females the wings are greatly reduced and the fore wings are triangular. During collections only a few male insects of this species were found in comparison with large number of males and females of other species. This shows that this species is not so abundant in this region.

Blattella germanica (L.): Blattellidae (The German cockroach)

This is a small-sized cockroach measuring 10-15 mm in length. The males are yellowish-brown and the females are slightly darker. In adults the wings cover the entire abdomen of females and in males the abdominal tip remains uncovered. The pronotum has two prominent black longitudinal bands separated by a lighter stripe in between.

Supella longipalpa (F.) : Blattellidae (The brownbanded cockroach)

This is a small-sized cockroach measuring 10-14 mm in length. The pronotum is uniformly dark with light coloured lateral areas. The male adults have slender body with wings extending beyond the tip of the abdomen. The adult females have short wings with exposed portion of broad abdomen. The wings of females are comparatively darker than that of males. There are two light-coloured transverse stripes on the fore wings, one near the base and the other over the abdomen.

Polyphaga indica Walk. : Polyphagidae

The males are winged measuring 27-30 mm in length. The females are wingless, nymph-like and measure 27-30 mm. The males look smoky brown due to the presence of light coloured wings while the females are uniformly brownish-black except the anterior margin of the pronotum. The pronotum has a light coloured anterior margin in both the sexes. The antennae are shorter than the body and the cerci are very short.

The above listed species can be separated by the use of the following key :

1. Middle and hind femora without spines but with hairs on latero-ventral margin.. *Polyphaga indica*

   Middle and hind femora with spines on latero-ventral margin.. 2

2. Length more than 18 mm ; female subgenital plate divided longitudinally; male styli uniform, slender, elongate and straight.. 3

   Length less than 18 mm; female subgenital plate entire ; male styli variable, often modified, assymetrical or unequal in size.. 5

3. Wings of both sexes vestigial.. *Neostylopyga rhombifolia*
Wings of both the sexes well developed or females with pad-like wings.......................................4

4. Length 30-40 mm ; wings of both sexes well-developed ; pronotum with dark brown patch surrounded by yellowish area.. *Periplaneta americana*

Length 19-25 mm ; wings of male well-developed and of females pad-like ; pronotum without dark brown patch surrounded by yellowish area.. *Shelfordella tartara*

5. Pronotum with two conspicuous longitudinal dark bands...................... *Blatella germanica*
Pronotum without longitudinal dark bands but with broad, dark, central area........ *Supella longipalpa*

Singh and Sohi (1957) listed *Shelfordella tartara* (Suass.) and *Periplaneta americana* (L.) as pests of household in the Punjab. However, in the present studies *Neostylopyga rhombifolia* (Stoll), *Blattella germunica* (L.) and *Supella longipalpa* (F.) are new records for Punjab as household pests. *Polyphaga indica* Walk. occurring outside the houses is also a new record for this region.

ACKNOWLEDGEMENTS

We thank the Director, Zoological Survey of India for the identification of the insects and Dr. A. S. Sidhu, Professor and Head, Department of Entomology for providing the necessary facilities.

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18. RECORD OF *APANTELES OBLIQUAE* WLKN. AND *METEORUS* SP. (HYMENOPTERA : BRACONIDAE) AS PARASITES OF THE HAIRY CATERPILLAR *AMSACTA MOOREI* BUTL. (LEPIDOPTERA : ARCTIIDAE)

The caterpillars of the moth *Amsacta moorei* Butl. defoliating bean plant, *Phaseolus acontifolius* Jack. in Mehrawal village in Aligarh district were collected during June 1978 and reared in the laboratory. The observations revealed that two braconid species namely, *Apanteles obliquae* Wlkn. and *Meteorus* sp. (probably undescribed) parasitise the caterpillars.

In India the caterpillars of *Amsacta albistriga* and *A. moorei* have been reported to be parasitised by the braconids *Apanteles creatonoit*, *A. bosei* and *A. flavipes* (David and Kumaraswami 1978). Therefore, this appears to be first record of *A. obliquae* and *Meteorus* sp. on *A. moorei*.

Out of 560 caterpillars collected and observed, 169 were parasitised by these two parasites showing a parasitisation of 30.8 per cent. The parasitisation due to *A. obliquae* was 17.5 per cent and the rest by *Meteorus* sp.

Meterous sp. is a solitary endoparasite. It forms brownish cocoon outside near the head. The mature cream-coloured grub measures 4.2 to 5.1 mm long and 1.45 to 1.75 mm wide. The cocoon measures 4.2 to 5.3 mm long and 1.65 to 2.15 mm wide.

ACKNOWLEDGEMENTS

I thank Professor S. M. Alam, Head of the Department of Zoology, A. M. U. Aligarh, for providing the facilities, and the Director, Commonwealth Institute of Entomology, London for identification of the parasites. Thanks are also due to Drs. M. Hayat, Shujauddin and Miss Shahnaz Anwar.

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19. NEW RECORD OF *MELANAGROMYZA PROVECTA* (DE MEIJERE) (AGROMYZIDAE : DIPTERA) ON SAFFLOWER FROM PUNJAB, INDIA

Safflower (*Carthamus tinctorius* Linn.) is one of the important oil seed crops. The Carthamine dye is extracted from its flowers and oil is obtained from the seeds. Rai (1976)[1] listed twenty-two insect pests of safflower from India. This list includes *Melanagromyza obtusa* (Malloch).

The wilting of safflower plants were noticed during the winter 1978-79, at the Punjab Agriculture University, Ludhiana, caused by the feeding of agromyzid maggots on the tap root. The pupae were collected from the roots of the attacked plants and reared in the laboratory in glass jars. The adults were identified as *Melanagromyza provecta* (de Meijere). The occurrence of this agromyzid on safflower in India is a new record.

ACKNOWLEDGEMENTS

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[1] Rai, B. K. (1976) : Pests of oilseed crops in India and their control. I.C.A.R. Bull. pp. 88-97.

20. NEW RECORDS OF TWO TACHINID PARASITES FROM *EUPROCTIS LUNATA* WALKER

The castor hairy caterpillar, *Euproctis lunata* Walker (Lepidoptera : Lymantriidae) is the most serious pest of castor (*Ricinus communis* L.) in India. The caterpillars are voracious feeders on the leaf and leave behind only the veins. While studying the biology of this insect at Ludhiana in 1977 some larvae collected from the field were found to be parasitized. Rearing of such larvae led to the emergence of two tachinid parasites. The specimens of these parasites sent to Commonwealth Institute of Entomology, London have been identified as *Carcelia corvinoides* (Wulp.) and *Exorista larvarum* (L.). Collective parasitization of the larvae was 10-15% during July-August, thereafter no larvae was found to be parasitised. However, both the species were again recorded parasitizing the larvae in the same season during 1978.

Two braconid parasites, *Apanteles colemani* Viereck and *A. euproctisiphagus* Muzaffar parasitise the larvae of this insect in the field (Bhatnagar 1948, Pandey 1967). Record of *Carcelia corvinoides* (Wulp.) and *Exorista larvarum* (L.) on the larvae of *Euproctis lunata* Walker is a first report from India.

ACKNOWLEDGEMENTS

Thanks are due to Dr. A. S. Sidhu, Professor-cum-Head, Department of Entomology, for research facilities and Director, Commonwealth Institute of Entomology, London for identification.

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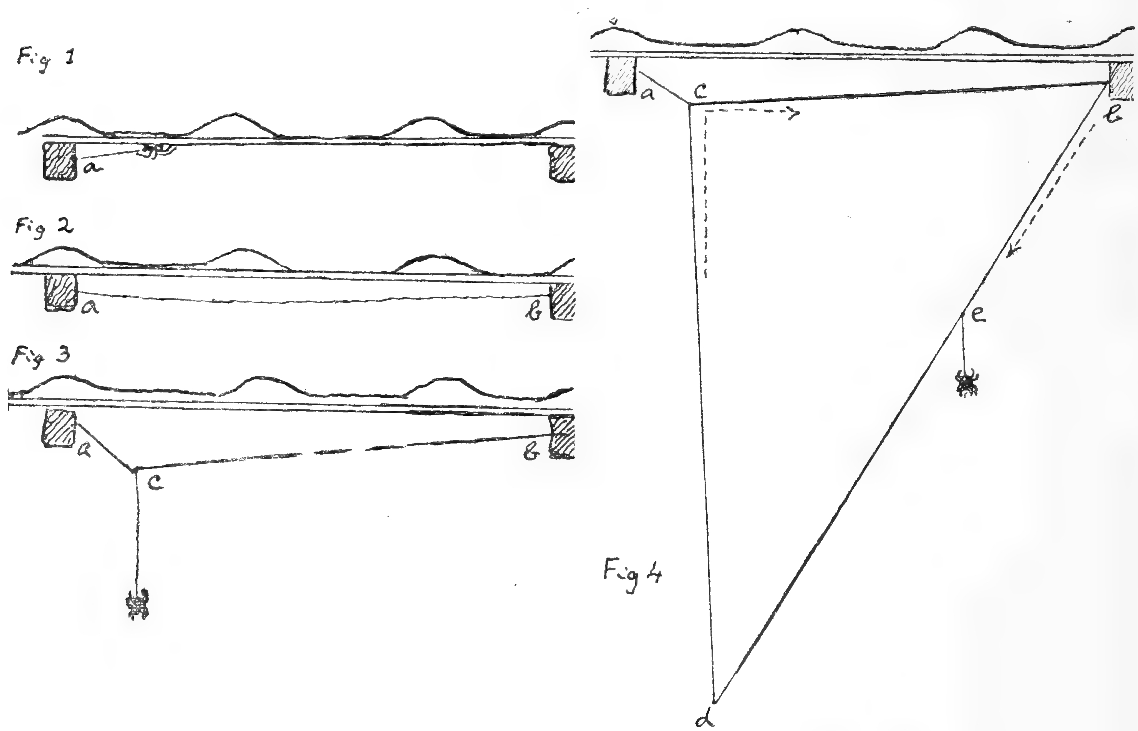
21. TWO CASES OF ORB WEB CONSTRUCTION BY ARANEUS

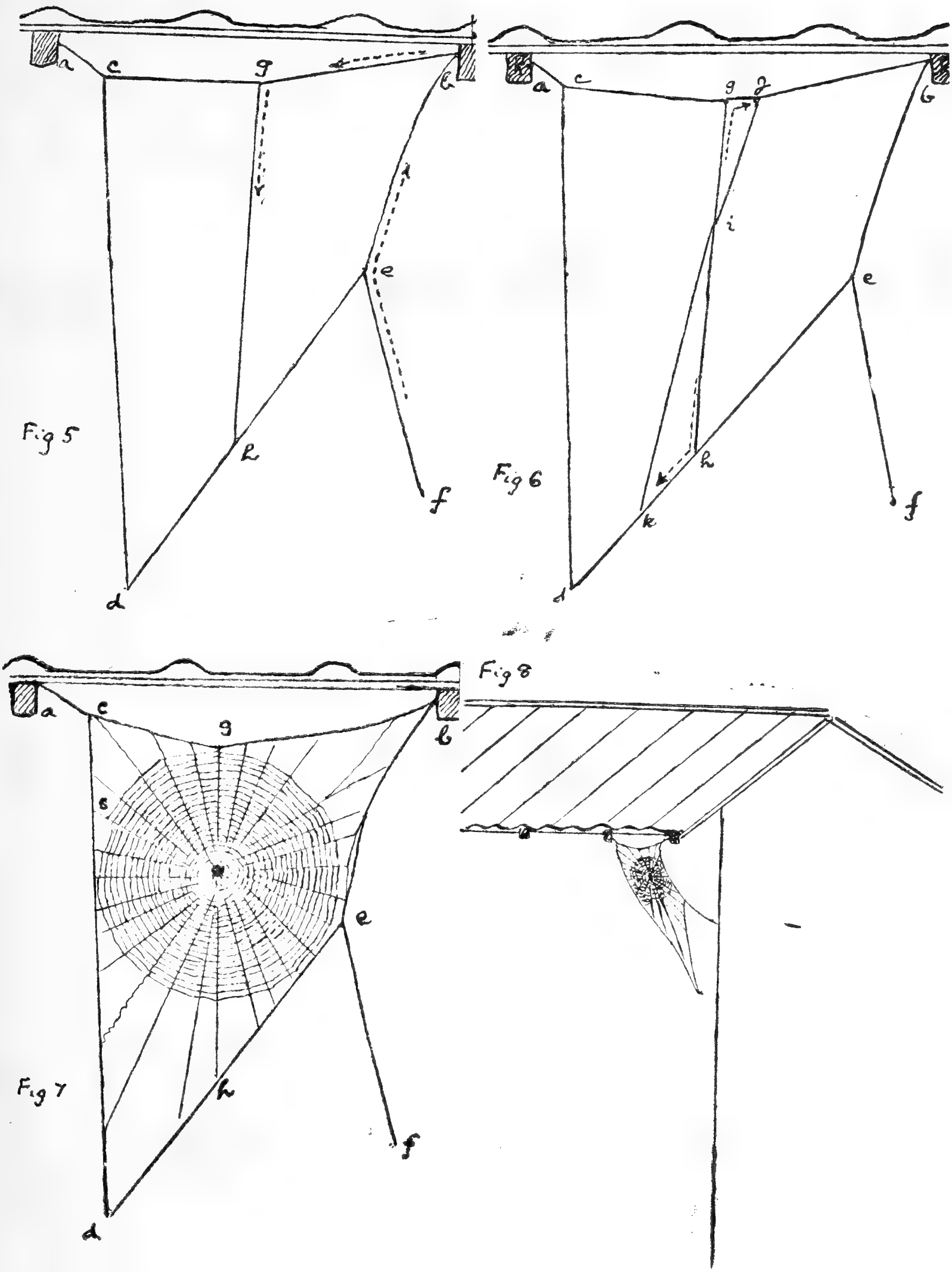
(*With nine text-figures*)

Recently I was able to watch a small garden spider making its orb-web. The spider was a young ash coloured Araneus measuring about 4 mm. The site of construction was between the extremities of two wooden rafters (45 cm apart) projecting from the outer wall of a garden house. These rafter ends, about 2 m above the ground level, were connected by a longitudinal purlin that supported an asbestos sheet above.

The spider, female, which concealed herself all day long at one of the rafter ends turned active by sunset (about 6 p.m.). By touching at point (*a*) with the hind end of her abdomen she stuck a thread there and extending and trailing the thread she moved slowly in an inverted position along the purlin in the direction of the other rafter end. In so doing she was holding the thread so carefully with one of her right hind-legs that the thread did not touch the purlin at any point. Reaching the rafter end she stuck the thread at point (*b*) and quickly ran back to (*a*) along the line doubling and strengthening it at the same time (Figs. 1 & 2). From (*a*) she made an ' about turn ', proceeded a few centimetres along *ab* and sticking with her spinnerets at (*c*) dropped down by a thread to about 60 cm (Fig. 3) and swayed to and fro waving her forelegs as if to catch at something. Through this oscillating process she touched the wall at (*d*) and immediately fixed the thread there and scurried back to (*c*) and back to (*d*) once more strengthening (*cd*). From (*d*) she moved carefully but quite fast towards (*b*) *via* (*c*) with a loose thread trailing behind and held by one of her hind-legs. Reaching (*b*) she pulled the loose thread taut thereby joining (*d*) with (*b*) (Fig. 4). From (*b*) the spider descended halfway down along (*bd*) and sticking the thread at (*e*) dangled by a thread and swayed until it touched the wall at (*f*) where it fixed the thread. This additional attachment was probably to reinforce and keep the plane of the web in an oblique position. After this operation she hurried to (*b*) and then upto middle of (*cb*), *i.e.* (*g*) where she fixed a thread and dropped down and swayed until it touched a point (*h*) along (*ed*) (Fig. 5). Fixing the thread at (*h*) she ran up along (*hg*) up to (*i*) where she stuck a new thread and holding it loose with the hind-leg proceeded upto (*g*) and then for about 4 cm, *i.e.*, point (*j*) along (*gb*). At (*j*)



FIGS. 1-4.



Figs. 5-8.

the thread fixed at (*i*) was pulled tight and stuck. The animal then ran down along (*ji*), started another loose line from (*i*) and proceeding first to (*h*) and then about 4 cm along (*hd*) pulled taut the line and fixed it at (*k*). Thus with (*i*) as the centre of hub or the orb four spokes were completed *viz. gi*, *ji*, *hi* and *ki*. (Fig. 6).

By similar operations other radii or spokes were made: a few spokes on the right alternating with a few spokes on the left. The work of laying the spokes—about 28 in all was completed by 7.20 p.m.

In about another 15 m the spider made a rough spiral of 6 rounds from the centre. She

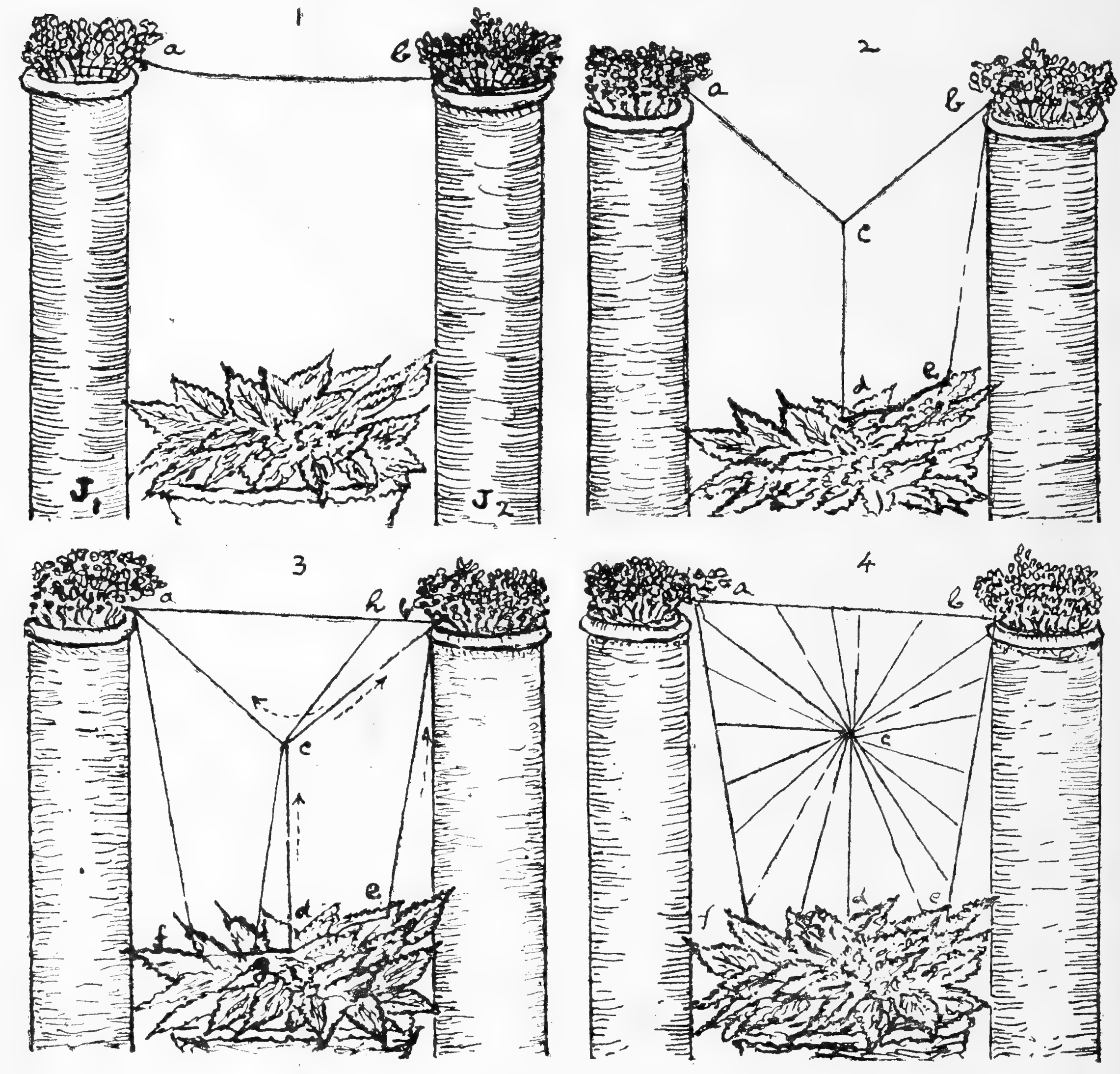


FIG. 9 (1-4).

then went up along (*ij*) and made a round along the boundary lines as though to test the strength. Then from a point (*s*) along a spoke near the upper part of the left boundary line (*cd*) she started the fine, concentric spiral work marching from spoke to spoke quite briskly, methodically and with precision. She made nearly 20 rounds—not at a continuous stretch, for I could see that at times she retraced her steps along the already made spirals probably to test the strength and at times she took rest for a few seconds to clean her spinnerets. On two occasions she rushed to the periphery and returned to the spire perhaps attracted by some small insects or to inspect the line. I could also observe the spider biting off the notches of the spokes in the centre but could not make out when she applied the viscous fluid to the spire and twanged them nor when she dismantled the rough spiral.

The web was completed by 8.20 p.m. *i.e.*, in 2 hours 20 mts. The orb measured nearly 30 cm across and contained 28 spokes and 20 spirals enclosed in an almost inverted right angles triangle the base of which between the rafter ends and the apex facing down and fixed to the wall (Figs. 7 & 8).

In another instance where the site of construction was between two *amaranthus* plants in two jars J1 & J2 placed some 60 cm apart on either side of a coleus plant. The spider was a small *Araneus* about 3 mm. Remaining at point (*a*) on plant in J1, the spider by kite method released a thread to the wind the end of which got stuck at point (*b*) on plant in J2 (Fig. 9, 1). This line was a little loose. Nevertheless the spider ran through it upto the middle and owing to the weight of the animal the line assumed a V shape. At the meeting point (*c*) she glued a fresh thread and dropped by a thread at point (*d*) over the Coleus and fixing the line there and again at (*e*) moved over the leaves in the direction of J2 trailing the thread behind. Climbing upto (*b*) she pulled the line taut making a boundary line (*eb*) on the right (Fig. 9, 2). From (*b*) still trailing the thread she ran to (*a*) via (*c*) and hauling the line tight and fixing it at (*a*) an upper boundary line was made. From (*a*) she dropped down by a thread and swayed touching point (*f*) from where she moved over the foliage and connected (*f*) with (*d*). From (*d*) she moved back a few centimetres along and at point (*g*) stuck a line and holding it loose ascended to (*c*) and pulling the line fixed it there making a spoke (*gc*). Again she started a fresh line from (*c*) and carried the thread to (*b*) and thence moving a few cm towards (*a*) at point (*h*) pulled taut the line and fixed it there making spoke *ch* (Fig. 9, 3). More spokes were made in the same fashion—about 20 in all (Fig 9,4). The spiral was made in the same way as in case No. 1 (Fig. 9, 5). The orb when completed measured 3.5 cm across with 20 spokes and 30 spirals (all could not be shown in the figure). The whole web was made in about one hour.

5

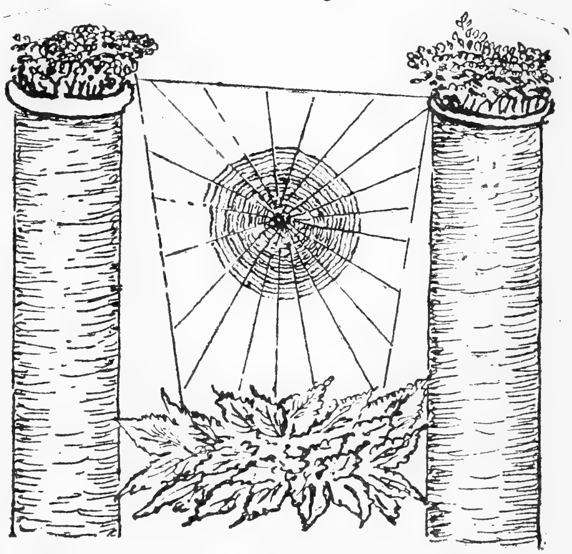


FIG. 9 (5).

From the above two cases it is revealed that 1. Depending upon the facilities available at the site of construction, provided there are contiguous objects which can be spanned by extending the limbs (as the purlin between the rafter ends in case No. 1) the spider prefers to lay the foundation line only entirely by foot. Only when the gap is long the kite method of paying out thread to the wind is adopted.

2. Foundation line on the sides and below are made by the dropping method or by trailing and hauling the loose thread taut.

3. The first bridge line is converted into spokes in Case No. 2 and the upper boundary line made afterwards.

4. Spokes are generally made by trailing loose thread and carrying it to the boundary line and hauling it tight.

5. The number of spokes and spiral rounds is not constant.

6. Construction proceeds from 'above' to 'below'—the structure broader nearer the upper foundation line gradually tapering down.

Altogether it may be generally stated that an orb-weaver modifies its mode of construction to suit the different situations.

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22. A NOTE ON *PRASHADUS PIROTANSIS* (MENON AND DATTA GUPTA) (ECHIURIDAE) FROM THE GULF OF CAMBAY, INDIA

Prashadus pirotansis (Menon and Datta Gupta), subfamily Thalassematinae, family Echiuridae, was first described by Menon and Datta Gupta in 1962 (Type locality: Pirotan Island in the Gulf of Kutch, India) under the genus *Ikedosoma*. Datta Gupta and Menon (1970) mentioned 'It should be proper at this stage to place the species under a separate genus'. Stephen and Edmonds (1972) erected a new genus *Prashadus* to accommodate *Ikedosoma pirotensis* and remarked that 'the genus is unique in the family Echiuridae on account of the distal position of its nephrostome'. Till today it enjoys the status of a monotypic genus. It resembles closely to *Ikedosoma* (Echiuridae) on the one hand and *Ikeda* (Urechidae) on the other.

The method of collection and habitat of this species are described in detail as the original description regarding the same appears to be insufficient. Presence of this animal on mud flat can be detected by its long, extensile proboscis. It is useless to remove this animal from its burrow by pulling on its proboscis as the latter invariably tears off and the animal remains hidden. It rests at a depth of 100-120 cm below the surface of the substratum. The general method of collection of echiuran described by Stephen and Edmonds (1972) is 'by pushing a piece of rubber tubing down the tube made by its proboscis' and then by carefully digging the substratum to expose the animal. But to dislodge this animal by this method is not possible as it lives in the mud with gravel and sand above.

In the Gulf of Kutch the substratum (mid-intertidal zone) which the animal inhabits consists of superficial layer of soft mud about 30 to 40 cm deep, followed by hard mud about 30 to 35 cm and finally a mixed layer of hard mud, sand and gravel. In some places the third layer is absent and the second layer continues upto a depth of 120 cm or so. But in some places black humus soil is noticed in the superficial layer just below the soft mud. One should be careful about the soft mud wherever it occurs, as it is about knee deep. Whenever a pit is made in the soft muddy substratum water oozes immediately into it and fills it up. So, as long as the digging continues, water is to removed frequently. But in Bhavnagar (Gulf of Cambay) the condition is different. The superficial layer of mud is hard and about 40 cm deep, then follows the sand, hard mud and gravel. It requires three to four persons to dig the animal out. The substratum (upper intertidal zone) should be dug around the hole (through which the proboscis projects out) about 45 to 50 cm away from it, upto a depth of 120 cm. While digging, care is to be taken that the animal should not be disturbed in any way. Then the soil column is to be scraped carefully from periphery of the hole, the wall of which is cemented throughout by mucous. The animal should be caught by the trunk (not by the proboscis) and carefully taken out.

I had the opportunity of surveying the coasts of Tamilnadu, Kerala, Karnataka, Gujarat and some parts of the Andaman Islands and noted the restriction of the species to the Gujarat Coast.

The present findings show that in addition to the localities (Pirotan Island, Byet Island, Deeda Island and Sika-in the Gulf of Kutch) mentioned by Menon and Datta Gupta (1962) it is also available at Bedi, Rosy, Sarmat and Navlakhi in the Gulf of Kutch and Bhavnagar in the Gulf of Cambay. It is for the first time recorded from the Gulf of Cambay. It is worthwhile to mention that this species occurred in abundance in Byet Island, Pirotan Island and Bhavnagar during my first survey tour in this area in 1968.

I visited Gujarat Coast after a gap of nine years and noted that the population of this species is much reduced. The question of seasonal fluctuation does not arise as the echiura lives in the burrows all the year around. The only other reason is probably the damage to the habitat. The areas are frequently visited by a large number of college students for field trips every year, as stated by several personnel of the Fisheries Department, Government of Gujarat. It is obvious that they make unsuccessful attempts to collect these animals by pulling on their proboscis and thereby damaging a good number. If no preventive measures are taken to restrict the visit of students to echiura inhabiting grounds particularly Balapur area of the Byet Island and the Pirotan Island, it will in no time, meet the same fate as *Balanoglossus* once faced at Krusadai Island.

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April 26, 1979.

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23. ON THE DISTRIBUTION OF *CROTALARIA TECTA* HEYNE EX ROTH (FABACEAE) IN MAHARASHTRA STATE

Roth (1821) erected the species *Crotalaria tecta* based on a collection of Heyne in Wallichian Herbarium no. 5897A (Type !) from Peninsular India. Later De Candolle (1825), Wight and Arnott (1834), Bentham (1843), Baker (1876) and Gamble (1918) recorded the distribution of this species in Peninsular India as follows: India Orient (De Candolle 1825), Madura (Wight & Arnott 1834), East Indian Peninsula, Courtallum and Madurai (Bentham 1943), Western Peninsula in Concan, Nilghiris and Pulney Mts. (Baker 1876) and Western Ghats, at the foot of Pulney hills, Nagarcoil in Travancore and plains of Tinnevelly (Gamble 1918). Thus the species is so far recorded only from the states of Kerala, Tamilnadu and Karnataka.

While studying the specimens of *Crotalaria* L. in the herbarium of the Industrial Section, Botanical Survey of India, Calcutta (BSIS), I came across a specimen, *Kalka Prasad* 30107 collected from Andheri in the Thana (Bombay) district of Maharashtra state. This specimen has been identified as *Crotalaria tecta* Heyne ex Roth and this is a new range of distribution of the species in Maharashtra state.

The up-to-date nomenclature, a short description and the phenology of the plant is given below.

Crotalaria tecta Heyne (Wall. Cat. no. 5397A. 1831-32. *nom. nud.*) *ex* Roth. Nov. Pl. Sp. Ind. Or. 334.1821 ; DC. Prodr. 2 : 126. 1825 ; Benth. in Hook. Lond. J. Bot. 2 : 569. 1843 ; Baker in Hook. f. Fl. Brit. Ind. 2 : 76. 1876 ; Gamble Pl. Presid. Madras 1 : 294.1918.

C. viminea Grah. (Wall. Cat. no. 5397.1831-32. *nom. nud.*) *ex* Wt. *et* Arn. Prod. 190.1834.

C. linifolia Linn. f. var. ? Wall. Cat. 5400-B. 1831-32. *nom. nud.*

C. punctata var. Wall. Cat. no. 5401. 1831-32. *nom. nud.*

Erect herbs, 30-50 cm high ; branches few, pubescent or suffruticose. Leaves sub-sessile, 0.6-2.5 × 0.5-1.2 cm, ovate or oblong, glabrous above, appressed pubescent beneath, emarginate at apex, cuneate at base. Flowers yellow in terminal appressed pubescent racemes. Pods 1-1.5 cm long, oblique, oblong, glabrous.

Flowers : August-October.

Fruits : September-November.

Specimen examined : KERALA : without specific locality, *M.A. Lawson* 298 (CAL); Makara, *M. Rama Rao* 1636 (CAL) ; Makarai, *C. C. Calder & M. S. Ramaswami* 837 (CAL). TAMILNADU : Thirunelveli, Courtallum, *K. K. N. Nair* 1249 (CAL). KARNATAKA : Carnatic, *J. D. Hooker & T. Thomson, s.n.* (CAL) ; MAHARASHTRA : Thana, Andheri, *Kalka Prasad* 30107 (BSIS).

Distribution : India : Kerala, Tamilnadu, Karnataka, Maharashtra.

I collected this plant from Courtallum forests (Tamilnadu) at an elevation of about 300 metres, where it grows along the sides of small canals. The stem is fleshy and green and is with light reddish longitudinal lines.

The species is closely allied to *Crotalaria linifolia* Linn. f. in general appearance. However the oblique-oblong pods and emarginate leaves in *C. tecta* distinguishes it from *C. linifolia* in which the pods are oblique-rounded or ovoid and the leaves are acute, blunt or rounded at apex.

ACKNOWLEDGEMENTS

I am thankful to the Curator, Industrial Section, Botanical Survey of India, Calcutta and to the Deputy Director, Central National Herbarium, Botanical Survey of India, Howrah for all facilities.

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K. K. N. NAIR

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24. NOTES ON AN INTERESTING SPECIES OF *SYMPLOCOS* JACQ.

Symplocos kurgensis Clarke and *Symplocos hebantha* Thw. ex Clarke were two endemic species described in FLORA OF BRITISH INDIA in 1882. The former is endemic to Coorg in Karnataka State, India and the latter is endemic to Ratnapura District of Sri Lanka (Ceylon). These two species were not collected after the type collections. *S. hebantha* Thw. ex Cl. was collected in 1866-68 (CP 3981).

The two species were lumped together and named *Symplocos kurgensis* Clarke by H. P. Nooteboom of Rijksherbarium, Leiden in his work in FLORA OF CEYLON (in press). The species are not represented in the Herbarium of the Southern Circle (MH). Specimens of *Symplocos* collected from Chandanathode in Cannanore Dt. of Kerala were identified by us with the help of literature as *Symplocos hebantha* Thw. ex Clarke and sent to H.P. Nooteboom who confirmed the identification. This is the first collection of *Symplocos kurgensis* Clarke (= *S. hebantha* Thw. ex Clarke) collected away from the type locality after about 100 years. It is likely to occur in other areas south of Coorg in the Peninsular India.

A full citation with a description and diagram is given here.

Symplocos kurgensis Clarke, in Fl. Brit. India 3 : 576. 1882 ; Brand, Pflanzr. 6 : 62. 1901 ; Brandis, Indian Trees : 441. 1907. *S. hohenackeri* Clarke, in Fl. Brit. India 3: 582. 1882 ; Brand, Pflanzr. 6 : 90. 1901 ; Brandis, Indian Trees : 439. 1906. *S. hebantha* Thw. ex Clarke, in Fl. Brit. India 3 : 586. 1882 ; Trimen, Handb. Fl. Ceylon 3 : 109. 1895 ; Brand, Pflanzr. 6 : 62. 1901. *S. macrophylla*

Wall. ex Dc. var. *kurgensis* (Clarke) Noot., Rev. Sympl. 229. 1975.

Small tree, twigs sericeous. Leaves oblong to elliptic, 3-12.8 × 0.8-5 cm, acuminate, margins minutely spinous denticulate, base rounded or cuneate (on the same twig), young leaves sparsely pubescent both sides, older leaves glabrous except the midrib on the lower surface; nerves 7-11 pairs, arched. Petioles 0.9-2 cm long, sericeous. Inflorescence in axillary spikes, 5-9.1 cm long, rachis densely tawny tomentose. Bracts 3×1.5 mm, deltoid, acute, densely tawny tomentose both sides, caducous; bracteoles small, caducous. Flowers white, scented. Calyx 5 lobed; tube glabrous, 1 mm long; lobes 5, ovate, 2-3×1-2 mm, valvate, spathulate, tomentose without except the scarious margins. Corolla 5 lobed; lobes 5-6×3 mm, oblong, obtuse, glabrous. Stamens 50-98, 3-5 mm long; anthers basifixed, 2 lobed. Pistil 6 mm long, style cylindric, base broad and hirsute; stigma capitate, disk 5 glandular. Fruits ovoid-cylindrical, 13-20×6-8 mm, stone with shallow lengthwise grooves, depressed at one side towards the base (description of fruit adopted from literature).

Specimens examined: INDIA: Kerala, Chandanathode, 710 m, 5-12-1967, *Ellis* 29476.

ACKNOWLEDGEMENTS

We wish to thank Dr. H. P. Nooteboom for confirming our identification and for the valuable information communicated through his letter. We are thankful to Dr. N. C. Nair, Dy. Director, for his help and encouragement.

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January 4, 1980.

25. HOST PARASITE RELATIONSHIPS IN *DENDROPHTHOE FALCATA* (LINN.F.) BETTINGH (*LORANTHUS LONGIFLORUS* DESR.)

A wide spectrum of host plants known for *Dendrophthoe falcata* (Linn.f.) Ettingh (Loranthaceae) seems to be quite unique in the whole angiospermic parasites. This fact has been substantiated by a large number of host plants reported so far for this taxon (Fischer 1926, Sambandam 1966, Sampathkumar and Kunchithapatham 1969, Sampathkumar 1970). It has also been pointed out earlier that although there existed no specificity in the selection of host plants for *D. falcata*, the selection of host plants was not entirely promiscuous since the seeds of the parasite could not establish successfully in some monocots and also a few dicots (Sampathkumar 1970) where they initially germinated but failed to establish later. One of the factors deciding the establishment of the parasite was thought to be osmotic pressure relationships between the host and the parasite (Sampathkumar 1970) for which experimental evidence presented in this paper lends support to this view.

The osmotic pressure relationships of the host as well as of the parasite in each case revealed in unambiguous terms that the parasite tends to have higher osmotic pressure than the host in question. Determination of osmotic pressure was made by plasmolytic method, using different molar concentrations of sucrose in which epidermal peelings of the leaves of host and the parasite were immersed separately for 30 minutes. By using the formula OP = CRT (C = molar concentration ; R = gas constant = 0.082; and T = Absolute temperature = 273° + lab temperature) the osmotic pressures of the host and the parasite were determined. The osmotic pressure differences between the host and the parasite were calculated in terms of atmospheres. From the data presented in Table 1, it is evident that invariably in all the cases, there is higher osmotic pressure in the parasite, as compared with the host, the difference in the pressure being very low (4.87 atm.) to very high (22.27 atm.), depending upon the host. Another interesting conclusion emerging from the present study is that there exists a narrow range in the osmotic pressure of the parasites on different host plants, with an average OP of 32.14 atmospheres (range : 29.47 to 36.91 atm.). It is also likely that this difference might well represent cases of physiologically distinct strains.

TABLE 1

Name of the host		Osmotic pressure in atmospheres		
		Host	Parasite	Difference
Annona squamosa Linn.	..	15.38	30.80	15.42
Ficus religiosa Linn.	..	18.56	32.08	13.52
Cordia rothii R. & S.	..	8.38	30.65	22.27
Citrus aurantium Linn.	..	21.76	34.61	12.85
Mangifera indica Linn.	..	18.54	33.32	14.78
Mimusops hexandra Roxb.	..	15.35	30.75	15.40
Psidium guajava Linn.	..	12.34	33.32	20.98
Oncoba spinosa Linn.	..	16.90	36.91	20.01
Crescentia cujete Linn.	..	19.81	29.52	9.71
Punica granatum Linn.	..	24.60	29.47	4.87

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26. SOME OBSERVATIONS ON THE FLOWERING AND FRUITING OF *BALANITES ROXBURGHII* Pl.

(*With a plate*)

INTRODUCTION

Balanites roxburghii Pl., family Simarubaceae is a very drought hardy tree growing wild in West Rajasthan and in other dry parts of the country. The roots and fruits of this plant have been analysed by a number of workers for diosgenin, a valuable steroidal drug precursor. At Central Research Farm, Jodhpur, 3.65% of diosgenin from the fruits has been obtained which is the highest so far reported. The seed kernels also yield 44% non-edible oil.

For the economic feasibility for exploitation, the knowledge of flowering and fruiting of this plant is of a great significance. Conflicting observations have been reported by various authors regarding the flowering season of this plant (Table 1). In a related species *B. aegyptiaca* Del. from Syria, Post (1932) reported flowering during May-July.

Field observations at Jodhpur and other places have revealed that *B. roxburghii* Pl. flowers twice a year, but the fruits reach maturity only once (Figs. 1, 2). Flower buds appear in the axils of the bifoliate leaves or on the thorns during the end of March and October. Flowers are pollinated by flies which are attracted by a secretion from the glandular margined, prominent disc. They deposit the eggs inside some of the ovaries and as the fruits mature, the larvae also develop inside the seeds. In such infected fruits, the kernel is completely consumed by the developing larva. The green larva finally emerges out by drilling a hole through the stony endocarp of the ripe fruit.

TABLE 1

FLOWERING AND FRUITING SEASON AT DIFFERENT LOCATIONS OF INDIA

Location	Flowers	Fruits	Authors
Bombay	March-May	..	T. Cooke, 1903
Rajasthan	October	..	E. Blatter and F. Hallberg, 1918
Upper Ganges	April-May	..	J. F. Duthie, 1960
Bihar, Orissa	November and February-May	November December	H. H. Haines, 1961
Punjab	April-May	Cold Season	R. N. Parker, 1973
West Rajasthan	October	October	M. M. Bhandari, 1978

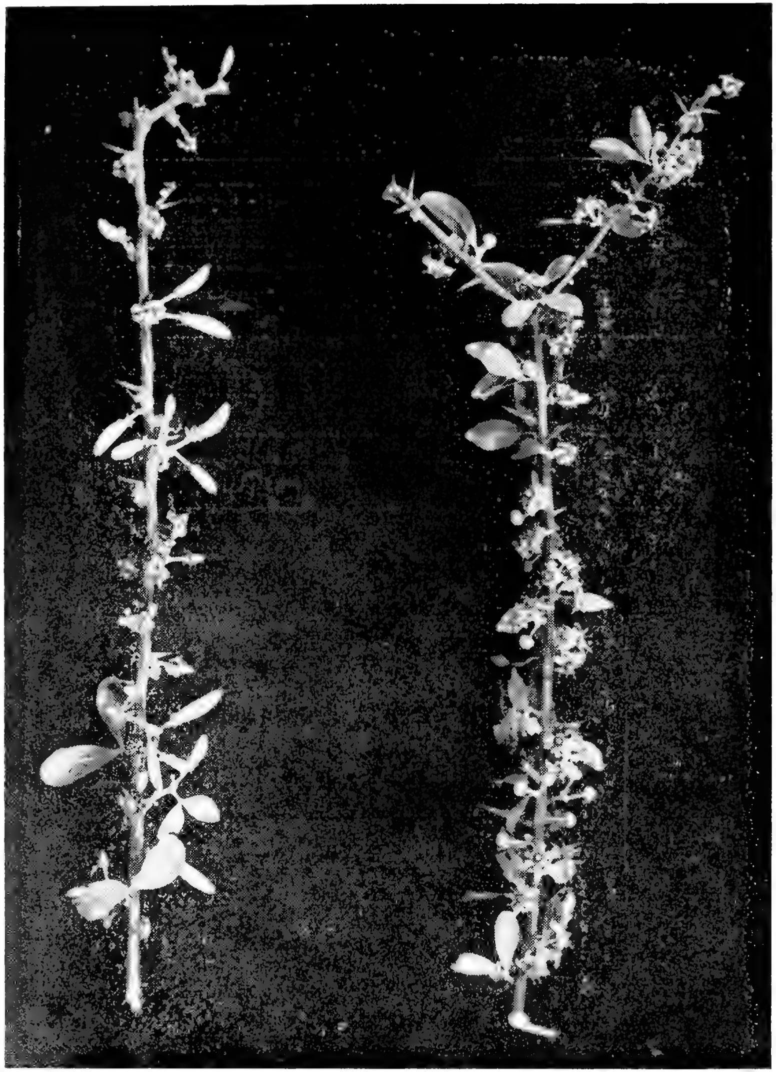

FIG. 1. Fruit set and Flowering in *Balanites* (April 1979).

FIG. 2. Mature fruits of *Balanites* (November 1979).

Nearly 30 per cent of the fruits have been observed to be infected.

TABLE 2

OBSERVATIONS ON GROWTH, FLOWERING AND FRUITING OF *Balanites*

Height (m)	Basal Stem Girth* (cm)	Observations	
		Flowering	Fruiting
0.9	7.5	Less	..
1.0	10.0	Less	..
1.8	9.5	Good	?
2.3	13.8	Profuse	..
2.75	20.0	,,	Less
2.5	20.0	,,	Less
2.8	27.5	,,	Less
3.0	33.5	,,	Good
4.5	40.0	,,	Good
5.5	45.0	,,	Profuse
6.0	48.0	,,	Profuse

(* Girth of stem measured 10 cm above ground)

The fruits mature during November-December, while there is another flush of less profuse flowering during October-November. These flowers are either completely shed or in few cases, in certain localities, develop into small shrunken fruits which prematurely fall off. Some plants never flower at all during November.

The information on the age of flowering and fruiting in *Balanites* is inadequate. It is, however, generally believed that the tree starts flowering at the age of five years. The youngest tree which was observed to flower was 90 cm high with a basal stem girth of 7.5 cm. But, fruit setting was observed to start at an older age and the minimum height of the tree with fruits was about 250 cm with a basal stem girth of 20 cm (Table 2). Flower production and fruit setting was found to increase with age of the tree. Trees with more than 40 cm girth were observed to fruit profusely.

ACKNOWLEDGEMENT

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27. *PRIMULA MALACOIDES* FRANCH.—NATURALISED IN GARHWAL HIMALAYA

Primulas are well known for their attractive flowers and have always fascinated Horticulturists. As a result, many of the beautiful species known from wild sources are now coveted ornamentals in green houses. Quite a number of such species are often naturalised after escape and flourish in wild habitats. *Primula malacoides* Franch. is one such species which has now established itself in Garhwal Himalaya. This species was collected near the water pump house at Lansdowne in Dist. Garhwal growing in moist shady place (J. N. Vohra 10679).

In India *P. malacoides* is known as a garden plant and there are collections from Darjeeling Botanic Garden at DD Herbarium. It's running wild in the N.W. Himalaya hill station has not been reported so far. A short description of the species is given below for locating this handsome *Primula* in other hill stations also.

Primula malacoides Franch. in Bull. Soc. Bot. France 33 : 64.1886. Slender herb 20-30 cm high. *Leaves* cordate, broadly lobed; lobes incise-dentate, petiole exceeding the leaf-blade. *Flowers* in many flowered, 2-6 superimposed umbels. *Calyx* white farinose, accrescent in fruit. *Corolla* bluish ; limb obcordately lobed, upto 1.3 cm across. *Capsule* globose, included.

The specimen is deposited in the BSD herbarium under the above collection number.

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BOTANICAL SURVEY OF INDIA,
NORTHERN CIRCLE,
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December 4, 1979.

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SURENDRA SINGH

28. NOTE ON AMBEMOHOR PAT (*PANDANUS AMARYLLIFOLIUS* ROXB.) FROM WESTERN INDIA

(*With a photograph*)

Along the coastal districts of Western India, pieces of grass like leaves are often used in cooking to give pleasant flavour to rice. According to local inhabitants, such method of cooking rice has been practised from ancient times. The flavour is very similar to that of the choice variety of *Ambemohor rice* popular in hilly tracts of Maharashtra and hence the local name of the plant is *ambemohor-pat*. It is also known in Ratnagiri and neighbouring districts of Maharashtra as *annapurna-pat*, a name, obviously given after the goddess of food *Annapurna*.

Lot of ambiguity exists about the correct identity of the plant. The plant multiplies by producing suckers and does not flower in spite of various types of environmental conditions provided. Nobody has witnessed or recorded flowering of this particular plant. Fusiform stilt roots at the base and pleat nature of leaves certainly show its affinity with *Pandanus*.

William Roxburgh named this particular plant as *Pandanus amaryllifolius* and published a short description in the flora 'Hortus Bengalensis' in 1814. He has also mentioned that the plant was introduced from Amboyna (now Indonesia) into the Botanical Garden of Calcutta in the year 1798. Roxburgh was quite confident about the likeness of the relevant plant with the genus *Pandanus* which shows fusiform roots arising from stem and larger branches, descending towards ground. He did not, however, give any information about the flowering of the plant and its scented leaves used for giving fragrance to cooked food. Later on a number of botanists working on the flora of South-east Asia like Voigt (1828), Hasskel (1842, 1844), Rumphious (1844), Merrill

(1917) and Ridley (1925) recognised the above plant by various botanical names.

Uncertainty in confirmation of the plant is mostly due to the unavailability of flowers and occurrence of two distinct ecotypes. Although the plant remains dwarf because of constant pruning, it grows into a shrub, 2.5-3 m in height if allowed to grow as a wild plant under a typical tropical environs. There is a report (Stone 1979) that the plant did flower in Botanic Gardens, Singapore in 1974. Unfortunately it was overlooked and by the time its importance was realised the inflorescence had dried out. Only the staminate flowers could then be collected and preserved. Since then pistillate flowers have not been observed or reported till this date. *Ambemohor-pat* is known by various names in South-Asian countries (Stone 1979) and ' Pundan wangi ' is the most popular name in Malaysia.

Stone (1976) noted that *Pandanus* with musk-odoured leaves occasionally seen planted in the kitchen gardens in Hassan district of Karnataka State, South India was dwarf cultivar of *Pandanus amaryllifolius* Roxb. In 1979, he further elaborated his findings by studying critically morphological diagnostic characters of this species. Electron microscope observations of leaf surface and other relevant literature available from European and Asian Herbaria finally confirmed the identity of the plant as *Pandanus amaryllifolius* Roxb., which had till then dubious recognition from the time of its naming.

Ambemohor-pat popular in Konkan area is a dwarf cultivar, reaching a maximum height of about 100 cm, if proper support is provided in the absence of which it becomes prostrate or procumbent. Constant pruning of the leaves forces the stem to grow erect, bearing tuft of leaves and short branches at the top (See the photograph). Even under this condition, side short branches give stilt roots. If such cultivars

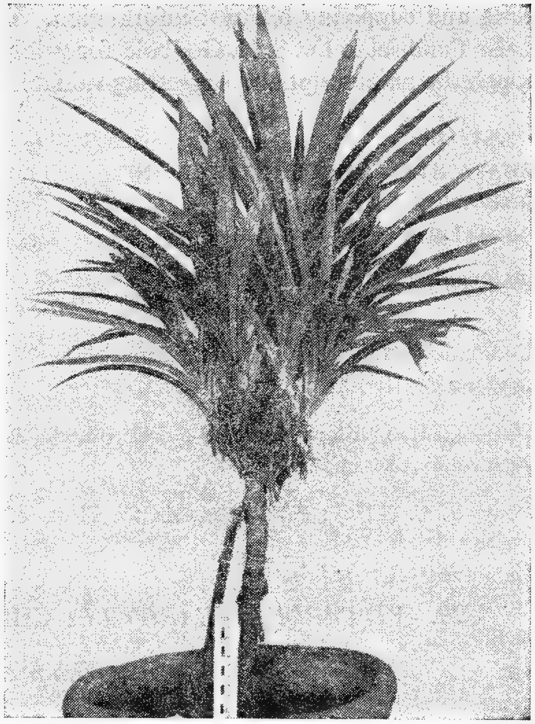

Photo : Ambemohor-Pat (*Pandanus amaryllifolius* Roxb.)

are planted in moist soil they grow vigorously into new plants. Leaves are 60-80 cm long, 4-8 cm broad, linear, lanceolate, dark green above, pale beneath, pleat along the two lateral ribs ; apex acute ; margins minutely prickled. Occurrence of female or male inflorescence has not been recorded or seen.

Fresh leaves are slightly scented but the fragrance becomes stronger when the leaves are crushed or boiled with food.

Reference specimens : RATNAGIRI—Thorla Sada, H-MACS 20860 ; POONA—cultivated H-MACS 21540.

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29. *VITTARIA LINEARIFOLIA* CHING—A NEW RECORD FOR INDIA

(*With five text-figures*)

In the course of studies on ferns of the genus *Vittaria* J. Sm. in India, I came across a peculiar specimen, collected from Arunachal Pradesh, characterised by its long linear, flexuose leaves, strongly incurved margins and midrib broader than the soral line. With the help of literature (Ching 1931)[1], the specimen was identified as *V. linearifolia* Ching and the identification was confirmed at Kew by Dr. G. Panigrahi.

V. linearifolia Ching is earlier reported from Tibet, Yunnan, and Burma, therefore, its occurrence in Arunachal Pradesh is a new record for the Indian region.

The species is described in detail with illustrations to facilitate its easy identification.

[1] Ching, R. C. (1931): The studies of Chinese ferns VI. Genus *Vittaria* of China and Sikkim—Himalaya. *Sinensia* **1** (12): 175-199.

Vittaria linearifolia Ching, Sinensia **1** (12): 183, t. 1, figs. 1-3, 1931.

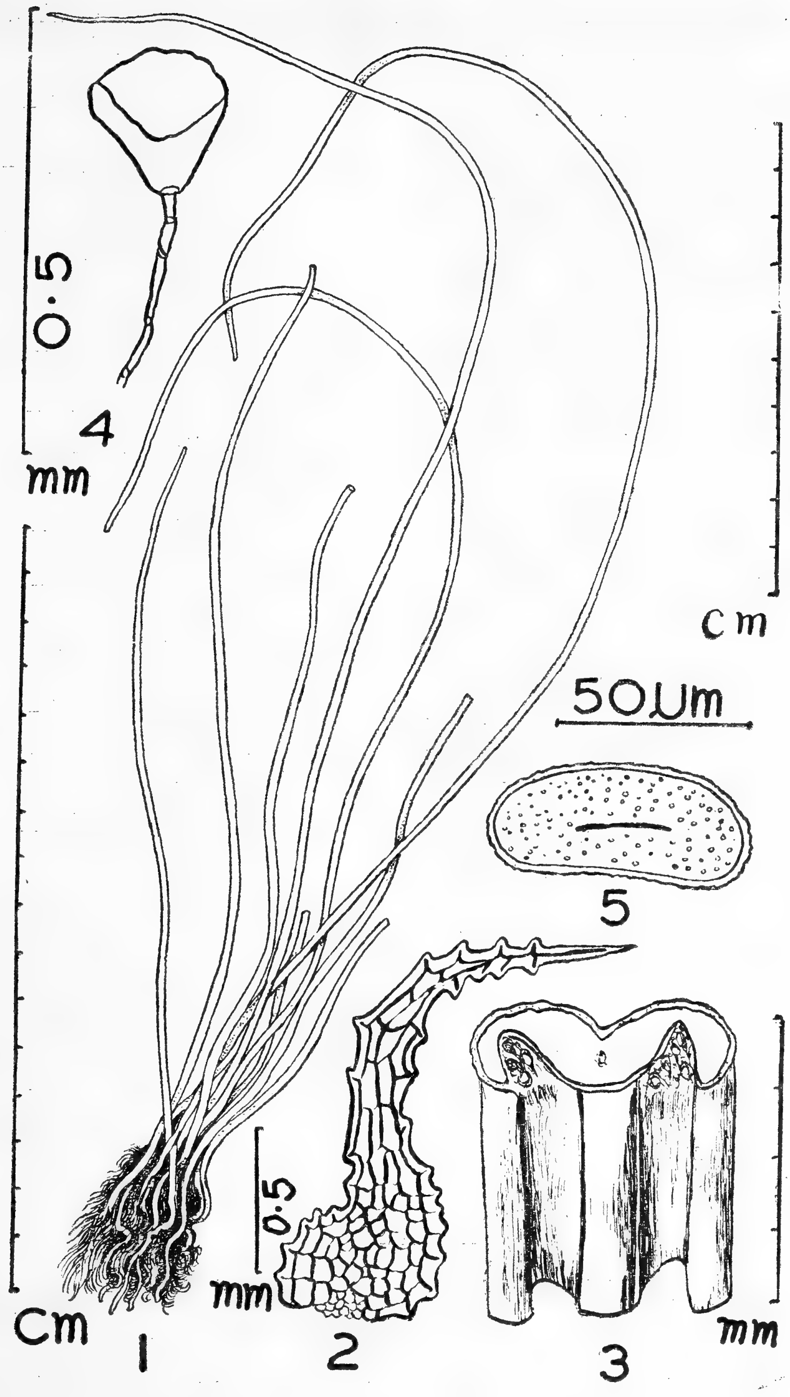
Plants epiphytic on moss covered tree trunks and branches. Rhizome creeping, clothed with many clathrate scales, ovate-lanceolate, 1-1.5 × 0.4-0.6 mm and margins dentate, Fronds tufted, stipes short, 3-5 mm long, leaves linear-lanceolate, 30-35 cm × 2-3 mm; flexuose, texture rigidly coriaceous but fragile on drying, margins strongly involute, midrib flattened and broader than the soral line, upper surface plane, lower surface longitudinally bisulcate. Sori intramarginal, completely filling up the space between midrib and margins; paraphyses capitate, spores monolete, 30-65 μm, verrucoid (Figs. 1-5).

Specimen examined: Arunachal Pradesh: Kameng district: Bomdila, *R. S. Rao* 7336 (ASSAM).

R. D. DIXIT

BOTANICAL SURVEY OF INDIA,
ALLAHABAD, U.P.,

November 26, 1979.



FIGS. 1-5. *Vittaria linearifolia* Ching.

1. Habit *Rao* 7336 (Assam); 2. Scale; 3. Part of leaf enlarged; 4. Paraphysis; 5. Spore.

30. SOME NEW HOSTS FOR *DENDROPHTHOE FALCATA* (LINN.F.) ETTINGH (*LORANTHUS LONGIFLORUS* DESR.)

One of the characteristic features of *Dendrophthoe falcata* (Linn.f.) Ettingh is its non-specificity in the selection of host plants (Fischer 1926, Sambandam 1966, Sampathkumar and Kunchithapatham 1969, Sampathkumar 1970). Although the selection of host plants is entirely at random, experimental evidence indicates that this parasite has its own spectrum of hosts controlled by some factors one of which seems to be osmotic pressure relationships between the host and the parasite. Evidence in support of this concept has been gained recently by the study of osmotic pressures of the different hosts as compared with the parasite. Interestingly, despite the large number of host plants recorded so far for this parasite, the monocots have been excluded completely and there is but a single report (Fischer 1926) of a gymnosperm host (i.e. *Pinus longifolia* Roxb.). In an earlier communication (Sampathkumar 1970) it was pointed out that the seeds of *D. falcata* germinate initially forming a massive haustorium in all the 'host' plants, but the fate was decided only when the haustorium penetrated the host tissue.

In the present paper, sixteen new hosts species have been listed from this locality, as given below :

1. *Atalantia monophylla* (Roxb.) DC.—
   Rutaceae
2. *Swietenia macrophylla* King.—
   Meliaceae
3. *Sesbania grandiflora* Pers.—
   Papilionaceae
4. *Crotalaria striata* DC.—
   Papilionaceae
5. *Cassia marginata* Roxb.—
   Caesalpiniaceae
6. *Rhizophora candelaria* DC.—
   Rhizophoraceae
7. *R. mucronata* Lamk.—
   Rhizophoraceae
8. *Acacia cunninghamii* Hook.—
   Mimosaceae
9. *Chomelia asiatica* O. Kze.—
   Rubiaceae
10. *Mimusops roxburghiana* Wt.—
    Sapotaceae
11. *Ervatamia coronaria* Stapf—
    Apocynaceae
12. *Nerium indicum* Mill—
    Apocynaceae
13. *Argyreia bella* (C. B. Clarke) Raizada—
    Convolvulaceae
14. *Excoecaria agallocha* Linn.—
    Euphorbiaceae
15. *Codiaeum variegatum* (L.) Bl.—
    Euphorbiaceae
16. *Jatropha gossypifolia* Linn.—
    Euphorbiaceae

While fifteen of the new hosts observed here belong to the ten families of dicots reported earlier, one new family (i.e. Convolvulaceae) has been added to the existing number of host families. Experimental observations are still well under way and it is hoped that some more new host species are likely to appear in future.

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January 12, 1980.

R. SAMPATHKUMAR
R. SELVARAJ

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CONTENTS

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CONTENTS

(p. 365); 5. Burrowing behaviour of *Rattus meltada pallidior*. (*With a text-figure*). By B. D. Rana and B. K. Soni (p. 370); 6. Notes on weight and size at birth of eight species of Indian Wild Ungulates in captivity. By L. N. Acharjyo and Ch. G. Mishra (p. 373).

BIRDS: 7. Ecology and behaviour of Great Indian Bustard (Family Otididae). By B. S. Kulkarni (p. 375); 8. Occurrence of the Sooty Tern (*Sterna fuscata*) in Bombay—An authentic record. By V. C. Ambedkar (p. 377); 9. Extension of range of Brown Wood Owl, *Strix leptogrammica*. By S. Dillon Ripley (p. 378); 10. A note on the feeding habits of Swifts (Apodidae: Apodiformes). By S. Thirumurthi and D. Krishna Doss (p. 378); 11. Golden Oriole *Oriolus oriolus* feeding a fledgling Cuckoo (*Cuculus* sp.). By Shaeque Ahmed Yahya (p. 379); 12. Large Racket-tailed Drongo and Common Babbler. By Asad Rafi Rahmani (p. 380); 13. On the validity of *Irena puella sikkimensis* Whistler & Kinnear and *I. p. andamanica* Abdulali. By Humayun Abdulali and Nosherwan Sethna (p. 381); 14. On the first record of occurrence of three Passerine Birds from Andhra Pradesh. By N. Majumdar (p. 382); 15. Extension of range of the Indian Maroonbreasted Sunbird, *Nectarinia lotenia hindustanica* (Whistler) [Aves, Nectariniidae], and the Northern Jungle Myna, *Acridotheres fuscus fuscus* (Wagler) [Aves, Sturnidae]. By N. Majumdar (p. 383); 16. Preliminary studies on the Graminivorous Munias (*Lonchura* spp.) of Bangalore. By Abraham Verghese and A. K. Chakravarthy (p. 384); 17. Siskin (*Carduelis spinus*) in Solang Nalla, Himachal Pradesh. By A. J. Gaston and S. Chattopadhyaya (p. 386).

AMPHIBIA: 18. Juvenile Bull Frogs (*Rana tigerina*) feeding on flies on resting Buffaloes. By N. J. George (p. 387).

REPTILES: 19. Egg-laying and Nest-guarding behaviour of Estuarine Crocodile (*Crocodylus porosus*, Schneider) in Captivity. By L. N. Acharjyo and Ch. G. Mishra (p. 387); 20. Maternal behaviour in the Gharial [*Gavialis gangeticus* (Gmelin)]. (*With a text-figure*). By D. Basu and H. R. Bustard (p. 390).

FISHES: 21. Growth records of Grass Carp, *Ctenopharyngodon idella* Val. from Rankala Tank, Kolhapur. By Jay S. Samant (p. 392); 22. Bamboo bridge fishing with lift net. (*With a text-figure*). By Tej Kumar Shrestha (p. 395).

CRUSTACEAE: 23. Occurrence of a species of *Palinnotus* (Amphipoda) on Port Blair Shore (Andaman Islands). (*With fifteen text-figures*). By A. L. N. Sarma and D. G. Rao (p. 397).

ANNELIDA: 24. Anachoresis of Earthworms (*With a plate & a text-figure*). By Radha D. Kale, Kubra Bano and R. V. Krishnamoorthy (p. 400).

INSECTS: 25. Some entomological notes from a visit to the Valley of Flowers. By Naresh Chaturvedi (p. 402); 26. First record and a new host record of *Trichogramma chilotraeae* Nagaraja and Nagarkatti from the Punjab. By Maninder and G. C. Varma (p. 407); 27. The Carpenter Bee (*Xylocopa fenestra*) in the Indian Thar Desert. By Indra Kumar Sharma (p. 408); 28. *Catopsilia crocale/pomona*. By D. G. Sevastopulo (p. 409); 29. Role of parasites and pathogens in the natural control of Safflower Caterpillar, *Perigea capensis* Guen. By K. C. Paliwal and S. S. Jakhmola (p. 410); 30. Incidence of Jowar Army Worm, *Mythimna separata* (Walker) (Lepidoptera: Noctuidae) on maize cobs. By R. Govindan, J. S. Awaknavar, C. Thippeswamy and M. C. Devaiah (p. 412); 31. New record of *Pygaera restitura* Walker (Notodontidae: Lepidoptera) on poplar. By G. S. Mann.

BOTANY: 32. *Eupatorium capillifolium* (Dog-Fennel) naturalising in India. (*With a text-figure*). By K. M. Vaid and H. B. Naithani (p. 413); 33. Additions to the Flora of Bihar and Orissa-III. By M. Brahmam and H. O. Saxena (p. 415); 34. A short note on the occurrence of *Lasia heterophylla* Schott in Maharashtra. (*With two text-figures*). By S. K. Malhotra and K. Madhusudan Rao. (p. 417); 35. Notes on some plants records for Bengal. By J. K. Sikdar (p. 419); 36. Cultivation of endangered plants in South India. (*With a plate*). By A. V. N. Rao, A. K. Banerjee and A. Subramaniam (p. 421); 37. *Melochia nodiflora* Swartz (Sterculiaceae)—A New record for India. By P. V. Sreekumar and N. C. Nair (p. 424); 38. A reassessment of the taxonomic position and status of *Aglaia bourdillonii* Gamble (Meliaceae) with notes on the nomenclature of related taxa. By K. K. N. Nair (p. 425); 39. Two new combinations of the genus *Asemanthia* (Stapf) Ridley (Rubiaceae). By A. K. Sinha and B. Mitra (p. 427).

Nestlings and fledglings of three Indian cuckoo species.

Top: Nestling of the Himalayan Cuckoo *Cuculus saturatus* from the nest of the Mountain Leaf Warbler *Phylloscopus trivirgatus*. Curug Cimahi, SW-slope of Mt. Pangrango, at 1700 m. W. Java, Indonesia. leg; Dr. M. Bartels Jr., 30 April 1942, RMNH reg. no. 80712.

Middle: Nestling (to the left) and fledgling (to the right) of the Bay Banded Cuckoo *Cacomantis sonneratii* fostered by the Common Iora *Aegithina tiphia*, Bogor, W. Java, 450 m, collected on 18 February 1945 (nestling) and 16 July 1941 (fledgling) by J. H. Becking. Fledgling specimen in RMNH reg. no. 24181,

Bottom: Nestling of the Drongo Cuckoo *Surniculus lugubris* from the nest of Horsfield's Babbler *Trichastoma sepiaria*, Botanic Gardens, Bogor, W. Java, 450 m, collected on 21 April 1945 by J. H. Becking. Specimen in RMNH reg. no. 24184.

[Colour painting by P. Barruel (France), except nestling of *Cacomantis sonneratii* which was painted from a live chick by Gusti Abdul Kadir (Bogor, Indonesia)].

× 0.7,

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NOTES ON THE BREEDING OF INDIAN CUCKOOS[1]

J. H. BECKING[2]

(With 1 coloured and 9 black-and-white plates and a text-figure)

INTRODUCTION

In spite of all that has been published by Baker (1906-07, 1907-08, 1934, 1942) and others, unequivocal data on the breeding of Indian parasitic cuckoos are, by and large, lacking. Much of what exists is of a dubious nature, and some eggs ascribed to this or that species appear to be wrongly identified or even not cuckoo eggs at all.

For this reason a thorough-going investigation of Indian cuckoo eggs *de novo* is an urgent need. A first attempt to this is made in the following pages. Objective criteria for the identification of cuckoo eggs are presented, and some corrections of earlier information are given. The present data were collated with a view to their incorporation in the new edition of the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, vol. 3, by Sálim Ali and S. D. Ripley (1969). For this reason the various species are treated in the same sequence as in the HANDBOOK. Extensive use has been made of the Catalogue of 'Cuckoo Eggs' (as marked on the spine) by Baker in the BM(NH) containing all original data and labels of his egg collection. The cuckoo egg catalogue is quite separate from the catalogue of other eggs (i.e. Catalogue of Indian Eggs, 18 volumes), it is hereafter referred to as Baker's catalogue (Baker, 1944).

In the present treatise advanced morphological techniques (scanning electron microscopy) and biochemistry (egg-white protein electrophoresis) are correlated with egg descriptions and field studies. Since many readers of this journal may have the opportunity for field work on Indian cuckoos, this study starts with some notes and suggestions which it is hoped may be helpful. For the same reason, in addition to ultra-structure micrographs of eggshells, some photographs are included of young cuckoos in nests as well as a colour plate of fledgling stages of some Indian cuckoos.

[1] Accepted May 1980.

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Field Studies

Field work on Indian and Asiatic cuckoos is still much needed. Very little is known not only of the breeding habits of Indian cuckoos, but also of their population ecology and territorial behaviour. In some species (e.g. *Cacomantis* species) the males apparently have fixed territories, calling regularly from the same look-out points during the breeding season, although territories may shift slightly from year to year, probably due to local environmental conditions and fluctuations in the numbers of their hosts (pers. observation, especially for *Cacomantis variolosus* and *C. merulinus*). For *Cuculus canorus*, it has been shown that in one territory one female was dominant and prevented other females so far as possible from laying in and robbing suitable nests in her territory. This female, which was associated with at least 2 males, laid by the end of the season a minimum of 12 eggs (Wyllie, 1975).

Sympatric cuckoo species probably occupy different ecological microniches with respect to habitat and food, and mainly exploit different foster species. In some species such as the Himalayan Cuckoo *Cuculus saturatus* northern migratory races may be temporarily sympatric with sedentary races. The resident race may even breed during the sojourn of the northern subspecies; whereas the resident race is vocal, the migratory race is always non-vocal.

Some cuckoo species appear to be generally solitary. Thus calling males of the Himalayan Cuckoo *Cuculus saturatus* are often observed singly; females are far more elusive as they do not advertise themselves. In contrast the Indian Cuckoo *Cuculus micropterus* is regularly observed in trios consisting probably of two males and one female; while so engaged the female occasionally advertises herself by a bubbling note. Nevertheless it is striking that the Bartels collection (now in the Rijksmuseum van Natuurlijke Historie (RMNH) Leiden, The Netherlands), which was collected in all seasons and probably more or less at random, contains 61 specimens of *Cuculus saturatus* of the Javanese breeding race *lepidus* of which 35 (57%) are males and 26 (42%) females among which 12 (46%) are in the hepatic (i.e. red) phase. However, of the Indian Cuckoo *Cuculus micropterus*, this collection contains 7 specimens of the Javanese sedentary race *concretus* of which only one (14%) is female. It is difficult to accept these differences as a mere coincidence.

It is highly desirable to make estimates of numbers of cuckoo species in well-defined biotopes and if possible with an estimate of sex ratios, which is very difficult in the field because of the usually non-vocal and cryptic behaviour of the females. These data should be related to quantitative data on foster species present.

In the absence of sufficient foster species within a biotope female cuckoos may dump eggs in nests of species not normally parasitised. Some of these are not even 'biological' hosts because they cannot rear a cuckoo beyond hatching. For instance, an exclusive seed-eater such as the Linnet *Carduelis cannabina* in Europe can never rear a cuckoo, although eggs of *Cuculus canorus* are regularly found with this fosterer. Therefore, a distinction should be made between non-biological and biological hosts. Biological hosts are foster species capable of raising a cuckoo beyond hatching.

Egg dumping seems to be a rather regular phenomenon among parasitic cuckoos, since in addition to *Cuculus* it has been observed in the genus *Cacomantis* (pers. observation) and in *Clamator* (Vernon, 1970). Apart from this, in *Clamator* often more than one egg is laid in the same nest, which appears to be a biological adaptation since *Clamator* chicks do not show the eviction response and the adult cuckoos do not remove foster eggs from the nests. Multiple laying has been shown for the Pied Crested Cuckoo *Clamator jacobinus* in Africa in 21.6% of the parasitized nests (Liversidge, 1971), while for the same species in India in 39% of the cuckolded nests (17 out of 44) cuckoos' eggs were laid in Jungle Babblers' nests which already contained one (Gaston, 1976). Often only the cuckoo fledgling(s) survive by monopolizing the food, but there is good evidence that in some cases (especially when the cuckoo egg is laid in a nest with incubated foster eggs, thus giving the foster fledglings a start) both the young cuckoo(s) and some foster fleldglings are successfully raised (R. M. Adam, cited by Hume and Oates, 1890; Bates, 1938; Gaston, 1976). *Clamator* species which parasitise babblers *Turdoides* spp. have in addition the advantage (or adaptation?) that the young are fed by foster groups, so-called helpers at nests, which reduces the possibility of limitation of food supply (Raj, 1964; Andrews and Naik, 1970; Zacharias and Mathew, 1977, Gaston, 1977, 1978). Survival of one or two cuckoos besides host nestlings is more the rule than the exception in the case of the Great Spotted Cuckoo *Clamator glandarius* and the Koel *Eudynamys scolopacea.*

Cuckoos may lay directly in the nest of the foster species. This has been observed and confirmed by cinema documentation in the case of *Cuculus canorus* with the Meadow Pipit *Anthus pratensis* (Chance, 1940; Seel, 1973) and the Reed Warbler *Acrocephalus scirpaceus* (Wyllie, 1975). In the Pied Crested Cuckoo *Clamator jacobinus* parasitizing a Jungle Babbler *Turdoides striatus* nest, it was observed that the cuckoo did not settle into the cup, but perching *c.* 15 cm above the babbler's nest dropped her egg into it; the impact caused some damage to one babbler's egg (Gaston, 1976). Direct laying into the nest cup or dropping into the nest cannot be readily visualized in the case of foster species with nests with small (side) entrances (hole breeders) and in the tiny, very fragile and enclosed pocket-shaped nests of tailorbirds *Orthotomus* spp. parasitized by *Cacomantis merulinus*, or certain nests of Nectariniidae (sunbirds) or the Flyeater *Gerygone sulphurea* parasitized by *Chrysococcyx* species. There is no authentic record of a cuckoo egg being laid on the ground and transported to the parasitized nest in the throat or beak in spite of some literature citations (e.g. Tutt, 1955). Female cuckoos have been observed to carry eggs of the host species in the beak and to eat them. As early as 1938 Livesey (1939) saw a Khasi Hills Cuckoo *Cuculus canorus bakeri* steal and eat an egg from the nest of the Burmese Stonechat *Saxicola caprata burmanica.* Stealing of the eggs of foster species is apparently a common habit of female cuckoos and probably a substantial source of food for them. A high incidence of nest robbing was also observed by Wyllie (1975) in *Cuculus canorus* parasitizing Reed Warblers *Acrocephalus scirpaceus* (at least 19 fresh eggs and two four-day old nestlings were taken in one season). Löhrl (1979) established from aviary observations that the egg-stealing behaviour is restricted to the female and that the stolen eggs are swallowed whole. Besides being a substantial protein and lipid nutritional source, they are probably also an essential source of calcium in the diet. One encaged female cuckoo swallowed 65 Passerine eggs in one breeding season. The egg-stealing habit of some cuckoos is probably the basis of the supposition that cuckoos transport their eggs to host species' nests as it is often difficult in the field (and sometimes even in the hand!) to distinguish between a fosterer's and a cuckoo's egg, and to be sure whether the egg is being transported to or from the nest.

Cuckoo eggs are generally characterized by thick shells and relatively short incubation periods (especially in relation to egg size) of 11-13 days, usually shorter than that of the fosterer's eggs. The short incubation period of cuckoo eggs is probably related to the fact that the egg is retained one day in the oviduct (laying intervals of 24 h) and that in some cuckoos, e.g. *Clamator* spp., the egg when it starts its development in the host nest is approximately 17-20 hours in advance of a normal chick embryo at time of laying (Liversidge, 1961; Vernon, 1970). This pre-incubation embryonic development is probably a general and basic feature of cuckoo's eggs as it has also been observed in *Cuculus* species (Hellebrekers, 1963; Perrins, 1967).

Egg Collections

Existing egg collections such as the Baker collection often contain material obtained near or outside the present borders of India, e.g. the Khasi Hills in Assam and parts of Upper Burma. This is probably due to the fact that collecting was mainly done as a pastime by military people, and by people working on estates in these localities. In these regions a full assortment of congeneric cuckoo species is usually present, so that there was much speculation as to the ownership of the supposed cuckoo eggs. Further, the collectors' own observations were often limited, and they bought eggs in some cases rather indiscriminately, from local inhabitants and paid good prices particularly for cuckoo eggs. This stimulated the production of odd clutch combinations or falsifications. Hence, the very extensive egg collections made in the past (e.g. more than 2,000 eggs of the Khasi Hills Cuckoo *Cuculus canorus bakeri* in the Baker collection) have contributed little to the better knowledge of the breeding biology, brood parasitism or ecology of cuckoos. In particular, many eggs of the Baker collection are of dubious identity and a number of supposed cuckoo eggs are in fact not cuckoo eggs at all. Even for the apparently locally rather common Khasi Hills Cuckoo, the incubation period has to my knowledge never been determined.

In this context, it should be stated that it is far more profitable *not* to collect the supposed cuckoo egg, but to let it hatch. Young cuckoos hatched from well-documented eggs (i.e. measured and described) would allow a proper identification of the cuckoo species involved. Nestlings and fledglings of cuckoos are often rather difficult to classify without adequate comparative material. Even experienced taxonomists have made mistakes with regard to this. For instance the supposed nestling of *Surniculus lugubris* in the nest of *Seicercus castaniceps* (Robinson, 1927; Chasen, 1939) is in fact that of *Cuculus saturatus* (see this study). It is advisable, when the identification of a cuckoo nestling is not absolutely certain, to collect it and deposit the skin in one of the major museum collections for subsequent identification and more general use.

Cuckoo Nestlings

As an aid to identification, Plate 1 depicts the nestling and fledgling plumages of some less-known Indian cuckoos. In addition, some plumage descriptions of juvenile cuckoos are given in the text and partially illustrated in black-white photographs under the headings of the various species discussed.

At all stages, even when just hatched, cuckoo nestlings are distinguishable from the host species. Just hatched cuckoo nestlings are completely naked and, because of their shorter incubation period, they usually hatch before the foster-species (Plate 2). They can easily be told apart from host nestlings by their conspicuous crimson red mouth lining (palate), which probably functions as a visual signal and stimulus for feeding (see Plate 1), and by their completely circular nostrils, which are often a little raised. Foster species like all Passerines have elongated nostrils. This feature of the nostrils is particularly prominent in recently hatched nestlings of representatives of the cuckoo genera *Cuculus*, *Cacomantis* and *Chrysococcyx*, but it does not hold for nestlings of the genus *Clamator* which have rather oblong nostrils. Moreover, nestlings of the latter genus do not have a hollow back and apparently do not actively evict their nestmates as do the nestlings of other parasitic cuckoos. Finally, cuckoo species possess in contrast to Passerines a zygodactylous foot structure, in which the second and third toes are directed forward, the first and fourth backward (see Plate 1).

As will be discussed in the following sections, some cuckoo species show a rather specialized host choice, being nearly one-host parasites, whereas others like the Khasi Hills Cuckoo *Cuculus canorus bakeri* have a multiple host range. However, in the latter species, special populations ('gentes') showing egg mimicry adapted to a certain host species may exist. A more detailed study of cuckoo nestlings will certainly be very rewarding, since to my knowledge the incubation period and nestling and fledgling periods have not been determined for any Indian cuckoo. So far no accounts have appeared describing individual laying histories, clutch size and number of eggs per season with respect to Indian parasitic cuckoos.

Cuckoo Egg Identification

It has always been claimed that the only genuine cuckoo egg (at least for the less known species) is the oviduct egg. It should, however, be remembered that these eggs laid in the death struggle or freed from the oviduct by dissection often lack the external superficial eggshell layers and therefore can seldom give reliable information on the ultimate colour and pattern of normally delivered eggs.

In the case of cuckoos whose eggs match the fosterer's eggs perfectly, it is often difficult to decide whether a true cuckoo egg is involved or not. Also it is often very difficult to discriminate between a cuckoo egg and a dwarf egg of the host species or an egg that is slightly aberrant in colour. However, irrefutable criteria are now available allowing us to identify a supposed cuckoo egg beyond any doubt. These criteria involve two quite unrelated characters: first, the eggshell surface ultra-structure, and secondly egg-white proteins. Metaphorically, the first can be regarded as the envelope of the message, the second as the letter itself.

With respect to eggshell structure, Becking (1975 a, b) has shown that ultra-structural characteristics, as revealed by scanning electron microscopy, can be used to distinguish cuckoo eggs from the eggs of Passerine fosterers. Cuckoo eggs possess a rather smooth eggshell surface of polyangular and triangular somewhat raised faces. They have also a very peculiar and characteristic type of eggshell pores with a cracked surface and plugged with granular material probably of organic nature (see Plate 3 and 10). In contrast, Passerine eggshells show a far more irregular surface dotted with numerous small pits (see Becking, 1975 a, Plate 10 a).

With regard to egg-white proteins, Sibley (1970) and Sibley and Ahlquist (1972) have shown that the gel electrophoretic patterns of egg-white proteins of Non-Passerine and Passerine birds are fundamentally different. In this context we have studied the starch gel electrophoretic patterns of egg-white proteins of cuckoo species and compared them with the foster species, if possible from the same clutch as the cuckoo egg (Becking, in preparation). Cuckoo egg-white proteins showed a characteristic and distinct pattern of protein bands compared to the proteins of Passerine eggs. In addition to specific differences in proteins of the same group, as evident from differences in the displacement rates, cuckoo egg-white generally exhibits strong ovalbumin bands, which are usually very faint or lacking in Passerine egg-white proteins. Moreover, in Passerine egg-white proteins their similarity was greater, the closer they were phylogenetically (and therefore taxonomically) related, as evident from the comparison of the egg-white proteins of Sylviinae (1) and (2) in Plate 4. Thus egg-white protein patterns may give clues to taxonomic relationships.

With the far more sensitive iso-electrofocusing electrophoresis technique using poly-acrylamide gels with a pH gradient obtained by ampholines, the resolution and separation of the individual protein bands is markedly increased. Applying a more restricted pH range over the same gel width, the resolution of the protein bands is still more increased. In this way, a distinct pattern of proteins can be obtained, which makes it possible to distinguish between the egg-whites of cuckoos at the species level. So far this has only been done for some African cuckoos, because egg-whites of these were available. But when egg-whites, preferably in combination with eggshell samples, of Indian cuckoos become available, this method will certainly enable us to discriminate between cuckoo species of this region. Such a study will be particularly important for the proper re-classification of Indian cuckoo eggs present in existing collections (e.g. the Baker collection), of which a considerable number are rather doubtfully identified.

Enumeration of species discussed

The following species are listed according to the sequence of the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, vol. 3 (Ali and Ripley, 1969).

In the egg descriptions in some exceptional cases the numbers of the eggs (clutches) of the Baker collection and catalogue are cited. These numbers, divided into box and clutch number, are still retained for the Baker collection in the British Museum in Tring. By these numbers any individual egg of the Baker collection can be found and so can be re-examined if this proves to be necessary.

In the egg descriptions some less known egg parameters are used, i.e. *shape index* (egg length : maximal egg width), *Rey's eggshell weight index* (egg length × width in mm divided by eggshell weight in mg) and *relative egg weight* (% egg weight of body weight of bird). Rey's index is the reverse of the so-called '*Ratcliffe-index*' (see Ratcliffe, 1970) used as a measure of eggshell thinning in the eggs of raptors and other birds caused by ingestion of chlorinated hydrocarbon residues. In the present study Rey's index is preferred since it gives indices above 1.0 for the eggs of all cuckoos and Passerines. Moreover, Rey's index is of older date (Rey, 1894; 1897).

In some of the descriptions of the cuckoo eggs for more precise colour indication Ridgway's (1912) colour nomenclature is used.

Clamator coromandus

REDWINGED CRESTED CUCKOO

BREEDING. Brood-parasitic mainly on Himalayan laughing thrushes, *Garrulax* species. The commoner hosts are *Garrulax pectoralis* and *G. moniligerus*, followed by *G. striatus*, *G. de-*

lesserti, *G. squamatus* and *G. caerulatus* in decreasing frequency of parasitization. Parasitizes also, but far less commonly, a number of other bird species, which may be regarded as accidental or abnormal (probably even non-biological) foster species. Baker (1942: 196-7) gives a full list of other fosterers, but some of the eggs cited are of doubtful identity.

Eggs, pale glaucous blue in various tints and shades, unmarked. Shape broad elliptical, sometimes nearly spherical with round nearly equal poles. Eggshell texture fine, eggs mostly glossless. Eggs usually matching the eggs of the fosterer perfectly, but often the cuckoo egg has a different shade of blue and less gloss. As a rule the *Clamator* egg is distinguishable by its nearly perfect spheroidal or obtuse elliptical shape (shape index : av. 1.17) and the absence of any gloss. Laughing thrush eggs are usually glossy and show a marked difference between the small and large end. Red-winged Crested Cuckoo eggs have extremely thick shells, being about double the thickness of the fosterer's eggshells (*Clamator* 200-204 μm, *Garrulax* spp. 103 μm). The considerable thickness of the *Clamator* eggshell is also evident from the Rey's index (length × width of the egg in mm divided by shell weight in mg), which in *Clamator coromandus* is near to 1.0 (av. 1.08), and in *Garrulax* species 1.56-1.84. This parameter therefore offers a good criterion for discriminating cuckoo eggs from fosterer eggs. Average of 50 *Clamator coromandus* eggs 26.9 × 22.8 mm, shape index 1.18 (Baker, 1934). Average of 8 eggs examined by me: 27.4 × 23.4 mm, shape index 1.17, av. shell weight 0.6014 g, Rey's index av. 1.08 (0.93-1.19). Fresh egg weight 7.4-8.0 g. Average body weight 78.9 (70.5-96.0) g ($n = 9$), relative egg weight 9.4-10.1%. Scanning electron microscopy revealed that the *Clamator* eggs have pores with granular plug material, very similar to the eggs of other parasitic cuckoo genera (*Cuculus, Cacomantis,* and *Chrysococcyx*). Eggs can be distinguished from those of the Pied Crested Cuckoo *Clamator jacobinus* by their larger size and a different surface ultra-structure of the eggshell.

Nestling cuckoo is thought to evict the rightful nest-mates from the nest, because *Garrulax* nests containing only one *Clamator* cuckoo have been regularly observed (Osmaston, 1916). However, this needs verification as the actual act of eviction of eggs or nest-mates, as in *Cuculus* and *Cacomantis,* has never been observed. The elimination of the nest-mates is probably due to starvation or trampling or by spread-eagling of the young cuckoo over the fosterer's young, preventing the chicks from lifting their heads when the parents come to feed, as observed in *Clamator jacobinus* in Africa and Asia. Two or more (up to 4 recorded) eggs of *Clamator* are sometimes laid in the same *Garrulax* nest. Occasionally also the same *Garrulax* nest is parasitized with an egg of *'Cuculus sparverioides'*. The blue eggs of the latter species I consider, however, to be eggs of *Cuculus canorus bakeri* (see later). Osmaston (1916) reported the occurrence of two *Clamator coromandus* young in the same *Garrulax* nest, which both survived and reached the fledgling stage. Initially this particular *Garrulax moniligerus* nest (Maymyo, 1100 m, Shan Plateau, Upper Burma; 22°01′N, 96°28′ E) contained the surprise packet of 3 young of the fosterer, 2 young of *Clamator coromandus,* and 1 egg of *'Cuculus sparverioides'*. One week later, it contained only two *Clamator* young, the *Garrulax* young having succumbed probably to starvation and trampling.

Fledgling plumage is rufous with pale bars above and white below. Crest development takes place at *c.* 5 weeks, and the young bird moults gradually into mature plumage at 3 months (Osmaston, 1916).

The Redwinged Crested Cuckoo is migratory and migrants on passage or rare stragglers are recorded from peninsular India. It winters only and does not breed in Ceylon (Phillips, 1948), and also occurs rather commonly as a winter visitor in South-East Asia (Malaysia, Indonesia). Thus, its migratory route is southeast, in contrast to the Pied Crested Cuckoo *Clamator jacobinus* which migrates southwest to continental Africa. This disparity in migration routes probably reflects a difference in evolutionary history of these species. The same difference is observed between *Cuculus saturatus* migrating southeast and *Cuculus poliocephalus* migrating southwest (see later).

Clamator jacobinus

PIED CRESTED CUCKOO

BREEDING. Brood-parasitic mainly on babblers of the *Turdoides* group, most commonly lowland and foothills species such as *T. striatus, T. caudatus,* and *T. malcolmi*. In the lower Himalayas laughing thrushes are presumably also victimized; *Garrulax lineatus* seems to be a popular host (Baker, 1934; 1942). The citation in the HANDBOOK (vol. 3, 1. c. p. 196) 'In Kashmir the Rufousbacked Shrike (*Lanius schach erythronotus*) is a frequent victim' needs verification, since this fosterer is not even mentioned by Baker (1934, 1942).

In Africa the Black-and-White Cuckoo *Clamator serratus* is now considered to be conspecific with *jacobinus*. The African breeding populations, which are all south of the Sahara, occur in three different colour phases in which the underparts are creamy white, grey on a creamy ground, or black. On the basis of these three morphs two races are usually distinguished in Africa, i.e. *pica* over the most of the African continent as well as Arabia and India, and *serratus* in South-East Africa. The Indian population winters in Africa, south to Natal, but irrefutable proof of migration (by ringing) from India to Africa is lacking (see Whistler, 1928; Simmons, 1930; Ali, 1931). Asian wintering birds, if they occur in Africa, are indistinguishable from white-breasted African birds (*pica*).

Like the Indian population, the African race *pica* parasitizes mainly babblers of the *Turdoides* group such as *T. plebejus*. Also like the Indian section it mainly lays blue eggs. Very rarely a white egg is reported, e.g. a white egg associated with a white-egg variety of *Turdoides plebejus* (Akokoro, N. Uganda, 2 April 1950; B.M. collection), if the identification is correct. On the other hand, the race *serratus* lays mainly white eggs and parasitizes bulbuls (*Pycnonotus capensis, P. barbatus,* and *Andropadus importunus*) and shrikes (*Lanius collaris*), and to a far lesser extent some other species but no babblers (Payne and Payne, 1967; Liversidge, 1969; Jensen and Jensen, 1969). In contrast to *pica,* for the race *serratus* only very rarely is a blue egg reported (also associated with *Pycnonotus barbatus*, Kenya, Konza, Machakos Distr., B.M. collection Reg. No. 1962. 9. 17), if correctly identified.

With the electron microscope ultra-structural differences were observed in the differently coloured eggs of the various populations and it is therefore possible that this taxonomically highly complex group is heterogeneous and in fact hetero-specific. It is remarkable that the related Striped Cuckoo *Clamator levaillantii* of Africa shows an egg ultra-structure related to the Indian forms of *Clamator jacobinus* and that like *jacobinus* this species mainly, and perhaps even exclusively, parasitizes babblers of the *Turdoides* group in Africa, i.e. *Turdoides jardinei, T. melanops, T. plebejus,* and *T. leucopygius* (Steyn, 1973; Steyn and Howells, 1975; Colebrook-Robjent, 1977, and B.M. collection). It is also remarkable that although bulbuls are plentiful in India. *C. jacobinus* has never been found to parasitize

Just hatched nestling of the Fan-tailed Cuckoo *Cacomantis variolosus* in the nest of the Rufous-backed Shrike *Lanius schach*. Coffee/Rubber Estate Dampar, Jember, East Java, Indonesia, 27 May 1937. × 1.0.

(Photo: *J. G. Kooiman*)

Scanning electron micrograph of the eggshell surface of a Fan-tailed Cuckoo *Cacomantis variolosus* egg showing the rather smooth surface with poly-angular raised faces and pores with granular pore-plug plaques, characteristic of parasitic cuculids. × 885.

bulbuls in India.

Clamator levaillantii has an extensive distribution on the African continent and is widely sympatric with *C. jacobinus*. Besides a blue egg, certain populations of *C. levaillantii* (i.e. in Nigeria) produce a pink egg associated with a pink egg-variety of *Turdoides plebejus* (B.M. collection). A more thorough electron microscopic survey of the eggshells of the various *Clamator* species, if possible in combination with egg-white protein analyses, would certainly clarify specific relationships in this rather complex and probably confused group of *Clamator* species.

Eggs of the Indian section of *C. jacobinus*, pale blue or sky blue, unmarked, varying in depth of tint, sometimes closely matching those of the fosterer, but usually lighter blue. Distinguishable from fosterer eggs by their usually larger size, more spherical/elliptical shape with rounded poles, and the absence of gloss. *Turdoides* eggs are generally very glossy and *Garrulax* eggs usually have a moderate gloss. Average of 100 *Clamator jacobinus* eggs, varying greatly in size, av. 23.9 × 18.6 mm (Baker, 1934). Shape index 1.28. Five eggs measured by me had a shell weight of av. 0.4609 g, fresh egg weight av. 4.5 (4.4-5.2) g, and Rey's index of 1.03-1.08. Eggshell thickness 140-161 μm, compared to *Turdoides c.* 101 μm and *Garrulax* species *c.* 103 μm. Average body weight of the African section 84 g (Payne, 1974), relative egg weight 5.4 (5.2-6.2) %, i.e. much smaller than in *C. coromandus*. Thus, although *C. jacobinus* is a heavier bird than *C. coromandus* it produces smaller eggs. This is correlated with the fact that *C. coromandus* parasitizes relatively large and *C. jacobinus* relatively small foster species.

Nestling *C. jacobinus* does not evict its nest-mates. Usually its nest-mates perish by starvation through monopolization of the food by the young cuckoo, jostling out of the nest or trampling. Newly hatched Pied Crested Cuckoos are naked and brownish to orange brown. Nostrils are oblong and not very prominent. Eyes open by the 2nd day. Mouth-lining red, with a yellow gape. Back not flat, but rather rounded. Nestlings darken till they are blackish dorsally by the pin-feather stage (morphological description for the African population by Skead, 1951). Feathered young are dull blackish-brown to brown above, slightly crested, and buffy white below. Faint white wing windows are discernible. Incubation for the South African population 11-12 days, i.e. rather short for such a large bird (Liversidge, 1969). An incubation of about 11 days, i.e. 3 days shorter than that of their host (Jungle Babbler), is reported for the Indian population (Gaston, 1976). Nestling Pied Crested Cuckoos also develop more rapidly after hatching, being ready to leave the nest at 11-12 days old compared to 14-16 days for the Jungle Babbler. The mean maximum rate of growth of nestling cuckoos was 6.5 g per day, compared with a mean of 5.2 g per day for Jungle Babblers *Turdoides striatus* which have the same sized egg, and 2.7 g per day for Common Babblers *T. caudatus* (Gaston, 1976). In a restricted area (forest near Delhi) 71.0% of the Jungle Babbler's and 38.7% of the Common Babbler's nests were parasitized (Gaston, 1976).

Multiple laying by the Pied Crested Cuckoo was quite regular. In the Delhi study area 39% cuckoo's eggs were laid in Jungle Babblers' nests which already contained one. In 8 out of 27 nests from which cuckoos fledged successfully at least one babbler was also fledged, and this was also true for 2 of 4 cases in which two cuckoos were fledged from the same nest. Young babblers disappeared only in cases where the cuckoo hatched 2 or 3 days before the first babbler, and was large enough to monopolize the food supply. Dead babbler chicks, clearly starved, were found in several nests containing young cuckoos (Gaston, 1976). Young cuckoos continued to be fed for 2-3 weeks after leaving the nest (Gaston, 1976).

The short incubation of cuckoo eggs is probably related to pre-incubation embryonic development. A newly laid egg has an embryo 17-20 hours advanced in development compared to a freshly laid domestic fowl egg-embryo (Liversidge, 1961). Embryonic development must also be very rapid; although for the African population parasitizing bulbuls the egg is about twice the host egg, its development is 2 days shorter (Liversidge, 1969).

Clamator jacobinus jacobinus

CEYLON PIED CRESTED CUCKOO

BREEDING. In Sri Lanka the locally common babbler, *Turdoides affinis taprobanus,* is the chief fosterer. Three eggs in the B.M. collection (Tring) examined by me were collected at Puttalam, Sri Lanka (8°02′N, 79°50′E) in April and May. *Eggs,* green glaucous blue with moderate gloss and of the typical more spherical/elliptical *Clamator* shape. Fosterer eggs, *Turdoides affinis,* were also deep blue, somewhat smaller and shell weights considerably lighter. *Clamator* eggs ($n = 3$): av. 23.8×19.6 mm, shell weight av. 0.4595 g, Rey's index av. 1.02 (0.97-1.06), fresh weight av. 4.7 (4.5-5.4) g. Host eggs ($n = 6$): av. 22.4×18.5 mm, shell weight av. 0.2576 g, Rey's index av. 1.62 (1.48-1.75), fresh weight 4.0-4.3 g. Eggshell thickness 156-165 μm, *Turdoides affinis* 100-102 μm.

Cuculus sparverioides

LARGE HAWK-CUCKOO

BREEDING. Brood-parasitic on the Streaked Spiderhunter *Arachnothera magna* and the Nepal Shortwing *Brachypteryx leucophrys.* The cuckoo eggs are uniform olive-brown and match rather closely the similar coloured eggs of the fosterer species except in size and shape. Baker (1934, 1942) also attributed a blue cuckoo egg in the nests of laughing thrushes *Garrulax* spp. to this cuckoo species. I believe, however, that at least some of these blue eggs belong to another cuckoo species, i.e. *Cuculus canorus* (see below). Support for Baker's view is given by A. E. Osmaston (1912), who mentioned that his brother B. B. Osmaston collected a nestling of *Cuculus sparverioides* from a nest of the Redheaded Laughing Thrush *Garrulax erythrocephalus.* The whereabouts of this skin are unknown to me.

Of the *brown egg-type* (which I agree belong to this cuckoo species) of the 145 collected eggs (Baker collection), 98 records (68%) are associated with *Arachnothera magna,* 24 (17%) with *Brachypteryx leucophrys,* 4 (2%) with *Arachnothera longirostris,* and 19 (13%) with various other host species of which about half were deserted nests (egg dumping) probably belonging to non-biological hosts.

Of the so-called *blue egg-type* (most of which I think do not belong to this cuckoo species) the Baker collection contains 36 eggs, which were mainly associated with *Garrulax* species (i.e. 22 eggs, 61%), but also with Turdinae such as *Myiophonus caeruleus, Zoothera citrina,* and *Z. dauma.* I examined 3 eggs of this turquoise blue egg-type in more detail, i.e. 2 associated with laughing thrushes and one with *Myiophoneus.* The eggs in *Garrulax* nests were associated with *G. moniligerus* (Baker's catalogue, Box 107, A 8) and *G. erythrocephalus* (B. M. collection, 195.2. 68/69, collected by A. E. Osmaston). The third egg was in the nest of *Myiophonus caeruleus* (Baker's catalogue, Box 107, D 3). These eggs measured 30.1×21.5, 30.2×20.5 and $30.3 \times$

20.6 mm, respectively. Their shape index (egg length : breadth) is 1.40-1.47, and the Rey's index 1.43-1.54. These parameters suggest that they belong to a blue egg-type of *Cuculus canorus*. The ultra-structure of the eggshell as observed by scanning electron microscopy also agrees with blue *Cuculus canorus* eggs from Europe. Up to now, however, there is no record of a *Cuculus canorus* nestling in the nest of *Garrulax*! It will therefore be very profitable to let hatch any such blue cuckoo eggs in laughing thrushes' nests for confirmation. Confusion with the egg of the Common Hawk-Cuckoo *Cuculus varius* also cannot be ruled out, since the egg of this species is virtually unknown. Further, in areas where Hodgson's Hawk-Cuckoo *Cuculus fugax nisicolor* occurs, confusion with this species may be also possible, since its breeding is very imperfectly known. In this treatise another type of egg of smaller size and weight is attributed to Hodgson's Hawk-Cuckoo.

Two oviduct eggs of the Common Hawk-Cuckoo *Cuculus varius*, described by Baker (1934, 1942), according to his description closely resemble the so-called blue egg-type of *Cuculus sparverioides*. Regrettably, these eggs (Box 114) could not be traced in the present Baker collection in the B.M. (M. P. Walters, pers. communication).

An examination of a large series of the so-called blue egg-type of *Cuculus sparverioides* in the Baker collection (Box 107) revealed that most of these eggs, which were mainly collected at Khasi Hills, Assam, are probably those of the Khasi Hills Cuckoo *Cuculus canorus bakeri* (Box 107 : A 6 & 7, B 3 & 6b, D 3, 4 & 5, E 1, etc.) as their measurements are consistent with this species and the Rey's index is within their range 1.30-1.64. Other eggs in this box, however, such as Box 107: 6b & 7a, I would definitely classify as *Clamator* eggs, as is obvious from their more rounded shape (shape index : 1.13-1.21), equal poles, absence of gloss, and very thick shells (Rey's index : 1.06-1.21). All the above-mentioned eggs were probably indiscriminately pooled by Baker for the average figures of the eggs of *Cuculus sparverioides* in his publications.

Eggs (as reclassified and delimited by me), uniform light brownish olive, seldom speckled with darker olive-brown specks, particularly around the blunt pole. Ground colour of varying shade or depth of tint from Olive Brown or Greyish Olive to Deep Greyish Olive or Citrine Drab (Ridgway). Seventy eggs measured by me (Baker collection, B.M.) av. 26.6 (24.5-29.0) × 18.6 (17.3-20.6) mm. Eggs broadly oval, shape index av. 1.43 (1.30-1.58), Rey's index av. 1.59 (1.27-1.83). Eggshell weight ($n = 70$) av. 0.3119 (0.2377-0.4298) g. Eggshell thickness av. 107 (101-120) μm, fresh egg weight av. 5.1 (4.7-5.4) g.

As discussed above mention of a blue egg-type of *C. sparverioides* should be deleted from the HANDBOOK. Arguments are given that these eggs belong to the Khasi Hills Cuckoo *Cuculus canorus bakeri*. These eggs are mainly found in the Khasi Hills. Furthermore, the blue egg-type was never found associated with *Arachnothera* species nor the brown egg-type with *Garrulax* species, which points to different cuckoo species with a different fosterer specialization.

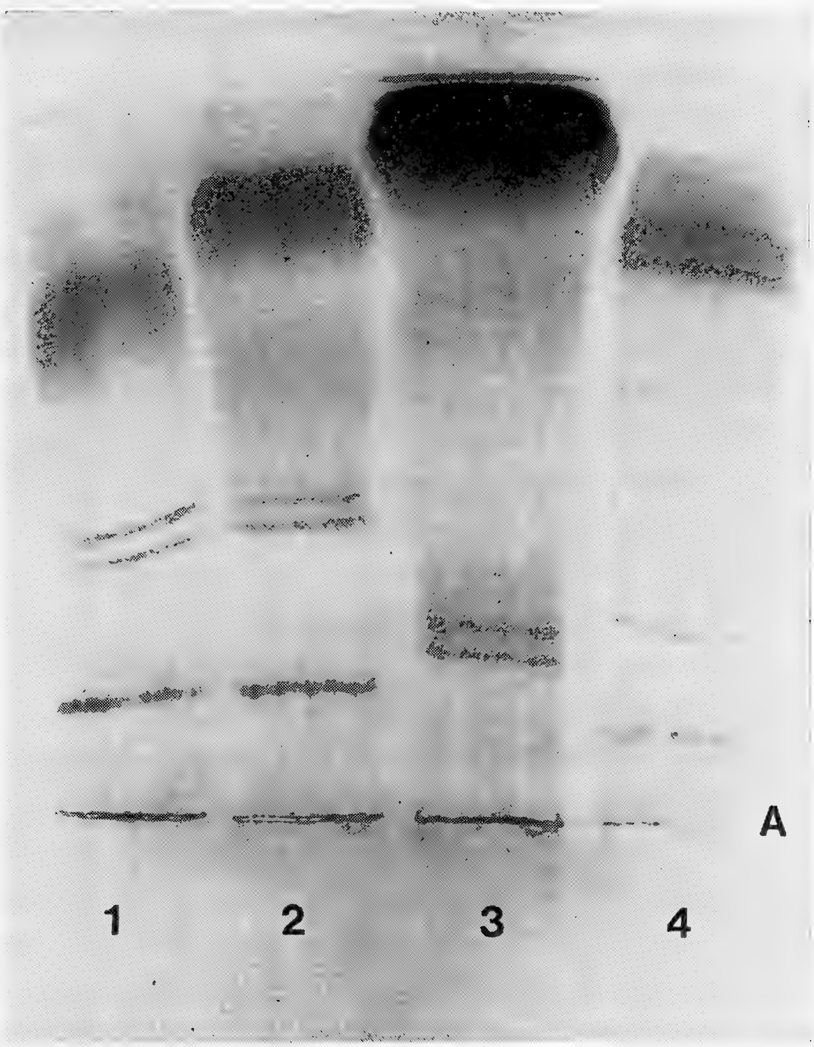
The majority of the *Cuculus sparverioides* eggs were associated with *Arachnothera magna* (68%) and very few (2%) with *Arachnothera longirostris*, in spite of the fact that the Small Spiderhunter is commoner in the Khasi Hills than its larger congener. Obviously the tunnel-shaped nest of the Small Spiderhunter is less suitable for the deposition of the egg of this large cuckoo than the more open, hanging cup of the Streaked Spiderhunter. It is remarkable that this cuckoo is adapted to two main fosterers which nest in very different sites and habitats, i.e. *Arachnothera* spp. building nests under large leaves (Musaceae, Zingiberaceae) usually in medium-sized vegetation, often secondary growth, and *Brachypteryx leucophrys,* a ground breeder in dense, usually primary forest.

Cuculus varius

COMMON HAWK-CUCKOO

BREEDING. Imperfectly known, for India no certain evidence. The Baker collection contains 78 eggs attributed to this species, including two oviduct eggs. These eggs were found mainly in the nests of babblers such as the Jungle Babbler *Turdoides striatus,* Whiteheaded Babbler *T. affinis* and the Rufous Babbler *T. rufescens,* and also in nests of many species of laughing thrushes, *Garrulax* species (for full list see Baker, 1934, 1942, and Baker's catalogue in B.M.). Baker's evidence for attributing these eggs to *Cuculus varius* is, in my opinion, rather flimsy. I regard a considerable number of the eggs attributed to *Cuculus varius* (Box 115, 116 & 117, Baker collection) as a hotchpotch of blue *C. canorus* eggs and *Clamator* eggs. In these series, all thick-shelled eggs with Rey's indices of 0.93-1.07 and of round, elliptical shape, I regard as *Clamator* eggs (i.e. Box 115; A 1, B 1, C 1 & 2; Box 116: A 1, B1; Box 117: A 1, A 2, B 1, C 1, D 1, etc.) while the other eggs with a Rey's index of 1.32-1.71 (av. 1.52) are probably *C. canorus* eggs. The averages given in Baker's publications have therefore little value as they concern a mixture of eggs of various species. From the set marks on the eggs and the original labels (Baker's catalogue) it is also evident that Baker several times changed his opinion on the identity of these eggs. Unfortunately, the two oviduct eggs of this species in Baker's collection (Box 114) could not be located in the present Baker collection (B.M.) inspite of determined efforts (M. P. Walters, pers. communication). According to the Baker catalogue both oviduct eggs were collected by Mr. C. M. Inglis. The measurements given for these eggs are 26.0×20.2 and 22.1×20.4 mm and shell weights 0.410 and 0.438 mg, respectively (Baker's catalogue). In the same sequence the shape index of the eggs is 1.27 and 1.08, and the Rey's index 1.29 and 1.03, respectively. The nearly round, thick-shelled egg (shape index 1.08, Rey's index 1.03) I would classify on the basis of these parameters as an egg of *Clamator*!

In my opinion the egg of the Common Hawk-Cuckoo is unknown. It is remarkable that no irrefutable eggs are known, seeing that its name suggests that it is rather common. A reliable record of its breeding is from Sri Lanka, where Phillips (1948) mentions that two observers (Mrs. C. Lushington and Mr. R. West) saw on three occasions a fledgling Common Hawk-Cuckoo being fed by the Jungle Babbler *Turdoides striatus.* One of these fledglings was collected (Mr. R. West), but the whereabouts of this skin are unknown to me. It is further noteworthy that in contrast to its occurrence in India, in Ceylon this cuckoo is essentially a highland species (Phillips, 1948). Another reliable record is cited in the HANDBOOK (Ali and Ripley, vol. 3, l.c. p. 202, 1969) of a young *Cuculus varius* accompanying a flock of Jungle Babblers *Turdoides striatus* and being fed by its presumed foster-parents, but occasionally also by other members of the party. In this context it is worth mentioning that communal breeding and helpers are frequently reported for members of the *Turdoides* group (Blencowe, 1960; Raj, 1964; Reynolds, 1965; Andrews and Naik, 1970; Grimes, 1974; Zahavi, 1976; Zacharias and Mathew, 1977; Gaston, 1977, 1978). Communal feeding of *Clamator* fledgling(s) by



Starch gel electrophoretic pattern of the egg-white of a cuckoo compared with its Passerine fosterers. A = point of application, top anodal (+), bottom cathodal (−) direction.

Egg-white proteins: (3) *Cuculus canorus*. Foster species: (1) *Sylvia atricapilla,* (2) *Acrocephalus schoenobaenus,* and (4) *Troglodytes troglodytes*. The cuckoo egg (3) was associated with species (2), same clutch. × 1.0.

A fourteen-day old nestling of the Indian Cuckoo *Cuculus micropterus* in the nest of the Amur Brown Shrike *Lanius cristatus confusus*. Lower Amurland. U.S.S.R.. June 1962. × 0.6.

(Photo: *I. A. Neufeldt*)

Turdoides groups has also been regularly reported (R. M. Adam in Hume and Oates, 1890; Bates, 1938; Gaston, 1976).

For the Indian subcontinent, it will be important to examine eggs attributed to the Common Hawk-Cuckoo in regions where Hodgson's (*Cuculus fugax*) is absent. Of the latter species, which is apparently nowhere common (Ali and Ripley, 1969) the Baker collection contains 82 eggs ! The possibility that the identification of the eggs of the two cuckoo species in Baker's collection should be reversed cannot therefore be excluded. Hence, it will be of great significance to record the hatching of the glossy turquoise blue egg attributed to this cuckoo species or the supposed olive-green egg of Hodgson's Hawk-Cuckoo, in order to identify the cuckoo species involved beyond any doubt.

Cuculus fugax

HODGSON'S HAWK-CUCKOO

BREEDING. Very imperfectly known. No records of fledgling cuckoos in host nests or fed by forster species. According to Baker (1934, 1942) brood parasitic mainly on the Nepal Shortwing *Brachypteryx leucophrys* (thus sharing this host with the Large Hawk-Cuckoo *Cuculus sparverioides*) and the Small Niltava *Muscicapa macgrigoriae*. One oviduct egg collected by Mr. Mandelli in Sikkim and described by Hume (cf. Baker, 1934, l.c. p. 349) is broad oval (22.6×16.3 mm, shape index 1.39), scarcely at all pointed at the small end, uniform olive-brown with an indistinct ring of a darker shade at the large end.

Similar eggs (82 specimens collected !) were described by Baker (1934, 1942) and are still present in his collection in the B.M. These eggs examined by me are very typical *long* ovals. Although their length is not much different from that of the Large Hawk-Cuckoo *Cuculus sparverioides,* they are much narrower in width, i.e. av. 15.8 (15.2-16.8) mm, giving a shape index averaging 1.50. Moreover, in contrast to Large Hawk-Cuckoo eggs, they have much lighter shell weights. The eggs are Light Brownish Olive or Olive Buff with Citrine Drab or Dark Olive Buff specks (Ridgway) forming a ring around the larger end. In some eggs the specks are larger and more blotch-like and more regularly distributed over the eggshell. This egg-type is very well illustrated by Baker (1942, Plate VIII, No's 11 & 12).

Although there is no absolute proof that these eggs belong to Hodgson's Hawk-Cuckoo, it is rather plausible, because it is smaller than its two congener Hawk-Cuckoos. Moreover, the Large Hawk-Cuckoo *Cuculus sparverioides* falls ouside consideration as its eggs are sufficiently known. However, as already stated the eggs of the Common Hawk-Cuckoo *Cuculus varius* are unknown and there is a possibility of confusion with this species (see *Cuculus varius*).

In this context it is worth mentioning that the eggs reported for *Cuculus fugax* in Japan are different. Five eggs of this cuckoo from Japan present in the Baker collection and collected by Kobayashi at Mt. Fuji were measured by me. They average 27.4×19.8 mm, shape index av. 1.79, Rey's index av. 1.49. These eggs are pale blue in colour and resemble some of the eggs described by Baker for *Cuculus varius*. Further, Kobayashi and Ishizawa (1932-40) described 14 eggs of *Cuculus fugax* from Hondo, Japan, mainly in the nests of the Japanese Blue Chat *Erithacus cyane* (Turdinae), as beautiful greenish light blue and gave as measurements av. 28.2×19.9 mm. These Japanese records are surely of considerable importance, because in Japan the pattern of sympatric cukoos is much simpler and moreover their breeding is better known. However, in spite of the above-mentioned statements the possibility still exists (and needs verification) that the described eggs are in fact the blue egg-type of *Cuculus canorus telephonus*.

Fourteen eggs of *Cuculus fugax* in India, of the long oval, olive-green type in the Baker collection (B.M.), and also attributed by me to this cuckoo species, measured by me average 23.8 (23.1-24.8) × 15.8 (15.1-16.8) mm, av. shell weight 0.1943 (0.1263-0.2270) g, shape index av. 1.50 (1.41-1.63), Rey's index av. 1.98 (1.80-2.94), shell thickness 62-98 μm, fresh egg weight av. 3.4 (3.1-3.5) g. Average body weight 76.2 (70.7-81.6) g (n = 2), relative egg weight 4.5%. The eggs were all collected in the Khasi Hills, Assam in April to June.

A supposed egg of *Cuculus fugax* was collected by J. Whitehead on Mt. Kinabalu, North Borneo (ex. coll. Crowley Bequest, B.M. coll.), 29 April 1888 (see also Whitehead, 1893, l.c. p. 214) from the nest of the Greyheaded Flycatcher *Culicicapa ceylonensis*. This egg is Ivory-Yellow with Cream Buff and Cartridge Buff (Ridgway) specks around the blunt pole and measures 22.1 × 16.4 mm, shell weight 0.1784 g, shape index 1.35, Rey's index 2.03. This egg is very reminiscent of a certain egg-type of *Cacomantis variolosus* in Indonesia, which in Java is also partly associated with the same host (Bartels collection, RMNH). However, the Bornean egg is rather large for a normal *Cacomantis variolosus* egg of Java, since of 80 eggs cf. the latter species examined by me the largest measures 21.7× 14.4 mm; av. 20.3 × 14.8 mm, shape index 1.37, Rey's index 2.33-2.37. It is, however, clear that the identity of the above mentioned egg as *Cuculus fugax* is very doubtful. A pale uniform bluish-white cuckoo egg described by Sharpe (1897, l.c. p. 264) from Bunang River, Borneo, May 1876, measuring 30.5 × 20.3 mm, shape index 1.50, found in a nest of the Black-and-Red Broadbill *Cymbirhynchus macrorhynchus*, might be an egg of *Cuculus fugax* (see Japanese eggs), but is probably still a little too large for this species. The largest Japanese egg (B.M. collection, ex. coll. Baker) measures 28.7 × 19.2 mm, shell weight 0.3572 g, shape index 1.50, Rey's index 1.54, Mt. Fuji, Subashiri, Japan, 5 June 1916.

Cuculus micropterus

INDIAN CUCKOO

BREEDING. Brood-parasitic on drongos (Dicruridae), mainly the Indian Black Drongo or King Crow *Dicrurus adsimilis* and the Indian Grey Drongo *D. leucophaeus*. Other fosterers in whose nests cuckoo eggs attributed to this species are found (see Baker, 1942, p. 190-191) are rather dubious. Probably, the Streaked Spiderhunter *Arachnothera magna*, the Paradise Flycatcher *Terpsiphone paradisi*, and orioles *Oriolus oriolus* and *O. sinensis*, should be omitted as hosts.

Baker (1934, 1942) distinguished two egg-types of this cuckoo: one white with reddish-brown markings and adapted to drongos, the other plain blue and adapted mainly to *Garrulax* species.

Of 9 eggs of the drongo-type of this cuckoo in the Baker collection, scanning-electron microscopic examination of the eggshell surface revealed that *only one* egg of this series was a cuckoo egg. All the other eggs (Box 98: E 2, E 4, F 1, 20 a & b′, etc.) were displaced drongo eggs apparently from other drongo clutches. Drongo eggs are rather variable in colour and markings and it is relatively easy to obtain eggs of a different pattern, which can be placed in nests of either other drongos or Paradise Flycatchers or orioles. The only genuine cuckoo egg (Box 98: 20 b″) was claimed to have been obtained from a nest of the Paradise Flycatcher, but in view of the above-mentioned displacements this cannot be accepted as certain. According to the original label (Baker's catalogue) this *Cuculus micropterus* egg was obtained by Mr. F. A. C. Munns (see also Munns, 1939) in the Champaran district of Bihar in Northern India, on 26 May 1939. The same collector provided Baker with two other eggs from the same locality, which prove to be falsifications, i.e. displaced drongo eggs.

Dicrurus adsimilis is also reported to be the host of *Cuculus micropterus* in the duars of North Bengal, as on two occasions a fledgling cuckoo was seen to be fed by this host species (O'Donel, 1936). A similar observation was made by Storrs (1944). Also other data indicate that drongos are the main foster species of this cuckoo in India. A nearly full-grown fledgling of *Cuculus micropterus* was collected by B. B. Osmaston at Dehra Dun, Uttar Pradesh, on 30 July 1897. Its skin, which came to the Leiden Museum (ex. coll. H. J. V. Sody, RMNH reg. no. 27040), bears on its label in Osmaston's handwriting: 'shot while being fed by *Dicrurus atra*' (=*D. adsimilis*) and 'it was calling like a young *Dicrurus*'. In the Simla region (Himachal Pradesh: 31°07′N, 77°09′E), Jones (1941) reported for *Cuculus micropterus* five cuckoo eggs in the nests of the Indian Grey Drongo *Dicrurus leucophaeus longicaudatus* and one fledgling cuckoo being fed by the same foster species. All cuckoo eggs were found in the month of May at elevations between 1800 m and 2000 m.

In Java fledglings of the local resident race *Cuculus micropterus concretus* have been observed and collected (Bartels collection, RMNH); they were fed by the Large Racket-tailed Drongo *Dicrurus paradiseus*. A genuine egg of this cuckoo (confirmed by electron microscopy) from this region is also from the nest of the same host species. It was collected by H. Bartels (Bartels egg-collection, RMNH) at Mt. Massigit, near Cibadak, W. Java, on 10 December 1927. In this area this cuckoo is especially vocal in the winter months, i.e. rainy season, at the time when the northern migratory race *micropterus* is also present in the same area (pers. observation).

For China, La Touche (1931) described an oviduct egg resembling very closely the egg of a drongo, and Herklots (1953) for the Hong Kong area mentioned fledglings and two eggs found in the nests of the Chinese Black Drongo *Dicrurus adsimilis*. Eggs and nestlings associated with *Dicrurus adsimilis* are also mentioned by Vaughan and Jones (1913, l.c. p. 186) from the Chinese mainland, a few miles from Macao. Further north, i.e. in Peking, North China, nestlings of *Cuculus micropterus* have been observed in the nests of the Chinese Blue Magpie *Cyanopica cyana* (Shaw, 1938, 1940; Hoffmann, 1950), and in the Amur region, U.S.S.R., its principal host is the Amur Brown Shrike *Lanius cristatus confusus*, as well documented by Neufeldt (1966).

As mentioned above, Baker (1934, 1942) also attributed an uniformly blue egg to this cuckoo species; but this is very dubious. Some of these eggs are, from their ultra-structure, not cuckoo eggs but probably those of Muscicapidae (Timaliinae) or even Sturnidae, e.g. the cuckoo eggs in Baker's collection Box 98: A 2 & 3. One egg 'found' in a drongo nest was according to its typical ultra-structural characteristics definitely a *Garrulax* spp. egg. Others, rather regularly associated with the Streaked Laughing Thrush *Garrulax lineatus*, are from their ultra-structure indeed cuckoo eggs, e.g. Box 98: A 1 & 4, B 1, etc. The blue eggs are nearly all collected in the Murree Hills, W. Pakistan (Murree: 33°55′N, 73°26′E), and on the basis of their parameters such as dimensions, shape and Rey's index and ultra-structural details of the eggshell, I regard them as blue eggs of *Cuculus canorus*. As for the so-called blue *Cuculus micropterus* eggs in the Baker and B.M. collection associated with *Terpsiphone paradisi* (B.M. 1962.24.477-8); Turdinae such as *Saxicola torquata* (Murree Hills, 19 June 1906), *Erithacus brunneus* (Murree Hills, 31 May 1903), *Enicurus maculatus*

(Murree Hills, 20 May 1911); Campephagidae: *Coracina melaschistos* (Murree Hills, 14 May 1911, B.M. 1962.24.479-80), and Emberizidae: *Emberiza cia stracheyi* (Murree Hills, 16 May 1911, B.M. 1962. 24.453-4), I regard all of these as blue eggs of *Cuculus canorus*. Ultra-structural examination showed that one of the 'host' eggs in a clutch with a cuckoo egg in Baker's collection (Box 98: A 4, Murree Hills, 15 June 1900) in a nest of *Garrulax lineatus* is in fact a *Clamator* spp. egg indicating once more that these various cuckoo species have partly the same fosterers. The confusion can be cleared up, if new material becomes available which would allow a combination of eggshell ultra-structure study and egg-white protein analyses. This would be particularly important for the immaculate plain blue cuckoo eggs which I attribute to *Cuculus canorus*.

Eggs, broad ovals (see shape index), pink or whitish pink with vinaceous, violet or scarlet-carmine ill-defined blotches and spots and more greyish underlying markings, mimicking drongo eggs very closely. For this reason ultra-structural analyses are absolutely necessary for irrefutable proof. One Indian egg (Baker collection; Box 98: 20 b″, dist. Champaran, Bihar, 26 May 1939) measures 26.2×17.9 mm, shape index 1.46, shell weight 0.2362 g, Rey's index 1.99, fresh weight 4.6 g. Measurements of 3 eggs from the Lower Amur region, U.S.S.R. reported by Neufeldt (1966) av. 25.2 × 19.5 mm, shape index 1.30. One egg of the sedentary Javanese race *C. micropterus concretus* distinctly smaller, 23.6 × 17.7 mm, shape index 1.33, shell weight 0.2259 g, fresh weight 4.0 g (Bartels collection. RMNH). Average body weight 118.2 (114.6-121.8) g (n = 2), relative egg weight 3.4-5.0%.

Season, available data for India scarce (see above), probably from May till July, i.e. the main season of its drongo hosts and the time when this cuckoo is most vocal.

Nestling and *fledgling*. Newly hatched blind and naked. Skin of body, bill, nostrils, and legs yellowish pink. Mouth orange-red, gape yellowish. In 4-5 days the first feathers developing, eyes half open. In 7 days the eyes entirely open, and by 9-10 days feathers emerge from their sheaths (Neufeldt, 1966). Feathered nestlings and fledglings are distinguishable from chicks of all other cuckoos by their peculiar pale, rather variegated appearance caused by a predominance of dirty cream and isabelline colour in the plumage. Feathers of upper part of the head, hind-neck, and throat basally brownish black, but with broad isabelline apical band. Lower throat sparsely marked with transverse bars, and belly pure isabelline coloured (see Plates 5 and 6). Incubation period 12 days, while in the Brown Shrike *Lanius cristatus* 14 days, therefore cuckoo nestlings usually hatch before the fosterers (Neufeldt, 1966).

Cuculus canorus bakeri

KHASI HILLS CUCKOO

It is well known that the widespread Eurasian Common Cuckoo *Cuculus canorus* parasitizes many host species, and that it is divided into so-called 'gentes' which lay quite different egg-types adapted to certain host species. Broadly speaking, it has a spotted egg-type mainly adapted to *Acrocephalus* and *Anthus* species and a plain blue egg-type adapted to the Redstart *Phoenicurus phoenicurus* and the Dunnock (or accentors) *Prunella modularis*, although of course intermixing sometimes occurs.

It is remarkable that Baker (1934, 1942) gave very little attention to blue egg-type of *C. canorus bakeri*. Only about 20 eggs of the blue egg-type were considered to be of the Khasi Hills Cuckoo, although altogether about 2,000 eggs of this race were collected. This

Fledgling of the Indian Cuckoo *Cuculus micropterus* fed by the Amur Brown Shrike *Lanius cristatus confusus,* showing the dark-brown and ivory white 'variegated' appearance of the cuckoo. Lower Amurland, U.S.S.R., 10 July 1962. × 0.7.
(Photo: *I. A. Neufeldt*)

Nest of the Bush Warbler *Cettia diphone* with female bird at nest entrance. This warbler is the main foster species of the Small Cuckoo *Cuculus poliocephalus*. Ussuriland, U.S.S.R., July 1966. × 0.9. (Photo: *I. A. Neufeldt*) was in spite of the fact that the blue egg-type was irrefutably established by B. B. Osmaston (1916) for Maymyo, Upper Burma (in association with *Saxicola caprata*!) and by Mackenzie (1918) for Maymyo and the North Chin Hills (in association with pipits and buntings). I regard all putative blue cuckoo eggs attributed by Baker (1934, 1942) to *Cuculus micropterus, C. varius,* or *C. sparverioides* (as already discussed under these species), to be in fact blue eggs of *Cuculus canorus bakeri.* Also the plain blue egg found in the nests of laughing thrushes, *Garrulax cineraceus* and *G. pectoralis,* and of the Rusty-cheeked Scimitar Babbler *Pomatorhinus erythrogenys,* described by Hopwood and Mackenzie (1917, l.c., p. 89) as those of the Large Hawk-Cuckoo *Cuculus sparverioides,* are probably *Cuculus canorus* eggs.

Although the Baker collection contains a great number of eggs of the Khasi Hills Cuckoo very little is known of its ecology and breeding habits. Except for Livesey (1936, 1939) nobody has studied its biology and behaviour at fosterer nests. For this race the incubation period and fledgling time are unknown. It will be far more useful not to collect any more eggs of this *C. canorus* race, but to let them hatch and confirm the identity of the cuckoo, especially in case of abnormal hosts and rather aberrant cuckoo eggs. Particularly the supposed *Cuculus canorus* eggs in *Garrulax* nests should be verified by hatching (see *Cuculus sparverioides* and *C. micropterus*).

BREEDING. The Eurasian races have a multiple fosterer range, parasitizing mainly small Passerines of the families Muscicapidae, in particular Turdinae (chats), Sylviinae (*Acrocephalus* spp.), Motacillidae (*Motacilla* spp., *Anthus* spp.) and Emberizidae (buntings). Baker's statement that the principal host of the Khasi Hills Cuckoo are small warblers (Sylviinae) of the genera *Cisticola* and *Prinia,* based on the number of eggs in his collection, probably does not truly reflect the choice of fosterer, since the nests of the latter species are more likely to be found by unintentional human activity (grass cutters, rice field harvest, etc.). From accounts by Mackenzie (1918), Livesey (1935 a, b), and Jones (1936), it is evident that *Saxicola* species (*S. caprata* and *S. torquata*), *Anthus* species (*A. sylvanus, A. novaeseelandiae rufulus*), *Megalurus palustris* (Sylviinae) and buntings (Emberizidae: *Melophus lathami*) are also very regularly parasitized and certainly equally important hosts.

Eggs. Six eggs of the spotted egg-type: white with reddish brown blotches (egg-type resembling a large European Robin egg), av. 24.4 × 17.3 mm, shape index 1.41, av. shell weight 0.2384 g, Rey's index 1.84 (1.76-1.80), fresh egg weight 3.6-4.3 g. In one of the host species, the Brown Hill Warbler *Prinia criniger,* the Rey's index is on average 2.86 (2.68-3.06), showing the great difference from the cuckoo eggs. Five eggs of *Cuculus canorus* from Northern Europe measure on average 22.8 × 16.9 mm, shape index 1.35 (1.27-1.43), shell weight 0.2420 (0.2287-0.2577) g, Rey's index 1.59 (1.52-1.77), indicating that the Khasi Hills Cuckoo has a somewhat larger, thinner-shelled egg compared to the European race. My assumption that the blue cuckoo eggs in *Garrulax* nests are those of *Cuculus canorus* is strengthened by the fact that the red spotted 'Robin-type' egg of this cuckoo is occasionally also found in association with *Garrulax lineatus* (Baker collection).

Cuculus saturatus

HIMALAYAN CUCKOO

BREEDING. This species is highly specialized in its fosterer choice. It is brood-parasitic on members of the closely related group of flycatcher and leaf warblers of the genera *Seicercus* and *Phylloscopus*. These are tiny birds less than one-third of the size of the cuckoo. In Kashmir the Large Crowned Warbler *Phylloscopus occipitalis* and in the Himalayas and Khasi Hills in Assam, the Crowned Leaf Warbler *Phylloscopus reguloides* are the most frequent foster species. In Malaysia and Indonesia, with respect to the sedentary race *C. saturatus lepidus* (formerly assigned to *Cuculus poliocephalus*, see Wells and Becking, 1975; and Becking, 1975 b) its host pattern is the same. In Malaysia the main fosterer is the Chestnut-headed Flycatcher Warbler *Seicercus castaniceps*, and in Java the Sunda-Island Flycatcher-Warbler *Seicercus grammiceps* and the Mountain Leaf Warbler *Phylloscopus trivirgatus*. Eggs and breeding in this geographical region are described by Becking (1975b).

A nestling of this cuckoo found at the Semangko Pass, Selangor-Pahang, Malaysia (alt. 850-1500 m) on 24 February 1908 in the nest of *Seicercus castaniceps butleri* was described by Robinson (1927) and Chasen (1939) as that of *Surniculus lugubris brachyurus*. Fortunately, definite proof could be obtained as I was able to locate this skin under the latter name in the B.M. collection, Tring (B.M. reg. no. 1936.4-14-359) and identified it as *Cuculus saturatus*. As in *Cuculus canorus*, nestlings and fledglings of *C. saturatus* are very variable in colour. Light and dark coloured specimens may occur. Light coloured specimens have whitish underparts heavily barred with dark chocolate brown and possess rufous red greater wing coverts (see colour Plate 1), whereas in dark specimens the barring is far less conspicuous and the upperparts are much darker, superficially resembling a *Surniculus lugubris* young. However, nestlings and fledglings of *Cuculus saturatus* can easily be told apart from those of *Surniculus lugubris* by a fundamentally different feather pattern. Feathers (underparts and back) of dark specimens of *Cuculus saturatus* are dark blackish brown with a white apical band, whereas those of *Surniculus lugubris* are blackish brown with a white triangular spot near the rachis at some distance from the apex (see Figure 1).

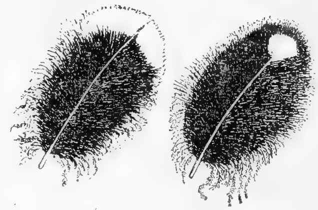


Fig. 1. Pattern of certain contour feathers (in this case back feathers) of the Himalayan Cuckoo *Cuculus saturatus* (left) and the Drongo Cuckoo *Surniculus lugubris* (right) showing the characteristic difference in the white pattern of the vane. × 1.0.

Eggs, long elliptical or sub-elliptical, rather variable in size and rather small for the size of the cuckoo. Ground colour white or whitish buff speckled with small spots and tiny lines of reddish brown, usually forming a conspicuous ring round the large end. In some cases mimicking the spotted eggs of a leaf warbler (*Phylloscopus* spp.), but in other cases not matching the plain white eggs of flycatcher-warblers *Seicercus* spp. and some other *Phylloscopus* species (e.g. *P. trivirgatus*). Average size of 10 eggs 21.1×15.6 mm, shape index 1.36 (1.27-1.45), shell weight 0.153 (0.130-0.165) g, Rey's index 2.16 (1.99-2.44). Six eggs have average fresh weight 2.89 (2.70-3.10) g. The Rey's index indicates that the eggs are rather thin-shelled; actual measurements showed a shell thickness of the calcified shell of 77-80 μm. Fosterer eggs are, however, much more thin-shelled, since the Rey's indices of the eggs of *Phylloscopus trivirgatus* and *Seicercus grammiceps* are 3.54 (3.26-3.87) and 4.09 (3.85-4.33), respectively.

Distribution and *migration*. The distribution map presented in the first edition of the HANDBOOK (Ali and Ripley, 1969, vol. 3) is incorrect, since the races *insulindae* and *lepidus* are now not assigned to *C. poliocephalus,* but to *C. saturatus* (Becking, 1975 b; Wells and Becking, 1975). The races *insulindae* and *lepidus* are sedentary and in the winter season, which is partly also their breeding season, they occur sympatrically with the migrant palaearctic races *saturatus* and *horsfieldi* (Becking, 1975 b). In India *Cuculus saturatus* is a typical montane species, breeding in the Himalayas from west to east and throughout the higher hills of Assam (Khasi Hills, etc.) and northern Burma and Thailand (Smythies, 1953). It is absent in the plains except some northern races as winter visitors. Migrants of the northern race *horsfieldi* (Japan, etc.) arrive earlier (because of earlier winter at higher latitude) in South-east Asia than the nominate race from central Asia (Becking, 1975 b). The direction of migration is south-east over Malaysia and the Indonesian islands to Papua, some even reaching the northern part of the Australian continent (Slater, 1971). In contrast, the sympatric Small Cuckoo *Cuculus poliocephalus* migrates south-west to Africa. The same difference of migration routes exists between two also partly sympatric *Clamator* species, i.e. *C. coromandus* and *C. jacobinus,* and must therefore been of ancient, evolutionary origin. The notation in the HANDBOOK (vol. 3, l.c. p. 212) 'Not uncommon in the Andaman and Nicobar Islands during the summer months' (Butler, 1899, l.c. p. 565) needs verification, since as pointed out above *Cuculus saturatus* is primarily a montane species and northern migratory races occur in the lowlands only in *winter.*

Cuculus poliocephalus

SMALL CUCKOO

BREEDING. Rather specialized on one host. Brood-parasitic on small warblers of the genus *Cettia* which nest near the ground. From the Himalayas to Assam and Upper Burma the main fosterer is the Strongfooted Bush Warbler *Cettia fortipes,* in Sikkim the Palefooted Bush Warbler *Cettia pallidipes.* In more northern regions the main host is the Chinese Bush Warbler *Cettia diphone,* e.g. in Amur region, U.S.S.R. (Neufeldt, 1971) and in Japan (Kobayashi and Ishizawa, 1932-40; Yamashina, 1961).

Season, May, June and July, synchronized with that of the fosterers at the various latitudes.

Eggs, broad ovals with rounded ends, terra-cotta red or deep chocolate-brown in colour, closely mimicking the similar coloured eggs of the host species. Plates 7 and 8 show an egg in a nest of *Cettia diphone.* As is evident from the picture, the cuckoo egg can hardly be distinguished from the host eggs. Baker (1934, 1942) also attributed a plain white egg, also associated with *Cettia,* to this cuckoo species. This needs, however, verification by letting such eggs hatch. Nevertheless it is plausible that such an egg belongs to this cuckoo species, because its ultra-structure is similar to that of the terracotta red eggs, and different from that of the Himalayan Cuckoo *Cuculus saturatus.* Ten terracotta red eggs measure av. 21.2×15.6 mm, shell weight 0.153 (0.130-0.165) g, shape index 1.36 (1.27-1.45) and Rey's index 2.16 (1.99-2.44). Direct measurements of the thickness of the calcified shell by scanning electron micrography give 77-80 μm. Six fresh eggs weighed 2.89 (2.70-3.10) g.

Distribution and *migration.* The distribution map given in the HANDBOOK (Ali and Ripley, vol. 3, 1st ed., 1969) is incorrect, since the races *insulindae* and *lepidus* do not belong to this species, but to the Himalayan Cuckoo *Cuculus saturatus* (see Wells and Becking, 1975). Its migration pattern is peculiar, since this cuckoo shows long distance migration in a south-west direction (probably over open sea, no records from the Middle East) straight from India and Ceylon (Sri Lanka) to South-East Africa. I have seen skins of this species collected in their winter quarters in Tanzania, Kenya, Uganda, Rhodesia and southern Africa in the months November to April (RMNH Leiden, B. M. Tring, MNH—Paris, Bulawayo Museum, Durban Museum and NHRM, Stockholm). The earliest date was 16 November, the latest 17 April; most of the specimens were collected in the months March and April. This cuckoo was also found among skin material from Madagascar (Forschungsinstitut Senckenberg, Germany, reg. no. 27780, collected by E. Ebenau in 1876) besides *Cuculus rochii,* which is not a race of *C. poliocephalus* but a separate species (Becking, in prep.). There is *one* certain record of *C. poliocephalus* from the South Andaman Islands (collected 5 November 1906) verified by us (Wells and Becking, 1975), but no other record between Asia and Africa.

Cacomantis sonneratii

INDIAN BAY BANDED CUCKOO

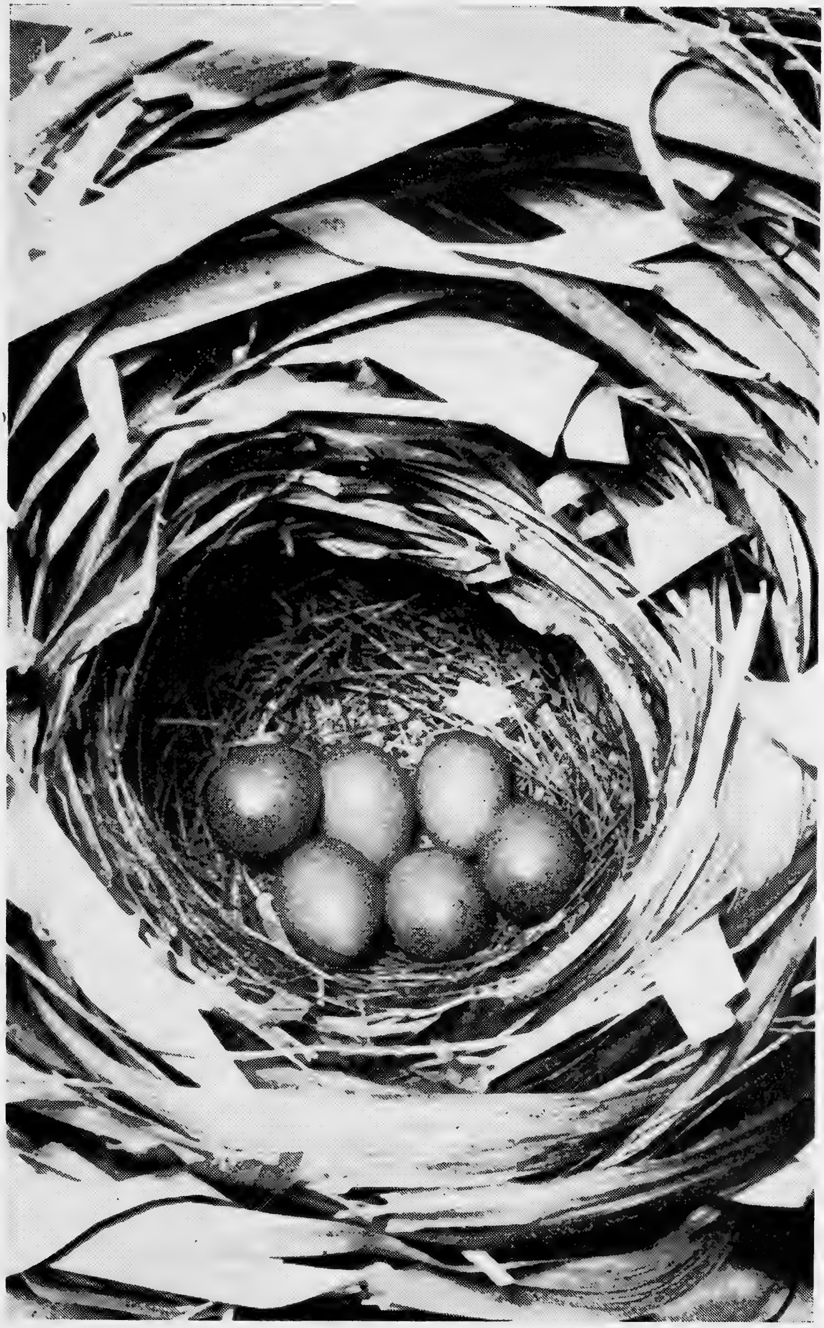
BREEDING. Brood-parasitic primarily on ioras *Aegithina tiphia* and probably to a lesser extent on minivets, *Pericrocotus* species. Both genera build rather similar, small cup-shaped nests. Egg mimicry with *Aegithina* eggs is perfect and cuckoo eggs can only be discriminated from fosterer eggs by ultra-structural analyses of the eggshell surface by means of scanning electron-microscopy. So far this has not yet been done for the Indian races owing to lack of material, but has been done with the eggs of the Javanese race *musicus,* the Sumatran race *schlegeli,* and the Ceylon race *waiti.* The eggs described by Baker (1934, 1942) for this species associated with babblers (Timaliinae), in particular the Nepal Quaker Babbler *Alcippe nipalensis,* are misidentified; they belong to the Drongo Cuckoo *Surniculus lugubris.*

One egg of the *Aegithina*-type was obtained by Abdulali (1943), who shot on 3 August 1941 a female at Khandala (Western Ghats, 18°01′N, 74°04′E) with a shelled egg in the oviduct. Although the egg was damaged by the shot, the remains were preserved and the egg agrees closely with an Iora's—white background with sparse reddish-brown blotches and streaks heavier towards the broader end. Already Abdulali remarked that it was certainly not like an egg of the Red-whiskered Bulbul as suggested by Baker (1942) (= egg of *Surniculus lugubris*).

Season, probably variable and prolonged (February to August), synchronized locally with its favourite host species *Aegithina tiphia.*

Eggs, broad ovals, ground colour white or pinkish, speckled and blotched with reddish- or purplish-brown primary markings and somewhat greyer underlying markings. Sometimes the blotches are more elongated and directed from pole to pole. Two eggs of the Javanese race *musicus* average 17.6 × 13.5 mm, shape index 1.30, shell weight 0.0985 (0.0954-0.1016) g. Rey's index 2.42 (2.41-2.43), fresh weight 1.80 (1.68-1.94) g. One egg of the Sumatran race *schlegeli* measures 18.8 × 14.4 mm, shape index 1.31, Rey's index 2.39, fresh weight 2.12 g. This egg is more densely blotched with olive-green and grey spots (somewhat resembling a *Passer* egg), but otherwise very similar to the Javanese eggs. It was obtained at Negerya, Tanjung Karang, Lampongs, South Sumatra on 18 April 1950. This egg, earlier described by Voous (1951), was laid in the hand by a bird shot with a sling.

The egg of the foster species *Aegithina tiphia* is rather variable in colour and markings. Although *Aegithina* eggs are of the same



Nest of the Bush Warbler *Cettia diphone* showing eggs of the fosterer with one egg of the Small Cuckoo *Cuculus poliocephalus*. The cuckoo egg (indicated by arrow) mimics the foster eggs closely. Ussuriland, U.S.S.R., 11 July 1966. × 1.0.
(Photo: *I. A. Neufeldt*)

Nestling of the Plaintive Cuckoo *Cacomantis merulinus* fed by its fosterer the Ashy Tailorbird *Orthotomus sepium*. The nest of the tailorbird is woven between two coffee (*Coffea robusta*) leaves. In the right-hand picture the cuckoo nestling shows threat behaviour against intruder by ruffling its crown feathers. Coffee/Rubber Estate Dampar, Jember, E. Java, Indonesia. 15 January 1936. ×0.6. (Photos: *J. G. Kooiman*) size as the *Cacomantis sonneratii* eggs, they are thinner shelled. Five *Aegithina tiphia* eggs average 0.0847 g, Rey's index 2.75-2.88. Egg-shell thickness in *C. sonneratii* is av. 143 μm, whereas in *Aegithina* 117-123 μm. There is no significant difference in fresh egg weight between cuckoo and fosterer, since *Aegithina* eggs weigh 1.71-1.89 g. Three adult specimens of this cuckoo averaged 33.7 (32.0-35.0) g, thus relative egg weight (related to body weight) is 5.2%. Two cuckoo fledglings (stage presented in Plate 1, middle right) weighed 25.0 and 26.0 g; they were collected by W. C. van Heurn (now collection RMNH) at Bogor, Western Java, in July 1925 and August 1926, respectively.

The young cuckoo evicts eggs and rightful nest-mates from the parasitized nest. The record by Bromley (1948), mentioning two *Cacomantis sonneratii* fledglings fed by the same parents (*Aegithina tiphia*) in Malaysia, is probably a confusion of two neighbouring cuckolded *Aegithina* pairs. The nestling of an unknown cuckoo species found in a Common Iora *Aegithina tiphia* nest, described by Hislop (1956) as having a reddish-brown 'woodcock' plumage, is definitely a *Cacomantis sonneratii* nestling. No other cuckoo has these plumage features. A colour representation of a very young *C. sonneratii* and a recently fledged fledgling is shown in Plate 1 (middle). As is evident from the colour plate, the young of this cuckoo species can be readily distinguished from all other cuckoos by their rufous-red striped upperparts and the fine black barring of throat and underparts. Further, it is the only small cuckoo with rather striking olive-green feet, a feature which is very prominent in nestlings and fledglings and to some extent also visible in juveniles and semi-adults.

Cacomantis sonneratii waiti

CEYLON BAY BANDED CUCKOO

BREEDING. A Common Iora *Aegithina tiphia multicolor* nest containing one cuckoo egg and two host eggs was collected by W. E. Wait at Colombo, Sri Lanka, in February 1909 (Baker collection, B.M.). This cuckoo egg was formerly assigned by Baker (1934, 1942) to the Drongo Cuckoo *Surniculus lugubris*. The cuckoo egg measures 17.4 × 13.5 mm, shape index 1.29, shell weight 0.0866 g, Rey's index 2.71. It mimics the Iora eggs closely, but in this particular clutch it is somewhat different from the Iora eggs, which as usual are rather variable in colour and markings in the various clutches.

Victimizes also the Orange Minivet *Pericrocotus flammeus*, since Mrs. C. Lushington (cited by Phillips, 1944, l.c. p. 219) observed a couple of these minivets on 4 September 1940 at Kahawatta (6°35′N, 80°34′E), Ratnapura district, Sri Lanka, feeding a fledgling of this cuckoo. Probably also parasitizes the Little Minivet *Pericrocotus peregrinus*, but irrefutable data are lacking. Fledglings and young cuckoos have been observed in June and October by Phillips (1944).

Cacomantis merulinus

INDIAN PLAINTIVE CUCKOO

BREEDING. Brood-parasitic on small warblers (Sylviinae) such as representatives of the genera *Prinia*, *Cisticola*, and *Orthotomus*. These fosterers are birds of rather open habitats such as savanna grassland, village gardens, plantations and secondary forest. In conformity with this, *Cacomantis merulinus* is a cuckoo of open habitats and secondary forest and is never found in dense primary forest. Most of its fosterers build dome-shaped nests with a side entrance or rather fragile deep purses with a narrow slit entrance between leaves. Thus, it is rather difficult to conceive how the cuckoo introduces its egg into these nests without damaging it. The act of egg laying has never been observed and needs to be determined. In Java where this cuckoo mainly parasitizes *Orthotomus sepium* and *O. sutorius* nests, a large proportion (i.e. 20%) of the parasitized tailorbird nests are afterwards deserted (Becking, pers. observation). A nestling of *Cuculus merulinus* fed by its fosterer, the Ashy Tailorbird *Orthotomus sepium*, is illustrated in Plate 9.

Season, overall May to September, with a distinct peak in July (58% of 53 breeding records, Baker collection). Breeding synchronized locally with the host species.

Eggs, several clear-cut colour types exist, adapted to special fosterer species. Eggs usually larger than fosterer's long oval with rounded ends, but in some cases somewhat tapering to the small end. Shell surface glossy or moderately glossy. Fourteen Indian eggs average 19.1 × 13.3 mm, shape index 1.44, shell weight 0.1187 (0.1016-0.1326) g, Rey's index 2.14 (2.04-2.39). Fresh egg weight 1.48 (1.33-1.56) g. Body weight of the bird is av. 25.7 g (n=6), thus the egg weight is 5.4-6.0% of the body weight. Colour of the cuckoo egg variable and distinct colour types (so-called 'gentes') mimicking certain fosterers can be distinguished. These types are mainly the following:

(1) Cuckoo eggs adapted to the eggs of the Ashy Wren-Warbler *Prinia socialis* are uniformly chestnut- or mahogany-red sometimes with some darker faint spots of the same colour around the large end. This type is mainly found on the Deccan plateau and Andhra Pradesh, e.g. in Hyderabad city and surroundings, Trimulghery, and Bolarum.

(2) An egg-type adapted to the Common Indian Wren-Warbler *Prinia inornata*. These eggs mimic the eggs of the fosterer perfectly except for their size, being larger. These cuckoo eggs have a pale blue ground colour boldly marked with sharply defined blotches and twisted lines of deep red, blackish brown or purple at the surface and somewhat greyer underlying markings completely similar to the foster species. This egg-type is found in Tamil Nadu, e.g. Kotagiri (11°21′ N, 76° 54′ E), Nilgiris near Ootacamund, and also much more north near Dehra Dun (30° 19′N, 78°03′ E), Uttar Pradesh.

(3) A cuckoo egg-type adapted to the tailorbirds *Orthotomus sutorius* and *O. sepium*, or the Streaked Fantail Warbler *Cisticola juncidis*. So far *Cacomantis merulinus* eggs have never been found in the nest of the Redheaded Fantail Warbler *Cisticola exilis*, which occurs in more scrubby habitat and builds a different type of nest. This third type of cuckoo egg has a light pinkish or bluish white ground colour marked with reddish-brown blotches and specks often forming a ring around the large end. This egg-type is widely distributed over the Indian subcontinent and occurs in various habitats.

A remarkable case of adaptation of this cuckoo species to its foster species is reported by R. K. Burnett in Andhra Pradesh (cited by Baker, 1907/08), where in Hyderabad city this cuckoo lays a brick-red egg (type 1) associated with the Ashy Wren-Warbler *Prinia socialis*, but in the surroundings of the city a spotted egg (type 3) associated with the Indian Tailorbird *Orthotomus sutorius*.

The extraordinary record cited in the HANDBOOK (Ali and Ripley, vol. 3, 1969, l.c. p. 219) of a chick of this cuckoo at Poona (Maharashtra) in the nest of a Purple Sunbird *Nectarinia asiatica* being fed in turns by its fosterers and by tailorbirds *Orthotomus sutorius* (cf. Suter, 1945) needs confirmation. The chick is more likely to have been a *Chrysococ-*

cyx[3] (=*Chalcites*) species (*C. maculatus* or *C. xanthorhynchus*) and its begging had probably elicited the feeding response of a pair of tailorbirds which had recently lost their offspring.

Cacomantis merulinus querulus

BURMESE PLAINTIVE CUCKOO

BREEDING. Probably more or less identical to the Indian race. The HANDBOOK (Ali and Ripley, vol. 3, 1969, l.c. p. 221) cites as hosts *Prinia criniger, P. atrogularis, P. hodgsonii, Cisticola cursitans,* and *Orthotomus sutorius.* It is very likely also that in the plains (grassland savanna and rice fields) the Streaked Fantail Warbler *Cisticola juncidis* and in grassland/scrub country the Yellowbellied Wren-Warbler *Prinia flaviventris* are regular victims, because these host species are often parasitized by this cuckoo in the more eastern regions of its distribution area such as Malaysia and Indonesia (Java).

Chrysococcyx maculatus

EMERALD CUCKOO

BREEDING. Very imperfectly known. Brood-parasitic on sunbirds, mainly the Indian Yellow backed Sunbird *Aethopyga siparaja seheriae* or Mrs. Gould's Sunbird *Aethopyga gouldiae* and the Little Spiderhunter *Arachnothera longirostris.* The Baker collection has a fair number of eggs of this and the following species, the Violet Cuckoo *C. xanthorhynchus,* nearly all collected in Assam. These localities are: Cherrapunji (Assam, 25°16′N, 91°42′ E), Goalpara (Assam, 26° 10′N, 90° 38′E), Gooma Reserve (near Goalpara, Assam), and Dumpep (Khasi Hills, Assam). Apparently in this region both species are widely sympatric and victimize the same hosts.

Comparison of these series of eggs in the Baker collection showed two distinct types of eggs in respect of markings and shape (long type versus round type). Since moreover also the ultra-structure of the eggshell was fundamentally different, it is evident that they belong to two different cuckoo species. Because no oviduct eggs are available of this species, nor of *Chrysococcyx xanthorhynchus,* there is at present no means of assigning the egg-types to either of these species. As is evident from the numerous changes in names on the labels and set marks on the eggs, Baker changed his opinion several times and his classification is rather arbitrary. Re-examining this material Harrison (1970) partly reversed Baker's classification, but I cannot subscribe to some of his allocations as some of these eggs probably belong according to me to the Plaintive Cuckoo *Cacomantis merulinus* (see *Chrysococcyx xanthorhynchus*).

Ultra-structural examination of these eggs in the Baker collection by scanning electron microscopy revealed irrefutably that both egg-types were cuckoo eggs. They showed all the structural characteristics of parasitic cuckoo eggs such as surface texture and the presence of plugged pores with cracks in the plug material (see Plates 3 and 10). As already stated, the two types had a different ultra-texture, indicating that they belong to different species. The mensural characteristics of both egg-types are also different. One egg-type is on average smaller and more rounded; the other is larger and more elongated (see shape indices and measurements). Since *Chrysococcyx xanthorhynchus* (body-length *c.* 17 cm, wing-lengths 90-105 mm) is a somewhat smaller bird than *C. maculatus* (body-length *c.* 18 cm, wing-lengths 105-114 mm) the smaller more rounded egg-type is provisionally attributed to *C.*

[3] But Poona is entirely outside the distributional range of these cuckoos !-Eds.

xanthorhynchus and the larger, elongated egg-type to *C. maculatus*. This classification is to some extent supported by the field observations of Inglis and Primrose, the main collectors of these eggs (see Inglis, 1908), as discussed under *C. xanthorhynchus*.

The supposed *Chrysococcyx maculatus* eggs mimic very closely those of the Little Spiderhunter *Arachnothera longirostris*, with which host they are often associated. The eggs are long ovals, glossless and in colour Light Buff or Orange Citric (Ridgway) covered with Light Brownish Olive spots and specks often forming a distinct ring around the blunt pole. Compared to *Arachnothera* eggs, the cuckoo eggs have markings of a more olive-brown tinge being less russet or vinaceous-fawn than *Arachnothera longirostris* eggs usually are. Eight of this type of cuckoo eggs average 17.6 × 12.3 mm (16.4-18.4 × 11.7-13.3), shape index av. 1.42 (1.33-1.53), shell weight av. 0.0889 (0.0780-0.0965) g, Rey's index av. 2.44 (2.32-2.73). Fresh egg weight *c.* 1.45-1.50 g.

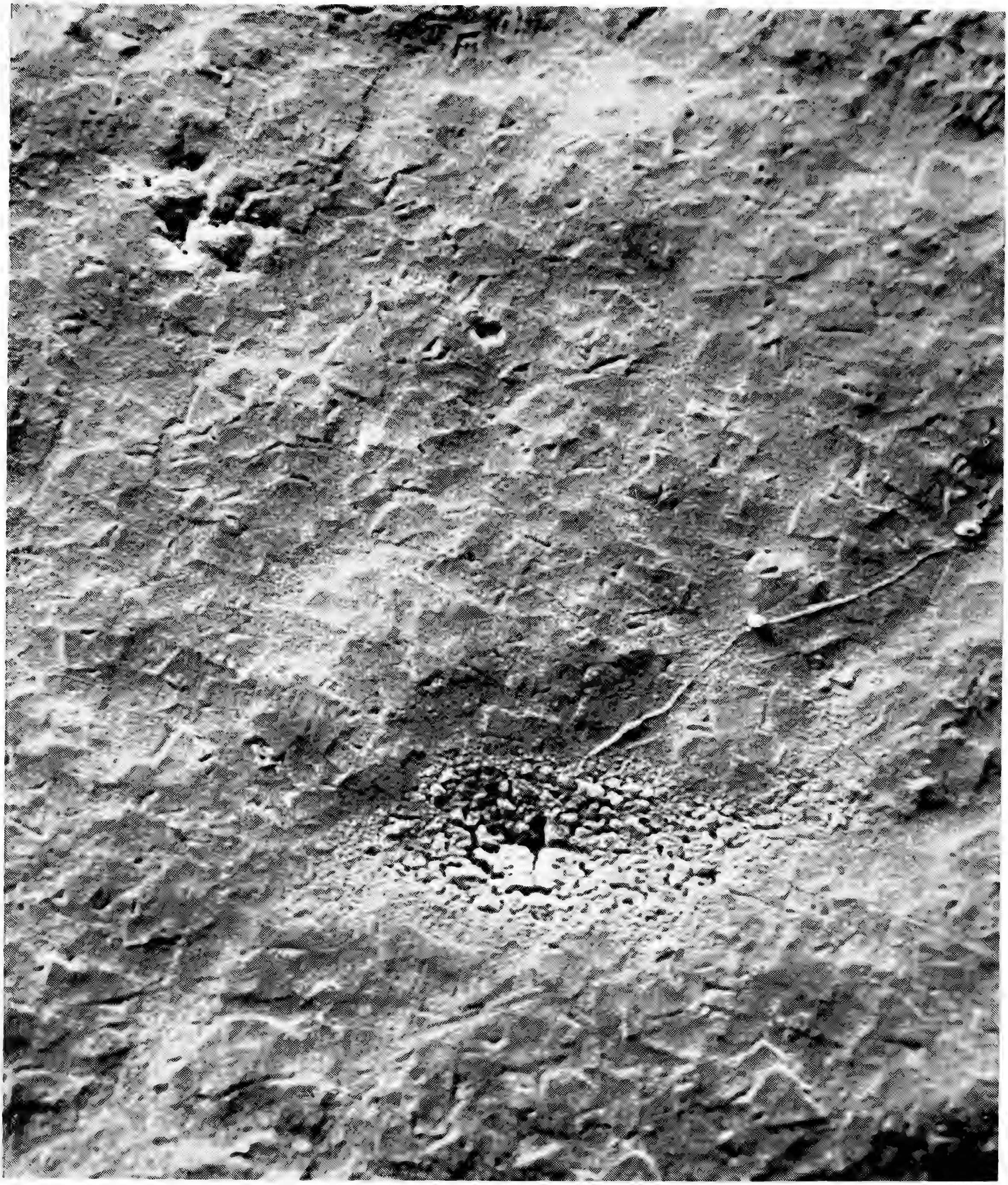
It will be absolutely necessary to determine the identity of the cuckoo hatching from these eggs before they can be attributed to *C. maculatus* with any confidence. Although not definitely observed in this species, nor in the next, *Chrysococcyx xanthorhynchus*, it is probable that the cuckoo nestling evicts the rightful nest-mates, since in some cases the sunbird nest contained only the cuckoo chick (Baker, 1907/08, 1908). Also in all congeneric species (extralimital) the cuckoo nestling is known to evict the rightful nest-mates.

Chrysococcyx xanthorhynchus

VIOLET CUCKOO

BREEDING. Very imperfectly known. Like the preceding species *Chrysococcyx maculatus*, mainly brood-parasitic on Yellowbacked Sunbirds *Aethopyga siparaja* and the Little Spiderhunter *Arachnothera longirostris*. Baker (1934, 1942) mentioned also as (putative?) hosts *Seicercus xanthoschistos* and *Orthotomus sutorius*, but these hosts seem unlikely and need confirmation. Harrison (1970), revising the eggs of the Indian *Chrysococcyx* species in the B.M. collection (Tring), gave a multiple host range for *C. xanthorhynchus* including the Streaked Fantail Warbler *Cisticola juncidis* and the Tailorbird *Orthotomus sutorius*. Some of these eggs which I have examined, I would classify as eggs of the Plaintive Cuckoo *Cacomantis merulinus*.

As explained under *Chrysococcyx maculatus*, on the basis of numerical features the smaller, more rounded egg was attributed to *C. xanthorhynchus*. Among material of this round egg-type in the Baker collection are eggs collected by Mr. A. M. Primrose and Mr. C. M. Inglis at the Gooma Reserve, Goalpara, Assam, and associated with *Aethopyga siparaja seheriae* (e.g. the clutches collected on 14 May 1906, 16 June 1906, 15 May 1908, etc.). In this respect it is of interest that Inglis (1908), commenting on Baker's (1908) identification of these eggs as those of the Emerald Cuckoo *Chrysococcyx maculatus*, mentioned that the only *Chrysococcyx* species seen and collected in the Gooma Reserve was the Violet Cuckoo *C. xanthorhynchus*. Of the two other cuckoos present in the Gooma Reserve, one, the Drongo Cuckoo *Surniculus lugubris*, has a much larger egg (as evident from an unshelled egg of a bird shot in the Reserve) and the other, the Plaintive Cuckoo *Cacomantis merulinus*, is rare. Violet Cuckoos were very numerous and actively calling, and in contrast to the two other cuckoo species were seen (and shot) in the vicinity of the sunbird nests. Therefore, Inglis (1908) concluded that these cuckoo eggs must belong the Violet Cuckoo *Chrysococcyx xanthorhynchus*. In reply Baker (1907/08, 1908) stated that Mr. Primrose suc-



Scanning electron micrograph of the surface of an eggshell of the Drongo Cuckoo *Surniculus lugubris,* showing the very fine texture of the surface with many regular triangular raised faces of characteristic dimensions and the typical cuculid pore. The thread running to the pore is a contaminating fungal hypha. This cuckoo egg of the so-called *Pycnonotus*-type was found in the nest of the Nepal Quaker Babbler *Alcippe nipalensis*, Cherrapunji, Assam, 29 April 1918, leg. U. Nissor Singh (Baker collection Box 125, D 7). × 350.

ceeded in rearing a young cuckoo from such a sunbird nest to the fledgling stage and this proved 'beyond all doubts' to be the Emerald Cuckoo, as evident from the skin sent to him for identification. Unfortunately, the whereabouts of this skin are unknown (not in the B.M. collection). In my experience it is rather difficult to distinguish these two species in juvenile plumage, especially females.

In this connection it is worth mentioning that Baker (1907/08, l.c. p. 685 and 1908, l.c. p. 278) reported that an Emerald Cuckoo was caught by 'one of his men' in a noose at the entrance of a Blackthroated Babbler *Stachyris nigriceps* nest (Gunjong, North Cachar, 10 August 1891) containing a distinct cuckoo egg, bright pinkish-cream with red-brown blotches, freckles and scriggly lines, and two quite different coloured host eggs. This is again an unreliable record caused by uncritical acceptance of eggs from local inhabitants. First, it is rather unlikely that a cuckoo could deposit an egg without first being caught by the noose, and secondly the egg, measuring 20.8×12.3 mm, is far too large for this bird and probably an egg of the Drongo Cuckoo *Surniculus lugubris*.

The smaller, round egg *provisionally* attributed to *Chrysococcyx xanthorhynchus* has a faint or moderate gloss. It is quite different from the supposed *C. maculatus* eggs, being profusely speckled and blotched with red vinaceous or violet (Ridgway: Indian Red, Corinthian Red) spots and more olive-brown secondary markings on a whitish buff or pink ground colour. The distinct spots are generally regularly distributed over the eggshell, but occasionally are more concentrated forming a loose ring round the blunt pole. Eight of these supposed *C. xanthorhynchus* eggs measure on average 16.4×12.3 mm ($15.9\text{-}16.8 \times 10.8\text{-}12.9$), shape index av. 1.34 (1.24-1.49), shell weight av. 0.0751 (0.0580-0.0843) g, Rey's index 1.34 (1.24-1.49). Compared to the preceding species they are thinner shelled (see Rey's index). Fresh egg weight av. 1.47 g. Body weight of two birds av. 21.0 (19.8 and 22.1) g, and accepting the above-mentioned provisional identification relative egg-weight is 7.0%.

It remains necessary to determine the cuckoo species which hatches from similar eggs before this egg-type can be attributed to this cuckoo species with any confidence.

Surniculus lugubris

INDIAN DRONGO-CUCKOO

BREEDING. Brood-parasitic on babblers, in particular the Nepal Quaker Babbler *Alcippe nipalensis* and the Blackheaded Babbler *Rhopocichla atriceps*. The often cited opinion that it is brood-parasitic on drongos *Dicrurus* spp., mentioned by the HANDBOOK (Ali and Ripley, vol. 3, 1969, l.c. p. 225), is definitely an error and probably inspired by the superficial likeness of this cuckoo to a drongo.

Eggs, the Baker collection (B.M., Tring) possesses a fair number of eggs of this species, although they are not recognized as such by Baker (1934, 1942), but attributed by him to the Bay Banded Cuckoo *Cacomantis sonneratii*. These *Surniculus* eggs were mainly collected in Assam (Khasi Hills, Shillong, Cherrapunji, etc.) and are of the so-called *Pycnonotus*-type, because of their superficial resemblance to *Pycnonotus* eggs. Scanning electron microscopic examination of the eggshell showed that at least a number of them are genuine cuckoo eggs because of their smooth surface with regular polyangular structures and characteristic cuckoo pores. Nevertheless, this analysis revealed also that a number of these eggs were not cuckoo eggs at all, but pycnonotid eggs, However, most clutches collected by Baker himself (as evident from Baker's catalogue) were real cuckoo eggs as proved by their ultra-structural characteristics. I was able to identify this *Pycnonotus*-type of cuckoo egg as that of the Drongo Cuckoo by its similarity, in texture pattern of regular triangular raised faces and in their dimensions (Plate 10), to genuine *Surniculus lugubris* eggs from Java. The observed pattern is characteristic for *Surniculus* and different from all other cuckoo eggshells examined. Among the Indian egg material in the B.M. Tring, there is also one egg resembling that of *Alcippe* in coloration and markings. This *Alcippe*-type cuckoo egg was associated with the Blackheaded Babbler *Rhopocichla atriceps* and was collected by J. Stewart in Kerala (formerly Travancore) at Aneichardi on 4 April 1907. It shows some similarity with *Surniculus lugubris* eggs of the nominate form of Java associated with Horsfield's Babbler *Trichastoma sepiaria* (so-called *Trichastoma*-type of *Surniculus* egg).

In Java the main fosterer of the Drongo Cuckoo is Horsfield's Babbler *Trichastoma sepiaria* and regularly, but less frequently, the Pearlcheeked Babbler *Stachyris melanothorax* and Bonaparte's Yellowbreasted Babbler *Macronous flavicollis*. Only in one case it was associated with the Javanese Quaker Babbler *Alcippe poiocephala*. *Surniculus* eggs in *Trichastoma* nests can scarcely be discriminated from the host's eggs; they are somewhat smaller in size, but clearly distinguishable by ultratexture. *Surniculus* eggs, however, do not mimic the plain bluish-white eggs of *Stachyris* and the white dark reddish-brown speckled eggs of *Macronous*. *Macronous* spp. seem also a host of *Surniculus* in Malaysia, since Medway and Wells (1976) mention a record of a Drongo Cuckoo fledgling being fed by a pair of Striped-throated Tit Babblers *Macronous gularis*.

The young cuckoo evicts unhatched eggs and rightful nest-mates from the nest, since in all cases only one cuckoo nestling was observed, even at a very young stage. Nestlings and fledglings are all black with white spots over the plumage. Closer examination shows that each feather has a white triangular spot at some distance from the tip near the rachis. Mouth lining and gape bright vermilion red, feet conspicuously vinaceous (see colour Plate 1).

Season, presumably March to October (January to April in Kerala?), when most were rather vocal and gonads of specimens were in breeding condition. In Assam (Khasi Hills, etc.) the breeding season is from the second half of April to July with a distinct peak in May and June (Baker collection).

Eggs, in various colour and marking variations (see above). Broad oval, usually heavily blotched and streaked with red and purplish on a white or pinkish underground resembling a small egg of a *Pycnonotus* species (*Pycnonotus*-type), while others, more faintly marked, are more reminiscent of *Alcippe* (*Alcippe*-type). The nominate race of Java has yet another egg-type very closely mimicking the egg of its principal fosterer *Trichastoma sepiaria*. The Indian eggs measure on average 19.8×15.5 mm, shape index 1.28 (1.23-1.32), shell weight av. 0.1352 g, Rey's quotient 2.24 (2.12-2.39), fresh egg weight 2.4 (2.2-2.6) g. Body weight adult av. 36.2 (30.0-43.6) g ($n = 28$), relative egg-weight (related to body weight) 6.7-7.3%. Eggshell weight and fresh egg weight not significantly different from fosterer eggs; often the cuckoo egg has a smaller fresh weight and its shell weight is lower!

Surniculus lugubris stewarti

CEYLON DRONGO-CUCKOO

BREEDING. Brood-parasitic on babblers, in general similar to the Indian race. A nestling of this cuckoo was collected by W. E. Wait at Anasigalla, Sri Lanka in March 1918 in the nest of the Ceylon Blackheaded Babbler *Rhopocichla atriceps.* Its skin is in the B.M. collection, Tring, under Reg. no. 1924.9.5.2 and the classification of the skin is confirmed by me (Becking).

Season, probably from December to May.

Eggs, probably identical to the Indian egg-types of this cuckoo.

CONCLUSIONS

From the foregoing it is evident that the brood-parasitism of the Indian cuckoos is very imperfectly known. Many of the data presented by Baker (1934, 1942) are rather doubtful and many of his egg identifications are erroneous. Baker's classification is often based on insufficient grounds or on flimsy evidence.

For instance, the plain blue egg attributed to the Large Hawk-Cuckoo *Cuculus sparverioides* does not belong to this species but probably to the Khasi Hills Cuckoo *Cuculus canorus bakeri.* On the whole the presence and frequency of the blue egg-type of *Cuculus canorus* (so well known in temperate regions) is underestimated for the Indian region, although blue eggs have regularly been reported in this region (Mackenzie, 1918; Livesey, 1935 a, b). The egg of the Common Hawk-Cuckoo *Cuculus varius* is unknown or confused with the supposed eggs of the Hodgson's Hawk-Cuckoo *Cuculus fugax.* Although the latter is apparently nowhere common (Ali and Ripley, vol. 3, 1969) far more eggs are attributed to it in the Baker collection than to the Common Hawk-Cuckoo. The eggs described by Baker as belonging to the Indian Bay Banded Cuckoo *Cacomantis sonneratii* are in fact those of the Drongo Cuckoo *Surniculus lugubris.* Drongo Cuckoos do not parasitize drongos (despite unfounded statements in literature!), but babblers.

The biology, distribution and parasitic behaviour of *Clamator jacobinus* and other *Clamator* species are extremely complex. The occurrence of partly discontinuous distributions, the presence of various colour morphs, and differences in eggshell ultra-structure, suggest that there may be more distinct species in this group than are at present recognized. Eggshell structure and host specificity may be conservative characters and may be useful clues for separating this group. Work on these lines is in progress. There are no irrefutable eggs of the Emerald Cuckoo *Chrysococcyx maculatus* or the Violet Cuckoo *Chrysococcyx xanthorhynchus,* in spite of the fact that the eggs of these two species are different in ultrastructure and in numerical characteristics. Both species parasitize approximately the same host species. On the basis of numerical features of the eggs and the birds, and supported by field observations of Inglis (1908), the main collector of these eggs, a provisional classification is made which needs to be verified by letting such eggs hatch, before it can be accepted with any confidence.

Owing to the fact that some collectors did not always collect their eggs personally but paid the local people for eggs, and paid especially well for cuckoo eggs, a large number of supposed cuckoo eggs are in fact not cuckoo eggs at all, but odd clutches (or falsifications) of Passerine eggs. In the Baker collection this is in particular the case with the eggs of the Indian Cuckoo *Cuculus micropterus,* brood-parasitic on drongos, and the Drongo Cuckoo *Surniculus lugubris* (described by Baker as the eggs of the Bay Banded Cuckoo *Cacomantis sonneratii*), brood-parasitic on babblers. The falsifications are drongo eggs from other clutches and pycnonotid eggs, respectively.

Some of the oviduct eggs are also of doubtful origin or do not belong to the cuckoo species to which they are attributed, e.g. in the case of the Common Hawk-Cuckoo *Cuculus varius*. In the case of oviduct eggs it is important that the skin is preserved in a well-known museum as proof and for possibility of future verification.

In spite of the immense size of the collections of Indian cuckoo eggs built up in the past (Baker collection: more than 2,000 eggs of the Khasi Hills Cuckoo (*Cuculus canorus bakeri*), these collections have contributed little to our knowledge of cuckoo biology. For some species there are no irrefutable eggs or breeding data, and eggshells by themselves have no value. It will be far more profitable in future *not* to collect supposed cuckoo eggs but to let them hatch in order to determine the identity of the cuckoo species involved. The identification of adult cuckoos is sometimes difficult, and of fledglings even more so; even experienced taxonomists have made errors, e.g. Robinson (1927) and Chasen (1939) with regard to *Cuculus saturatus* versus *Surniculus lugubris*. Therefore in cases where the identification is not unambiguous the help of a museum should be asked.

Hence, an extensive area for field studies lies open for future research. Data on the incubation, nestling and fledgling periods of Indian cuckoos are by and large lacking. Nothing is known of the ecology, the behaviour of individual cuckoos, number of eggs (clutches) produced per season, laying intervals and the interrelations of cuckoo species and their hosts within a biotope. An evaluation of all these aspects would be necessary to preserve these species in their natural habitats, which in South-East Asia are surely much endangered by man. A more exact knowledge of their breeding habits would result in a better classification and therefore a more profitable use of existing egg collections in various museums.

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I am much indebted to Dr. Irena Anatoljewa Neufeldt (Zoological Institute, Academy of Sciences of the U.S.S.R., Leningrad) for the photographs of the *Cuculus micropterus* nestling and fledgling and those of *Cuculus poliocephalus*. I likewise thank my friend Mr. J. G. Kooiman (The Netherlands) for the photograph of the *Cacomantis variolosus* and *merulinus* nestling.

I wish to thank Mr. M. W. Woodcock (Staplehurst, Kent, England) for some minor corrections, mainly of the soft part colours in Barruel's water colour painting.

I also gratefully acknowledge the kind help of Dr. D. Snow (British Museum of Natural History, Tring, England) for reading and correcting the English of the text and making useful comments on an earlier draft of the manuscript.

As a youth of 17 years I watched a Common Iora feeding a *Cacomantis sonneratii* fledgling within a few feet (Bogor, Western Java, Indonesia, 16 July 1941, see Plate 1), since when I have been in the grip of the problem of the biology of brood-parasitism in Asiatic cuckoos. A new dimension was added to this interest by the development of new techniques such as scanning electron microscopy and protein electrophoresis, which enabled me to distinguish between cuckoo eggs and fosterer eggs and sometimes to classify cuckoo eggs to the species level.

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BOMBAY NATURAL HISTORY SOCIETY—
The Founders, the Builders and the Guardians

Part 2

SALIM ALI

(*With Three Plates*)

[*Continued from Vol.* 75 (3): 569]

I had originally thought to deal separately with the Founders, the Builders and the Guardians of the Society. However, except for the Founders as listed chiefly in Part 1 of this paper, it is difficult to tell the other two categories apart considering that their activities overlap so closely. Both are therefore being treated together henceforth.

The Builders and the Guardians

CHARLES LIONEL AUGUSTUS DE NICEVILLE
1852-1901 (Vol. 14: 140) Anon.

The scion of a noble Huguenot family long domiciled in England, and the last Baron of his line. From his early schooldays de Nicéville showed a decided bent for entomology and spent all his spare time in studying insects instead of participating in the ordinary school games. He came out to India in 1876 and held several minor non-scientific appointments, one of the last being as Clerk in the Calcutta Small Causes Court! He employed his holidays and daily leisure in the study of Oriental butterflies, on which he published over 70 papers, and came to be recognized as 'the greatest authority'. By experimental breeding de Nicéville proved that in many cases seasonal forms of the same butterfly had been wrongly separated as species, and by the same method he was also able to elucidate the biology of many other forms. His entomological researches in the East extended far and wide—from Ladakh to Sumatra and Japan. He described many new species of butterflies and contributed much to our knowledge of the distribution of these insects. His work for many years—apparently part-time and voluntary—was carried out in a room allotted to him in the Indian Museum, and the very fine and extensive collection which he kept there was later acquired by that institution. He was a frequent contributor to various scientific journals including those of the Asiatic Society of Bengal and the Bombay Natural History Society. His papers in the latter, mostly on insects, chiefly butterflies, are spread between Volumes 2 and 13. He was of the greatest assistance to the editors of the *Journal* as he long undertook the correcting of proofs, a task in which he was most painstaking and assiduous. The qualities of method and industry were characteristic of the man and make his publications of the very highest value. His great work on the *Butterflies of India, Burma and Ceylon* was unfortunately never finished, but such portions of it as were published have been of very great usefulness. For the three years 1881-1884 de Nicéville was put on special assignment in the Indian Museum for the arrangement of its butterfly collection. It was only a few months before his untimely death in December 1901 that he had the satisfaction of being officially appointed to the Indian Museum in the newly created post of Government Entomologist. His singularly kind and genial disposition had endeared him to all. With a wide capacity for enjoyment of life he combined singularly simple tastes, and both in this and in the equanimity of his temper and cheerfulness he showed himself a true philosopher.

ROBERT A. STERNDALE 1839-1902 (Vol. 14. 804) by Editors

Mr. Sterndale came to Bombay soon after the Bombay Natural History Society was formed (1883) and at once joined it, and worked for it with characteristic enthusiasm. That it rose so rapidly from the littleness and obscurity of its origin must be attributed in a great measure to its good fortune in having among its members a naturalist of Mr. Sterndale's distinction, and one so exceptionally qualified by his versatile gifts to popularize its work. The list of contributions from his pen (in Vols. 1 and 2) gives no idea of the extent to which the Society was indebted to him. The idea of starting a journal originated with him and proved practicable only because of the way in which his ready pen and pencil solved all difficulties. Mr. Sterndale's presence at the monthly meetings also added to much of their interest. He was not a museum naturalist but a lover of animals, and he imparted a living interest to every creature about which he discoursed. He continued to edit the *Journal* till he left Bombay in 1887 to become Governor of the island of St. Helena.

R. A. Sterndale was the author of A NATURAL HISTORY OF THE MAMMLIA OF INDIA AND CEYLON published in 1884—a popular work which was well received and is still of great relevance and usefulness to the student of Indian Mammals.

CHARLES THOMAS BINGHAM 1848-1908 (Vol. 19: 214) by H.M.L.(efroy)

Lieut.-Colonel, late Bengal Staff Corps and Conservator of Forests, Burma. Widely known as a keen naturalist who during his long service in Burma devoted himself to the study of Natural History. Though his work was not crowned by academic honours or the fellowship of learned societies, it will rank with that of Wood-Mason and de Nicéville, and to no one has it been possible to so signally advance the study of the subject to which he devoted himself. The large collections made by him formed the basis of much of the FAUNA OF BRITISH INDIA volumes on butterflies, bees and wasps. As a keen and dedicated observer he added much to our knowledge of the ways and habits of bees and wasps. His earlier papers related to birds and were published in *Stray Feathers* between 1876 and 1881. After the founding of the Bombay Natural History Society, by which time his interest seems to have switched mainly to insects, he published frequently in the *Journal*. Col. Bingham had the rare distinction of combining the rigid accuracy of the systematist with the breadth of view and power of observation necessary for studying the living insect in its many activities and varied habits. The two volumes of the FAUNA dealing with the Aculeate Hymenoptera of India and Burma represent the result of his special study. Col. Bingham undertook the completion of the unfinished work of Lionel de Nicéville on the FAUNA Butterfly volumes after the latter died in 1901. The two volumes dealing with the Nymphalids, Papilionids, Pierids and part of the Lycaenidae were published, and the final volume was in preparation at the time of his death.

He succeeded Dr. W. T. Blanford as Editor of the FAUNA OF INDIA in 1905, and workers in Indian entomology owe a great debt to his untiring efforts to secure the cooperation of authorities in Zoology and to give help of every possible kind to workers in India.

Col. Bingham joined the Society in 1887 and remained an active member until his death in England in 1908. Between Volumes 3 and 13 of the *Journal* there are 14 papers and notes by him chiefly on Hymenoptera, including a very useful one on their collection and preservation.

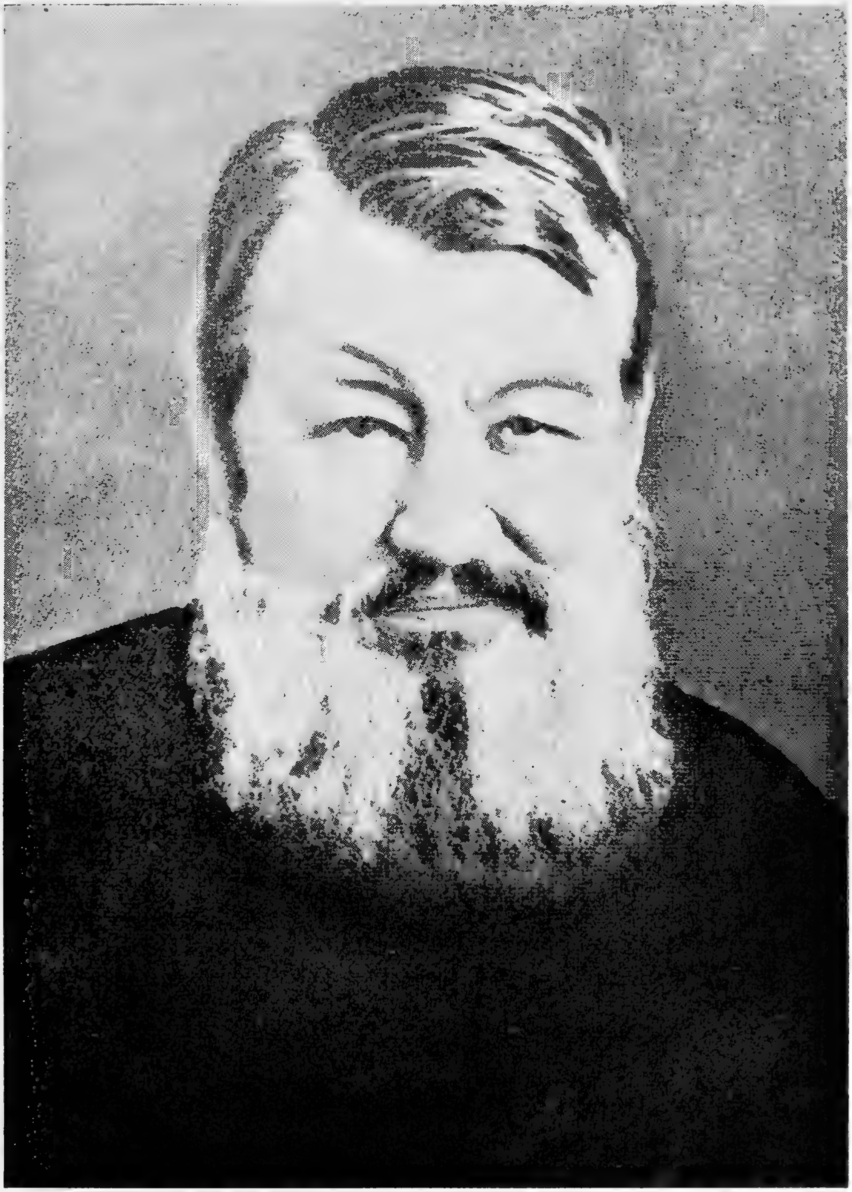
EUGENE W. OATES 1845-1911 (Vol. 21: 651) by W.R.O.-G. (Ogilvie-Grant)

Died 16th November **1911** aged 66. Served in the Public Works Department in Burma from 1867 to 1899, and was Chief Engineer at the end of his service. He was an ardent naturalist with few equals as an ornithologist, and devoted all his spare time to the study of his favourite science. When in England in 1882-3 he spent much of his time at the British Museum, Bloomsbury, in preparing his first well-known work A HANDBOOK OF THE BIRDS OF BRITISH BURMAH. Subsequently he wrote the first two volumes on Birds in the FAUNA OF BRITISH INDIA series edited by W. T. Blanford. On page 290 of Vol. 2 of this otherwise admirable work there is a ridiculous and puzzling description of the call of the Streakeyed Wagtail (*Motacilla ocularis*) as "a prolonged Pooh". 'The explanation of this remarkable statement may now be given the author and editor, as well as the perpetrator of the joke being now, alas, dead' writes his obituarist. 'When Oates was in the middle of preparing his second volume, at the Natural History Museum, the writer and the late Dr. Sharpe happened to pass the table covered with his manuscript on their way to lunch, and Sharpe, who loved a joke, said "let us add something funny to Oates's description of this Wagtail", little thinking that his remarks would get into print. He never doubted that the eagle-eye of the author would detect and strike out the line, after having a laugh over it, knowing the source from whence it came'. The incident was forgotten, the volume completed and Oates returned to India. The long forgotten joke unfortunately went unnoticed in the revises of the proofs; thus has the impossible call of the wagtail remained a standing perplexity to ornithologists and 'a warning to all practical jokers'. Oates's other well-known books included a second edition of Hume's NEST AND EGGS OF INDIAN BIRDS and A MANUAL OF THE GAME BIRDS OF INDIA. He also wrote the first and second volumes of the CATALOGUE OF THE COLLECTIONS OF BIRDS' EGGS IN THE BRITISH MUSEUM, covering about 50,000 specimens, and was joint author with Capt. Savile G. Reed of the third and fourth volumes of the same work. In the last years of his life Oates became deeply interested in the difficult group of Kalij and Silver Pheasants of which his fine collection was transferred to the Natural History Museum shortly before his death.

Oates is described by those who knew him as being a lovable but at times a hot tempered man. The fact that Hume made over to Oates the whole of his notes and correspondence when the latter was preparing his work on THE NESTS & EGGS OF INDIAN BIRDS testifies to the high regard he inspired in his contemporaries.

REV. FR. F. DRECKMANN, S.J. 1840-1917 (Vol. 25: 293—photo) by E.B.(latter)

Born in Soest in Westfalia (Germany). Joined the Society of Jesus at the age of 19. After going through the usual comprehensive course of philosophical, scientific and theological studies he was sent out to India in 1874 and posted to St. Xavier's College in Bombay, soon to be made Professor of Physics, and 10 years later, Principal of the College. Fr. Dreckmann was a zealous and enthusiastic student of natural history and a prominent member of the Bombay Natural History



F. Dreckmann
(1840-1917)

Nelson Annandale
(1876-1924)

Society almost from its very beginning. He contributed some interesting notes to the earlier volumes of the *Journal*, and the very first plate published in it belongs to an article by Fr. Dreckmann on 'An undescribed Homalopsida'. For a number of years he was on the Society's Executive Committee and President of the Reptile and Fish sections. From early youth he took a delight in watching reptiles and birds, and later in life he made a special study of the snakes of the Bombay Presidency. During his accustomed holidays in Khandala he would wander about in the wild romantic ravine that stretches out between 'Reversing Station' (now demolished) and the 'Duke's Nose' and study its flora and fauna. Bloodsuckers, scorpions, spiders, jungle cats, snakes and other interesting denizens of the wilds were the most favourite objects of his observations. He knew how to catch alive the most deadly snakes with an almost uncanny calmness, and would watch their habits in captivity. Fr. Dreckmann was not a writer and very little has been published under his name; but many a scientific article written by others has been enriched by his valuable accurate observations. He was a man of deep conviction, transparent sincerity, and unflinching courage in expressing his opinions. He hated cant and hypocrisy and liked to deal with men who were sincere and upright, and anything savouring of underhand dealing was detestable to him.

LIEUT.-COL. K. R. KIRTIKAR, I.M.S. (Retd.) 1849-1917 (Vol. 25: 295) by E.B.(latter)

Born in Bombay. After medical training in the Grant Medical College he went to England to compete for the Indian Medical Service, then virtually a British preserve. Soon after his return to India he was sent out from 1878 to 1880 on field service in the Afghan War where he distinguished himself for gallant behaviour in the battle of Maiwand. In 1902 he became Brigade Surgeon Lieut-Colonel, and retired from service in 1904 to take up permanent residence at Andheri (now in Greater Bombay). Col. Kirtikar's interests were many and varied—social, literary and scientific. One subject in which he had shown special interest and marked talent throughout his carrer was Botany. 'I found him amidst his books, chiefly botanic, and he delighted in showing me his valuable volumes, his microscopes, his collections of dried plants, his water colours of Algae and Fungi, and many other things that interest only an enthusiast...He had kept his eyes open, he had read a good deal, he had seen much in many lands, he had taken notes on many botanical subjects and jotted them down in books and on slips of paper that were scattered all over the library. There is no department in Botany, except perhaps physiology, which he did not cultivate...The many contributions to our journal (chiefly in volumes 1-10, especially the serial on 'The Poisonous Plants of Bombay' in 19 parts between volumes 7 and 11 and then in volumes 14 and 15) were written at a time when professional duties claimed all his energy, and it is astonishing that he has been able to do so much. A posthumous work of his on INDIAN MEDICAL PLANTS was published in 1918, and revised in 1933 by Blatter *et al.* and is recognised as the standard manual on the subject.

ROBERT CHARLES WROUGHTON 1849-1921 (Vol. 27: 929) by Oldfield Thomas

Born at Nusseerabad, the son of Major-Gen. R. C. Wroughton, himself an ardent sportsman and naturalist. Served with distinction in the Indian Forest Service from 1871-

1904, starting as Asst. Conservator in Bombay Presidency, and ending as Inspector General of Forests for India. During his service he was specially interested in ants. He collected abundant material and acquired considerable knowledge working in conjunction with the well-known Swiss formicologist Forel. Towards the end of his official career he took to collecting scorpions and myriopods for the benefit of R. I. Pocock of the British Museum on the basis of which material the latter published two papers in Vol. 7 of the *Journal*, the same issue in which also appears a paper on Scorpions by Wroughton himself. Soon thereafter he began collecting the series of bats on which his first mammal paper, 'Some Konkan Bats' published in 1899, (JBNHS Vol. 12) was based; and it was in working out these at the South Kensington Museum during a furlough in England that Wroughton found his metier as a mammalogist, a capacity in which he later did so many years admirable work.

On retirement he settled near London and was a regular attendant at the Natural History Museum. He now turned his attention to African mammals, large collections of which were then coming in from colonial Africa. It was while engaged in their study that he realized, and bitterly deplored the paucity of material from 'our greatest dependency' in the British Museum collections. And it was in the collusion between Wroughton and W. S. Millard, when the latter became Honorary Secretary of the Society, that the splendid idea of the Mammal Survey of India, Burma and Ceylon was conceived and carried through. 'This Survey is undoubtedly the finest thing of the sort that has ever been done, if we except the American Survey of their own Territories, done out of Government funds, while the Bombay Survey has been mainly carried out by private generosity. The Survey, the material obtained by it for the benefit of the National (i.e. British) and Bombay museums, and the papers written on this material all together form a monument to Wroughton's memory which will remain as long as Zoology exists.' Wroughton's mental energy was astounding. No work was too laborious, too great or too difficult for him to start on. Most striking of his personal characteristics were his simplicity, his keen humour and his power of attracting the willing voluntary help of his co-workers.

DR. HENRY NEVILLE COLTART 1873-1922 (Vol. 29: 266) Anon. [E. C. Stuart Baker]

Came to India in 1899 as Medical Officer to the Makum Tea Company in N. Lakhimpur district, Assam and immediately took up the study of the local avifauna for which his position gave him exceptional facilities. As a medical doctor he came into friendly contact with the various tribes of the adjoining Naga Hills and by his patient attention to their complaints and illnesses earned their respect and admiration. It was through them that he was able to obtain many of his greatest rarities in birds as well as their eggs, and to discover the breeding habits of many species unknown till then. This is how he obtained his earliest specimens of the hornbill *Ptilolaemus tickellii austeni*, then only known from those obtained by Godwin-Austen and Dr. Ernst Hartert. The rare laughing thrush (Ogle's) *Garrulax nuchalis* he discovered breeding within a stone's throw of his dispensary at Makum, and he was also the first to unravel the breeding habits of many other birds such as *Alcippe rufogularis, Dicaeum trigonostigma, Heteroxenicus sinensis,* etc. Amongst his other Assam discoveries, named in his honour by Dr. Hartert and Mr. Stuart Baker are *Stachyris nigriceps coltarti* and

Alcedo asiatica coltarti. He was a close associate and collaborator of E.C. Stuart Baker who was also in Assam as a Police Officer in that period. Many of Coltart's discoveries are described or recorded by Baker in his various papers on Assam avifauna in the *Journal*, and constantly referred to in the *New Fauna*, including also recollections of dubious sightings, years earlier, of highly unlikely extralimital species "when accompanied by my friend Dr. Coltart"—long since dead and incapable of corroborating! In 1900 he moved to Bihar in a new assignment, but still continued to do good ornithological work, though in that very thoroughly worked area, the home ground of Inglis and others, his opportunities for discovering novelties were greatly inhibited. Dr. Coltart was a good athlete and excelled in all outdoor games such as tennis, hockey, football and polo. He left India in 1913 to join his father's medical practice in England.

Alexander Melfort Primrose 1872-1922 (Vol. 29: 546) by C.M.I.(nglis)

Came out to India in 1888 aged 16. Started his career as a tea planter in 1893 on the Bagh-o-Bahar tea garden in Cachar, a new garden just being opened up in primeval forest, where he was able to indulge, to a very large extent, his taste for natural history and to spend his most successful collecting days. He subsequently went to the Surma and Rema tea gardens in South Sylhet and was there till early 1902. Thereafter, following a short spell in tea in the Nilgiris, on the Terramia and Halashana gardens, he returned to Assam joining the Mornai garden of the Sonthal Mission in the Goalpara district where he remained till January 1908. This was far away from any railway station, and the proximity of forests and of the Sankos river gave him good opportunities for small game shooting and fishing. It was here that the new subspecies of Painted Quail, *Perdicula manipurensis inglisi* was obtained, also the first eggs of the Emerald Cuckoo, *Chalcites maculatus*. His next assignment was on Longview Estate in Darjeeling district from 1910-1913, after which he returned to Assam where he remained till 1921, his last garden being Murphulani, also an opening-up job in the midst of forest. These historical data concerning Primrose's movements are important because of the various dates and localities labelled on his many bird specimens now in the Society's collection, either presented by himself or accessioned indirectly. Although his principal interest was birds it was by no means confined to them; he also made a fine collection of snakes while he was in Sylhet. 'As a naturalist he was exceedingly observant and a true field ornithologist, being no lover of the present day minute differentialities nor of "dry-as-dust" lists, and the writer was often chaffed by him about some of his writings which appertained to that description'. A.M.—'Prim' to his intimate friends—died of typoid fever while on a visit to his brother Colin at Bhind in Gwalior.

John Duncan Inverarity 1847-1923 (Vol. 29: 822) Anon.

Born in Bombay, educated in England. Returned to Bombay in 1869 where by sheer force of character and brilliancy of intellect he soon established himself as one of the leading lights of the Bombay Bar. He was a great lawyer who, according to the then Chief Justice of Bombay High Court 'for thirty years had no equal in India'. But outside the law Inverarity's reputation rested on his prowess as a big game hunter and naturalist. He was closely associated with the Society almost from its inception in 1886, and was Vice President from 1897 to the time of his death. His varied and exciting adventures while hunting big game are recounted by him in a number of articles in the *Journal* in a plain matter-of-fact style which speak more for the high courage of the man than pages of superlative description could have done. These include the behaviour of a gaur when he charges—how he commences by running at you with his head well up and nose in the air and only kicks his head down for the final toss when a few yards off, 'At least that is the way the ones that charged me behaved'. He also tells you how it feels when being charged and mauled by a wounded lion (Somaliland). 'The claws and teeth entering the flesh does not hurt so much as you would think. The only really painful part of the business is the squeeze given by the jaws on the bone... The power of the lion's jaw may be conceived from the fact that the lioness that seized me, although it had a broken jaw, scored deep grooves in the barrel of my rifle with her teeth'. Inverarity's many articles in the *Journal*, coming from a man who combined the highest ethics of sport with the keenest power of observation and a great love of nature and outdoor life, would make an excellent guide book for sportsmen in India.

NELSON ANNANDALE 1876-1924 (Vol. 30: 213) Anon.

Eldest son of Professor Thomas Annandale, a distinguished Edinburgh surgeon. He came to India in 1904 as Deputy Superintendent in the Natural History Section of the Indian Museum, Calcutta. In 1916 Dr. Annandale achieved one of his principal aims in the foundation of the Zoological Survey of India, and as an institution with research as its main object and the entire 'Indian Empire' as its field of work. He was a very versatile scientist and a prolific writer on zoological and anthropological subjects. Though a highly reputed taxonomist, he considered taxonomy as only a means to an end and not the end itself. The subject which held his particular interest and devotion was Ecology—the study of faunas as a whole: of the animal in its environment, its response to changes in that environment, its relations with its neighbours and its adaptations to special localities and peculiar conditions. He was an emphatic advocate of field work in which he himself—in spite of a gnawing physical malady which carried him off at the early age of 48—was indefatigable.

Dr. Annandale was an authority of world-wide reputation on such diverse animals as sponges, polyzoa, barnacles and molluscs, but there is scarcely a group in the animal kingdom on which he did not make original observations. He penetrated to all corners of the 'Indian Empire' and acquired a personal knowledge of its fauna which has surely never been equalled. Much of his later work consisted of a comparative study of the faunas of Asiatic lakes. He had personally investigated the Sea of Galilee in Jordan, the Hamun-i-Helmand in Seistan, the Chilka Lake in Orissa, the Logtak Lake in Manipur, the Inle Lake in Burma, and others in the Malay Peninsula, China and Japan. His numerous faunal papers were published mostly in the *Records* and *Memoirs* of the Indian Museum and in the *Journal* and *Memoirs* of the Asiatic Society of Bengal; some also in the *Journal of the Bombay Natural History Society* between Vols. 18 and 28, and a particularly interesting posthumous one on 'Termite Mounds' in Vol. 30. Annandale was of a highly strung temperament with a prodigious capacity for work and physical exertion when in the field. He was the first Director of the Zoological Survey of India, and perhaps the most successful and inspiring one among his successors.

Harold Maxwell Lefroy
(1877-1925)

HAROLD MAXWELL LEFROY 1877-1925
(Vol. 30 : 899) Anon.

Imperial Entomologist to the Government of India from 1907 to 1912, during which time he was a member of the Managing [Advisory?] Committee of the Society and a frequent contributor to the pages of the *Journal* in which he published several notes on the life histories of Indian insects, particularly those of economic importance. His method was to study the life history of the insects in the field as he believed there could be found some weak link in the chain—some phase in the insect's life—in which it could be most easily attacked if it were noxious, or encouraged if it were useful. He followed this up by translating the methods he devised from a state in which they could be applied only by highly skilled persons to a form suitable for mass application. Lefroy believed that it was often possible to encourage the natural insect enemies of insects, and some of his most interesting work was the result of observations in the field of what insects preyed on others and how these benefactors could be transferred to areas in which their services were required (Biological Control). But his favourite method was the employment of suitable chemical poisons, and his investigations of these led him deep into purely chemical work. In fact it was while experimenting on chemical insecticides in his private laboratory at the Imperial College in London that he was overcome by gas fumes and met his tragic death. In addition to many official papers in the *Memoirs of the Agricultural Department in India*. Lefroy wrote three books of great importance: INDIAN INSECT PESTS (1906), INDIAN INSECT LIFE (1910), MANUAL OF ENTOMOLOGY (1923). Jointly with C. W. Mason the ornithologist of the Pusa Agricultural Institute (Bihar) he published a seminal paper on 'The Food of Birds' (1912) which remains a classic of its kind even today.

(To be continued)

GEOGRAPHIC DISTRIBUTION OF THE RHESUS AND THE BONNET MONKEYS IN WEST CENTRAL INDIA[1]

NAOKI KOYAMA[2] AND P. B. SHEKAR[3]

(With four text-figures)

INTRODUCTION

Two species of macaques, namely the bonnet macaque (*Macaca radiata*) and the rhesus macaque (*Macaca mulatta*), occur in West Central India. The distribution of the bonnet macaque is confined to the southern peninsula, whereas that of the rhesus is widespread throughout northern India. It is well known that the rivers the Tapti and the Godavari form boundaries which separate the two species allopatrically (Fiedler 1956, Prater 1965). However, these two rivers are not effective barriers in limiting the distribution of hanuman langurs (*Presbytis entellus*) which inhabit almost the whole of India. The rivers never join each other and the minimum distance between them is about 130 km. Little field research has been conducted on the distribution of macaques in this region. The area sandwiched between the two rivers was the focus of our field-survey. The purpose was to clarify the present distribution-patterns of the above-mentioned species of macaques and hanuman langurs, and to elucidate their group composition and habitat ecology.

METHODS

In the States of Maharashtra, Gujarat and Madhya Pradesh, a vehicle (jeep) was used for transportation of personnel during the survey. Information on the general distribution of the two species of macaques was collected from the office of the Chief Conservator of Forests in each State, and several Divisional Forest Offices were selected as places worth visiting. Interviews were conducted in each area with local forest officials and non-official persons. The questions asked were related to the occurrence or absence of different types of species and, when their occurrence was confirmed, on the place, time and number of animals seen. Regarding the type of species, three different photographs of bonnet macaque, rhesus macaque and hanuman langur, respectively were shown during interviews in order to avoid confusion. Most of the people interviewed were able to distinguish the 'black-face monkey' (= hanuman langur) from the 'red-face monkey' (= bonnet and rhesus), although they were not capable of distinguishing bonnet macaques from rhesus monkeys. Queries were also addressed to forest officials regarding dominant tree-species and the forest-conditions prevailing in each area.

The survey-period conducted by jeep lasted for 101 days from August 17 to October 15, 1972 and again from December 5 to January 14, 1973. The total area covered was 9900 km. Besides this survey, the senior author made a preliminary survey in the State of Andhra

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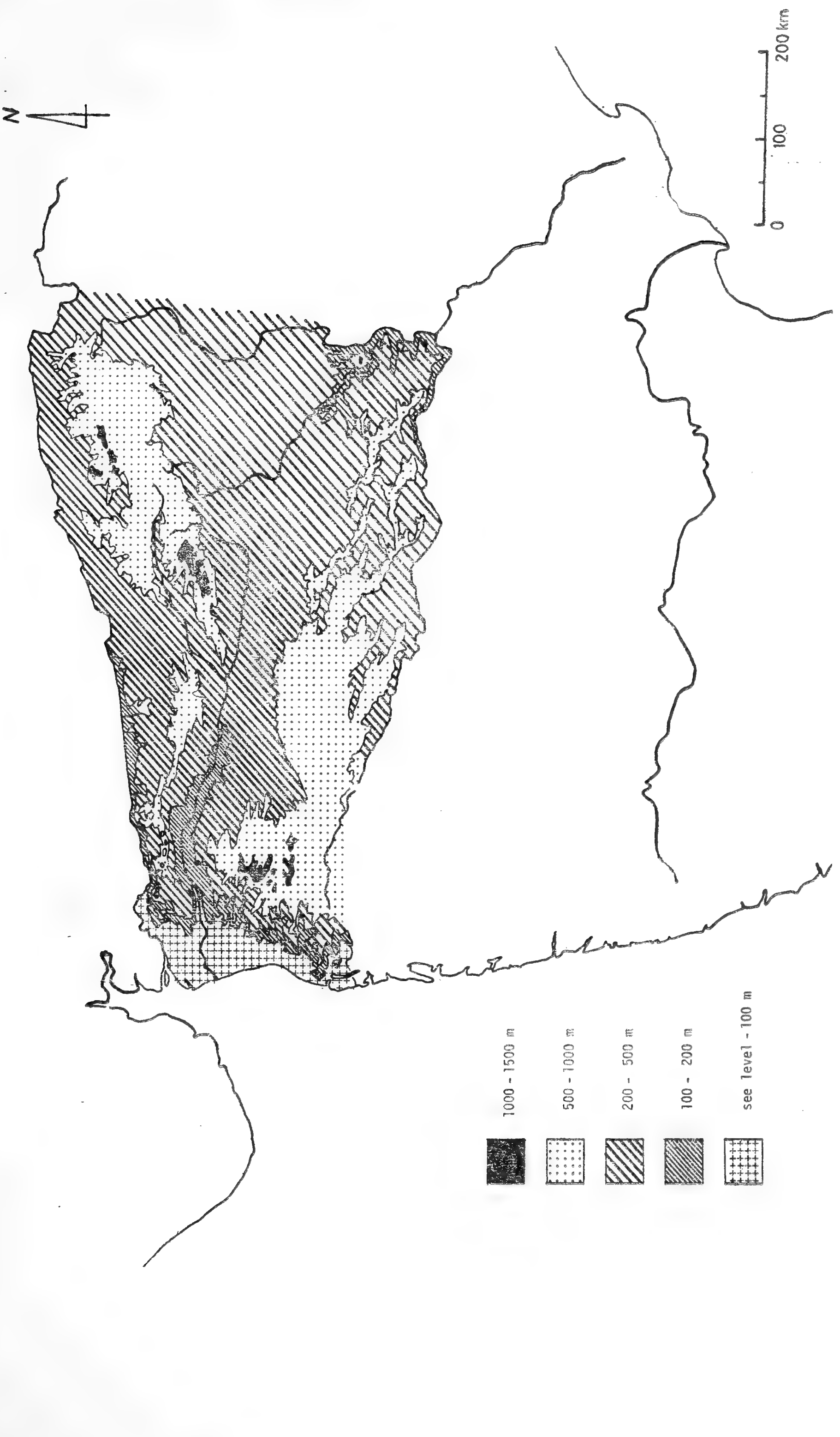

Fig. 1. Relief of the main study area.

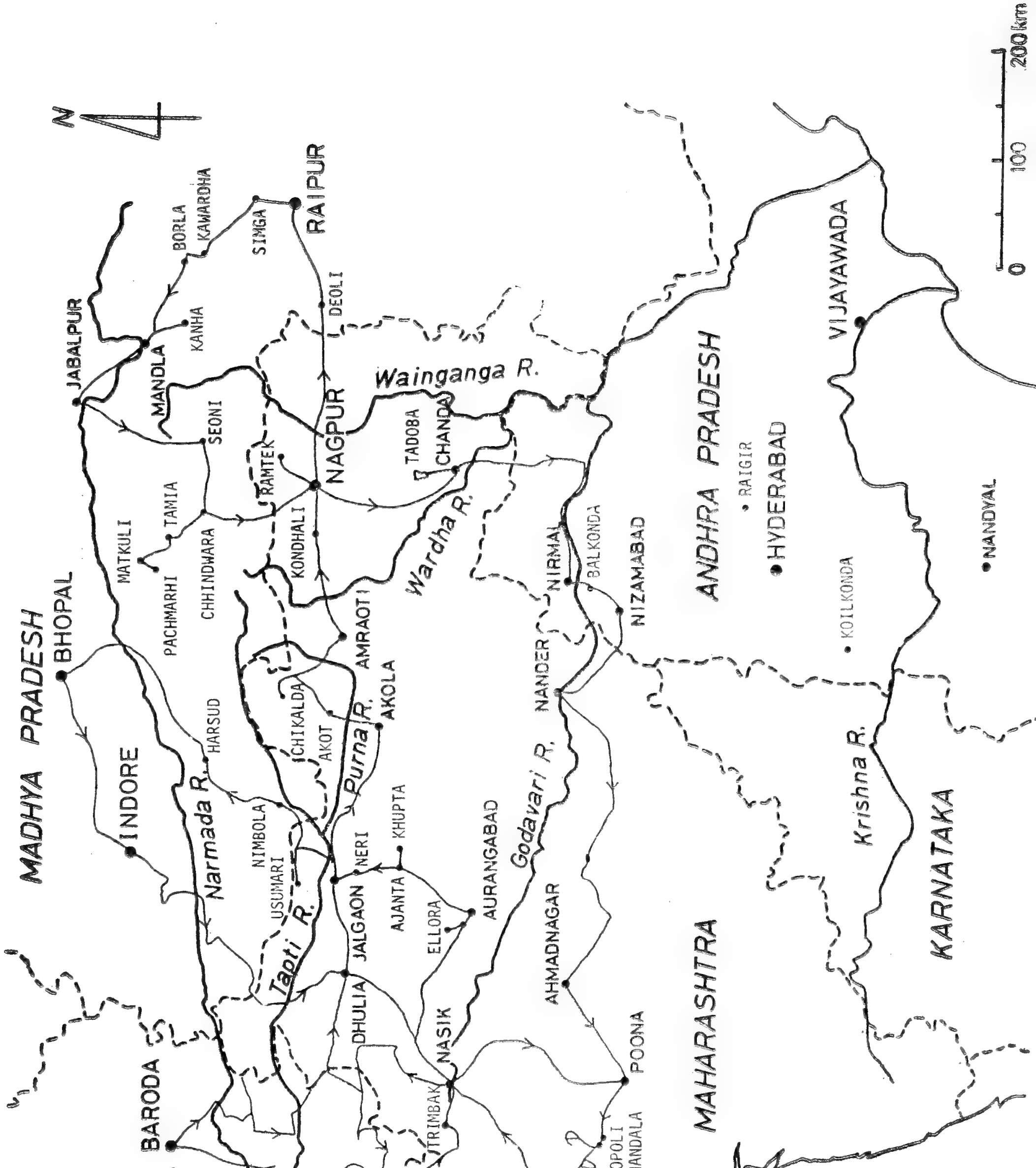

Fig. 2. Survey-route traversed by jeep.

Pradesh for 23 days from November 6 to November 28, 1972, using local transport.

Study area

Although the study area covered southern Gujarat, Maharashtra, southern Madhya Pradesh and Andhra Pradesh, detailed survey was conducted only in the region surrounded by the Narmada, Wainganga and Godavari rivers. The relief of this area and the survey-route traversed by jeep is shown in Figs. 1 and 2. As shown in Fig. 1, the area consisted of four major divisions based on relief, namely, the Satpura range, the Konkan coastal strip, the Western Ghats and the Deccan Plateau. Forming a physical boundary between North India and the Deccan Plateau, the source of the river Narmada is located in an area of the East-Central Highlands known as Maikala range. The total length of the Narmada, the fifth longest river in India, is about 1310 km. The Tapti flows for a distance of about 670 km from east to west, originating from the Satpura range. The Godavari, the fourth longest river of the country, runs across the Deccan Plateau from the Western Ghats. One of the sources of this river is located on the side of a hill named Trimbakeshwar, about 80 km from the shore of the Arabian sea. Another source is at Kalsubai, a peak 1646 m above the sea level and the highest in Maharashtra State. The total length of the Godavari is about 1465 km. The Wainganga originates near the town of Seoni in the Satpura range and flows for about 546 km before joining the Wardha. The Pranhita, at the confluence of the Wainganga and the Wardha, is a tributary of the Godavari.

According to the classification proposed by Champion and Seth (1968), 16 climatic forest types can be differentiated in India. The following six forest types occurred in the main study area: (1) Evergreen forest. Found along the western face of the Western Ghats, the extent of this type of forest is very limited. (2) Semi-evergreen forest. This type of forest, also of limited distribution, occurs mostly on the Western Ghats between the evergreen and the moist deciduous forests.
(3) Moist deciduous forest. Found both in the hilly areas of Western Ghats, Chikalda, Pachmarhi, as well as in the plains of Chanda, in a rainfall zone of 1500 to 2000 mm. In general, the height of this type of forest ranges from 30 to 36 m.
(4) Dry deciduous forest. This type of forest is common throughout the Deccan Plateau. The typical annual rainfall ranges from 1000 to 1300 mm. The height of this type of forest varies from 13 to 20 m.
(5) Thorn forest. Found throughout the dry peninsular tract of Central India, this type is characterized by the abundance of *Acacia* species reaching 6 to 9 m in height.
(6) Littoral and the swamp forests. Found along the coastal area of the sandy beach and the river mouth, it also has a limited distribution. It is characterized by various species of mangroves.

Results

Distribution and composition of hanuman langur troops and groups:

As shown in Fig. 3, a total of 59 troops[4] and groups[5] were observed during the survey-period. Hanuman langurs were distributed throughout the study area, although the population density was not uniform within this range. The species inhabited moist deciduous forest, dry deciduous forest and even thorn forest, but, were very rarely found in evergreen or semi-evergreen forests along the

[4] Troop = bisexual. [5] Group = unisexual.

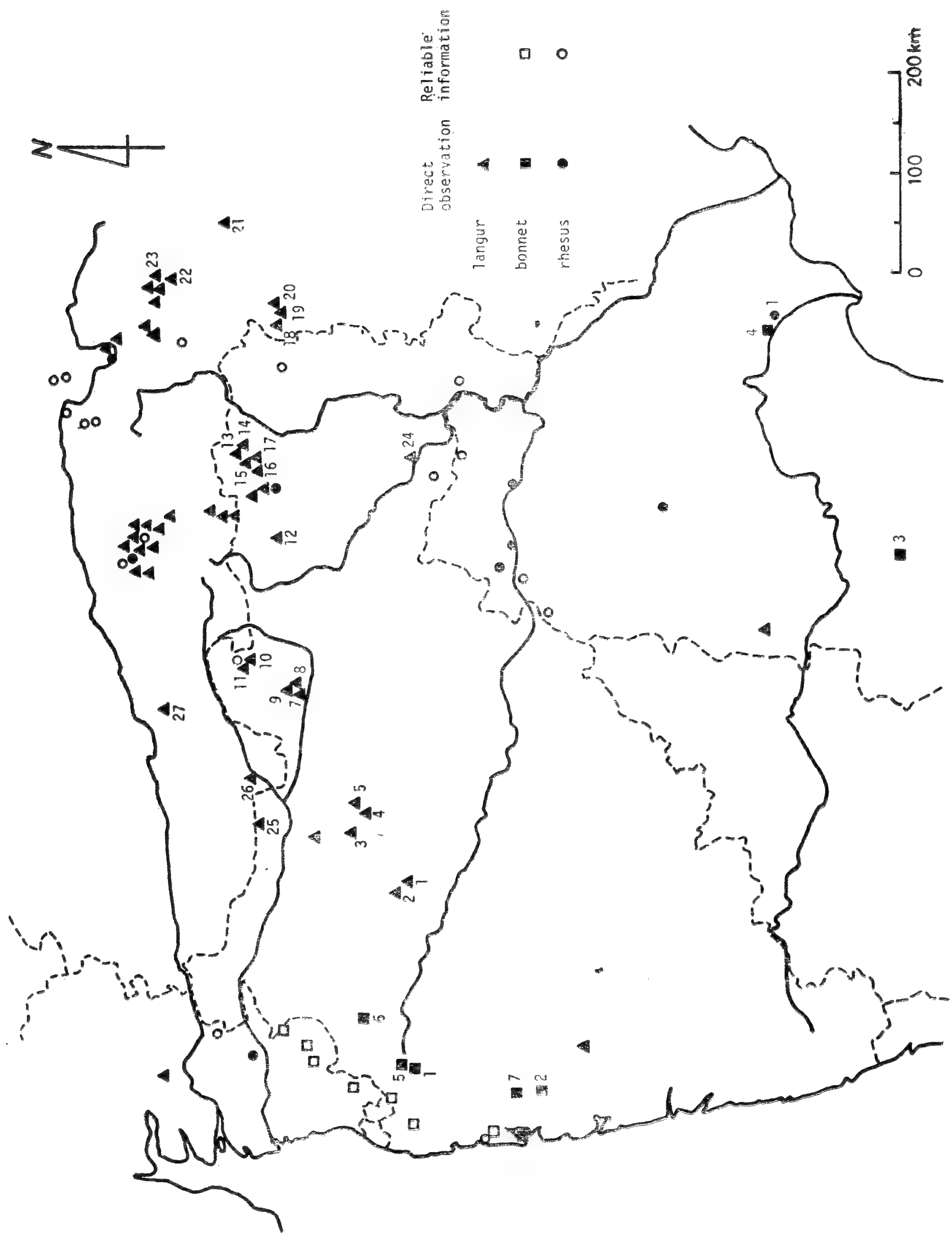

Fig. 3. Localities of three species of monkeys.

Western Ghats where macaques were of fairly common occurrence. Data on size and composition, available only for 24 troops and three unisexual male groups (=all-male groups), are listed in Table 1, together with the date of observation, locality number and the name of the place. Of the 24 troops, six (25%) contained more than two adult males each

TABLE 1

COMPOSITION OF TROOPS AND ALL-MALE GROUPS OF HANUMAN LANGURS

<table>
<tr><th rowspan="2">Date</th><th rowspan="2">Locality No.*</th><th rowspan="2">Place</th><th colspan="2">Adult</th><th>Sub-Adult</th><th colspan="2">Juvenile</th><th colspan="2">Infant</th><th rowspan="2">Total</th></tr>
<tr><th>Male</th><th>Female</th><th>Male</th><th>Male</th><th>Female</th><th>Male</th><th>Female</th></tr>
<tr><td>1972</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Aug. 23</td><td>1</td><td>Daulatabad</td><td>5</td><td>13</td><td>1</td><td></td><td>10</td><td></td><td></td><td>29</td></tr>
<tr><td>29</td><td>2</td><td>Ellora</td><td>1</td><td>13</td><td></td><td colspan="2">6</td><td colspan="2">5</td><td>25</td></tr>
<tr><td>30</td><td>3</td><td>Ajanta</td><td>3</td><td>22</td><td></td><td colspan="2">6</td><td colspan="2">1</td><td>32</td></tr>
<tr><td>31</td><td>4</td><td>Khupta</td><td>1</td><td>10</td><td></td><td></td><td>6</td><td colspan="2">3</td><td>20</td></tr>
<tr><td>,,</td><td>5**</td><td>,,</td><td>9</td><td></td><td></td><td>9</td><td></td><td></td><td></td><td>18</td></tr>
<tr><td>Sep. 2</td><td>6</td><td>Neri</td><td>1</td><td>12</td><td>1</td><td colspan="2">11</td><td colspan="2">3</td><td>28</td></tr>
<tr><td>7</td><td>7</td><td>Akot</td><td>1</td><td>9</td><td></td><td></td><td>2</td><td></td><td></td><td>12</td></tr>
<tr><td>,,</td><td>8**</td><td>,,</td><td>9</td><td></td><td></td><td>3</td><td></td><td></td><td></td><td>12</td></tr>
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<tr><td>10</td><td>10</td><td>Chikalda</td><td>1</td><td>3</td><td></td><td>1</td><td>1</td><td colspan="2">2</td><td>8</td></tr>
<tr><td>12</td><td>11**</td><td>,,</td><td>7</td><td></td><td></td><td>2</td><td></td><td></td><td></td><td>9</td></tr>
<tr><td>13</td><td>12</td><td>Kondhali</td><td>1</td><td>10</td><td></td><td></td><td>7</td><td colspan="2">2</td><td>20</td></tr>
<tr><td>14</td><td>13</td><td>Ramtek</td><td>1</td><td>20</td><td></td><td colspan="2">15</td><td colspan="2">8</td><td>44</td></tr>
<tr><td>,,</td><td>14</td><td>,,</td><td>1</td><td>9</td><td></td><td></td><td>3</td><td>1</td><td>1</td><td>15</td></tr>
<tr><td>,,</td><td>15</td><td>Ramtek-Nagpur</td><td>2</td><td>10</td><td></td><td>1</td><td>2</td><td></td><td></td><td>15</td></tr>
<tr><td>,,</td><td>16</td><td>,,</td><td>1</td><td>6</td><td></td><td></td><td>1</td><td>2</td><td></td><td>10</td></tr>
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<tr><td>17</td><td>18</td><td>Deori-Durg</td><td>1</td><td>7</td><td></td><td>1</td><td>3</td><td></td><td>2</td><td>14</td></tr>
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<tr><td>,,</td><td>20</td><td>,,</td><td>1</td><td>23</td><td></td><td colspan="2">8</td><td colspan="2">10</td><td>42</td></tr>
<tr><td>19</td><td>21</td><td>Simga</td><td>1</td><td>10</td><td></td><td></td><td>4</td><td colspan="2">2</td><td>17</td></tr>
<tr><td>,,</td><td>22</td><td>Kawardha</td><td>3</td><td>10</td><td>1</td><td></td><td>3</td><td colspan="2">2</td><td>19</td></tr>
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<tr><td>,,</td><td>23</td><td>Borla</td><td>4</td><td>10</td><td>1</td><td></td><td>5</td><td></td><td></td><td>20</td></tr>
<tr><td>Oct. 2</td><td>24</td><td>Chanda</td><td>1</td><td>9</td><td></td><td>2</td><td>6</td><td>5</td><td>3</td><td>26</td></tr>
<tr><td>Dec. 26</td><td>25</td><td>Usumari, Pal</td><td>1</td><td>5</td><td></td><td></td><td></td><td colspan="2">3</td><td>9</td></tr>
<tr><td>27</td><td>26</td><td>Nimbola</td><td>1</td><td>6</td><td></td><td colspan="2">5</td><td colspan="2">1</td><td>13</td></tr>
<tr><td>28</td><td>27</td><td>Harsud-Harda</td><td>1</td><td>4</td><td></td><td colspan="2">3</td><td></td><td></td><td>8</td></tr>
<tr><td colspan="2">all-male group</td><td>(3 groups)</td><td>25
(8.33)</td><td></td><td></td><td>14
(4.67)</td><td></td><td></td><td></td><td>39
(13)</td></tr>
<tr><td colspan="2">bisexual troop</td><td>(24 troops)</td><td>38
(1.58)</td><td>263
(10.96)</td><td>4
(0.17)</td><td colspan="2">11 54 72
(5.71)</td><td colspan="2">9 49 10
(2.83)</td><td>510
(21.25)</td></tr>
<tr><td colspan="3">TOTAL</td><td>63</td><td>263</td><td>4</td><td colspan="2">151</td><td colspan="2">68</td><td>549</td></tr>
</table>

** All-male group * See Figure 3.

("multi-male troops") and the remaining eighteen (75%) included only one adult male each ("one-male troops"). At the outskirts of the town Kawardha (Locality No. 22), two sub-troops were once observed resting separately in two trees about 50 metres away from each other. One sub-troop was composed of two adult males, seven adult females, one subadult male, two juvenile females and two infants whereas the other was one-male subtroop, consisting of one adult male, three adult females and one juvenile female. Finally, the smaller sub-troop joined the bigger one resulting in the formation of one multi-male troop.

The average number of individuals per troop was 21.25, consisting of 1.58 adult males (7.5%), 10.96 adult females (51.6%), 0.17 subadult male (0.8%), 5.71 juveniles (26.9%) and 2.83 infants (13.3%). Adults accounted for about 59 per cent of the total troop members. The mean value of the socioeconomic sex ratio, i.e. number of adult females per one adult male, for these 24 troops was *c.* 6.9. As in unisexual male groups, the average number of individuals per group was 13.0 comprising 8.33 adult males (64.0%) and 4.67 juveniles (36.0%).

Distribution and composition of bonnet monkey troops:

Bonnet monkeys were confined to the well-forested narrow belt along the Western Ghats (Fig. 3). South of the Tapti, the northernmost limit for bonnet was 21°05′N, 73°35′E near Songadh in Gujarat State. They occurred in the moist deciduous and the dry deciduous forests, but never in the dry scrub or thorn forests where the height of the trees does not exceed 50 feet. In some areas, such as Dangs and Dharampur forests of Gujarat State, many troops of bonnet monkeys still exist. Adjacent to these forests, Surgana, Peint and adjoining forests belts extend upto East Nasik, West Nasik and West Dhulia Divisions of Maharashtra State. However, due to the poorer forest conditions, the population density in these areas does not seem to be as high as in Dangs and Dharampur.

During the survey, a total of eight troops of bonnet monkeys were observed in all. One troop inhabiting the Elephanta island in the Bombay harbour, for which the information available is incomplete, is also included in this treatment of the results. Excepting this troop, complete counts were made for the other seven. Table 2 shows the composition of the latter troops; the average number of individuals per troop was 25.7 which included 4.29 adult males (16.7%), 8.14 adult females (31.7%), 0.714 subadult male (2.8%), 3.43 juvenile males (13.3%), 4.71 juvenile females (18.3%) and 4.29 infants (16.7%). Adults accounted for about 48.3 per cent of the total number of troop members. The mean value of socio-economic sex ratio was *c* 1.9.

Changes in troop membership were recorded for two troops from Trimbak (Locality No. 1) and Khandala (Locality No. 2), respectively. On August 19th, the Trimbak troop (Locality No. 1) contained 25 individuals but by December 17th, i.e. four months later, one subadult male joined and four infants disappeared, while there were two births. The Khandala troop contained 25 individuals on October 13th, but on January 13th, i.e. three months later, one new-born infant was seen in this troop. Besides the above mentioned births, four other new-born were seen at Matheran in January.

Distribution and composition of rhesus monkeys:

Rhesus monkeys occurred along the Satpura range in the region north of the river Tapti and its tributary, the Purna. North of of the Tapti, the westernmost limit for the

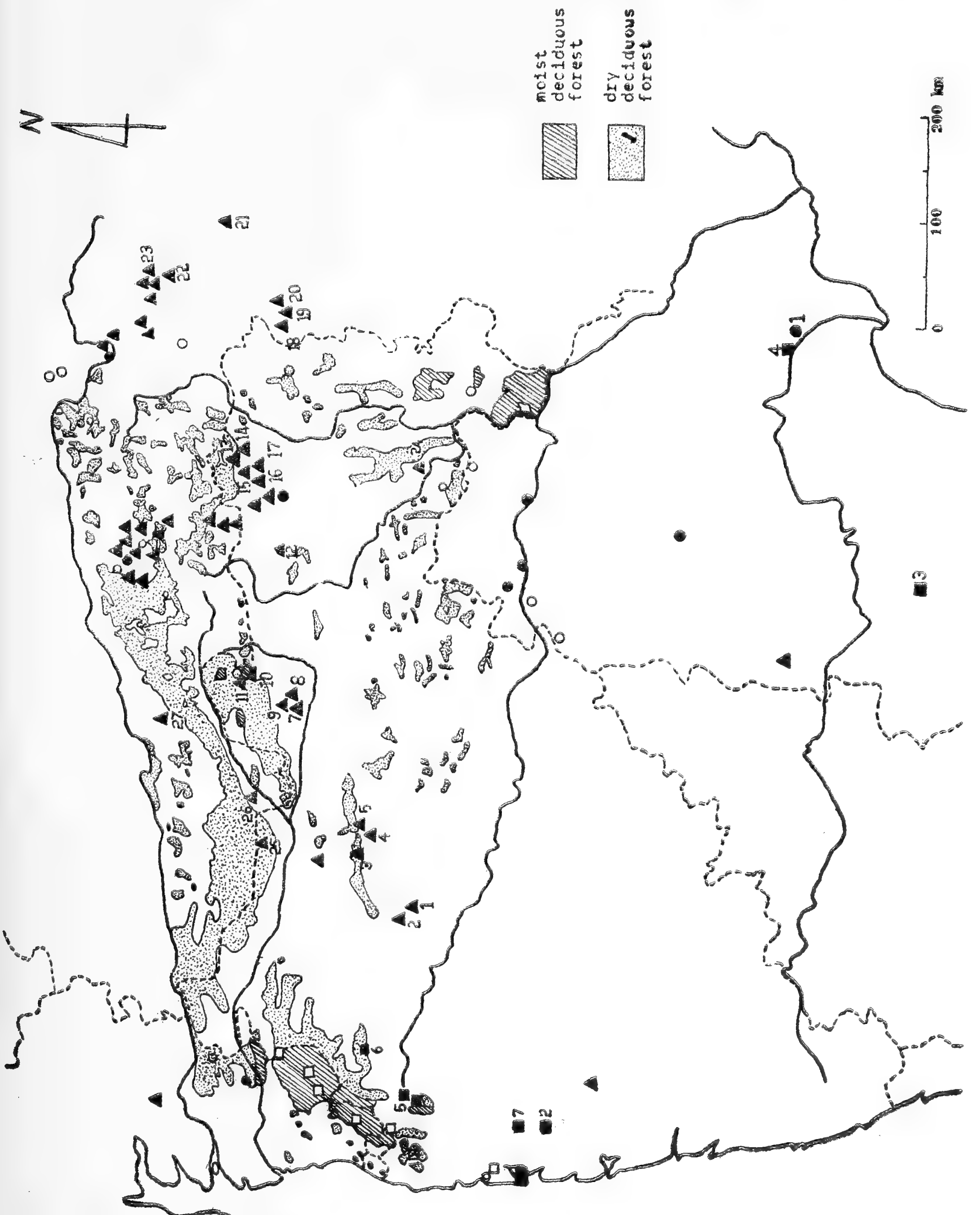

Fig. 4. Distribution of the moist deciduous and the dry deciduous forests in main study area.

distribution of rhesus was 21°20′N, 73°30′E in Kherwada forests of Gujarat State. They also occur in east Maharashtra and in north Andhra Pradesh as far south as 16°30′N, 80°35′E, crossing the river Godavari (Fig. 3). The names of the places which were noted to be inhabited by free-ranging rhesus monkeys are Balkonda, Alisagar (about 5 km from Nizamabad), Raigir and Vijayawada. Monkeys in these localities must have been the artificially introduced ones. Besides these monkeys, one more troop inhabited the Borivli National Park about 35 km north of Bombay. This is also an artificially introduced troop.

During the survey period, nine troops of rhesus monkeys were encountered. However, complete counts were made only for one habituated troop. Near a temple in Vijayawada (Locality No. 1 in Table 3), one rhesus monkey troop, occurred together with a troop of bonnet monkeys (Locality No. 4 in Table 2). As shown in Table 3, this

TABLE 2

TROOP COMPOSITION OF BONNET MONKEYS

Date	Locality No.**	Place	Adult Male	Adult Female	Sub-Adult Male	Juvenile Male	Juvenile Female		Infant Male	Infant Female	Total
1972											
Aug. 19	1	Trimbak	3	9		3	5		5		25
Oct. 13	2	Khandala	5	4	2	5	6	1		2	25
Nov. 17	3	Nandyal	3	4		4	2	1		1	15
21	4	Vijayawada	3	6	2	3	3	1		3	21
Dec. 17	5	Trimbak	7	14		2	8	2		4	37
17	1	Trimbak	3	9	1	3	5		2*	1	24
18	6	Vani	5	9		1	5	1		2	23
1973											
Jan. 12	7	Matheran	4	11		6	4	1	4*	3	33
13	2	Khandala	5	4	2	5	6	1	1*	2	26
TOTAL			30 (4.29)	57 (8.14)	5 (0.714)	24 (3.43)	33 (4.71)	7 (1.0)	7 (1.0)	16 (2.29)	179 (25.7)

* New-born Infant

** See Figure 3.

TABLE 3

TROOP COMPOSITION OF RHESUS MONKEYS

Date	Locality No.**	Place	Adult Male	Adult Female	Sub-Adult Male	Juvenile Male	Juvenile Female	Infant Male	Infant Female	Total
1972										
Nov. 21	1	Vijayawada	4*	5		6	1		3	19*

* The number includes one bonnet monkey

** See Figure 3.

TABLE 4

FOREST TYPES OCCURRING IN MAHARASHTRA STATE
NAME OF FOREST TYPE: (3B/C1) SLIGHTLY MOIST AND MOIST TEAK FOREST

Forest Division or Sub Division	East Nasik	West Nasik	Dah-anu	Thana	Shaha-pur	Kolaba	Roha	Bhan-dara	Chand-rapur	Yeot-mal	South Chanda	Alla-pall
Tectona grandis	×	×	×	×	×	×	×	×	×	×	×	×
Terminalia tomentosa	×	×	×	×	×	×	×	×	×	×	×	×
Anogeissus latifolia	×	×				×	×	×			×	
Dalbergia latifolia	×					×	×			×		×
Adina cordifolia	×	×	×	×	×	×	×		×			×
Lagerstroemia parviflora	×					×	×	×	×		×	×
Mitragyna parvifolia	×	×	×	×	×					×	×	×
Pterocarpus marsupium	×		×	×	×	×	×	×		×	×	
Albizzia lebbek	×					×	×					
Albizzia procera	×											
Garuga pinnata		×				×	×					
Lannea coromandelica		×				×	×					
Acacia catechu			×	×	×							
Holarrhena antidysenterica			×	×	×							
Dillenia pentagyna			×	×	×							
Careya arborea			×	×	×	×	×					
Butea monosperma			×	×	×							
Diospyros melanoxylon			×	×	×			×	×		×	×
Carissa carandas			×	×	×							
Terminalia paniculata						×	×		×			
Salmalia malabarica						×	×					
Terminalia belerica						×	×					
Grewia tiliaefolia						×	×					
Xylia xylocarpa								×			×	×
Bassia latifolia								×		×	×	×
Dendrocalamus strictus								×	×			×
Boswellia serrata								×				
Schleichera trijuga										×		

troop consisted of nineteen individuals. However, the highest-ranking adult male of this troop was a bonnet which may have immigrated from the troop of bonnet monkeys living in the same place. No hybrids of bonnet and rhesus could be seen, suggesting that the bonnet male had immigrated to this troop fairly recently.

Distribution-patterns and forest-conditions:

Characteristic species of trees from slightly moist and moist teak forests occurring in each Forest Division or Subdivision of Maharashtra State are shown in Table 4 and typical species of trees from dry deciduous forest are shown in Table 5. From these tables it is evident that teak (*Tectona grandis*) and ain (*Terminalia tomentosa*) are abundant throughout the moist deciduous and the dry deciduous forests. Distribution of these forests, surrounded by the rivers Narmada, Wainganga and Godavari, is shown in Fig. 4. Occurrence or absence of two species of macaques in different forest-types of each forest division of

Maharashtra State is summarized in Table 6. From this table, it is clear that the incidence of the two species of macaques is highly dependent on the presence or absence of moist deciduous or mixed deciduous forest with trees exceeding 50 feet (*c* 15 m) in height.

DISCUSSION

Although hanuman langurs occupy a broader spectrum of habitats than macaques (Vogel 1977), data collected during the survey period suggest that macaques and langurs have different habitat preferences. While macaques are limited to areas with moist deciduous and dry mixed deciduous forests, langurs inhabit dry mixed deciduous and dry scrub forests. In a broader sense, it seems likely that the places where the population of macaques is dense, langurs are less common. Absence or paucity of hanuman langurs in the areas along

TABLE 5

FOREST TYPES OCCURRING IN MAHARASHTRA STATE (I)
NAME OF FOREST TYPE: (5A/C1) DRY TEAK-BEARING FORESTS

Forest Division or Sub-Division	East Nasik	North Dhulia	West Dhulia	Jalgaon	East Melghat	West Melghat	Amra-vati	Buld-hana	West Yeot-mal	Buldhana & Akola
Tectona grandis	×	×	×	×	×	×	×	×	×	×
Terminalia tomentosa	×	×	×		×	×	×	×	×	
Ougeinia oojeansis	×							×	×	
Dalbergia latifolia		×	×		×	×	×	×		
Pterocarpus marsupium		×	×					×		
Adina cordifolia		×	×		×	×	×			
Grewia tiliaefolia		×								
Lannea coromandelica		×								
Salmalia malabarica			×							
Acacia catechu			×	×						
Sterculia urens			×							
Diospyros melanoxylon			×					×	×	
Bassia latifolia			×							
Boswellia serrata		×		×				×		×
Anogeissus latifolia				×				×	×	×
Hardwickia binata				×						
Emblica officinalis				×						×
Garuga pinnata				×						
Lagerstroemia parviflora					×	×	×		×	
Mitragyna parvifolia										×
Butea frondosa										×
Zizyphus jujuba										
Lannea grandis										
Acacia leucophloea										×
Buchanania latifolia										
Chloroxylon swietenia										
Cleistanthus collinus										

TABLE 5 (contd)

FOREST TYPES OCCURRING IN MAHARASHTRA STATE (II)
NAME OF FOREST TYPE: (5A/C1) DRY TEAK-BEARING FORESTS

Forest Division or Sub-Division	East & West Yeotmal	Wardha	Nagpur	Nagpur	Wardha	Rajura	South Cha-nda	West Cha-nda	South Cha-nda	Nand-ed
Tectona gradis	×	×	×	×	×	×	×	×	×	×
Terminalia tomentosa	×	×	×	×	×		×	×	×	×
Ougeinia oojeansis										
Dalbergia latifolia										
Pterocarpus marsupium				×	×				×	×
Adina cordifolia										
Grewia tiliaefolia										
Lannea coromandelica										
Salmalia malabarica						×	×	×		
Acacia catechu										
Sterculia urens										
Diospyros melanoxylon	×	×	×	×	×	×	×	×	×	×
Bassia latifolia										×
Boswellia serrata	×	×	×	×	×	×	×	×		×
Anogeissus latifolia	×	×	×	×	×	×	×	×	×	×
Hardwickia binata										
Emblica officinalis										
Garuga pinnata										
Lagerstroemia parviflora	×	×	×						×	×
Mitragyna parvifolia										×
Butea frondosa										
Zizyphus jujuba										
Lannea grandis		×	×						×	×
Acacia leucophloea									×	
Buchanania latifolia	×	×	×							
Chloroxylon swietenia						×	×	×		
Cleistanthus collinus						×	×	×		

the Western Ghats may due to the hunting by tribes and the predation by wild animals. Many tribes such as Bhil, Gond, Varli and Kokna live along the Western Ghats. According to the 1961 population census, the population of scheduled tribes in Maharashtra was 2,397,000. Within Maharashtra, the Bombay division contained 70.39 per cent of the 1961 scheduled tribes population. Krishnan (1971) reported that tribal hunting exterminated the langurs in Sholinghur within half-a-dozen years. It seems that it is easier to hunt langurs than to hunt macaques, due to the larger body sizes and the smaller home ranges of the former. At Kanha National Park of Madhya Pradesh, langurs are commonly captured by tigers (Schaller 1967). Tigers and leopards still occur in the well-forested areas along the Western Ghats, at least in Dangs of Gujarat State. In connection with habitat preference,

TABLE 6

OCCURRENCE OF ABSENCE OF TWO SPECIES OF MACAQUES IN EACH FOREST DIVISION OF MAHARASHTRA STATE, WITH SPECIAL REFERENCE TO FOREST TYPES

Forest Circle & Division	Total forest area (km^2)	Forest area with trees 50+ ft. high (km^2)	%of forest, to total forest area with trees 50+ft. high	Forest type			Occurrence or non-occurrence		Population density
				F1	F2	F3	bonnet	rhesus	
Region I									
THANA									
Dahanu	2269.66	863.84	38.1	+	+	–	+	–	low
Shahapur	1164.45	505.06	43.4	+	+	–	+	–	low
Thana	1166.32	552.90	45.0	+	–	–	(+)?	–	rare
Borivli	61.90			+	–	–	+	+*	rare
Kolaba	1763.40	178.88	10.1	+	–	–	(+)?	–	rare
Roha Sub-Dn.	1305.32	97.20	7.4	+	–	–	(+)?	–	rare
NASIK									
East Nasik	2251.09	746.32	33.2	+	+	–	+	–	low
West Nasik	1115.99	512.93	46.0	+	+	–	+	–	medium
North Dhulia	3027.06	382.86	12.6	–	+	–	–	(+)?	rare
West Dhulia	1698.45	267.13	15.7	–	+	–	(+)?	–	rare
Jalgaon	983.31	0	0	–	+	+	–	–	
Yawal	1103.43	116.55	10.6	–	+	–	–	(+)?	rare
POONA									
Poona	1179.62			(+)	+	+	–	–	
Satara	2398.38			–	+	+	–	–	
Kolhapur	2148.55	no data**		(+)	+	+	?	–	
Koyananagar Sub-Dn.	299.97			(+)	+	–	?	–	
Bhor Sub-Dn.	328.38			–	+	+	?	–	
Sawantwadi	376.52			(+)	–	–	?	–	
AURANGABAD									
Ahmednagar	1875.68	0	0	–	(+)	+	–	–	
Jannar (Ghod project)	460.78	0	0	–	–	+	?	–	

TABLE 6 (contd.)

Region II									
AURANGABAD									
Aurangabad	1097.61	0	0	–	(+)	+	–	–	
Nanded	1720.37	8.64	0.5	–	+	+	–	–	
Region III									
AMRAVATI									
East Melghat	1332.15	1305.00	43.2	(+)	+	–	–	+	medium
West Melghat	1689.76			(+)	+	–	–	+	medium
Amravati Sub-Dn.	649.12	0.90	0.1	–	+	+	–	(+)?	rare
East Yeotmal	1895.15	26.32	0.7	+	+	+	–	–	
West Yeotmal	1926.26			+	+	+	–	–	
Akola	874.74	1.49	0.2	–	+	+	–	–	
Buldhana	1567.43	1.00	0.1	–	+	+	–	–	
NAGPUR									
Nagpur	2779.01	60.97	2.2	–	+	+	–	(+)	rare
Wardha	890.35	7.48	0.8	–	+	+	–	–	
Bhandara	1904.83	168.46	8.8	+	+	–	–	+	low
Gondia	2373.92	47.48	2.0	–	+	+	–	(+)?	rare
CHANDA									
South Chanda	3251.60	4858.71	26.3	+	+	–	–	+	low to high
Allapalli	2599.30			+	–	–	–	+	low to medium
East Chanda	4689.71			–	+	+	–	+	low to medium
Central Chanda	1394.68			–	+	+	–	+	low to medium
West Chanda	2808.38			–	+	–	–	(+)?	rare
Bhamragarh	3731.79			–	+	–	–	(+)?	rare
Spl. Forest Dn.	31.22			no data	no data	no data	–	?	
Maharashtra State	66185.64	10710.12							

F1: moist deciduous, F2: dry mixed deciduous, F3: dry scrub.
* Introduced ** Details of stock-mapping not available, the area is mostly mixed forests not above 50 feet.

it may be possible to hypothesize that once the Nilgiri langurs (*Presbytis johnii*) inhabited the humid zone along the Western Ghats as far north as the river Tapti. Due to unknown reasons, they disappeared from this region leaving the vacated area available to langurs. Nilgiri langurs occupy the moist evergreen forest in the southern strip of the Western Ghats (Poirier 1970, Kurup 1977). Also, as suggested by Fooden (1975), lion-tailed macaques (*Macaca silenus*) must once have inhabited the rain forest along the whole part of the Western Ghats. With the recession of the rain forest and an increase in human population, lion-tailed macaques disappeared from this region and, consequently, the bonnet macaques might have filled the vacant habitat.

With respect to the distribution patterns of some macaques in peninsular India, Fooden (1976) suggested that *M. silenus* may have dispersed first followed by *M. radiata* and relatively recently *M. mulatta*. He also suggested that the inferred recent spread of the *fascicularis* (crab-eating macaque) group (including *mulatta*) may have been responsible for the reduction and disjunction of the range of the *sinica* (toque monkey) group (including *radiata* and *assamensis*. In accordance with this hypothesis, it may be possible to speculate on aspects of inter-specific competition between the bonnet and the rhesus. If it is assumed that the Narmada and the Wainganga functioned as an outer moat, and if the Tapti and the Wardha are considered as an inner moat, the present distribution-patterns indicate that the troops of rhesus monkeys crossed over these barriers through the 'gates' located at Mandla and Chindwara, moved *en masse* to the Western Ghats where advance troops of bonnet monkeys were stationed.

The present study revealed that not only the rivers Tapti and Godavari, but also the semi-arid zone of the Deccan Plateau of central India acted as barriers isolating the distribution ranges of the two species. The rhesus monkeys were artificially introduced to the region south of the river Godavari. In some places such as Borivli and Vijayawada, the bonnet monkeys and the rhesus monkeys are co-existing. North of the Tapti, the westernmost limit for the distribution of the rhesus is 21°20′N, 73°30′E in the Kherwada forests of Gujarat State, whereas south of the Tapti, the northernmost limit for the bonnet is 21° 05′N, 73°35′E near Songadh, Gujarat State. Bonnet monkeys are found mostly in hilly and sporadically forested areas of the Western Ghats. Hanuman langurs are distributed not only in the dry deciduous forests but also in the dry scrub forests of the Deccan Plateau which is not an effective barrier for making the distribution of this species isolated into populations like those of macaques.

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TAXONOMIC NOTES OF THE GENUS *PORTULACA* LINN. IN INDIA[1]

V. V. SIVARAJAN[2]

Geesink (1969, 1971), while revising the genus *Portulaca* Linn., of Indo-Australia and the Pacific has amended the circumscription of the species drastically and considered the genus (formerly believed to include about 200 species) to have not more than 40 'good species'. In this note in accordance with Geesink's concept of species, four species in India are recognised, where formerly 7 species were reported. This paper also attempts to discuss Geesink's concept of infraspecific categories and has made certain deviations for reasons discussed in the text.

INTRODUCTION

Portulaca Linn. is a tropical and subtropical 'heliophilous' genus of succulent and semisucculent herbs' with a preference for bare places'. This genus, previously considered to have about 200 species (Santapau & Henry 1973), is of very limited economic importance. *P. pilosa* ssp. *grandiflora* is grown widely as a summer ornamental, while *P. oleracea* is eaten as a vegetable.

von Poellnitz (1934) monographed the genus and recognised 104 species to which about 30 species were added later by subsequent workers. He also proposed a subgeneric classification which was found to be untenable by Geesink (1969), who in turn proposed its subdivision into two subgenera, *viz*. subg. *Portulacella* and subg. *Portulaca*. The former restricted to Australia, exhibits the most primitive inflorescence structure in the genus and hence it is suggested that the ancestral lineage of the genus is found in Australia (Geesink 1969).

The predominently autogamous breeding system has played an active role in isolation and divergence in this genus and has resulted in the emergence of homogenous populations with 'sharp delineations against each other' and constant in their details. This probably prompted the earlier taxonomists to recognise each one of these 'pure-lines' as a distinct species, taking the total number of them as high as 200. The concept of species has however, undergone drastic changes in the recent past. Geesink (1969) has suggested that in the genus there are 'not more than 40 good species'. Consequently, several of Poellnitz's species are lumped together or reduced to subspecific taxa, and some are even considered not deserving any 'systematic recognition as formal taxa'.

This shift in the concept of species and subspecific taxa in this genus has warranted a reconsideration of its Indian species too. The 7 species reported from India (Santapau & Henry 1973), have been reduced to 4 'good species', namely *P. oleracea, P. pilosa, P. quadrifida,* and *P. wightiana.*

While broadly in agreement with Geesink's concept of species in the genus, I find it difficult to accept his treatment of certain 'purelines' which were originally described as distinct species, for obvious morphological dis-

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tinctiveness, as 'races' of no taxonomic consequence. Under *P. pilosa* ssp. *pilosa*, he has recognised 6 'races' of which race *pilosa* and race *tuberosa* are represented in India. While the former was considered to be a species by itself the latter included in it two different species namely, *P. tuberosa* and *P. suffruticosa*, as recognised by most systematists. *P. tuberosa* was set apart on account of its tuberous roots, diffuse or prostrate habit and non-tuberculate seeds, while the latter had branched woody roots, suffruticose habit and tuberculate seeds. However, they intergrade so much, that their separation seems to be unjustified even at subspecific levels. Even when one accepts that self-pollination explains the 'profuse occurrence of more or less purelines ...in nature which keep constant details' and that their distinctiveness is governed by only a few genes (Geesink 1969), one doubts the very expediency of keeping such populations out of bounds for the taxonomists, dumping them as 'races' of no formal taxonomic status. The primary task of the taxonomist is to recognise plant groups as they exist in nature and to give names to different plant populations, so that their properties can be recorded, information tabulated and detailed phytogeographical studies made. Even if a species is polymorphic, some grouping of the variants is still necessary if this primary aim is not to be lost sight of (Verdcourt 1970, p. 236).

Morever, the term 'race' has been rather confusing and 'it is worth realising now that the term 'race'......is seldom found in recent literature......it is sometimes translated as meaning subspecies and lead to serious problems of interpretation and nomenclature' (Davis & Heywood 1963, p. 100). The International Code of Botanical Nomenclature (1972) also does not recognise 'race' as a formal taxonomic category. So it seems worthwhile, to bring the various groups ('races') under formal taxonomic terminology. I propose varietal rank for the so called 'races' and consequently new combinations are proposed.

Key to the species and subspecific taxa

1. Leaves flat:
   2. Flowers in heads:
      3. Leaves obovate-spathulate .... *P. oleracea* var. *oleracea*
      3. Leaves linear-oblong, acute............................ *p. oleracea* var. *linearifolia*
   2. Flowers solitary:
      4. Leaves concealed by scales .... *P. wightiana*
      4. Leaves not concealed by scales.................................. *P. quadrifida*
1. Leaves linear, terete or subterete:
   5. Flowers small, less than 2 cm across.............................*P. pilosa* ssp. *pilosa*
      6. Flowers pink..................var. *pilosa*
      6. Flowers yellow............var. *tuberosa*
   5. Flowers large, 4-5 cm across................................*P. pilosa* ssp. *grandiflora*

Systematic Treatment

P. oleracea Linn. Sp. Pl. 445. 1753; Dyer in Hook. f. Fl. Brit. Ind. 1: 247. 1874; Cooke, Fl. Pres. Bomb. 172. 1901; Gamb. Fl. Pres. Madr. 66. 1915; Poelln. in Fedde Rep. 37: 258. 1934; Geesink in Blumea 17: 292. 1969 & Fl. Males. 7: 129. 1971; Khoshoo & Singh in Bull. Bot. Surv. Ind. 8 : 278-286. 1966.

var. **oleracea :**

Leaves fleshy, obovate-cuneate, truncate, obtuse or retuse at tips, up to 2×1 cm in size; flowers bright yellow (Hiralal 15969, Lucknow is recorded to have white flowers) crowded at the tips of branches; capsules ovate-acute 7-8 mm long; seeds 20-25 in each capsule, minute, shining black, tubercled.

Specimens examined:

Andamans: Bhargava 2384, 1802. Balakrishnan 57. Thothathri 10800. *Andhra Pradesh*:

Sebastine 5982, Narayana Swami 145; Thothathri 9679; Balakrishnan 1147; Krishanan Sn. 80380 (Cuddapah), Murty 137 (Waltair). *Arunachal*: A. S. Rao 48156 (NEFA); Joseph 48445 (NEFA); Hare 1898 (NEFA); Bor 1118 (Aka Hills). *Assam*: Mann (Sn. 43688; Craib 277; Panigrahi 14332; R. S. Rao 9906; Gill 43; Nath 13360; Masters 44; Srivastava 79919 (Jorhat); Nayar 51247 (Kamrup); Panigrahi 11417; Verma 41770 & 46545; Joseph 38205; (Nongpoh) Beb 35192. *Bihar*: Prain Sn. 43682 (Ranchi), Shetty 227 (Champaran), Srivastava 46611 (Patna). *Gujarat*: Rao 1911; Kaul 9188 (Girmar). *Goa*: Eradi 2421 (Panaji). *Jammu & Kashmir*: Saran 39900, 29869; Vohra & Wadhwa 767. *Karnataka*: A. S. Rao, 80243. *Kerala*: Sivarajan 633, & 1309 (Calicut); Calder & Narayana Swami 1568. *Madhya Pradesh*: Kaul 5366 (Machaghat); *Maharashtra*: Santapau 283 (Bombay), Saran 61524 (Lonavala), Patil 2349 (Patil has recorded that 'the plant is useful in Scurvy and liver diseases. The juice of the stem applied to prickly heat and to hands and feet where burning sensation is felt'). King 227, Wadhwa 64309 & 68656, Billore 116213. *Manipur*: Deb 343. *Meghalaya*: Deb 29253 (Garo Hills); Sharma 18674 (Khasi & Jaintia Hills), Deka 1647 (Khasi & Jaintia Hills). *Orissa*: Panigrahi 23828 & 8516, Raju 7521, Panigrahi 23468; Saran 58609, G. V. S. Rao 30403. *Punjab*: Kaul 22995 (Jullundur). *Rajasthan*: Nanteyal 25428 (Jodhpur), Singh 3243; Verma 588; Singh 319. *Tamil Nadu*: Sebastine 186 & 580. *Tripura*: Debbarnian 290 (Agartala), *Uttar Pradesh*: Bell 180; T. A. Rao, 11633; Mackinnon Sn. 43669; Misra 9783; Srivastava 24600 (Lucknow), Hiralal 15969 (Lucknow); Duthie 6331 (Itawah), 43201 (D. Dun), Saxena 1989 (Mussoorie), Ashraf Alam 72012 (Rai Bareli); *West Bengal*: Ghosh, Mukherjee 5331 & 5947 (Howrah).

var. **linearifolia** Sivarajan et Manilal, New Botanist 4: 30. 1977.

This variety differs from *P. oleracea* var. *oleracea* in having linear leaves and 55-75 seeds in each capsule which are much smaller than those of the latter.

Ecology: In fields and gardens along with the typical form of the species mainly in N. India. This has been reported from U.P., Punjab, Bihar, Maharashtra and Gujarat.

Specimens examined:

Bihar: Srivastava 46612 (Patna). *Rajasthan*: Singh 3213. Sharma 477; Roy 2163; Shetty 3312, 1848. *Uttar Pradesh*: Coll. ? Sn. 43671 records that it is "cultivated form known as 'Kulfa Sag' and eaten as pot herb in United provinces" Nair 14739; Chandra 42790 (Sahranpur—type), Coll. ? Sn. 146 (Kanpur), Kapoor 18891 (Lucknow), Hiralal 15970 (Lucknow), Kaul 47601 (Allahabad), Saran 26628 (Lakhimpur Kheri), *Delhi*: Kaul 8317, *Locality*: ? Royle Sn. 43703, Gustavmann 52, *W. Bengal*: Chatterjee 90 (Purulia), *Assam*: Kurz. Sn. 43687, *Orissa*: Panigarhi 8276.

P. wightiana Wall. (Cat. 6842. 1828, nomen.) *ex* Wt. & Arn. Prod. 356. 1834; Dyer *l.c.* 247; Cooke, *l.c.* 72. Gamb. *l.c.* 314; Poelln. *l.c.* 314; Geesink *l.c.* 290. 1969.

Branched, prostrate herbs, branches angled, jointed; leaves fleshy, ovate-acute, nodal appendages silvery white; flowers terminal, solitary, sessile; capsule globular, operculum straw coloured.

Ecology: A heliophilous semisucculent herb common along the sandy sea coast, chiefly along the eastern coast of S. India.

Specimens examined:

Andhra Pradesh: Fischer 4341 (Chittoor Dt.). *Tamil Nadu*: King Sn. ? Fischer 2154 (Coimbatore), Gamble 17771 (Bellary), Lawson Sn. 2.

P. quadrifida Linn. Mant. Pl. 1 : 73. 1767; Dyer *l.c.* 246; Cooke *l.c.* 72; Gamb. *l.c.*, poelln. *l.c.* 275; Geesink *l.c.* & Fl. Males. 7:127. 1971. *P. meridiana* Linn. f. suppl. Sp. Pl. 248. 1781. *P. geniculata* Royle, Ill. Bot. Himal. I:221. 1839, *nomen.*

Diffuse or prostrate herbs, rooting at nodes with fleshy ovate or elliptic, acute leaves up to 6×3 mm; nodal hairs silvery white; flowers yellow, solitary; capsules conical, 5 mm long; seeds black, tubercled.

Ecology: In moist grasslands, garden premises, waste places and railway embankments. Quite variable in their hairiness.

Specimens examined.

Andhra Pradesh: Murty 1881 (Waltair), Thothathri 9678; Balakrishnan 1157. *Bihar*: Srivastava 46737. Banerjee 316. *Gujarat*: Deo 14293 (Somnath), Srivastava 14223. *Kerala*: Lawson 328 & 329. *Maharashtra*: Rao 2309 & 2214. *Madhya Pradesh*: Kaul 18142. *Orissa:* Srivastava 93905 (Puri), Abraham 33 & 280; Mukherjee 6065, Annandale 1216. *Punjab*: Aitchison 1024. *Rajasthan*: Hiralal 34425 (Alwar), Raizada 23763 (Rajkot), Tiwari 1124; Duthie 4520. *Uttar Pradesh*: Hiralal 15971 (Lucknow), Kohli 44521 (Meerut), Ratanlal Sn.? (Dehra Dun), Arora 4793 & 3882. *Tamil Nadu*: Lawson 328 (Cape comorin), Sebastine 8308 & 673, Fisher 122; Perottet 422, Subramanyam 141 & 829; Wight Sn. 43716.

P. pilosa Linn. Sp. Pl. 445. 1753; DC. Prod. 3:354. 1828. Poelln. in Fedde, Rep. 37:261. 1934; Bailey, Man. Cult. Pl. 365. 1949; Geesink in Blumea 17: 294. 1969.

Leaves spiral, with conspicuous axillary hairs, capituli 1-12 flowered; flowers surrounded by membraneous bracteoles and hairs; capsules ovate or obovate.

Tropics, some are grown as ornamentals and very often escape cultivation.

ssp. **pilosa:** Geesink in Blumea 17 : 295-97. 1969.

Leaves usually linear-acute, subterete; flowers yellow or pink, crowded in 2- many flowered heads; fruit globose.

var. **pilosa :**

P. pilosa sensu Poelln. *l.c.* 261; Bailey, Man. Cult. Pl. 365. 1949. *P. pilosa*, ssp. *pilosa*, 'race' *pilosa*' Geensink in Blumea 17: 94. 1969 & Fl. Males. 7: 131. 1971.

Herbs with linear, subterete leaves and pink flowers, roots not tuberous; capsules globose, 2-3 mm across; testa cells elliptic stellate, tubercled.

Ecology: on bare rocky laterite and sandy beaches.

Specimens examined:

Andhra Pradesh: Balakrishnan 1102. *Bihar*: Panigrahi 11697. *Kerala*: Nair 19090. *Rajasthan*: Shetty 1249, Wadhwa 8370. *Uttar Pradesh* Prasad 327. *West Bengal*: Dutt 478, Nuskar Sn. 43739.

var. **tuberosa** (Roxb.) Sivarajan, Stat. nov. *P. tuberosa* Roxb. Fl. Ind. (ed. Carey) 2:464. 1832; Dyer, *l.c.* 246; Cook, *l.c.* 73; Gamb. *l.c.;* Poelln. *l.c.* 312. *P. suffruticosa* Wall. (Cat. 6844. 1832, *nomen. nud.*) *ex* Wt. & Arn. Prod. 356. 1834; Dyer *l.c.* 247; Cooke, *l.c.*, Gamb. *l.c.*, Poelln. *l.c.* 313; *P. pilosa*, ssp. *pilosa*, (race '*tuberosa*') Geesink in Blumea 17: 296. 1969 & in Fl. Males. 7: 131. 1971.

A semisucculent herb with tuberous or woody much branched roots, leaves subterete, linear-acute, axillary hairs short; flowers usually solitary; seeds usually tubercled.

Ecology: On wet, moist rocky laterite and sandy sea coasts.

Studies on herbarium materials and in the field have shown that there are a number of intermediates between *P. tuberosa* Roxb. and

P. suffruticosa Wall. *ex* Wt. & Arn. making a distinction very difficult.

Specimens examined:

Andhra Pradesh: (Waltair) Murty 189, (Hyderabad) Kaul 4696. *Bihar*: Mukherjee 4454; *Kerala*: (Calicut) Sivarajan 1169, 1170; *Laccadives*: Coll.? Sn. 43712. *Maharashtra*: Wadhwa 69863; *Orissa*: Abraham 263, Rao 5977. *Punjab*: Ramlakhan 9717, Kaul Sn. 29715 (Jullundur). *Rajasthan*: (Ajmir) Sharma 100288; *Tamil Nadu*: Rao 1434, Majeed 15504 (Courtallam); *Uttar Pradesh*: (Kukrail forests) Umashankar 1010, (Unnao) Kanjilal, Sn. 96816, Prasad, 328, 329.

P. pilosa ssp. **grandiflora** (Hook.) Geesink in Blumea 17: 297. 1969 & in Fl. Males. 7: 131. 1971. *P. grandiflora* Hook. Bot. Mag. n.s. 2. t. 2885. 1829, Poelln. *l.c.* 264.

Diffuse succulent herbs with linear, subterete leaves, and axillary hairs up to 5 mm long; flowers 3-4 cm across, in clusters of 4-6, sessile, colour variable; capsules subglobose.

Specimens examined:

Kerala: Sivarajan 1725 (Calicut). *Tripura*: Deb 267 & 2198. *Uttar Pradesh*: Kapoor 20405 (Lucknow), Umashankar 3590. Sn. 149, 150 (Kanpur), Rajkumar Sn. 37387 (Nainital); *W. Bengal*: Coll.? Sn. 43741.

Note: This tropical American taxon very widely cultivated throughout India falls under two categories.

1. Annuals—Solely propagated by seeds.
2. Perennials—those that do not set seeds and are propagated vegetatively.

Since, basically the species is an annual, the perennial nature might have been produced as a result of constant human selection to prefer certain cultivars, which otherwise breakdown and segregate.

Several cultivars, chiefly distinguished by their flower colours and numbers of petals are under cultivation. Genetic experiments have shown that the double flowered form is conditioned by a dominent allele (Yasui 1920). Katsuyoshi and Harding (1969) have also demonstrated the genetic varibility of petal length, width and number in commercial populations of this taxon. All flower colours and form variations are found to be differences in the genic level, but for one cultivar, 'jewel' which has a chromosome number n = 5, while the basic number of this taxon is n = 9 (Sultana Rizvi *et al.* 1972).

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A CATALOGUE OF THE BIRDS IN THE COLLECTION OF THE BOMBAY NATURAL HISTORY SOCIETY—23

CAMPEPHAGIDAE: (Cuckoo-Shrikes, Minivets);
IRENIDAE: (Fairy Bluebirds, Ioras, Leaf Birds).

HUMAYUN ABDULALI

[*Continued from Vol. 77* (1): 99]

This part covers 1007 specimens of 59 species and subspecies. After the main work was completed 32 specimens of 16 species and subspecies mostly collected by Sálim Ali in different parts of India, and a few erroneously unregistered have been formally added to the collections. These have been examined and entered under the appropriate headings, but all have not been included in the tables of measurements.

I am grateful to Mr. Nosherwan Setna who helped me with the measurements and other work for several months.

1064 **Hemipus picatus capitalis** (Horsfield) (Assam) Brownbacked Pied Flycatcher-Shrike **2: 307**

15: 10 ♂♂ (1 by pl.) 4 ♀♀ 1 o?

2 Bhagat State, 1 Simla Hills; 1 Tama, 1 Mangdechu, C. Bhutan; 1 Dehra Dun, U.P.; 1 Dibrugarh, 2 Sadiya, 1 Martam, Rongni Valley, 2 Silchar, Assam; 2 *N. Shan States;* 1 *Jade Mines, Upper Burma.*

Unsexed specimen No. 4818 collected by C. M. Inglis (probably at Cachar where he obtained No. 4819) has the upperparts blackish brown, i.e. a mixture between *capitalis* and *picatus* which replaces it in Southern Burma.

Measurements on p. 279.

1065 **Hemipus picatus picatus** (Sykes) (Dukhun) Blackbacked Pied Flycatcher-Shrike **2: 306**

41: 27 ♂♂ 13 ♀♀ 1 o?

3 Kolkaz, 1 Rangobeli, Melghat, Berar; 1 Malegaon, Surat Dangs; 1 Canacona, Goa; 1 Karwar, 1 Balemani, 2 North Kanara; 1 Sethipalli 2500′, Shimoga; 1 Begur, Manantoddy, 1 Padagiri, Nelliampathis, Cochin, 1 Thekaddy, Periyar Lake, Kerala; 1 Coonoor, Nilgiri; 1 Shambaganur, Palnis; 1 Billigirirangans, 2 Chitteri Range, Salem district; 2 Anantgiri, 1 Lamasinghi, 3 Sankrametta 3500′, 1 Upper Sileru, Vizagapatam district; 1 Gurguria, Simlipal Hills, 3 Badrama (Bamra), Orissa; 1 Mandikheri, Piparia; 1 Geedam, 1 Makri, 3 Antagarh, 1 Bailadila, Bastar, M.P.; 1 *Khayauk Chaung,* 1 *Sedan Chang, Thayetmyo,* 2 *Tonya, Prome, Burma.*

Laid on their backs, both sexes show considerable variation in the extent of the white on the chin and the vinaceous brown on the underparts. Four from North Kanara (2 ♂♂ 2 ♀♀) collected at the turn of the century by T. R. Bell and E. H. Aitken can be picked out by their pale yellowish almost unmarked underparts. A recent specimen from Goa does not show this difference.

No 4831 from Khayauk Chaung, Thayetmyo, Burma, originally marked ♀ is in ♂ plumage.

Stuart Baker (FAUNA, 2, p. 307) refers to a perfectly typical specimen of *picatus* from Darjeeling and Mt. Victoria in Chin Hills and an equally typical specimen of *capitalis* from Malabar and wonders if they are wanderers or aberrants.

Among those in female plumage, only 4 (1 ♂ 2 ♀♀ 1o?) have the head concolorous with the back, all the others, including two young males, from Chitteri Range, Salem district, having distinctly darker caps.

The tails of birds along the western side of the country (Kolkaz to Billigirirangans in the above list) average shorter than those from Vizagapatam hills, Orissa and eastern Madhya Pradesh.

Measurements on p. 279.

1066 **Hemipus picatus leggei** Whistler (Ohiya, Ceylon) Ceylon Pied Flycatcher-Shrike

nil.

This subspecies is separated from nominate *picatus* by the single fact that the sexes are alike, i.e. the female acquires the male plumage.

It was originally confined to Ceylon, but in INDIAN HANDBOOK (6: pp. 3-5) it is said to occur in southern Kerala, where "the sexes are however dimorphic"!?*

The southernmost female available is from Padagiri, Nelliampathis, Cochin, which does not differ from other females of *picatus*.

1067 **Tephrodornis gularis pelvica** (Hodgson) (Nepal) Nepal Wood Shrike **2:** 309

30: 20 ♂♂ (2 by pl., 4 imm.) 9 ♀♀ (2 imm.) 1 o?

1 Sukna, 2 Sevoka, Darjeeling, 4 Ranibagh, 2100′ U.P.; 4 Kameli (Bailadilla) Bastar, M.P.; 1 Sankrametta, Vizagapatam, A.P.; 3 Gurguria, 2 Mahendragiri, Simlipal Hills, Orissa; 1 Gaumara, Jalpaiguri; 1 Dibrugarh, Assam; 1 Roopachena, Cachar; 1 *Jungle, N. Shan States;* 1 no data.

Immature males have horny bills (*contra black*) and little or no grey on the upperparts. Their wings and bills average slightly less than in the adults, and they are excluded from the measurements.

8 (5 ♂♂ 3 ♀♀) obtained in Bhutan in 1966 have only recently been registered. In series the grey heads and brown backs of the males appear duller than those of other *pelvica*.

The measurements (p. 279) separately placed, are also a little smaller.

1068 **Tephrodornis gularis sylvicola** Jerdon (Malabar Coast) Malabar Wood Shrike **2:** 311

22: 12 ♂♂ 8 ♀♀ 2 o? (juv.)

1 Waghai, Surat Dangs; 2 Canacona, Goa; 1 Kodra, 1 Karwar, 1 Balammani, N. Kanara; 1 Kuriarkutti, Cochin; 1 Padagiri, Nelliampathis; 2 Thattakad, 1 Tenmalai, 2 Ponmudi, 2 Thekaddy, Periyar Lake, 1 Kalekare, 1 Begur, Manantoddy, 2 Manalur, Kerala; 1 Kannampalli, Nilgiri, 1 Palni Ghats; 1 Ulavi, Sorat Taluka, Mysore.

Measurements on p. 279.

EL **Tephrodornis gularis jugans** Deignan [Doi-Langka = Khao Pha Cho (19°N, 99°25′ E) Thailand].

5: 4 ♂♂ (2 imm.) 1 ♀.

2 *Mindan Yoma Reserve, Thayetmyo,* 1 *near Jebawgyi, 2300′ Sandoway;* 1 *Nyaunggyo, 2500′,* 1 *3000′, Prome dist., Burma.*

Except that the males appear to show less grey on the head, these birds are barely separable from *pelvica*.

Measurements on p. 279.

1069 **Tephrodornis pondicerianus pallidus** Ticehurst (Larkhana, Sind) Sind Wood Shrike **2:** 314

25: 14 ♂♂ (1* fledgling) 9 ♀♀ (1 juv.) 2 o?

1 Sind*; 3 Ambala, Punjab; 5 Meerut, U.P.; 2 Delhi; 1 Bharatpur; Rajasthan; 1 Narwar Fort, Gwalior; 7 Bhuj, Kutch; 1 Jawar, Jaswantpura, Jodhpur; 1 Mathar, Narbudda Valley, Bhopal; 2 Deesa, Palanpur, I Nadiad, Kaira, Gujarat.

*See remarks by S. Dillon Ripley, *JBNHS* 78: 168-9.

As accepted by earlier workers, the two races *pallidus* and *pondicerianus* recognised in Indian limits are not easily separable, particularly without any topotypical material to hand. The single specimen from Sind is a fledgling which is very much paler than 3 others in the same stage of plumage from southern India, but it is dated 4 May 1877 and much of the paleness may be due to fading.

Measurements on p. 279.

1070 **Tephrodornis pondicerianus pondicerianus** (Gmelin) (Coromandel) Indian Wood Shrike **2:** 312

61: 29 ♂♂ (1 fledgling) 25 ♀♀ (2 fledglings) 7 o?

1 Songadh, Navsari, Gujarat; 1 Raipur, 1 Dhargarh, Melghat; 1 Santa Cruz, 1 Bandra, Bombay City; 2 Khandalla, 1 Talegaon, 2 Poona; 1 Ratnagiri; 3 Karwar, 1 N. Kanara; 3 Murgimatta, Mysore; 1 Anaikatty, Gudalur, Nilgiris; 1 Palnis, 1 Rajanipure, Panthaiam Hills; 1 Akkakulam, 1 Nettayam, Kerala; 1 Nillapuria, foothills near Jamestown, Kanyakumari; 1 Gingee, S. Arcot, 1 Kurumbapatti, Salem; 5 Seshachalam Hills, 1 Koduru, 2 Palkonda Hills, S. Cudappah: 1 Nallamalai Range; 1 Anantgiri, Vizagapatam; 2 Jabalpur, 2 Bhanuprattapur, Kanker, 1 Golapalli, Bastar, M.P.; 3 Barkot (Bamra), 2 Band, 1 Kutri, Daspalli, 1 Samastipur, 1 Chahala, Simlipal Hills, Orissa; 1 Rajputee, Saran, 3 Baghownie, Darbhanga, Bihar; 1 Cawnpore, 1 Pilibhit Terai, 1 Kalkuna, foot of Kumaon Hills, U.P.; 1 Tribani, Nepal; 1 *Maymyo, Upper Burma; 2 Kandi, Prome dist.;* 1 *Kyibin, Henzada, Burma.*

Reference has already been made to the differences which cannot be localized. The 5 from Seshachalam Hills in south India appear paler than the others from the surrounding areas, but these skins are excellently prepared, by Lapersonne, which in itself separates them from the others.

Two fledglings taken on the same day at Khandalla by T. Yamamoto are probably of the same brood and age, but show a difference in the extent of spotting on the head.

In some birds the head appears darker than the back, while in others it appears to be streaked. A male, No. 4880, from Baghownie, Bihar, has the eye-brows creamy white, a character shared with another ♂ (No. 17088) of *pallidus* from Ambala, Punjab, and seen in others near Bombay .

Birds from Burma cannot be separated. The measurements show wide variation which it is not possible to associate with place or plumage. Larger series from the same place obtained over the whole year may perhaps provide some explanation.

Measurements on p. 279.

1071 **Tephrodornis pondicerianus affinis** Blyth (Ceylon) Ceylon Wood Shrike **2:** 313

nil.

1072 **Coracina novaehollandiae macei** (Lesson) (Calcutta, Bengal) Large Cuckoo Shrike **2:** 343

26: 16 ♂♂ (1 by pl., 9 adults) 10 ♀♀

1 Patan, Mehsana, 1 Dalkhania, Amreli, 1 Juna, Rajpipla, 1 Ajwa, Baroda; 1 Meskhatri, Surat Dangs; 1 Jaithari, Bhopal, C.I.; 1 Andheri, Bombay; 3 Ratnagiri; 1 Kumta, 2 North Kanara; 1 Mercara, Coorg, 1 Trivandrum; 1 Mudumalai; 1 Shevaroy Hills, 2 Nallamalai Range, South Kurnool; 1 Antagarh, 1 Kanta, Bastar, 1 Kanker, M.P.; 1 Balasore, 1 Dapur, 1 Chilka, 1 Maidapur, Angul, Orissa.

The single adult male from Trivandrum has the underparts more closely barred than in any of the others in this plumage, and a 159 mm wing.

There is considerable variation in the amount of barring on the underparts but, except that the females and immature males from Orissa and Bastar, M.P., appear to be more closely barred on the underparts, and also show wider bills, it is not possible to isolate any of the differences.

Measurements on p. 280.

1073 **Coracina novaehollandiae nipalensis** (Hodgson) (Nepal) Nepal Large Cuckoo Shrike **2:** 344

5: 1 ♂ 3 ♀♀ 1 o?

1 Ambala*, 1 Kalka, Punjab; 1 Madhubani, Darbhanga, Bihar; 1 Goalpara, 1 Doyang, Sibsagar, Assam.

1 ♂ (wing 181) grey throat and upper breast, no barring on underparts.

3 ♀ (wings 168, 169, 178), 1 with chin barred, 2 grey; all three with grey upper breast, and varying amount of barring below.

* Whistler (JBNHS 36: 346) stated that in this form the throat/chin is never barred, either in the female or first year plumage. In Sp. No. 17215 from Ambala, Punjab, the chin is barred, followed by a grey upper breast and further barring on the underparts. In the absence of any such specimen among *macei* in this intermediate plumage, and the large 169 mm wing, it is left with *nipalensis*.

Measurements on p. 280.

1074 **Coracina novaehollandiae layardi** (Blyth) (Ceylon) Ceylon Large Cuckoo Shrike **2:** 345

nil.

1075 **Coracina novaehollandiae andamana** (Neumann) (Andaman Islands) Andaman Large Cuckoo Shrike

7: 3 ♂♂ 3 ♀♀ 1 o?

1 Long I., 1 Maya Bunder, North Andaman; 2 Middle Andaman; 3 South Andaman.

These birds are similar to *nipalensis* and *siamensis* (as below) but the upper and lower parts are a clearer grey, and the belly a purer white than in any of the others. The two adult males (one with enlarged testes) show no barring on the underparts, while traces show in the other three, being least noticeable in a female with developed ovaries. Their bills are larger than in both *nipalensis* and *lushaiensis*.

Measurements on p. 280.

1075a **Coracina novaehollandiae lushaiensis** (Koelz) (Sungau, Lushai Hills = Mizo).

6: 5 ♂♂ 1 o?

1 Sadiya, U. Assam; 1 N. Cachar, 1 *Upper Burma*, 1 *Kamaing, Myitkyina;* 1 *Loi Kan, N. Shan States,* 1 *Pankkaing, Prome, Burma.*

The males are very different from both *nipalensis* and *siamensis* from the north and south, being much darker on the underparts, the grey deepening to black at the tip of the chin.

Koelz (1954, *Contrib. Inst. Reg. Expl.* 1 p. 15) described *lushaiensis* (Sungau, Lushai Hills, Assam) which he said was darker than *siamensis* and extended through the Naga Hills to Kohima, presumably north to Sadiya (east of Sibsagar in the plains) and west to the Jaintia Hills. This has been synonymised with *nipalensis* (SYNOPSIS, p. 322 and IND. HANDBOOK) but unless found to be identical with some other race from outside India, it appears to be separable not only from *nipalensis* but also from *siamensis* further south.

Measurements on p. 280.

EL **Coracina novaehollandiae siamensis** (Baker) (Krabina River).

3: 2 ♂♂ 1♀

2 *Thayetmyo dist.,* 1 *Henzada dist., Burma.*

They are very close to *andamana* but less grey above and with smaller bills.

Measurements on p. 280.

1076 **Coracina striata dobsoni** (Ball) (Andamans) Barred Cuckoo Shrike **2:** 346

2: 1 ♂ 1♀ Wrightmyo, South Andaman.

IND. HANDBOOK (6: 18) refers to the underparts of the females, "below the breast" being barred, implying that the chin and upper breast are not barred. In the single specimen available, the entire underparts from chin to vent are barred.

Measurements on p. 280.

1077 **Coracina melaschistos melaschistos** (Hodgson) (Nepal) Dark Grey Cuckoo Shrike **2:** 337

36: 21 ♂♂ (2 by pl.) 15 ♀♀ (3 by pl.)

1 Dungagali 7500′; 1 Murree, 1 Dakuri, 1 Almora, Punjab; 1 Koti State 6500′, 1 Jabli 3500′, 2 Simla, 1 Patiala State 4500′; 1 Chamoli, Garhwal, 1 Kumaon, Naini Tal, 1 Bankulwa Morung, Nepal; 1 Bhapalapatnam, 1 Amraoti, Bastar, M.P.; 2 Badrama (Bamra), 1 Korai (Bonai), 2 Chahala, Simlipal Hills, Orissa; 1 Baghownie, Tirhut, Bihar; 1 Sukna, Darjeeling; 1 Peshoke 2600′, Sikkim; 1 Tama, 1 Gedu, West, 1 Shamgong, Central Bhutan; 1 Bara Pani, Shilong, 2 Dibrugarh, 2 Margherita, 1 Martan, Rongni Valley, 1 Lohit Valley, 1 Assam; 1 Bagho-Bihar, Cachar; 2 *N'Kraung, Upper Burma.*

The grey of the upper and underparts varies appreciably and the latter carry different markings in white which are referred to hereunder but their significance is not understood.

The females are generally paler than the males and differ in the more extensive barring on the underparts, particularly on the under tail-coverts. The statement in IND. HANDBOOK (6: 19) separating the females by the roundish white patch on the wings is not quite correct, for several young males with brown primaries or barred underparts have similar patches.

Several females have fine white streaks below and behind the eyes, which character is entirely lacking in the males.

No. 5137 (unsexed) from Dungagali N.W.F.P. is barred over most of the underparts but marked "Nesting" indicating that birds breed without acquiring the adult plumage.

Two females No. 5128, Margherita, Assam, and 5143, Kumaon, Naini Tal, lack the white spots on the wings and are exactly like some of the males. This is presumably the final plumage in both sexes and one is inclined to accept Blanford's statement (FAUNA 1: 492) to this effect, and to which he adds "Fully adult females are however seldom met with".

Some of the males show unmarked white under tail-coverts and it has not been possible to determinate the position of this phase in the sequence of plumages.

INDIAN HANDBOOK (1971, 6: 20) refers to the southernmost records as from Londa *c.* 15° 30′N on the west coast. The BNHS Bird Migration Camp at Pt. Calimere, 10°15′N., on the east coast claims to have ringed 70 birds passing through in autumn and 7 in spring. This would indicate its visiting Ceylon, where it has not yet been recorded!?

Measurements on p. 280.

EL **Coracina melaschistos avensis** (Blyth) (Arakan)

1 ♀ *Tonbe, Prome, Burma.*

The undersurface of the tail is not black as in all phases of nominate *melaschistos,* and the bird is paler all over.

Measurements on p. 280.

1078 **Coracina melanoptera melanoptera** (Ruppell) (Bhadwar, Punjab) Himalayan Blackheaded Cuckoo Shrike **2:** 340

nil.

1079 **Coracina melanoptera sykesi** (Strickland) (Dukhun) Peninsular Blackheaded Cuckoo Shrike

36: 21 ♂♂ (6 juv.) 15 ♀♀ (4 juv.)

1 Gujri, Dhar, C.I.; 2 Dabka, Baroda; 1 Wada, Bhiwandi, 1 Vikhroli, 1 Trombay, 2 Andheri, Bombay; 1 Santgol, 1 Alanki, 1 Karwar, 2 Kumta Div., 2 N. Kanara; 1 Molem, Goa; 3 Bangalore, 1 Kolar, Mysore; 1 Gudalur 3000′, 1 Segoor, 3500′, 1 Coonoor, Nilgiris; 1 Mercara, Coorg; 1* Cape Comorin, 1* Sheshachalam Hills; 1 Kurumbapatti, Salem; 1 Dantewara, 1 Antagarh, 2* Dantewara, Bastar, M.P.; 1* Bengasai, Mahendragiri, 1 Berbera, Puri, Orissa; 2. Kumaon, Naini Tal, 1 Kesarwala, Dehra Dun, U.P.

The key to subspecies in INDIAN HANDBOOK (6: 20) separates males of nominate *melanoptera* from *sykesi* by their darker colour and larger wing, 107 mm or over, but later in the text the males are said to measure 98-110. Four males from Orissa, Central Provinces, Karnataka and as far south as Cape Comorin, have wings 109-111 mm and the underparts strikingly darker than in the others. In the absence of any topotypical material from the Himalayas or the Punjab, it is not possible to determine the identity of these four, which are marked* in the list above. Their measurements are also separately placed.

In adult males both the upper and lower mandibles are black, except in 5165 (20 November). In the juveniles they are both yellow, with the upper mandible horny in 5151 and 5149 (29 April and 10 April).

In the females, the 4 juveniles are browner above, *contra* grey in the adults, and also have a slight fulvous wash on the underparts. No. 5166 marked as with soft skull (7 September) has traces of barring on the upper plumage.

Measurements on p. 280.

1079a **Coracina nigra davisoni** (Kloss) (Nicobar Islands) Nicobar Pied Cuckoo-Shrike.

6: 2 ♂♂ 2 ♀♀ 2 o?

2 Nancowry, 1 Trinkut, 3 Camorta, Central Nicobars.

Both the unsexed birds are barred below as in females; one of them, No. 22623, has black patches on the back suggesting a change of colour into the male plumage.

Measurements on p. 281.

1080 **Pericrocotus flammeus speciosus** (Latham) (Darjeeling) North Indian Scarlet Minivet **2:** 319

21: 13 ♂♂ 7 ♀♀ 1 o?

1 Mussoorie, 3 Dehra Dun; 2 Nawacot, 2 Loharipowa, Nepal; 1 Rangpo, 1 Kalijhora, 1 Singtam, 1 Tista, Sikkim; 1 Tama, C., 1 Deothang, E. Bhutan; 1 Sevoke, 1 Longview, Darjeeling; 1 Buxa Duars, 1 Hazarpatha, Bengal; 1 Mishmi, 1 Rotang, Abor Hills; 1 no locality.

The twelve males in red plumage all have the outer web of the first two primaries unmarked, while of the six females, two are similar to the males but the other four have three. The latter include a juvenile with traces of barring on the neck, and an orange wash on the underparts, suggesting that adults of both sexes have two unmarked primaries.

Four males have all black central tail-feathers, while the others have a varying amount of red on the outer webs.

The bird from Mussoorie has an exeptionally curved bill, 19.5 mm. from feathers, and this figure is excluded from the table of measurements.

The key in INDIAN HANDBOOK (6:25) says this is larger than *fraterculus* (1082) with the wing 96 mm and over, *contra fraterculus* 90-98, but later p. 29 Deignan is quoted indicating 96-103 for the latter.

♂ No. 4952 from Mishmi, Abor Hills, is pinkish on the right wing and body and on the whole tail (except 2 central feathers which are black).

See remarks under 1082 below.

Measurements on p. 281.

1080a **Pericrocotus flammeus andamanensis** Beavan (Andaman Islands) Andaman Scarlet Minivet **2:** 322

7: 5 ♂♂ 2 ♀♀ (1 juv.)

3 Wrightmyo, 1 Pochang, Shoal Bay, 2 Pyinmanala, 1 Chirria Tapoo, South Andaman.

The males have the first three primaries unmarked on the outer webs and the central tail-feathers all black. The two females have the same characters. Of 2 ♂♂ and 2 ♀♀ examined at the Zoological Survey in Calcutta, the males were similar but the females (1 Wrightmyo; 1 Bonnington, N. Andaman) had the first four primaries unmarked as required in IND. HANDBOOK.

Measurements on p. 281.

1081 **Pericrocotus flammeus flammeus** (Forster) (Ceylon) Peninsular Indian Orange Minivet **2:** 322

43: 23 ♂♂ (3 imm. yellow) 20 ♀♀

1 Galkund, 2 Mheskatri, 3 Waghai, 1 Mahal, Surat Dangs; 1 Suriamal, Thana; 1 Bhimashankar, 2 Khandala, Poona; 1 Mahableshwar, Satara; 1 Savantwadi; 2 Kadra, 2 Karwar, 1 Kumta, 1 Castle Rock, 1 North Kanara; 1 Molem, Goa, 2 Murgimatta, 1 Keegore, Jog Road, Sagar, Shimoga; 1 Bandipur, 1 Bababudan Hills, Kadur district, Mysore; 1 Kodanad, 6400′, 1 Anaikutty, 2 Gudalur, Nilgiris; 1 Shembaganur, 1 Vengaparai, 1 Kodiakanal, Palnis; 1 Palam Ghat, 2 Ponmudi, S. Travancore, 1 Kumili; 3 Billigirirangan Hills, Coimbatore; 2 Shevaroy Hills; 1 Madura.

The majority of males have the central tail-feathers all black, a few having small orange tips. Except for one male and one female the first four primaries in both sexes (not three as in IND. HANDBOOK) have the outer webs unmarked.

Measurements on p. 281.

1082 **Pericrocotus flammeus fraterculus** Swinhoe (Hainan) Hainan Scarlet Minivet **2:** 320

11: 8 ♂♂ (1 yellow juv.) 3 ♀♀

1 Goalpara, 2 Dibrugarh, 3 Margherita, 2 Tezu, Lohit Valley; 1 Garo Hills, 1 Haflong, 1 N. Cachar.

As far back as 1877 (*Stray Feathers* 5: 194) Hume held that birds from Assam and Burma differed from *speciosus* in being slightly smaller and having the outer webs of the central tail-feathers red. Subsequent workers have agreed that birds from Assam are slightly smaller (wings of ♂ *speciosus* average 102.7 mm *contra* 98.8 in these, with some overlap —H.A.) but there is some uncertainty regarding the name that should apply.

Hume referred to them as McClelland's *elegans* described on pages 156-157 of *Proceedings of Zoological Society of London,* 1839. In INDIAN HANDBOOK the reference is changed to Horsfield *P.Z.S.*, 1840, and this needs clarification. Horsfield reported on a collection made by McClelland and described *elegans* on pages 156-157 of *P.Z.S.* for 1839, which was actually *published* in 1840. The change of author is correct according to the rules of nomenclature but since the journals are referred to by year, it would, I think be more reasonable to quote the source as *"P.Z.S.,* 1839 (published 1840)".

Hume (*loc. cit.*) held that *speciosus* weighed "nearly double what *elegans* does."

Ticehurst in Stanford's 'Birds of Prome District, Burma' (*JBNHS 34*: *906*), refers to "11 male *fraterculus* from the type locality, having the central tail-feathers black or occasionally red on distal half of the outer webs, while out of over twenty males from Burma, only two have them black." Among those listed above as *speciosus* are 11 adult (red) males, of which 4 single birds from Dehra Dun, Nawacote, Mishmi, and Hazaria, Patharghatta have all-black central tail-feathers, while of the 7 red males in this group (1082) one each from Margherita and Goalpara have similar tails.

No topotypes of *fraterculus* are available and I cannot separate the birds from eastern Assam from those from further south, i.e. Garo Hills, Cachar etc., which are said to be *fraterculus* in INDIAN HANDBOOK. All-black central tail-feathers are also a female character shared with juvenile males and with the material and literature available, I would be reluctant to separate them from *speciosus.* If the differences exist the name *elegans* is more appropriate with priority over *fraterculus,* should that be identical.

In the birds from Burma and Siam now available, 7 have the outer webs of the central tail-feathers completely red. As it is not possible to call them *fraterculus* (as was done by Stuart Baker), I am leaving them all under *flammifer* q. v.

Again, if the birds from Assam are different from those from Burma, the former can hardly have the popular name of "Burmese" Scarlet Minivet as in INDIAN HANDBOOK.

The extralimital distribution of this subspecies is omitted in IND. HANDBOOK (6: 29).

The males have the outer webs of the first two primaries unmarked and the females three. In IND. HANDBOOK (loc. cit.) the primaries of the male are compared with the rectrices of the female.!

Of the 3 males from N'Kraung, Upper Burma, obtained in July/August, 2 have the central rectrices black but the third has the half-grown feathers red. They undoubtedly belong to *flammifer*, the black central tail-feathers in the male being a subadult character in some races, e.g. *semiruber*.

As in *speciosus* some males show yellow patches on the breast, chin and secondaries, presumably in the course of changing from juvenile to adult plumage.

Several females have traces of orange in the yellow, but this count be due to the same reason.

Measurements on p. 281.

EL **Pericrocotus flammeus flammifer** Hume (region of the Pak Chan Estuary, Malay Peninsula, at latitude 10°N).

22: 12 ♂♂ (1 yellow juv.) 10 ♀♀

1 *Taungdwin Chg., Upper Chindwin;* 1 *Tongaunchy,* 1 *Yagyi,* 1 *Kani, Lower Chindwin,* 1 *Chindwin;* 3 *N. Kraung,* 1 *Upper Burma;* 1 *N. Shah States;* 3 *Maymyo,* 1 *Sadan Chang, Thayetmyo,* 1 *Theme,* 1 *Thanichaung Pass,* 1 *Nyaunggyi, Prome, Burma;* 3 *Lampang, Pangla,* 1 *Bau, Nong Tong,* 1 *Siam.*

See remarks under 1082 and 1083

These birds do not agree with the description in Stuart Baker's FAUNA in so far as the males and females have two and three outer primaries unmarked and not three and four as stated therein. Juvenile ♂ 4955, N. Shan States has the wing and tail both 98 mm.

The Siam birds (3 ♂♂ 2 ♀♀) are brighter than those from Burma.

Measurements on p. 281.

1083 **Pericrocotus flammeus semiruber** Whistler & Kinnear (Sankrametta, Vizagapatam) East Indian Scarlet Minivet

16: 11 ♂♂ (2 imm.) 5 ♀♀

1 Anantgiri, 3000′, 1 Dharakonda, U. Sileru, Vizagpatam; 1 Lohattar, Kanker; 3 Daiba, 1 Makri, 1 Kameli (Bailadila), 2 Antagarh, 3 Chota Dongar, Bastar, M.P., 1 Tigiria, 1 Kutri, Daspalla, 1 Chahola, Simlipal Hills, Orissa.

Of the 9 red males, eight have the outer webs of the two outermost primaries unmarked and the outer webs of the central tail-feathers red for most of their length. Two immature males (both yellow with an orange tinge) have 3 unmarked primaries and the central tail feathers black, as in the ninth red male No. 17118 which has three unmarked primaries; this is as in four of the five females, one having only two unmarked.

The birds from Thailand under *flammifer* above are marked *semiruber* by Deignan and the distribution in Peters' CHECKLIST is extended to "Southern Burma, southward to Central Tenasserim (where intergrading with *flammifer*); Thailand (except to southwestern and peninsular provinces); Indo-China (except the area occupied by *elegans*)".

Semiruber is however distinctly larger and the Thailand birds referred to above agree more closely with what I have placed under *flammifer*, than with *semiruber*.

Measurements on p. 282.

1084 **Pericrocotus brevirostris brevirostris** (Vigors) (Himalayas=Sikkim foothills) Short-billed Minivet **2**: 324

11: 8 ♂♂ 3 ♀♀

1 Rangpo, 1 Pashok, 1 Penionche, 1 Rinchingpong, Sikkim; 2 Tama, 1 Shamgong, Central Bhutan, 2 Deothang, E. Bhutan; 1 Huchugaon, Goalpara, 1 Margherita, Assam.

Both sexes average slightly smaller than *ethologus*. The males can be identified by the absence of red running backwards along the edges of the inner secondaries. In the females the yellow on the forehead extends on to the crown. The yellow on the outer web of the second innermost rectrice extends to the tip, while the inner web either has a small yellow spot or a wedge of yellow at the tip (Mayr 1940, p. 713).

Measurements on p. 282.

1085 **Pericrocotus ethologus favillaceus** Bangs & Phillips (Koolloo Valley, northern India) West Himalayan Longtailed Minivet.

74: 38 ♂♂ (6 imm. yellow, including 2 barred above, 1 partly red) 31 ♀♀ (1 chick 1 juv. barred above) 5 o? (1 juv. barred above).

1 Wana, S. Waziristan; 2 Ajun, 3 Chitral; 1 Attock, 1 Ambala, 1 Rawalpindi, 1 Lahore, 1 Pipli, Karnal; 1 Nankhri, 8000′ (?), 2 Chini, 22 Simla Hills; 1 Padar, Kishtwar, 1 Srinagar, 1 Yusmarg, 1 Kashmir; 3 Jajjah, 2 Bahawalnagar, Bahawalpur; 1 Surwaya, Gwalior; 1 Pili, 1 Kolkaz, 2 Rangobeli, Melghat; 1 Jubbalpore; 9 Meerut, 1 Salukapur, U.P.; 1 Darmar, Ranikhet, 1 Konain-Jamsar, 1 Guptakashi, 2 Lambathach, Kumaon; 1 Partapur, 1 Sipuri, Nepal, 2 Dhanaulti, 2 Mussoorie, 2 Shikarpur (F.J.R. Field 1891?).

The birds collected in the plains and obtained between 9th November and 21st March are no doubt winter migrants. Four females with the lightest grey upperparts are from Simla, Bahawalpur, Jubbalpore and Melghat, while two males from Rawalpindi and Lahore appear to be the deepest red. Two females from Simla (No. 17132 incubating) and Partapur, Nepal (4973) have their underparts tinged with orange. In the latter, the orange wash extends on to the forehead.

The present identifications are mainly on geographical grounds, though in series, males of *laetus* (*infra*) are a slightly deeper red, particularly on the rump, and the females a deeper yellow.

In *Stray Feathers* 5, p. 414/5, V. Ball has referred to the chin and throat of young males of *P. speciosus* (now *P.f. semiruber*) from Sambalpur being mottled with, if not wholly, scarlet before showing any sign of the ultimate black. Stuart Baker in FAUNA (2, p. 320) says "the change of plumage in all Minivets is very interesting, as specimens are numerous which show signs of attaining an increase of red in the old feathers prior to the moult. Birds in this stage show no signs of the barring on the upper surface and are obviously undergoing, or about to undergo, the second moult."

Juvenile ♂ No. 17137 from Simla (5th July) is barred on the head and upper back.

No. 17135 dt/11th July from Simla a yellow juvenile ♂ has patches of black on the back and head, and red on the breast and rump. The 7th to 9th primaries are barred red and the others yet yellow.

In JBNHS 41, p. 93 is a note regarding a yellow bird marked ♂, moulting to yellow.

Measurements on p. 282.

1086 **Pericrocotus ethologus laetus** Mayr (Jeyluk, Sikkim) East Himalayan Longtailed Minivet

16: 10 ♂♂ (1 yellow) 6 ♀♀

1 Chungthang, N. Sikkim; 1 China Kothi, 1 Ha Road, West Bhutan, 1 Khosela, 6 Rongtong, E. Bhutan; 1 Goalpara, 3 Shillong, 1 Dibrugarh, 1 Margherita, Assam.

Juvenile ♂ 21719 from Chungthang, N. Sikkim, is marked *Pericrocotus solaris* by Sálim Ali, but this appears to be in error, because of *a*) the large 92 mm wing; *b*) presence of a slight yellow on forehead, and *c*) the absence of yellow tips to the second innermost rectrices.

The females have an olive tinge on the back.

Measurements on p. 282.

1087 **Pericrocotus ethologus mariae** Ripley (Phek, eastern Naga Hills) Nagaland Longtailed Minivet

nil.

EL **Pericrocotus ethologus yvettae** Bangs (Ma-li-pa, Kokang, Burmese Wa States) North Burmese Longtailed Minivet

2: 1 ♂ 1 ♀
2 *N. Shan States, Burma*
Measurements on p. 282.

1088 **Pericrocotus solaris solaris** Blyth (Darjeeling) Yellowthroated Minivet **2:** 326
10: 5 ♂♂ 5 ♀♀
1 Temi, 2 Tung, Sikkim; 1 Honka W., 3 Gomchu, 1 Deothang, E. Bhutan; 1 around Bewehaung, Sarag country, 1 Shillong, Assam.

The five males show bright orange-red ("red-orange", Deignan, BIRDS OF NORTH THAILAND, p. 277) and not scarlet or red as referred to in Indian literature. In BIRDS OF MALAYA (2: 150) the immature male of *P. solaris montanus* Salvadori is said to be "At first like the adult female, but gradually acquiring the scarlet plumage of the male, in part by moult, but in part it would appear by a direct change in the pigment of the feather, passing through orange to the pure scarlet."

The females are distinguished from *ethologus* by the total absence of yellow on the forehead and the yellow tip to the second innermost tail feathers (as in *brevirostris q.v.).* They are also a brighter yellow below.

Measurements on p. 282.

1089 **Pericrocotus roseus roseus** (Vieillot) (Bengal) Rosy Minivet **2:** 328
30: 23 ♂♂ (1 by pl.) 7 ♀♀
1 Dharampur, 2 Koti, 2 Bhajji State, Simla Hills; 1 Kumaon, Naini Tal Dist; 3 Khandala, W. Ghats; 1 Canacona, Goa; 1 Kadra, N. Kanara; 3 Darba, 1 Bhopalapatnam, 1 Barsur, Bastar, M.P.; 1 Sankrametta, Vizagapatnam dist., A.P.; 2 Badrama (Bamra), 1 Kendrapara, 1 Anantpur, 5 Dibrugarh, 1 Shillong, Khasia Hills, Assam; 1 *Kani, Lower Chindwin;* 1 *Inbin, Henzada,* 1 *Prome, Burma.*

Only three males have red on the rump. No. 5056 from Kani, Lower Chindwin has a large patch extending from the rump on to the upper tail-coverts.

Four males (17 June, Simla; 10th and 12th September Dibrugarh; 16th October Kumaon) have yellow patches in the wing, including two with red on the rump (Kumaon and Dibrugarh).

The winter distribution is more extensive than suggested in the map in IND. HANDBOOK (6: 38), the bird having been recorded from Karachi, Bombay area, Travancore etc.

Measurements on p. 282.

1089a **Pericrocotus divaricatus divaricatus** (Raffles) (Singapore) Ashy Minivet **2:** 334
1 ♂ Karnala, Pen, Kolaba, Maharashtra.
Measurements on p. 283.

1090 **Pericrocotus cinnamomeus pallidus** Baker (Larkhana, Sind) Sind Little Minivet **2:** 332
1 ♂ Bahawalpur, s.w. Punjab.

This specimen is marked *pallidus* by Whistler and has a grey chin, the least amount of orange-red on the upper breast among the adult males available, followed by almost pure white all over the lower belly, under tail-coverts and tail. The upperparts are the palest grey among specimens available and the bar on the wing is yellow, with almost no trace of red or orange. It is the only specimen with the outermost tail-feathers pure white.

One from Karnal, Punjab, and six from Meerut, U.P., appear very similar to this specimen but others from Jagadhri, Ambala and Delhi lying in-between, are no doubt *peregrinus.*

In the FAUNA (1924) Stuart Baker said *pallidus* was found in Sind, to the extreme northwest of India, and possibly Mt. Aboo. Later (1929, Bull. Brit. Orn. Cl. 49, p. 64) he changed the words to "Sind, the northwest province and Mt. Aboo".

This is confusing, for North-Western Provinces was the old name for Agra District and the distribution may be either north-west from Sind into Baluchistan or eastwards towards Agra!

The distributional map in IND. HANDBOOK (6: 400) shows this form as extending up to Rawalpindi, but specimens from this place appear nearer to *peregrinus*, the type locality of which, Ambala, as pointed out by Ticehurst (*Ibis* 1922, p. 613 & *JBNHS* 31, p. 496) is unfortunately too close to Sind. There is also the possibility of the bird from Bahawalpur being wrongly identified and not the same as topotypical *pallidus* from Sind, and this matter needs to be re-examined. It is evident that there is much variety in all the races and it is difficult to name every specimen by itself.

In this and subsequent races, the descriptions refer to the males and the differences among the females, if any, are specifically said to apply to them.

In all races, the females are pale-brown, rather than grey above.

Measurements on p. 283.

1091 **Pericrocotus cinnamomeus peregrinus** (Linnaeus) (Ambala) Northern Little Minivet **2:** 324

62: 42 ♂♂ 18 ♀♀ 2 o?

Whistler and Kinnear after examination of the material collected in the Eastern Ghats accepted *peregrinus* (type locality Ambala) as extending over the whole of India, excluding the ranges of *malabaricus* (Malabar) *pallidus* (Sind) and *vividus* (Orissa and northeastwards) and separated Ceylon birds (*ceylonensis*) as distinct. In IND. HANDBOOK, *peregrinus* is replaced south of about Gujarat by *cinnamomeus* named in Ceylon, with *ceylonensis* as a synonym of the latter.

The arrangement appeared unlikely for the birds from Ceylon had at some stage or the other been said to resemble *malabaricus* by Van Schauburg (1930), Whistler & Kinnear, Whistler, Koelz, Ripley & Sálim Ali. No specimens from Ceylon were available but the loan of 10 specimens (5* ♂♂ 5 ♀♀) from the British Museum (N.H.) appear to have provided an explanation confirming that the earlier isolation of the Sri Lanka birds was correct (see under 1093). The others from peninsular India, with the exclusions referred to above, are for the moment placed in 3 groups under this form.

*Three of them are marked *malabaricus*.

(a) **peregrinus,** including topotypes

25: 19 ♂♂ (1 yellow juv.) 5 ♀♀ 1 o? (yellow)

1 Choi, Campbellpore; 3 Rawalpindi, 1 Chandigarh, 1 Jagadhri, 2 Ambala; 1 Ladwa, Karnal; 4 Delhi; 6 Meerut, 1 Salukapur, 2 Bulandshar, U.P.; 1 Baghowni, Darbhanga, 1 Pilibhit Terai, 1 Rajputtee, Saran.

As indicated under 1090 some from the Punjab are very similar to that marked *pallidus*. Of the 3 males from Rawalpindi two have black chins and breasts and the third grey. Some of the skins are in poor condition.

(b) 20: 10 ♂♂ 9 ♀♀ 1 o?

1 Ajmere, 3 Bhuj, 1 Kutch; 1 Deesa, Palanpur, 1 Cambay, 1 Bodeli, 1 Ajwa, Baroda; 1 Narwar Fort, Gwalior, 1 Bijnor, Indore; 1 Jubbalpore, 2 Gondia; 2 Bhanuprattapur, Kanker; 1 Darba, 1 Bhopalapatnam, 1 Konta, 1 Geedam, Bastar.

♂ 5099 from Bhuj, Kutch, is very close to *pallidus*, but another from the same place agrees more closely with some from Gujarat. There is some variation in plumage, but in series most of these would be closer to group (a) than to the male *pallidus* from Bahawalpur. ♀ No. 5116 collected at Ajmere was listed under *P. erythropygius*.

(c) 9: 8 ♂♂ (1 chick) 1 ♀

1 Bhiwandi, Thana; 1 Malad, 3 Andheri, 2 Trombay Island, 1 Bombay; 1 Khandala, Pune.

The males have definitely darker grey backs and blacker throats than (a), and also more orange and yellow on the underparts. Two males from Trombay are very close to birds from Valpoi and Colvalle, Goa with dark grey chins but the latter are placed with *malabaricus* as other birds from N. Kanara appear to be of this form.

(d) **sidhoutensis** Koelz

8: 5 ♂♂ 3 ♀♀

1 Satara, Maharashtra; 1 Gingee, S. Arcot; 1 Palkonda, 1 Koduru, 2 Seshachalam Hills, S. Cuddapah; 1 Kolar, E. Mysore; 1 Cumbum Valley, Kurnool dist.

Birds from Cuddapah district were listed with *peregrinus* by Whistler but separated as *sidhoutensis* by Koelz, 1939, *Proc. Biol. Soc. Washington* 52: 69 and later synonymised with *cinnamomeus* in IND. HANDBOOK. The specimens available have smaller wings, purer white on the underparts, and paler grey upperparts than those in (b) above. It is possible that this is another of Koelz's races which may merit recognition.

Measurements on p. 283.

1093 **Pericrocotus cinnamomeus cinnamomeus** (Linnaeus) (Ceylon) Ceylon Small Minivet

nil.

The following 10 (5 ♂♂ 5 ♀♀) were borrowed from British Museum (N.H.):

2 Uragaha, 1 Gan Maduwa, 1 Nedimala, 2 Willimada, 1 Kumbalgamha C.P., 1 Pusiwalla, 1 Cocawatte, 1 Ceylon.

Reference has been made under 1091 to the confused position regarding the identity of birds from Ceylon and South India. The males are almost as deeply coloured as in *malabaricus* but are dark grey *contra* blackish above, the orange-red on the underparts is less extensive, there being more white on the lower belly and vent.

The females are similar to those of *peregrinus* and the other races in peninsular India except *malabaricus q.v.*

The colour differences have been set out in detail by Whistler in THE AVIFAUNAL SURVEY OF CEYLON (1944) and the subsequent confusion is partly due to changing the specific name from *peregrinus* to *cinnamomeus* and partly to the fact that the Ceylon males approach *malabaricus* and the females *peregrinus*/*sidhoutensis* in colour.

In addition to this both males and females resemble those of *malabaricus* (and *vividus* from the Andamans) in the wings being equal to or slightly longer than the tails.

Measurements on p. 283.

1094 **Pericrocotus cinnamomeus malabaricus** (Gmelin) (Malabar Coast, restricted to Mahe) Malabar Little Minivet

9: 5 ♂♂ 3 ♀♀ 1o? (juv.)

1 Colvalle, 1 Valpoi, Goa; 1 Karwar, N. Kanara; 2 Murchiston, Ponmudi, 1 Maruthankuzi, 1 Urumbikera, Mundakayam, 1 Pambanar, Peermade, 1 Wadakancheri, Kerala.

This race is very distinctive, the males being distinguished by their almost black backs, the jet black chin and throat, the bright scarlet and orange-yellow on the underparts, including the under tail-coverts. The females are a much deeper yellow below than in any other race, the upper breast is washed with pale brown rather than yellow. Except in the single female from N. Kanara, the wing is longer than the tail, a character not consistent in those from Goa and further northwards.

Vidal (*S.F.* 9: 59) has referred to a "richly coloured bird" from Ratnagiri, but there is nothing to indicate what he was comparing it with. There is an appreciable amount of variation in the extent of the red on the underparts.

Measurements on p. 283.

1095 **Pericrocotus cinnamomeus vividus** Baker (Attaran River, Amherst Dist., Tenasserim, Burma, restricted to Pabyouk, 22m SE. of Moulmein) Eastern Little Minivet **2:** 331

20: 12 ♂♂ 7 ♀♀ 1 o?

When describing this form Baker (1920) apparently accepted it for the Andamans also, but this place is not referred to in the FAUNA (1924) where he gave the range as "Eastern Bengal and Assam, Burma, Siam, Cochin

China, Yunnan and Annam". This has later been extended westwards to include the birds from Orissa and northeast Andhra Pradesh, and also those from the Andamans. In the absence of topotypical material it is not possible to settle this matter but the Andaman and Orissa populations show the following differences:

ANDAMANS	ORISSA
1) *Chin* dark grey	1) black or darker grey
2) *Bill* longer and heavier	2) shorter and lighter
3) *Upperparts* darker grey	3) paler grey
4) *Orange-red of underparts* extending to vent	4) lower belly paler, whitish to vent
5) *Outermost rectrices, from below* orange-red.	5) pale, pinkish
6) Wing equal to or longer than tail	6) wing shorter than tail

Items 5 and 6 hold good for females also.*

The females are very similar to those from Ceylon except that the under wing-coverts at the edge of the wing appear a brighter and more prominent yellow.

Under these conditions I am leaving the two groups separately under the same name:

(a) Andamans 10: 4 ♂♂ 5 ♀♀ 1 o?

2 Long I., Middle Andamans; 3 Wimberleyganj, 2 Wrightmyo, 1 Landfall I., 2 South Andaman.

Schauburg (1930) thought that a single female collected at Port Blair, Andamans, by B. B. Osmaston differed from continental birds in its larger bill, wholly white underparts with a faint tinge of yellow on the flanks, and proposed that it should be named after the collector, should it be found to deserve separation.

(b) 10: 8 ♂♂ 2 ♀♀

1 Anantgiri, 1 Sankrametta, Vizagapatnam; 2 Chota Dongar, Bastar, M.P., 1 Gurguria, Simlipal Hills, 1 Keonjgarh, 1 Badrama (Bamra) 1 Barkot, 1 Ranipathar, Phulbani Dist., Orissa; 1 Goalpara, Assam.

Birds from Bastar, eastern M.P., and Vizagapatnam grade into this form which is very distinctly brighter on the underparts than those from the south and others under *peregrinus*.

This single bird from Assam is in very poor condition. A pair from Maymyo, Burma, is so different that I am listing them separately below.

Measurements on p. 283.

EL **Pericrocotus cinnamomeus** subsp.

2: 1 ♂ 1 ♀ *Maymyo, Burma.*

Both were collected on 25th August 1913. The ♂ is largely orange coloured below, unlike any other specimen available, and with a grey throat much paler than in Andaman birds. The female is yellow below, not unlike one from the Andamans. Their tails are 8 and 5 mm longer than the wings, which is more than in any others of the species.

Measurements on p. 283.

1096 **Pericrocotus erythropygius erythropygius** (Jerdon) (S. India =Ajanta) Whitebellied Minivet

21: 12 ♂♂ (3 juv.) 8 ♀♀ 1 o?

1 Dhirpur, 2 Ambala, 1 Bunni, Kadwa, Karnal, Punjab; 1 Ajmere; 3 Delhi; 1 Meerut; 3 Rapar, 2 Kutch; 1 Kuno, Gwalior; 1 Malwa plateau, Bhopal; 1 Saugor, 1 Mather, Narbada Valley (north): 1 Bodeli, Baroda district; 2 Raipur, Melghat, Berar.

Measurements on p. 283.

* On a recent (June 1980) visit to the Zoological Survey of India at Calcutta, I had the opportunity of examining and comparing 7 males and 3 females from the Andamans with 6 males and 6 females from Orissa and Balaghat, M.P., in their collections, and the above remarks are supported by this material.

Aegithina tiphia

Hume as far back as 1877 (*Stray Feathers* 5: 420-441) examined some 240 specimens in his collection and after referring in great detail to the variations and similarities in the males and females from all parts of its range said "...is it logical or expedient to break this species up into several on the strength of such very variable and inconstant differences? In my opinion it is not."

In 1952, Daniel Marien (*Amer. Mus. Novit.* 1589) got together some 425 specimens and made another attempt at clarification. This was followed by a paper on the taxonomic importance of variation in non-breeding plumage in *Aegithina tiphia* and *A. nigrolutea* by Mrs. B. P. Hall (1957, *Ibis* 99, pp. 143-156) and also referred to racial differences in birds from further east—Burma, Thailand, Malaya and the Sumatran Islands. This work is based on the examination of almost 900 skins.

But I have been unable to sort out this small collection into the five races now accepted with the certainty or confidence with which such work is ordinarily accepted, and part of the present grouping is based on the geographical distribution in INDIAN HANDBOOK (6, pp. 47-53). Perhaps the 90 specimens are too few to carry out this work, but where the specimens do not agree with the literature available, I have made some small changes in the accepted distribution and referred to them under the subspecies.

We have blackheaded males from 30th January (Orissa) to 16th October (Kumaon) and males in non-breeding plumage or without black heads from 16th October to 22nd June (Cachar) though no specimens obtained in May or early June are available.

It is curious that in both species the male wings are slightly (1%) larger than in the females, but the latter have their tails about 5% longer than in the males.

1097 **Aegithina tiphia septentrionalis** Koelz (Bhadwar, Kangra, Punjab) Northwestern Iora

4: 1 ♂ 3 ♀♀

1 Madhopur, 3 Chandigarh, Punjab.

These are slightly larger than any of the others, particularly the bills of the male and one female. The male obtained on 19th February has no trace of black above except in the tail, in which the outermost feathers are edged with white and the two central feathers tipped greenish; other males of *humei* (one marked juvenile) and *deignani* have similar green in the tail.

Measurements on p. 284.

1098 **Aegithina tiphia tiphia** (Linnaeus) (Benghala = neighbourhood of Calcutta) Common Iora **1:** 340

6: 4 ♂♂ (1 by pl.) 2 ♀♀ (1 o?)

2 Naini Tal, Kumaon; 1 Dibrugarh Assam; 1 Rupachena, Cachar; 1 Rewa Tea Estate, S. Sylhet; 1 *Sandoway, Arakan, Burma.*

One male from Naini Tal (16th Oct.) has a totally black head while another male obtained on the same day has a green back and head. Marien has illustrated *septentrionalis* and nominate *tiphia* as races in which the male does not acquire a black head, and this appears to be endorsed by Mrs. Hall. Sálim Ali & Ripley in INDIAN HANDBOOK are not very definite and as indicated earlier it is apparently possible to separate these races only on an average with several hundred specimens in hand (?).

Measurements on p. 284.

1099 **Aegithina tiphia humei** Baker (Raipur, M.P.) Central Indian Iora **1:** 342

15: 8 ♂♂ (1 juv.) 7 ♀♀

1 Narwar Fort, 1 Surwaya, Gwalior; 1 Mandu,

Dhar; 1 Chikalda, Amraoti, Berar; 1 Patan, Mehsana, 1 Nadiad, Kaira, 1 Cambay, 2 Gir, Amreli, 1 Dabaka, 1 Bodeli, Baroda, 1 Laochali, Surat Dangs, Gujarat; 2 Jubbulpore, 1 Dhaura, Bina, M.P.

The females are a little paler and yellower than in the other races. The immature male is slightly darker than the female. All are paler than those from further east in M.P., Orissa etc., and I can only see this form restricted to a relatively small area in Gujarat and adjacent places. There is no doubt that *nigrolutea* occurs in the same place, e.g. Deesa.

Measurements on p. 284.

1100 **Aegithina tiphia deignani** Hall (Yawdwin, Pakokku dist., Central Burma) Peninsular Indian Iora

35: 20 ♂♂ 15 ♀♀

1 Satara, 2 N. Kanara* 2 Palkonda Hills, 2 Seshachalam S. Cudappah, 1 Gingee, S. Arcot; 2 Nallamalai Range, S. Kurnool; 1* Jeypore Agency, 1 Sankrametta, Vizagapatam; 2 Gondia, 2 Bhanuprattapur, Kanker, 2 Geedam, 2 Konta, Bastar, M.P.; 1 Konai, Bonai, 2 Band, 1 Rampur, 3 Barkot, 1 Badrama (Bamra), Orissa; 2 *Shwebo,* 1 *Upper Burma;* 1 *Hsipaw, N. Shan States,* 2 *Tonye,* 1 *Kendin, Prome, Burma.* *missing.

*Other birds from N. Kanara have been listed under *multicolor,* but these two, possibly from the eastern side of the district agree more closely with this form. The females are a shade darker than *humei,* while some of the males have yellow bases to the black feathers and are paler than *multicolor* above. This is a very difficult race to separate.

Measurements on p. 284.

1101 **Aegithina tiphia multicolor** (Gmelin) (Ceylon) Ceylon Iora **1:** 342

29: 15 ♂♂ 13 ♀♀ 1 o?

1 Pali Hill, 1 Trombay, 1 Malad, 1 Kurla, 1 Hog I., Bombay; 1 Rajapur, Ratnagiri; 1 Canacona, Goa; 1 Anshi, 1 Castle Rock, 1 Kudra, 1 Karwar, N. Kanara; 1 Ulavi, Sorab, 1 Murgimatta, Sagar, 2 Kolar, E. Mysore; 2 Bangalore; 1 Shembaganur, Palnis; 1 Tirumalai, 1 Thekadi, Periyar, 1 Aramboli, 1 Rampara, Panthalem Hills, Kerala; 1 Elavakulam, 1 Colombo, Ceylon; 4 Kurumbapatti, Salem; 1 Kalavachu, Shriharikota.

I have moved this form as far north as Bombay on the west for the deep green on the back is similar to that in birds from the south, and the amount of black on the head and back of the breeding male is admittedly very variable and not a satisfactory character. The Colombo male (1st June) is the deepest yellow below. In this specimen the black on the head goes down the nape but does not extend on to the back, which is the deepest green among the specimens available; the second wing-bar is restricted to a small white spot, a character shared with others from peninsular India, where a double wing-bar may occur in birds from the same place. The bird from Anshi, N. Kanara has the most extensive black on the back, extending almost on to the rump. Whistler 1935 (*JBNHS* 38, p. 83) in Birds of Travancore and Cochin came to the conclusion that the darker and duller green of the upperparts of the female and of the male in "winter plumage" was the only satisfactory feature on which this race could be maintained. Fairbank (1876, *S.F.* 4, p. 258) in 'Birds of Khandala etc.', says that mature birds in the *zeylonica* (*multicolor*) plumage are more common at Khandala than at Ahmednagar (further into the open Deccan —H.A.).

The ♀ from Elavankulam, N.W.P., Ceylon has the underparts the brightest yellow in the whole series.

Measurements on p. 284.

EL **Aegithina tiphia horizoptera** Oberholser (Telok Bluku, Nais I., western Sumatra)

1 ♂ Singapore

Wing 63 mm Tail 44 mm W/T ratio 69.8

1102 **Aegithina nigrolutea** (Marshall) (Meerut) Marshall's Iora **1:** 344

18: 9 ♂♂ 7 ♀♀ 2 o?

In 1954, Koelz, *Contrib. Inst. Regional Exploration, No. 1*:9 separated birds from Sihor near Bhavnagar, in Kathiawar as *sulfurea*, "slightly paler, more sulfury above and less yellow below, edgings of large wing feathers more white with less yellow wash". This was not accepted by Mrs. Hall, (*Ibis* 1957, p. 146) and later in IND. HANDBOOK, but the birds from Kutch appear to be outstandingly different from the others both in their paler more yellow *contra* green colour above, and smaller size.

The single bird from Victoria Park, Bhavnagar, in Kathiawar has the small wing and bill of those from Kutch and it is possible that a re-examination of the measurements of the type and specimens available abroad will indicate that the birds from Kutch and Kathiawar are distinct and Koelz's *sulfurea* can be maintained for that area. I am for the moment listing both groups separately under the nominate form:

a) 7: 4 ♂♂ 3 ♀♀ (possibly *sulfurea*)

1 Bela. Ropar, 1 Godsar, 1 Mandvi, 1 Nakharatna, 2 Bhujia, Kutch; 1 Victoria Park, Bhavnagar, Kathiawar.

b) 11: 5 ♂♂ 4 ♀♀ 2 o?

1 Jagadhri, Punjab; 2 Bharatpur; 4 Delhi; 1 Bhind, Gwalior, 2* Deesa, Palanpur, Gujarat, 1 Sarasnoor, Saharanpur, U.P.

Sp. No. 2736*, an unsexed bird from Deesa, Palanpur with an all-green tail was obtained by Sálim Ali and the label is marked "Shot at same time as GS 876 (now bearing BNHS registration No. 2535 and listed above—H.A.) an undoubted *nigrolutea*. Is post-juvenal plumage indistinguishable from *A. tiphia*—S.A." In the Gujarat Survey Report (*JBNHS* 52, p. 743) he says it was collected on the same day and in the same locality removing the first impression that they were together. In any case, the distribution of *nigrolutea* and *tiphia* overlaps in some places, e.g. West Khandesh (Barnes) and Jhansi, Etawah, Saharanpur (Hume) and I am not inclined to agree with S.A.'s acceptance of this bird as a juvenal form of *nigrolutea*. In addition to the colour differences the wing-tail ratio of 77.7% is much greater than in others of this species and approaches that of *tiphia*. With these reservations I am leaving it with *nigrolutea*, but recording its measurements separately.

It may be worth noting that the Koelz collection is said to have a ♂ and a ♀ obtained as far south as Salem, Madras.

Measurements on p. 284.

1103 **Chloropsis aurifrons aurifrons** (Temminck) (Sumatra, India = Cachar) Northern Goldfronted Chloropsis **1:** 346

24: 16 ♂♂ 4 ♀♀ 4 o?

2 Badrama (Bamra), 1 Ranipathar, Phulbhani, 1 Tikerpara, Angul, Orissa, 1 Upper Barakhamba, Simlipal Hills, Orissa; 1 Lalkua, foot of Kumaon Hills, 1 Kumaon, Naini Tal, 1 Ranibag 2050′, 1 Pilibhit, Terai, U.P.; 1 Langharjan, 2* Rupchena, Assam; 1 Rewa Tea Estate, Cachar; 1 *Kanaing*, 2 *Upper Burma;* 1 *N. Shan States;* 1 *Mt. Victoria, Pokokku, Chin Hills;* 1 *S.E. of Maymyo;* 1 *Yin Chang*, 2 *Sadon Chang, Thayetmyo;* 1 *Panklaing, Henzada;* 1 *Ataran, Burma.*

Two males from Cachar have a bluish tinge in the green of the underparts.

Measurements on p. 285.

1104 **Chloropsis aurifrons frontalis** (Pelzeln) (Khelgate near Goa) **1:** 348

See remarks under 1105.

1105 **Chloropsis aurifrons insularis** Whistler & Kinnear (Cotta, N.P. Ceylon) Ceylon Goldfronted Chloropsis.

26: 14 ♂♂ 12♀♀

Whistler and Kinnear when working out the specimens from the Eastern Ghats noticed that they were larger than those from Ceylon and Travancore, and named the latter *insularis* (Type locality in Ceylon), arbitrarily fixing the northern boundary on the west as the Palghat Ghat. The birds in the Eastern Ghats and north of the Palghat Gap on the west were left as *C. aurifrons davidsoni* Stuart Baker (Type locality, Malabar) which name was later found to be occupied and changed to *frontalis* of Pelzeln (Type locality, Khelgate near Goa).

In the material available, the birds from Goa, Western India, southwards into Kerala show no differences of size which would warrant the acceptance of two separate races from this area. No specimens from Ceylon are available and unless these are found to be smaller (which is not suggested by the figures published by Whistler) or different in some other respect, *insularis* becomes a synonym of *frontalis,* leaving the larger birds from north of Goa and the Eastern Ghats without a name. I am listing the specimens in accordance with these remarks.

Small Goldfronted Chloropsis = *frontails*

14: 7 ♂♂ 7 ♀♀

1 Molem, Goa; 2 Castle Rock, 1 Karwar, 2 N. Kanara, 1 Jog, Shimoga, Mysore; 1 Wynaad; 2 Edanad, Chengamnur, 1 Tenmalai, 1 Santhanpara, Cardamon Hills, 1 Thekady, Periyar Lake, 1 Maraiyur 3500 ft, Kerala.

Large Goldfronted Chloropsis 12: 7♂♂ 5♀♀

(a) *from northern portion of Western India* 6: 4 ♂♂ 2 ♀♀

1 *Songadh, Navsari, 1 Waghai, Surat Dangs, Gujarat; 1 Tulsi-Vehar, 2 *Mulund, Salsette; 1 Khandalla, Pune dist. Maharashtra.

*Two males show a yellowish ring after the black throat, as in *aurifrons,* but paler. This character is not visible in any of the smaller birds from the south.

(b) *from Eastern Ghats* 6: 3 ♂♂ 3 ♀♀

2 Nallamalai, S. Kurnool; 1 Bhanuprattapur, Kanher, C.P.; 3 Anantgiri, Vizagapatnam dist.

The species has been recorded from Delhi and it remains to be determined if it is of this form or nominate *aurifrons.*

Measurements on p. 285.

1106 **Chloropsis hardwickii hardwickii** Jardine & Selby (Nepal) Orangebellied Chloropsis **1:** 349

46: 27 ♂♂ 16 ♀♀ 3 o?

1 Dehra Dun, 2 Gangolinath, Almora, 4 Ranibagh, Kumaon; 1 Kurseong, 1 Singtam, Sikkim; 4 Long View, Darjeeling, 1 Honka, west, 2 Deothang, 1 Narphang, East, 1 Tama, 2 Maie River, Bhutan; 2 Martam Rongni Valley, 1 Mais, 1 Kalaktang, A.P.; 2 Tezu, Lohit Valley; 1 Rotung, 1 Abor Country; 2 Margherita, Lakhimpur dist., 1 Kohima, 2 Naga Hills, 1 Baster, Cachar, 1 Laikey, Assam; 1 *Mogok,* 2 *Kamaing,* 1 *Upper Burma;* 1 *Tago HKA Chindwin River;* 2 *Katha;* 1 *Loikaw,* 1 *N. Shan States;* 1 *Sandoway, Arakan;* 1 Bombay market.

The immature males with the purplish blue on the wing edges replaced by green, are separately measured. In ♂ No. 1737 from the Naga Hills the chin and upper breast are not yet completely black, and it lacks the dark blue-black shoulder of the subadult male. ♀ No. 4577 from Tezu, Lohit Valley has a deep navy-blue line along the shoulder (edge of wing) lacking in all the other females. The blue chin stripe is also slightly darker than in the females and very similar to the male referred to above. ♂ sp. No. 1730 from Sandoway dist., Arakan, the southernmost specimen from Burma in subadult plumage with a very yellowish head is marked *C.h. malayana* by C. B. Ticehurst, but Deignan (BIRDS OF N. THAILAND, p. 327) states that this cannot be maintained as a valid form.

Measurements on p. 285.

1107 **Chloropsis cochinchinensis jerdoni** (Blyth) (Central India) Jerdon's Chloropsis **1:** 352

39: 23 ♂♂ (3 juv.) 15 ♀♀ 1 o?

1 Bodeli, Baroda, Gujarat; 1 Chanderi, Gwalior; 3 Raipur, Melghat; 1 Borivli, 1 Andheri, Bombay, 1 S. Konkan, 2 Canacona, Goa; 3 Karwar, N. Kanara; 1 Bhadrapur, Shimoga, Mysore; 1 Tope, Palnis; 1 Thattakad, N. Travancore; 1 Anurudipur, Ceylon; 1 Kurumbapatti, 1 Chitteri Range, Salem; 1 Koduru, S. Cudappah, 1 Nallamalai, Range; 4 Jabalpur, 2 Sonawani, Balaghat, 2 Bhanuprattapur, Kanker; 1 Bhopalapatnam, 1 Golpalli, 1 Kameli, 1 Konta, Bastar, M.P,; 1 Jeypore, Vizagapatnam;

1 Baramba State; 1 Bansura, 1 Barkot, 1 Badrama, Bamra, 1 Berbera, Puri, Orissa.

From the specimens available it would appear that the juvenile male (No. 1701 Karwar, N. Kanara, July 1898) first has a blue chin as in the female, which turns green before becoming black as in the adult male (No. 24096 of 8 Dec. 1972 from Canacona, Goa). This bird with the blue chin has a pale coloured bill and slight specks of black on the chin.

Measurements on p. 285.

1108 **Chloropsis cochinchinensis cochinchinensis** (Gmelin) (Cochin China) Bluewinged Chloropsis **1:** 350

7: 4 ♂♂ 2 ♀♀ 1 o?

1 Rupchena, 1 Cachar; 1 *Singhaling, Kanti, Chindwin,* 1 *Mondon Yoma Res., Thayetmyo;* 1 *Mai Village, Sandoway;* 1 *Kywizin, Henzada; Burma.*

The four males have little yellow on the breast but the term 'Goldmantled' used in INDIAN HANDBOOK hardly appears appropriate, and I have changed it as above.

Measurements on p. 285.

1109 **Irena puella puella** (Latham) (Travancore) Fairy Bluebird **3:** 1

20: 10 ♂♂ (1 imm.) 10 ♀♀ (4 imm.)

2 Molem, Goa, 1 Katyal, 2 Anshi, 1 Karwar, 1 Potoli, 3 N. Kanara; 1 Talewadi, Belgam; 1 Bhadrapur, Shimoga; 2 Coonor Ghat, Nilgiris; 1 Tope, Palni Foothills, 1 Manalur, Palnis; 1 Maraiyur, 1 Tenmalai, 1 Merchiston, Ponmudi, Travancore, 1 Chitteri Range, Salem dist.

Measurements on p. 286.

1110 **Irena puella sikkimensis** Whistler & Kinnear (Sukna, Darjeeling) Northern Fairy Bluebird

20: 14 ♂♂ (5 imm.) 6 ♀♀ (1 imm.)

1 Sevoke, Long View, 5 Darjeeling: 2 Gaylegphug, C. Bhutan; 1 Tezu, Lohit Valley, 1 Changchang Pani, 1 Mayhenta, Upper Assam; 1 Gunjang, North Cachar, 1 Chutti Bhil, Cachar; 1 *Arakan Yomas, Bassein;* 1 *Ngapoli,* 1 *Sandoway dist.;* 2 *Nyauggyo, Prome dist;* 1 *Attaran,* 1 *Hank-Yadoma Chq., Burma.*

See note on validity of this form, p. 381 infra.

Measurements on p. 286.

1110a **Irena puella andamanica** Abdulali (Long I., Middle Andamans) Andaman Fairy Bluebird

10: 5 ♂♂ (2 imm.) 5 ♀♀ (1 imm.)

2 Bakultala, 1 *Long Island, Middle Andamans; 3 Wrightmyo, 2 Chouldhari, 1 Landfall I., 1 Chivia Tapoo, South Andamans. *Type.

See note on validity of this form, p. 381 infra.

The map in IND. HANDBOOK shows the species as occurring in the Andamans and Nicobar Islands. There is no authentic record of its occurrence in the Nicobars.

Measurements on p. 286.

EL **Irena puella malayensis** Moore (Malacca)

2: 1 ♂ 1♀

The long undertail-coverts are distinctive.

Measurements on p. 286.

1064-1065 **Hemipus picatus** subspp.

	Wing	Bill	Tail
♂♂			
1064 *capitalis* (9)	62-66 av. 63.3	12.7-14.7 av. 13.6	57-61 av. 59.5
	(IH ♂♀ 62-67	from skull 16-18	58-65)
1065 *picatus* (20)	59-65 av. 62	12.4-14.2 av. 13.5	52-59 av. 55.6
	(IH 60-66	from skull 14-16	57-62)
♀♀			
1064 *capitalis* (4)	62,63,65,67	13.2, 13.3 (2)	55,60 (2), 64
1065 *picatus* (12)	61-64 av. 62	12.5-14.1 av. 13.2	50-62 av. 55
	(IH 58-64	from skull 15-17	56-65)

1067/8 **Tephrodornis gularis** subspp.

	Wing	Bill	Tail
♂♂			
1067 *pelvica* (5) northern	121-125 av. 122.8	21.4-25 av. 22.5	80-90 av. 85.8
(9) southern	118-123 av. 120	22.5-25 av. 23.7	81-87 av. 85
(4) Bhutan	115-117	21-22.2	80-86
	(IH 115-124	from skull 23-29	82-91)
1068 *sylvicola* (7) black bills	111-120 av. 117	20-25.2 av. 23.5	75-83 av. 80.5
(4) grey bills	111-117 av. 114	22.5-23.7 av. 22.9	80-85 av. 82
	(IH 112-120	from skull 25-30	79-84)
jugans (2)	118, 120	23.2, 23.4	83. 84
♀♀			
1067 *pelvica* (6, 2 imm.)	116-123 av. 120	21.5-25.5 av. 23.5	83-91 av. 84.5
Bhutan (3)	115-117	20, 22, 22.5	85, 86, 90
		from skull 25-29	84-92)
	(IH 115-124	21-24.7 av. 22.1	78-85 av. 82
1068 *sylvicola* (8)	113-119 av. 116	from skull 23-27	80-88)
	(IH 111-121		
jugans (1)	116	24	81

1069/70 **Tephrodornis pondicerianus** subspp.

	Wing	Bill	Tail
♂♂			
1069 *pallidus* (13)	84-94 av. 89.2	16.5 (2), 18-20 av. 18-7	58. 61-69 av. 64.5
	(IH 82-94	from skull 19-23	59-73)
1070 *pondicerianus* (24)	82-95 av. 88.3	17-20.5 av. 19.5	58-70 av. 63.2
	(IH as in *pallidus* for both sexes)		
Burmese (3)	87-92 av. 87.6	17.8-18.6	59-70
♀♀			
1069 *pallidus* (8)	86-89 av. 88	17-19.3 av. 18.2	63-69 av. 65.5
	(IH 80-89	from skull 18-23	56-71)
1070 *pondicerianus* (22)	83-92 av. 86.6	16.8-20.6 av. 18.3	60-66 av. 62.6
Burmese (1)	79	17.4	61

1072/76 **Coracina novaehollandiae** subspp.

	Wing	Bill	Tail
♂♂			
1072 *macei* (9) adults	159-170 av. 164	23.4-27.5 av. 25.4	112-124 av. 116.9
(7) juveniles	151-170 av. 162	23-26 av. 24.9	117-127 av. 121.4
	(IH 153-173	from skull 27-31	111-134)
1073 *nipalensis* (1)	181	27.5	120
	(IH 175-193	from skull 30-34	126-148)
1075 *andamana* (3)	175, 176, 181	28.2, 28.7 (2)	126, 132(2)
	(IH 173-176	—	—)
1075a *lushaiensis* (5)	172-183 av. 177	26-29.1 av. 27.2	114-138 av. 124
— *siamensis* (2)	169, 182	26.5 (2)	122, 137
♀♀			
1072 *macei* (10)	158-166 av. 161.3	23-26.6 av. 24.5	112-132 av. 120
	(IH 156-167	from skull 26-30	108-135)
1073 *nipalensis* (3)	168, 169, 178	25.3, 25.5, 26.2	120, 121, 132
	(IH 173-188	from skull 30-32	126-143)
1075 *andamana* (3)	165, 170, 173	24, 26.6, 27	120, 128, 132
	(IH 167-174	—	—)
1075a *lushaiensis* 1 o?	174	27.5	120
— *siamensis*	180	28.6	135

1076 **Coracina striata dobsoni**

1 ♂	168 (153-170)	29.7	131
1 ♀	158 (151-172)	26.2	129

1077 *et al.* **Coracina melaschistos melaschistos** and **C. m. avensis**

	Wing	Bill	Tail
1077 ♂♂ (19)	113-128 av. 120	16.5-19 av. 17.8	93-117 av. 104.5
	(IH 118-128	from skull 19-23	111-123, once 95, once 96)
♀♀ (12)	115-124 av. 120	16.6-19.3 av. 17.9	94-117 av. 105.8
	(IH 114-124	from skull 19-22	109-120)
EL *avensis* ♀ (1)	111	17.7	101

1079 *et al.* **Coracina melanoptera** subspp.

♂♂			
1079 *sykesi* (?) (4)	109-111	17.3-18 av. 17.6	72-90 av. 82
	(IH ex Koelz 107-112	—	85-92)
1079 *sykesi* (8 adult)	100-107 av. 104.6	17-18.6 av. 17.5	71-85 av. 76.2
1079 *sykesi* (16 juv.)	97-107 av. 101	16-17.3 av. 16.8	73-82 av. 76.6
	(IH 98-110	from skull 18-20	72-84, once 94)

1079 *et al.* **Coracina melanoptera** subspp. (contd.)

	Wing	Bill	Tail
♀♀			
1079 *sykesi* (9 adult)	100-104 av. 101.5	14.6-17 av. 16.5	74-82 av. 77
sykesi (4 juv.)	98-103 av. 100	15.5-17 av. 16.6	70-77 av. 73.5
	(IH 98-104	from skull 17-20	71-80)

1079a **Coracina nigra davisoni**

	Wing	Bill	Tail
♂♂ (2)	91 (2)	16, 16.4	65, 72
	(IH 88-92	from skull 18-19	65-72)
♀♀ (2)	86, 89	16.4 (2)	68, 69
	(IH 88, 89	from skull 18, 19	69, 73)

1080/83 **Pericrocotus flammeus** subspp.

	Wing	Bill	Tail
♂♂			
1080 *speciosus* (12)	97-107 av. 103	14.5-17.9 av. 16.6	85-100 av. 94.3
	(IH 95-110	from skull 19-21	96-113)
1080a *andamanensis* (5)	90-97 av. 94.8	15.4-16.2 av. 15.7	86-91 av. 89
	(IH 92-96	from skull 19-20	87-98)
1081 *flammeus* (20)	88-99 av. 92.5	14.6-16 av. 15.2	81-95 av. 88
	(IH 87-97	from skull 17-20	82-101)
,, (3 juv.)	85, 92, 94	15.4, 15.5, 15.7	86, 93, 95
1082 *fraterculus* (7)	95-102 av. 98.9	16-17 av. 16.3	91-102 av. 97.5
	(IH ♂♀ 90-97	13-14	78-81)
,, (1 juv.)	95.0	—	88.0
flammifer (8)	93-102 av. 97.9	14.5-16.5 av. 15.7	87-95 av. 90.8
,, (1 juv.)	98.0	15.9	98
Siam (3)	98	16-17.7 av. 16.7	92-98 av. 95
1083 *semiruber* (9)	102-111 av. 104.2	14.6-16.5 av. 15.9	88-102 av. 95.7
	(IH 100-106	from skull 20-21	94-102)
,, (2 juv.)	99-101	16.4-16.9	95-100
♀♀			
1080 *speciosus* (7)	99-104 av. 101.5	15.5-16.9 av. 16.4	95-103 av. 99.7
	(IH 96-108	from skull 19-22	94-110)
,, (1 juv.)	97	16.5	95
1080a *andamanensis* (2)	92, 93	15, 15.5	90, 98
(1 juv.)			
1081 *flammeus* (20)	86-94 av. 90.4	13.8-16.9 av. 15.3	81-95 av. 87
	(IH 87-96	from skull 16-19	86-96)
1082 *fraterculus* (3)	93-99 av. 96.7	14.5-16.6 av. 15.5	90-95 av. 93.3
	(IH ♂♀ 90-97	13-14	78-81
EL *flammifer* (8)	87-98 av. 94.3	14.2-16.5 av. 15.1	80-90 av. 86
Siam (2)	91, 96	15.5 (2)	86, 91

1080/83 **Pericrocotus flammeus** subspp. (contd.)

		Wing	Bill	Tail
	♀♀			
1083	*semiruber* (5)	101-102 av. 101.5	15.5-16.7 av. 16.1	94-96 av. 95.0
		(IH 96-102	from skull 19-20	92-101)

1084 **Pericrocotus brevirostris brevirostris**

♂♂ (8)	85-89 av. 87.3	11.8-13.4 av. 12.8	84-97 av. 90.8
	(IH 85-91	from skull 15.0	88-103)
♀♀ (3)	87, 88, 89	12.0, 12.7, 13.0	94, 95, 96
	(IH 85-90	from skull 15.0	90-100)

1085/87 **Pericrocotus ethologus** subspp.

		Wing	Bill	Tail
	♂♂			
1085	*favillaceus* (31)	90-96 av. 93.4	11.5-13.7 av. 12.8	98-110 av. 103
		(IH 89-96	from skull 14	104-114)
	Yellow juveniles (7)	87-92 av. 90	12.2-14.6 av. 13.3	95-108 av. 101
1086	*laetus* (9)	89-95 av. 91.6	12.0-13.2 av. 12.7	92-107 av. 100.5
		(IH 89-95	from skull 15-16	101-107)
	Yellow juveniles (1)	92	12.2	99
EL	nominate *ethologus*	91	13.6	103
	♀♀			
1085	*favillaceus* (29)	86-97 av. 91.8	11.8-13.9 av. 12.91	96-112 av. 103.8
		(IH 86-94	from skull 14-15	101-114)
1086	*laetus* (5)	87-93 av. 89.6	127-134 av. 13.2	93-103 av. 97.4
		(IH 86-92	from skull 15-16	98-108)
EL	*yvettae*	91	12.6	97

1088 **Pericrocotus solaris solaris**

♂♂ (5)	82-88 av. 85.2	11.8-13 av. 12.5	93-99 av. 95.4
♀♀ (5)	80-86 av. 83.8	12-12.7 av. 12.5	91-99 av. 94.8
	(IH ♂♀ 78-90	from skull 14-16	83-102)

1089 **Pericrocotus roseus roseus**

♂♂ (23)	82-92 av. 87.7	13-15 av. 14	80-91 av. 85.2
	(IH 87-94	from skull 15-17	87-94)
♀♀ (7)	82-93 av. 86.3	13.4-14.2 av. 13.7	72, 80-89 av. 82.5
	(IH 90-94	from skull 15-17	89-91)

1089a Pericrocotus divaricatus divaricatus

	Wing	Bill	Tail
♂ (1)	95	15.3	93
	(♂♀ 95-101	c. 16	86-94)

1090/5 Pericrocotus cinnamomeus subspp.

♂♂	Wing	Bill	Tail	W/T ratio
1090 *pallidus* (1)	**68**	10.3	75	.906
	(IH 64-70	from skull 11-12	64-76)	
1091 *peregrinus* (a) (16)	68-74 av. 69-7	10.1-11.8 av. 10.7	69-75 av. 74.1	.940
(b) Gujarat (5) MP (6)	66-73 av. 68.9	10.2-12 av. 11	65-75 av. 70.6	.975
(c) Bombay area (9)	66-71 av. 68	10.8-12 av. 11.5	68-70 av. 69.2	.982
(d) South eastern India (5)	65-69 av. 67.2	10.8-11.5 av. 11.2	65, 69(2)	.994
	(IH 63-72	from skull 12-14	65-77)	
1093 Ceylon (5)	70-73 av. 71.2	11.6-13.2 av. 12.1	69-73 av. 70.2	1.01
1094 *malabaricus* (3)	71, 72, 75	11.5 (3)	67. 73	1.038
	(IH 69-75	from skull 12-14	66-74)	
1095 (a) *Andamans* (4)	70-72 av. 71.5	11.5-13 av. 12.2	71-73 av. 71.7	.997
(b) *vividus* (6)	65-72 av. 69.5	10.4-11.7 av. 11	69-73 av. 72	.965
	(IH 66-72	from skull 12-14	66-76)	
Maymyo, Burma (1)	75	11.4	83	.903
♀♀				
1091 *peregrinus* (a) (5)	68-69 av. 68.4	10.3-11.4 av. 10.8	71-76 av .72.8	.94
(b) Gujarat and MP (5)	63-70 av. 66.5	10-11 av. 10.3	66-76 av. 70.4	.944
(c) Bombay (1)	68	10.9	—	—
(d) S.E. India (3)	65, 66 (2)	10, 11.2, 11.6	65, 67, 71	.970
	(IH 64-72 .	from skull 12-13	67-78)	
1093 Ceylon (4)	68-70 av. 69	11-12.1 av. 11.3	67-70 av. 68.5	1.07
1094 *malabaricus*	68, 71	11, 11.5	68, 69	1.014
	(IH 68-76	from skull 13-14	67-7)	
1095 (a) Andamans (4)	70-74 av. 71.2	11.5-11.9 av. 11.7	71-74 av. 71.7	.993
(b) *vividus*	71	11.4	75	0.946
	(IH 65-75	from skull 13-14	68-75)	
Maymyo, Burma (1)	74	10.7	79	.936

1096 Pericrocotus erythropygius erythropygius

	Wing	Bill	Tail
♂♂ (9 adults)	68-73 av. 69.3	10-12.4 av. 10.8	74-85 av. 78
♀♀ (8)	67-72 av. 68. 9	10-10.8 av. 10.4	72-78 av. 75
	(IH ♂♀ 68-70	from skull 12-13	75-78 once 87)

1097 *et al.* **Aegithina tiphia** subspp.

	Wing	Bill	Tail	W/T ratio
♂♂				
1097 *A.t. septentrionalis* (1)	70	17	51	72.8
	(IH 63-65	—	—)	
1098 *A.t. tiphia* (4)	65-68 av. 66	13.8, 15.5	45-50 av. 47	67.5-76.9 av. 71.5
	(IH 62-66	from skull 18-19	49-52)	
1099 *A.t. humei* (8)	64-67 av. 65.2	15-16 av. 15.5	45-53* av. 47.6	69.2-81.5* av. 74
	(IH 61-69	from skull 16-20	44-55)	
1100 *A.t. deignani* (18)	63-68 av. 65.9	14.6-16.2 av. 15.6	42-50 av. **46.6**	63.6-74.6 av. 70.1
	(IH measurements as in *humei*)			
1101 *A.t. multicolor* (15)	62-68 av. 65.2	14.5-17 av. 16	44-52 av. 46.5	67-80 av. 70.5
	(IH measurements as in *humei*)			

* marked juvenile ♂ and with greenish tail.

	Wing	Bill	Tail	W/T ratio
♀♀				
1097 *A.t. septentrionalis* (3)	68, 69 (2)	16(2), 17.5	50, 51, 52	72.4, 73.9, 76.4
	(IH 63-65	—	—)	
1098 *A.t. tiphia* (2)	60, 63	14.9, 15	51, 52	82.5, 85
	(IH 60-65	from skull 18-19	50-59)	
1099 *A.t. humei* (7)	63-68 av. 64.8	14.2-15.7 av. 15	47-53 av. 49.7	73.4-82.5 av. 76.6
	(IH 62-67	from skull 16-19	46-56)	
1100 *A.t. deignani* (15)	61-68 av. 64.2	14.4-16.4 av. 15.5	47-53 av. 50.2	71.2-84 av. 79.5
	(IH measurements as in *humei*)			
1101 *A.t. multicolor* (13)	63-68 av. 65.1	14-16.3 av. 15	45-53 av. 48.5	66.1-84 av. 74.2
	(IH measurements as in *humei*)			

1102 **Aegithina nigrolutea**

		Wing	Bill	Tail
♂♂				
(a)	(4)	62-64 av. 63	13.2-14.2 av. 13.8	44-46 av. 45
(b)	(5)	65.5-69.5 av. 66.8	14.8-16.3 av. 15.5	46-50 av. 47
		(IH 62-65	from skull 14-18	43-47)
♀♀				
(a)	(2)	61, 62	13, 13.2	44, 46
(b)	(6)	62-67 av. 64.5	13.3-16 av. 14.8	46-49 av. 47.5
		(IH 61-64	from skull 14-17	45-51)

1103/5 **Chloropsis aurifrons** subspp.

	Wing	Bill	Tail
♂♂			
1103 *aurifrons* (14)	88-100 av. 93.5	16.5, 18.3- 21.7 av. 20	56-72 av. 63.4
	(IH 90-103	from skull 24-26	65-77)
1104 *frontalis* (*sic*) (7)	91-100 av. 96	19.5-22.5 av. 21	67-72 av. 70
	(IH 87-101	from skull 23-26	69-77)
1105 *frontalis/insularis* (7)	91-95 av. 90.1	19.3-21.3 av. 20.1	63-69 av. 64.8
	(IH 86-94	from skull 22-25	65-70)
♀♀			
1103 *aurifrons* (4)	89-91 av. 89.7	20-20.2 av. 20.1	61-64 av. 62
	(IH 89-94	from skull 24-25	66-70)
1104 *frontalis* (*sic*) (5)	91-95 av. 93.6	20-21.5 av. 20.7	66-70 av. 68
	(IH 83-95	23-25	64-71)
1105 *frontails/insularis*	84-93 av. 90.1	19.5-21.5 av. 20.3	61-68 av. 63.7
	(IH 87-88	from skull 22-24	59-64)

1106 **Chloropsis hardwickii hardwickii**

	Wing	Bill	Tail
Ault ♂♂ (16)	91-100 av. 96	18.5-22.5 av. 20.8	64-74 av. 69.6
	(IH 93-100	from skull 21-26	73-79)
Imm. ♂♂ (11)	89-97 av. 92.7	19-21.3 av. 20.4	63-73 av. 68.7
♀♀ (15)	85-95 av. 89.5	19-20.9 av. 19.8	58-71 av. 65.5
	(IH 88-94	from skull 22-25	65-72)

1107/8 **Chloropsis cochinchinensis jerdoni** and **C.c. cochinchinensis**

	Wing	Bill	Tail
♂♂ *jerdoni* (22)	87-97 av. 91.5	18.8-21 av. 20.1	68-78 av. 72.2
	(IH 86-96	from skull 21-26	66-81)
♂♂ *cochinchinensis* (4)	82-88 av. 85	16.6, 19, 19.4	61-69 av. 65.5
	(IH 84-90	from skull 21-22	65-72)
♀♀ *jerdoni* (15)	84-90 av. 86.4	19.2-21 av. 19.9	63-74 av. 68
	(IH 82-88	from skull 21-25	62-72)
♀♀ *cochinchinensis* (2)	79, 82	18. 18.5	62 (2)
	(IH 76-84	from skull 20-22	61-68)

1109/10a **Irena puella** subspp.

	WING	BILL	WIDTH AT NOSTRIL	TAIL	AV. T/W
♂♂ adults					
puella (9)	124-132 av. 129	22-24 av. 23.1	7.9-9.3 (8.5)	95-106 av. 100.3	(77.7)
sikkimensis (9)	126-136 av. 132.8	22-24 av. 24.4	8-9.5 (8.7)	90-101 av. 97.6	(76)
andamanica (3)	129, 133, 133 av. 131.6	24.5, 25.5, 26 av. 25.3	8.8-10	104, 105, 107 av. 105.3	(80)
♂♂ *juv.*					
puella (1)	124	23.3	8.2	97	(78)
sikkimensis (5)	128-134 av. 131.4	21.3-23.7 av. 22.5	8.1-9 (8.3)	91-98 av. 96.2	(73.2)
andaminca (2)	125, 126	24.2, 25	8.6, 9.3	100, 107	(80, 84.9)
♀♀ adults					
puella (6)	124-128 av. 126.3	22.3-24.2 av. 23.2	8.3-9.6 (8.8)	93-102 av. 97.5	(77.3)
sikkimensis (5)	125-136 av. 130. 8	23, 23.7, 24.3 av. 23.6	8.5-9.2 (8.8)	92-103 av. 97.2	(74.3)
andamanica (4)	122, 126, 126, 127	24.2 (2), 24.3, 27.4	8.6, 9.7	98, 101, 102, 105	(80.9, 83.3)
♀♀ juv.					
puella (4)	121-130 av. 125.5	23-24.2 av. 23.4	8.2-9.2 (8.8)	95-102 av. 97.5	(77.7)
sikkimensis (1)	128	23.2	8	93	(74)
andamanica (1)	129	25.5	9.7	99	(76.7)

EL **Irena puella malayensis** Moore (Malacca)

♂	121	22.7	80
♀	120	22.8	83

(to be continued)

OVIPOSITION BEHAVIOUR OF *CERATOSOLEN FUSCICEPS* MAYR (AGAONIDAE: HYMENOPTERA) AND THE MECHANISM OF POLLINATION IN *FICUS RACEMOSA* L.[1]

MATHEW JOSEPH AND V. C. ABDURAHIMAN[2]

(*With four text-figures*)

Ceratosolen fusciceps Mayr breeds in the gall ovaries of *Ficus racemosa* L. The *Ficus* species depends exclusively on the females of these insects for pollination. The female wasp enters the young syconium through its ostiole which is blocked with thickly packed bracts. The morphological adaptations of the female for this penetration and the different stages of oviposition are briefly discussed.

Prior to eclosion from the ripe figs, the female wasps actively load pollen grains into their paired mesothoracic pollen pockets. Inside the tender figs, they deliberately unload the pollen grains before the termination of each oviposition. The whole process of oviposition and pollen transfer in respect of one ovary takes about 50-70 seconds.

INTRODUCTION

Information on the oviposition and pollination behaviour of agaonids are scanty. Certain aspects of the oviposition behaviour of *Blastophaga psenes* that breeds in *Ficus carica* were observed by Grandi (1920 & 1929) and Joseph (1958), and of *Ceratosolen marchali* in *Ficus hispida* by Abdurahiman & Joseph (1976). The pollination behaviour of *Ceratosolen arabicus* and *Blastophaga quadraticeps*, the pollinators of *F. sycomorus* and *F. religiosa* respectively, were studied by Galil & Eisikowitch (1968a & b, 1969 & 1974) and Galil & Snitzer-Pasternak (1970). Galil *et al.* (1973) made a closer look on pollination in *F. costaricana* and *F. hemsleyana* by *Blastophaga estherae* and *B. tonduzi* respectively. Chopra & Kaur (1969) made a brief study on the pollination and fertilization in some *Ficus* species like *F. carica, F. racemosa, F. tsiela* and *F. virens*. Ramirez (1969) studied the mechanism of pollen transfer by some species of wasp genera including *Agaon, Allotriozoon, Blastophaga, Ceratosolen, Elisabethiella, Liporrhopalum* and *Pleistodontes*. Galil (1973), and Galil & Neeman (1977) studied in detail the pollen transfer and the mechanism of pollination in *F. fistulosa* by *C. hewitti*, and in *F. carica* by *B. psenes*. The present studies comprise a detailed analysis of the behaviour of oviposition and the mechanism and adaptations involved in pollination in the case of *Ceratosolen fusciceps* that breeds in the receptacles of *F. racemosa*.

MATERIALS AND METHODS

Ficus racemosa trees have a fair distribution in the Calicut University campus, where the present studies were undertaken. Ripe and tender figs of appropriate stages were collected from the trees. The females of *C. fusciceps* that eclose from ripe figs penetrate into the receptive tender figs provided. Such figs containing the females in the act of oviposition

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and pollination were observed under the Stereomicroscope with bright illumination. The pollen loading behaviour were studied in the ripe fig halves wrapped in transparent cellophane and observed under the microscope in the early morning. Anaesthetized adult females stained with alcoholic acid fuchsin (0.5% acid fuchsin in 70% alcohol) were utilized for the study of the "pollen pockets".

Observations and Results

The structure of the fig:

F. racemosa is monoecious with the male, female and 'gall flowers' occurring in the same syconium (Fig. 1). The male flowers are few in number and are arranged in 2-3 rows encircling the ostiole. The gall and female flowers are intermingled. The female 'seed flowers' have ovaries with long styles, while the 'gall flowers' have short styles and they are modified for the development of insects. The inflorescence is highly protogynous, the female flowers maturing first and the male flowers maturing only after 2-3 weeks. The stigmata of neighbouring gall and female flowers interconnect forming a 'syn-stigma'. Thus the syconial cavity is lined continuously, which prevents the slipping down of the pollinators between the styles and ovaries.

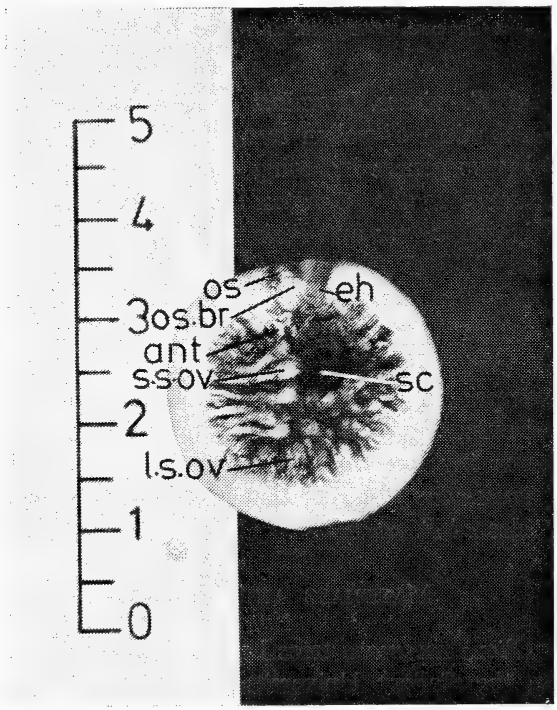

Fig. 1. Median longitudinal section of a ripe fig of *Ficus racemosa* L.

Abbreviations:
ant, anthers; eh, exit hole; l.s.ov, long-styled ovary; os, ostiole; os.br, ostiolar bracts; sc. syconial cavity; s.s.ov, short-styled ovary.

Oviposition

The eclosion of *Ceratosolen* females from mature figs occurs largely during the morning hours between 6 a.m. and 11 a.m. In the field, they fly in search of tender receptive figs for oviposition. Such figs of the female phase may be present either on the same tree or on other nearby trees. The *Ceratosolen* females wander over the surface of the tender figs till they locate the ostiolar opening by their antennae. Since the ostiole of the young syconium is thickly packed with overlapping bracts, the insect struggles hard to enter the syconium. It raises its abdomen and the head is pushed into the ostiole. The morphological adaptations of the insect such as the dorso-ventrally flattened head with serrated mandibular appendages and strongly built fore and hind legs, make its entry easy. The wings and flagella of the antennae are often lost during this strenuous effort of penetration. The time taken for the penetration varies depending on the age of the young figs, though, it is usually about 8-10 minutes.

After entry, the mutilated female moves on the surface of the stigmata for a few minutes and then prepares for oviposition. The ovipositor which is kept horizontally ensheathed in the ovipositor sheaths is taken out by bending the abdomen and using her hind pair of legs. The hypopygium forming a triangular flap that encloses the ovipositor basally, is lowered and held vertical to the long axis of the abdomen. This organ supports and guides the ovipositor shaft during oviposition. The ovipositor sheaths and remains extended upwards from the tip of the abdomen. The site of penetration, namely, the stigmal opening is detected by the tip of the ovipositor which is provided with sensillae. The wasp rises on its legs and the tip of the ovipositor is moved back and forth on the stigmal surface. On locating the stigmal opening, the abdomen is raised and the ovipositor is introduced into the style of the gall ovary (Fig. 2). It is lowered slowly and the further bending of the abdomen brings about complete penetration of the ovipositor down the style and the egg is deposited in the ovule. The abdomen vibrates during oviposition and the wasp is found actively engaged in biting the stigmata with its mandibles. After the deposition of the egg, she withdraws her ovipositor. The ovipositor is not ensheathed and the wasp continues her egg laying in other 'gall ovaries'. The whole process of oviposition in a given ovary of *Ficus* takes about 50-70 seconds. After the oviposition, the female dies within the syconium.

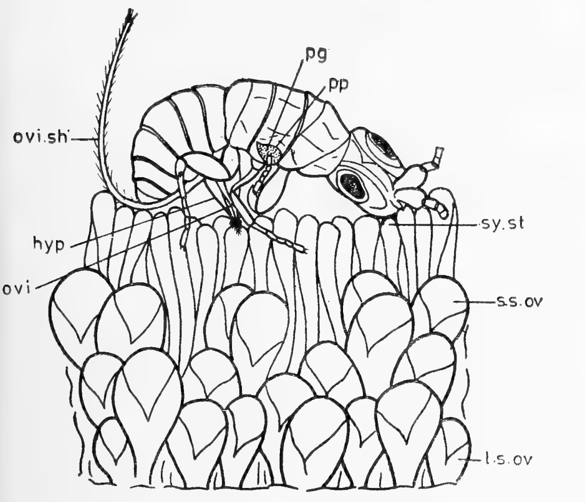

Fig. 2. Ovipositing female of *Ceratosolen fusciceps* Mayr at the pollination act.
hyp, hypopygium; l.s.ov, long-styled ovary; ovi, ovipositor; ovi.sh, ovipositor sheath; pg, pollen grains; pp, pollen pockets; s.s.ov, short-styled ovary; sy.st, synstigma.

Pollination

Prior to their eclosion from mature figs, the females of *C. fusciceps* actively load pollen grains in their specialised organs called 'pollen pockets'. These paired thoracic pockets are seen as triangular depressions on the ventrolateral sides of the mesothorax with their narrow ends directed backward (Fig. 3). Each

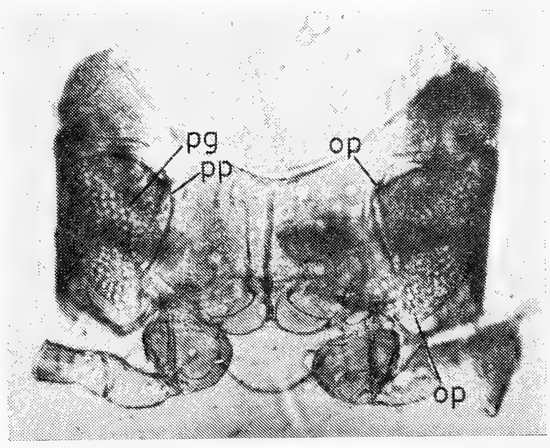

Fig. 3. Thoracic 'pollen pockets' with pollen grains. op, openings; pg, pollen grains; pp, pollen pockets.

pollen pocket ($173 \times 155\ \mu$) bears two openings, one at the narrow inner end and the other at the anterior inner border.

The thoracic pockets are loaded with pollen grains in the early morning between 3 a.m.

and 6 a.m. After emergence from the galls, the female approaches the anthers previously cut down by males and pushes her head into its median slit. Keeping the anther sacs open by their antennal scapes, she crumbles the pollen grains within the anther and then performs the pollen lifting movements. The pollen grains are lifted from the anthers to the underside of the mesothorax by repeated swift alternating movements of the fore legs, dipping the arolia in the anther and raising them backward to the thorax. Then the wasp curves the thorax, and the pollen grains are brushed into the pockets by the sweeping movements of the fore coxae and their combs which are formed of a row of 16 stiff bristles on the inner margins of the coxae (Fig. 4). This

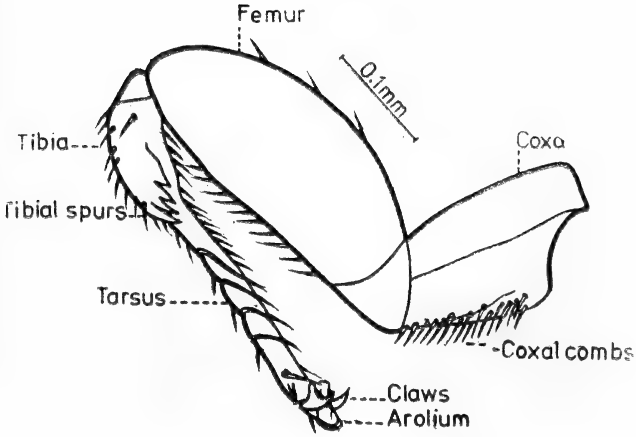

Fig. 4. Fore leg of *Ceratosolen fusciceps* Mayr showing 'coxal combs'.

shovelling movements are repeated several times after each sequence of pollen lifting movements. Such females escape out of the syconium through the exit holes gnawed by the males near the ostiole.

The unloading of pollen grains and the subsequent pollination of the *Ficus* inflorescence occur at the end of each oviposition in the young syconium. Before the termination of the oviposition, the female folds up her fore legs and scratches the pockets 3-5 times with her arolia and claws (Fig. 2). This simultaneous and alternating to and fro movements of the two fore legs shovel some of the pollen grains to the stigmata. Then she strikes the tarsi of the fore legs against each other and the arolia and claws are rubbed on the stigmal surface effecting the transference of pollen grains directly to the stigmata. These repeated pollination movements of the fore legs take about 3-5 seconds.

Discussion

Ceratosolen fusciceps deposit their eggs in between the nucellus and inner integument of the gall ovaries of *F. racemosa,* as shown in *B. psenes* of *F. carica* by Joseph (1958) and in *C. marchali* of *F. hispida* by Abdurahiman & Joseph (1976). The oviposition behaviour of all the agaonids studied are very similar. The hypopygium supports and guides the ovipositor during the process of egg laying. Unlike in the other agaonids the females of *B. quadraticeps* of *F. religiosa* remain stationary and exhibit no stigmal biting during oviposition (Galil & Snitzer-Pasternak 1970). *B. estherae* of *F. costaricana* (Galil *et al.* 1973) takes 3-4 minutes for the completion of oviposition, unlike *C. fusciceps* and *C. arabicus* which need only 50-70 seconds.

The pollination behaviour of *C. fusciceps* is akin to that of *C. hewitti* in the dioecious fig *F. fistulosa* (Galil 1973) and *C. arabicus* in *F. sycomorus* (Galil & Eisikowitch 1968, 1969 & 1974). The 'coxal corbiculae' as described by Ramirez (1969) is absent in *C. fusciceps.* The closed thoracic pockets with coxal combs are common features present in these pollinators. The pollination movements of *B. estherae* and *B. tonduzi* in *F. costaricana* and *F. hemsleyana* respectively (Galil *et al.* 1973) are much more complicated by the presence of 'coxal corbiculae'. They use these corbiculae as shovels in addition to its role in the storage of pollen grains.

The pollination movements of *C. fusciceps* are deliberate, as in other pollinators, such as *B. quadraticeps, C. arabicus* and *C. hewitti*. The loading and unloading of pollen grains in the wasps are purposeful movements. Such a deliberate pollination movement is explained as 'Ethodynamic pollination' by Galil (1973b), in contrast to 'Topocentric pollination' in *F. carica. B. psenes*, the pollen vector of *F. carica*, lacks pollen pockets and they carry pollen grains in the 'inter-segmental concavities' of the body. The passive loading of pollen grains into these concavities occur when the body shrinks as a result of water loss following eclosion. In the young syconium, the body of the wasp swells due to the higher humidity and thus pollen grains indirectly come in contact with the stigmas effecting pollination (Galil & Neeman 1977).

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VASCULAR PLANTS OF VEDANTHANGAL WATER BIRDS SANCTUARY AND SURROUNDING REGIONS IN CHINGLEPUT DISTRICT, TAMIL NADU[1]

A. N. Henry and M. S. Swaminathan[2]

208 taxa of vascular plants recorded in the Vedanthangal Water Birds Sanctuary and surrounding regions including Karikili Water Fowl Refuge are enumerated in this paper.

The urgent need to preserve the existing flora and fauna has led to the creation of many Wild life Sanctuaries and National Parks in India. The Vedanthangal Water Birds Sanctuary is perhaps the oldest Bird Sanctuary in South India preserved since 1790, but officially recognised from 1936. The Botanical Survey of India took up the Survey of this sanctuary in 1974-1976, on priority basis, to assess its floristic wealth. Also the data collected by floristic studies will greatly help in understanding plant and bird relationship and consequently in improving the conditions for mutual benefit.

The Sanctuary is situated 82 km south of Madras City, in Madurantakam Taluk, Chingleput District. It is about 120 m above MSL, and less than 48 km inland from the Coromandal Coast. The Sanctuary includes the 30 hectare Vedanthangal tank. The average annual rainfall is 115 cm, most of which falls during north-east monsoon from September to December. The hottest months are April, May and June.

The countryside surrounding Vedanthangal is flat comprised primarily rocky plains and paddy fields interpersed with bushes and scattered trees. There are a few low ridged hillocks, and tanks or small lakes dotting the landscape like Karikili Water Fowl Refuge.

The Vedanthangal tank which comprises the Sanctuary, and Karikili are the only places in this region that provide compact groves of *Barringtonia acutangula* trees suitable for nesting of birds. The western bund of Vedanthangal tank impounds the water. *Acacia nilotica* ssp. *indica, Alangium salvifolium, Albizzia lebbek, Antidesma ghaesembilla, Borassus flabellifer, Cassia fistula, Derris indica, Polyalthia suberosa* and *Streblus asper* are some of the trees observed along the slope of the bund. These trees were often interpersed with thick growth of *Calamus rotang, Derris scandens* and *Solanum trilobatum*. The common herbaceous plants which colonise the semi-marshy area of the tank are *Chryzophora rottleri, Cleome chelidonii, Coldenia procumbens, Echinochloa colonum, Eclipta alba, Euphorbia serpens, Glinus oppositifolius, Heliotropium indicum, Marsilea minuta, Panicum repens* and *Phyla nodiflora. Aeschynomene aspera, Lemna perpusilla, Limnophyton obtusifolium, Nechamandra alternifolia* and *Ottelia alismoides* are the aquatics of this region.

Surrounding the Vedanthangal tank, there are vast stretches of agricultural lands mostly used for paddy cultivation and these afford food for the birds gathering here during breeding season. Further the tank water contains high fertilizing properties due to the droppings of birds and hence agricultural fields irrigated from Vedanthangal tank give a good yield. The birds by eating the pests and insects of

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[2] Botanical Survey of India, Coimbatore.

the fields also help man. Thus man and bird are mutually benefitted.

For an account of the water birds visiting the Sanctuary, Spillett (1968) may be referred to.

208 taxa of vascular plants have been recorded. The specimens are deposited in the herbarium of the Southern Circle. Botanical Survey of India, Coimbatore (MH). For each species mentioned in the list, the collection number of A. N. Henry is given.

It may be mentioned here that though Wild Life Sanctuaries and National Parks are created, in general, for the protection of wild fauna and flora, in India much remains to be done in respect of protection to the flora for the sake of fauna. Most of the Sanctuaries have not been kept as exclusive reserves for the preservation of the local flora and fauna to improve conditions for their mutual benefit. The overgrazing of domestic livestock in the Vedanthangal Sanctuary area poses a great threat to the very existence of the comparatively rare taxa of the local plants; only a few widespread pantropical weeds are able to resist this threat. Further the rare local plants which illustrate evolutionary process and potentialities are disappearing and will not be available for study unless strenuous efforts are made to preserve them. Hence it is suggested that restrictions on domestic livestock grazing be imposed, so that the flora of Vedanthangal Water Birds Sanctuary is kept in as natural a state as possible.

ISOETACEAE

Isoetes coromandeliana Linn. 47080

MARSILEACEAE

Marsilea minuta Linn. 47060

ANNONACEAE

Polyalthia suberosa (Roxb.) Thw. 45422, 47008

MENISPERMACEAE

Tiliacora acuminata (Lamk.) Miers 45424
Tinospora cordifolia (Willd.) Miers ex Hk. f. & Thoms. 45434

CAPPARACEAE

Cadaba fruticosa (Linn.) Druce
(*C. indica* Lamk.) 45480
Cleome aspera Koenig ex DC. 45468
C. chelidonii Linn. f. 45447
C. viscosa Linn. 45430

VIOLACEAE

Hybanthus enneaspermus (Linn.) F. v. Muell.
(*Ionidium suffruticosum* (Linn.) Ging ex DC.) 45402

POLYGALACEAE

Polygala chinensis Linn. 45439

MALVACEAE

Abelmoschus ficulneus (Linn.) Wt. & Arn. ex Wt.
(*Hibiscus ficulneus* Linn.) 47068
Abutilon indicum (Linn.) Sweet 47026
Hibiscus micranthus Linn. f. 47038
H. vitifolius Linn. 45511, 47028
Sida cordata (N. Burman) Borssum
(*S. veronicifolia* Lam.) 47056

STERCULIACEAE

Melochia corchorifolia Linn. 45449, 47015

TILIACEAE

Corchorus aestuans Linn.
(*C. acutangulus* Lam.) 47040
Triumfetta rhomboidea Jacq. 47023

ELAEOCARPACEAE

Muntingia calabura Linn. 45425

Zygophyllaceae

Tribulus terrestris Linn. 47078

Oxalidaceae

Biophytum nervifolium Thw.
(*B. sensitivum* (Linn.) DC. var. *nervifolium* (Thw.) Edgew. & Hook. f.) 45491, 47077

Rutaceae

Citrus medica Linn. var.? 45436
Glycosmis mauritiana (Lam.) Tanaka
(*G. cochinchinensis* sensu Gamble *p.p.*) 45481
Toddalia asiatica (Linn.) Lamk. var. **gracilis** Gamble 45517

Rhamnaceae

Scutia myrtina (Burm. f.) Kurz 47101
Ziziphus oenoplia (Linn.) Mill. 47049

Vitaceae

Cissus quadrangularis Linn. 45464
C. setosa Roxb. 47095
C. vitiginea Linn. 45435

Sapindaceae

Allophyllus serratus (Roxb.) Kurz 45518
Cardiospermum halicacabum Linn. var. **microcarpum** Bl. 45459
Lepisanthes tetraphylla (Vahl) Radlk. 47105

Papilionaceae

Abrus precatorius Linn. 47018
Aeschynomene aspera Linn. 47104
A. indica Linn. 47046, 47065
Alysicarpus rugosus (Willd.) DC. var. **pilifer** Prain 45441
Atylosia scarabaeoides (Linn.) Benth. 47091
Crotalaria linifolia Linn. f. 45488
C. verrucosa Linn. 47009
Derris indica (Lam.) Bennett
(*Pongamia glabra* Vent.) 45405
Derris scandens (Roxb.) Benth. 45519
Desmodium biarticulatum Benth. 45497
Indigofera linifolia (Linn. f.) Retz. 47088
I. linnaei Ali
(*I. enneaphylla* Linn.) 45415
I. tinctoria Linn. 45456
Lablab purpureus (Linn.) Sweet
(*Dolichos lablab* Linn.) 45510, 47019
Mucuna pruriens (Linn.) DC.
(*M. prurita* Hook.) 47022
Pseudarthria viscida (Linn.) Wt. & Arn. 47017
Stylosanthes fruticosa (Retz.) Alston
(*S. mucronata* Willd.) 45495
Tephrosia hirta Ham. 47097
T. purpurea (Linn.) Pers. 45408
Teramnus labialis (Linn. f.) Spreng. 47006
Vigna trilobata (Linn.) Verdc.
(*Phaseolus trilobus* sensu Aiton) 47029

Caesalpiniaceae

Cassia auriculata Linn. 45475
C. fistula Linn. 45414
C. pumila Lamk. 45483
Piliostigma racemosa (Lamk.) Benth.
(*Bauhinia racemosa* Lamk.) 45516

Mimosaceae

Acacia caesia Willd. 47050
A. nilotica (Linn.) Willd. ex Del. subsp. **indica** (Benth.) Brenan
(*A. arabica* auct. non (Lamk.) Willd.) 45401
Albizzia lebbek (Linn.) Willd. 47010
Leucaena leucocephala (Lamk.) de Wit
(*L. glauca* Benth.) 47109
Pithecellobium dulce (Roxb.) Benth. 47003

Droseraceae

Drosera burmanni Vahl 47115

Lecythidaceae

Barringtonia acutangula (Linn.) Gaertn. 45413

Lythraceae

Ammannia baccifera Linn. 47099
Nesaea brevipes Koehne 47051
Rotala verticillaris Linn. 47092

Onagraceae

Ludwigia perennis Linn.
(*L. parviflora* Roxb.) 47111

Passifloraceae

Passiflora foetida Linn. 45420

Cucurbitaceae

Blastania garcini (Linn.) Cogn. 47032
Coccinia grandis (Linn.) Voigt
(*C. indica* Wt. & Arn.) 45427, 47042
Cucumis melo Linn. var. **agrestis** Naud.
(*C. pubescens* Willd.) 45451
Diplocyclos palmatus (Linn.) C. Jeffrey
(*Bryonopsis laciniosa* sensu Naud.) 47004
Mukia maderaspatana (Linn.) M. Roem.
(*Melothria maderaspatana* (Linn.) Cogn.) 47016

Aizoaceae

Trianthema portulacastrum Linn. 45452

Molluginaceae

Glinus oppositifolius (Linn.) A.DC.
(*Mollugo oppositifolia* Linn.) 45429
M. pentaphylla Linn. 45492

Rubiaceae

Borreria articularis (Linn. f.) F. N. Will.
(*B. hispida* (Linn.) K. Sch.) 45453
Canthium parviflorum Lamk.
(*Plectronia parviflora* (Lamk.) Bedd.) 45410
Dentella repens (Linn.) J.R. & G. Forst. 45463
Morinda coreia Buch.-Ham.
(*M. tinctoria* Roxb.) 45412
Oldenlandia herbacea (Linn.) Roxb. 47054
Tarenna asiatica (Linn.) Alston
(*Chomelia asiatica* O. Kze.) 47073
Thecagonum biflorum (Linn.) Babu
(*Oldenlandia biflora* Linn.) 45461

Compositae

Ageratum conyzoides Linn. 47039
Blumea bifoliata DC. 47082
Eclipta alba (Linn.) Hassk.
(*E. prostrata* (Linn.) Linn.) 45442
Epaltes pygmaea DC. 47093
Sphaeranthus indicus Linn. 47069
Vernonia cinerea (Linn.) Less. 47036

Plumbaginaceae

Plumbago zeylanica Linn. 47024

Ebenaceae

Diospyros chloroxylon Roxb. 47079

Apocynaceae

Catharanthus pusillus (Murr.) G. Don
(*Lochnera pusilla* K. Schum.) 45484

Asclepiadaceae

Calotropis gigantea (Linn.) R. Br. 45411
Hemidesmus indicus (Linn.) R. Br. 47005
Pergularia daemia (Forsk.) Chiov.
(*P. extensa* (N. Jacq.) N.E.Br.) 45419
Tylophora indica (N. Burman) Merr.
(*T. asthmatica* (Linn. f.) Wt. & Arn.) 45479

Gentianaceae

Canscora heteroclita (Linn.) Gilg.
(*C. sessiliflora* Roem. & Schult.) 47113

Enicostemma hyssopifolium (Willd.) I. C. Verdoorn
(*E. littorale* Bl.) 45496

HYDROPHYLLACEAE

Hydrolea zeylanica Vahl 47075

BORAGINACEAE

Carmona retusa (Vahl) Masamune
(*C. microphylla* (Lamk.) Don) 45501
Coldenia procumbens Linn. 45432
Heliotropium indicum Linn. 45416
H. marifolium Retz.
(*H. scabrum* Retz.) 45466

CONVOLVULACEAE

Argyreia cymosa Sweet 47021
Ipomoea aquatica Forsk.
(*I. reptans* Poir.) 47098
I. coptica (Linn.) Roth ex Roem. & Schult.
(*I. dissecta* Willd.) 47085
Merremia hederacea (Burm. f.) Hall. f.
(*M. chryseides* Hall. f.) 47072
Operculina turpethum (Linn.) Silva Manso 47030

SOLANACEAE

Physalis minima Linn. 45421
Solanum trilobatum Linn. 45403

SCROPHULARIACEAE

Centranthera tranquebarica (Spreng.) Merr.
(*C. humifusa* Wall. ex Benth.) 45487
Limnophila aquatica (Willd.) Santapau
(*L. polystachya* Benth.) 47100
L. indica (Linn.) Druce
(*L. gratioloides* R. Br.) 47071
Striga angustifolia (D. Don) Sald.
(*S. euphrasioides* sensu Benth.) 45489
S. densiflora (Benth.) Benth. 45467

PEDALIACEAE

Martynia annua Linn. 45513
Pedalium murex Linn. 45426

ACANTHACEAE

Asystasia gangetica (Linn.) T. And. 47013
Dipteracanthus prostratus (Poir.) Nees
(*Ruellia prostrata* Poir.) 47007
Ecbolium viride (Forsk.) Alston
(*E. linneanum* Kurz) 45508
Hygrophila auriculata (Schum.) Heine
(*Asteracantha longifolia* (Linn.) Nees) 47076
Indoneesiella echioides (Linn.) Sreem.
(*Andrographis echioides* Nees) 45457
Lepidagathis cristata Willd. 45498
Rostellularia prostrata (Roxb. ex Cl.) Majumdar
(*Justicia prostrata* (Roxb. ex Cl.) Gamble) 47035

VERBENACEAE

Gmelina asiatica Linn. 45490, 45520
Phyla nodiflora (Linn.) Greene
(*Lippia nodiflora* (Linn.) A. Rich.) 45440
Premna corymbosa Rottl. & Willd. 45500

LABIATAE

Anisomeles malabarica (Linn.) R. Br. ex Sims 47027
Basilicum polystachyon (Linn.) Moench.
(*Moschosma polystachyum* Benth.) 47012
Geniosporum tenuiflorum (Linn.) Merr.
(*G. prostratum* Benth.) 45486, 47086
Hyptis suaveolens (Linn.) Poit. 45409, 47070
Leucas lavandulaefolia Rees
(*L. linifolia* (Roth) Spreng.) 45431

NYCTAGINACEAE

Boerhavia diffusa Linn. 45503
Pisonia aculeata Linn. 47048

AMARANTHACEAE

Achyranthes aspera Linn. 47037
Aerva lanata (Linn.) Juss. 45515
A. monsoniae (Linn. f.) Mart. 47089
Allmania nodiflora (Linn.) R. Br. var. **dichotoma** (Roth) Hook. f. 45470
Amaranthus spinosus Linn. 45423
Celosia argentea Linn. 45485
Pupalia lappacea (Linn.) Juss.
(*P. atropurpurea* Moq.) 47002

CASSYTHACEAE

Cassytha filiformis Linn. 45469

LORANTHACEAE

Dendrophthoe falcata (Linn. f.) Etting
(*Loranthus longiflorus* Desr.) 47074

EUPHORBIACEAE

Acalypha lanceolata Willd. 45471, 45509
Antidesma ghaesembilla Gaertn. 45505
Chryzophora rottleri (Geis.) A. Juss. ex Spreng. 45450
Croton bonplandianum Baill.
(*C. sparsiflorum* Morong.) 45407
Drypetes sepiaria (Wt. & Arn.) Pax & Hoffm.
(*Hemicyclea sepiaria* Wt. & Arn.) 47106
Euphorbia hirta Linn. 45446
E. serpens H.B.K.
(*E. microphylla* sensu Gamble *p.p.*) 45428
Jatropha gossypifolia Linn. 45482
Kirganelia reticulata (Poir.) Baill. 45506
Phyllanthus fraternus Webster
(*P. niruri* auct. plur. (non Linn.) 45433
P. maderaspatensis Linn. 45454
P. virgatus Forst. f.
(*P. simplex* Retz.) 45458
Sebastiania chamaelea (Linn.) Muell.-Arg. 45494
Securinega leucopyrus (Willd.) Muell.-Arg.
(*Fluggea leucopyrus* Willd.) 45406
Synostemon bacciforme (Linn.) Webster
(*Agyneia bacciformis* (Linn.) A. Juss. 45462
Tragia involucrata Linn. 45460

URTICACEAE

Pouzolzia zeylanica (Linn.) Benn.
(*P. indica* Gaud.) 45463

MORACEAE

Fiscus hispida Linn. f. 45504
F. racemosa Linn.
(*F. glomerata* Roxb.) 47110
F. religiosa Linn. 45404
F. tomentosa Roxb. ex Willd. 47107
Streblus asper Lour. 45514, 47044

HYDROCHARITACEAE

Nechamandra alternifolia ((Roxb.) Thw.
(*Lagerosiphon alternifolius* Druce) 47059
Ottelia alismoides (Linn.) Pers. 47067

LILIACEAE

Asparagus racemosus Willd. 47031

XYRIDACEAE

Xyris pauciflora Willd. 47116

COMMELINACEAE

Commelina benghalensis Linn. 45473
C. ensifolia R. Br. 45418
Murdannia spirata (Linn.) Bruckn.
(*Aneilema spiratum* Br.) 47062

PALMAE

Phoenix farinifera Roxb. 45477
P. sylvestris (Linn.) Roxb. 47014

LEMNACEAE

Lemna perpusilla Torr.
(*L. paucicostata* Hegelm.) 45512

Alismataceae

Limnophyton obtusifolium (Linn.) Miq. 47103

Eriocaulaceae

Eriocaulon quinquangulare Linn. 47114

Cyperaceae

Bulbostylis barbata (Rottb.) Cl. 45474
Cyperus bulbosus Vahl 45478
C. distans Linn. f. 45472
C. kyllingia Endl.
(*Kyllingia monocephala* Rottb.) 45502
Cyperus pumilus Linn.
(*Pycreus pumilus* Dom.) 47064
Cyperus rotundus Linn. 45444
C. tenuispica Steud. 47055
C. triceps (Rottb.) Endl.
(*Kyllingia triceps* Rottb.) 47063
Fimbristylis argentea (Rottb.) Vahl 45417
F. ovata (N. Burman) Kern
(*F. monostachya* (Linn.) Hassk.) 45476, 47083
Schoenoplectus articulatus (Linn.) Palla
(*Scirpus articulatus* Linn.) 47058
S. lateriflorus (J. F. Gmelin) Lye
(*Scirpus supinus* auct. non Linn.) 47066

Gramineae

Alloteropsis cimicina (Linn.) Stapf 45499
Apluda mutica Linn.
(*A. aristata* Linn.) 47057
Arundo donax Linn. 45507
Bothriochloa pertusa (Linn.) A. Camus
(*Amphilophis pertusa* (Linn.) Nash ex Stapf) 47112
Chloris barbata Sw. 45455, 47033
Echinochloa colonum (Linn.) Link 45443
Enteropogon monostachyos (Vahl) K. Schum. & Engl. 47108
Eragrostiella brachyphylla (Stapf) Bor
(*Eragrostis brachyphylla* Stapf) 45493
E. riparia (Willd.) Nees 47096
E. tenella (Linn.) P. Beauv. ex Roem. & Schult.
(*E. plumosa* (Retz.) Link) 47025
Eriochloa procera (Retz.) C. E. Hubb. 45445
Oplismenus compositus (Linn.) P. Beauv. 47047
Panicum repens Linn. 45437
Paspalidium geminatum (Forssk.) Stapf 47045
Saccharum spontaneum Linn. 47041
Sporobolus tremulus (Willd.) Kunth 45448
Vetiveria zizanioides (Linn.) Nash 47084

Acknowledgements

We are thankful to Dr. N. C. Nair, Deputy Director, Southern Circle, Botanical Survey of India for facilities and to the Wild Life Warden and staff of the Tamil Nadu Forest Department for their co-operation and help.

Reference

Spillett, J. Juan (1968): A report on Wild Life Surveys in South and West India. *J. Bombay nat. Hist. Soc. 65* (3): 646-653.

AIDS TO THE IDENTIFICATION OF ARTIODACTYLAN HAIRS WITH GENERAL COMMENTS ON HAIR STRUCTURE[1]

B. R. KOPPIKER[2]

AND

J. H. SABNIS[3]

(*With six text-figures*)

A system for rapid identification of hair specimens by means of hair impression studies is outlined. A series of camera lucida diagrams depicting the structure of hairs of some artiodactylan species is presented. This facilitates identification by permitting a direct visual comparison with the hair pattern of an unknown hair specimen.

INTRODUCTION

In nature it is very difficult to keep track of all the animals killed by the Tiger and one of the important methods of knowing the food habits is through collection of faeces containing hairs which will reveal the animal preyed upon by the Tiger. The prey animals cover a wide range of species which fall in the category of both domestic and wild animals. Primary need for studying food habit of carnivores in general and Felidae in particular prompted the authors to undertake study of hair structure of some wild Artiodactyla which forms the prey animals of carnivora.

The present work involves hair impression study.

MATERIAL AND METHODS

Initially, all hair specimens were carefully washed in hot water. They were air dried thoroughly. The medium for taking hair impression is prepared as follows:

A solution of cellulose acetate is obtained by dissolving 2.5 g of cellulose in 10 ml of acetone and 40 ml of ethyl lactate are added to give a uniform viscous colourless solution.

A drop or two of this viscous medium is carefully spread over a clean microscope silde to give a uniform thin layer and a piece of the hair under investigation is placed on it immediately and allowed to stand for 10 minutes. The slide is then dried in an air oven at 55°C for about 30 minutes, when the hair piece can be easily lifted off. The clear impression obtained can be examined under a microscope by focussing on the medial region. The advantages of this method developed in the Forensic Science Laboratory, Bombay by Dr. M. S. Madiwale, are:

1. Even a small piece of hair can be studied as no stretching or fixing of hair is necessary.
2. As no stretching is done or pressure is applied, impressions obtained are reproducible.
3. Drying under reproducible conditions give faithful impressions which can be repeated.
4. Impressions are suitable for easy handling and preservation as record for future reference.

[1] Accepted August 1978.

[2] Project Tiger, Melghat, Paratwada.

[3] Department of Zoology, Vidarbha Mahavidyalaya, Amravati.

The magnification of diagrams is × 940.

OBSERVATIONS

The structural parts of a hair are cuticle, cortex. medulla, pigment and hair cells. In the system of hair identification to be outlined only cuticle is important. The structure of these patterns which form the basis of their identification under study are given along with macroscopic characteristics.

BLACK BUCK *Antelope cervicapra*

Fig. 1.

Gross Appearance:

Length 1 to 2 cm. The hairs look slightly curved and are more or less equal in diameter throughout except a gradual taper at apex. The diameter at the proximal end measures 48 μ. The colour of hair is white in the proximal region with grayish coloured band immediately below the distal one third region. The terminal portion is black. Some hairs are pure light brown in colour and some pure white and black.

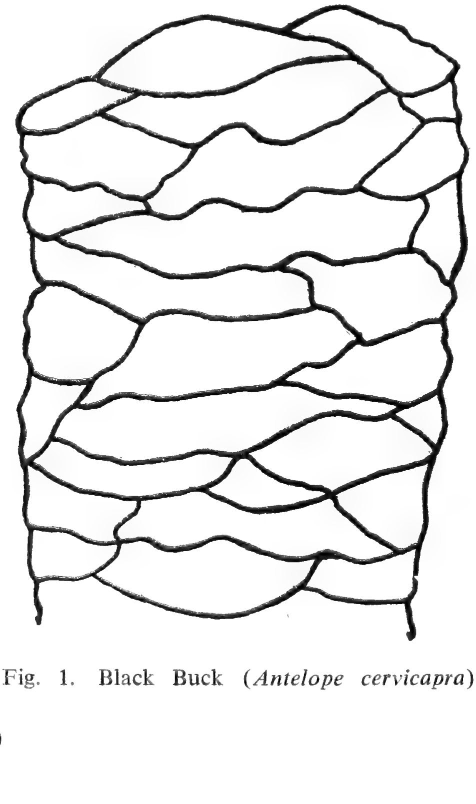

Fig. 1. Black Buck (*Antelope cervicapra*)

Microscopic Appearance:

Scales are imbricate with plain borders.

BARKING DEER *Muntiacus muntjak*

Fig. 2.

Gross Appearance:

Length 2 to 3.8 cm. The hairs look straight and more or less equal in diameter. The diameter at proximal region measures 112 μ. The colour of hairs is brown with black tip. Others are white.

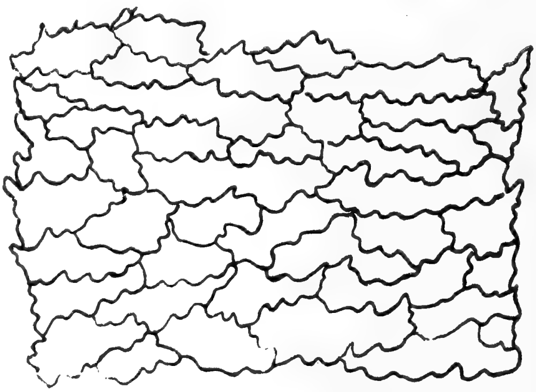

Fig. 2. Barking Deer (*Muntiacus muntjak*)

Microscopic Appearance:

Scales are imbricate with serrate edges.

SAMBAR *Cervus unicolor*

Fig. 3.

Gross Appearance:

Length 3 to 5 cm. They are narrow in proximal region, becoming broader in the medial and tapering off in the distal region. They measure 180 μ in diameter in the medial region. The colour of hair is almost pure white in the proximal region, gradually changing to yellowish brown in the medial region. The distal region is black.

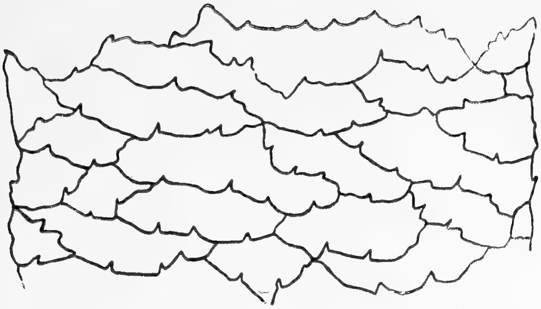

Fig. 3. Sambar (*Cervus unicolor*)

Microscopic Appearance:

The scales are imbricate with dentate edges.

SPOTTED DEER *Axix axis*

Fig. 4.

Gross Appearance:

Length 3 to 4 cm. Hair stems are slightly wavy. The diameter of the hair at the proximal region is 84 μ. The colour of the hair is white in the proximal region which changes to brown in the medial region. The distal region is yellowish brown.

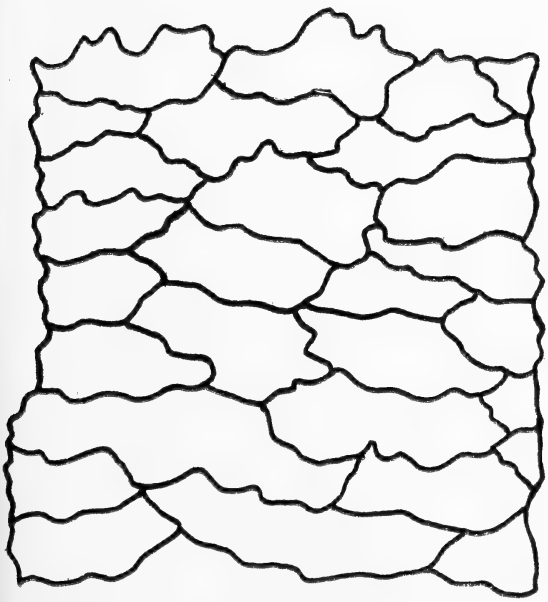

Fig. 4. Spotted Deer (*Axis axis*)

Microscopic Appearance:

The scales are imbricate serrate.

CHINKARA *Gazella gazella*

Fig. 5.

Gross Appearance:

Length 18 to 22 cm. The hair measures 54 μ in diameter in the proximal region increasing perceptibly in size in the medial region and then gradually tapering in the distal region. At the proximal region colour is generally black, medial region being greyish, and the distal region is white. Some hairs are pure white.

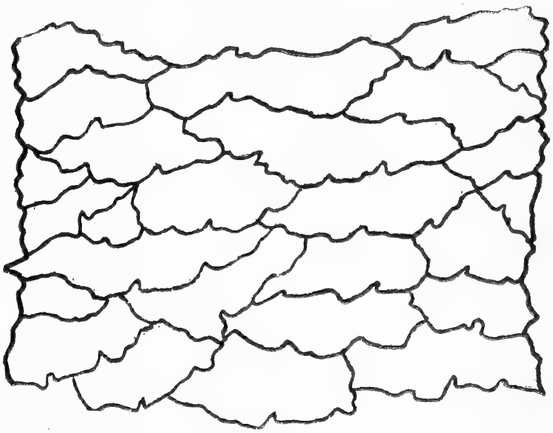

Fig. 5. Chinkara (*Gazella gazella*).

Microscopic Appearance:

Scales are imbricate with serrate edges.

NILGAI *Boselaphus tragocamelus*

Fig. 6.

Gross Appearance:

Length 23 to 27 cm. The hair at the proximal region measures 140 μ in diameter. Stems are quite fragile and easily broken. The colour of the hair is almost white in the proximal region. In the medial region two third portion is brown gradually changing to black in the distal region.

Microscopic Appearance:

The scales are imbricate with flattened edges.

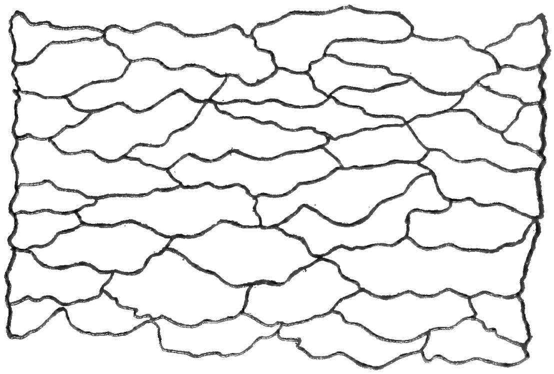

Fig. 6. Nilgai (*Boselaphus tragocamelus*).

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SOME OBSERVATIONS ON NESTING HABITS AND BIOLOGY OF *VARANUS SALVATOR* (LAURENTI) OF BHITARKANIKA SANCTUARY, ORISSA[1]

S. BISWAS[2] AND S. KAR[3]

(*With a plate & two text-figures*)

INTRODUCTION

So far little is known about the nesting habits and biology of *Varanus salvator* (Laurenti) which is mainly distributed in the coastal region of West Bengal and Orissa and also in Assam of Eastern India. However some observations have been made on the breeding and egg laying habits of the species in captivity in Madras Snake Park (1976 & 1978), Ahmedabad Zoo (1970) and Nandankanan Biological Park (1977). The present observation was carried out in the Bhitarkanika island situated in the Mahanadi Baitarani estuary of Orissa. Bhitarkanika, an area of 176 sq Km, has now been declared as a Crocodile sanctuary by the Orissa Government. Four nests with eggs of *Varanus salvator* were located within the sanctuary from an area of nearly 1 sq km adjacent to Dangmal village and four hatchlings of another species, *Varanus flavescens* (Gray) were also collected from the same area (Biswas & Kar 1979). The Water Monitor is now thriving well here, protected from exploitation by skin traders. It is presumed that mongoose is the predator of eggs of the monitor as they are common in this area.

This paper is a preliminary report on observations on the nesting habit and incubation experiment on the eggs of *V. salvator*. One clutch of freshly laid eggs was collected which did not hatch out but another clutch collected in an advanced stage of development, hatched out in the hatchery.

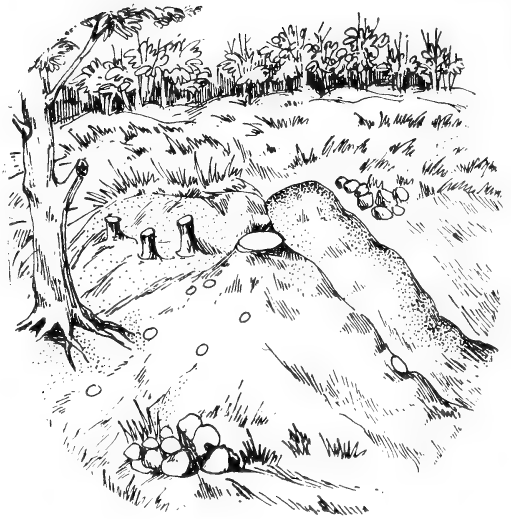
Selection of nest site: In Bhitarkanika *V. salvator* nests in the month of June during the wet season. The nesting places are always selected on high ground in secluded places. Bhitarkanika estuarine area is inundated by tide water twice daily and in the full-moon and new-moon the tide reaches its maximum. Therefore selection of nest site is made in such a way that even in maximum high tide, water does not reach the nest. Almost all the nests are seen placed in secure places free from human disturbance since there is no village situated on the island. All the villages are either close to or away from the river and its associated creek systems, which encircle the main Bhitarkanika island.

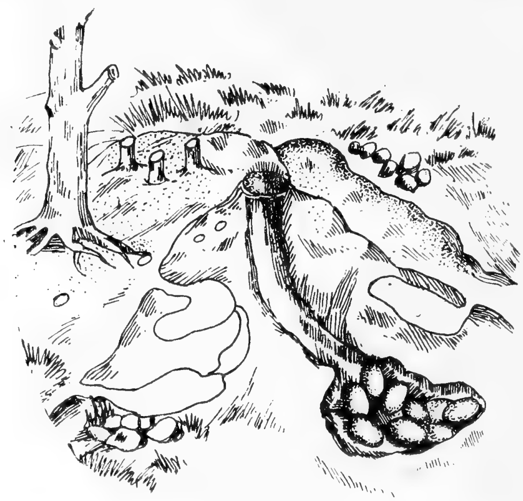
The most interesting observation in their selection of nesting site is that the monitor invariably selects a termite mound. The nesting mother selects one or two already existing holes of the mound and enlarges them into a cavity (Figs. 1 & 2). Though generally the nesting site is free from biotic interferences sometimes it may be situated close to human settlements inside the sanctuary. Selection of the nesting site is mainly guided and determined by the availability of termite mounds. The monitor prefers termite mound so much that it does not mind even if the

[1] Accepted March 1980.

[2] Zoological Survey of India, Calcutta.

[3] Salt-water Crocodile Scheme, Forest Dept., Government of Orissa.





Left: Fig. 1. Diagram of a termitarium mound.
Right: Fig. 2. Diagram of the same dug up mound showing the location of eggs.

mound is close to the road or houses or in unused fields.

Nest hole or the cavity: The nest soil is mainly hard and loamy. The varanus selects a nest-hole in the slope of the termitarium at a high level from its base. In two nests measured the height from the base of the mound to the nest cavity is 9″ and 12″. The mother makes the hole wider and deeper by scraping soil from the mound by both fore and hind limbs and does not spend much energy for preparation of the nest. The shape of the nest is somewhat flask shaped, narrow neck with wide bottom (Figure 2). Four nests of *V. salvator* were examined (Table 1).

The nest nos. 1 and 4 are same. It is presumed that the same monitor utilised the nest for laying her eggs.

It appears from the Table 1 that the nest size depends on the size of the clutch.

Egg laying and its collection: Egg laying was observed on one occasion by a person who was working a few yards away from the nest (nest no. 1). On 24th June 1977 near about 7-30 A.M., a female varanus was seen on a way side termite mound scraping the soil with her limbs. After sometime she rested, with her head towards the top of the mound and the tail on the ground. The presence of the observer disturbed her and she left the nest site.

TABLE 1

No. of nests	Date	Nest size	No. of eggs	Nest temp. at the time of coll.	Air temp.	Time
1	24.6.77	30 × 21 cm	20	29.5°C	32°C	10 A.M.
2	25.2.78	22.5 × 17.5 cm	9	28.5°C	30°C	1 P.M.
3	18.6.78	20 × 19 cm	6	28.0°C	27°C	4 P.M.
4	19.6.78	27.5 × 17.5 cm	Nil	29.5°C	30°C	8 A.M.

When the site was examined, the nest hole was seen filled up with scraped up soil and it is possible that the varanus was observed when she was filling up the nest hole after laying the eggs.

Eggs were collected from three nests (nest nos. 1, 2 and 3) but the eggs of the 4th nest were found broken. The eggs of nest no. 2 were accidentally collected while some workers were clear felling an area and digging up a termite mound for soil. The nine eggs of this nest were in an advanced stage of development and hatched just eight days after they were placed for incubation. The embryos were already in a mature stage when three out of the 9 eggs were broken at the time of collection to ascertain the status of development of the embryo. One hatchling from these three eggs died immediately but the two other eggs were kept with the other incubating eggs.

Incubation: For incubation of the collected eggs an artificial nest mound of size, 45 × 30 cm was built with sand in the crocodile hatchery at Bhitarkanika and for recording temperature inside the nest a hollow bamboo pipe with a stopper on the top end of the pipe was inserted in the middle of the mound.

The incubation experiment on eggs of nest No. 1 was unsuccessful. After keeping the eggs inside the artificial nest for 43 days from 24.6.77 to 5.8.77 the nest was opened for inspection but it was found that eggs were all rotten and the shells were covered with fungal growth. The eggs of the 2nd nest required only eight days of incubation and no experiment was conducted on the eggs of the 3rd nest.

Incubation experiment on the eggs of nest No. 2 indicated that if the egg is an advanced stage is broken but the embryo of the broken egg case is not disturbed and incubation is continued, the hatchlings may survive.

The temperature record of the two clutches of eggs, Nest No. 1 (N-1) sterile and Nest No. 2 (N-2) consisting of eggs in advanced stage of development, placed for incubation in an artificial nest is given in Table 2.

TABLE 2

Clutch & Nest No.	Nest temp.			Range	Average
25°C	8°C	27.6°C	N-1	Minimum at 6 P.M.	
33°C				Maximum at 2 P.M.	
24°C	6.5°C	25.8°C	N-2	Minimum at 6 A.M.	
30°C				Maximum at 2 P.M.	

Weight and measurement of eggs:

The egg is elongated with both ends tapering bluntly and the shell is white, soft and leathery.

The measurement and weight of the three clutches of eggs, N-1, freshly laid but sterile, N-2, in advance stage of development and N-3, status unknown, is given in Table 3.

TABLE 3

Nest Nos.	N-1	N-2	N-3
Nos. of eggs	20	6	3
Range of length	68 to 79 mm.	68 to 76 mm.	64 to 77 mm.
Average of length	71.6 mm.	72.3 mm.	75.5 mm.
Range of breadth	38 to 41 mm.	44 to 47 mm.	35 to 38 mm.
Average of breadth	39.16 mm.	46 mm.	36.5 mm.
Range of weight	52.40 to 65.90 gm	77.50 to 87.20 gm	55 to 60.50 gm
Average of weight	58.24 gm	82.35 gm	58.87.gm

If the average breadth and weight (39.16 mm. and 58.24 gm) of the freshly laid eggs are compared with that of eggs of advanced stage of development (46 mm. and 82.35 gms.) then it may be presumed that the eggs of the 3rd clutch (36.5 mm. and 58.87 gms) were also freshly laid. The increase in egg size is more in width than in the length.

Hatching out of hatchlings out of the egg case: No indication was available of the time of emergence of the hatchlings except for the flow of the egg fluid when the hatchlings made slits on the egg case with their egg tooth. The fluid adhering to the thermometer inserted in the nest gave the indication that the hatchlings were ready to come out of the egg case. When the eggs were examined after opening the nest, 2 to 3, 2.5 to 5 cm long longitudinal slits or cracks on the egg shell were seen. These had been made by the sharply pointed egg tooth on the lip below the snout of the hatchling. After opening the nest on 5.3.78, the first batch of three hatchlings emerged from the egg shell. Two of the hatchlings still had chords but these became detached after 45 and 53 minutes and in one case after 2 hours of their emergence. The remaining 5 hatchlings emerged a day later.

Two slightly broken eggs were also kept for incubation along with the 6 other eggs. These two also hatched on 6.3.78 but the hatchlings were very inactive and their stomachs were swollen with chord attached with the egg membrane. It took 25 hours for freeing the chord from the egg cases.

The hatchlings were very active immediately after hatching. One just after emergence went up a wooden pole of *c* 50 cm hight. If disturbed they hissed with swollen neck and raised head and during this moment the tongue would be seen darting out very frequently. All the hatchlings excepting two were very active and immediately after coming out of the egg shell they started moving about the hatchery and climbing on its poles and wire netting.

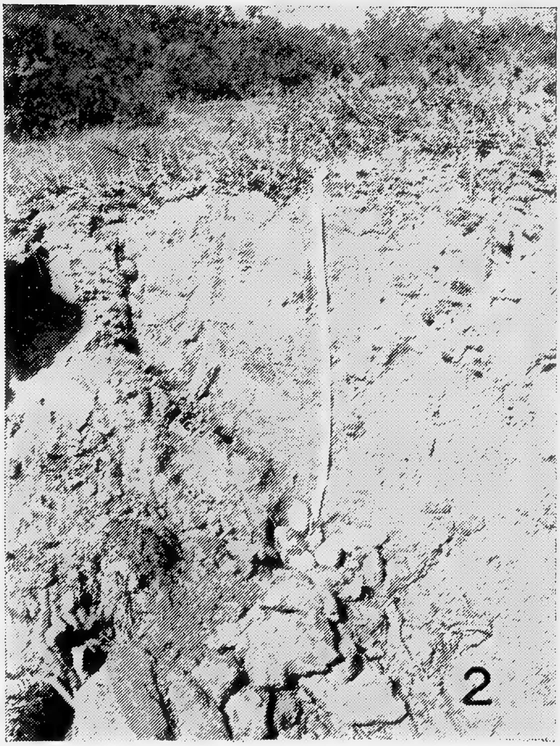
In colour, the hatchlings were very black with yellow spots arranged dorsally in transverse rows.

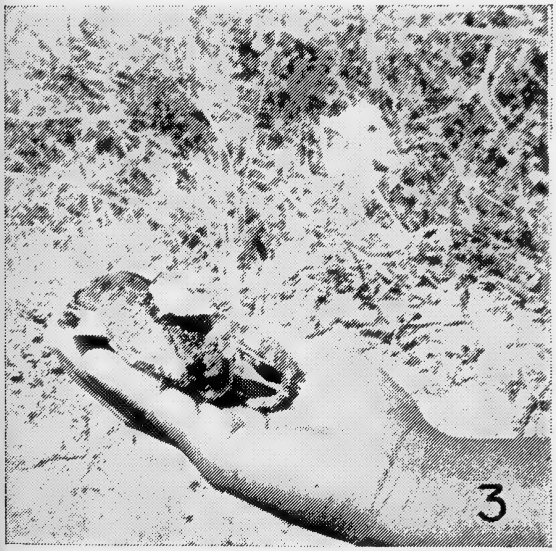
Parental care: Though parental care in varanus was not studied in detail, observations on the mother varanus were continued after collecting her eggs from the nest on 24.6.77. She was found on the same night, on the nest for nearly about one hour scraping soil to fill up the opened but empty nest hole. On the morning of 25.6.77 she was again seen near the nest, disappeared immediately on seeing the observer. This varanus was kept under regular observation upto 2.7.77. Mostly in the evenings it was seen in a hole close to the nest, with the snout protruding from the hole. But on 3.7.77 it was disturbed during the day by village boys and from that day onwards she was not seen coming near her nest.

The observations on the mother varanus could not be completed to decide whether she takes special interest in opening the nest to help the hatchlings to emerge. But it has been observed in the case of artificially incubated eggs that the hatchlings produced no noise inside the nest as is produced by hatchlings of crocodiles. Therefore, it is presumed that there is no parental assistance for opening the nest. The nature of the soil of the selected nest site in termitarium, particularly from the soil used by the mother to close the nest it can be deduced that there is no necessity for help for the hatchling to come out of its nest. The closed nest not being compact, it is very easy for the active and agile hatchling to come out of the nest without the mother's help.

It will appear from the table that in the hatchling there is an approximate equal proportion between total length of the body to the weight and the tail to snout vent proportion which is nearly 1.5.

Plate





Varanus salvator (Laurenti)
Fig. 1. View of an adult female.
Fig. 2. Dug out egg nest in a termitarium showing actual position of eggs with a measuring tape. Fig. 3. Showing just hatched out hatchling. Fig. 4. Showing a view of partially dug out nest in the natural surroundings.

Weight and measurement of hatchling:

Sl. No.	Length total in cm.	S.V. Length in cm.	Tail length in cm.	Weight in gm.	Average L & W
1	33.2	14.0	19.2	35.0	
2	33.0	14.0	14.0	30.0	Length=32.3 cm.
3	32.0	13.4	18.6	35.5	Weight=32.80 gm.
4	32.0	13.5	18.5	30.8	
5	31.8	13.5	18.3	32.0	
6	32.5	13.8	18.7	31.0	
7	32.0	13.5	18.5	33.5	
8	32.0	14.0	18.5	34.6	

Post hatching care of the hatchling:

The hatchlings were kept in a concrete pool of the size $3 \times 3 \times 1$ m., one side of which was sloping. The pool was one third filled with water. Phoenix canes were kept inside the dry portion of the tank to be used as hide-out by the hatchlings. On the ground of the enclosure of the pool some artificial burrows were provided as it was observed in the wild condition that varanus hide inside bushes and live in existing or prepared burrows.

The hatchlings were not provided with any food till five days after hatching and from the 6th day they were each supplied with prawns, about 2 gms. each for the 1st fortnight and 3 gms. afterwards. It was observed that nearly a week after the supply of food they did not take any but afterwards started feeding.

The hatchling when 80 days old (hatched out 26.4.78 and reared upto 24.7.78) reached a length of 37 cm. The average length of a just hatched out hatchling being 32.3 cm. it grew about 4.7 cm. during this period in the abnormal condition of captivity.

It was observed that hatchlings spent more time in a dry place than in the water and only occasionally went in to the water. They hide immediately when some one approached the enclosure. The experiment could not be continued further as the hatchlings died during a period of cyclonic weather in the region

Remarks: The preference for termite mounds by Varanus for egg laying had been observed by Annandale (1922) in case of *Varanus bengalensis* (Daudin) at the Barkuda island of Chilka Lake, Orissa. In September, 1920 a half grown embryo was dug out of the interior of a mound of *Termes* (*Odontotermes*) *obesus*.

Biswas and Acharjyo (1977) found eggs of water monitor in a cage and David (1970) collected hatchlings which developed out of the laid eggs in a zoo enclosure probably in a burrow. So, it may lay eggs during its captivity in abnormal situations. A termitarium is probably selected as a convenient and safe place for the protection and development of the eggs in an esturine condition. Therefore, if an artificial termitarium is provided for the egg nest we hope to get good results in egg laying and incubation of eggs of Water Monitor in captive conditions.

Biswas and Acharjyo (loc. cit.) recorded an egg laying incidence on 29th July, 1971 of a water monitor at Nandankanan Biological Park and Madras Snake Park (1976 & 1978) also had mentioned incidences of laying once of four eggs on 16th June, 1976 at intervals of two to three hours and another fourteen eggs on 19th June, 1977. According to Smith (1935) in Thailand the species lays eggs in June, at the beginning of rainy season. Therefore, it can be safely deduced that egg laying season of this species is June and July.

Further according to Smith (loc. cit.) the number of eggs laid at a time, i.e. the clutch size is 15 to 30 whereas in the three nests we have got only 6 to 20 eggs. The average measurement of freshly laid eggs of this species from the Bhitarkanika is 71.6×39.16 mm which comes very near to the 70×40 mm mentioned by Smith.

Honegger (1971) mentioned in respect of incubation experiment on eggs of *V. salvator* by incubator in laboratory condition that the incubation period is 207 to 209 days at an average temperature of 30°C (range 29°C to 31°C). So, we may presume that when nest temperature varies between 25.8°C to 27.6°C in natural condition then incubation period may be longer than the above mentioned incubation period. In the natural condition when in winter atmospheric temperature goes down the nest temperature may not be higher than 25°C.

In this connection we like to point out that David (loc. cit.) collected hatchlings on 1st April, 1969; the actual coming out of egg case may be a few days earlier, when he was maintaining five *Varanus salvator* in an enclosure of Ahmedabad Zoo. Taking into consideration that water monitor lay eggs in June and the hatchlings come out in the March or April (David and our observation) we may presume a prolonged incubation period of eggs (nearly 270 days) of this species. This observation is further supported by the report of the Madras Snake Park (1978) that one egg took 260 days to hatch out.

According to David (loc. cit.) the size of the two breeding males and three females was 1.4 to 1.5 m. Four hatchlings were 30-32 cm long but in the present case the average length of eight hatchlings is 32.3 cm.

Finally this report shows the importance of Bhitarkanika sanctuary as a breeding place for two species of varanus by the location of four nests of *Varanus salvator* within an area approximately 1 sq. km. near the Dangmal village within the sanctuary and also the collection of hatchlings of ***Varanus flavescens*** (Gray) within this area (Biswas and Kar 1977).

Acknowledgements

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A SURVEY OF THE CEYLON FROGMOUTH (*BATRACHOSTOMUS MONILIGER*) HABITAT IN THE WESTERN GHATS OF INDIA[1]

R. SUGATHAN[2]

INTRODUCTION

The Ceylon Frogmouth (*Batrachostomus moniliger* Blyth—family Podargidae), is one of the least known birds species of the evergreen forest biotope of the Western Ghats. Though the presence of this species was recorded by Sálim Ali (1953) during his bird survey of Kerala and by Vijayan (1979) during his general survey of wildlife in the Parambikulam wildlife sanctuary, the status of the bird in the south-west of India was uncertain. Hence, to ascertain its present status, a general survey was conducted during six months from April to September 1976. Survey was concentrated on the western slopes of the western ghats of India in the state of Kerala.

Batrachostomus moniliger (Blyth) is one of the two representatives of the Genus *Batrachostomus* (Gould) present in the Indian Subcontinent, and is restricted to the heavy rainfall tracts of Western Ghats. The other species, *Batrachostomus hodgsoni hodgsoni* is a resident of the subtropical evergreen forests of Northern India. Nothing much is known about the status, distribution, biology etc. of this bird. The last two reliable records published on the Ceylon Frogmouth are, by Sálim Ali from Thattakadu in the year 1953 (BIRDS OF KERALA) and by V. S. Vijayan from Parambikulam sanctuary at a place called Varayatumudi in the year 1976 in Kerala. Both were accidental sightings or hearing its call when the bird suddenly flushed out from a thicket on the observer's approach. As stated by Sálim Ali in his report, this bird is very seldom seen even if it is close to the observer due to its immobility and cryptic plumage. Calls are very seldom heard and have not yet been authoritatively recorded. Food and feeding habits, breeding activities and other aspects of the bird are unknown.

Distribution:

The distributional range of the Ceylon Frogmouth is believed to be from the wet evergreen forests of Karnataka state in the Western Ghats to the southern tip of the country in Tamilnadu and Sri Lanka. The elevational limit of this bird is believed to be 1200 m MSL. The survey of the bird was restricted to the heavy rainfall tracts of the Western Ghats, and was mainly limited to the Kerala forests —from the forests of Silent Valley in North Kerala through Parambikulam, Sholayar forests, Thattakadu, Periyar-Sabarimala forests etc.

1) **Silent Valley:**

The Silent Valley (11°5′ 33″ N, 76°27′ 15″E) 8952 ha in extend lies in the Palghat district of Kerala state. The entire forest is on a plateau with undulating terrain, at an average elevation of 2000 m MSL. Silent Valley which contains India's last substantial stretch of tropical evergreen forest which is

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perhaps the only near-virgin forest in the whole of the Western Ghats. The floristic and faunistic contents of the forest are highly complex and have not been studied completely.

About half of the total area of Silent Valley forest is occupied by the wet evergreen type. This is mostly concentrated on either side of the main river of the area called Kunthipuzha. Towards the northern side of the reserve are vast areas of grass covered hills and in-between the hills occurs shola type of evergreen forest of the higher altitudes. Towards the eastern side of the reserve, wet evergreen forests merge with semi-evergreen and deciduous forests.

An extensive study of the flora of Silent Valley has not yet been done. The main floristic composition of the whole area is as follows: *Aglaia roxburghiana, Artocarpus hirsutus. Artocarpus integrifolia, Aphyllorchis prainii, Bischofia javanica, Calophyllum elatum, Cullenia excelsa, Dipterocarpus indicus, Hopea wightiana, Euphorbia longana, Knema attenuata, Lansium anamallayanum, Myristica beddomei, Mesua ferrea, Melia dubia. Lophopetalum wightianum, Pelaquim ellipticum, Saraca indica, Spondias acuminata, Trewia nudiflora, Baccaurea courtalensis, Chrysophyllum lanceolatum, Antidesma menasu, Drypetes macrophyllus, Croton argeratus, Cinnamomum iners, Hydnocarpus laurifolius, Scolopia crenate, Pterospermum rubiginosum, Diospyros bourdillonii, Apama siliquosa, Ervatamia heyneana, Trichilia connarioides, Polyalthia fragrans, Memecylon heyneanum, Sonerila versicolor, Sarcandra grandifolia, Angiopteris evecta, Cyathea gigantia, Pothomorpha subpeltata, Anaphyllum wightii, Pinanga dicksonii, Lasiathus jackianus* etc;

Along the river bed large formations of *Ochlandra wightii* and *Schumanianthus virgatus* are met with.

The first Frogmouth in the Silent Valley area was seen among the *Ochlandra wightii* clumps, not very far from the proposed dam site for the Silent Valley Hydroelectric project. Three others were located in the forest areas in-between Silent Valley and Mukkali. Another one was seen in the forest opposite to the Mukkali forest rest-house on the other side of the river. The three birds located between Silent Valley and Mukkali were among the solanum and strobilanthus undergrowth. The one sighted oposite to the rest-house was sitting on a dry tree branch about 15 feet above ground level. Even though this was visible from a long distance, I could not make it out until I approached the tree and saw the bird flying. In other cases also, I could make out the presence of the birds only after its flight due to the disturbance caused by my presence.

Batrachostomus moniliger seen in Silent Valley:

1) By the side of Kunthipuzha, near the dam-site	..	1
2) Between Silent Valley and Mukkali	..	3
3) In the forest opposite to Mukkali rest house	..	1
Total	..	5

2) **Parambikulam area:**

The Parambikulam Wildlife Sanctuary (10°25′N, 76°43′E) lies in the Palghat district of Kerala, at an altitude of 600 m. It has on its eastern border the Anamalai Wildlife Sanctuary of Tamil Nadu. The Nelliampathy reserve forest of Nenmara division of Kerala forest lies to the north-west of the sanctuary, and on the south and south-west lie the Vazachal and Sholayar ranges of Trichur district.

Unlike Silent Valley, Parambikulam has a wide variety of habitats, both natural and man-made. The natural habitat includes evergreen and moist-deciduous forests, grasslands etc. Teak plantations are the important man-made habitat in the area. Eucalyptus and other plantations are also met with in certain places.

At the foot of hills with vast grasslands, we met with extensive areas of swamp which are the feeding areas for animals such as the gaur and Indian wild boar.

The moist areas hold evergreen forests and the much drier hilltops are covered with grassland. The important and common evergreen species are:
Cullenia excelsa, Myristica fragrans, Hydnocarpus wightiana, Aporosa lindleyana, Cinnamomum iners, Herpullia arborea, Diospyros assimilis, Diospyros malabaricum, Adenosoma sp., *Baccaurea courtallensis, Machilus macrantha, Vatica indica, Mesua ferrea* etc.
In the moist deciduous areas:
Adina cordifolia, Careya arborea, Grewia tiliaefolia, Pterocarpus marsupium, Dalbergia latifolia, Clerodendron infortunatum, Glycosmis pentaphylla, Helicteres isora, Lantana camara, Randia dumetorum etc. are common. *Bambusa arundinacea* and Eeta bamboo are common along the sides of the streams.

During the survey, seven birds were seen in Parambikulam. Two of them were sighted at a place called Varayatumudi about 4 km from the Thunukadavu dam and on the way to Parambikulam dam. Vijayan (op. cit.) has also reported the presence of frogmouth from the same area during his Parambikulam survey. These birds were seen in the bamboo forest during day-time. When I threw stones into bamboo clumps to flush the birds, one bird suddenly shot out from a bamboo thicket and sat on a nearby cane plant. It gave a call 'Coroo' and immediately another bird flew out more or less from the same area and perched on a nearby tree. They sat quietly and I was able to see them for about 3 to 5 minutes. They then flew off into the thick undergrowth of the cane forest which prevented me from searching further for the birds. On the opposite side of Parambikulam dam, towards the eastern slope of the highest hill range 'Karimala Gopuram' three more Frogmouth were located. This area is less disturbed due to the inaccessibility of the terrain. This is one of the best Elephant areas of Parambikulam Wildlife sanctuary. I only had a glimpse of these birds, but in different areas on different days. I am therefore not certain whether they were separate birds. On the way to Karimala Gopuram from Sholayar two more birds were seen on the same day in evergreen biotope. Karimala Gopuram, the highest peak on the western ridge of Parambikulam has an elevation of 1440 m. The hill top is grass-covered and is Nilgiri Tahr country. One day's stay at the top of this hill helped me to locate 8 Tahr in this area.

Sholayar Vazachal area:

Sholayar is contiguous with Parambikulam on the west. Sholayar range has an area of 15,513.60 hectares as per the forest records, and out of this about 1,820.73 hectares have been leased out for Sholayar dam and for tea estates. The other portions are thick evergreen type of forest. It is very unfortunate that the forest department has started selection felling of trees in this area. Three birds were seen on the way from Karimala Gopuram to Sholayar dam in thick evergreen forest. This beautiful strip of virgin forest is now disturbed by selection felling of trees and a motorable road has been laid from Sholayar to the foothills of Karimala Gopuram and lorries are plying up and down the road carrying timber. Birds in this area were located in cane and eeta bamboo areas. One bird was seen in the small strip of bamboo forest at a place called Orukombankutty in-between the Orukomban river and the old tramway going to Parambikulam. In-between Vazhachal and Porungal dam in the eeta forest along the riverside one more bird was located.

Batrachostomus moniliger seen in Sholayar-Parambikulam areas:

1) Parambikulam area	..	7
2) Sholayar area	..	3
3) Orukombankutty	..	1
4) Vazachal area	..	1
	..	12

3) **Thattakadu :**

Thattakadu, situated at the foothills of Munnar is on the bank of Periyar river close to Narayamangalam. The old Munnar road ran through this forest area. This is one of the best areas for birds. The forest is semi-evergreen, but large scale plantations are also met with. The area is famous for eeta bamboo and cane forests. When Dr. Sálim Ali conducted the bird survey of Kerala, this area was one of the best virgin forest areas in Kerala and he had seen the Frogmouth here. The conditions have now completely changed and we could hardly see any untampered forest in the area. The catchment area of Periyar valley irrigation project extends up to the eastern side of Thattakadu. This provides water for agricultural activities, and which has induced people to invade and encroach the area for cultivation. This has changed the face of Thattakadu. Except for a few plantation and forest areas, this can be now considered as a village with coconut and banana pantations.

A two-week survey was conducted in this area for Frogmouth, but I could not locate any. Even a suitable habitat for the bird was not to be seen. However, this is still one of the best areas for other birds. The animal population also is very poor.

4) **Periyar-Sabarimala areas :**

Periyar wildlife sanctuary, situated at 9° 15′ and 9° 40′ north latitude and 76°55′ and 77°25′ east longitude, has varying altitudes from 900 m to 1800 m. The average annual rainfall is 2030 mm. The topography of the land is uneven and is covered by forest and grassland. The rugged terrain, virgin forest, deep lake and rushing brooks are favourite haunts for wild animals and birds. The area has a very pleasant climate. Maximum temperature is 30°C and minimum 15.5°C. Within the forest area, there is a conspicuous and extensive tableland at an altitude of 1400 m which is covered by grassland and is an ideal place for *Eurostopodus macrotis bourdilloni*. Vellimali is the highest peak in the area having an elevation of 2019 m. The Periyar, the longest river in Kerala, takes its origin from Sivagiri hills of Periyar sanctuary. The Sabarimala-Pamba forests are adjacent to Thekkady forest. This is one of the undisturbed areas of the Western Ghats. The famous pilgrim centre of the God Ayappa is at Sabarimala, and the present day expansion of Sabarimala temple is causing considerable damage to the adjoining forest areas. This forest is continuous upto Neyyar or even further towards Trivandrum side. Inaccessibility, was the main protective barrier of this area. After the construction of Pamba Hydro Electric Project, roads have been run through this forest, and as a result more and more damage is occurring to this forest. The forest in this area is typically Evergreen interspersed with grasslands. Semi-evergreen type also is met with in certain places. Important and common flora here are *Artocarpus hirsuta, Acacia intsia, Ailanthus malabarica, Asparagus racemosus, Bambusa arundinacea, Bombax ceiba, Butea frondosa, Calamus rheedii, Calamus rotang, Calamus travancoricus, Cassia fistula, Cedrela toona, Cycas circinalis, Dalbergia latifolia, Eleocarpus ferrugineus, Emblica officinalis, Ficus* sp.; *Ochlandra travancorica, Rhododendron arboreum, Solanum* sp., *Strobilanthes* sp; *Xylia xylocarpa,* etc. The maximum number of Frogmouth seen during the survey were observed in the Sabarimalai areas. 16 birds were located around Sabarimala and Pamba. Only one bird was seen in Periyar Wildlife sanctuary. This was located while walking to Mangaladevi hills from Kumuli along the side of a seldom-used forest road. I saw this bird sitting on a bare branch, and was the only one which I saw in a place where there was enough light for taking a photograph. Unfortunately, I did not have my camera with me at that time!

7 birds were located in Sabarimalai area between Uppupara and Pamba river. Out of this 3 were seen in the eeta bamboo forest on the western side of the temple. Two were observed among Strobilanthus plants, by the side of the pipeline road on the eastern side of the temple. One was seen among the forest area on the eastern side of Saramkutti among eeta. Another bird was seen in the forest area on the way to Pamba at a place called Appachikuzhi.

9 of them were seen on the other side of Pamba river, out of which 4 were seen in a narrow strip of forest near a place called Thrivani in Pamba. This area is not very far from human habitations in Pamba. 5 of them were seen in the forest area between Pamba Plapalli and Chalakkayam. The forest in these areas are very thick at a little distance from the main road. The main undergrowth is *Strobilanthes* sp.

All the birds located were seen during the day. One bird in Sabarmalai was seen during rain. Vijayan was also with me when I saw this particular bird, and it was only after three flights that we could locate the bird. In this case we went as close as 5 m of the bird, and it did not move even then. But when we moved closer, the bird turned its head towards one side, opened its eyes and flew away.

Batrachostomus moniliger seen in Periyar—Sabarimalai area:

1) Periyar Wildlife Sanctuary	..	1
2) Sabarimalai area	..	7
3) Pamba area	..	9
		17

Habitat of the Ceylon Frogmouth

According to available literature, the Frogmouth is a rare resident of evergreen biotopes of the Western Ghats. Sálim Ali notes them as nocturnal, shy and seldom seen, apparently not very vocal, hence possibly less rare than it appears. He came across it only once at Thatakkadu during his survey of the birds of Kerala. The habitat in which he saw the bird was dense secondary jungle with cane brakes. Vijayan saw a speciman flying from the bamboo forest during his survey of the Parambikulam Sanctuary.

The 34 birds located during the 6-month long survey were seen in different habitats. Bamboo and eeta forest along with *Solanum* and *Strobilanthes* undergrowth nearby, can be said to be the best habitat for the Ceylon Frogmouth. A forest disturbed either by man or by cattle is apparently unsuitable. An example is the Thattakad area, which was once a frogmouth area and now has none. Bamboo and eeta extinction also affects its population density. Big bamboo, especially the dead ones, provide them an ideal habitat. This also provides ample space for them to hunt their insect food. Plantations of various kinds are unsuitable. During the survey in Parambikulam, old teak plantations were also searched for frogmouth. Even though its natural habitats are developed in the plantations, I did not see any there. Highly suitable habitats for frogmouth were seen in places such as Silent Valley and Sabarimalai areas. In Parambikulam-Sholayar areas its natural habitat is much thinned out, hence they are concentrated in places where the natural habitat exists.

Habits of frogmouth

Being a shy and nocturnal bird, it is very difficult to study frogmouth during daytime. Nothing very important was noticed on the habits of the bird during the survey. It is very sluggish by nature, hence is easily approachable when at rest during daytime. During the survey I was able to get as close as 2 metres and even then the bird sat quietly on the branch. They were seen to rest with closed eyes and neck slightly pulled downwards. Sálim Ali describes it as perching with its bill pointing skywards; the birds I saw kept the bill somewhat parallel to the ground while resting. They were not seen coming to the ground at all. When disturbed, they often turn the head to either side and then bob the head twice or thrice before flying away. When they do this they were seen ruffling their neck feathers and also sometimes, the tuft of feathers above the eyes would project upwards. I think this happens when they are disturbed, because at rest the feathers lie sleekly against the body.

Field Characters:

The bird is about the size of a Myna, cryptically coloured with vermiculations of grey and brown streaked with black and white. They merge perfectly with dry bamboo poles or lichen-covered tree trunks where they spend most of their time. The female is slightly larger than the male, and more dull in colour. The white band around it's neck seems extended up to the hind neck forming a ring. (This is not visible when seen from a distance. Unless a bird is in hand one cannot note this correctly, and during the survey I did not have an opportunity). The tuft of feathers above the eyes are visible from a long distance. We (Vijayan and I) noted the iris as golden when the eyes were open. This was seen on the bird at Sabarimalai.

Calls, food, feeding and breeding activities were not studied during the survey. Before the survey while staying one night, at the Electricity Board rest-house at Sholayar with Dr. Paul Slud, Associate Curator, Division of birds at the National Museum of Natural History, Smithsonian Institution, in March we heard a call "Coroo, Coroo, Coroo" for a long time which Vijayan identified as the call of frogmouth. This was heard from a bamboo forest area on a moonlit night. During the survey, I also located one frogmouth from the same area.

Conclusion

During the six-month survey of the population of frogmouth, thirtyfour birds were seen in their natural habitat, the Evergreen forests of the Western Ghats in Kerala State. As Sálim Ali has stated in his survey report of birds of Kerala, 'it is possibly less rare than it appears'. The present survey report shows that even though they are not very common, they are not endangered. For the uninitiated, it is a very difficult bird to locate. As the time for survey was limited, I could not study much about its various activities. It is a cause for concern that it's natural habitat is being reduced day by day, and hence possibly the population of the birds also. The proposed Silent Valley project, if it takes place, will affect the frogmouths along with so many other birds and animals which are also facing the loss of their habitat. Its population in areas of the Western Ghats other than Kerala state and in Sri Lanka also, has to be studied without delay. The best place to conduct a study on the frogmouth is the Sabarimalai area. This area also is now subjected to high human disturbances for the development of the famous Sabarimalai temple and its surroundings.

Other interesting birds observed during the Survey:

BOURDILLON'S GREAT EARED NIGHTJAR (*Eurostopodus macrotis bourdilloni*):

Near Sholayar dam, on a full-moon night, I heard the continuous calls of Bourdillon's Great Eared Nightjar. It was very loud and I could hear it from the rest house, about a kilometre away from the place of the calls. It sounded somewhat like 'Vie-View, 'Vie-View' of a truck horn. I netted this bird after a few weeks, along with two Indian jungle Nightjar from the same area.

BROADBILLED ROLLER (*Eurystomus orientalis laetior*):

Four were seen during the survey. We saw one in Parambikulam Sanctuary on a tall dry tree by the side of a river. Another was seen in Thattakadu. Two were seen in Sabarimalai calling from a tree. It was raining at that time. The bird came close to the bungalow, where we were sitting and watching, and sat for a very long time on the electric wire in front of our bungalow cocking its short tail up and down. When it became dark it flew away. A pair was seen there and we suspected that they were breeding.

GREAT INDIAN HORNBILL (*Buceros bicornis*):

This was one of the commonest birds in places where I searched for the frogmouth, except at Thattakadu. In Thekkady, I once had the opportunity of seeing a flock of about 27 Great Indian Hornbills moving from one tree to another crossing the lake. I think it was a most uncommon sight indeed to see these birds in such a big group.

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I am grateful to Dr. Sálim Ali for suggesting the problem to me and his advice during the course of the Survey. I wish to express my sincere thanks to the following people and Organisations for the generous advice and help during the Survey. Mr. J. C. Daniel, Dr. V. S. Vijayan, Mr. S. A. Hussain, Bombay Natural History Society, Kerala Forest Research Institute and the Forest Department personal of Kerala and Madras States.

SPECIES MAINLY ENDANGERED SEEN DURING THE SURVEY

Species	seen		heard	Place
Presbytis johni (Nilgiri langur)	196		11	Silent Valley
	112		4	Parambikulam
	223		19	Periyar-Sabarimalai
Macaca silenus (Lion-tailed Macaque)	96		4	Silent Valley
	19		2	Parambikulam
	37		8	Periyar-Sabarimalai
Panthera tigris (Tiger)	1		..	Silent Valley
	..		..	Parambikulam
	..		..	Periyar-Sabarimalai
Panthera pardus (Panther)	1	(Black)	..	Silent Valley
	..		1	Parambikulam (Sholayar)
	..		..	Periyar-Sabarimalai
Cuon alpinus (Wild dog)	..		..	Silent Valley
	7		..	Parambikulam
	5		..	Periyar-Sabarimalai
Melursus ursinus (Sloth Bear)	..		..	Silent Valley
	2		..	Parambikulam
	1		..	Periyar-Sabarimalai
Elephas maximus (Indian Elephant)	56		..	Silent Valley
	31		..	Parambikulam
	67		..	Periyar-Sabarimalai
Bos gaurus (Gaur)	3		..	Silent Valley
	27		..	Parambikulam
	7		..	Periyar-Sabarimalai
Hemitragus hylocrius (Nilgiri tahr)	16		..	Silent Valley
	30		..	Parambikulam
	..		..	Periyar-Sabarimalai

Animals such as *Macaca radiata, Herpestes edwardsi,* Otter (*Lutra* sp.), *Funambulus* sp., *Hystrix indica, Cervus unicolor, Axis axis, Muntiacus muntjak, Tragulus meminna, Sus scrofa,* etc. were also seen during the survey.

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FURTHER REPORT ON THE TAXONOMY OF FOULING BRYOZOANS OF BOMBAY HARBOUR AND VICINITY[1]

S. R. Madhavan Pillai[2]

(*With nine text-figures*)

Nine species of fouling bryozoans from Bombay coast are described. One is a new subspecies and two are new records from Indian waters.

Introduction

Studies on the fouling communities of Bombay harbour and vicinity has established that bryozoans are a major group contributing to the problem of marine fouling here, perhaps next in abundance to barnacles (Iyengar *et al.* 1957, Gopalakrishnan & Kelkar 1958, Chhapgar & Sane 1966, Santhakumaran & Pillai 1970, Pillai & Santhakumaran 1972, Pillai 1978). In two previous communications (Pillai & Santhakumaran 1972 and Pillai 1978) taxonomic details of 3 species namely *Hippoporina indica* Pillai, *Electra belulla* Hincks and *Scrupocellaria harmeri* Osburn have been presented. This paper deals with the taxonomy of 9 more species representing 7 genera which includes one new subspecies and two new records from Indian waters.

Materials and Methods

Specimens were collected from timber test panels and submerged objects from Bombay harbour area and its vicinity.

To bring out taxonomic characters, the colonies were treated in sodium hypochlorite solution and stained lightly with ordinary fountain pen ink. Illustrations were made from such treated specimens with a camera lucida.

[1] Accepted November 1978.

[2] Forest Research Centre, Coimbatore.

Measurements of the various parts of the zooids are presented in the following form, which would be useful in evaluating the constancy of various taxonomic characters and in comparing populations from different areas, as suggested by Cheetham (1966): abbreviation of the item measured; number of specimens measured; mean; standard deviation; observed range. All measurements are in millimetres. Measurements were made from random samples of zooids selected from different colonies as far as possible. All the zooids measured were fully grown and mature. The following abbreviations are used for measurements:—

Lz = Zooid length
lz = Zooid width
Lo = Primary orifice length including sinus.
lo = Primary orifice width
Lov = Ovicell length
lov = Ovicell width
Lav = Avicularium length
lav = Avicularium width
Lopes = Opesia length
lop = Operculum width .

SYSTEMATIC ZOOLOGY

Order—CTENOSTOMATA Busk, 1852.
Suborder—VESICULARINA Johnston, 1847.
Family—VESICULARIIDAE Johnston, 1838.
Genus—*Zoobotryon* Ehrenberg, 1831.

Zoobotryon verticillatum (delle Chiaje), 1828.

(Fig. 1)

Hydra verticillata delle Chiaje, 1828:203.

Zoobotryon pellucidus Ehrenberg, 1831: no pagination.

Amathia goodie Verril, 1901:329.

Zoobotryon pellucidum Marcus, 1937:139.

Zoobotryon pellucidum Osburn, 1940:341.

Zoobotryon verticillatum (delle Chiaje) Maturo, 1957:25.

Occurrence: A drifting colony from Trombay, found entangled on a nylon rope used for exposing test panels. Several colonies from Versova Creek growing on a nylon rope placed about 2 m deep.

Description: Translucent colonies consisting of repeatedly and densely branched tufts growing several cm in length. Stolon divided into sections of 0.2 to 5 cm length with two to four branches arising from each joint; zooids ovoid or subcylindrical clustered irregularly at the distal ends of younger internodes, but arranged in two rows on each side of the older internodes. Polypide with 13 tentacles.

Measurements:

Lz (36)0.441(0.051)mm; 0.343—0.530 mm.

lz (36)0.204(0.027)mm; 0.156—0.234 mm.

Remarks:

Considerable differences were noticed in growth, internoding and distribution of zooids on the stolon between the colonies from Trombay and Versova. The Trombay specimens showed liberation of sperm through their tentacles to the neighbouring water. The occurrence of sperm liberation in this species was earlier reported by Bullivant (1967).

Previous records from Indian waters:

Vishakhapatanam harbour (Bay of Bengal) (Ganapathi & Rao 1968).

Distribution:

Widely distributed in the warm waters of the world including the Mediterranean and Adriatic.

Order—CHEILOSTOMATA Busk, 1852.

Suborder—ANASCA Levinsen, 1909.

Family—MEMBRANIPORIDAE Busk, 1854; Osburn, 1950.

Genus—*Membranipora* Blainville, 1830; Osburn, 1950.

Membranipora amoyensis Robertson, 1921,

(Fig. 2)

Membranipora amoyensis Robertson, 1921: 49.

Acanthodesia serrata Hastings, 1930:707 (not of Hincks, 1882).

Membranipora hastingsae Osburn, 1950: 29 (not of Marcus, 1937).

Membranipora annae Osburn, 1953:774.

Occurrence:

Several colonies collected from test panels exposed at Trombay (Bombay Harbour).

Description:

Colonies form whitish unilaminar or bilaminar encrustations. Zooids moderate in size, quadrangular in shape, alternately arranged and separated by conspicuous lines. Gymnocyst poorly developed with its distal rim slightly raised and possesses two areas of thin calcification at the corners—the 'lacunae'. An extensive cryptocyst, growing from the proximal part extending laterally and reaching up to the opercular level with regularly spaced spinules numbering from 7 to 12 extending from its inner margin, present. Small tubercules often found on the cryptocyst. 'Nodules' as described by Hastings (1930) developed from the 'Lacunae' of the distal rim in many zooids and growing as spines forward and backward with extensive branching. Vicarious avicularia, usually larger than normal zooid, possessing tongue-shaped mandible, often present. Polypide with 13 tentacles.

Measurements:

Lz(33)0.427(0058)mm; 0.343—0.655 mm.

lz(33)0.211(0.034)mm; 0.156—0.280 mm.

Lav(10)0.447(0.083)mm; 0.312—0.546 mm.

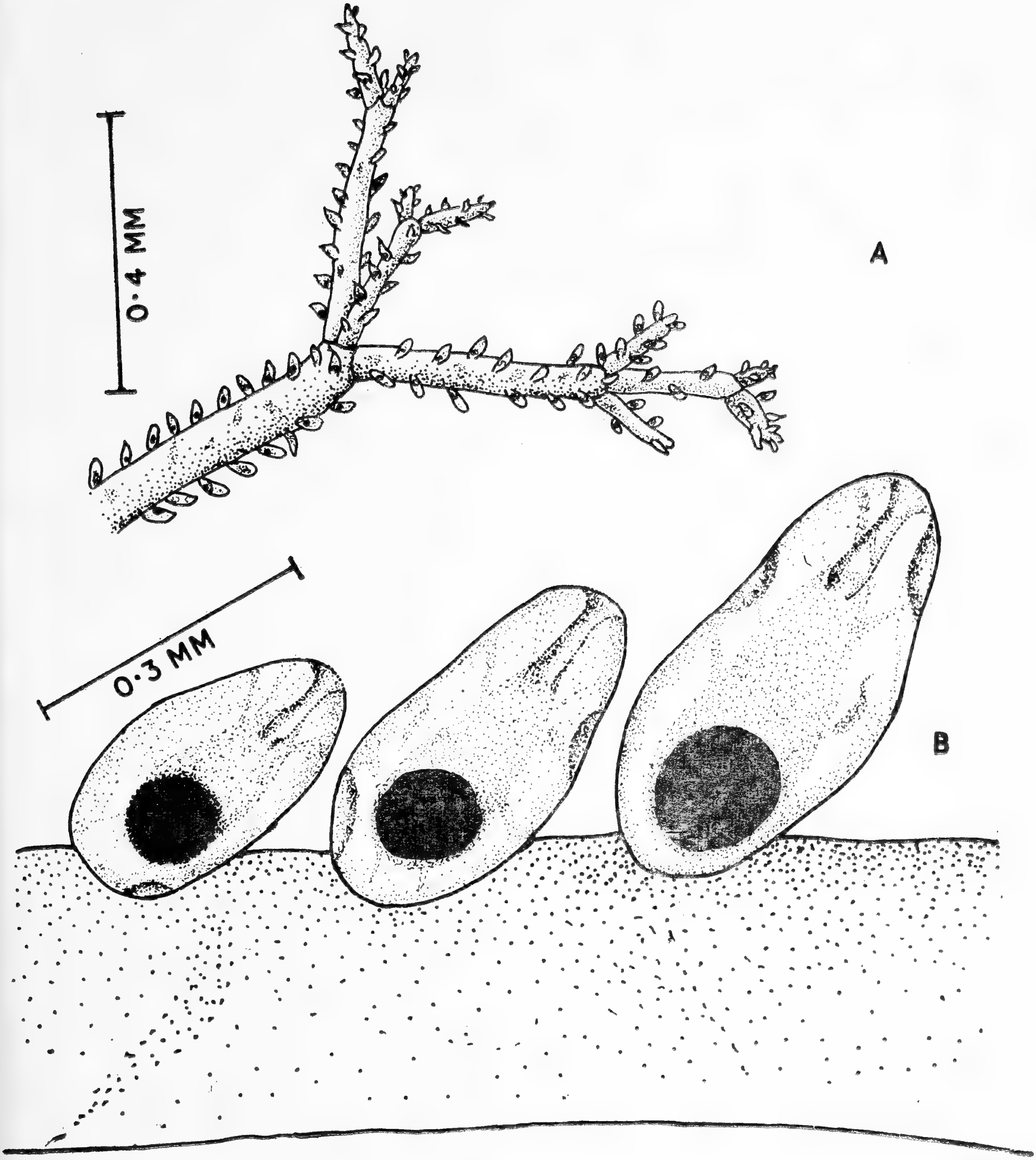

Fig. 1. *Zoobotryon verticillatum* (delle Chiaje)
A. Portion of colony showing internoding and arrangements of zooids. B. An internode bearing zooids.

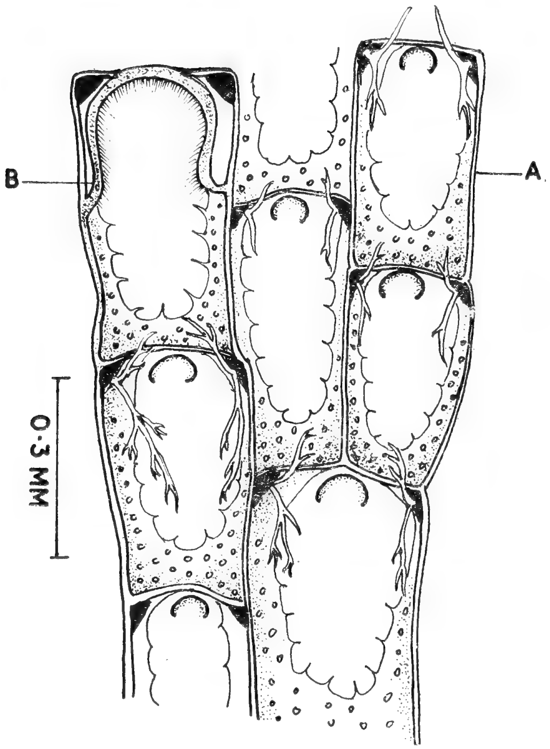

Fig. 2. *Membranipora amoyensis* Robertson—Portion of colony with normal zoids and a vicarious avicularium.
A. Zooid. B. Avicularium.

lav(10)0.242(0.024)mm; 0.202—0.280 mm.
lop(31)0.137(0.009)mm; 0.124—0.156 mm.
Lopes(32)0.327(0.055)mm; 0.218—0.390 mm.

Remarks:

A comparison of the descriptions and figures given by Osburn (1950 & 1953) with that of Robertson (1921) clearly indicates that both are one and the same. Examination of a large number of the present specimens showed almost all the characters mentioned by Robertson (1921), Hastings (1930) and Osburn (1950 & 1953). In addition, it is noticed that the spines developed from the 'lacunae' are capable of growing and branching more extensively. In many cases, they are long and densely branched and almost cover the opesia of the zooids from which they grow by their proximal growth and the proximal area of the succeeding zooid by their distal growth. Another difference noticed is in the size of the avicularia which, on an average, are larger than the normal zooids. It is reported by Cook (1968a) that *Membranipora annae* a synonym of this species is found in warm shallow waters where the salinity is reduced or variable. A study of the vertical distribution and seasonal occurrence of this species at Bombay Harbour area, however, showed that they occur up to the mud level at Trombay where the depth is about 9 m with maximum intensity just below the low water level and a marked decrease in their occurrence during the monsoon months when salinity dropped considerably. Maximum settlement was found to be during the post-monsoon period of the year.

Previous records from Indian waters:

Cochin harbour (Arabian sea) (Menon & Nair 1967).

Distributions:

Chinese coast (Robertson 1921) Panama canal (Hastings 1930, Osburn 1950, 1953; Powell 1971) West African Coast (Cook 1968 a).

Membranipora tenuis Desor, 1848.

(Fig. 3)

Membranipora tenuis Desor, 1848:66.
Membranipora denticulata Busk, 1856:176.
Biflustra denticulata Smitt, 1873:18.
Membranipora tenuis Verrill & Smith, 1874: 712.
Biflustra denticulata Verrill, 1878:305.
Membranipora tenuis Osburn, 1912:231; 1950:26.
Hemiseptella tuberosa Canu & Bassler, 1923:71.
Acanthodesia tenuis Mercus, 1937:42

Acanthodesia tenuis Osburn, 1940:353; 1944:35; 1947:9.

Acanthodesia tenuis Hutchins, 1945:539.

Membranipora tenuis Pearse & Williams, 1951:137.

Membranipora tenuis Maturo, 1957:35.

Occurrence:

Several colonies collected from test panels exposed at Trombay (Bombay harbour).

Description:

Colonies form whitish unilaminar or multilaminar encrustations. Zooids moderate in size, rectangular or quadrangular in shape, linearly arranged and separated by conspicuous lines; membranous ectocyst present; Gymnocyst very much reduced and mural rim finely beaded; distal wall slightly raised and arcuate; cryptocyst well developed, extending from the proximal end narrowly along lateral walls up to the distal end; its surface tuberculated and border serrated into short spines projecting inward; operculum well sclerited. Tentacle number varies from 10 to 13.

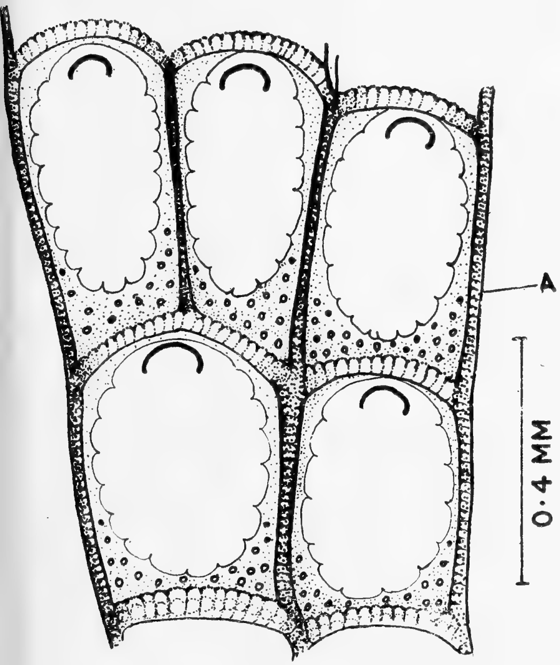

Fig. 3. *Membranipora tenuis* Desor—Portion of a colony showing the arrangement of zooids. A. Zooid.

Measurements:

Lz (32)0.417(0.078) mm; 0.310—0.765 mm.
lz (32)0.204(0.037)mm; 0.140—0.275 mm.
lop (32)0.146(0.011)mm; 0.124—0.156 mm.
Lopes (32)0.384(0.079)mm; 0.280—0.640 mm.

Remarks:

An examination of a number of colonies of the present specimens revealed that the features exhibited agree with the descriptions given by various authors for both *M. tenuis* and *M. perfragilis* except for the absence of avicularia in any of the colonies examined. Hastings (1945) and Osburn (1950) have confirmed in their description the presence of avicularia in *M. perfragilis*. Therefore, based on this difference the present specimens are tentatively classified under *Membranipora tenuis*. This species showed sperm liberation through tentacles. They occur along Bombay harbour area throughout the year with maximum intensity during post-monsoon period. They are vertically distributed from below low water level up to mud level at this harbour.

Previous records from Indian waters:

Bombay harbour (Arabian Sea).
(Gopalakrishnan and Kelkar 1958).

Distribution:

It occurs on the Atlantic coast from Massachusetts to Brazil.

Membranipora savartii (Audouin), 1826.
(Fig. 4)

Flustra savartii Audouin, 1826:240.

Biflustra savartii Smitt, 1873:20.

Membranipora savartii Osburn, 1914:194.

Acanthodesia savarti Canu & Bassler, 1923: 31; 1928:14.

Acanthodesia savartii Marcus, 1937: 40.

Acanthodesia savartii Osburn, 1940:352.

Acanthodesia savarti Osburn, 1947:9.
Membranipora savarti Osburn, 1950:27.
Membranipora savartii Maturo, 1957:35.
Acanthodesia savartii Chhapgar & Sane 1967:450.

Occurrence:

Several colonies collected from test panels exposed at Trombay (Bombay harbour).

Description:

Colonies form whitish unilaminar or multilaminar encrustations, zooids moderate in size, rectangular or quadrangular in shape, alternately arranged and separated by distinct lines. Gymnocyst poorly developed and the mural rim plane; cryptocyst well developed and its proximal part bears the most distinguishing part—the denticulate process projecting into the opesia. This process assumes varying shapes in different zooids and can be totally absent in certain zooids as illustrated by Harmer (1926). A few small spines may project into the opesia from its margin. Polypide with 12 tentacles.

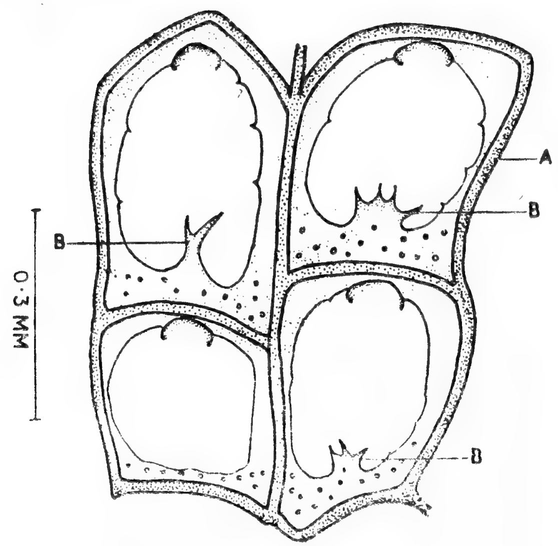

Fig. 4. *Membranipora savartii* (Audouin)—Part of a colony showing arrangements of zooids and different types of denticulate processes.
A. Zooid. B. Denticulate process.

Measurements:

Lz (41)0.329(0.029)mm; 0.280—0.405 mm.
lz (39)0.237(0.028)mm; 0.171—0.296 mm.
Lopes (39)0.271(0.025)mm; 0.218—0.312 mm.

Remarks:

The variability in the development of cryptocyst and the denticle developed from it is well exhibited in the present specimens. As may be noted from the diagram the denticle may assume the form of a multiserrated process or just a bifurcated spine. The mural rim and cryptocyst of the present specimens are completely devoid of tubercles. Sperm liberation, in this species is found to be through tentacles. This species occurs along Bombay coast throughout the year with maximum intensity during post-monsoon period. They are vertically distributed at Trombay from just below low tide level up to the mud level.

Previous records from Indian waters:

From Indian Ocean (Thornely 1907, as *Membranipora denticulata*), Bombay coast (Arabian sea) (Chhapgar & Sane 1966, Santhakumaran & Pillai 1970 as *Acanthodesia savartii*)

Distribution:

It is a common species around the world in warmer shallow waters.

Genus *Conopeum* Gray, 1848.

Conopeum reticulum (Linnaeus), 1767.
(Fig. 5)

Millepora reticulum Linnaeus, 1767:1284.
Membranipora lacroixii Robertson, 1908: 261.
Membranipora lacroixii var. *triangulata* O'Donoghue, 1923:25.
Conopeum reticulum Harmer, 1926: 211.
Conopeum reticulum Osburn, 1940:350; 1950:31.

Occurrence:

Several colonies collected from test panels exposed at Trombay (Bombay harbour).

Description:

Colonies form whitish unilaminar or multilaminar encrustations. Zooids moderate in size, hexagonal to oval in shape, alternately arranged and separated by distinct lines; Gymnocyst very much reduced and the opesia occupies the whole of the frontal surface. The gymnocyst bears the characteristic triangular area at the proximal corners; short spines seldom formed from both or one of these areas; cryptocyst almost uniformly formed around the opesia and its margin is characteristically crenated with small tubercles on it. Operculum strongly sclerited.

Measurements:

Lz(35)0.334(0.044)mm; 0.234—0.437 mm.

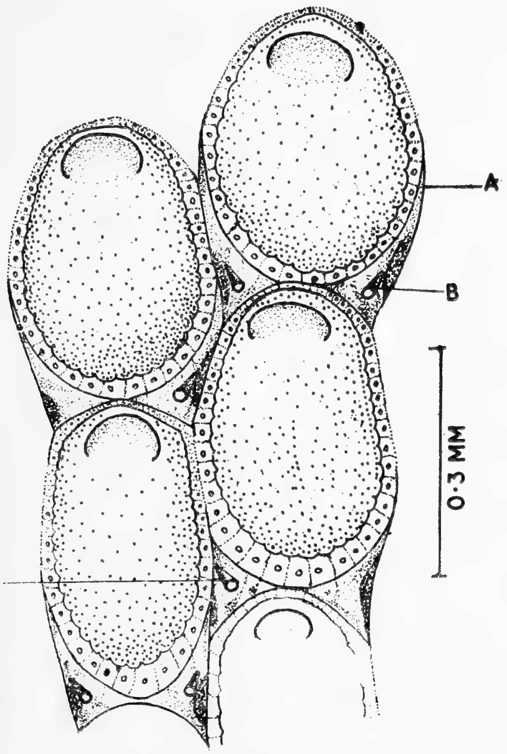

Fig. 5. *Conopeum reticulum* (Linnaeus)—Part of a colony showing the arrangement of zooids and the short spine arising from the triangular area. A. Zooid. B. Spine.

lz(35)0.171(0.037)mm; 0.078—0.249 mm.

Lopes (35)0.307(0.039)mm; 0.203—0.405 mm.

Remarks:

It is observed in the present specimens that the growths from the triangular area assume the form of short spines, not as tubercles as described by Osburn in case of his specimens. The cryptocyst showing conspicuous crenation is another speciality of the present specimens. Reproductive habits showed sperm liberation through tentacles in this species also. At Trombay this species is found to occur throughout the year with peak settlement during the post monsoon period. It is found vertically distributed from low water level up to mud level.

Previous records from Indian waters:

From Chilka lake (Bay of Bengal) (Annandale 1907).

Distribution:

In American waters it is recorded from Alaska to Southern California (Osburn 1950) and in Europe this species extends from Skagerrak and Kattegat down the Atlantic coast and possibly into Mediterranean (Ryland 1965).

Family Electrinidae d'Orbigny, 1851

Genus *Electra* Lamouroux, 1816.

Electra bengalensis (Stoliczka), 1869.

(Fig. 6)

Membranipora bengalensis Stoliczka, 1869: 55.

Membranipora bengalensis Thornely, 1907: 186.

Electra anomala Osburn, 1950:36.

Electra bengalensis Cook, 1968b: 141.

Occurrence:

Several colonies collected from test panels immersed at Trombay (Bombay port).

Description:

Delicate colonies forming whitish unilaminar or multilaminar encrustations or bushy clumps; zooids smooth, relatively large in size, quadrangular in shape and separated by thin lines; gymnocyst most pronounced at proximal part and extends distally in such a way as to form an oval opesia abruptly narrowing at the base of the operculum; marginal spines vary in number from 10 to 20 and of different size also, depending on the age of zooids. In older zooids, they form a roof above the frontal membrane; two short spines always present on either side of the operculum, looking as if arising from the distal zooids; a pair of characteristic spines, which ramify into branches in course of growth, present on the frontal surface of the semicircular operculum; cryptocyst not evident.

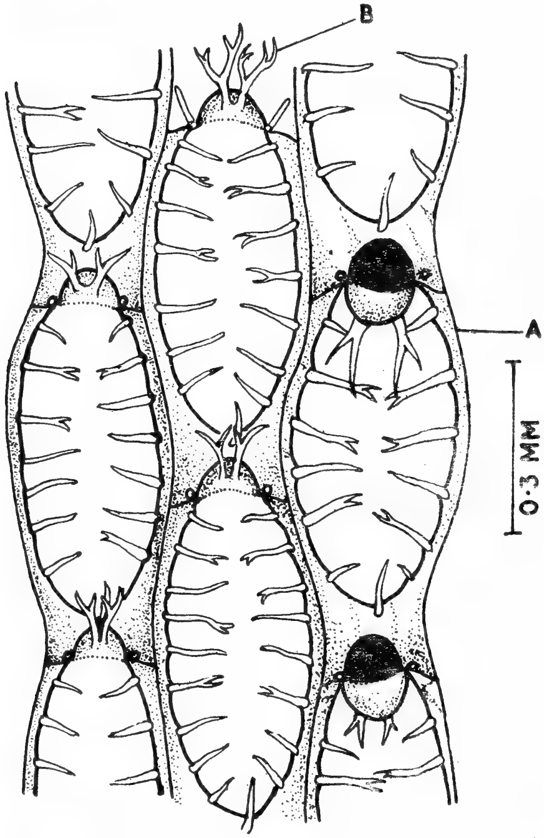

Fig. 6. *Electra bengalensis* (Stoliczka)—Part of a colony showing arrangements of the zooids and multibranched spines on the operculum.
A. Zooid. B. Multibranched spine.

Measurements:

Lz (31)0.614(0.05)mm; 0.468—0.702 mm.
lz (31)0.283(0.03)mm; 0.218—0.327 mm.
lop (38)0.143(0.01)mm; 0.124—0.156 mm.
Lopes (31)0.543(0.037)mm; 0.436—0.6 mm.

Remarks:

A special feature noticed in the present specimens is the multibranched nature of the paired spines present on the operculum in older zooids, whereas previous authors have mentioned bifurcated ones for their specimens. It may be a geographic variation or previous authors might have observed insufficiently grown colonies. Sperm liberation is through tentacles. At Trombay, this species occurs throughout the year with peak settlement during the post-monsoon period. It is found vertically distributed from low water level up to mud level at this place.

Previous records from Indian waters:

Port Canning ponds (Stoliczka); Snod Island (Thornely 1907); Visakhapatnam harbour (Ganapati & Satyanarayanan Rao 1968) (all from Bay of Bengal), Bombay harbour (Santhakumaran & Pillai 1970) (Arabian sea).

Distribution:

Balboa (Osburn 1950), Bay of Panama (Powell 1971), West Africa (Cook 1968a).

Suborder—ASCOPHORA Levinsen, 1909.
Family—SMITTINIDAE Levinsen, 1909.
Genus—*Smittina* Norman, 1903.

Smittina smittiella Osburn, 1947.
(Fig. 7)

Escharella landsborovi var. *minuscula* Smitt, 1873:60.
Smittina sp. (Marcus), 1938:44.
Smittina smittiella Osburn, 1947:37.
Smittina smittiella Osburn, 1952:404.

Occurrence:

A few colonies obtained from a big vertebra (possibly of whale) collected at 10 fathoms from Bombay.

Description:

Colonies form light brownish unilaminar or multilaminar encrustations with tubular expansions of zooids formed from them. Zooids distinct; rectangular and serially arranged. Frontal a tremocyst with a network of pores borne on small tubercles all over, numbering about 50; orifice almost circular, slightly wider than long with a pair of very delicate condyles. A broad lyrula with laterally projecting corners present. Orifice surrounded by a fairly raised collar. Secondary orifice has inward projections on its proximal side due to the presence of avicularia on it. Distal wall visible through the orifice due to its proximal inclination. Usually three suboral avicularia present on the proximal part of orifice—two laterals and one median; avicularia somewhat triangular with the frontal portion projecting into the secondary aperture and the rostrum directed away from the orifice. Lateral wall has 2 rows of communication pores, each having 6 pores. Distal wall with 4-6 pores scattered near the base.

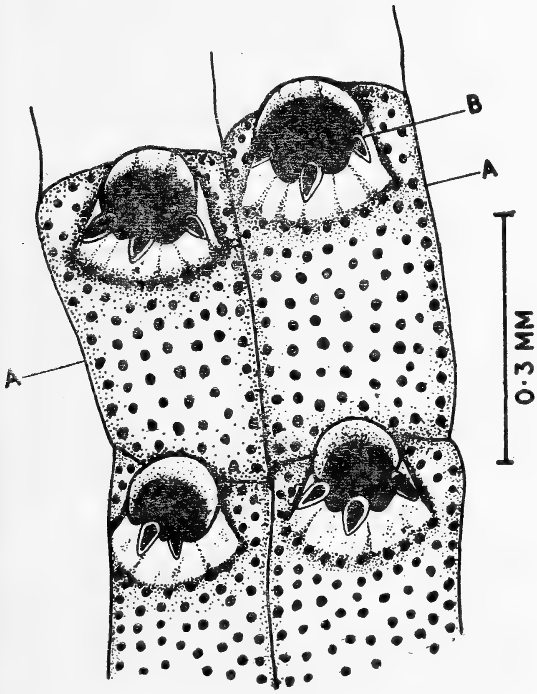

Fig. 7. *Smittina smittiella* Osburn—Part of a colony showing arrangements of zooids and the suboral avicularium.
A. Zooid. B. Suboral avicularium.

Measurements:

Lz(25)0.477(0.05)mm; 0.343—0.561 mm.
lz(25)0.227(0.02)mm; 0.187—0.265 mm.
Lo(25)0.083(0.006)mm; 0.078—0.094 mm.
lo(25)0.089(0.008)mm; 0.078—0.101 mm.
Lav(25)0.046(0.002)mm; 0.043—0.050 mm.

Remarks:

The present specimens agree in size and main features with Osburn's description (1947). However, the serrations or denticulations on the tip of the rostrum reported by him is absent in the present ones. Another difference noticed is the presence of three suboral avicularia on most of the zooids. These specimens do not show ovicell also. Perhaps it was collected before attaining sexual maturity.

Previous record from Indian waters:

This is the first record of this species from Indian waters.

Distribution:

Carribean sea, Florida, eastern Pacific (Osburn 1952). Bay of Santos, Brazil (Marcus 1938).

Genus—*Parasmittina* Osburn, 1952.

Parasmittina crosslandi serrata (subsp. nov.)
(Fig. 8)

Diagnosis:

A subspecies of *Parasmittina crosslandi* with orifice possessing serrated anter, devoid of lyrula and with nonporous ovicells.

Description:

Zoarium whitish, forming unilaminar or multilaminar encrustations with tubular expansions often formed from them; zooids quadrate to hexagonal in shape, arranged in quincunx, separated by vague calcareous lines. Frontal a granular pleurocyst having a row of areolar pores and occasionally additional pores at the distal part, totally numbering between 10 and 20. Orifice oblong, with delicate condyles dividing it into a semicircular anter and a slightly curved poster. Margin of the anter serrated into 'teeth' numbering between 11 and 14. Lyrula absent. Orificial collar of moderate height, discontinuous proximally giving rise to two or three upward projections, making the secondary orifice irregular in shape.

Avicularia of various sizes, 'lingulate', located proximal to the orifice. Rostrum mostly directed proximally, occasionally laterally also. A few zooids showed more than one avicularium.

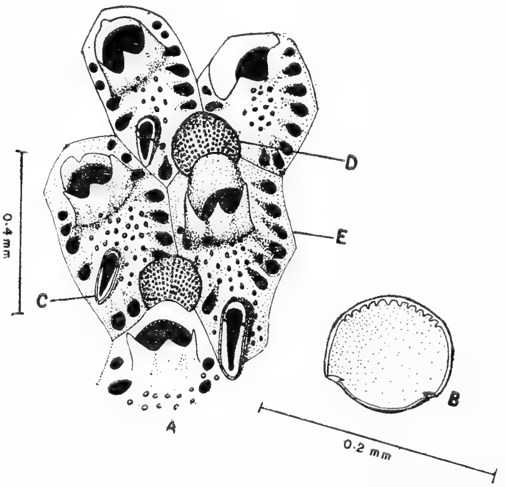

Fig. 8. *Parasmittina crosslandi serrata* (subsp. nov.) A. Part of colony showing arrangement of zooids. B. Orifice showing the anter with 'Serrations'. C. Avicularium. D. Ovicell. E. Zooid.

Ovicells hyperstomial, globular and partially embedded in the succeeding zooids. Small tubercles found all over.

Lateral wall with one row of 6 to 8 septula and distal wall with one row of 4 to 6 septula. Pores comparatively large in size.

Measurements:

Lz(25)0.422(0.050)mm; 0.280—0.520 mm.
lz(25)0.310(0.043)mm; 0.240—0.400mm.
Lo(25)0.105(0.012)mm; 0.080—0.120 mm.
lo(25)0.115(0.009)mm; 0.090—0.120 mm.
Lov(25)0.142(0.018)mm; 0.120—0.160 mm.
lov(25)0.174(0.018)mm; 0.160—0.200 mm.
Lav(25)................0.120—0.320 mm.

Comparison:

In general size and features the present specimens resemble *Parasmittina crosslandi* Hastings (1930) very much. It possesses the 'lingulate 'type of avicularia as reported by Osburn (1952). The configuration of the orificial collar is also more or less of the same pattern. However, the important difference observed is the presence of the teeth-like serrations on the border of the anter. This is a unique feature, so far not reported for any other species of this genus. The present specimens do not possess a lyrula also, further differentiating it from *P. crosslandi*. Yet another difference is the absence of pseudopores on ovicells.

Material:

A number of colonies obtained from a big vertebra (possibly of whale) collected at 10 fathoms from Bombay (19°05′N and 72°38′E).

Type specimens:

Holotype and paratype are deposited in the collection of Wood Preservation Centre (Marine) of the Forest Research Institute, at Central Institute of Fisheries Education, Bombay-400 061.

Family—Hippoporinidae Bassler, 1935.
Genus—*Hippoporina* Neviani, 1895.
Hippoporina porosa (Verrill), 1879.
(Fig. 9)

Escharella pertusa? (Esper) Verrill, 1875: 41.
Escharina porosa Verrill, 1879: 193.
Lepralia pertusa (Esper) Osburn, 1912: 214.
? *Hippodiplosia pertusa* (Esper) Hastings, 1930: 724.
Hippodiplosia pertusa (Esper) Osburn, 1933: 41.
Hippoporina porosa Maturo & Schopf, 1968:48.

Occurrence:

A number of colonies found encrusted on a big vertebra (possibly of whale) collected at 10 fathoms from Bombay.

Description:

Colonies form reddish brown unilaminar or multilaminar encrustations with tubular expansions of the zooids often formed from it. Zooids distinct, rectangular to hexagonal in shape and arranged serially; frontal a tremocyst with a network of 50 to 70 pores; orifice almost round, slightly wider than long, bipartite by strong condyles into large semicircular anter and small crescentic poster; avicularium absent; ovicells hyperstomial, prominent, globose and are perforated by small pores; lateral wall with two rows of communication pores numbering from 6-8 and distal wall with 8-12 communication pores scattered all round.

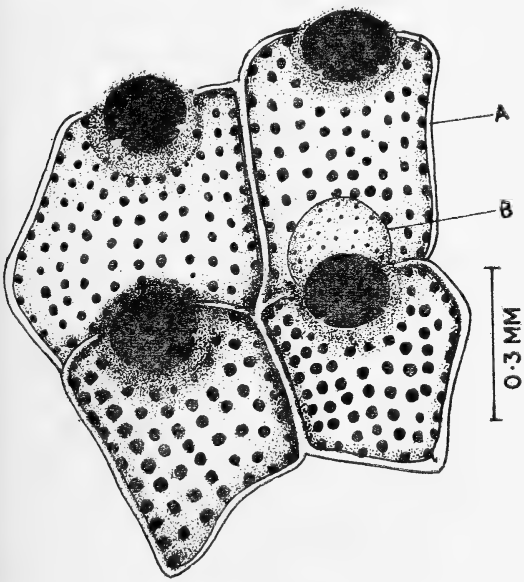

Fig. 9. *Hippoporina porosa* (Verrill)—Part of colony showing arrangement of zooids. A. Zooid. B. Ovicell.

Measurements:

Lz(26)0.497(0.071)mm;	0.360—0.640 mm.
lz(26)0.358(0.036)mm;	0.280—0.400 mm.
Lo(25)0.139(0.019)mm;	0.120—0.160 mm.
lo(25)0.159(0.019)mm;	0.120—0.200 mm.
Lov(21)0.350(0.032)mm;	0.280—0.400 mm.
lov(21)0.392(0.022)mm;	0.320—0.420 mm.

Remarks:

This species was erected by Verrill in 1879 as *Escharina porosa* for the material he collected in 1874 and first described in 1875 as being possibly representative of *Escharella pertusa* (Esper). Later, in 1912, Osburn described it as a synonym of *Cellepora pertusa* Esper, 1796, the type genus of *Hippoporina* Neviani, 1895. Recently Maturo & Schopf (1968) re-examined the species described by Verrill and commented that "there are at least five concepts of *pertusa* Esper, none of which encompasses *porosa* Verrill". Elucidating these points, they have confirmed the validity of Verrill's species. The present specimens agree in most of the features with the photograph of Verrill's specimens given in Maturo and Schopf's publication (Maturo & Schopf 1968, p. 87, fig. 12A). Length and width of the zooids and the nature of frontal are very similar. However, dimensions of the orifice and ovicells show slight differences. In the present case the orifices are slightly smaller and ovicells are slightly bigger than in Verrill's specimens. Nature of communication pores is almost similar.

Previous records from Indian waters:

This is the first record of this species from Indian waters.

Distribution:

"Vine Yard, Sound and Long Island Sound, 8 to 12 fathoms" (Verrill 1879) Gorgona, Colombia, Galapagos Islands (Hastings 1930).

ACKNOWLEDGEMENTS

The present work was carried out at the Central Institute of Fisheries Education, Bombay, under the Centre of Wood Preservation Branch, Forest Research Institute, Dehra Dun. The author is indebted to Mr. K. H. Alikunhi, former FAO Project Manager, Indonesia for suggesting the problem, to Prof. N. K. Velankar, former Director, Central Institute of Fisheries Education, Bombay for providing facilities and to Dr. L. N. Santhakumaran, Research Officer, Wood Preservation Centre, Bombay for his co-operation.

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SPECIES OF *CHIONANTHUS* SW. (= *LINOCIERA* SW.) (OLEACEAE) IN THE INDO-BURMESE REGION[1]

K. K. N. Nair and K. P. Janardhanan[2]

Introduction

Linociera Sw. (Schreb. Gen. 2: 784, 1791) is a tropical genus and the species under it occurring in Indo-Burmese region had been referred earlier under either *Linociera* Sw. (Clarke 1882, Prain 1903, Cooke 1908, Duthie 1911, Haines 1922, Gamble 1923, Alston 1931, Kanjilal *et al.* 1939, Abeywickrama 1959) or *Chionanthus* Linn. (Roxburgh 1820, Thwaites 1860, Beddome 1871, Kurz 1877).

Recently, W. T. Stearn (1976), based on a survey of the morphological and palynological characters in a diversity of the species from America, Africa and Asia, has considered these two as congeneric, thus confirming the earlier observation of Thwaites (1860) that there seems scarcely any ground for separating *Linociera* as a genus distinct from *Chionanthus*. Accordingly, *Chionanthus* Linn. with the type species *Chionanthus virginicus* Linn. is the valid name for the combined taxon. Various taxa belonging to the genus *Chionanthus* Linn. in India, Burma and Sri Lanka together with their range of distribution is enumerated below. In order to make the nomenclature up-to-date, 12 nomenclatural combinations have also been proposed.

Chionanthus

Linn. Sp. Pl. 1: 8, 1753; Gen. Pl. ed. 5: 9, 1754. Species lectotypical: *C. virginicus* Linn.

[1] Accepted November 1979.

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Enumeration of the species

1. **Chionanthus axillaris** R. Br. Prodr. 523, 1810.
   C. albidiflora Thw. Enum. Pl. Zeyl. 189, 1860. *Linociera albidiflora* (Thw.) Clarke in Hook. f. Fl. Brit. India 3: 608, 1882; Alston in Trim. Handb. Fl. Ceylon 6 (suppl.): 189, 1931; Abeywickrama, Ceylon J. Sci. 2(1): 210, 1950, Sri Lanka.
2. **Chionanthus axillaris** R. Br. var. **prostrata** (Thw.) Nair et Janardh. comb. nov. *Chionanthus prostrata* Thw. Enum. Pl. Zeyl. 189, 1860. *Linociera albidiflora* (Thw.) Clarke var. *prostrata* (Thw.) Clarke in Hook. f. Fl. Brit. India 3: 608, 1882, Sri Lanka.
3. **Chionanthus leprocarpa** Thw. Enum. Pl. Zeyl. 189, 1860; Bedd. For. Man. Bot. 154, 1872. *Linociera leprocarpa* (Thw.) Clarke in Hook. f. in Fl. Brit. India 3: 608, 1882; Alston in Trim. Handb. Fl. Ceylon 6 (suppl.); 189, 1931; Abeywickrama, Ceylon J. Sci. 2(1): 210, 1959. Sri Lanka.
4. **Chionanthus leprocarpa** Thw. var. **courtallensis** (Bedd.) Nair et Janardh. comb. nov. *Chionanthus courtallensis* Bedd. For. Man. Bot. 155, 1872. India: S. India (Kerala, Tamilnadu).
5. **Chionanthus linocieroides** (Wt.) Nair et Janardh. comb. nov. *Olea linocieroides* Wt. Icon. t. 1241, 1848. *Linociera wightii* Clarke in Hook. f. Fl. Brit. India 3: 608, 1882; Gamble, Fl. Pres. Madras 1(5): 794, 1923. *Linociera linocieroides* (Wt.)

K. K. N. Nair (ined.). India: S. India (Kerala, Tamilnadu).

6. **Chionanthus macrocarpa** Bl. Mus. Bot. Ind. Bat. 1: 319, 1850. *C. insignis* Miq. Fl. Ind. Bat. suppl. 559, 1860. *Linociera insignis* (Miq.) Clarke in Hook. f. Fl. Brit. India 3: 610, 1882. *Chionanthus montanus* Kurz, For. Fl. Brit. Burma 2: 159, 1877 & in J. As. Soc. Bengal pt. 2: 243, 1877 (non Bl.). *Linociera montana* G. Don, Gen. Syst. 4: 53, 1887. *Linociera macrocarpa* (Bl.) King et Gamble, J. As. Soc. Bengal 74: 11, 1906. Burma; Sumatra.

7. **Chionanthus macrophylla** Bl. Mus. Bot. Lud. Bat. 1: 319, 1850. *Linociera macrophylla* (Bl.) Wall. ex G. Don, Gen. Syst. 4: 53, 1837; Clarke in Hook. f. Fl. Brit. India 3: 610, 1882; Gamble, Fl. Pres. Madras 2(5): 795, 1923; Kanjilal *et al.* Fl. Assam 3: 236, 1939. India: E. India (Assam); S. India (Andhra Pradesh, Kerala, Tamilnadu); Burma.

8. **Chionanthus macrophylla** Bl. var. **attenuata** (Clarke) Nair et Janardh. comb. nov. *Linociera macrophylla* Wall. ex G. Don var. *attenuata* Clarke in Hook. f. Fl. Brit. India 3: 610, 1882. *Linociera attenuata* Wall. Cat. no. 2239, 1831 (*nom. nud.*). India: Andaman Islands; Burma.

9. **Chionanthus malabarica** (Wall. ex G. Don) Bedd. For. Man. Bot. 154, 1872 & Fl. Sylv. t. 239, 1872. *Linociera malabarica* wall. (Cat. no 2828, 1831. (*nom. nud.*) ex G. Don Gen. Syst. 4: 53, 1837; Wt. Icon. t. 1246, 1848; Clarke in Hook. f. Fl. Brit. India 8: 607, 1882; Cooke, Fl. Pres. Bombay 2: 117, 1908; Haines, Bot. Bih. & Orissa pt. 3: 528, 1922; Gamble, Fl. Pres. Madras 1(5): 794, 1923. India: (Maharashtra, Karnataka, Kerala, Tamilnadu, Orissa).

10. **Chionanthus minutiflora** Kurz, For. Fl. Brit. Burma 2: 159, 1877 & in J. As. Soc. Begnal 1877, pt. 2: 243, 1877. *Linociera minutiflora* (Kurz) Clarke in Hook. f. Fl. Brit. India 3: 610, 1882. Burma.

11. **Chionanthus paniculata** (Roxb.) Nair et Janardh. comb. nov. *Olea paniculata* Roxb. Fl. Ind. 1: 104, 1820 (non R. Br. 1810). *Chionanthus smilacifolius* Wall. ex Roxb. Fl. Ind. 1: 108, 1820. *Linociera intermedia* Wt. Icon. t. 1245, 1848; Clarke in Hook. f. Fl. Brit. India 3: 609, 1882; Haines, Bot. Bih. & Orissa pt. 3: 528, 1922; Gamble, Fl. Pres. Madras 2(5): 794, 1923. *Chionanthus intermedia* (Wt.) Bedd. Fl. Sylv. t. 239, 1871. *Linociera paniculata* (Roxb.) K. K. N. Nair (ined.). India: S. India; Burma.

12. **Chionanthus paniculata** (Roxb.) Nair et Janardh. var. **roxburghii** (Spreng.) Nair et Janardh. comb. nov. *Olea roxburghii* Spreng. Syst. 1: 34, 1822. *Olea roxburghiana* Roem. & Schult. Syst. Veg. 1: 77, 1822. *Linociera intermedia* Wt. var. *roxburghii* (Spreng.) Clarke in Hook. f. Fl. Brit. India 3:609, 1882; Prain, Bengal Pl. 1: 661. 1903; Cooke, Fl. Pres. Bombay 2: 111, 1903; Duthie, Fl. Upper Gang. Pl. 2: 26, 1911; Haines, Bot. Bih. & Orissa pt. 3: 528, 1922. India: (Andhra Pradesh, Orissa, Bihar, Uttar Pradesh, Sub-Himalayan tracts, Maharashtra, Karnataka).

13. **Chionanthus parkinsonii** (Hutch.) Nair et Janardh. comb. nov. *Linociera parkinsonii* Hutch. Kew Bull. 1919: 227, 1919. India: Andaman Islands.

14. **Chionanthus pauciflora** (Clarke) Nair et Janardh. comb. nov. *Linociera pauciflora* Clarke in Hook. f. Fl. Brit. India 3: 609, 1882. *Olea pauciflora* Wall. Cat. no. 2812 'pt. a', 1831 (*nom. nud.*). Malaya.

15. **Chionanthus pauciflora** (Clarke) Nair et Janardh. var. **evolutior** (Clarke) Nair et Janardh. comb. nov. *Linociora pauciflora* Clarke var. *evolutior* Clarke in Hook. f. Fl. Brit. India 3: 609, 1882. India: Andaman Islands; Burma; Malaya.

16. **Chionanthus pauciflora** (Clarke) Nair et Janardh. var. **palembanica** (Miq.) Nair et Janardh. comb. nov. *Chionanthus palembanica* Miq. Fl. Ind. Bat. Suppl. 558, 1860; Kurz, For. Fl. Brit. Burma 2: 159, 1877 & in J. As. Soc. Bengal 1877, t. 2: 243, 1877. *Linociera pauciflora* Clarke, var. *palembanica* Clarke in Hook. f. Fl. Brit. India 3: 609, 1882. India: Andaman Islands; Burma.

17. **Chionanthus terniflora** (Kurz) Griff. Notul. 4: 740, 1854. *Olea terniflora* Kurz, For. Fl. Brit. Burma 2: 157, 1877 & in J. As. Soc. Bengal 1877, pt. 2: 244, 1877. *Linociera terniflora* (Kurz) Wall. ex Clarke in Hook. f. Fl. Brit. India 3: 610, 1882; Prain, Bengal Pl. 1: 661, 1903; Kanjilal *et al.* Fl. Assam 3: 236, 1939. India: Assam; Bangladesh; Burma.

18. **Chionanthus terniflora** (Kurz) Griff. var. **acuminata** (Clarke) Nair et Janardh. comb. nov. *Linociera terniflora* (Kurz) Wall. ex Clarke in Hook. f. Fl. Brit. India 3: 610, 1882. Burma.

19. **Chionanthus zeylanica** Linn. Sp. Pl. 8, 1753; Thw. Enum. Pl. Zeyl. 188, 1860; Roxb. Fl. Ind. 1: 36, 1820. *Linociera purpurea* Vahl, Enum. 1: 47, 1804; Clarke in Hook. f. Fl. Brit. India 3: 608, 1882. *Linociera zeylanica* (Linn.) Gamble, Fl. Pres. Madras 2(5): 794, 1923; Alston in Trim. Handb. Fl. Ceylon 6 (suppl.): 189, 1931; Abeywickrama, Ceylon J. Sci. 2(1): 210, 1950. *Thouinia natans* Linn. f. Suppl. 89, 1781. India: S. India (Andhra Pradesh, Kerala, Tamilnadu); Sri Lanka.

20. **Chionanthus zeylanica** Linn. var. **dichotoma** (Wall. ex Clarke) Nair et Janardh. comb. nov. *Linociera purpurea* Vahl var. *dichotoma* Wall. (Cat. no. 2825, 1831. (*nom. nud.*) ex Clarke in Hook. f. Fl. Brit. India 3: 608, 1882. Sri Lanka.

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MADHYA PRADESH FORESTS REVISITED[1]

C. E. Hewetson[2,3]

(*With a plate*)

In the recent cold weather of 1980-81 I spent two months in India for part of the time as a guest of the Forest Departments of Madhya Pradesh and Maharashtra. I had come out after 25 years retirement to re-visit the Forests in which I had worked since 1926, naturally my wife and I looked forward to renewing our acquaintance with the beautiful and engaging bird population of the plains of India.

On our first morning in Delhi in the attractively placed International Centre and the adjacent Lodi Gardens, we were reminded at once how beautiful are many of the commonest birds. Who can deny the thrill of seeing their first flock of parrakeets, flashing in the sunlight and hearing their exuberant calls? Or the perkiness of the Mynahs as they strut about your feet? How smart the White Breasted Kingfisher is and how good to relish again the wicked and predatory look of the crows, how commonplace to the native, how delightful to the returning visitor!

In 1956 I had contributed an article[4] published in the *Journal* of the Bombay Natural History Society recording my observations of the birds of the old Central Provinces for the 29 years I had served in the state. As we journeyed south from Delhi to Bhopal, the Satpura Forests and on to Nagpur and then to Chanda and the Melghat, we kept a record of the birds seen and clearly identified. As we were mostly taken about by the Forest Department who were eager to show their work, we did not have time to walk about a great deal in the forest and as we were usually accompanied by a number of Forest Officers we did not have the leisure to walk quietly and to sit down and listen to the bird calls which is one of the best ways to find out what birds are present. I had made the point in my article that after years of short rainfall such as 1951-53 the bird population was very reduced particularly of the insect eating birds. I understand that in the last 10 years there have been years of deficient rainfall, the most recent being 1978, and that the rains finished abruptly in 1980. The cold weather was also the time when there were fewer birds in Central India both by species and numbers. So our record of birds seen is only of small scientific value but may have some interest as one man's view after 25 years of absence.

One of the birds I looked forward to seeing particularly was the Whitebrowed Fantail Flycatcher (*Leucocirca aureola* Lesson) recorded by me in 1958 "as one of the commonest and most widely spread birds of the state found in all places where there are some trees and woody growth". I had always enjoyed its grace and the cheerful dancing motions which perhaps have a biological purpose

[1] Accepted April 1981.

[2] Longcross Farm, Headley, Newbury, Berks, England.

[3] The author was the last serving British forest officer in India after Independence. He retired in 1955 as Chief Conservator of Forests of the former 'Central Provinces'—Eds.

[4] Observations on the bird life of Madhya Pradesh. Vol. 53(4): 595-645.

but to humans an added and aesthetic pleasure. We did not see a single specimen in all our travels and one wonders whether this was a chance failure or less the bird become rare or extinct in part of its range? We saw the allied species the Whitespotted Fantail (*R. pectoralis*) on three occasions, once in a deep ravine on the Pachmarhi Plateau, once in Allapalli and once in the Melghat but this was in line with my previous observations that it was a species of deep forest.

Another of the colourful and fascinating common birds, the Blue Jay or Roller was not recorded until we were well into Madhya Pradesh and I feared this was another species on the decline but subsequently we saw it in normal numbers.

On the other hand many of the other common species were seen in great numbers. Wherever we went in the forest we saw numerous families of Jungle Babblers and the Common Babbler in more open country. Common Mynahs were everywhere, and at places we saw great numbers of the Spotted Dove and the Ring Dove. Particularly at the Bharatpur Sanctuary and round Delhi one could quite see why the Ring Dove had found it expedient to move out and colonise Europe. Two other birds which we saw everywhere and in good numbers were the Magpie Robin, even in the Forest, and the Indian Robin.

The game birds are a group of birds which have benefitted from the high price of cartridges and the end of prestige shooting parties. That Bharatpur should have become an internationally famous sanctuary is evident to anyone fortunate enough to visit it, but elsewhere wherever we went we could see large parties of ducks of many different species serenely and quietly resting during the day and obviously with little fear of man. I was particularly pleased to see that the Spotbill was found in good numbers. I had noticed in 1956 that I had recorded it in only one district and said "it is the sort of bird which might disappear altogether without anyone being sure when the last bird was seen". The Peafowl and Jungle Fowl have also benefitted from the reduction in small game beats and we saw them plentifully in the Forest and in cultivation—and both the Red and Grey Jungle Fowl.

It was not until we were at Bharatpur and saw several family parties of Sarus Crane that I realised I had not seen any birds in Madhya Pradesh or Maharashtra though we travelled many miles in the rice growing districts of Bhandara, Balaghat and Chanda. Let us hope this was only a piece of bad luck on our part as the great expansion of irrigation and building of many new tanks should have increased their potential feeding grounds, but perhaps the abrupt end to the rains in Central India in September 1980 may have caused them to move to moister areas. Species which have obviously benefitted from the great expansion of irrigation both from reservoirs and wells have been the Egrets. We saw them everywhere even in Rajasthan and Delhi District.

Some other species which I looked forward to seeing we did not record, but as they were always rather irregular in distribution it may have no significance. For instance the Brahminy Kite was recorded by me as "resident and well-distributed throughout the State". I had always admired his rather tasteful brown and grey plumage and he was one of the birds I had looked forward to seeing. Another favourite bird was the Indian Crested Swift (*Hemiprocne coronata*) which I had recorded as "a very regularly distributed bird in nearly all the Forests of the State". It is a particularly graceful flyer and fascinating when it skims the water to drink, and one can admire a bird which has evolved such a miniature nest only large enough to hold one egg and

Teak forest

Sal forest

consisting of scraps of bark and feather gummed together with saliva.

If such relatively common species can become difficult to see, what about birds already recorded with an irregular distribution? Looking back at my notes several species are brought to mind which I saw only in a few localities. Such as the Emerald Dove, the Bank Mynah, the Jungle Mynah, the Indian Grackle and the Green Munia (*Estrilda formosa*).

It seems quite possible that small isolated colonies of such species might die out with no one to remark on their disappearance. We need observers all over India who could record their bird watching particularly on such species as noted above. However expert in Forestry, I met few officers who could recognise any but the most common birds, and a few who had gained a reputation for knowing about birds proved in conversation to be of doubtful value. The example of a bird like Jerdon's Courser (*Cursorius bitorquatus*) is a case in point. The bird has not been recorded since 1900 and was only described from a very restricted range in the Deccan. With wild life conservation becoming a subject on its own and a separate Department, it may be hoped that officers in the serivce may be encouraged to learn to identify birds and to be aware of which species are at risk to the same extent as the animals.

Which turns my mind to the animal popu lation and the number of different species you could see in 1926 when I first came to India. I was in time to see herds of Black Buck and Chinkara in the fields as one travelled in the train from Bombay. When I first joined the service in the Forests of the old Central Provinces it must be admitted that the major subject of conversation was Shikar. The main concern of the Forest Staff was protection and exploitation was only just beginning to be important. Large parts of the Forest were unworkable at a profit due to distance from market or lack of roads. The needs of the local population were met from the Malaguzari forests. Coupes were usually sold standing to contractors and illicit fellings were uncommon as supervision could be strict. The Forest Officer could tour for months with a secure feeling that nothing was likely to interrupt his leisurely progress through the Forest unless it was a fire when he would consider it his duty to lead his subordinates and villagers to put it out.

Naturally there were parts of the Forest where Carnivora were not to be found, but Tigers were found in most places and the favorite tiger territories were well known and if the terrain was suitable for beats the officer would arrange his touring to get some days' halt at such places.

The best blocks were sometimes reserved for District Officers but there were regular applications by people coming to shoot. Perhaps the majority were Army officers but also businessmen came. There would usually be a limit placed on the number of animals to be shot. Only Stags could be killed but game of all species could be seen and were not anything especially to be remarked. The carnivores had only the officers and block holders to fear as there were few crop protection licences and guns were called in at the end of the harvest. Now with many guns in the villages and knowledge of how to poison kills and other lethal devices, even an official ban on tiger shooting and on the trade in trophies may not be effective and one can well imagine that tigers and panthers may face many more dangers than 50 years ago. To be effective, protection has to be well organised and not dependent only on the Law.

I was impressed by the logical way they have proceeded in the Kanha National Park in Madhya Pradesh. They have persuaded the villages within the park to accept land in villages outside and have resettled them with new houses and land. This has removed two sources of danger to wild life. There is no longer damage to the villagers' crops by the deer and less chance of the tigers falling victims to poison or village traps. The deer can increase and provide sufficient prey to support a viable population of Tigers. On the other hand in the Melghat Tiger Project in Maharashtra there are many large villages which cannot be resettled and only a small part which they call the 'Core' is sufficiently remote for the Tigers to be left undisturbed for breeding and safe from villagers. However though this is a tract of great natural beauty with steep slopes it seems unlikely to carry a great number of Herbivores and consequently can support only a few Tigers. In this wild country we were rewarded by seeing a male of the Paradise Flycatcher. My wife had only seen the bird once before and this was an unlooked for bonus as I had previously noted it was more common as a summer migrant. Its beauty is so outstanding that one can in retrospect recall the place where the bird is seen even many years after.

So I look back on a wonderful two months in India and again I am filled with admiration of the Animal and Bird population. There are so many beautiful birds and there is still so much to be learnt about their status and breeding. There is the constant threat to the habitat as the human and cattle population increases, but there does seem to be a greater awareness of the Wild Life than when I was in India 25 years ago.

I hope interest in the birds will increase in the schools and colleges so that sufficient bird watchers will be found all over the country to monitor the changes in the population and the status of individual birds: and to add numerous correspondents bombarding the Bombay Natural History Society with information and details of many species.

Finally I must refer to the actions of the Forest Development Corporations and Forest Departments in the conversion of the natural mixed forests to pure plantations of teak, sal or even *Eucalyptus* spp. This must have an effect on the populations of different bird species and animals in a way which cannot be forecast. I am sure all conservationists would like to see significant belts of the natural forest left between blocks of plantations so as to maintain the environment to which different species are adapted and to help control the damage done by insect pests in large stretches of pure plantations.

NEW DESCRIPTIONS

ON SOME NEW SPECIES OF *TETRASTICHUS* HALIDAY (HYMENOPTERA: EULOPHIDAE)[1]

M. YOUNUS KHAN AND S. ADAM SHAFEE[2]

(*With three text-figures*)

Tetrastichus indicus sp. nov.
(Fig. 1, A-L)

Female

HEAD (Fig. 1 A).—Dark brown, wider than long in facial view (0.39:0.28 mm); front-overtex much wider, more than one-half the total head width; ocelli white, arranged in obtuse triangle, lateral ocelli more than their own diameters from orbital margin and less than their own diameters from occipital margin; eyes red and smooth: antennae inserted at lower level of eyes; prominence between antennal sockets one-third the width of frons between eyes; malar space longer than eye width; malar sutures distinct; lower margin of clypeus without dents medially; mandibles tridentate with apical tooth acute, mesal rounded and lower rudimentary (fig. 1 B); maxillary and labial palpi each 1-segmented (fig. 1 D).

ANTENNAE (Fig. 1 C).—Yellowish brown, 8-segmented excluding one ring segment; scape cylindrical, four times as long as wide (0.12: 0.03 mm), longer than basal two funicle segments together; pedicel twice as long as wide, slightly longer than first funicle segment; funicle 3-segmented, segments 1-3 gradually decreasing in length distad; first funicle segment one and a half times as long as wide, second slightly longer than wide, third as long as wide; club 3-segmented, slightly more than two times as long as wide, longer than preceding two funicle segments together.

THORAX (Fig. 1 E).—Dark brown; pronotum with posterior margin slightly concave and with 4 pairs of setae, anterior margin concave in middle (fig. 1 G); parapsidal furrows complete; scutum with a mid-longitudinal groove and 3 setae in single row near each parapsidal furrow; scutellum slightly shorter than scutum with two submedian grooves and two pairs of setae, posterior margin rounded; each parapside with single seta; mesopostphragma not reaching beyond the propodeum; propodeum with a well developed median carina.

FORE WINGS (Fig. 1 F).—Hyaline, slightly less than two and a half times as long as wide, apex broadly rounded; costal cell as long as marginal vein and with 2 small setae; submarginal and marginal veins with 1 and 8 setae respectively; postmarginal vein absent; marginal fringe short, spaced by a distance equal to one-fourth their length.

HIND WINGS.—Hyaline, six times as long as wide (0.74:0.12 mm); marginal fringe long, one-half the wing width, spaced by a distance equal to one-sixth their length.

LEGS.—Yellow except coxae and pretarsus which are brownish; tarsi 4-segmented; pretarsus longer than tarsal segments 1-3 separately; middle tibial spur shorter than basitarsus.

ABDOMEN (Fig. 1 H).—Yellow except late-

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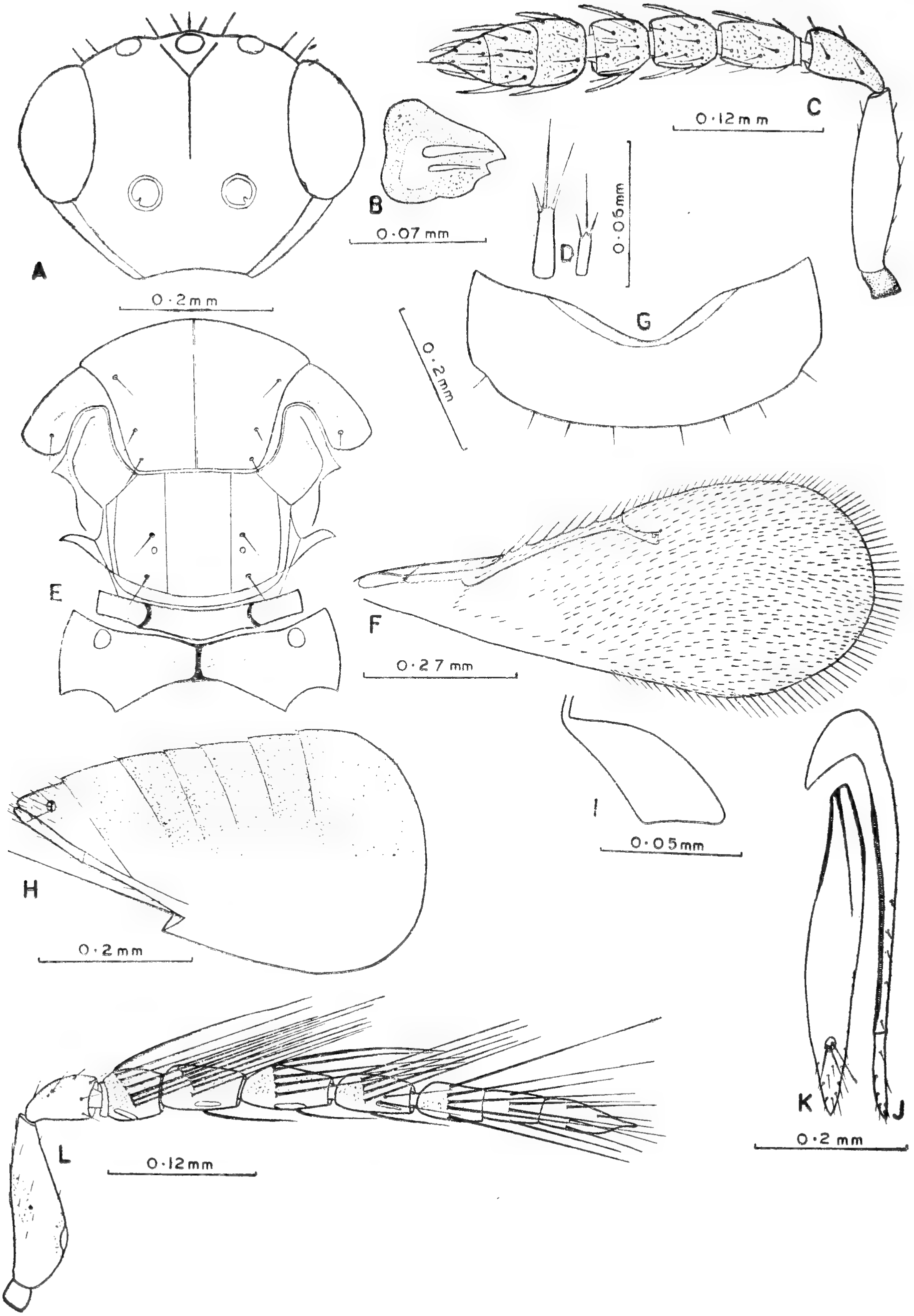

Fig. 1. A-L. *Tetrastichus indicus* sp. nov., ♀, ♂: (A) Head, in facial view, ♀; (B) Mandible, ♀; (C) Antenna, ♀; (D) Maxillary and labial palpi, ♀; (E) Propodeum and part of thorax in dorsal view, ♀; (F) Fore wing, ♀; (G) Pronotum, ♀; (H) Abdomen in lateral view, ♀; (I) First valvifer, ♀; (J) Second valvifer and third valvula, ♀; (K) Outer plate of ovipositor, ♀; (L) Antenna, ♂.

ral and apical portions of dorsum which are dark brown, as long as head and thorax together (0.56:0.56 mm); ovipositor concealed, arising from base of abdominal venter; first valvifers triangular with basal and apical angles at different levels (fig. 1 I); second valvifers long, more or less of uniform width, third valvulae movably articulated with second valvifers (fig. 1 J); outer plates of ovipositor shorter than the length of second valvifers and third valvulae together, narrow at apex (fig. 1 K).

Female length: 1.13 mm.

Male antennae as shown in (fig. 1 L).

Holotype ♀, INDIA: Tamil Nadu, Madurai, ex Mealy bugs on *Cassia* sp., 9.iii.1975 (*M. Younus Khan*).

Paratypes. 5 ♀, 3 ♂ (Same data as holotype).

Tetrastichus aligarhensis sp. nov.
(Fig. 2, A-J)

Female

Resembles *T. indicus* except in the following characters:

HEAD.—Dark with metallic reflections; eyes reddish brown; prominence between antennal sockets one-fourth the width of frons between eyes; malar space about as long as eye width; lower margin of clypeus with two dents medially.

ANTENNAE (Fig. 2 B).—Brown except scape which is yellow; scape three and a half times as long as wide, as long as funicle; pedicel less than twice as long as wide, distinctly longer than first funicle segment; first funicle segment slightly longer than wide, second and third as long as wide; club slightly more than twice as long as wide.

THORAX.—Dark with metallic reflections; pronotum with posterior submarginal ridge bearing 4 pairs of setae, antero-lateral angles obtuse and laterally directed (fig. 2 C); scutum slightly longer than wide and with 7 setae near each parapsidal furrow; each parapside with 6 setae; scutellum more than one-half the length of scutum.

FORE WINGS.—Slightly more than twice as long as wide (0.93:0.44 mm); costal cell with 7 setae; submarginal and marginal veins with 2 and 9 setae respectively (fig. 2 E); disc with a line of setae running beneath the cubital hair line.

LEGS.—Yellow except coxae which are dark with metallic reflections.

ABDOMEN.—Dark with metallic reflections; ovipositor arising from apical one-third of abdominal venter; third valvulae short, triangular, less than twice as long as wide, about one-fifth the length of second valvifers (fig. 2 G); outer plates of ovipositor slightly longer than second valvifers and third valvulae together (fig. 2 H); subgenital plate more or less of uniform width, posterior margin with a notch in middle (fig. 2 I).

Female length: 1.13 mm.

Male antennae as shown in (fig. 2 J).

Holotype ♀, INDIA: Uttar Pradesh, Aligarh University Agricultural Farm, ex *Pulvinaria* sp. on *Azadirachta indica,* 10.v.1977 (*M. Younus Khan*).

Paratypes. 2 ♀, 1 ♂ (same data as holotype).

Tetrastichus ajmerensis sp. nov.
(Fig. 2, K-S)

Female

Resembles *T. indicus* except in the following characters:

HEAD.—Eyes silvery white; prominence between antennal sockets one-sixth the width of frons between eyes; lower margin of clypeus with two dents medially.

ANTENNAE (Fig. 2 K).—Yellowish; scape three and a half times as long as wide (0.1: 0.03 mm); pedicel one and a half times as long

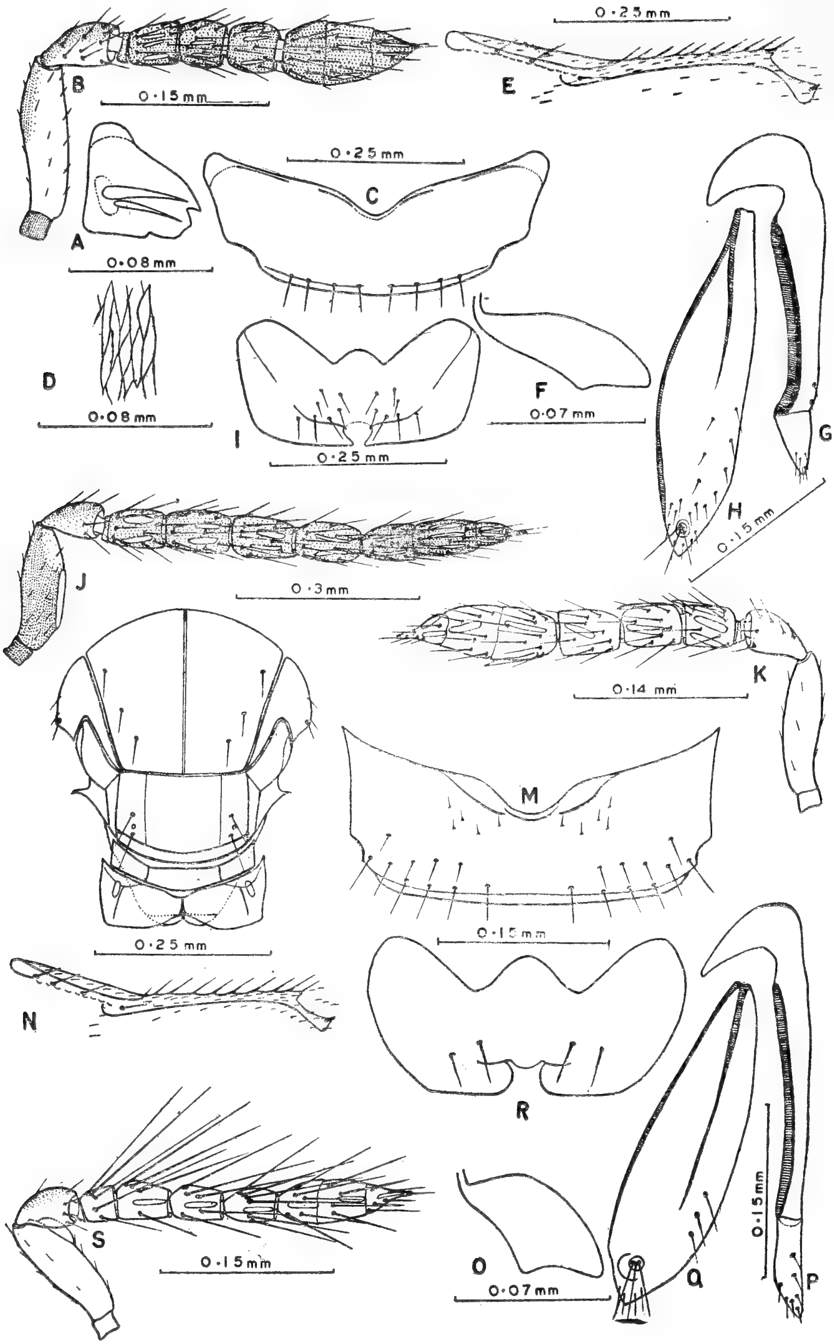

Fig. 2. A-J. *Tetrastichus aligarhensis* sp. nov., ♀, ♂: (A) Mandible, ♀; (B) Antenna, ♀; (C) Pronotum, ♀; (D) Sculpture of scutum, ♀; (E) Fore wing venation, ♀; (F) First valvifer, ♀; (G) Second valvifer and third valvula, ♀; (H) Outer plate of ovipositor, ♀; (I) Subgenital plate, ♀; (J) Antenna, ♂.
K-S. *Tetrastichus ajmorensis* sp. nov., ♀, ♂: (K) Antenna, ♀; (L) Propodeum and part of thorax in dorsal view, ♀; (M) Pronotum, ♀; (N) Fore wing venation, ♀; (O) First valvifer, ♀; (P) Second valvifer and third valvula, ♀; (Q) Outer plate of ovipositor, ♀; (R) Subgenital plate, ♀; (S) Antenna, ♂.

as wide; two ring segments distinct; funicle segments 1-3 slightly longer than wide, first shorter than second and third separately; club three times as long as wide (0.12:04 mm).

THORAX (Fig. L).—Brownish; posterior margin of pronotum straight, posterior submarginal ridge distinct bearing 6 pairs of setae (fig. 2 M); scutellum about one-half the length of scutum; submedian grooves of scutellum widely separated.

FORE WINGS.—Costal cell slightly shorter than marginal vein and with 8 setae; submarginal and marginal veins with 3 and 8 setae respectively (fig. 2 N); marginal fringe spaced by a distance equal to one-fifth their length.

LEGS.—Yellowish except coxae and femora which are brown.

ABDOMEN.—Brownish except base which is yellow; third valvulae three and a half times as long as wide, one-third the length of second valvifers (fig. 2 P); outer plates of ovipositor slightly longer than second valvifers (fig. 2 Q); subgenital plate broad, posterior margin with a notch in middle (fig. 2 R).

Female length: 0.91 mm.

Male antennae as shown in (Fig. 2 S).

Holotype ♀, INDIA: Rajasthan, Jaipur, ex *Coccidohystrix insolitus* (Green) on *Solanum melongena* Linn., 28.ix.1975 (*M. Younus Khan*).

Paratypes. 23 ♀, 10 ♂ (Same data as holotype).

Tetrastichus annulicornis sp. nov.
(Fig. 3, A-F)

Female

Resembles *T. indicus* except in the following characters:

HEAD.—Yellowish except dorsum which is brown; antennae inserted just above lower level of eyes; prominence between antennal sockets one-fifth the width of frons between eyes; eyes deep red; lower margin of clypeus with two dents medially.

ANTENNAE (Fig. 3 A).—Brownish except scape which is yellow; pedicel less than twice as long as wide, as long as first funicle segment; three ring segments distinct; first funicle segment one and a half times as long as wide, second and third slightly longer than wide.

THORAX.—Yellowish brown; scutum with 5 setae near each parapsidal furrow; scutellum slightly more than one-half the lentgh of scutum.

FORE WINGS.—Twice as long as wide (0.74: 0.37 mm); costal cell shorter than marginal vein and with 7 setae; submarginal and marginal veins with 4 and 10 setae respectively (fig. 3 B); disc with a line of setae running beneath the cubital hair line.

LEGS.—Yellow except fore coxae which are brown; middle tibial spur as long as basitarsus.

ABDOMEN.—Dark brown except basal one-third which is yellow; ovipositor arising from basal one-third of abdominal venter; first valvifers semicircular (fig. 3 C); third valvulae six times as long as wide, more than one-third the length of second valvifers (fig. 3 D); outer plates of ovipositor as long as second valvifers (fig. 3 E); subgenital plate broad, posterior margin with a notch in middle.

Female length: 1.07 mm.

Male antennae as shown in (fig. 3 F).

Holotype ♀, INDIA: Rajasthan, Jaipur, ex *Coccidohystrix insolitus* (Green) on *Achyranthus aspera*, 30.ix.1975 (*M. Younus Khan*).

Paratypes. 6 ♀, 6 ♂ (same data as holotype).

Tetrastichus psyllidis sp. nov.
(Fig. 3, G-N)

Female

HEAD.—Completely yellow; eyes red with 6 dark patches; antennae inserted above lower level of eyes; mandibles with well developed teeth (fig. 3 G).

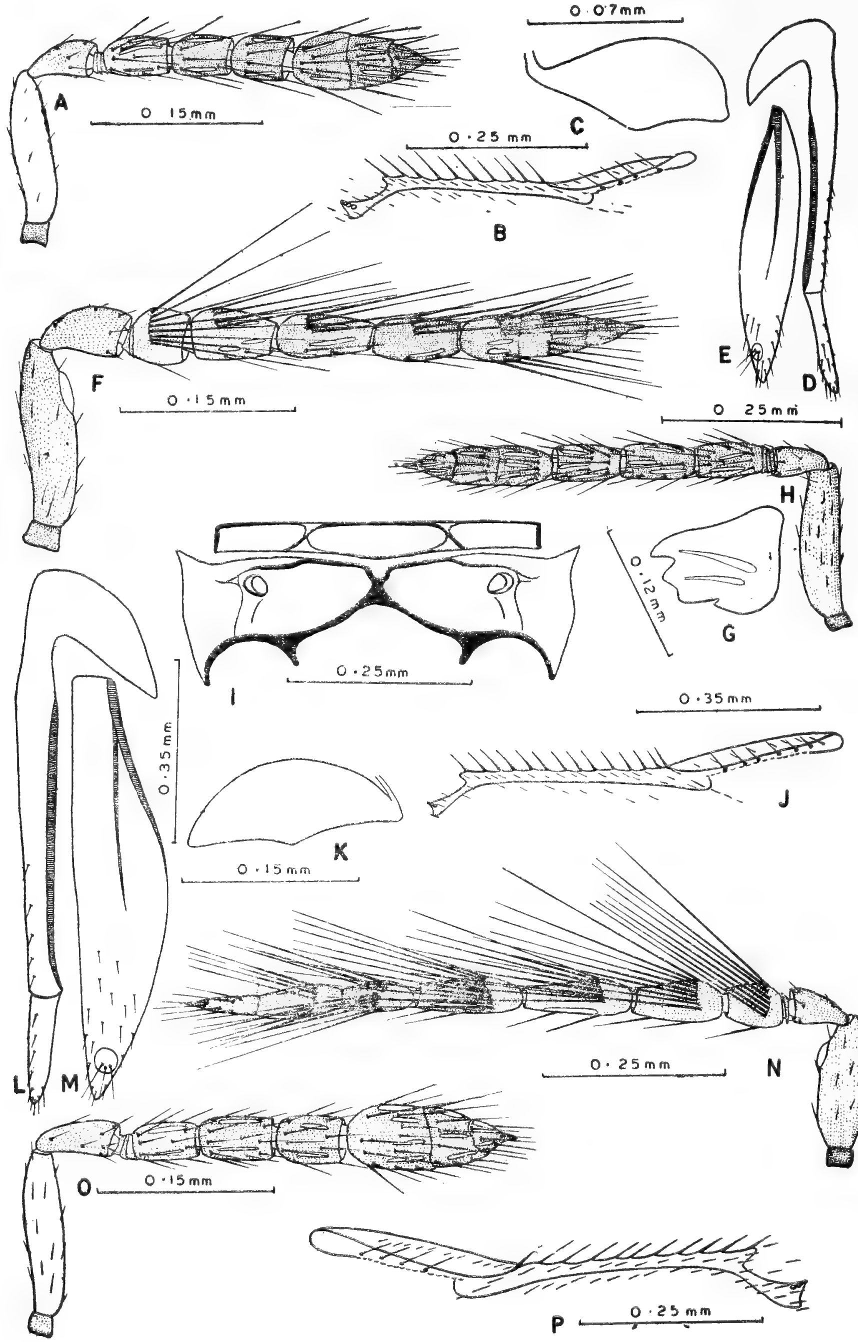

Fig. 3. A-F. *Tetrastichus annulicornis* sp. nov., ♀, ♂: (A) Antenna, ♀; (B) Fore wing venation, ♀; (C) First valvifer, ♀; (D) Second valvifer and third valvula, ♀; (E) Outer plate of ovipositor, ♀; (F) Antenna, ♂.

G-N. *Tetrastichus psyllidis* sp. nov., ♀, ♂: (G) Mandible, ♀; (H) Antenna, ♀; (I) Metanotum and propodeum, ♀; (J) Fore wing venation, ♀; (K) First valvifer, ♀; (L) Second valvifer and third valvula, ♀; (M) Outer plate of ovipositor, ♀; (N) Antenna, ♂.

O. & P. *Tetrastichus flavidus* sp. nov., ♀: (O) Antenna; (P) Fore wing venation.

ANTENNAE (fig. 3 H).—Scape slightly less than four times as long as wide (0.18:0.05 mm), as long as basal two funicle segments together; pedicel less than twice as long as wide, shorter than first funicle segment; three ring segments distinct; funicle segments 1-3 subequal in length, each twice as long as wide; club three and a half times as long as wide, as long as preceding two funicle segments together.

THORAX.—Completely yellow; posterior margin of pronotum with 7 pairs of setae; scutum with 8 setae near each parapsidal furrow; scutellum slightly more than one-half the length of scutum; propodeum very narrow in middle, posterior margin much sclerotized (fig. 3 I).

FORE WINGS.—Slightly less than two and a half times as long as wide (1.38:0.58 mm); costal cell shorter than marginal vein and with 7 small setae; submarginal and marginal veins with 7 and 14 setae respectively; postmarginal vein rudimentary (fig. 3 J); disc with a line of setae running beneath the cubital hair line.

LEGS.—Completely yellow; middle tibial spur as long as basitarsus.

ABDOMEN.—Completely yellow except apex of ovipositor infuscated; longer than head and thorax together (1.24:0.91 mm); ovipositor slightly exserted; first valvifers semicircular (fig. 3 K); third valvulae four times as long as wide, one-fourth the length of second valvifers (fig. 3 L); outer plates of ovipositor as long as second valvifers (fig. 3 M).

Female length: 2.15 mm.

Male antennae as shown in (fig. 3 N).

Holotype ♀, INDIA: Uttar Pradesh, Aligarh, Jawahar Park ex Psyllids in leaf galls of *Grewia asiatica* Linn., 2.ix.1975 (*M. Younus Khan*).

Paratypes. 3 ♀, 2♂ (same data as holotype).

Tetrastichus flavidus sp. nov.
(Fig. 3, O & P)

Female

Resembles *T. indicus* sp. n. except in following characters:

HEAD.—Completely yellowish brown; antennae inserted just above lower level of eyes; prominence between antennal sockets about one-fourth the width of frons between eyes; eyes silvery white.

ANTENNAE (Fig. 3 O).—Yellowish brown except scape which is yellow; scape slightly more than four times as long as wide (0.13: 0.03 mm.); three ring segments distinct; funicle segments 1-3 subequal in length, each one and a half times as long as wide.

THORAX.—Completely yellowish brown; scutum with 5 setae near each parapsidal furrow; scutellum more than one-half the length of scutum.

FORE WINGS.—More than twice as long as wide; costal cell shorter than marginal vein and with 11 setae; submarginal and marginal veins with 4 and 10 setae respectively; postmarginal vein slightly developed (fig. 3 P); disc with a line of setae running beneath the cubital hair line.

ABDOMEN. — Yellow except 5 transverse bands on dorsum which are brown; longer than head and thorax together (0.89:0.68 mm); ovipositor slightly exserted, arising from basal one-third of abdominal venter.

Female length: 1.57 mm.

Holotype ♀. INDIA: Andhra Pradesh, Guntur, ex Coccid on Weed plant, 3.viii.1976 (*M. Younus Khan*).

ACKNOWLEDGEMENTS

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TWO NEW SPECIES OF TETRASTICHINAE FOERSTER (HYMENOPTERA: EULOPHIDAE) FROM INDIA[1]

M. YOUNUS KHAN AND S. ADAM SHAFEE[2]

(*With two text-figures*)

Two new species of *Syntomosphyrum* Foerster (*S. cerococci* sp. nov. and *S. mashhoodi* sp. nov.) are described in detail. Holotype and paratypes are deposited in Zoological Museum, Aligarh Muslim University, Aligarh, India.

Syntomosphyrum cerococci sp. nov. (Fig. 1 A-J)

Female (Fig. 1 A).

HEAD (Fig. 1 B).—Dark with metallic reflections, wider than long in facial view (0.42: 0.34 mm); frontovertex smooth, width more than one-half the total head width; scrobes deep and convergent above; ocelli white, arranged in obtuse triangle, lateral ocelli by their own diameters from orbital margin; antennae inserted just below lower level of eyes; prominence between antennal sockets one-fourth the width of frons between eyes; malar space longer than eye width; malar sutures distinct; eyes reddish brown; mandibles tridentate with apical tooth acute, mesal rounded, lower rudimentary (Fig. 1 C); maxillary and labial palpi each 1-segmented (Fig. 1 D); lower margin of clypeus with two dents medially (Fig. 1 B).

ANTENNAE (Fig. 1 E).—Brown except scape which is yellowish brown; 8-segmented excluding 1 ring segment; scape cylindrical, four times as long as wide (0.16:0.04 mm), as long as funicle; pedicel one and a half times as long as wide, longer than first funicle segment; funicle 3-segmented, first slightly longer than wide, second and third each as long as wide; club 3-segmented, about twice as long as wide (0.13:0.06 mm), longer than preceding two funicle segments together.

THORAX.—Dark with metallic reflections; posterior margin of pronotum with submarginal ridge bearing 5 pairs of setae (Fig. 1 F); parapsidal furrows well developed; mesoscutum with 3 setae near each parapsidal furrow and without mid longitudinal groove; scutellum with 4 setae and without submedian grooves; propodeum with a well developed carina.

FORE WINGS.—Hyaline, slightly more than twice as long as wide (1.13:0.5 mm); disc with hyaline setae, broadly rounded at apex; costal cell longer than marginal vein and with 4 small setae; submarginal vein with 1 long seta directing apically and 3 small setae directing backward; marginal vein with 9 setae; postmarginal vein absent; marginal fringe short, spaced by a distance equal to one-third their length.

HIND WINGS.—Hyaline, five times as long as wide (1.1:0.22 mm), narrow at apex; disc with hyaline setae; marginal fringe spaced by a distance equal to one-fourth their length.

LEGS.—Yellowish brown except coxae and femora which are dark brown; tarsi 4-jointed; middle tibial spur shorter than basitarsus.

ABDOMEN.—Dark brown and petiolate, shorter than head and thorax together; ovipositor concealed, arising from apical one-third of abdominal venter; first valvifers triangular with basal and apical angles at different levels (Fig. 1 G); anterior margin of basal part of second valvifers not much curved; third valvulae short and blunt, two and a half times

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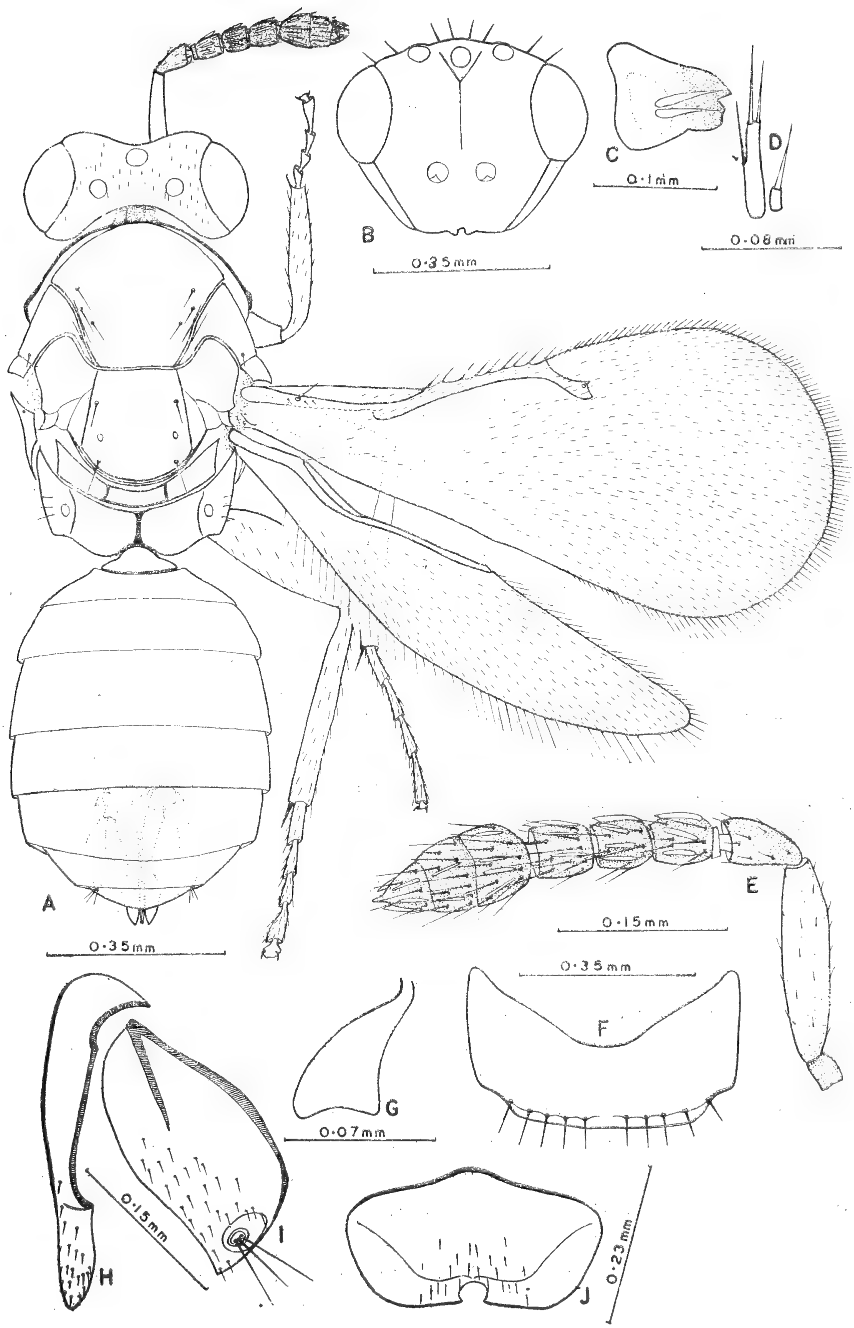

Fig. 1. A-J. *Syntomosphyrum cerococci* sp. nov., ♀: (A) Entire body; (B) Head in facial view; (C) Mandible; (D) Maxillary and labial palpi; (E) Antenna; (F) Pronotum; (G) First valvifer; (H) Second valvifer and third valvula; (I) Outer plate of ovipositor; (J) Subgenital plate.

as long as wide, less than one-half the length of second valvifers (Fig. 1 H); outer plates of ovipositor broad, twice as long as wide with thickened dorsal margin, apex broadly truncated (Fig. 1 I); subgenital plate short and of uniform width, posterior margin with a small semicircular notch in middle (Fig. 1 J).

Female length: 1.38 mm.

Holotype ♀. INDIA: Karnataka, Bangalore city, ex *Cerococcus hibisci* Green on *Hibiscus rosasinensis* Linn., 4.viii.1976 (*M. Younus Khan*).

Paratypes. 4 ♀ (same data as holotype).

In the key to species of *Syntomosphyrum* Foerster proposed by Khan & Shafee (1980) the new species is close to *S. javanicum* Ferrière, but is distinguished by the mesoscutum having 3 setae near each parapsidal furrow, pedicel one and a half times as long as wide, antennae with one ring segment, club distinctly longer than preceding two funicle segments together.

Syntomosphyrum mashhoodi sp. nov.
(Fig. 2 A-G)

Female

HEAD.—Yellowish brown, wider than long in facial view; frontovertex width more than one-half the total head width; ocelli white, arranged in obtuse triangle, lateral ocelli twice their own diameters from orbital margin and close to occipital margin; eyes red and smooth; antennae inserted at lower level of eyes; prominence between antennal sockets one-third the width of frons between eyes; malar space longer than eye width; malar sutures distinct; mandibles with apical tooth acute (Fig. 2 A); maxillary and labial palpi each 1-segmented.

ANTENNAE (Fig. 2 B).—Yellow, 8-segmented excluding 1 ring segment; scape cylindrical, three and a half times as long as wide; pedicel one and a half times as long as wide, as long as first funicle segment; funicle 3-segmented, first and second segments subequal in length, each slightly longer than wide, third longest, more than one and a half times as long as wide; club 3-segmented, three times as long as wide (0.16:0.05 mm), slightly shorter than funicle.

THORAX.—Dark brown; pronotum with posterior margin slightly curved, posterior submarginal ridge distinct bearing 3 pairs of setae (Fig. 2 C); parapsidal furrows complete; mesoscutum with 2 setae near each parapsidal furrow and without median groove; scutellum wider than long with 2 pairs of setae and without submedian grooves; propodeum with a median carina.

FORE WINGS.—Hyaline, more than twice as long as wide (1.2:0.53 mm), broadly rounded at apex; disc with hyaline setae; costal cell sightly longer than marginal vein and with 11 setae; submarginal and marginal veins with 1 and 8 setae respectively (Fig. 2 D); marginal fringe short, spaced by a distance equal to one-half their length.

HIND WINGS.—Hyaline, five times as long as wide (0.96:0.19 mm), disc with hyaline setae; marginal fringe short, spaced by a distance equal to one-half their length.

LEGS.—Yellow except coxae and femora which are brown; tarsi 4-jointed; middle tibial spur shorter than basitarsus.

ABDOMEN.—Brown, petiolate, about as long as head and thorax together; ovipositor concealed, arising from mid of abdominal venter; first valvifers triangular with basal and apical angles at different levels (Fig. 2 E); anterior margin of basal part of second valvifers much curved; third valvulae six times as long as wide, less than one-half the length of second valvifers (Fig. 2 F); outer plates of ovipositor slightly shorter than second valvifers and third valvulae together (Fig. 2 G).

Female length: 1.2 mm.

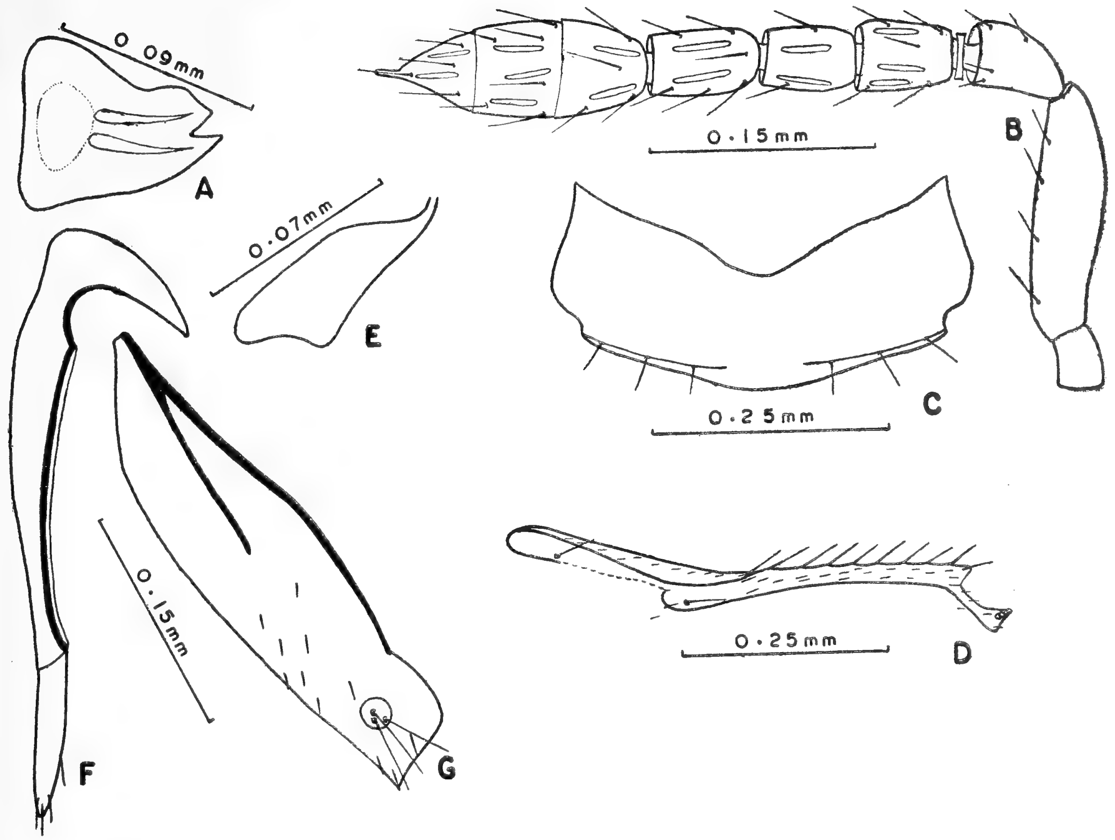

Fig. 2. A-G. *Syntomosphyrum mashhoodi* sp. nov., ♀: (A) Mandible; (B) Antenna; (C) Pronotum; (D) Fore wing venation; (E) First valvifer; (F) Second valvifer and third valvula; (G) Outer plate of ovipositor.

Holotype ♀. INDIA: Uttar Pradesh, Aligarh, University Campus, ex Coccinellid larvae on aphids on *Solanum melongena* Linn., 10.vii. 1977 (*M. Younus Khan*).

Paratypes. 2 ♀ (same data as holotype).

In the key to species of *Syntomosphyrum* Foerster given by Khan & Shafee (1980) *S. mashhoodi* sp. n. is close to *S. taprobanes* Waterston, from which it can be separated by the pedicel being more than one-third the length of scape, antennae with one ring segment, first and second funicle segments subequal and each distinctly longer than wide, third funicle segment longest, disc of fore wings with hyaline setae, submarginal vein with one seta.

This species is named for Prof. S. Mashhood Alam, in recognition of his contributions to our knowledge of the Chalcidoidea.

ACKNOWLEDGEMENTS

We are deeply indebted to Prof. S. Mashhood Alam, Head, Department of Zoology, for providing research facilities. Thanks are also due to Prof. Nawab H. Khan, for encouragement. One of us (M.Y.K.) is thankful to the U.G.C., New Delhi for financial assistance during the tenure of this work.

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KHAN, M. Y. & SHAFEE, S. A. (1980): Taxonomic studies on some Eulophid parasites (Hymenoptera: Chalcidoidea). *J. Bombay Nat. Hist. Soc.* *76* (2): 324-334.

NEW SPECIES OF THE GENUS *CHRYSONOTOMYIA* ASHMEAD (HYMENOPTERA: EULOPHIDAE) FROM INDIA[1]

M. YOUNUS KHAN AND S. ADAM SHAFEE[2]

(*With sixteen text-figures*)

The genus *Chrysonotomyia* was proposed by Ashmead (1904) for the species *Eulophus auripunctatus* Ashmead. Recently, Boucek (1977) included the genus *Achrysocharis* Girault in the synonym of *Chrysonotomyia* Ashmead. The distinguishing characters of this genus have been given by Ashmead (1904). We suggest some new generic characters, which are as follows: Pronotum with posterior margin much curved, anterolateral angles acute (Fig. D); first valvifers triangular with basal and apical angles at different levels (Fig. J); third valvulae short, movably articulated with second valvifers (Fig. K); outer plates of ovipositor long, narrow at base with a submarginal ridge along basal two-third of dorsal margin (Fig. L).

Chrysonotomyia kerrichi sp. nov. (Figs. A-M)

Female

HEAD.—Orange yellow, slightly wider than long in facial view (0.44:0.4 mm); frontovertex slightly longer than wide, width one-third the total head width; ocelli red, arranged in equilateral triangle, lateral ocelli less than their own diameters from orbital margin and twice their own diameters from occipital margin; eyes red and sparsely setose; antennae inserted at lower level of eyes; prominence between antennal sockets about one-half the width of frons between eyes; malar space much shorter than eye width; malar sutures absent; mandibles tridentate with two acute teeth and a truncation which is serrated (Fig. A); maxillary and labial palpi each 1-segmented (Fig. B).

ANTENNAE (Fig. C).—Yellowish brown except scape which is yellow; 7-segmented excluding 2 ring segments; scape cylindrical, six times as long as wide (0.18:0.03 mm); pedicel more than twice as long as wide, longer than first funicle segment and subequal to second; funicle 2-segmented, first one and a half times as long as wide, second twice as long as wide and longer than first; club 3-segmented, five times as long as wide, much longer than funicle.

THORAX (Fig. E).—Yellowish except mesos-

[1] Accepted September 1980.

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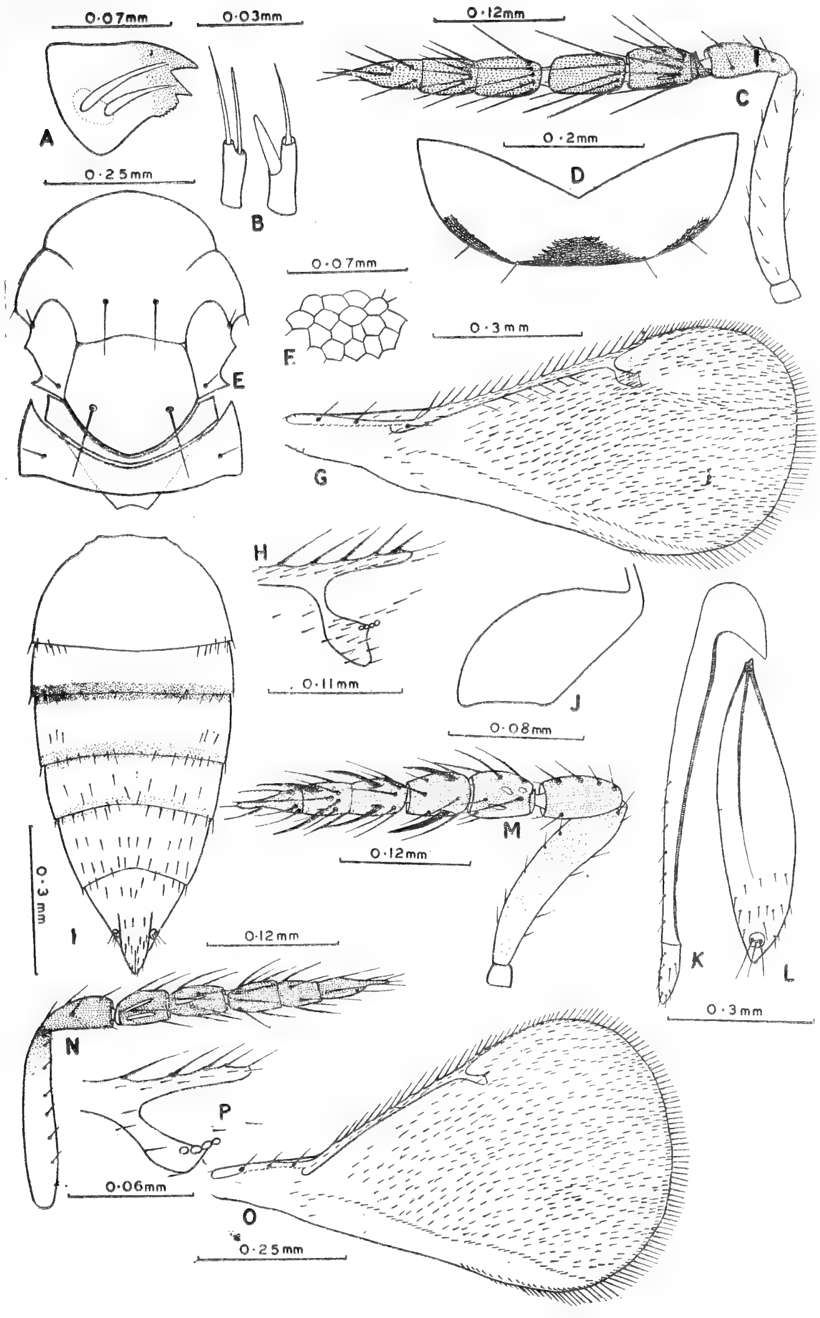

Figs. A-M. *Chrysonotomyia kerrichi* sp. nov., ♀, ♂: (A) Mandible, ♀; (B) Maxillary and labial palpi, ♀; (C) Antenna, ♀; (D) Pronotum, ♀; (E) Propodeum and part of thorax in dorsal view, ♀; (F) Sculpture of mesoscutum, ♀; (G) Fore wing, ♀; (H) Part of fore wing venation, ♀; (I) Abdomen in dorsal view, ♀; (J) First valvifer, ♀; (K) Second valvifer and third valvula, ♀; (L) Outer plate of ovipositor, ♀; (M) Antenna, ♂.

N.P. *Chrysonotomyia latipennis* sp. nov., ♀: (N) Antenna, (O) Fore wing, (P) Part of fore wing venation.

cutum and mid of scutellum with metallic green reflections; pronotum with posterior margin much curved bearing two pairs of small setae, antero-lateral angles acute (Fig. D); mesoscutum and scutellum reticulately sculptured and each with a pair of long setae and without longitudinal grooves; parapsidal furrows distinct anteriorly; mesopostpharagma reaching just beyond the propodeum; propodeum without median carina.

FORE WINGS (Fig. G).—Hyaline, more than twice as long as wide (1.26:0.56 mm), rounded at apex; a line of hairs extending distad of the stigmal vein to the wing margin, space between the line and front wing margin bare, another hair line (cubital) extending obliquely apex of submarginal vein to the base of outer wing margin; costal cell shorter than marginal vein and with 2 small setae; submarginal and marginal veins with 2 and 16 setae respectively; postmarginal vein as long as stigmal vein (0.08:0.08 mm) (Fig. H); marginal fringe short, spaced by a distance equal to one-third their length.

HIND WINGS.—Hyaline, four and a half times as long as wide (0.63: 0.14 mm); marginal fringe one-third the wing width, spaced by a distance equal to one-third their length.

LEGS.—Orange yellow; tarsi 4-segmented; middle tibial spur shorter than basitarsus.

ABDOMEN. (Fig. I).—Yellow except dorsum with three brown transverse bands, longer than head and thorax together (0.88:082 mm); ovipositor slightly exserted, arising from base of abdominal venter; first valvifers with basal and apical angles at different levels (Fig. J); anterior margin of basal part of second valvifers much curved and U-shaped, third valvulae three times as long as wide, one-sixth the length of second valvifers (Fig. K); outer plates of ovipositor long, narrow at base with a submarginal ridge along basal three-fourth of outer margin (Fig. L).

Female length: 1.7 mm.

Male

Resembles female except in the following characters:

Antennae with 1 ring segment; scape five and a half times as long as wide (0.17:0.03 mm); pedicel twice as long as wide; club four times as long as wide (0.16:0.04 mm) (Fig. M); costal cell without setae; marginal vein with 11 setae; postmarginal vein longer than stigmal vein; abdominal dorsum with 6 transverse brown bands.

Male length: 0.98 mm.

Holotype ♀. INDIA: Uttar Pradesh, Aligarh, Jawahar park ex psyllid in leaf galls of *Grewia asiatica* Linn., 2.ix.1975 (*M. Younus Khan*).

Paratypes 8 ♀, 1 ♂ (same data as holotype).

This species is named for Dr. G. J. Kerrich, in recognition of his contribution to our knowledge of the Chalcidoidea.

Chrysonotomyia latipennis sp. nov.
(Figs. N-P)

Female

HEAD.—Dark with metallic green reflections except clypeal region which is yellow and reticulately sculptured, wider than long in facial view; frontovertex as wide as long, width more than one-third the total head width; ocelli yellowish, arranged in equialteral triangle, lateral ocelli by their own diameters from orbital margin and twice their own diameters from occipital margin; eyes red and smooth; antennae inserted above lower level of eyes; malar space shorter than eye width; malar sutures absent; maxillary and labial palpi each 1-segmented.

ANTENNAE (Fig. N).—Yellowish brown except scape which is yellow, 7-segmented excluding 1 ring segment; scape cylindrical, five times as long as wide (0.15:0.03 mm); pedicel twice as long as wide, longer than first funicle segment; funicle 2- segmented, first one and a half times as long as wide, second twice as long as wide and slightly longer than first; club 3-segmented, five times as long as wide (0.15:0.03 mm), much longer than funicle.

THORAX.—Mesoscutum, parapsides, aixllae except base, mid of scutellum, propodeum, meso and meta sternites dark with metallic reflections rest of the thorax yellow; parapsidal furrows distinct anteriorly; each parapside without transverse suture; mesoscutum and scutellum with 4 and 2 setae respectively; propodeum smooth without median carina.

FORE WINGS (Fig. O).—Hyaline, less than twice as long as wide, apex broadly rounded; a line of hairs extending distad of the stigmal vein to the wing margin, space between the line and front margin of wing bare, another hair line (cubital) extending obliquely apex of submarginal vein to the base of outer wing margin; costal cell very narrow, much shorter than marginal vein; submarginal and marginal veins with 3 and 12 setae respectively; postmarginal vein longer than stigmal vein (Fig. P); stigmal vein of uniform width; marginal fringe short, spaced by a distance equal to one-third their length.

HIND WINGS.—Hyaline, five times as long as wide; marginal fringe about one-half the wing width, spaced by a distance equal to one-fourth their length.

LEGS.—Yellowish white except coxae which are slightly infuscated; tarsi 4-segmented; middle tibial spur shorter than basitarsus.

ABDOMEN.—Yellow except base of dorsum and venter completely dark with metallic reflections; longer than head and thorax together; ovipositor slightly exserted, arising from base of abdominal venter.

Female length: 1.15 mm.

Holotype ♀. INDIA: Uttar Pradesh, Aligarh, Hardwagunj ex in leaf galls of *Mangifera indica* Linn., 31.xii.1974 (*M. Younus Khan*).

Chrysonotomyia postmarginaloides
(Saraswat) comb. nov.

Tetrastichus postmarginaloides Saraswat, 1975: 19-22.

A close study of the Indian species of the genera *Tetrastichus* Haliday and *Chrysonotomyia* Ashmead, and the details on the characters of the species *Tetrastichus postmarginaloides* Saraswat do give an impression that there are certain characters namely absence of grooves on mesoscutum and scutellum, presence of style on the last club segment, fore wings with long postmarginal vein and prsence of a line of hairs between distad of stigmal vein and wing margin (Saraswat 1975, fig. 8 A-K), which agrees in every respect with the generic diagnosis of the genus *Chrysonotomyia* Ashmead. Therefore, *Tetrastichus postmarginaloides* Saraswat is here transferred to *Chrysonotomyia*.

ACKNOWLEDGEMENTS

We are deeply indebted to Prof. S. Mashhood Alam, Head, Department of Zoology, for providing research facilities. Thanks are also due to Prof. Nawab H. Khan, for encouragment. One of us (M.Y.K.) is thankful to the U.G.C., New Delhi for financial assistance during the tenure of this work.

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ZENKERIA JAINII—A NEW SPECIES OF POACEAE FROM KERALA[1]

N. C. NAIR, P. V. SREEKUMAR AND V. J. NAIR[2]

(*With nine text-figures*)

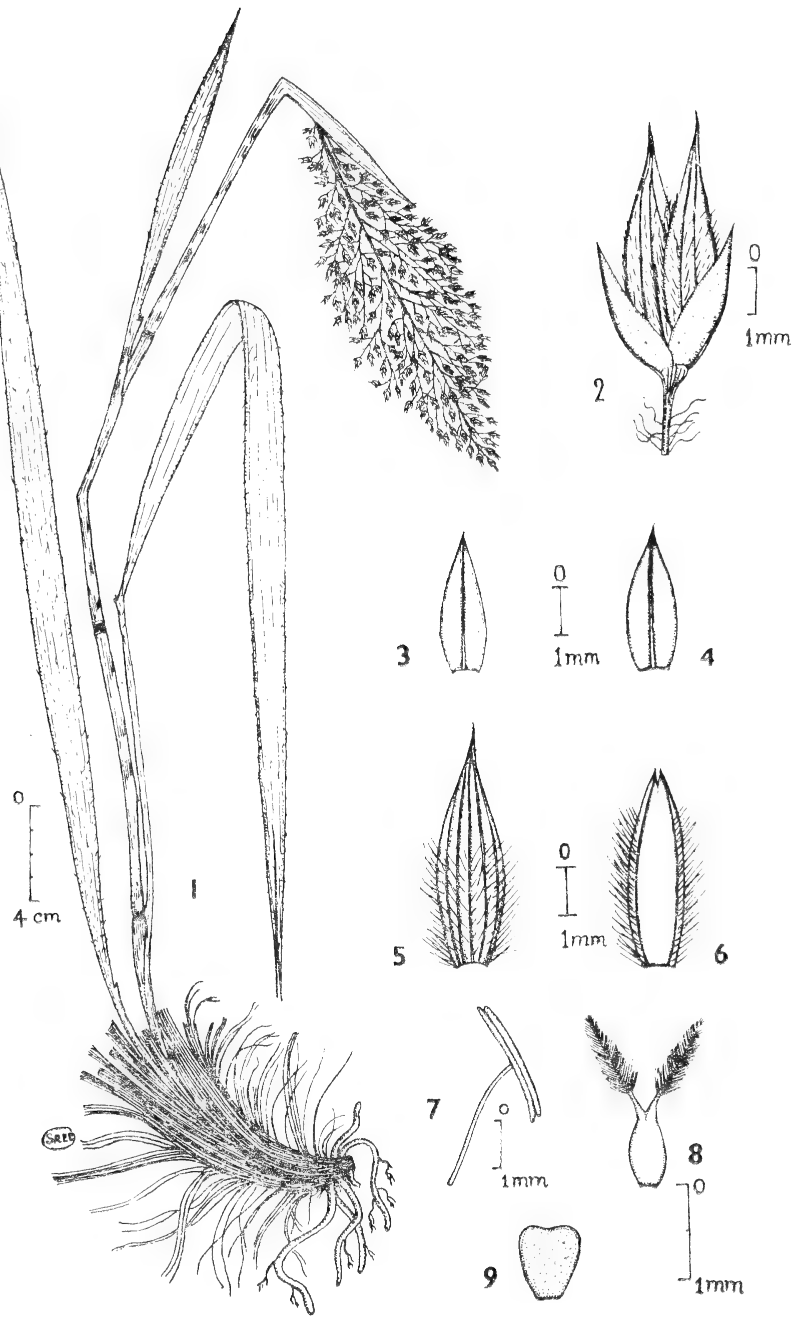
The genus *Zenkeria* Trin. is so far known to have four species restricted to South India and Sri Lanka. A recent collection of *Zenkeria* (*P. V. Sreekumar* 68419) from Eravikulam Sanctuary in Idukki District, Kerala, after examining the specimens at CAL and MH, turned out to be distinct from all other earlier known species. It differs from *Zenkeria elegans* Trin. in its longer glumes, larger spikelets and broader hairy leaves and from *Zenkeria stapfii* Henr. in the flat broader hairy leaves and larger spikelets. The Sri Lanka species *Zenkeria obtusiflora* Benth. is distinct from the present specimens in having obtuse lemmas, smaller spikelets, broader and glabrous leaves. It has some similarity to the recently described South Indian species *Zenkeria sebastinei* Henry & Chandrab. in their larger spikelets, villous pedicels, flat rigid leaves and acuminate lemmas, but differs in the following characters.

As the present collection *P. V. Sreekumar* 68419 is quite distinct from all the other known species of the genus, it is described here as a new species.

	Zenkeria sebastinei Henry & Chandrab. (Isotype in MH!)	*P. V. Sreekumar* 68419
Leaves	Narrowly elliptic, shorter than the panicle ($5\text{-}18 \times 1\text{-}2.2$ cm) Glabrous except towards tip on lower surface.	Linear lanceolate, exceeding the length of the panicle ($15\text{-}50 \times 0.8\text{-}1.6$ cm) Glabrous on lower surface, sparsely villous throughout on upper surface.
Ligule	A rim of long hairs	A tuft of short hairs.
Sheaths	5-7 cm long, glabrous	Sheaths 8-16 cm long, sparsely villous.
Nodes	Hairy	Glabrous.
Spikelets	4-4.5 mm long	5-5.5 mm long.
Glumes	Unequal, ovate, acute (lower *c.* 2.5×1.5 mm; upper *c.* 3.5×1.7 mm)	Subequal, lanceolate, shortly acuminate ($2.8\text{-}3 \times 1$ mm).
Palea	3-3.2 mm long, acute at apex.	4-4.5 mm long, notched at apex.
Filaments	Less than half the length of anthers, at the most 1 mm long.	More than half the length of anthers, equal to or even exceeding its length (1.5-3.5 mm).
Styles	Slender, long (*c.* 0.5 mm). Stigma smaller.	Stout, short (*c.* 0.2 mm); Stigma large.
Lodicules	Oblique and denticulate at apex; 1-2 nerved, one nerve prominent, the other faint.	Retuse at apex, nerveless.

[1] Accepted December 1980.

[2] Botanical Survey of India, Coimbatore.



Figs. 1-9. *Zenkeria jainii* sp. nov.: 1. Plant; 2. Spikelet; 3. Lower glume; 4. Upper glume; 5. Lemma; 6. Palea; 7. Stamen; 8. Pistil; 9. Lodicule.

Zenkeria jainii sp. nov.

Affinis *Z. sebastinei* a qua tamen differt foliis longioribus villosis, spiculis amplis, paleis incisuris, lodiculis enervibus, filamentis magnis, stilis brevibus.

Holotypus *Sreekumar* 68419 et isotypi in collibus Eravikulam in District Idukki in ditione Kerala ad altit ± 2000 m, die 20 Augusti anni 1980. Holotypus positus ad CAL; isotypi ad MH.

Perennial herbs. Culms 45-60 cm long, erect from a decumbent rooting base; nodes glabrous; internodes 5-14 cm long. Leaf blades 15-50 × 0.8-1.6 cm, chartaceous, linear-lanceolate, tapering at both ends, sparsely villous on the upper surface; sheaths 8-16 cm long, chartaceous, glabrous or sparsely villous, basal ones breaking up into fibres; ligule a tuft of short hairs. Panicles 14-18 cm long, densely flowered with capillary, villous spreading branches. Spikelets 5-5.5 mm long, all alike, each 2-flowered, bisexual. Pedicels 0.2-1.5 cm long, villous; rachilla short, bearded, disarticulating above the glumes. Glumes subequal, *c.* 3 × 1 mm, ovate—lanceolate to lanceolate, acute or shortly acuminate, hyaline, glabrous, 1- nerved, keeled, persistent, spreading. Lemmas *c.* 5 × 1.2 mm, lanceolate, acuminate, 5-nerved, coriaceous, long ciliate below the middle. Paleas *c.* 4 × 1.1 mm, ovate-lanceolate, notched at apex, 2- keeled, 2- nerved, hyaline, long ciliate along the keels except at the upper quarter. Lodicules 2, each *c.* 0.7 × 0.4 mm, without nerves, obovate, retuse at apex. Stamens 3; anthers 2-2.5 mm long, narrow, purple; filaments 1.5-3.5 mm long, slender. Ovary *c.* 0.8 × 0.4 mm, ovate, glabrous; styles 2, each *c.* 0.2 mm long, stout; stigmas *c.* 1 cm long, feathery, white. Grains not seen.

The holotype *P. V. Sreekumar* 68419 and isotypes were collected from Eravikulam Sanctuary (alt. ± 2000 m) in Idukki District, Kerala State on 20-8-1980. The holotype is deposited in CAL. The isotypes are deposited in MH.

Zenkeria jainii grows in clumps in the crevices of moist rocks.

The present species is named after Dr. S. K. Jain, Director, Botanical Survey of India, Howrah, for his notable contributions to the study of Poaceae in India.

A NEW SPECIES OF *SYZYGIUM* GAERTN. (MYRTACEAE) FROM SOUTH INDIA[1]

M. Chandrabose and V. Chandrasekaran[2]

(*With eight text-figures*)

Syzygium chandrasekharanii sp. nov.

S. lanceolati (Lam.) Wight & Arn. affinis tamen differt foliis (sub) sessilibus, obtusis, apicibus subacutis vel emarginatis, basis subcordatis; cymis terminalibus vel laterali corymbosis; calycibus anguste obconicalibus; petalis calyptratis; baccis 2.5-2.8 cm longis.

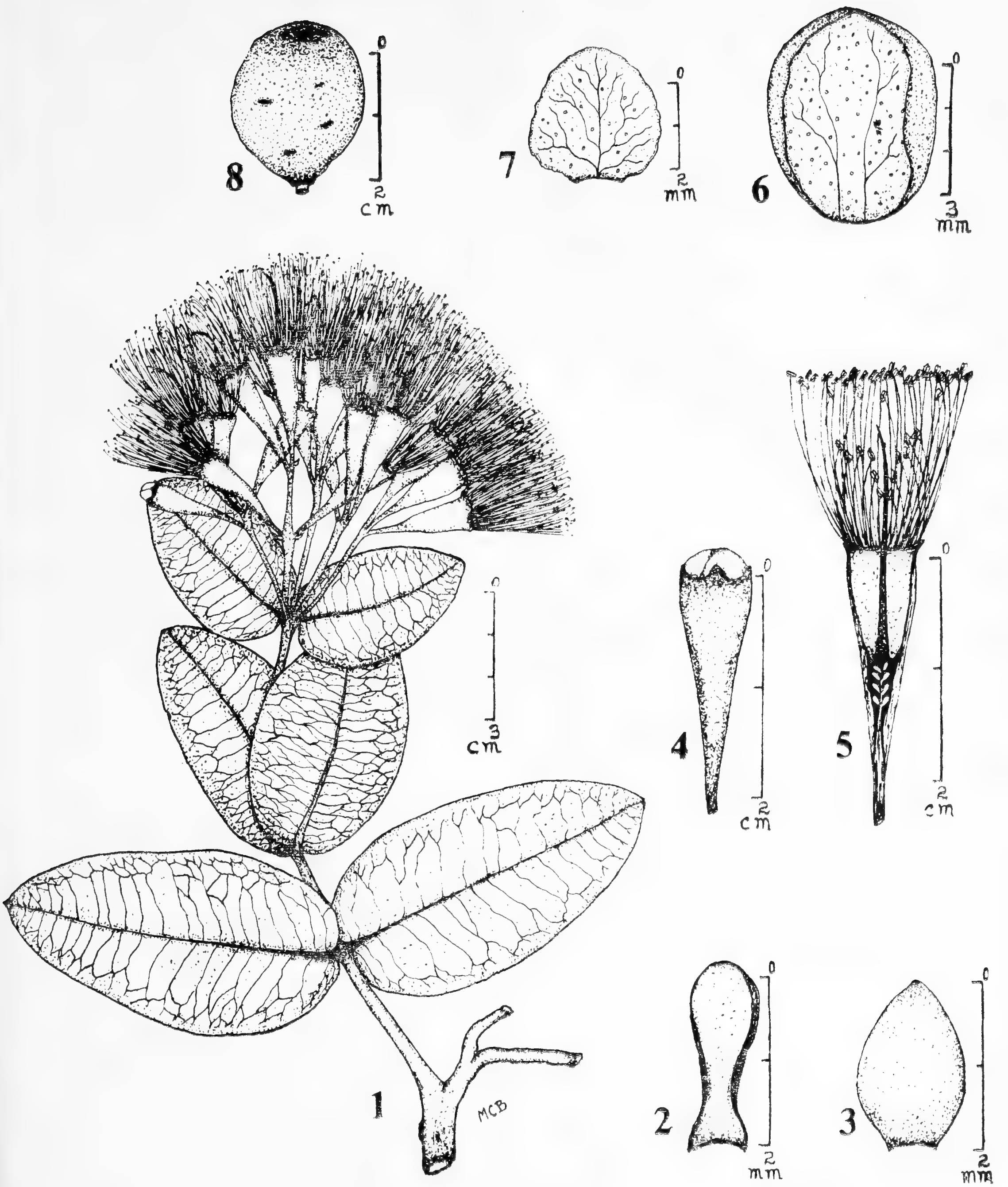
Holotypus *Chandrabose* 65811 A (CAL) et isotypi *Chandrabose* 65811 B-G (MH) lecti apud Konalar, Anamalai, Dist. Coimbatore in statu Tamil Nadu (Madras) die 15-2-1980. Paratypi *Makali* 65898 A-G (MH) lecti eodem in loco die 12-4-1980.

Syzygium chandrasekharanii sp. nov.

Allied to *Syzygium lanceolatum* (Lam.) Wight & Arn., but differs in: leaves sessile or subsessile, obtuse, subacute or emarginate at

[1] Accepted January 1981.

[2] Botanical Survey of India, Coimbatore-641 003.



Figs. 1-8. *Syzygium chandrasekharanii* sp. nov., 1. Twig; 2. Bract; 3. Bracteole; 4. Flower bud; 5. L.S. of a flower; 6. Outer petal; 7. Inner petal; 8. Berry.

apex, subcordate at base; flowers in terminal or lateral corymbose cymes; calyx narrowly obconical; petals calyptrate; and berries 2.5-2.8 cm long.

Trees 10-15 m high; trunk 40-70 cm in diam.; bark greyish black; branchlets tetragonous. Leaves 3-10 × 1.5-5.5 cm, sessile or subsessile, usually opposite, decussate, rarely alternate, ovate, ovate-elliptic, elliptic or elliptic-oblong, entire, recurved along margins, coriaceous, glabrous, obtuse, subacute or emarginate at apex, obtuse and subcordate at base; lateral nerves many, thin, prominently reticulate. Flowers 2-3 cm long, dull white, sessile, 20-30 in terminal or lateral corymbose cymes 8-12 cm across; peduncles up to 3 cm long; bracts ± 2.2 × 0.7 mm, spathulate, concave; bracteoles ± 2 × 1.2 mm, ovate-elliptic. Calyx 1.7-2.5 cm long, greenish pink, narrowly obconical, glabrous, rugulose without; tube 1.5-2.3 cm long, adnate with the ovary to about half its length, mouth produced beyond the ovary; lobes 4, each ± 2 × 3 mm, broadly triangular, subacute. Petals 8, each 3-5 × 3-5 mm, unequal, outer 4 larger than the inner, suborbicular, subentire, glabrous, gland-dotted, calyptrate. Stamens many, unequal, free; filaments white, slender, incurved in bud; anthers versatile. Ovary inferior, usually 2-loculed; ovules many, axile; style 1.7-2 cm long, thick, glabrous; stigma simple. Berries 2.5-2.8 × 1.7-2.5 cm, purple, obovoid, depressed at apex with persistent calyx lobes, 1-seeded; seeds ± 1.3 × 1 cm, brown, obovoid, truncate at apex, longitudinally striate, glabrous, cotyledons fused together. (Figs. 1-8).

The holotype *Chandrabose* 65811 A (CAL) and isotypes *Chandrabose* 65811 B-G (HM) were collected in Konalar, Anamalai Hills in Coimbatore District, Tamil Nadu (Madras State) on 15-2-1980; and paratypes *Makali* 65898 A-G (MH) were collected from the same locality on 12-4-1980.

Though there exists controversy in keeping *Eugenia, Syzygium, Jambosa,* etc. as distinct genera, we follow R. Schmid (Amer. J. Bot. 59 (4): 423—436. 1972) in keeping *Syzygium* as a distinct genus; and our specimens fit well within the characters of *Syzygium* as given by him.

This graceful evergreen tree perhaps escaped the eyes of earlier Botanists as it occurs in sholas beyond Konalar, a remote and difficult terrain of Anamalais at an altitude of 1,825 m. This species is named in honour of Dr. N. Chandrasekharan Nair, Deputy Director, Botanical Survey of India, Coimbatore for his significant contributions to Indian Botany.

ACKNOWLEDGEMENTS

Our sincere thanks are due to Rev. Fr. Dr. K. M. Matthew, S.J., Rapinat Herbarium, St. Joseph's College, Tiruchirapalli for rendering Latin translation; and to Dr. A. N. Henry, Regional Botanist, Botanical Survey of India, Coimbatore for helpful suggestions.

REVIEWS

1. THE BIRDS OF THE GAMBIA—AN ANNOTATED CHECKLIST AND GUIDE TO LOCALITIES. By J. V. Jenson & J. Kirkeby. pp. 284 (21 × 14.5 cm) including many figures and photographs. Denmark, 1980. Aros Nature Guides. L11.8/D.kr. 148 including postage and packing.

The country Gambia 10,360 square kilometres in extent is the smallest in Africa lying at the western extremity of the Continent and, as stated in the Preface, being essentially the valley of the River Gambia. It extends about 300 km inland varying in width from 55 km at the coast and 22/30 km inland.

Though called an annotated checklist it includes photographs showing different avifaunal zones together with maps illustrating several of the 37 places which are described in some detail and would be of interest and use to the local resident or visitor.

Part three covers the Systematic List. In the small area the total number of birds recorded is 489 species and subspecies with another 27 doubtfully noted. This number is about equal to that found in Maharashtra which is thirty times larger. Almost each species is accompanied by a sketch map marked with spots of different sizes showing the dry season (1 November—30 April) distribution in terms of numbers in different places. This however has not been explained in the text and I have also been unable to undertsand the significance of the figures, e.g. ≤ 5 ≤ 10 ≤ 25 shown under the different maps.

There is nothing to indicate which of the species have been identified on the basis of specimens collected or how the subspecific identifications where mentioned have been determined.

Except for the palaearctic migrants most species are different from those found in India though in several the English name is the same as that used here. Where the species is the same, the subspecies may be different.

It is stated that in 1974 an upsurge of interest in bird life resulted in an increase in tourism and also in the formation of the Gambia Ornithological Club with 14 members, which has now increased to a hundred.

The book is an excellent introduction to the Ornithology of the area. Though the price is on the high side it is quite possible that it will sell well among the tourists and those interested in the birds of that area.

HUMAYUN ABDULALI

2. BIRDS OF EAST AFRICA THEIR HABITAT, STATUS AND DISTRIBUTION. Editor, P. L. Britton, Paintings by Rena Fennessy. pp. xiv + 271 (25 × 17 cm) with four coloured and eight black-and-white plates & four maps. Nairobi, 1980. East Africa Natural History Society, Ornithological Sub-Committee. Price Kenya Shilling 130.00 (about Rs. 134).

The Foreword, Preface and Introduction, cover the circumstances under which the book has been published and the last is an excellent example of a short and handy description of the different biotopes which go to make up East Africa comprised of Uganda, Kenya and Tanzania.

The text is largely a checklist covering 1293 species so far recorded from the area mentioning the subspecies, often more than one, and their distribution and status. Just over 200 are of the same species as found in India including about 141 identical (mostly palaearctic migrants) while the remainder are represented by different subspecies. This leaves over a thousand species different from those occurring in India.

The variety even of the same genus is staggering—29 *Cisticolas,* 19 Francolins, also 20 species of hornbills, 16 nightjars and 32 barbets, over 70 weaver birds many of them being again broken up into additional subspecies.

A closer examination of the movements of the same species may perhaps help to decide where Indian birds go to or come from e.g. in Indian literature *Clamator jacobinus pica* is synonymised with *C. j. serratus* but here they are separately treated with the former "breeding in diverse localities, but numbers may be augmented by non-breeding visitors from the northern and southern tropics, and even by birds from North and Central India, and East Palaearctic. In some places it is a fairly common passage migrant in November/January and April-early May, hardly recorded at other times". The race *serratus* is said to be an uncommon non-breeding visitor.

Two races of the Broadtailed Grass Warbler *Schoenicola platyura* (Jerdon) are referred to, while Indian literature treats this as without races. Dark morphs of *Egretta garzetta* referred to on p. 19 do not appear to have been noticed in India. *Falco amurensis* the Redlegged Falcon is still said to arrive in thousands over the Indian Ocean, but the last record from Indian limits is a single bird obtained near Kalyan, Bombay in 1950. What part of India do they pass over unseen?

The text against the species does not indicate which is illustrated in colour and the fine frontispiece of the Longcrested Eagle could only be named by an accidental reference to the list of illustrations.

There are 5 colour plates of birds and 15 black and white pictures representing different ecological areas. Some of the latter are unfortunately not very well reproduced. All these are financially sponsored by a list of companies and/or institutions including names which are familiar in India. It is possible that the latter may be approached for similar assistance for some of the Society's publications. Each colour plate is covered by a sheet of thin paper giving the name of the sponsor.

A 7-page bibliography, several maps and a gazetteer of the places mentioned, makes this an indispensable reference for any work on the birds of this area. A similar work for Maharashtra or Peninsular India may be worthwhile.

HUMAYUN ABDULALI

3. COLOURED ILLUSTRATIONS OF THE BUTTERFLIES OF JAPAN. By Akito Kawazoe and Morio Wakabayashi, supervised by Takashi Shirozu. pp. 423 (21×14.5 cm). Osaka, 1980. Hoikusha Publishing Co. Ltd. (Completely revised edition). Price—Yen 3,900 in Japan.

I have read that even more than the birds, the butterflies are a symbol of freedom. They cannot be either tied down or tamed. Their economic importance in the pollination apart, they surpass imagination in beauty and grace. Nobody can divorce the butterflies from the flowers, and they together are one of the ultimate in aesthetic value. Their metamorphosis, from egg to caterpillar to pupa to butterfly, is in itself a marvel of nature.

The book on Japanese butterflies by Kawazoe & Wakabayashi is a treat to go through. It is the 1980 reprint of its first edition produced in 1976, but a completely revised version. The popularity of the work can be easily guessed from the fact that ever since its original publication in April 1976, it has been reprinted every year, even twice in 1977.

As the title shows, the book is full of coloured illustrations. I tried to count them, there being no list, and found that there are totally 1037 coloured figures of 260 species arranged on 72 plates.

Besides, there are a large number of explanatory black and white text-figures, to be exact 80 numbered and 9 unnumbered and drawings of the genitalia of altogether 264 species, in many cases of both sexes. There are a few maps and some photographs of scales. The wing-venation of 18 species has been depicted on two pages.

The text is arranged family and genera-wise. Brief description of characters of the genus; a dichotomous key to Japanese species; descriptions and figures of genitalia of some species (both sexes in most cases) are given, followed by the account of selected individual species. All genera and species have been numbered.

Obviously all known Japanese species have not been included in the illustrations. Those which have been selected, have their coloured figures juxtaposed with their description on the opposite page [the style of the BOOK OF INDIAN BIRDS by Sálim Ali comes to mind, but it is not exactly similar]. Description of each species provides the name of species and its author (but not the year). No synonyms are listed. The genitalia of most of the species are figured in black and white, Characters have been shown amply and the subspecies occurring in Japan have been pointed out, with their differentiation. These subspecies in many cases have been illustrated (in colour) side by side, thus making the identification easy. It is to the credit of authors, and publishers, that the size of illustrated specimens is life-like. The reduction, if done, is shown in light blue on the upper left hand corner of each Plate and is not below 0.9 time of actual size in most cases.

To my pleasant surprise, there are more species common between India and Japan, than expected. In general, however, the Indian fauna is richer. Talbot (1939, FAUNA OF BRITISH INDIA—BUTTERFLIES, 2nd ed., Vol. 1, Taylor & Francis, London) has recorded 1,443 species from the Indian region. In comparison to it only 260 species are illustrated in this book. Out of these, I suppose 50% + can be find within our limits as well, by referring to the classical book of W. H. Evans, (1932, IDENTIFICATION OF INDIAN BUTTERFLIES, 2nd ed., Bombay Nat. Hist. Soc.). However, for the coloured illustrations, this book ought to be compared with our BUTTERFLIES OF THE INDIAN REGION by M. A. Wynter-Blyth (1957, Bombay Nat. Hist. Soc.) and at the very first glance one would say that the Japanese work is superior, both in quality and quantity of the coloured illustrations.

The one point that requires careful attention of the lepidopterists is the generic assignment of many species used in this book. In a number of cases combinations have been used, which are quite different to what we understand from other studies. Let me cite an example, selected at random (citations on the left side are from the Japanese book with its page number, and on the right side from my paper (1979) in this *Journal*, 76 (1): 33-40).

Page No.	Cited as	For
185	*Anosia chrysippus* Linnaeus	*Danaus chrysippus* (Linnaeus)
185	*Salatura genutia* Cramer	*Danaus genutia* (Cramer)
186	*Danaus plexippus* Linnaeus	*Danaus genutia* (Cramer)
191	*Parantica sita* Kollar	*Danaus sita* (Kollar)
194	*Tirumala limniace* Cramer	*Danaus limniace* (Cramer)

When a very common name like *Papilio demoleus* (The lime butterfly) has been changed to *Princeps demoleus* it requires careful attention. The one reason which I can guess for such combinations being used, is that in the opinion of the authors. Kawazoe & Wakabayashi, a number of generic names which we have been treating as synonyms are also valid. In the example cited above, *Anosia, Salatura, Tirumala, Parantica* are synonyms of *Danaus* (see Varshney, 1973, *Curr. Sci.*, 42 (19): 698-699). In another case, while we treat *Terias* as a synonym of *Eurema*, the authors have treated the former as a subgenus of the latter. In yet another case, *Pachliopta* has been used for *aristolochiae* (Fabr.), and not *Atrophaneura* which we consider valid (see Varshney, 1979, l.c.). The absence of parenthesis on author's name in changed combinations, is also strange. Thus, there seems to be a necessity to carefully check and restudy the validity of the generic assignments used in this book. However, it must be clearly stated that no attempt is made here to suggest that the combinations used in this book are invalid. In fact, in one case, the well known butterfly *Vanessa cardui* (the Painted lady) has been referred as *Cynthia cardui*, which fully agrees with my own contention as reported elsewhere (Varshney, 1977, *Newsletter Zool. Surv. India*, 3 (1): 13-14).

One reason why I could not make better use of this work is plainly my ignorance of the Japanese language (almost the whole text and even the captions of illustrations are in Japanese). Yet I may be permitted to repeat, what has been earlier said in a review of a book of the Chinese birds in this *Journal* recently, that the arrangement is such that even someone unfamiliar with the Japanese language should get sustenance. With a little effort, I could correlate the coloured illustrations with the description of respective species, by comparing the Japanese calligraphy.

Towards the end of the book, some general information has been provided (page 340 onwards). It includes a chapter on the morphology of the butterflies, with details of terminology for various parts of the body. A comparative table shows the notation of different veins in the wings, as applied by Hampson, Meyrick, Tillyard, Snodgrass, Ehrlich and Comstock & Needham. Then there is a note on how to preserve and study butterflies. The chapter on classification provides keys to families and subfamilies, and in some cases to genera. The book ends with a bibliography and index (both in Japanese as well as in English).

Printing is superb (done in Japan). The card-board jacket of the book carries a life—like picture of *Papilio maackii* on one side, and a collage of 24 species on another side. The hard cover of the book bears a beautiful photo of *Sasakia charonda*. A most welcome work for the butterfly lovers all over the world.

R. K. VARSHNEY

MISCELLANEOUS NOTES

1. NEW RECORDS OF TOMB BAT (CHIROPTERA: EMBALLONURIDAE) FROM BIHAR WITH SOME ECOLOGICAL REMARKS

INTRODUCTION

During a recent field survey in South Bihar, I collected two species of Tomb Bats, *Taphozous melanopogon melanopogon* Temminck and *Taphozous kachhensis kachhensis* Dobson not recorded earlier from Bihar.

All measurements are in mm and the figures in parentheses represent average measurements. Abbreviations used in the text are: *f*: length of forearm; *t*: length of tibia; *ft*: length of foot including claws; *l*: total length of skull; *zw*: zygomatic width; *cw*: cranial width; m^3-m^3: maxillary width; c-m^3: length of upper tooth row; c-m_3; length of lower tooth row; *ml*: length of mandible.

OBSERVATIONS

1. **Taphozous melanopogon melanopogon** Temminck.

Material: Patna Dist.—Patna City: Govind Bag Mandir, 18.vii.1977 and 15.viii.1977, 7♂♂, 10♀♀; Raja Ghat, 15.viii.1977, 3♂♂.
Measurements: 10♂♂: *f*., 63-66.1 (64.4); *t*., 23.6-25.2 (24.6); *ft*., 13-14.3 (13.7). 19♀♀: *f*., 62-67.3 (65.4); *t*., 24-25.6 (24.5); *ft*., 13-15.2 (14.2).
Skull.—8♂♂: *l*., 20.5-21.4 (20.9); *zw*., 12.7-13.8 (13.1); *cw*., 10.3-10.5 (10.4); m^3-m^3., 8.7-9.6 (9.3); c-m^3., 9-9.6 (9.3); c-m_3, 9.7-10.3 (10); *ml*., 16.1-17.1 (16.6). 2♀♀: *l*. 21, 21.2; *zw*., 13.1, 13.1; *cw*., 10.3, 10.5; m^3-m^3, 9, 9.6; c-m^3 9, 9; c-m_3, 9.5, 9.7; *ml*., 16.1, 16.5.
Distribution: Java, Malaysia; Sumatra; Kalibangan; Laos; Vietnam; Burma; China; Peninsular India; and Sri Lanka.

In India this species is hitherto known from Kerala, Karnataka, Maharashtra, Madhya Pradesh, Gujarat and Andaman Islands. The present collection from Bihar extends the range of distribution further northeast in India.

Observations.

General: It is obvious from the measurements that the forearm in the female is slightly longer than in the male as given by Sinha (1970). Against the statement of Dobson (1876) that the black beard develops only in breeding season, I have found among 10 males, collected in July, 6 had black beard and the rest had no sign of beard. Brosset (1962) reports the breeding season for this species as January to May and according to him even subadult males possess beard. Among 9 females collected during July, 3 have a pair of prominent pectoral teats.

Habit and habitat: Two types of colonies of this bat were observed in Patna City. One mixed colony of both sexes (*c*. 500 exs.; sex ratio of collected specimens is 2: 3) was found in a dark and discarded room of Govind Bagh temple and other (of seven males only) on the roof of a semidark entrance to Rajaghat. No other bats were found in association with this bat as was observed by Brosset (1962) in Kanheri Badami and Ellora (Maharashtra). No ectoparasites were seen on the body.

A cat was seen with a *Taphozous melanopogon* in its mouth on the verandah of the temple.

2. **Taphozous kachhensis kachhensis** Dobson

Material: Gaya Dist.: Bodh Gaya, 22.vii. 1978, 1♂ (Subad.); Rohtas Dist.: Sasaram, 27.x.1978, 1♀.

Measurements: 1♂: *f.*, 69.2; *t.*, 28; *ft.*, 18. 1♀: *f.*, 74; *t.*, 32; *ft.*, 17.5.

Skull.—1♂: *l.*, 25.5; *zw.*, 15; *cw.*, 11.8; m^3-m^3, 10.6; c-m^3, 11.3; c-m_3, 13; *ml.*, 20.4.

Distribution: Pakistan and India.

ACKNOWLEDGEMENTS

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SINHA, Y. P. (1970): Taxonomic notes on some Indian bats. *Mammalia, 34*: 81-92.

2. OBSERVATION OF HOMOSEXUAL BEHAVIOUR IN ASIATIC LION *PANTHERA LEO PERSICA*

Homosexual behaviour has been observed in male African lions. (Schaller 1972). There is no record of homosexual behaviour of the females in Africa or India.

I observed homosexual behaviour in two adult lionesses on three occasions, in Raidi & Vaniavav areas in the Gir Wildlife Sanctuary of Western India. Both the lionesses were adult, over 15 years in age. For convenience, I will call them lioness 'A' and lioness 'B'.

These two lionesses were observed mostly together. Lioness 'A' was in estrous and one young male of 5 to 6 years was courting her. One day later lioness 'B' also came into estrous and started following 'A'. The same male started mating with lioness 'A' and their matings continued only for two days. All this time lioness 'B' kept fairly close to the mating couple. Whenever lioness 'B' came closer, the male chased her away. On the third day of the mating, the male seemed to be tired, and kept resting most of the time, Lioness 'A', apparently not satisfied sexually, continued to present herself to the male and when he did not respond, she went upto him and nudged him with head between his two hindlegs, sometimes even partly lifting him from behind. At this the male would move over to another place.

On the fourth day when lioness 'A' was posturing for the male to mount, lioness 'B' came and mounted her with same actions as that of male including neck biting, growling and later on rolling on its back. Then the females switched positions with lioness 'B' mounting lioness 'A'. This was repeated once on the same day and once on the fifth day. All this time the male was also close, apparently indifferent to the females.

I have not observed homosexual behaviour among Asiatic male lions in Gir.

Schaller (1972), in his study of African lions, has observed homosexual behaviour only in male lions. Paul Joslin (1973) in his study of Asiatic lions, does not mention having observed homosexual behaviour in lionesses.

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3. ON THE LONGEVITY OF THE CAT-BEAR OR RED PANDA (*AILURUS FULGENS*) IN CAPTIVITY

Three specimens (one male and two females) were received at the Nehru Zoological Park, Hyderabad (A.P.) on 30-6-66, 12-2-67 and 24-3-67 from an animal dealer of Delhi.

A female received on 24-3-1967 died on 8-8-79, establishing a longevity of 12 years 4 months 15 days in captivity. The other two specimens had died earlier within 4 years 5 months.

The maximum period of life in captivity for this species recorded in the San Diego Zoological Park namely 12 years and 10 months. One lived for 5 years and 4 months (Mitchell 1911) at the New York Zoological Park for 4 years, 11 months and 9 days (Crandall 1965). Another at the Nandan Kanan Biological Park, Orissa lived for 5 years and 4 months (Acharjyo, pers. comm.). According to Walker *et al.* (1964) only a few of this species adapt themselves sufficiently to survive long in captivity.

ACKNOWLEDGEMENTS

We wish to express our sincere thanks to Sri A. K. Mathur, I.F.S., Addl. Chief Conservator of Forests (W.L.M.), A.P., Hyderabad and Sri Pushp Kumar, I.F.S., Conservator of Forests (W.L.M.), A.P., Hyderabad for their help and encouragement.

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4. STUDIES ON *BANDICOTA BENGALENSIS BENGALENSIS* GRAY IN KERALA[1]

(*With four text-figures*)

INTRODUCTION

The lesser bandicoot rat *B.b. bengalensis* is a serious pest of tuber crops in the State of Kerala. The present studies were taken up with the object of obtaining detailed information on the distribution and habits of *B.b. bengalensis* in the State.

MATERIALS AND METHODS

The burrow openings of the species were first located in gardens and the adults and young in each occupied burrow were collected by locating the segment of the net work which the animals inhabited, as follows:

To locate the actual section occupied by the rat and the brood, the burrow system was opened up at three or four spots along the entire burrow net work. The actual segment of the burrow containing the rat was then plugged and the animal smoked to death. Thereafter, the burrow network was exposed by gently working with a crow-bar and spade to study the basic burrow pattern and the nature of chambers.

The damages caused by *B.b. bengalensis* was ascertained by looking for crop damage around the burrow system. The remnants of food from within the borrow were collected and examined for information on the normal food habits of the species.

RESULTS AND DISCUSSION

The present study revealed that in Kerala, burrows of *B. bengalensis bengalensis* were mostly seen in gardens holding tapioca, colocasia and yam and in rubber and coconut plantations, as well as orchards and thick forests and rarely along paddy field bunds. This finding is at variance with the observation of Ramakrishnan (1972) that *B. bengalensis* was confined to rice fields.

The burrows of *B. bengalensis* were located in all types of soils both dry and moist, though Yashoda (1968) reported that *B. bengalensis* dug burrows in fine and moist soil. Krishna Ayyar (1931) found that the burrows of *B. bengalensis* were long, extensive and somewhat complicated and that these extended upto 20 to 30 feet. During the present studies certain burrows were found to be shorter and of simple construction, while some were longer, ramifying and extensive. The maximum horizontal coverage of a burrow was found to be 59.11 m as against Deoras's (1962) record of 30 m.

The burrow patterns were of four basically different types, namely, short and simple (Fig. 1) of medium length with more number of openings (Fig. 2), elongated extensive with winding passages (Fig. 3) and burrow system with food chambers (Fig. 4). These are described in Table 1.

The number of openings for the burrow system varied from two to thirteen as against four to five openings previously recorded by Krishna Ayyar (1931). According to him the burrow depth seldom exceeded 60 cm. Deoras (1962) recorded a depth of 72.5 cm, but in the present study the maximum depth recorded was 90 cm.

Prem Sagar and Bindra (1973) have indicated that the brood chamber/bed chambers

[1] Part of the M.Sc. (Ag.) thesis submitted to the Kerala Agricultural University by the senior author for the award of the M.Sc. (Ag.) Degree.

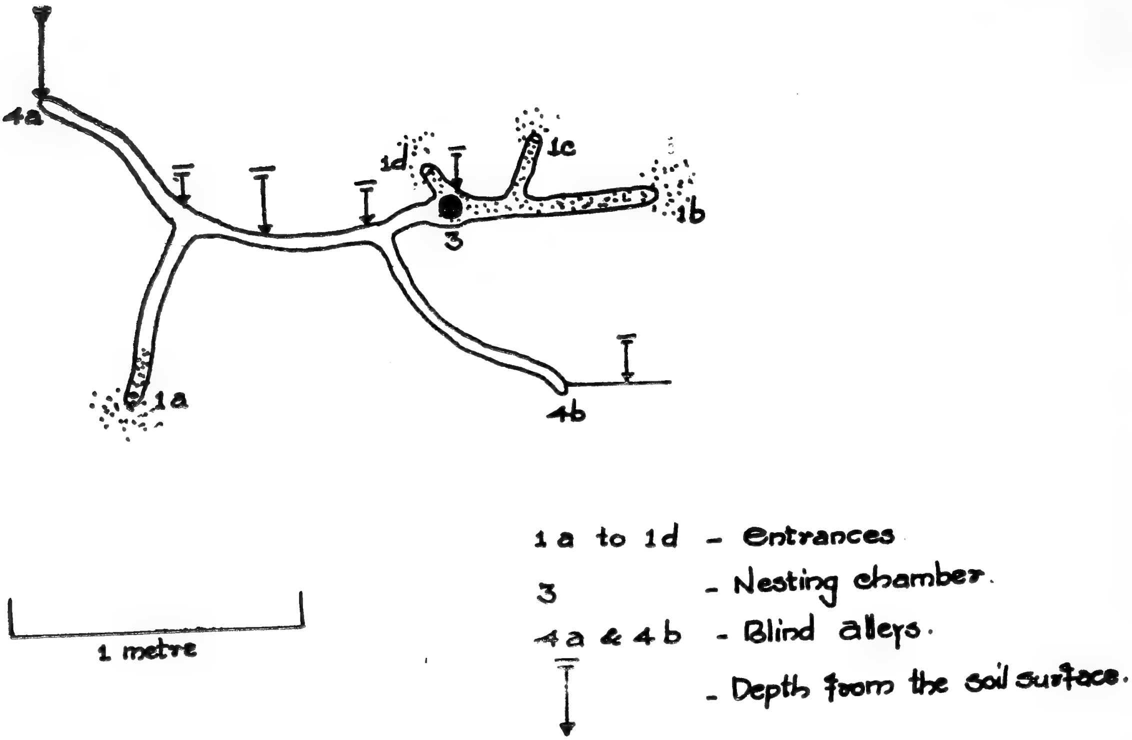

Fig. 1. Short and simple type of burrow pattern of *Bandicota bengalensis bengalensis.*

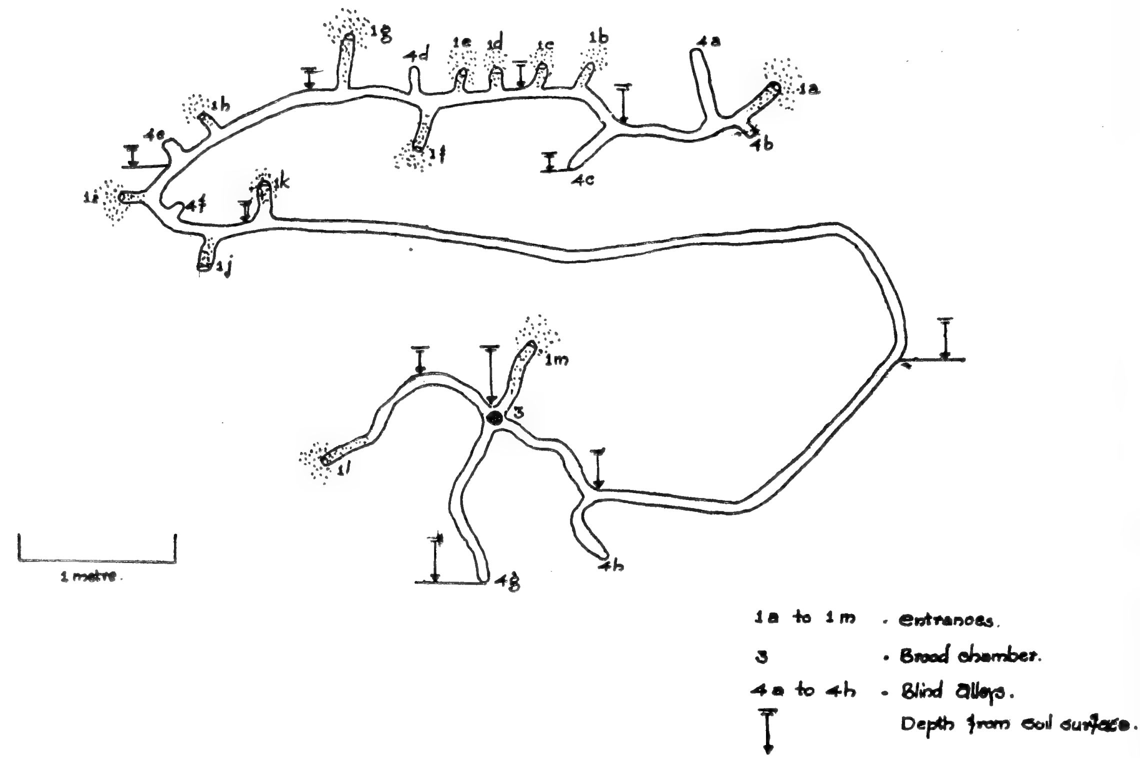

Fig. 2. Burrow pattern of *Bandicota bengalensis bengalensis* medium length with numerous surface openings.

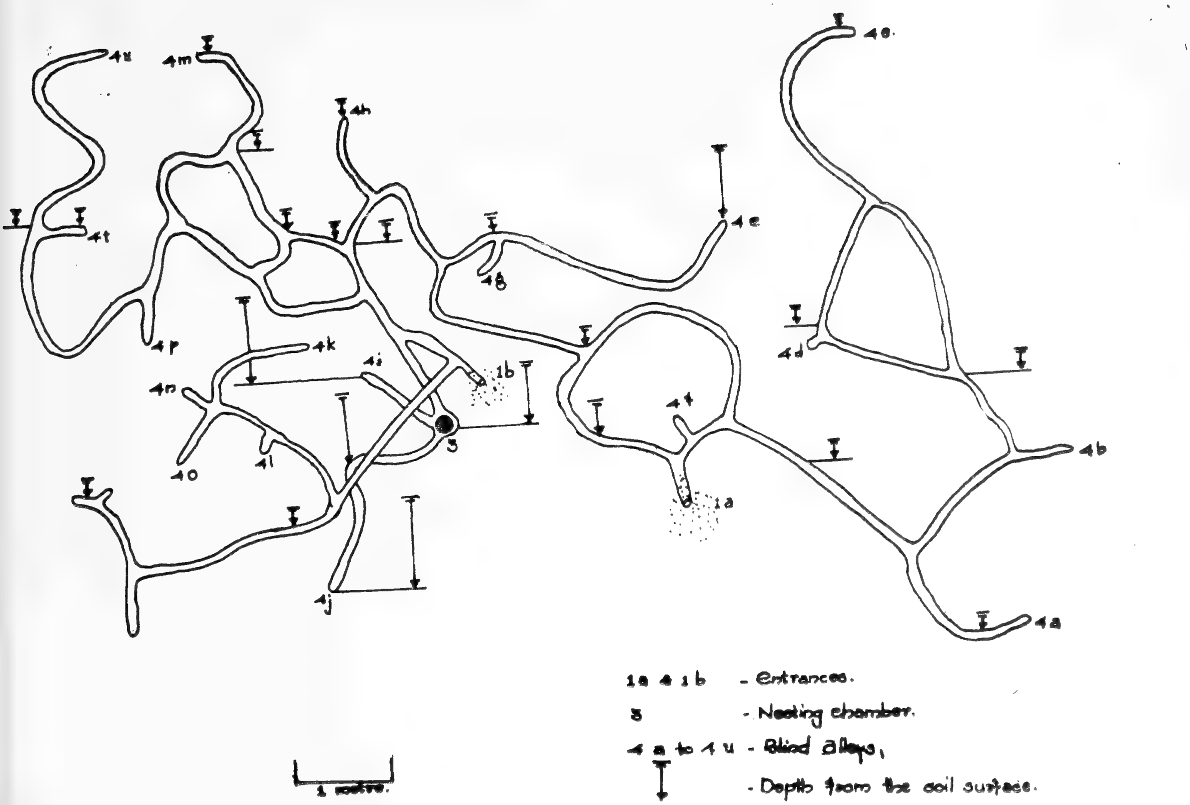

Fig. 3. Elongated and extensive type of burrow pattern of *Bandicota bengalensis bengalensis*.

were located at the centre of the system at the maximum depth of the burrows. Out of the 25 burrow systems studied, only three burrow systems had their brood chamber located at the centre while in nine cases the chamber was located at the maximum depth.

The burrow systems containing male rats were also provided with a nest in the bed chamber. This observation is not in consonance with early report of Premsagar and Bindra (1973) who did not locate bed chambers in burrows inhabited by male rats.

It has been reported that *B. bengalensis* hoards food in special chambers located in their burrows (Wagle 1927). In the present survey, food hoarding was detected only in four out of 25 burrows examined. These were located along paddy field bunds and in one of these burrows, definite food chambers were found. In the other burrows paddy was found to be stored throughout the length of the burrow net-work with just adequate space for the movements of the rat. The non-hoarding habit of *B.b. bengalensis* in Kerala can be explained on the basis of the easy accessibility to crops and other food material throughout the year. The hoarding habit might be essential in arid and semi-arid

TABLE 1

STRUCTURAL FEATURES OF BURROW SYSTEMS OF *B.b. bengalensis*

Features	Type-1 Short & simple type	Type-2 Medium type with large no. of openings	Type-3 Elongated, extensive with winding passages	Type-4 Containing hoarded grains
Location	Cannanore	Trichur	Cannanore	Palghat
Vegetation around the burrow	Tapioca	Rubber	Tapioca	Paddy
Nature of soil	Laterite	Laterite	Laterite	Clay
No. of openings	Four	Thirteen	Two	Two
Nature of soil plugging	Entrance closed by heap of soil	Closed by heap of soil	Closed by heap of soil	Closed by heap of soil—an additional plugging inside the burrow
Mean horizontal profile	2.1 m × 1.1 m	5.1 m × 3.6 m	10.8 m × 6.7 m	2.25 m × 1.35 m
Mean length of the burrow system	3.85 m	19.63 m	59.11 m	5.46 m
Burrow width range	5-8 cm	6-12 cm	5-20 cm	6-11 cm
No. of chambers	One	One	One	Three
Maximum width of brood chamber	8 cm	12 cm	20 cm	9 cm
Depth of brood chamber from ground level	14 cm	33 cm	59 cm	33 cm
Maximum depth of the entire burrow system	32 cm	33 cm	90 cm	35 cm
Shape of brood chamber	Sub-spherical	Round	Round	Cylindrical
Nesting materials	Dry tapioca leaves and petioles	Dry rubber leaves	Dry tapioca leaves and petioles and bits of dry banana leaves	Hay
No. of blind alleys	2	8	21	5
No. of rats inhabiting the burrow	One male	Female and four young ones	One male	One female
Food materials hoarded in the burrows	Nil	Nil	Nil	500 g paddy earheads

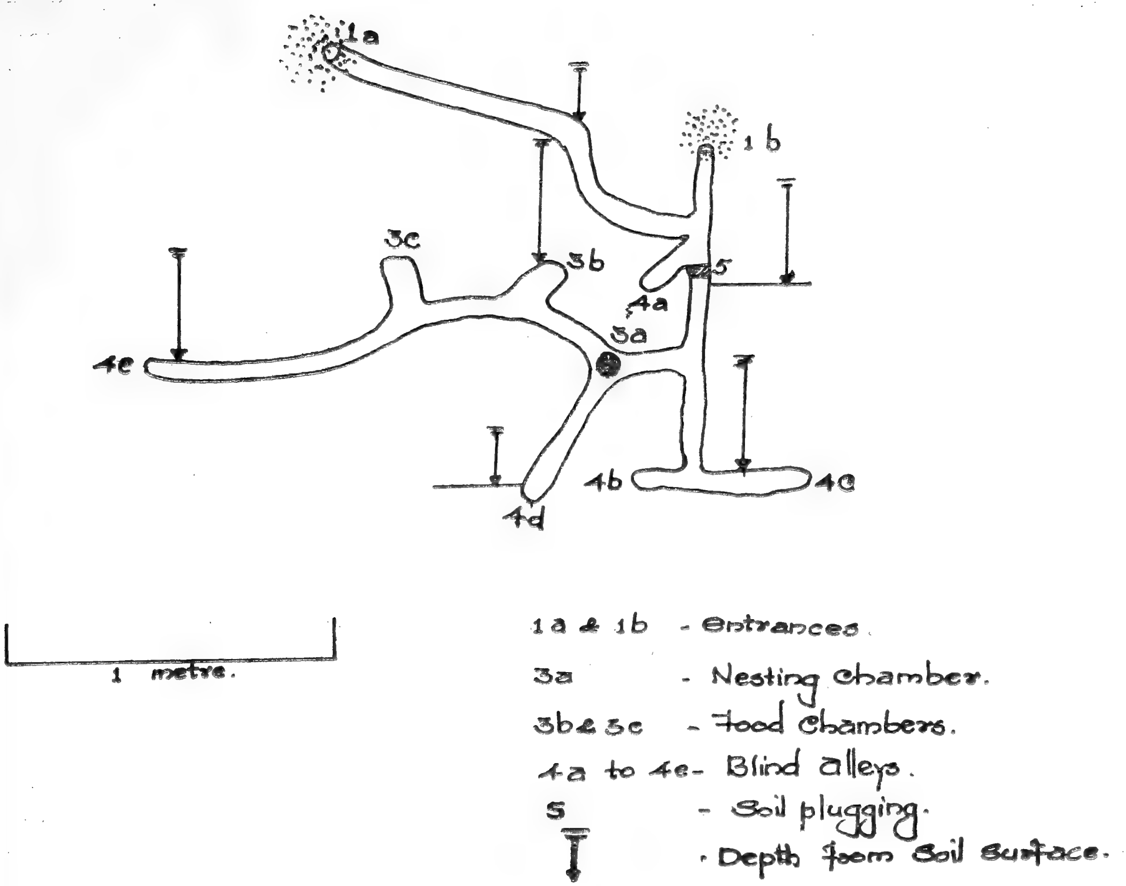

Fig. 4. Burrow pattern of *Bandicota bengalensis bengalensis* with food chambers.

regions characterised by the non-availability of crops and/or food materials throughout the year.

A main tunnel for the burrow system was reported by Yashoda (1968). This was not however, found in Kerala conditions except in a very few cases where the burrows were located along paddy field bunds. In all the other circumstances, the burrow systems did not conform to a particular structural pattern.

ACKNOWLEDGEMENTS

The Zoological Survey of India, Calcutta, has identified the various rat species collected during the survey work. We are indebted to Dr. V. S. Agarwal, Superintending Zoologist, Dr. Sujit Chakraborty, Zoologist and Dr. P. K. Das, Officer-in-charge, Mammal and Osteology Section for identifying the rats. The facilities for this study were provided by the Associate Dean, College of Horticulture and we wish to place on record our gratefulness to him.

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5. BURROWING BEHAVIOUR OF *RATTUS MELTADA PALLIDIOR*

(*With a text-figure*)

The soft-furred field rat, *Rattus meltada* is a serious pest of Indian agriculture. It lives in shallow, round and vertically directed burrows situated on the bunds or in cracks in and around crop fields (Rana & Prakash 1980), and grassland. To study the burrows' environment and its structure, twenty burrows were excavated in relation to various stages of growth of cotton and chilly crops, at Bisalpur (25°7′N, 73°10′E), south eastern fringes of western Rajasthan near the Aravali ranges. Most of the burrows were found in the crop fields and the majority of the burrows excavated were simple and of single tier structure. The length, depth and opening of burrows increased significantly ($P < 0.001$, 0.001 and 0.01 respectively) with the maturity of crops. One to four and two to six surface openings in single burrows were observed in immature and mature stage of crops respectively and the difference was significant ($P < 0.01$ respectively). In the majority of the burrows, nest chambers were present. In one of the burrows, four nests filled with damaged chillies, cotton fibres and unripe cotton capsules were found. One female along with a litter of six young ones was also recovered from the burrow. Three young ones were recovered from metad burrow at Mandsaur, Madhya Pradesh by Jain (1976) and five young ones at Ludhiana, Punjab by Chopra and Sood (1980). Barnett and Prakash (1975) did not witness bolt run in the burrow of this rat. However, we observed 3 to 4 bolt runs on an average in a single burrow system (Fig. 1). The mean of the maximum length and depth of burrows during ripening stage of crops was 2.50 ± 0.32 and 0.35 ± 0.04 m. respectively (Table 1B),

TABLE 1

DIMENSIONS OF BURROW OF *Rattus meltada pallidior* IN COTTON AND CHILLY CROPS IN RELATION TO STAGE OF CROPS

Burrow No.	No. of Openings	Burrow: Depth (m) Minimum	Depth (m) Maximum	Average diameter (m)	Total length (m)
A. *Immature Stage*					
1	3	0.10	0.25	0.10	1.05
2	2	0.08	0.20	0.09	0.95
3	3	0.18	0.25	0.13	1.95
4	1	0.13	0.18	0.07	0.45
5	2	0.15	0.28	0.10	0.85
6	4	0.12	0.31	0.09	1.30
7	2	0.16	0.24	0.08	1.05
8	1	0.15	0.26	0.08	0.85
9	3	0.15	0.30	0.08	1.15
10	2	0.13	0.27	0.70	0.90
Mean $\pm$ S.E.	2.3 $\pm$ 0.03	0.13$\pm$0.01	0.25$\pm$0.01	0.09$\pm$0.01	1.05$\pm$0.12
B. *Mature Stage*					
1	5	0.15	0.35	0.09	2.95
2	4	0.22	0.36	0.09	2.68
3	6	0.20	0.40	0.10	3.03
4	4	0.18	0.29	0.10	2.88
5	3	0.21	0.29	0.09	2.72
6	4	0.16	0.33	0.08	2.80
7	3	0.15	0.28	0.09	1.65
8	3	0.18	0.30	0.09	1.85
9	6	0.24	0.38	0.12	3.29
10	2	0.15	0.22	0.07	1.15
Mean $\pm$ S.E.	4.0 $\pm$ 0.42	0.18$\pm$0.01	0.35$\pm$0.04	0.09$\pm$0.007	2.50$\pm$0.32
't' values between the means of A & B	3.28**	2.23*	7.0***	—	5.82***

* = $P < 0.05$
** = $P < 0.01$
*** = $P < 0.001$

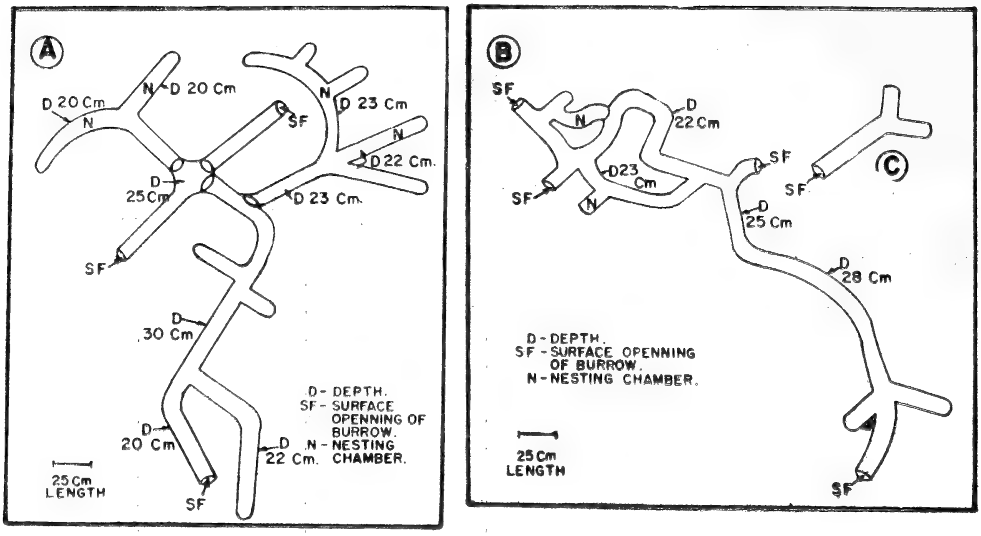

Fig. 1. Burrow system of *Rattus meltada pallidior.*

whereas, during early stage of the crops were only 1.05 $\pm$ 0.12 and 0.25 $\pm$ 0.01 m., the difference was found to be significant ($P < 0.001, 0.001$) respectively (Table 1A). The results indicated that the dimension of the burrows increases with the maturing of the crops. A small live toad *Bufo* sp. was collected from the same burrow. The occurrence of *Bufo* in association with *R. meltada* indicates that both live together amicably. In Karnataka, arthropods were found co-habitating in the burrows of the other rodents namely *Bandicota bengalensis, B. indica,* and *Tatera indica* (Yashoda *et al.* 1966).

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6. NOTES ON WEIGHT AND SIZE AT BIRTH OF EIGHT SPECIES OF INDIAN WILD UNGULATES IN CAPTIVITY

The present note embodies some data on the weight and size at birth of eight species of Indian wild ungulates in captivity observed at the Nandankanan Biological Park, Orissa. The weight and size at birth were recorded either immediately after birth or within about twelve hours of birth. The details of our observations are given in the Table.

TABLE

Species of wild ungulates	Peried of observation	No. of specimens under study	Mean weight (Range) in Kg	Mean total length (Range) in cm	Mean shoulder height (Range) in cm
1	2	3	4	5	6
Indian Sambar (*Cervus unicolor niger*)	1-7-1972 to 31-7-1980	20	10.270 (7.000-12.300)	99.4 (88.0-107.0)	55.1 (49.0-59.0)
Spotted Deer (*Axis axis*)	1-7-1972 to 31-7-1980	34	2.991 (2.200-4.000)	71.1 (65.0-77.0)	37.7 (33.0-40.0)
Hog Deer (*Axis porcinus*)	1-7-1972 to 31-7-1980	6	2.365 (2.000-2.740)	57.1 (54.0-60.0)	30.0 (27.0-32.0)
Barking Deer (*Muntiacus muntjak*)	1-7-1972 to 31-7-1980	22	1.554 (1.200-2.010)	51.0 (45.0-56.0)	26.6 (24.0-30.0)
Mouse Deer (*Tragulus meminna*)	1-7-1972 to 31-7-1980	4	0.319 (0.288-0.382)	27.9 (26.5-30.5)	14.6 (14.0-16.0)
Black Buck (*Antilope cervicapra*)	1-7-1972 to 31-7-1980	33	3.276 (2.600-4.200)	68.5 (64.0-75.0)	38.4 (36.0-44.0)
Four-horned Antelope (*Tetracerus quadricornis*)	1-4-1974 to 31-7-1980	7	0.942 (0.740-1.065)	43.4 (42.0-46.0)	25.4 (24.0-27.5)
Indian Wild Boar (*Sus scrofa cristatus*)	1-10-1972 to 31-7-1980	7	0.681 (0.630-0.715)	36.4 (34.0-38.0)	16.2 (15.5-17.0)

The observations on weight and size at birth of these eight species of Indian wild ungulates as reported by earlier workers are given as follows.

INDIAN SAMBAR: At birth the weight of seventeen sambar fawns was from 7.600 Kg to 11.000 Kg with an average of 9.653 Kg, the length was from 91 cm to 106 cm with an average of 98.8 cm whereas the shoulder height was from 53 cm to 58 cm with an average of 55.2 cm (Acharjyo and Misra 1972). The average weight of nine sambar fawns at birth was 8.270 Kg, the average length 98 cm and the average shoulder height was 53 cm (Acharjyo 1970).

SPOTED DEER: The weight at birth of twenty-four fawns of this species was from 2.200 Kg to 4.000 Kg with an average of 3.129 Kg, the length was from 65 cm to 79 cm with an average of 72.6 cm and the shoulder height was from 36 cm to 44 cm with an average of 39.7 cm (Acharjyo and Misra 1972). The average weight of 33 fawns was 3.320 Kg, the average length was 71 cm and the average shoulder height was 39 cm at birth (Acharjyo 1970). The weight at birth of two male spotted deer fawns was 3.630 and 4.500 and their total lengths were 77 cm and 74 cm (Sankhala and Desai 1969).

HOG DEER: At birth the average weight of three premature and dead fawns were 1.333 Kg and their average length was 51.7 cm (Acharjyo and Misra 1972). Sankhala and Desai (1969) stated that the three Hog deer fawns weighed from 1.500 Kg to 3.180 Kg and measured 53.0 cm to 57.8 cm in total length at birth.

BARKING DEER: According to Sankhala and Desai (1969) the two male fawns of this species of Delhi Zoological Park weighed 1.360 Kg and 2.000 Kg and measured 41.3 cm and 52.0 cm in total length at birth. A barking deer fawn weighs about 0.550-0.650 Kg at birth (Walker *et al.* 1964). The birth weight of nine fawns was varying from 0.900 Kg to 2.000 Kg with an average of 1.520 Kg, the length from tip to tip at birth was from 43 cm to 55 cm with an average of 50 cm and the shoulder height was from 25 cm to 30 cm with an average of 27 cm (Acharjyo 1970). Acharjyo and Misra (1972) have given the mean weight of six fawns as 1.250 Kg, the mean length as 49.1 cm and the mean shoulder height as 24.9 cm at birth.

MOUSE DEER: A female fawn of this species weighed 203 grams, measured 27 cm in total length and had a shoulder height of 12.5 cm (Acharjyo and Misra 1972).

BLACK BUCK: One male black buck young at birth weighed 4.770 Kg. and measured 71.2 cm in total length (Sankhala and Desai 1969). According to Acharjyo and Misra (1972) the average weight and size at birth of twelve blackbuck young were as follows: Weight, 3.558 Kg; the length 70.1 cm and the shoulder height 39.8 cm.

FOUR-HORNED ANTELOPE: The weight and size at birth of seven young of this species as reported by Acharjyo and Misra (1975) were as follows: Weight- from 0.75 to 1.2 Kg with an average of 1.04 Kg, length from tip to tip —from 42 to 45 cm with an average of 43.5 cm and the shoulder height—from 24.5 to 27 cm with an average of 25.2 cm. At birth one female young of this species weighed 1.250 Kg and had a total length of 45 cm (Sankhala and Desai 1969). At birth a fawn of this species weighed $2\frac{1}{4}$ pounds, measured 15 inches in length and the shoulder height was 10 inches (Shull 1958).

INDIAN WILD BOAR: Seven piglets weighed from 325 to 665 gm with an average of 557.43 gm and measured 31.5 to 37 cm with an average of 35 cm and had shoulder heights from 14 to 16.5 cm with an average of 15.36 cm (Acharjyo and Misra 1974).

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7. ECOLOGY AND BEHAVIOUR OF GREAT INDIAN BUSTARD (FAMILY OTIDIDAE)

Introduction

In Maharashtra the Great Indian Bustard is seen in Ahmednagar, Sholapur and Aurangabad districts in some numbers. The survival of the great Indian Bustard in these three districts is due to the presence of suitable habitat in the form of new forest areas which are being developed by D.P.A.P. and which provides them sufficient cover and food. These areas are protected from trespassers and are used for cultivation of new grass types such as Hamatu and Scresis under the guidance of the World Bank.

The present study was undertaken with a view to develop measures for its conservation as the bird is on the verge of extinction.

Habitat

The study was carried out at Nanaj, a small village 16 km from Sholapur city, and at Karmala of the same District of Maharashtra. Nanaj village is well known for its grapes. Under D.P.A.P. Scheme nearly 100 hectares of stony land 2 km from the village has been brought under a very successful plantation programme. The whole area from Sholapur to Nanaj is bare open rocky land and Nanaj plantation is the only green patch in it. The height of the grass is *c.* 1 m, and the trees have grown to nearly 1.5 to 2 m. There is a small lake also near the plantation.

Karmala Taluka is well known for its barren landscape. Water is so scarce that people are not willing to give their daughters to youths from this place. Under D.P.A.P. Scheme the forest department is afforesting about 200 hectares of land which the birds inhabitat.

I have seen a number of birds (7 to 12) at Karmala, another four birds at Akalkot Road near Sholapur City and 2 at Degaon, a place hardly 4 km from Sholapur City. The total number of Bustards in the district will not be more than 25 today.

Study Methods

The study commenced from 7th September, 1978 and continued till 9th August, 1980, and covered the hatching period at Nanaj in the month of September, and breeding period at Karmala and other places in November, December, January and March.

I made 15 visits, eight times to Nanaj, (observation of hatching) 6 times to Karmala and twice to other places, like Akalkot and Degaon, spending 2/3 hours in the morning and evening watching the birds. I counted 12 birds at Karmala and a pair at Nanaj. Since it is easy to get near the birds by a jeep, I could count them easily. One flock, had 6 birds, one male and 5 females.

RESULTS AND DISCUSSIONS

Population: A cause of great concern has been the dwindling numbers, though I was fortunate enough to locate a flock of 12 in 1978 and 1979, recently I could see only 3 birds and that too after waiting for 3 days.

BREEDING: I saw an egg at Nanaj on 7th October, 1978 which hatched after twenty days. The chick died due to heavy rains after 15 days. Again on October 24th 1979 an egg was found in shallow ground. On this occasion breeding was successful and the chick was seen running with its mother and when I went near it took shelter in the grass, keeping absolutely silent for some time. Afterwards it started making low cries to attract the attention of the mother. On each occasion only one egg was laid. The male was not close by.. Though I cannot vouch for it I believe that the pair was the same in both years.

Food: The grasslands are their usual habitat but they forage for food in the low standing crop. They thrive on locusts, beetles, various other insects, snails, lizards and snakes. They also feed on grain shoots in the fields, mainly Bajra and its leaves and berries of *Capparis*. I have also seen them eating eggs of lark and one live sparrow was caught by a male Bustard. Just to find out the quantity of insects available for bustard the following experiment was made. During night a bucketful of water was kept under a fluorescent tube and in the morning the bucket was full of insects (mainly grasshoppers) and the weight was about 1 Kg. When these birds walk in the field, insects fly up and are often caught in flight.

Calls: In the evening I heard the call of the male, a bell like "hook" which alerts the flock. Some time the call is a soft 'hook'. But often sounds like the bursting of a rubber balloon can be heard from a long distance. The people of Karmala recognise its call and can exactly imitate the sound.

Behaviour: The male Bustard is wary and is usually seen 20 to 30 m from the flock. The white neck as it stands is very noticeable and that is why we can see and find it easily. Among bushes the bird is well camouflaged. In Bajra crop I have twice seen the bustard moving slowly with its upright neck looking just like periscope. Bajra field affords good protection and is a main crop in this area. The birds forage from morning to sunset constantly. I have watched a flock of 4 to 5 feeding for nearly 8 to 9 hours in a Hulga plantation at Devichamal, Karmala.

CONCLUSION

My observations suggest that the Bustard is a resident species in Sholapur District and its breeding areas need protection. The bustard is under severe poaching pressure. A local villager offered to get us a chick of the bird for Rs. 5/- and an adult for Rs. 10/- to 15/-. Local Tribes kill it mercilessly and sell its meat. The Forest Department is unable to protect it. The Police Department does not know its importance though the bird is on the verge of extinction.

Local people are not aware that it is a species protected by law. The local farmers do not kill them but also do not give any protection.

Recommendations:

1. There should be more vigorous and effective conservation programmes.
2. The local people should be educated on the importance of this bird.
3. After the completion of the D.P.A.P. Scheme it has been decided to give the grasslands for sheep grazing. Some arrangements should be made so that the bustard is not deprived of their feeding ground.
4. Shooting by any weapon should be prohibited.
5. At present the bustard survives in Maharashtra in three widely separated districts. The proposed sanctuary should be brought into existence early as possible and a trained ornithologist appointed as officer-in-charge.

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8. OCCURRENCE OF THE SOOTY TERN (*STERNA FUSCATA*) IN BOMBAY—AN AUTHENTIC RECORD

At about 6.30 p.m. on 26th May, 1980, I went to the Tata Institute of Fundamental Research, situated at the southernmost tip of Bombay Island, and my attention was drawn to a dead bird which had been picked up by a gardener on the Institute Premises. The specimen was brought to the Society's offices and subsequently identified as the Sooty Tern (*Sterna fuscata*). It was sexed a male (Wing 288, Bill 42, Tarsus 19, Tail 159) and has been added to the Bombay Natural History Society's collection under Registration No. 24422. It has not been possible to determine the subspecies.

Though older records said that this bird occurred near Bombay, Abdulali (1970, JBNHS, *67*(*1*):110-111) discussed the evidence available and concluded that there was no authentic record from this area. He also questioned his own record of the bird breeding on the Vengurla Rocks, West coast, India (1942, *JBNHS*, *43*(*3*):446-451) as the specimens then examined were not available for re-examination.

The present specimen would therefore be the first satisfactory record from this area. It was of course known to breed in great numbers further south at Cherbaniani Reef in the Laccadive Islands (Hume, 1876, *Stray Feathers*, Vol. *4* pp. 477).

Incidentally Mr. Abdulali has drawn my attention to an excellent article by Robertson, W. and Kahl, M.P. (1980, *National Wildlife*, Vol. *18*(*2*):37-39) where there is reference to a ringed bird of this species surviving for 32 years.

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9. EXTENSION OF RANGE OF BROWN WOOD OWL, *STRIX LEPTOGRAMMICA*

On June 6th 1980 during a visit to the summer palace of the Dalai Lama in Lhasa, at Norbulinka, a colleague picked up a secondary feather of an owl from the ground near the large pine trees growing outside the villa. Examination of this single feather which is fresh and in good condition confirms that it belongs to *Strix leptogrammica,* presumably of the subspecies *newarensis* which is recorded from as high as 4000 metres in the adjacent Himalayan range to the south. This is a first record for Southern Tibet at an altitude of 3,822 metres (12,500 feet).[1] The presence of large trees and groves of willows, poplars, pines, junipers, elms, walnut, etc. in the neighborhood would provide an ideal habitat for such a medium-sized reclusive forest species, although the intervening distance from the Himalayan slope to the oasis of Lhasa would indicate infrequent exchange between the nearby populations in the Himalayas.

It would be interesting if local ornithologists would confirm the presence of such an owl in the Lhasa region.

[1] (Ludlow F., Ibis, 1944, p. 373, reports seeing a species of *Strix* in conifer forest above Pe and on the Lusha La in S.E. Tibet, altitude over 3050 metre).

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10. A NOTE ON THE FEEDING HABITS OF SWIFTS (APODIDAE: APODIFORMES)

Certain species of swifts (Apodiformes) have been reported to be predaceous on a variety of insects (Ali and Ripley 1970). The present observations at two locations in Madurai district in South India indicate the possible role of these birds as natural controls during epidemics of certain types of insect pests and the possible impact of plant protection chemicals on the food of the birds.

In Oddenchatram area, there was a serious outbreak of the chilli white aphid, *Myzus persicae* Sulzer. The incidence was fairly heavy and chemical control failed resulting in overcrowding and the formation of alates. It was during this stage that large number of the swift *Apus affinis* (J. E. Gray) were attracted to the aphid-infested fields. These house swifts were observed flying in flocks upto 30-50 hawking the flying aphids in the air. Their activity was continuously observed throughout the day until dusk.

The apterous aphids were not picked directly from the plants.

At Madurai during a recent serious outbreak of the rice earhead bug, *Leptocorisa acuta* Thunberg, the palm swift, *Cypsiurus parvus* (J. E. Gray) was observed to feed on these bugs in large numbers. These birds were noticed to fly across the fields singly or in small groups of not more than 3-4 hawking the flying insects. Their activity appears to be high in the morning hours and decreased after 10.00 a.m. when the temperature here shoots up even in the months of January and February.

To combat the rice earhead bug, the dusting of BHC 10% and Carbaryl 10% was resorted to at 25 kg/ha. This treatment was noticed to drastically affect the activity of the palm swift, *C. parvus batasinensis* over the treated area. A mean of as much as 318 sorties over an area of one acre was observed over a two hour period of observation in untreated plots whereas the treated plots could account for only 12 in case of BHC and 26 in case of carbaryl.

The observations indicate the possible potential of swifts in the natural control of specific pests in epidemics. The effective action of BHC and carbaryl and the reduction in flying insects is also evident from the counts of the birds hawking over treated and untreated fields.

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11. GOLDEN ORIOLE *ORIOLUS ORIOLUS* FEEDING A FLEDGLING CUCKOO (*CUCULUS* SP.)

I observed a male Golden Oriole *Oriolus oriolus* feeding a fledgling cuckoo. The oriole and the fledgling were sitting on a *Bridelia retusa* tree and the oriole fed the young cuckoo 5 times within 15 minutes, twice the berries of *Bridelia retusa* and thrice insects picked up from the foliage of the same tree. The fledgling cuckoo fluttered wings, called and crouched each time it received the food. While hopping from branch to branch in search of food the oriole also called repeatedly. The cuckoo followed the oriole when it finally flew away. This observation was made at Betla Tiger Reserve, Palamau District, Bihar, North India on 19 September 1979 in the afternoon.

The young cuckoo was probably an Indian cuckoo *Cuculus micropterus* or the Common Hawk-cuckoo *Cuculus varius*, both of which were quite common in that area.

Baker 1934 (NIDIFICATION vol. 3) does not mention Oriole as a foster parent of either of these cuckoos. Sálim Ali and Ripley 1969 (HANDBOOK 3) mention the Blackheaded oriole *Oriolus xanthornus ceylonensis* as one of the host parents of Indian Cuckoo.

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12. LARGE RACKET-TAILED DRONGO AND COMMON BABBLER

On 8th December, 1979, a Large Racket-tailed Drongo (*Dicrurus paradiseus*) was seen in company of the Common Babbler (*Turdoides caudatus*) in a grove of Casuarina (*Casuarina equisetifolia*) and Shisham (*Dalbergia sissoo*) in Aligarh in Uttar Pradesh. The Drongo was actively catching flying insects but the Babbler was not observed to catch any insect.

I had not seen the drongo earlier, during five years of bird study. According to Whistler (1935) this species inhabits "the densest and dampest of the Indian forest, though it is also found in any well-wooded country and even comes into gardens". Ali (1977) says that it has a patchy distribution, more or less throughout India south of the Himalayas.

The Drongo which was seen in Aligarh was certainly a vagrant because it disappeared as quickly as it appeared. Two days of intensive search in and around the campus, especially in the thickly-wooded Scindia Fort near the University, did not reveal any other specimen of this species. According to Ali (1977) the large Racket-tailed Drongo is commonly seen in hunting parties associated with Tree Pie and Jungle Babbler. However, it is difficult to explain the association of the Babbler with such a transient as this Racket-tailed Drongo. It is unlikely that the babbler migrated with the drongo because the Common Babbler is a resident species and moreover, it is mostly found in semi-arid and dry country unlike the Racket-tailed Drongo which prefers damp forests. The babbler in this case was alone with the drongo though normally it lives in flocks of a half dozen or more. It is remarkable that the Common Babbler made a deep though short-lived friendship with a vagrant which it (the babbler) must have met for the first time in life.

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13. ON THE VALIDITY OF *IRENA PUELLA SIKKIMENSIS* WHISTLER & KINNEAR AND *I. P. ANDAMANICA* ABDULALI

In 1933 (*JBNHS* 36 p. 582) Whistler and Kinnear when working on the birds collected in the Eastern Ghats separated the Fairy Blue Bird (*Irena puella*) from northern India and Burma as *sikkimensis* (type locality Sukna, Darjeeling) holding that they were larger than nominate *puella* (Latham, type locality Travancore). Twelve adult males from Sikkim and the Duars were measured to have wings 133.5 to 141 mm. against a similar number from the southwest measuring 123-131 mm.

In a footnote to *I. p. puella* in Peters' CHECKLIST OF THE BIRDS OF THE WORLD (1960 IX p. 307) it was held that as 3 birds from further east (?) measured 124-140, the small difference did not warrant subspecific recognition. Later one of us (H.A.) described another race, *andamanica,* from the Andaman Islands (type locality Long Island, Middle Andaman), similar to *puella* in size of wing, but with bill and tail larger than in both *puella* and *sikkimensis*.

In Sálim Ali & Ripley's INDIAN HANDBOOK (1971, 6 p. 65) both races have been synonymised with *puella,* but a re-examination in the course of cataloguing the Bombay collection (50 specimens, 30 ♂♂, 20 ♀♀) has brought some interesting points to light which may be worth recording:

1) The six adult females of nominate *puella* from southwest India can be separated from immature birds by their black, *contra* horny bills, and show a brightness in the blue on the upper and lower plumage, most prominent in the tail coverts, which is lacking in northern females from Darjeeling and Burma (*sikkimensis*), as also in those from the Andamans (*andamanica*). The absence of this character distinctly separates *sikkimensis* and *andamanica* from nominate *puella.*

2) The wing measurements of *andamanica* and *sikkimensis* overlap, but the table hereunder will show that *andamanica* have larger bills and tails. The latter also have wider bills, which character is more visible to the eye than indicated by the measurements.

		andamanica	sikkimensis
		Bill from feathers	
Adult ♂♂	(3)	24.5, 26.5, 26	(9) 22-25.7 av. 24.4
Adult ♀♀	(2)	24.2, 27.4	(3) 23, 23.7, 24.3
Imm. ♂♂	(2)	24.2, 25	(5) 21.3-23.7 av. 22.5
Imm. ♀♀	(1)	25.5	(1) 23.2
		Width of bill at nostril	
Adult ♂♂	(3)	8.8, 8.9, 10	(9) 8-9.5 av. 8.7
Adult ♀♀	(5)	9-10.2 av. 9.6	(4) 8.5, 8.6, 9.2, 9.2
		Tail	
Adult ♂♂	(3)	104, 105, 107	(9) 90-101 av. 97.7
Adult ♀♀	(2)	102, 105	(5) 90-103 av. 97.2
Imm. ♂♂	(2)	100, 107	(5) 91-98 av. 96.2
Imm. ♀♀	(1)	99	(1) 93

In addition to this the tail/wing ratio of *andamanica* is always 80 or over, while that of *sikkimensis* 78 or less.

These differences are, we think, sufficiently consistent to establish the validity of both *sikkimensis* and *andamanica.*

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14. ON THE FIRST RECORD OF OCCURRENCE OF THREE PASSERINE BIRDS FROM ANDHRA PRADESH

During the course of avifaunal survey in January-February 1978 in Adilabad district, Andhra Pradesh, India, I collected three examples of the Northern Ashy Wren-Warbler, *Prinia socialis stewarti* Blyth, and while working out the unnamed collections from Andhra Pradesh, collected by Dr. C. B. Srivastava of this department in 1970 and by Shri B. Nath of this department (since retired) in 1962 and 1963, I noted an example of the Assam Purple Sunbird, *Nectarinia asiatica intermedia* (Hume) [Nectariniidae] and two males of the Blackbacked Indian Robin, *Saxicoloides fulicata* (Linnaeus), which were collected from Guntur district, and Nalgonda district respectively. Andhra Pradesh has not been included in the known distribution of these forms. The particulars of the specimens are as follows:

1) Northern Ashy Wren-Warbler, *Prinia socialis stewarti* Blyth (Aves, Muscicapidae: Sylviinae).

Material: 2♂; Birsaipet, *c* 35 km. northeast of Kaddam, Adilabad district; February 12 and 15, 1978.

1♀: Kaddam *c* 48 km. east of Nirmal, Adilabad district; February 10, 1978.

Measurements (in mm.):

	Wing	Tail	Bill
2♂	51(2)	62+, 73	15, 16
1♀	51	63+	13

Distribution: According to Ali and Ripley (1973), it ranges from Pakistan in the plains of the upper Indus river system, and northern India from the Himalayan foothills, south through the gangetic plain, northern Madhya Pradesh and eastern Rajasthan to the Kathiawar peninsula, the Narmada river and southern Bihar roughly above 20° lat. However, I have already reported the occurrence of this subspecies in Orissa; and the present material further extends its distributional range to the south to northern Andhra Pradesh.

2) Assam Purple Sunbird, *Nectarinia asiatica intermedia* (Hume) (Aves, Nectariniidae).

Material: 1♂; Nagarjuna Sagar, Guntur District, Andhra Pradesh; February 6, 1970.

Measurements (in mm.): Wing 59, tail 36, bill 20.

Distribution: According to Baker (1926) and Ali and Ripley (1974) this subspecies is found in Assam and Bangladesh. I have (1980) already recorded its occurrence in Orissa, and the present specimen further extends its range to Andhra Pradesh.

3) Blackbacked Indian Robin, *Saxicoloides fulicata fulicata* (Linnaeus) (Aves, Muscicapidae: Turdinae).

Material: 2♂: Devrokonda, Nalgonda district, August 20, 1962; and Yelleswara, Nalgonda district, October 19, 1963.

Measurements (in mm.): 2♂; Wing 70, 74; tail 62, 66; bill 16(2).

According to Ripley (1961), and Ali and Ripley (1973), this subspecies is found in southern India south of the Krishna river. The present examples from Nalgonda district, therefore, extends its range further northwards, i.e. north of the Krishna river.

ZOOLOGICAL SURVEY OF INDIA,
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December 27, 1978.

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15. EXTENSION OF RANGE OF THE INDIAN MAROONBREASTED SUNBIRD, *NECTARINIA LOTENIA HINDUSTANICA* (WHISTLER) [AVES, NECTARINIIDAE], AND THE NORTHERN JUNGLE MYNA, *ACRIDOTHERES FUSCUS FUSCUS* (WAGLER) [AVES, STURNIDAE]

During the avifauna survey in Puri district, Orissa, in March 1976, I collected two species of birds, namely, the Indian Maroonbreasted Sunbird, *Nectarinia lotenia hindustanica* (Whistler) [Nectariniidae] (one example) and the Northern Jungle Myna, *Acridotheres fuscus fuscus* (Wagler) [Sturnidae] (three examples). According to standard literature on Indian Ornithology Baker (1926) and Ali and Ripley (1972, 1974), the first has not so far been reported from Orissa, and the latter does not extend southward beyond the mouth of the Mahanadi river in Orissa.

Nectarinia lotenia hindustanica (Whistler)

Material: 1♂: Dhuanali, 19° 50′N. 85° 05′E., alt. 92 m., *c.* 25 km west of Balugaon, Puri district; March 12, 1976.

Measurement (in mm.): Wing 57, tail 38, bill from skull 27.

Weight: 7 g.

Ali and Ripley (1974, p. 28) recorded it as "Fairly common resident in the southern Indian Peninsula, on the east side north to the Nallamalai Hills (*c.* 16°N.) and on the west side north to the Thana and Kolaba districts near Bombay (*c.* 20°N.). Occurs in the low country and hills up to *c.* 1600 m (Kerala)".

Acridotheres fuscus fuscus (Wagler)

Material: 1♂, 2♀♀; Dhuanali, 19° 50′ N. 85° 05′ E., alt. 92 m, *c.* 25 km west of Balugaon, Puri district; March 15, 1976.

Measurement (in mm.):

	Wing	Tail	Bill from skull
1♂	123	73	25
2♀♀	114, 118	68, 72	25, 27

According to Ali and Ripley (1972, p. 183) this subspecies is known from northern India; its southern limit extends roughly to a diagonal line from Mount Abu in Rajasthan to the mouth of the Mahanadi river in Orissa (*c.* 20° 20′ N). The present example from Dhuanali, Puri district, therefore, extends its range further southwards (19° 50′ N.).

ACKNOWLEDGEMENT

I am grateful to Dr. B. Biswas, Zoological Survey of India, Calcutta, for his valuable suggesions and for going through the manuscript.

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BAKER, E. C. S. (1926): Fauna of British India, Birds. 3. Taylor & Francis, London.

16. PRELIMINARY STUDIES ON THE GRAMINIVOROUS MUNIAS (*LONCHURA* SPP.) OF BANGALORE

In the Bangalore area there are five species of munias feeding on cereals and millets. Of these four *L. punctulata* (Spotted Munia), *L. malabarica* Linn. (Whitethroated Munia), *L. malacca* Linn. (Blackheaded Munia), and *L. striata* Linn. (Whitebacked Munia), feed on millets, while the Red Munia (*Estrilda amandava* Linn.) was seen only on rice. The birds cause heavy damage to millets, especially bajra (*Pennisetum typhoides* Rich.), by feeding on the earheads, from the milky stage onwards.

MATERIAL AND METHODS

Observations were made during 1974 to 1976 when the status of all the munias, their habitat preference and food habits, in general, were studied under Bangalore conditions. Next a bajra field (rainfed) of approximately one thousand sq. m. was selected on the Main Research Station, University of Agricultural Sciences, Hebbal, Bangalore. Adjacent to the bajra plot were plots of ragi (*Eleusine coracana* Gaertn.) and navane (*Setaria italica* Linn.). Observations were made on the feeding rate (pecks/minute) of different species of munias using a programmable pocket calculator. Counts on the number of different species of munias visiting the field were also maintained. A pair of 8 × 30 field glasses was used. The study was conducted during October and November of 1976.

RESULTS

Blackheaded Munia

Blackheaded Munias had the highest feeding rate (6 pecks/mt.) (Table 1). This bird is essentially a bird of the wet tract, and was

TABLE 1

FEEDING RATE, HABITAT PREFERENCE AND RELATIVE ABUNDANCE OF MUNIAS IN THE STUDY AREA

Bird species	Feeding rate pecks/mt.	Habitat pre-ferred	Per cent popula-tion
Blackheaded Munia	6.00	Wet tract	11
Spotted Munia	5.82	Dry tract	33
Whitethroated Munia	5.41	Dry tract	44
Whitebacked Munia	3.17	Dry tract	12
Red Munia	—	Wet tract	0

more common in paddy fields and therefore the population was the least (11%) in the bajra plot which was in the dry tract. The bird is of relatively lesser importance here.

Whitethroated Munia

The most abundant of the munias in the study area. It also had a relatively high feeding rate and therefore could be considered as an important pest. However, it was found that these birds showed a greater preference for navane (*Setaria italica*) which was grown adjacent to the bajra plot. The feeding rate timed on navane was 6.1, which showed that the bird could feed faster on navane than on bajra. This probably is one of the factors favouring the birds' preference for navane. Navane being a more hardy crop can be effectively used as a trap-crop for this species.

Spotted Munia

The Spotted Munia was the most common species on the bajra crop, and second only to the whitethroated Munia. It had a high feeding rate. Of the four species of munias here, this was the most serious pest, hence the control of its numbers is essential.

Whitebacked Munia

This bird had the lowest feeding rate and was not common in the study area and can be considered as the least harmful.

Feeding hours and mode of feeding:

Munias usually arrive in small flocks to the bajra fields, and gather first on the power lines over the field. Later they descend on the earheads. Normally only one bird alights per earhead, but occasionally two may be found for brief periods. After alighting the bird holds on to the earhead with its feet and works on it with its powerful beak. The grains are picked off the earhead, dehusked, cut, and swallowed, some times dropped down, wholly or partly.

Conclusion

In dry tracts, Spotted Munia and Whitethroated Munia can cause appreciable damage to bajra and navane, respectively. Whitebacked Munia and Blackheaded Munia were found to be of lesser economic importance in the agroecosystem studied.

Acknowledgement

This study was initiated by Dr. Rodger Mitchell (Fulbright Professor, Ohio State University, U.S.A.) who besides stimulating interest was very useful in the field. We appreciate the comments and suggestions given by Dr. Sálim Ali and Dr. G. P. Channa Basavanna (Entomology Department, U.A.S.) which helped in the preparation of the final manuscript.

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17. SISKIN (*CARDUELIS SPINUS*) IN SOLANG NALLA, HIMACHAL PRADESH

At 13:30 hours on January 25, 1980, while conducting a wildlife survey associated with Himachal Wildlife Project, we encountered a flock of 21 small finches feeding on the seeds of an Alder tree (*Alnus* spp.) close to Solang Nalla, the stream which forms the headwater of the river Beas, at an altitude of 2600 m. AJG, who was quite familiar with the species from Europe, identified them quickly as Siskins (*Carduelis spinus*). Initially they were feeding more than 15 m above the ground, making their plumage difficult to see, but later some of the flock descended to within 10 m, allowing the following descriptions to be made:

"Small, *Carduelis*-type finches, with deeply notched tails. Shape and size similar to Goldfinches (*Carduelis carduelis*).
Males: green above, greenish-yellow below, shading to whitish on the belly. Small black bib on the chin, dark crown, dark streaks on flanks, yellow wing-bar (double bar on closed wing).
Females: similar to males, but brownish above. paler yellow below and lacking the black bib and dark crown. Streaks on flanks and sides to breast paler, brown.
Call: a dry, twittering trill, less liquid than Goldfinch."

Observations lasted about 15 minutes, both observers using 8 × binoculars. Comparison of size was facilitated by the presence nearby of a mixed flock of Goldcrests (*Regulus regulus*), Crested Black Tits (*Parus melanolophus*) and Greenbacked Tits (*P. monticolus*). The finches appeared similar in size to the Crested Black Tits. The presence of a black bib in the males appears to rule out the possibility of any other members of the genus *Carduelis* and the green upper parts are also diagnostic. Neither observer noted the presence of a yellow rump, but this may have been overlooked because for much of the time the birds were only visible from below.

The flock foraged actively, swinging on thin twigs at the extremities of the branches and sometimes hanging upside down. The ground below was liberally scattered with cone scales as evidence of their work. While feeding they maintained a continuous low twittering. Eventually they all flew off together, calling loudly, and were not encountered again.

The Siskin is not included in the relevant volume of the HANDBOOK (Ali & Ripley 1974), or in the BIRDS OF NEPAL (Fleming *et al.* 1975). The breeding range of the species covers the boreal regions of Europe and the U.S.S.R. as far east as 75°E and another, disjunct, population occurs in the Amur Valley, Sakhalin and Hokkaido (Dementiev and Gladkov 1954). Siskins have occurred as vagrants in Southeast Asia (King *et al.* 1975) and in Afghanistan (Reeb 1977) but the present sighting appears to constitute the first record for the Indian sub-continent. In view of the number of birds involved it is possible that Siskins may be regular winter visitors to the western Himalayas, an area where observations have rarely been made in winter, and anyone visiting the area at this season is urged to look out for the species.

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18. JUVENILE BULL FROGS (*RANA TIGERINA*) FEEDING ON FLIES ON RESTING BUFFALOES

On 23rd August 1980 at 9 a.m., on my way to University, I saw a buffalo lying in a puddle of water with about six small frogs on its back vigorously engaged in jumping and catching the flies that disturbed the buffalo. I could spend only a few minutes to observe this incident but I noticed that as and when the frogs jumped and caught the flies, the buffalo also got restless probably due to irritating sensation on it's skin. I could not collect the flies to identify them but I believe they are either the common house fly or some related species. Again on 25th September 1980, I saw 3 buffaloes lying in a puddle in front of the University Examination wing with small frogs on their back catching flies. A frog collected from the puddle has been identified as *Rana tigerina*. I have not read of this type of behaviour, and I think that both the buffaloes and the frogs mutually benefitted from this association.

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19. EGG-LAYING AND NEST-GUARDING BEHAVIOUR OF ESTUARINE CROCODILE (*CROCODYLUS POROSUS*, SCHNEIDER) IN CAPTIVITY

The present communication deals with egg-laying and nest-guarding behaviour observed in an estuarine crocodile (*Crocodylus porosus*) at the Nandankanan Biological Park, Orissa, India.

The female estuarine crocodile laid eggs for the first time when she attained a length of 255 cm and at an estimated age of ten years. The number of eggs laid in four clutches was 29, 34, 35 and 34 eggs.

The nest-guarding behaviour in the crocodile was observed for a period of $2\frac{1}{2}$ months, corresponding with the period of incubation.

In India, the estuarine or saltwater crocodile (*Crocodylus porosus*) is known to occur in the tidal mangrove forests of Sunderbans in West Bengal, Bhitar Kanika in Orissa and in the Union Territory of the Andaman and Nicobar Islands. This communication presents data on egg-laying and nest-guarding behaviour of the estuarine crocodile observed at Nandankanan Biological Park, Orissa, India.

A female specimen of this species, measuring about one metre and with an estimated age of about 27 months, was received at the Park from Paradip area (adjacent to Bhitar Kanika) on 19th November 1967. It is fed live fresh-water fish.

From early 1975 the female crocodile has been housed alone (there being no mate) in a 10.5 × 9.3 m enclosure of which approximately 1/3 (32.5 sq. m) is taken up by the pool.

Results

Egg-laying

This female first laid on 30 May 1975 inside the pool, out of which one damaged egg was seen floating. The female has laid in each succeeeding year and the dates of laying and clutch size are given in Table 1. The nest is constructed at a distance of about half a metre from the water's edge and consists of soil, sticks and dry leaves in a heap of about 30 cm high above. Although actual egg-laying was not observed, it is presumed that the eggs were laid very early in the morning on all four instances.

Table 1

Nesting date and clutch size in four successive years

Date of Laying	Number of Eggs
30 May 1975	29
4 June 1976	34
2 June 1977	35
22 May 1978	34

The mother crocodile laid eggs for the first time when it had attained a length of 2.55 m and at an estimated age of about ten years.

The oval, hard-shelled and white-coloured eggs measured 69-80 × 40-48 mm (N = 50) and weighed 70.5-90 g (N = 19).

Nest-guarding behaviour

In the first year the mother corocodile did not show any interest in the eggs as the eggs were laid inside the pool. But in the subsequent years it remained for most of the time very near the nest in a dug out wallow or inside the pool or sometimes partly over the nesting site, zealously guarding the nest. At the sign of the slightest disturbance, it used to reach the nest-site in one leap with open mouth.

The nest-guarding by the mother continued for a period of about 2½ months, corresponding with the period of incubation. Throughout the period she remained vicious and never allowed even the keeper to go inside the enclosure.

Discussion

As there was no male, all the eggs were infertile but even then the mother crocodile exhibited the nomal nest-guarding behaviour of the species. The egg laying season, at least in captivity, is restricted to late May and the first few days of June. The inter-egg-laying period observed numbers 370, 362, and 353 days respectively.

According to Yangprapakorn (1971) this species reaches sexual maturity at the age of 12-15 years, clutch size is 30-50 eggs and the incubation period is 78-80 days. Smith (1931) states that the mother crocodile of this species remains in the vicinity until the young are hatched, possibly to assist them to water when they emerge from the shell. He further states that the clutch size of two nests from Java were 50 and 60 eggs and the eggs were about 85 × 55 mm in size. It is prone to attack human beings more especially in the breeding season which takes place during the months of June and July (Lydekker 1896, Bustard and Choudhury 1979). The mother *Crocodylus porosus* digs two wallows wider than but not so long as her body, close to the nest and in one or the other crocodile remains there during the period of incubation (Loveridge 1946). The number of wallows seen near the nests of this species in North Andaman Island varies from one to three (Choudhury and Bustard 1979) and one to four in Northern Australia (Webb *et al.*, 1977).

The clutch size of 775 nests of nile crocodile (*Crocodylus niloticus*) is given as 25-95 eggs with an average of 60.4 per nest (Cott 1961). He further states that very few females (less than 2%) of nile crocodile were nesting before they had attained a length of 8 feet (2.44 m) and the largest number of breeding females occur in the length ranges between 9 feet 6 inches and 11 feet 6 inches (approximately 3-3½ m) [(mean length 10 feet 5 inches (3.2 m)].

Wild female gharial shows nest-guarding behaviour (Singh and Bustard 1977). Nest-guarding behaviour in Nile crocodile (*Crocodylus niloticus*), American alligator (*Alligator mississippiensis*) and marsh crocodile (*Crocodylus palustris*) has been observed (Cott 1971). Parental care in crocodilians has also been reviewed by Bustard (1979). Nest-guarding behaviour has also been observed in spectacled Caiman (*Caiman crocodilus*) in Mexico (Alvarez 1969) and in the American crocodile (*Crocodylus acutus*) (Ogden and Singletary 1973).

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20. MATERNAL BEHAVIOUR IN THE GHARIAL [*GAVIALIS GANGETICUS* (GMELIN)]

(*With a text-figure*)

INTRODUCTION

Observations have been made in recent years on aspects of maternal behaviour in various species of crocodilians (see Singh and Bustard 1977, and Bustard 1980, for references). Singh and Bustard recorded nest-guarding in the gharial and noted that a female's visits to the actual nesting site occurred around the time of anticipated hatching. Singh and Bustard assumed that the female's presence indicated her intention to assist the hatching process by digging up the nest, (a view corroborated by the fact that hatchling gharial break the egg shell, protrude the head, and remain in this position calling intermittently until the nest is opened (Bustard *et al.* in prepn.), however, no actual data were recorded on this topic. Singh and Bustard were of the view that due to morphological limitations—the gharial's greatly elongated jaws, the location of the eyes and the piercing tooth type —the gharial would not be able to pick-up and convey the hatchlings from the nest to the water.

Bustard (1980) reported post-natal care lasting many weeks in the gharial.

OBSERVATIONS AND DISCUSSION

We confirm that the gharial does excavate the nest on the basis of observations which occurred during the night of 9/10 June 1978 in Chambal River, North India. A gharial nest was intact at midnight on the 9th June. At 0500 hours on 10 June there was a well-marked saucer-shaped excavation measuring $2.57 \times 2.10 \times 0.4$ m deep with tracks of a large gharial between the water and the excavation (Figure 1). The distance from the centre of the excavation to the water was 10.7 m and the height of the nest above the water was 1.48 m. On the basis of scute length observations using the technique of Bustard and Singh (1977) the length of the female was estimated as 3.4 m.

Twentynine hatchlings were recovered from the water and further excavation of the nest disclosed the presence of another 16 still within the nest. Fortyfive eggshells were present indicating a 100% hatch. We presume that had we not been present, the mother would

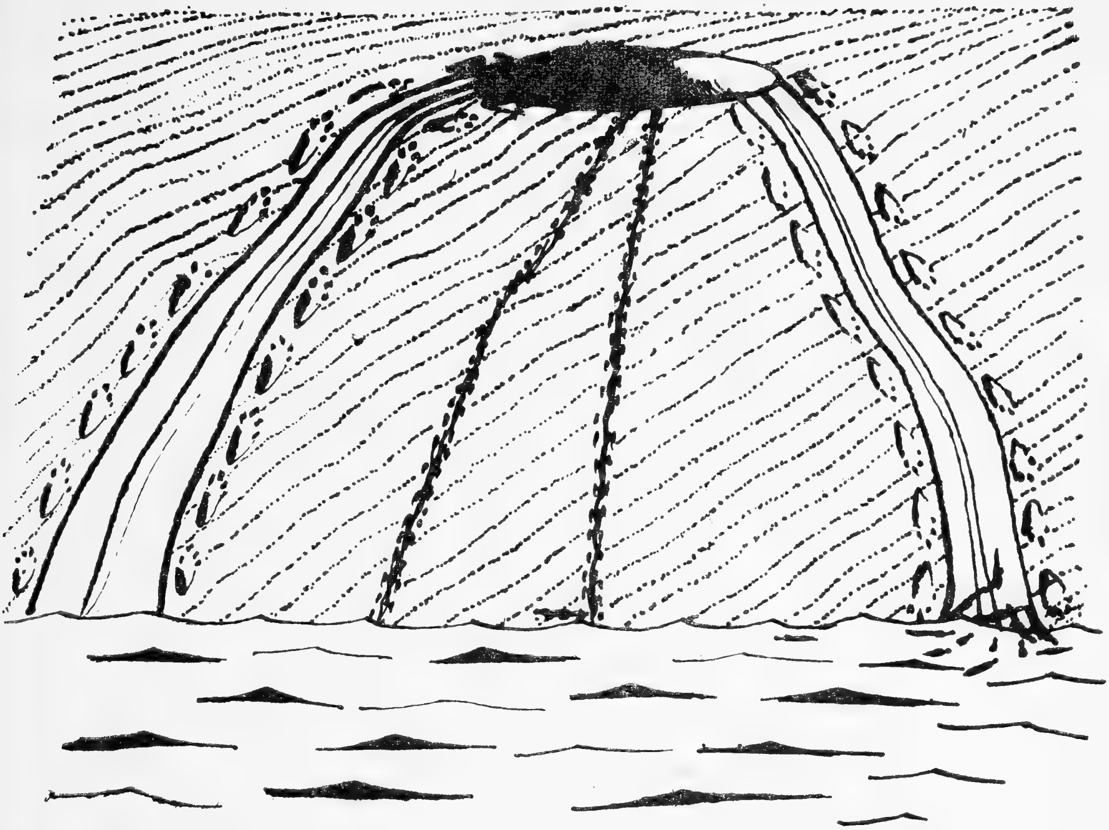

Fig. 1. Visual impressions of the excavation, tracks of a large gharial, presumably a female, between a disturbed area around the nest and the river and two clear tracks of hatchling gharial leading from the nest site to the river.

have returned to the nest in the early morning and excavated it further.

Apart from the belly slide of the female only 2 hatchling spoor marks were visible (Figure 1). (The very fine sand leaves excellent impressions even of animals of the size of a 2 cm beetle.) This strongly suggests to us that the female gharial took the young to the water. Such a view contrasts with that expressed by Singh and Bustard (1977) who considered the long snout, the location of the eyes, and the tooth type of the gharial were unsuited for picking up and holding the hatchlings uninjured.

If the hatchlings were not carried within the mother's mouth, they may perhaps have been carried on her body or moved closely beside her and their spoor obliterated by her belly slide. However, in the latter instance, it seems highly unlikely that there would be no traces of spoor from individuals which had moved outside the area of her belly slide. We therefore, conclude that the hatchlings were most likely carried to the water in the mother's mouth.

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21. GROWTH RECORDS OF GRASS CARP, *CTENOPHARYNGODON IDELLA* VAL. FROM RANKALA TANK, KOLHAPUR

Introduction of Grass Carp, *Ctenophyrangodon idella* Val. in weed infested water bodies has proved to be very successful as a weed control measure, the world over. According to Nikolskii (1956), the juveniles of grass carp bigger than 30 mm in length are almost herbivorous feeding mainly on aquatic macrophytes. The fish eats food as much as above 25% to 50% of its body weight every day in the warm climates, (Woynarovich 1975). Similar example of voluminous feeding and excellent rate of growth has been reported from a tank known as Rankala at Kolhapur in Maharashtra.

The Rankala tank has a thick growth of a large number of submerged, rooted, emergent and floating macrophytes. The phytoplankton is also rich in quantity and quality. The more common forms found in the tank are different species of *Vallisneria, Eichhornia, Pistia, Lemna, Wolffia, Nymphaea, Nymphoides, Hydrilla, Najas, Potamogeton, Typha, Ipomoea, Eleocharis,* etc. out of which *Hydrilla* and *Vallisneria* are commonest. The endemic fauna of the tank is also quite rich and the fishes like *Chela phulo* (Ham.), *Danio aequipinnatus* (McClelland), *Rasbora daniconius* (Ham.), *Puntius kolus* (Sykes), *Garra mullya* (Sykes), *Labeo calbasu* (Ham.), *Labeo porcellus* (Hackel), *Rohtee vigorsii* (Sykes), *Noemacheilus botius* (Ham.), *Ompok bimaculatus* (Bl.), *Mystus cavasius* (Ham.), *Mystus malabaricus* (Jerdon), *Mystus seenghala* (Sykes), *Wallago attu* (Bl.), *Channa gachua* (Ham.), *Channa marulius* (Ham.) and *Glossogobius giuris* (Ham.) are frequently caught.

To observe the effect of grass carp on the aquatic vegetation of the tank, about 2000 grass carp fingerlings of 6 to 7 cm length were introduced in the tank in September 1976 by the local fisheries department. In order to study growth and rate of survival of the introduced fish, there was no fishing of the grass carp from September 1976 to April 1979. In April 1974 the grass carp introduced as fingerlings in the tank in 1976 were fished for the first time using gill net with mesh bar size of 6″.

The catch consisted of 13 grass carps along with other fishes. The growth of the grass carps was fantastic. In two years seven months and fifteen days (i.e. about 955 days) the fish had grown up to an average length of 117 cm, and their weight ranged between 15 kg to 18.5 kg. In May 1980, another 17 grass carps were caught and they showed still better results. The average body length was 125 cm and the body weight ranged from 20 kg to 35 kg and this growth was achieved in 1365 days.

This growth rate is considered by me to be one of the best when compared with records from India and abroad. The growth of grass carps from different countries as reported by Jhingran (1976) is given in Table, for comparison.

It can be seen from the above table that the rate of growth shown by the grass carp from Rankala tank is outstanding. Till the first experimental fishing (i.e. in 955 days) the rate of daily growth was 17.5 g/day. It went up to 19.8 g/day in 1365 days, i.e. at the time of second fishing. The highest rate of growth was noticed in between these two fishings, i.e. 11.25 kg body weight in 410 days with the daily growth rate of 27.4 g/day.

Though the stocking densities are same in the Rankala and at Singapore, and the average weight of fish from Singapore is nearer to the weight of the lowest weight from Rankala, the fish from Singapore have taken 4.5 months more to gain this weight. Also the average rate of daily growth in case of fish from Rankala is 17.5 gm/day as compared to that of 13.7 gm/day for the fish from Singapore.

It must also be borne in mind that in the majority of the results expressed above and elsewhere in this report (except in China and Russia where the grass carp is endemic), the experiments were conducted in fish farms, free from predators and competitors. In certain cases suitable diet in the form of different weeds was also supplied to the fish. Also grass carp is well adopted in South East Asian countries where it has been introduced a long time ago.

TABLE

No.	Country	Age years	Stocking/ ha	Avg. growth length cm	Avg. growth weight kg	Daily growth g/day
1.	China	2	—	23	1.8–2.3	2.4 to 3.1
2.	Hongkong	2	500–1250	30–38	1.2	1.7
3.	Malaysia	1	1300	—	1.8	5.2
4.	Israel	2.5	325–400	—	3.8–4.4	4.0 to 5.6
5.	Thailand	1	857	—	3.0	8.0
6.	Singapore	3	200	—	15.0	13.7
7.	India	1.6	300–500	60	2.7	4.7
Rankala tank:						
	2 yrs 7 month 15 days 955 days		200	117	15.0-18.5 (Av. 16.7)	17.5
	3 yrs 9 months 1365 days		—	125	20.0-35.0 (Av. 27.0)	19.8

According to Kuronuma (1968) grass carp from south and central China weighs 6 to 8 kg in four to five years (growth rate 4.2 gm/day). Whereas in Russia a length of about 48 cm is reached in the 7th year of fish grown in natural condition (Nikolskii 1961). In Rankala the growth shown by some giant grass carps in three years and nine months is 35.0 kg, where the rate of growth comes to about 25.6 gm/day.

In India, at Cuttack experimental fish farm, three year old fishes reached a length of about 73.8-86.0 cm and weighed 4.45-7.0 kg (i.e. about 5.3 gm/day), (Alikunhi and Sukumaran 1964). Sinha and Sharma (1976) have mentioned the polyculture experiments in West Bengal where the grass carp grew to about 2.4 kg in 13 months, a growth rate which was considered to be satisfactory.

The average rate of growth at Rankala tank, which is 19.8 gm/day (with a maximum of 25.6 gm/day), is far more than the growth rate recorded so far anywhere else. According to Jhingran (1976), the maximum length and weight of grass carp reported so far is, 120 cm and 32 kg respectively. The number of years taken to achieve this growth rate is not known. Therefore, the length gained by the grass carp from Rankala 125 cms and weight 35 kg is not only above average but perhaps larger size will be reached if allowed to grow for longer time.

This exceptional rate of growth at Rankala tank is under natural conditions and without any culture practice, protection against predators, or supplementary feeding. This fast rate of growth can be attributed to the availability of suitable aquatic weeds in large quantity, warm subtropical temperatures throughout the year, and lastly low rate of stocking of fish which was about 200 fish per ha.

It is interesting to note that apparently there was no obvious change in the density and quality of aquatic weeds in the tank even after the introduction of the fast growing grass carp in the tank. Therefore, the aquatic vegetation in the tank can support a greater standing crop of grass carp without significant effect on the present growth rate of fish. It is not known whether the browsing of the carps on the tender branches of aquatic weeds like *Hydrilla* sp. help further growth of the plant instead of eliminating them completely.

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22. BAMBOO BRIDGE FISHING WITH LIFT NET

(*With a text-figure*)

The fisherfolk of Nepal have devised varied fishing methods which may probably date back to basic culture of mankind. During the fishery resource survey of the Kulaekhani area of Nepal, an unique fishing method was witnessed. This is locally known as "Thakaulight Kurnae" which means waiting for fish under bamboo bridge. In the fishing village of Kulaekhani every fisherman has ownership of his own "Thakaulighat" or "traditionally owned fishing section". Fishing snow trout sitting on bamboo platform and dipping and lifting net is an impressive spectacle that may be observed in Kulaekhani streams.

For bamboo bridge fishing following accessories are needed:

I. *Bamboo bridge*:

The bamboo bridge fishing platform is set above an ideal river section, where quiet pools and fish shelter occur. The bamboo bridge is made by stretching green bamboo stems across two supporting rocks. The bamboo bridge lies just about 60 cm above the water level of the fishing pool. The bridge so made is meticulously tied with vines draped with green leafy twigs of shrubs.

II. *Dip net or lift net*:

The lift net is prepared from the fibre of the plant (*Bhoehmeria platyphylla*). It is squarish in shape and measures about 125× 125 cm. The mesh size of the net is about 1.5 cm. The netting material weighs 60 gm. The four corners of the lift net are tied respectively and held between four bamboo poles each measuring 120 cm (figure 1). Each adjacent pair of bamboo poles is held in each hand of the fisherman while operating the net in water. As soon as fishes swim over the net the poles in each hand are clapped together.

III. *Stone slabs*:

In the vicinity of the fishing area white stone slabs are put together. The stone slabs attract and entice fish to swim nearby and provide the fisherman good background to see the fish. The catch is made by dipping the net, and lifting it from the water at the right moment when a shoal of snow trout is gathered over the stone slabs.

Fishing operation

A fisherman sits on the bamboo bridge and watches the water quietly. When he detects a

Fig. 1. Showing bamboo bridge fishing with lift net. (B, Bamboo bridge; H, Bamboo pole; K, Knot of netting material; W. Stone slabs; S, Fish shoal trapped inside the net.

moving shoal of fish, he orients the net in a favourable plane so that the net hangs loosely. The swimming fish passing by is then lifted clear out of water. While operating, the ends of the lift net are held tightly so that the captured fish may not escape.

Environmental conditions

The bamboo bridge fishing is practised in clear water pools of hill streams during spring and summer. In monsoon this method is not fruitful due to high turbidity of the water. Generally a warm sunlit day is chosen for fishing. This is an efficient and selective method of fishing in hill streams. This method is useful for sampling snow trout population in hill-streams as it is selective and allows the fisherman to catch only large fish and discard smaller ones. About 5-8 kg. of fish may be harvested daily (in 8 hours of fishing) by this method. The hydrography of Kulaekhani river has now changed greatly due to the erection of a dam and diversion of streams. This method is now used in adjacent hill-streams and the upper reaches of Kulaekhani Khola, for capturing snow trout (*Schizothorax plagiostomus* and *S. richardsonii*).

Brandt (1972) opined that the term 'lift net' and 'dip net' bear more or less the same meaning. He preferred use of the former term because the catch is collected not be dipping the nets but by lifting them again. Therefore, the term 'lift net' is used in the present context. Brandt (1972), Went (1964) and Treide (1965) described lift nets and operating platforms of entirely different design and structures used in fishing in European waters. The present method of fishing appears to be a novel type. Enquiries show that the indigenous fishing method has been used for over two centuries.

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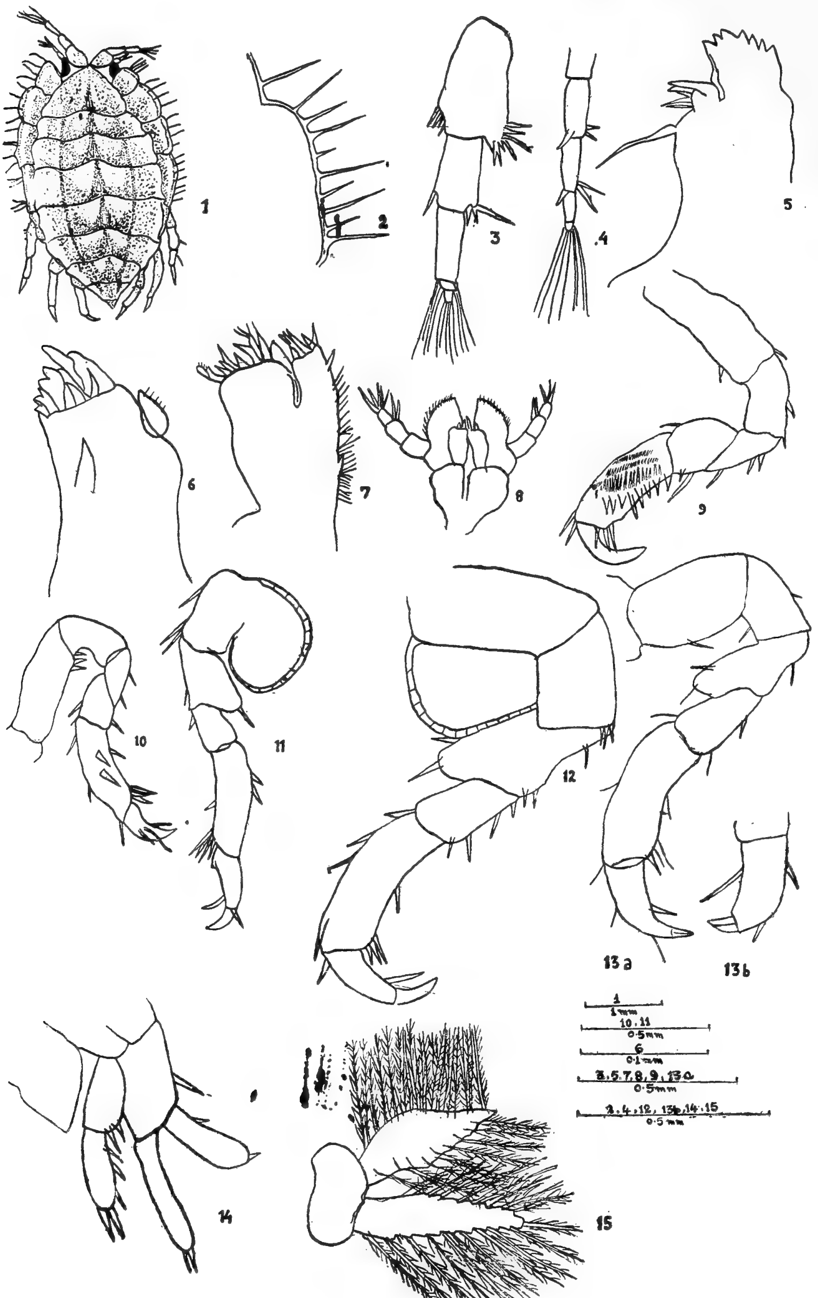
23. OCCURRENCE OF A SPECIES OF *PALINNOTUS* (AMPHIPODA) ON PORT BLAIR SHORE (ANDAMAN ISLANDS)

(*With fifteen text-figures*)

While examining the Phytal-faunal associations of littoral algal samples of *Halimeda opuntia* and *Jania rubens* collected at Port Blair, Andaman Islands, three specimens of the extremely rare amphipod genus *Palinnotus* Stebbing (1900) were collected. A perusal of literature reveals the existence of only four species of *Palinnotus*. The distribution of the species of this genus is given in Table 1 along with reference. The present record forms the first report of *Palinnotus* from eastern Indian Ocean.

A brief description and illustrations of the *Palinnotus* are given below.

The specimens collected ranged 2 to 3.13 mm in length and 1 to 2 mm in breadth. The presence of an elongate ovatoquadrate article 2 of the paraepod 5, subquadrate or trapezoidal article 4 of paraepod 5, clawed dactyle of paraepod 5, a distinct small conical fleshy palp of first maxilla and well defined median spination on article 6 of gnathopod 1 and absence of such spination on gnathopod 2 are the diagnostic features. The absence of a nasiform posterior lobe and distal constriction on article 2 of paraepod 5 readily differentiate the specimens from *P. natalensis, P. thomsoni* and *P. holmesi*. The specimens differ from



Genus *Palinnotus* Stebbing

Figs. 1-15: 1. Entire Specimen—Dorsal view, 30 mm line; 2. Margins of side plates, 75 mm line; 3. First Antenna, 62.5 mm line; 4. Second Antenna, 75 mm line; 5. Mandible, 62.5 mm line; 6. First Maxilla, 50 mm line; 7. Second Maxilla, 62.5 mm line; 8. Maxilliped, 62.5 mm line; 9. First Gnathopod, 62.5 mm line; 10. Second Gnathopod, 50 mm line; 11. Third Paraepod, 50 mm line; 12. Fourth Paraepod, 75 mm line; 13a. Fifth Paraepod, 62.5 mm line; 13b. Fifth Paraepod tip enlarged, 75 mm line; 14. Telson and Uropods, 75 mm line; 15. Pleopod, 75 mm line.

TABLE 1

Species	Locality	Reference
I. *P. thomsoni*	New South Wales, Pacific coast of Australia.	Stebbing (1899)
	Watson's bay, New South Wales, Pacific Coast of Australia.	Barnard, J. L. (1972)
II. *P. natalensis*	Tsipingo, Natal, East coast of Africa.	Barnard, K. H. (1940)
	Travancore, west coast of India, Arbian sea.	Krishna Pillai, N. (1954)
III. *P. holmesi*	Japan Sea.	Gurjanova, E. (1938)
IV. *P. alaniphlias*	Hawaii, Pacific Ocean.	Barnard, J. L. (1970)
V. *Palinnotus* sp.	Port Blair, Andaman Islands, Bay of Bengal.	Present Report

P. alaniphlias in that, in the latter species, article 2 of paraepod 5 is evenly quadriform and scarcely broader than article 3 and the dactyle of paraepod 5 is unclawed. Further, unlike in *P. alaniphlias*, the outer plates of the maxilliped in the Port Blair specimens are not large and do not extend equally with palp. In view of the characters used to differentiate the species in this genus, these differences should suffice to name a new species. However, such an attempt is kept in abeyance because Pillai (1954) and Barnard (1972) have reported variability of characters within species in this genus.

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24. ANACHORESIS OF EARTHWORMS

(*With a plate & a text-figure*)

Introduction

The present study was undertaken (1) to examine how far three different species of earthworms exhibit their individualities in forming the burrows in the soil of similar nature and their work output; (2) to observe the nature of burrowing movements while attempting to enter the soil and the way in which they draw themselves into the soil; and (3) to note the movements in a burrow.

Material and methods

Three locally available earthworms, *Pheretima elongata* E. Perr, *Lampito mauritii* Kinberg and *Pontoscolex corethrurus* Fr. Mull, were collected from fields and maintained in the laboratory in troughs filled with garden soil. Blocks of 10 × 10 × 110 cm. were prepared by kneading the soil with sufficient amount of water. Individual worms were left on each block covered with small Petri dish in order to prevent the worm moving away from the block and to initiate burrowing. After 12 hours the block was carefully sliced both transversely and vertically and numbered in X and Y axis to trace the actual path of the worm and these pieces were dried at 110°C after removing the worm. Five per cent vinyl acetate in acetone was introduced into the holes by means of rubber teated pipette with a fine nozzle. After polymerization of the vinyl acetate, casts were collected by dissolving the block in water and the pieces were washed in running tap water. The tubular pieces thus obtained were glued in the same way they were in the blocks with synthetic resin adhesive 'Fevicol' (Pidilite Industries Pvt. Ltd., Bombay).

But for the haphazard movement of the worm, the entire block could have been used in introducing the vinyl acetate into the track of the worm. As this was not possible, the blocks had to be sliced in order to get the cast of entire track of the worm.

The average diameter of the bore and the bore and the angle of entry into soil from surface were measured with the help of these casts. From these data, the work output of each was calculated using the equation

$$\frac{W = \pi\ ^2r\ ldg}{2}$$

Where W = work done, r = radius of the burrow cross section, d = density of the soil material, l = length of the burrow track, g = acceleration due to gravity of the place where the burrow is made

In order to examine the movements of the worm in a burrow the following experiment was conducted. One per cent agar (Sarabhai M. Chemicals, India) gel with 1% cellulose (Karl Schleicher and Schull., W. Germany) was prepared by adding the mixture slowly into boiling water with constant stirring. The thickened gel was chilled in the refrigerator in 500 ml beaker. A small depression was made on the surface of the gel and the worm was held in the hand in such a manner that the anterior tip of the worm came into contact with the depression on the gel surface. As the worm advanced in the medium the characteristic movements of the prostomium and anterior segements to make way through the medium were observed through the transparent gel. Application of water soluble paint to the posterior tip of the worm would leave the trail along the path as it moved in the gel.

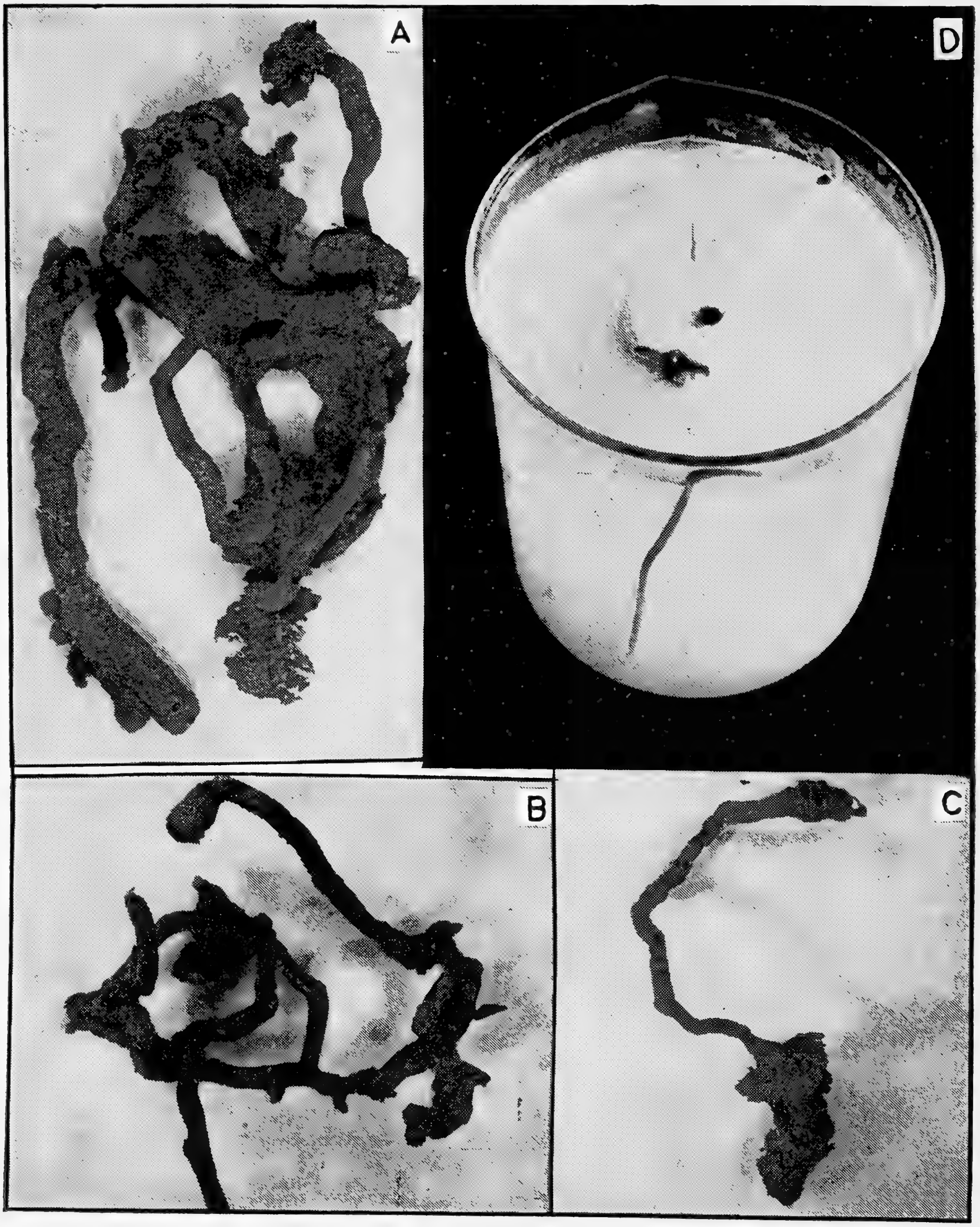

Fig. 2. Burrow casts of earthworms—A) *Pheretima elongata;* B) *Lampito mauritii;* C) *Pontoscolex corethrurus;* D) Agar cellulose gel preparation showing burrowing of *Pontoscolex*.

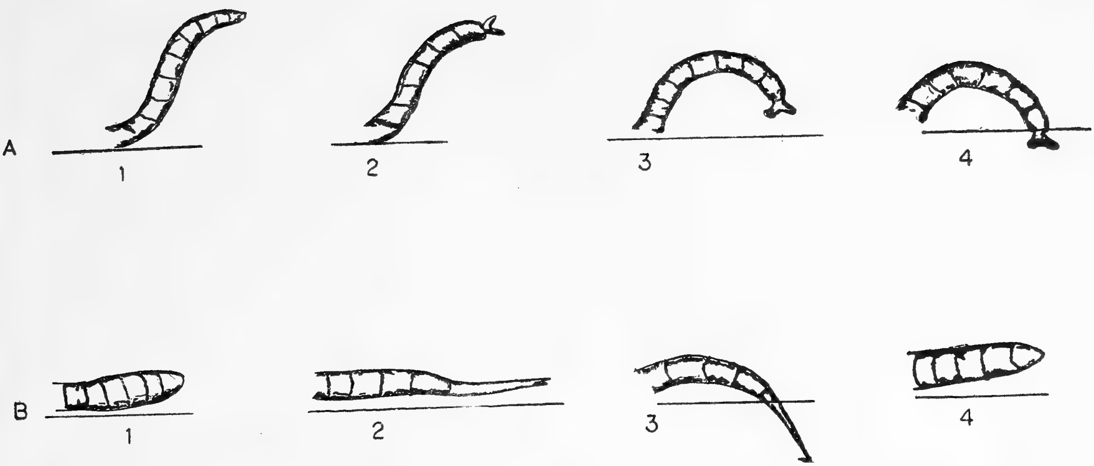

Fig. 1. Diagrammatic representation of prostomium and preclitellar segements of *Pheretima elongata* and *Pontoscolex corethrurus* while attempting to enter soil.

Results and Discussion

Darwin (1881) noted species—specific differences in the time taken by earthworms to burrow into different kind of soils. The passing of contractile waves over the anterior half of the body and the passive withdrawal of the posterior half during movement was described by Yapp (1956). The characteristic movements by the worms while attempting to enter the soil thus came to be related to soil types in which they were found. A short funnel-like prostomium and the lifting up of the anterior preclitellar segments helped *Pheretima elongata* to apply pressure on the soil surface (Fig. 1). The fine prostomium of *Pontoscolex corethrurus* which can be extended and withdrawn exerts a piston like action while making its way into the soil without the use of body segments; this is similar to what was reported earlier by Yapp (1956) (Fig. 1) *Lampito mauritii* which falls in between these two genera in applying the pressure of anterior segments without propulsive prostomium, prefers to enter the soil through the loosened areas and avoids making a burrow aperture on the smoothened surface.

The burrow casts of worms of these three species obviously depict their individuality to work in a given type of soil. *Pheretima elongata* displays greater excavation of soil while burrowing than *Lampito mauritic* and *Pontoscolex corethrurus* (Fig. 2a, b, c, and Table 1).

Table 1

The work done by *Pheretima elongata, Lampito mauritii* and *Pontoscolex corethrurus* in Soil

Species	Work done (ergs per day Mean + S.E.)	θ
Pheretima elongata	7.849±0.22	60°
Lampito mauritii	3.796±0.212	43°
Pontoscolex corethrurus	0.376±0.007	153°

Note: θ = Angle of worm entry into the soil.

The powerful musculature and prostomium of *Pheretima elongata* are suitable for its burrowing to depths of 20 to 75 mm in hard soils of marshy regions. *Lampito mauritti* on the other hand is active in loose soil. For the same reason this probably explains why its numbers are high in arable lands and loose garden soil. The uncertain nature of movement of this species could well be made out in the cast (Fig. 2b) which reveals the haphazard movement of the worm. Both burrow casts (Fig. 2c) and observations made in the agar cellulose gel (Fig. 2d) show that *Pontoscolex corethrurus* prefers to move almost parallel to the surface to start with and later tends to move vertically downwards into the soil. Under favourable conditions it is found in subsurface soils.

Recently, Dexter (1978) studied the tunnelling in soil by earthworms. The tunnelling was independent of soil strength over the range of micropenetrometer resistance from 0.3 to 3 M Pa. These strengths are obviously larger than the coelomic fluid pressures. This possibly would suggest that the worms tunnel by ingesting soil particles from ahead of them; even though they can push very loose soil out of the way.

Previous observations in relation to interspecific zonation in the glass cage filled with soil of homogeneous nature (Kale *et al.* 1977) when taken together with the present findings regarding the anachoresis of these three species of earthworms bring out in clear focus their morphological and behavioural adaptation vis-a-vis their respective habitats. Further investigations are likely to throw more light on these interesting invertebrates.

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25. SOME ENTOMOLOGICAL NOTES FROM A VISIT TO THE VALLEY OF FLOWERS

The Valley of Flowers in the Garhwal Himalaya is situated at an altitude of *C.* 11,500 ft. contains a large and diversified variety of flowers which have a short span of life during the summer months. The short span of life restrict the time available for reproductive activities. Pollination by insects is one of the major factors that affect most of the flora in the valley. It was therefore felt that it would be interesting to study insect fauna in relation to the flowers of the Valley.

The valley is divided into numerous meadows by the river Pushpavati and several subsidiary streams and a snowbridge. Collections were made in each area. It was observed that there was difference in time of flowering for each species of plant. When we reached the valley on 27th July, the red flowers of *Potentilla atrosanguinea* were in full boom. After 30th July they started to wither and the yellow flowers of *Potentilla ambigua* appeared in large numbers. Besides these, there were patches of *Pedicularis pectinata; Lentopondium alpinum* and *Geranium wallichianum; Anaphalis royleana; Bupleurum himalayense* and *Androsace sarmentosa.* Single plants of *Meconopsis aculeata* were also observed growing in between rocks and stones. *Silene vulgaris* and *Codonopsis rotundifolia* were present at the entrance to the valley. Plants like *Polygonum polystachyum* and *P. rumicifolium* and *Senecio chrysanthemoides* were also present at frequent intervals. The creamy white flower of *Anemone narcissiflora* started to wither from 7th August. The fern *Polystichium aculeatum* occurred in a big patch in the valley. (See Appendix 1). During the period of stay, 140 specimens of insects, and 2 specimens of spiders were collected. Bumble bees (*Bombus* spp.) and Dipterous flies play a major role in pollination. Flowers of *Potentilla* spp. were visited by Bumble bees and few butterflies only, while dipterous flies preferred plants with umbeliferous inflorescene. Upto 15 to 20 Syriphid and Tachinidae flies were observed on a single plant. Only a few species of butterflies were seen in the valley and it appeared that they play a limited role in pollination. Besides the pollinators, bugs and coccinellidae beetles were noticed hiding below the leaves and coming to the upper surface when there was sunshine.

The species collected are listed below.

HEMIPTERA

Family: LYGAEIDAE

Lygaeus equestris. Found on the leaves of *Geranium* spp. and *Polygonum* spp.

Distribution: Common Palaearctic species, Muree

Family: PENTATOMIDAE

Tolumia lanticep. Found on the leaves of *Geranium* and *Polygonum* spp.

Family: CICADIDAE

Cosmopsaltria sp. One specimen collected from a tree trunk in the valley.

LEPIDOPTERA

BUTTERFLIES

Family: PAPILIONIDAE

COMMON YELLOW SWALLOWTAIL *Papilio machaon asiatica* Men.

Collected from the plateau of the valley of flowers. One specimen collected across the snowbridge. Not very common. One or two specimens were observed flying at a distance. Sits on *Potentilla, Senecio* and *Anemone* spp.

Distribution: Mussoorie, Dist. Dehra Dun; and 3000 to 9000 ft. in Kumaun. Chitral to Nepal.

Family: NYMPHALIDAE

QUEEN OF SPAIN FRITILLARY *Argynnis lathonia* L.

Very common throughout the valley. A fast flier which suddenly settles on flowers. Visits *Geranium wallichianum* Sweet, *Chamaenerium lantifolium,* and *Potentilla atrosanguinea* frequently.

Distribution: Mussoorie, Dist. Dehra Dun; and 5000 to 10000 ft. in Kumaun.

PAINTED LADY *Vanessa cardui* Linn. Common. Visits *Geranium* sp. settles on stones and soil near streams.

Distribution: Mussoorie, Dist. Dehra Dun, Kashmir, Kulu Valley, and 6000 to 10000 ft. in Kumaun.

INDIAN TORTOISE SHELL *Vanessa cashmirensis* Kollar.

Not very common. Mostly settles on stones, near dung (cow and horse dung). One specimen was collected from the snowbridge sitting on decaying organic matter.

Distribution: Mussoorie, Dist. Dehra Dun, and 2000 to 18000 ft. in Kumaun.

Family: PIERIDAE

COMMON BRIMSTONE *Gonepteryx rhamni nepalensis* Db.

Very common. The female is more numerous than the male. A fast flier which visits flowers of *Potentilla, Geranium, Erigeron, Pedicularis,* and *Chamaeneriun.*

Distribution: Mussoorie, Dist. Dehra Dun, and 3000 to 9000 ft. in Kumaun.

DARK CLOUDED YELLOW *Colias electo fieldi* Mene.

Common in open field. Visits *Pedicularis pectinata, Impatiens gigantea.*

Distribution: Mussoorie, Dist. Dehra Dun, Dun Valley, and upto 14000 ft. Kumaun.

Family: SATYRIDAE

COMMON SATYR *Aulocera swaha* Kollar.

Common throughout the valley. Found visiting *Pedicularis, Geranium* and *Anemones.*

Distribution: Mussoorie, Dist. Dehra Dun, Kulu Valley, 6000 to 10000 ft. in Kumaun.

NARROW BANDED SATYR *Aulocera brahminus* Blan.

Common.

Distribution: Mussoorie, Dist. Dehra Dun, Nila Pass and 6000 to 10000 ft. in Kumaun, Kulu Valley.

Family: LYCAENIDAE

COMMON COPPER *Lycaena phleas* Linn.

Common. Moderate flier, flies near the ground and suddenly settles on flowers like *Lentopodium, Bupleurum* sp., *Androsace sarmentosa* Wall. Common across the river Pushpavati.

Distribution: Mussoorie, Dist. Dehra Dun, and 5000 to 9000 ft. in Kumaun.

YAMFLY *Loxura atymnus.*

Only one specimen was collected at the entrance of the valley.

Distribution: Mussoorie, Dist. Dehra Dun, 4500 ft. in Kumaun.

MOTHS

Family: SATURNIDAE

Actias selene Hub.

Collected at Govindghat.

Distribution: Throughout India.

Leopa katinka Wasw.

Collected at valley of flowers.

Distribution: Himalayas, Assam.

DIPTERA

Family: SCIARIDAE

Leptosciara sp.

Collected on plants with umbeliferous inflorescence.

Family: BIBIONIDAE

Bibio sp.

Found on *Geranium* spp. and *Polygonum* spp.

Family: EMPIDIDAE

Rhamphomyia sp.

Very common on *Polygonum* spp.

Family: SYRPHIDAE

Metasyrphus confrater Wied.	Feeding on plants
M. luniger Mg.	with Umbeliferous
Eristalis sp.	inflorescenee and
Chrysotoxum sp.	restricted to
Cheilosia sp.	certain areas.

Family: Calliphoridae

Calliphora vomitoria L.
Collected on Horse Dung.

Family: Tachinidae

Servillia rufoanalis Macquart *S. ursinoidea* Tothill	Collected on plants with Umbeliferous inflorescence.

HYMENOPTERA

Family: Sphecidae

Psen orientalis *Ectemnius martjanowii tibeticus* Leclerq.	Common on *Potentilla* spp. and *Geranium* spp.

Family: Vespidae

Paravespula sp.

Family: Tenthredinidae

Tenthredo sp.

Family: Apidae

Halictus sp. *Bombus* sp.	Very common. Collected on various flowering plants

Family: Ichneumonidae

Netelia sp.
Ichneumon sp.
Ophion sp.

COLEOPTERA

Family: Coccinellidae

All specimens were collected from valley.

Adalia luteopicta Muls. on *Potentilla* spp. and *Geranium* spp.

Distribution: Nepal, North East India, China, Tibet.

Epilachna ocellata Redte. on *Potentilla* spp. and *Geranium* spp.

Distribution: In the Himalayas from Kashmir to North Bengal.

Coccinella septempunctata.

Distribution: Throughout India.

The first two species were restricted to some patches only while the third species was quite common in the valley.

Acknowledgements

The Project was sponsored by the Sálim Ali Nature Conservation Fund. I am thankful to Mr. J. C. Daniel, Curator for his suggestions and encouragement. My thanks are due to Mr. S. A. Hussain, Mr. P. B. Shekar, Mr. Vasant Naik and members who accompanied, for their co-operation during the Camp. I am also thankful to the Director, Botanical Survey of India, Northern Region, for identifying the plants collected at the Valley of Flowers.

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APPENDIX I

Common flowering plants of the Valley of Flowers

Plant Species	Distribution
RANUNCULACEAE	
1. *_Aconitum falconeri_ Stapf	Few plants observed in the meadow only.
2. *_Anemone narcissiflora_ L.	Common growing at frequent intervals.
3. *_A. rivularis_ Buch.-Ham.	—do—
4. _Thalictrum_ sps.	Common at entrance of Valley.
PAPAVERACEAE	
5. _Meconopsis aculeata_ Royle	One or two plants growing between stones. Common throughout Valley.
ROSACEAE	
6. *_Potentilla atrosanguinea_ Lod.	Throughout Valley.
7. *_P. ambigua_ Camb.	—do—
COMPOSITAE	
8. _Leontopodium alpinum_ Cass.	Patches observed near streams.
9. *_Senecio chrysanthemoides_ Dc.	Throughout Valley.
10. _Solidago virga aurea_ L.	Distributed among other plants.
11. _Anaphalis royleana_ DC.	Several patches seen.
12. _Erigeron_ sps.	Observed on a meadow at the confluence of the two streams.
GERANIACEAE	
13. *_Geranium wallichianum_ Sweet	Throughout the valley.
POLYGONACEAE	
14. *_Polygonum polystachyum_ Wall.	Small patches of shrubs observed frequently.
15. *_P. viviparum_ L.	—do—
16. *_P. rumicifolium_ Royle	—do—
17. _Rumex acetose_ L.	
SCROPHULARIACEAE	
18. *_Pedicularis punctata_ Deene	Patches of these plants seen only near Pushpavati river and other smaller streams.
19. _P. pectinata_ Wall.	
20. *_Euphrasia kurramensis_ Pennel	
SAXIFRAGACEAE	
21. _Saxifraga brachypoda_ Don.	A few patches seen near the entrance to the valley.
PRIMULACEAE	
22. *_Androsace sarmentosa_	Patches seen near streams.

FUMARIACEAE	
23. **Corydalis ramosa*	Common throughout the valley.
BALSAMINACEAE	
24. **Impatiens gigantea* Edgew	Common.
ERICACEAE	
25. *Rhododendron* spp.	Isolated bushes present throughout the valley.
BORAGINACEAE	
26. **Myosotis sylvatica* Hoftm.	Dense clumps were observed at the entrance and in between stones present near nullah.
CARYOPHYLLACEAE	
27. **Silene vulgaris*	Common.
28. **Stellaria decumbens* Edgew.	
CAMPANULACEAE	
29. **Codonopsis rotundifolia* Benth.	Near the Fern patch and also near entrance to the valley.
ONAGRACEAE	
30. **Epilobium roseum* Schreb	Uniformly distributed.
FERN	
31. *Polystichium aculeatum*	A big patch.

* = not recorded by B. N. Ghildyal: 'A Botanical Trip to the Valley of Flowers', Journ. Bom. nat. Hist. Soc. Vol. 54, p. 365-386.

26. FIRST RECORD AND A NEW HOST RECORD OF *TRICHOGRAMMA CHILOTRAEAE* NAGARAJA AND NAGARKATTI FROM THE PUNJAB

The *Trichogramma chilotraeae* Nagaraja and Nagarkatti was described from eggs of stem borer, *Chilo infuscatellus* Snellen, from Plassey, Nadia District of West Bengal (Nagaraja and Nagarkatti 1969).

During the survey of natural enemies of maize and sugarcane borers of the Punjab it was recovered from the eggs of *C. infuscatellus* and *C. partellus* (Swinhoe) in May and April, 1979 respectively from Jullundur district. This is the first record of this parasitoid from the state and from *C. partellus*. The incidence of parasitism varied from 13.00 to 16.6 per cent.

The *T. chilotraeae* was multiplied on the eggs of *Corcyra cephalonica* Stainton. It completed its life cycle in 9-10 days at 26.3 ±

0.9°C and 69 ± 6 per cent relative humidity, in the laboratory.

ACKNOWLEDGEMENTS

We are thankful to Dr. Sudha Nagarkatti, Project Coordinator, National Centre for Biological Control, Bangalore for the identification of parasitoids. Our thanks are also due to the Professor-cum-Head, Department of Entomology, Punjab Agricultural University, Ludhiana for providing the facilities for research work.

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REFERENCE

NAGARAJA, H. AND NAGARKATTI, S. (1969): Three new species of *Trichogramma* (Hymenoptera: Trichogrammatidae) from India. *Entomophaga 41*: (4): 393-400.

27. THE CARPENTER BEE (*XYLOCOPA FENESTRA*) IN THE INDIAN THAR DESERT

The Carpenter-bee (*Xylocopa fenestra*), on the one hand damages timber and on the other acts as a prominent pollinating agent. Hence it is of much economic and biological importance. These observations on *Xylocopa* were made around Jodhpur city ,and desert areas of Jodhpur and Jaisalmer districts from February 1976 to May 1979.

Habitat and distribution. Light jungles of *Acacia senegal* as well as of *Calotropis procera*, large orchards and gardens, agricultural farms having large trees and vegetable crops and villages having thatched huts were the favourite haunts of *Xylocopa* and *Calotropis* scrub and gardens with large flower flowering trees were the preferred habitats.

Roost sites (*tunnels*). For the roost tunnels, thick *Calotropis* shrubs were preferred, in the wild. Its roost tunnels were observed in thick dry stems of *Capparis*, castor (*Ricinus communis*) grown in farms and courts of houses and *Jatropha gossypifolia* in gardens. The tunnels were also observed in the dry wood of several other trees such as *Prosopis cineraria, Ficus religiosa* and *Acacia senegal* etc.

In city areas it has taken to roosting in empty open water pipes of houses, five *Xylocopas* have been living in such pipes in my house.

Favourite flowers

IN THE WILD. *Calotropis procera* and *Tephrosia purpurea* were observed to be the most favourite flowers for the *Xylocopa*, next were *Tecomella undulata, Prosopis cineraria, P. juliflora* and *Solanum xanthocarpus* etc.

IN GARDENS. Hollyhock (*Althae rosea*), *Cassia fistula, C. siamea, Luffa* spp., *Cucurbita* spp., *Antirrhinum orontium, Adhatoda vasica*, and *Ipomoea carnea* flowers were the favourite cultivated flora of *Xylocopa*.

Daily activities cycle. On mild winter days, it comes out about 30-45 minutes after sunrise and flies around most of the day (except at noon, if gets too hot) till sunset. In summer, it comes out early, about 30 minutes before sunrise and flies around for about three hours after sunrise, then retreats to its hideout and again emerges late in afternoon about two hours before sunset to 30 minutes past sunset. *Annual activities cycle.* It was observed under hibernation from late November to early February when temperature is below 24°C, yet it was occasionally observed hovering during the mid-day on warm spells during the winter. It was observed to be in semiaestivation from May to June, when temperature rises above 35°C and humidity was low (less than 60%), flighting only in the early morning and late afternoon.

In the rainy season it was active after rains, but hides during showers.

Predators. Calotes versicolor picks up the unwary *Xylocopa.* The green bee-eater (*Merops orientalis*), drongo (*Dicrurus adsimilis*) and the grey shrike (*Lanius excubitor*) were also observed, occasionally taking *Xylocopa.* Monitor lizard (*Varanus* sp.) catch them close to the roost site tunnel (log or dry branch of a tree).

Breeding. The young were mainly observed in March. The breeding tunnels were seen in *Calotropis, Capparis* and *Prosopis cineraria* trees or Shrubs and dry wood stems.

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28. *CATOPSILIA CROCALE/POMONA*

I refer to R. K. Varshney's paper under the title *Revised Nomenclature for Taxa in Wynter-Blyth's* book on the BUTTERFLIES OF INDIAN REGION (1980, *J. Bombay nat. Hist. Soc., 76* (1): 33-41) and his new combination of *Catopsilia crocale crocale* Cr. and *Catopsilia crocale pomona* F. and his statement that "numerous authors have reported that they interbreed in the nature and are, thus, conspecific". Talbot "FAUNA OF BRITISH INDIA, *Butterflies,* i. (2nd edit.) is not mearly as categoric as Varshney implies. He writes "in the Indian area there is no difficulty in separating them, but in the Malayan islands, and in Australia and New Guinea, the characters, so constant in India, become intermixed and much difficulty is experienced in separating the two forms". He goes on to quote Corbet as saying that in Malaya pairs found in *copula* are always *crocale* × *crocale* or *pomona* × *pomona,* and adds a remark by Corbet that he(Corbet) feels certain that in Malaya they are not conspecific, whatever may be the position in the more easterly parts of their range. Frustorfer, in Setz' INDO-AUSTRALIAN RHOPALOCERA, states categorically that the genitalia differ, in contradiction to Talbot, who states that they are the same. Frustorfer goes on to write that both de Niceville and Hagen state that both species have been bred from the same brood. In spite of these statements, both Frustorfer and Talbot treat the two as separate species. In Australia, I.F.B. Common in AUSTRALIAN BUTTERFLIES (*Jacaranda Pocket Guides*) treats both as forms, not subspecies, of *C. pomona* and says nothing about interbreeding.

Personally, I would prefer to treat them as separate species until considerably more experimental breeding has been done. With the technique of hand-pairing this should not be difficult.

I also wonder how careful and accurate de

Niceville and Hagen's breeding records were. Here, in East Africa, we once had a classic example of the chaos that can be caused by a laboratory assistant trying to conceal casualities in his cultures. Working on the black *Charaxes,* in an attempt to work out the relationship between the various forms of female and the related males, this individual replaced dead larvae in his broods with others collected from the bush (the larvae of several species are almost impossible to separate) and, as a result, associated separate and distinct species as members of the progeny of the same female. It took much time and trouble to sort out the resulting muddle.

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29. ROLE OF PARASITES AND PATHOGENS IN THE NATURAL CONTROL OF SAFFLOWER CATERPILLAR, *PERIGEA CAPENSIS* GUEN.

Safflower caterpillar, *Perigea capensis* Guen. (Lepidoptera: Noctuidae) is one of the most destructive pests of safflower (*Carthamus tinctorius* Linn.) and niger (*Guizotia abyssinica* Cass.) and is widely distributed throughout India (Narayanan 1961).

In Central India, the pest remains active from July to February and infests niger from July to October and safflower from October to February. During the course of investigations during 1976-77, five hymenopterous parasites namely *Apenteles ruficrus* Holiday, *Rogas percurrens* Lyle, *Eriborus argenteopilosus* Cam, *Euplectus euplexiae* Roh. and a nematode parasite (*Mermis* sp.), nuclear polyhedral virus and a green muscardine fungus (*Metarrhizium anisopliae*) were recorded as natural enemies of the larvae of *P. capensis*. The previous records of the larval parasites of the pest are *A. ruficrus, R. percurrens* (Narayanan, 1961); *Protapenteles* sp., *Heterogamus* sp., *E. euplexiae* (Ayyar, 1920); *Apanteles antipoda* (Wilkinson, 1929) and *A. fluripes, Chelonus munakata* (Lal, 1944). During the present studies *E. argenteopilosus, Habrocytus* sp., *Mermis* sp., nuclear polyhedral virus and fungus *M. anisopliae* were recorded for the first time on the insect.

The percentage parasitization by important parasites and pathogens is presented in Table 1.

A *rufricus* remained active from first week of August to first week of February and parasitized on an average 13.0 per cent larvae, with maximum of 30.7 pe rcent parasitization in the first week of October. *R. percurrens* started its activity from first week of September and remained active upto first week of February, parasitizing on an average 19.0 per cent larvae during its active period. With a maximum of 42.4 per cent in the second week of Novmber. *E. argenteoplosus* remained active only during September and October and parasitized maximum 2.0 per cent larvae in the first week of September. Two other hymenopterous parasites *E. euplexiae* and *Habrocytus* sp. have no significance in the natural control of *P. capensis* as they parasitized less than 0.5 per cent larvae only during November-December.

Nuclear polyhedral virus was the most

TABLE 1

PERCENTAGE LARVAL PARASITIZATION OF *Perigea capensis* GUEN. BY IMPORTANT PARASITES AND PATHOGENS

Months/dates (Standard week)	*A. ruficrus*	*R. percu-rrens*	*E. argent-copilosus*	*Mermis* sp.	*M. ani-sopliae*	N. P. V.
July						
16-22	0.0	0.0	0.0	0.0	0.0	0.0
23-27	0.0	0.0	0.0	0.0	0.0	0.0
August						
30-5	6.7	0.0	0.0	6.7	0.0	20.0
6-12	5.6	0.0	0.0	0.0	0.0	22.2
13-19	8.3	0.0	0.0	0.0	0.0	29.2
20-26	11.5	0.0	0.0	0.0	0.0	38.5
27-2	11.1	0.0	0.0	0.0	0.0	33.3
September						
3-9	5.1	2.0	2.0	1.0	3.0	15.2
10-16	4.7	2.7	2.0	1.3	2.0	13.3
17-23	5.9	3.9	0.7	2.0	2.6	15.0
24-30	4.8	2.4	0.8	1.6	2.4	13.7
October						
1-7	30.7	10.7	0.0	2.9	3.6	21.4
8-14	29.7	9.4	1.4	1.4	2.2	20.3
15-21	29.4	8.1	0.7	0.7	2.2	18.4
22-28	23-1	38.5	0.8	0.0	1.5	17.7
November						
29-4	16.3	38.8	0.0	0.0	2.3	17.1
5-11	14.4	42.4	0.0	0.0	1.6	16.8
12-18	13.3	41.7	0.0	0.0	0.0	16.7
19-25	12.5	37.5	0.0	0.0	0.0	16.7
26-2	12.8	39.1	0.0	0.0	0.0	16.2
December						
3-9	16.2	14.3	0.0	0.0	0.0	18.4
10-16	17.5	15.0	0.0	0.0	0.0	20.0
17-23	14-3	17.1	0.0	0.0	0.0	22.9
24-31	18.2	22.7	0.0	0.0	0.0	31.8
January						
1-7	10.5	31.6	0.0	0.0	0.0	31.6
8-14	20.0	20.0	0.0	0.0	0.0	40.0
15-21	14.3	7.1	0.0	0.0	0.0	35.7
22-28	9.1	9.1	0.0	0.0	0.0	9.1
February						
29-4	16.7	16.7	0.0	0.0	0.0	0.0
5-11	0.0	0.0	0.0	0.0	0.0	0.0
Average during active period	14.16	19.58	1.05	1.56	2.34	2.97

effective agent for the natural control of the pest infecting on an average 21.8 per cent larvae during its active period from first week of August to last week of January. Maximum 40.0 per cent larval infection was observed in the second week of January. The infection of green Muscerdine fungus (*M. anisopleae*) was seen in the first week of September and continued up to second week of November with maximum 3.6 per cent infection in the first week of October. The incidence of *Mermis* sp. was maximum 6.7 per cent in the first week of August, although its activity continued upto the third week of October but the incidence was low.

A. ruficrus, R. percurrens and nuclear polyhedral virus were the most potential agents for the natural control of the larvae of *P. capensis* and wiped out together 66.5 to 80.2 per cent larval population from the last week of October to last week of November.

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30. INCIDENCE OF JOWAR ARMY WORM, *MYTHIMNA SEPARATA* (WALKER) (LEPIDOPTERA: NOCTUIDAE) ON MAIZE COBS

The army worm, *Mythimna separata* (Walker) is known to be an important defoliator of *jowar*. This species has also been reported to infest maize, paddy, wheat, oats and other millets (Ghosh 1924).

During the months of September-October, 1979, we observed the caterpillars of *M. separata* damaging severely the cobs of maize at the Regional Research Station, University of Agricultural Sciences, Dharwar Campus. Karnataka. The caterpillars fed on the silk of the cob and also on the developing tender grains at the tip of the cob. The number of caterpillars per cob ranged from one to two. The percentage of damaged cobs ranged from 15.87 to 60.86 in different plots, the average being 36.62.

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REFERENCE

GHOSH, C. C. (1924): A note on the occurrence of *Cirphis unipuncta* (Haw.) in the role of army worm. *Rep. Proc. 5th Ent. meeting,* Pusa, pp. 90-91.

31. NEW RECORD OF *PYGAERA RESTITURA* WALKER (NOTODONTIDAE: LEPIDOPTERA) ON POPLAR

Poplar is an important deciduous forest/ ornamental tree in India. In October 1975, a serious incidence of *Pygaera restitura* Walker was observed. The trees had a withered look owing to the severe feeding on the leaves by the larvae of this insect. The young larvae were gregarious in feeding. They nibble from the undersurface of the leaves and only the epicuticle was left. The older instar larvae were solitary and completely devoured the leaves, leaving behind only the main veins. The pupae concealed in silken cocoons were also found either in a rolled leaf or by the joining two or three leaves by silken threads.

The adults obtained by rearing these larvae were identified as *Pygaera restitura* Walker. In India this insect is so far known to infest *Casearia tomentosa* in South Coorg (Gardner 1943) However, a related species, i.e. *P. anastomosis* L. (=*Clostera anastomosis*) is recorded from poplar in U.S.S.R. (Egorov 1962) and Yugoslavia (Maksimovic 1973).

ACKNOWLEDGEMENTS

I am thankful to the Director, Commonwealth Institute of Entomology, London for identification and to Dr. O. S. Bindra, the then Prof. and Head, Department of Entomology, Punjab Agricultural University, Ludhiana for providing facilities.

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32. *EUPATORIUM CAPILLIFOLIUM* (DOG-FENNEL) NATURALISING IN INDIA

(*With a text-figure*)

During a recent botanical trip to Arunachal Pradesh we collected specimens of *Eupatorium capillifolium* (Lamk.) Small, from Deomali in Tirap Forest Division where this species is grown in the Forest Rest House compound as an ornamental plant. From the wiry,

Fig. 1. *Eupatorium capillifolium* (Lamk,) Small
A, Shoot; B, Flower; C, Corolla and achene.

tangled nature of the branches, the plant had a superficial resemblance to *Ephedra foliata*. Deb (J. Bombay nat. Hist. Soc. 70(1): 92. 1973) has also reported that it is cultivated as a garden plant in Margherita—Jairampur. Evidently, it must be becoming a popular perennial in gardens at other places also. Lately, a few specimens were received for identification from Saugar University (M.P.) where the collector, T. R. Sahu recorded the plant to be found growing wild in marshy places in Hoshangabad. This would mean that *Eupatorium capillifolium* has, in all probability, escaped from cultivation and run wild in that area. The plant is otherwise native of Southern United States, and there are about 5 more South American species of *Eupatorium* which have already become naturalised in India.

Eupatorium capillifolium (Lamk.) Small, Mem. Torr. Club. 5:311. 1894; Britton & Brown, Ill. Fl. North United States, Canada 3:307, f. 2. 1898; Britton, Fl. Bermuda, 387. f. 2. 1918; Britton, Bhama, Fl. 437. 1920—*Artemisia capillifolia* Lamk. Encycl. 1:267. 1783—*Eupatorium foeniculaceum* Willd. Sp. Pl. 3:1750. 1804.

Erect, paniculately much branched. *Stem* finely pubescent, 1-3 m high. *Leaves* crowded, dissected into filiform segments, glabrous, alternate, the lower petioled, the upper sessile. *Head* numerous. *c* 3 mm, short-peduncled, racemose-paniculate, 3-6-flowered; *involucral bracts* in about 2 series, linear, cuspidate, narrowly scarious-margined, glabrous. *Flowers* greenish white or yellowish. *Corolla* regular, tube slender, 5-lobed. *Anthers* obtuse and entire at the base. *Style* branches elongated. *Achene* 5-angled. *Pappus* numerous capillary, scabrous bristles arranged in one row.

Specimens examined:

Vaid & Naithani Ser. II No. 731, Deomali, Arunachal Pradesh, 5-11-1976 (Cult.).

T. R. Sahu, s.n. Hoshangabad (Madhya Pradesh) Feb.-April 1979.

Distribution: Southern United States, Bermuda, Bahamas, Cuba and West Indies.

English Name: Dog-Fennel, French-Fennel.

Use: As an ornamental in gardens.

K. M. VAID
H. B. NAITHANI

SYSTEMATIC BOTANY BRANCH,
FOREST RESEARCH INSTITUTE & COLLEGES,
DEHRA DUN,
June 10, 1980.

33. ADDITIONS TO THE FLORA OF BIHAR AND ORISSA-III

During the course of detailed botanical explorations in Ganjam district of Orissa by us for the last seven years, several interesting plants were collected. Reported here are 14 species which were not hitherto recorded from Bihar and Orissa. *Syzygium cuneatum* (Duthie) Wall ex Brahmam & Saxena, a new nomenclatural combination.

The specimens are preserved in the herbarium of the Regional Research Laboratory, Bhubaneswar.

Acalypha racemosa Wall. ex Bail

A. paniculata Miq.

Brudhakhol, common roadside weed, fl. & fr. 4.viii.77. *Brahmam* 2623. Also seen at Buguda and Berhampur.

Distribution: Deccan Peninsula; Sri Lanka, Java and Tropical Africa.

Aganosma cymosa (Roxb.) G. Don

Echytes cymosa Roxb.

Mahendragiri, 1000 m., in mixed forests

along streams, fr. 25.x.78. *Saxena & Brahmam* 3546.

Local names: Madiki (Saora), Malti (Oriya).

Distribution: Western Peninsula; Silhet, Sri Lanka, China.

Argyreia choisyana (Wight) Wight ex C.B. Clarke

Batatas choisyana Wight

Chandiput, a climber, seen climbing over hedges, fr. 6.xi.73. *Saxena* 1438.

Sorada, fl. 16.ix.77. *Saxena* 2889.

Khallikote, in thickets, fl. 10.vii.77. *Brahmam* 3314.

Distribution: Deccan, hills of the ceded districts.

Combretum latifolium Blume

C. extensum Roxb. ex D. Don

Adava, in the forest along a stream, fl. 26.ii.78, *Saxena & Brahmam* 3322.

Brudhakhol, fl. 1.iii.78 *Saxena & Brahmam* 3293.

Distribution: Deccan Peninsula, Sri Lanka, Singapore. Burma, Indochina, Thailand, Malaysia.

Cyanotis vaga (Lour.) J. A. & J. H. Schultes

C. barbata D. Don

Mahendragiri, 1000 m. in moist situations, fl. 25.x.78. *Saxena & Brahmam* 3648.

Distribution: Subtropical Himalaya from Kashmir to Khasia Mountains, Burma, China, Java.

Dunbaria conspersa Benth.

Serango, 800 m., fl. & fr. 1.xi.73 *Saxena* 1173.

Distribution: Eastern tropical Himalayas, North Bengal, Duars, Assam, Western Peninsula; Silhet, Malaya, China and North Australia.

Justicia glabra Koenig ex Roxb.

Raphidospora glabra (Roxb.) Nees

Narayani, in the forest undergrowth, fl. & fr. 8.iv.77. *Saxena, Brahmam & Panigrahi* 2508, 2514.

Mahendragiri, 1000 m. fl. & fr. 24.x.78. *Saxena & Brahmam* 3357.

Ganjam fort, in shady places, fl. 8.vii.77. *Brahmam* 2508.

Distribution: South Deccan Peninsula; Sri Lanka, Java.

Justicia prostrata (C. B. Clarke) Gamble

J. diffusa Willd. var. *prostrata* C. B. Clarke

Rambha, in open grassy places close to Chilka lake, fl. & fr. 8.iv.77. *Saxena, Brahmam & Panigrahi* 2491.

Parsurampur, fl. 31.x.73 *Saxena* 1122.

Distribution: Madras, Karnataka, Southwards to S. Travancore; Sri Lanka.

Maoutia puya (Hook.) Wedd.

Boehmeria puya Hook.

Mahendragiri, 1000-1300 m., on hillsides, fl. 23.xi.79. *Saxena & Brahmam* 3969.

Distribution: Himalayas from Garhwal & Assam; Burma, Japan.

Moschosma polystachyum Benth.

Serango, along paths in the forest, fl. 5.i.78. *Brahmam* 2976. Also seen at Ajayagad.

Distribution: Deccan Peninsula, West Bengal; Sri Lanka, Burma, Java, Philippines, China and Tropical Africa.

Polystachya flavescens (Blume) J. J. Smith

P. wightii Reichb.

P. purpurea Wight

Mahendragiri, 1350 m, an epiphyte, fr. 25.x.78. *Saxena & Brahmam* 3621.

Distribution: N. Kanara, Western Ghats Southwards at 600-1200 m; Sri Lanka, Malaya, Sumatra, Philippines.

Sida rhombifolia Linn. ssp. **retusa** (Linn.) Borssum

S. rhombifolia Linn. var. *retusa* (Linn.) Mast.

Mahendragiri, 1200 m., in open forest, fl. & fr. 26.x.78 *Saxena* & *Brahmam* 3695.

Distribution: Tropics of both hemispheres.

Sophora interrupta Bedd.

Mahendragiri, 1300 m, in exposed places, fl. & fr. 22.xii.79. *Saxena* & *Brahmam* 3868.

Distribution: Cuddapah to North Arcot and hills of Karnataka.

Syzygium cuneatum (Duthie) Wall. ex Brahmam et Saxena comb. nov.

Eugenia cuneata Duthie in Hook. f., Fl. Brit. India 2:495, 1978.

Mahendragiri, 1300 m in exposed places. *Saxena* & *Brahmam* 3723.

Distribution: Khasia Mountains, 900-1500 m; Silhet.

ACKNOWLEDGEMENTS

We are thankful to Prof. P. K. Jena, Director and Dr. P. K. Dutta, Project Coordinator, Regional Research Laboratory, Bhubaneswar for the facilities and to the Director, Botanical Survey of India and the staff of the Central National Herbarium, Howrah for their co-operation and facilities provided for consulting the Herbarium.

REGIONAL RESEARCH LABORATORY,
BHUBANESWAR-751 013,
April 5, 1980.

M. BRAHMAM
H. O. SAXENA

34. A SHORT NOTE ON THE OCCURRENCE OF *LASIA HETEROPHYLLA* SCHOTT IN MAHARASHTRA

(*With two text-figures*)

During the plant exploration of Bhandara district, Maharashtra State *Lasia heterophylla* Schott was found along streams in thick forest. This species has not been recorded earlier by Cooke (1901-1908) or Haines (1916). Hence it is a new record for Maharashtra State. However, the species is reported from Rampa Hills in Madras Presidency (Gamble 1928). Singhbhum in Bihar (Haines 1924) and Bengal (Prain 1903).

In view of its rarity and absence of any known published illustration for the plant a line drawing is given along with a brief description.

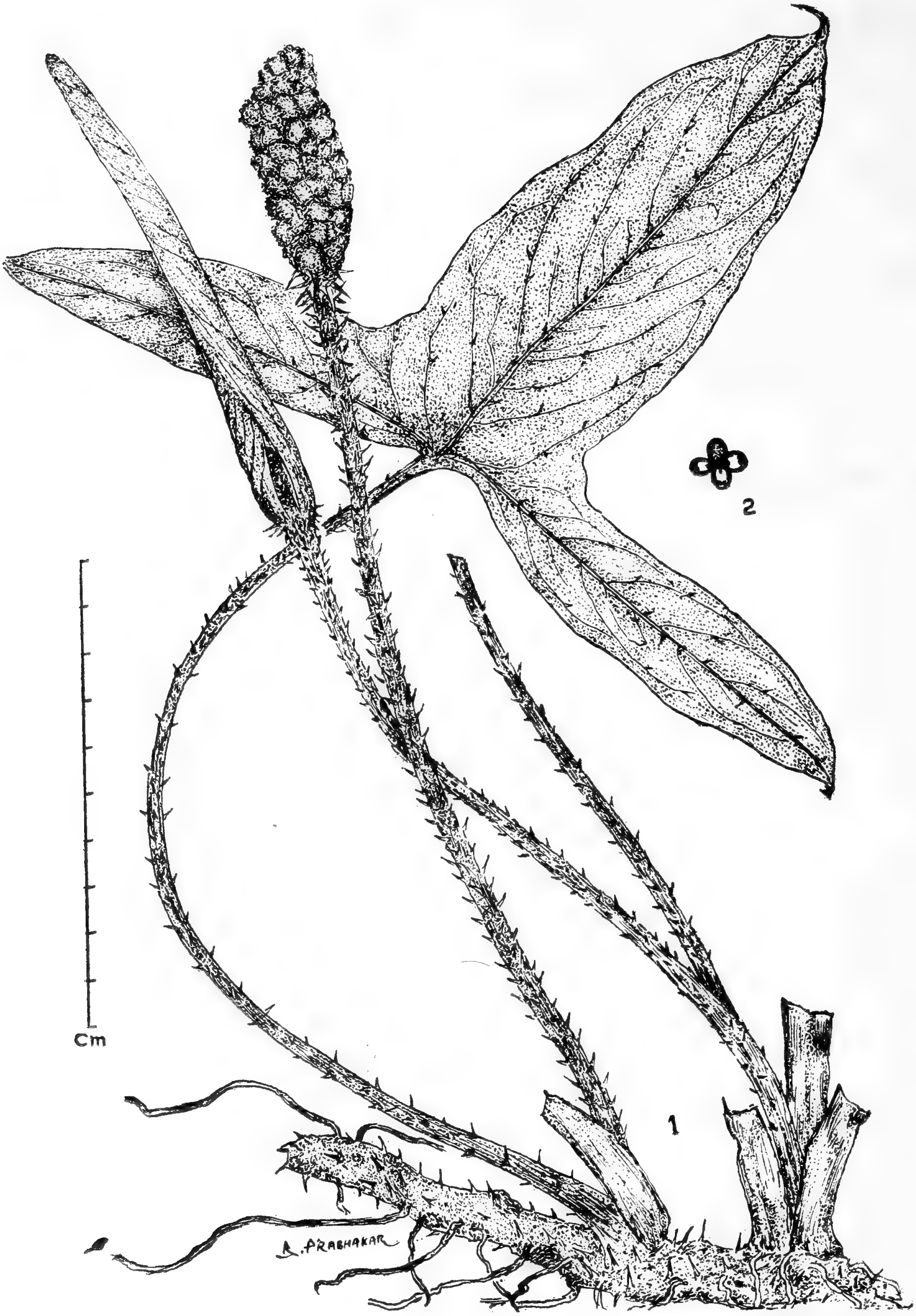
Lasia heterophylla Schott, Maletemata botanica 21, 1832; Hook. Fl. Brit. Ind. 6: 550. 1893.

A stout, prickly, marsh plant. Rhizome, densely spinous. Leaves, when young, hastate or sagittate. Petioles terete, sheathing towards the base. Peduncles as long as the petioles. Spathe opening at the base, longer than the cylindric spadix. Perianth segments 4, pink. Flowers hermaphrodite. Berries densely, minutely muricate at the apex.

Fl. & Frt.: April-June. Loc. Daldali forest, *Malhotra* 149713.

ACKNOWLEDGEMENTS

We are thankful to Dr. B. D. Sharma, Deputy Director, Botanical Survey of India, Western Circle, Poona for encouragement and to the Director, Botanical Survey of India, Howrah for facilities.



Figs. 1-2. *Lasia heterophylla* Schott
1. A flowering and fruiting twig; 2. A floret.

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE, PUNE 400 001,
May 19, 1980.

S. K. MALHOTRA
K. MADHUSUDAN RAO

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35. NOTES ON SOME PLANTS RECORDS FOR BENGAL

In course of floristic study of Jalpaiguri district of West Bengal, several rare and interesting plants were collected from different forest areas of the district. While examining the previously collected materials held at Herb (CAL) and the present collections from the district. I came across different taxa not recorded earlier in the Flora of West Bengal. This note is in continuation of previous commuications on the distribution of plants in Jalpaiguri district and notes on some species (Sikdar 1976, 1979 & 1981 and Sikdar & Ghosh 1978 & 1979a, b). The occurrence of seven more taxa in the district is recorded here with annotations.

MENISPERMACEAE

Pycnarrhena pleniflora (Wall.) Miers., Contrib, 3:553. t. 141. 1871; Hook. f., Fl. Brit. India 1:106. 1872; Prain, Bengal Plants 1:136. 1903 (repr.); Kanjilal *et al.*, Fl. Assam 1(i): 58. 1934. *Cocculus planiflorus* Wall. Cat. n. 4961. 1831, *nom. nud. Pycnarrhena planiflora* Hook. f. & Thoms., Fl. Ind. 206. 1855.

A woody climbing shrub; leaves 12-15.5 × 3.2-5.5 cm, alternate, oblong-lanceolate, glabrous and shining above, bluntly acuminate, nerves arching near the margin; flowers yellowish-white, dioecious, in fascicles from the leaf-axils; male in short congested panicles, females 1-2 flowered; fruit ± 1.2 cm, greenish, smooth.

Specimens examined: Gosaihat, Moraghat range, fl. & frt., 3rd Jun. 1975, *Sikdar* 461; Titi, Madarihat range, fl. & frt., 2nd Mar. 1976, *Sikdar* 4475; fl. & frt., 5th Mar. 1976, *Sikdar* 4529; fl. & frt., 6th Mar. 1976, *Sikdar* 4556.

Common particularly near the foothills of Titi area, sometimes along the forest fringe, occasionally associated with *Hiptage madhablota, Boehmeria malabarica, Ardisia solanacea* etc.

This species is found in Bhutan, Bangladesh, China and in Assam, Meghalaya, Arunachal Pradesh, Tripura and Mizoram in India. Prain (i.c.) reported it from Chittagong (Bangladesh).

ASCLEPIADACEAE

Ceropegia angustifolia Wight, Contrib. Ind. Bot. 31. 1834; Hook. f., Fl. Brit. India 4:72. 1883; Kanjilal *et al.*, Fl. Assam 3:308. 1939; Huber, Mem. Soc. Biol. 12(1):203. 1957; Raizada, Suppl. copy of Duthies Fl. Upper Gangetic plain 149. 1976.

An extensive climber, pubescent; leaves 5-18 × 0.8-1.6 cm, narrowly lanceolate, acuminate, with decurved margin, coriaceous; peduncles 3-5 flowered; corolla tube purplish; corona of ± 10 lanceolate ciliate lobes.

Specimens examined: Mahakalguri, Alipurduars, fl., 26th Sept. 1891, *E. A. Heawood Esqr.* 73; East of Chalsa, Jalpaiguri, fl., 25th Aug. 1908, *I. H. Burkill* 30788.

Grows in dense forest under shade.

It has been reported so far from Sikkim, Khasi hills and Dehra Dun only. It is worth recording the extension of its distribution further south-westward in the northern plain tract of West Bengal.

Hoya obcordata Hook. f. in Fl. Brit. India 4:56. 1883.

Herb with branched, creeping and rooting stem; leaves 1.2 cm long, obcordate, tip rounded or with a slight notch, base rounded; flowers in loose peduncled umbel.

Specimens examined: On way to Sinchula, ± 1700 m, Buxaduar range, fl., 2nd May 1934, *K. Biswas* 2001.

A rare species known only from Sikkim Himalaya.

ORCHIDACEAE

Ascocentrum micranthum (Lindl.) Holtt., Gard. Bull. 11:275. 1947; Orch. Malaya 1: 735. 1953; Rao & Balakrishnan in Rec. Bot. Surv. India 20(2): 205. 1973; Babu, Herb. Fl. Dehra Dun 480. 1977. *Saccolabium micranthum* Lindl. Gen. Sp. Orch. 220. 1833; Hook. f., Fl. Brit. India 6:59. 1890. *Cleisostoma micrantha* (Lindl.) King & Pantling in Ann. R. Bot. Gard. Calc. 8:231, t. 312. 1898; Prain, Bengal Plants 2:768. 1903 (repr.); Duthie, Fl. Upper Plain 2:293. 1903 (repr.).

Small epiphyte with stout compressed stem; leaves 7-12 cm long, narrowly oblong, unequally and obtusely 2-lobed; flowers small, pinkish-white, usually pink on the tip, arranged in small lateral dense-flowered racemes.

Specimens examined: Buxaduar, 850 m, Buxaduar range, fl., 14th May 1976, *Sikdar* 4665; Buxa to Bhutan road, 1150 m, fl., 17th Mar. 1949, *V. Narayanswami* 2647.

Occasional, rather restricted to the Buxaduar hills over 700 m alt., growing on *Spathodia campanulata, Duabanga grandiflora* etc.

It is usually found in Nepal, Bhutan, Bangladesh, Burma and Sikkim, Assam, Naga Hills, Uttar Pradesh and Bihar in India. Prain (*l.c.*) menioned its distribution in Chota Nagpur.

Pholidota articulata Lindl. var. **griffithii** (Hook. f.) King & Pantling in Ann. R. Bot. Gard. Calc. 8:147, t. 204. 1898; Rao & Balakrishnan in Rec. Bot. Surv. India 20(2):216. 1973; Babu, Herb. Fl. Dehra Dun 1977. *Pholidota griffithii* Hook. f., Ic. Pl. 9:t. 1811. 1889 ('griffithii'); Fl. Brit. India 5:845. 1890; Hara, Fl. East. Himal. 193. 1971.

Epiphytic stout herbs, branched with 6-12 cm long furrowed internodes; leaves 7.5-8.5 × 2.5-3.0 cm, narrowly oblong-lanceolate, 2-from the nodes, young ones sheathed at the base; flowers 5 cm across, white tinged with brown and pink, in 2.5-5 cm long decurved racemes.

Specimens examined: Way to Buxaduar, 750 m, Buxaduar range, fl., 12th May 1976, *Sikdar* 4615; Buxa to Bhutan road, 1200 m. fl., 16th May 1949, *V. Narayanswami* 2559; Tobgaon, 1400 m, fl., 18th May 1949, *V. Narayanswami* 2709 & 2731.

Frequent, restricted to the Buxaduar hills.

It has been reported from Nepal, Bhutan and Sikkim in the Eastern Himalayas and Khasi hills and Uttar Pradesh.

CYPERACEAE

Carex japonica Thunb., Fl. Jap. 38. 1784; C. B. Clarke in Hook. f., Fl. Brit. India 6: 736. 1894.

A glabrous sedge; rhizome with brown

scales; stem stout, 3-winged with stolons; leaves as long as the stem; spikes 5, close together.

Specimen examined: Gajalduba, Apalchand range, fl. & frt., 26th Apr. 1962, *S. K. Mukerjee* 5580.

It occurs in Nepal, Japan and in India in the Sikkim Himalaya, Khasi hills, Manipur and Himachal Pradesh.

Cyperus substramineus Kuk. Pfl. R. Heft 101:398. 1936; Kern in Fl. Males. Ser. I, 7(3): 653. 1974. *C. stramineus* Nees in Wight, Contr. 74. 1834, *non* Desf. 1820. *Pycreus stramineus* C. B. Clarke in Hook. f., Fl. Brit. India 6:589. 1893; Prain, Bengal Plants 2:855. 1903 (repr.).

A tufted annual sedge with spicate congested inflorescence.

Specimen examined: Near Buxaduars, Buxaduar range, fl. & frt., 2nd Feb. 1934, *K. Biswas* 2037.

It often grows in grassy localities.

It is found in Bangladesh, Sri Lanka, Burma and Malay peninsula and also reported from Orissa, Assam, Khasi hills, Karnatak, Andhra Pradesh and Andaman Island.

ACKNOWLEDGEMENTS

I am grateful to Dr. R. S. Rao, Ex Joint Director in Charge, Botanical Survey of India, Howrah for valuable suggestions, to Dr. M. P. Nayar, Deputy Director, Central National Herbarium for facilities and to Dr. R. B. Ghosh, Systematic Botanist of the same Institute for kindly going through the manuscript.

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HOWRAH-711 103 (W.B.),
March 13, 1980.

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36. CULTIVATION OF ENDANGERED PLANTS IN SOUTH INDIA

(*With a plate*)

INTRODUCTION

The Experimental Garden of B.S.I., Southern Circle, Yercaud has been introducing and cultivating some of the endangered plants of the country.

Nepenthes khasiana Hook. f. erected as a species from the Khasi hills of the present Meghalaya by J. D. Hooker in 1893, is now treated as endangered due to its restricted distribution in the country and absence from any other part of the world. The genus *Nepen-*

thes forming an unigeneric family Nepenthaceae has about 60 species, distributed in the old world tropics. Only one species namely *N. khasiana* Hook. f. has been reported from India, particularly from Khasia and Jaintia hills. Hooker's note 'a specimen of this in Herb. Wallich is marked as from "Courtallam, Herb. Heyne", but has never been found there by any subsequent collector, and it is inconceivable that the natives should not know so remarkable a plant' is interesting. Courtallam is in Tamilnadu of South India and there has not been any other report upto now of the appearance of this species either in Courtallam or any other part of India.

Material, Methods and Observation

The Experimental garden of the Botanical Survey of India, Southern Circle, Yercaud obtained and introduced in May 1975 and 1977 plants from Meghalaya but these did not establish in spite of the best care. However, 2 plants in pots from Shillong displayed in the exhibition at National Botanic Garden, Lucknow in February, 1978 were received intact and introduced into the experimental garden at Yercaud. As these performed better, subsequently more plants were collected with soil from its natural habitat namely Jurrain R.F. of Jaintia hills (Plate, Fig. 1). Then environmental factors of this area were also noted. The plants were introduced into the experimental garden at Yercaud subsequently, after locating an area with more or less similar environment. Pot and bed culture were practised. The comparative climatic data for Shillong (obtained from Meteorological Observatories, Poona) and Yercaud (A. V. N. Rao *et al.* 1979) are furnished in Table (1).

Table 1

Climatic factors of Shillong and Yercaud

Place	Altitude Mtrs.	Annual rainfall	Temperature		Humidity
			Max.	Min.	
Shillong, Meghalaya	1500 MSL	2400 mm	24.1°C	3.6°C	57 to 89%
Yercaud, Shevaroy Hills	1380 to 1511 MSL	1600 mm	28.0°C	11.0°C	67 to 87%

Two plants received from Shillong in February, 1978 were kept in the same medium upto 16th July, 1978. Repotting of one of the plants in a new medium of 2 parts of clayey soil, 2 parts of leaf mould and 1 part of sand was made and the other divided into 4 sets in sucker region with Seradix treatment were planted in the new medium. The undivided plant thrived well with good foliage and pitcher formation etc. (Plate, Fig. 2 and table 2) and the divided plants did not establish. Later 15 plants were brought again with the soil of its place of collection in March, 1979 particularly from areas where *Lycopodium cirnuum, Drosera burmanni* etc. were growing were put in pots initially in the same medium. Subsequently, in June, 1979 whitish clayey soil from the area where associated plants were growing at Yercaud was brought and made into a bed with water flow arrangement. Six plants were put into this bed and the remaining repotted with 2 parts of the above soil and 2 parts of humus. These plants have been doing well with better foliage growth and pitcher formation (Plate, Fig. 3).

Fig. 1

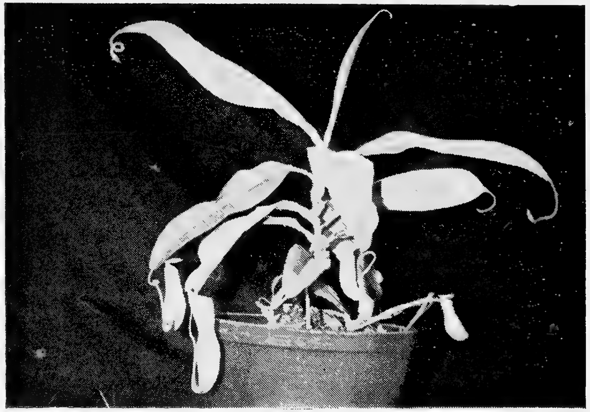

Fig. 2

Fig. 3

Fig. 1. Plants in natural habitat at Jurrain, Jaintia hills.
Fig. 2. Plant in pot at Yercaud.
Fig. 3. Bed culture at Yercaud.

TABLE 2

GROWTH BEHAVIOUR OF *Nepenthes khasiana* HOOK. F. IN YERCAUD, SHEVAROY HILLS

Sl. nos. of leaf	Leaf initiation date	Pitcher initiation date	Max. size of pitcher in cm	Date of opening of pitcher lid	Date of pitcher collapsing	Length X Breadth. of leaf in cm at Max. maturity	Leaf area in Sq. cms at Max. maturity
1	2	3	4	5	6	7	8
a.	26.8.1978	12.10.1978	12.00	20.12.1978	27.2.1979	29.0 × 7.1	145.00
b.	5.10.1978	25.11.1978	13.00	2.2.1979	9.4.1979	30.5 × 7.0	148.5
c.	30.10.1978	24.12.1978	10.5	24.2.1979	25.4.1979	25.0 × 6.5	132.25
d.	25.12.1978	13.2.1979	14.0	10.4.1979	10.6.1979	31.0 × 7.0	151.5

N.B.: Average difference between Col. No. 2 & 3 is = 52 days.
„ „ „ „ 3 & 5 „ = 64 „
„ „ „ „ 3 & 6 „ =131 „
„ „ „ „ 5 & 6 „ = 65 „
Month of sucker initiation: February.
Months without pitcher formation: March to May

CONCLUSION

The above observations indicate possibilities of this species establishing well in Yercaud. The data furnished in table 2 indicate months of pitcher formation and sucker initiation in this climatic condition. The approximate period of lapse between leaf formation and pitcher initiation and the average span of life of the pitcher average period of its functioning as insect trap are also furnished.

It is interesting to note that the size of the pitcher shows a direct correlation to the area of the leaf irrespective of the period of formation.

ACKNOWLEDGEMENTS

We are grateful to Dr. S. K. Jain, Director, and Dr. N. C. Nair, Deputy Director of Botanical Survey of India respectively for their interest and encouragement. We are also thankful to the Deputy Director General of Observatories, Govt. of India, Poona for furnishing the climatic data of Shillong.

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A. K. BANERJEE
A. SUBRAMANIAM

BOTANICAL SURVEY OF INDIA,
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YERCAUD, SALEM DT.,
TAMIL NADU 636 601,
March 21, 1980.

37. *MELOCHIA NODIFLORA* SWARTZ (STERCULIACEAE)—A NEW RECORD FOR INDIA

During a recent visit to Trivandrum (Kerala) one of us (P.V.S.) located a large population of *Melochia* L. which was not identical to the already described species from India. On closer scrutiny of these specimens, it turned out to be *Melochia nodiflora* Swartz a hitherto unknown species in India.

Further studies enabled us to locate this plant from various other parts in Kerala and Coimbatore in Tamil Nadu. It is not represented in MH, the herbarium of University College, Trivandrum or in other herbaria of the region. The plant is a native of Tropical America. This may be a new introduction here and is rapidly spreading. It shows luxuriant growth near the margins of open drains, canals, pools and ditches where human disturbance is very minimum. The plant has also been located in open drier areas where the population is very sparse, and the plants are stunted. This species can easily be distinguished from the other two species of the genus represented in India namely *M. corchorifolia* L. and *M. umbellata* Stapf based by the key given below As this forms a new record for India and is not described or illustrated in any of the Indian floristic works a detailed description along with figures based on fresh materials collected by us, is given here to facilitate easy identification.

KEY TO THE SPECIES OF MELOCHIA L. IN INDIA

1. Herbs or shrubs, flowers in densely crowded clusters, filaments variously united, capsules globose to sub-globose.
    2. Herbs, flowers in terminal clusters, filaments united halfway or more, but never upto the tip, capsules globose........*M. corchorifolia*
    2. Shrubs, flowers in axillary clusters, filaments united almost upto the tip, capsules subglobose .... *M. nodiflora*
1. Small trees, flowers in umbellate corymbs, filaments united at the base, capsules oblong.... .... *M. umbellata*

Melochia nodiflora Swartz, Prodr. Veg. Ind. occ. 97. 1768; C. A. Backer & R. C. Bakh. Fl. Java 1: 405-406. 1963. *M. borbonica* Cav. Diss. 7: 321. 1788.

Shrubs or undershrubs, 0.50—2.50 m tall. Stems woody, terete, much branched. Branches drooping, older ones with reddish tinge, stellately pubescent. Leaves broadly ovate or ovate-lanceolate, acuminate, cordate at base, margins sharply serrate. Petioles 0.2-3.5 cm long. Lamina $1\text{-}13 \times 0.75\text{-}7$ cm, sparsely pubescent on both surfaces, main nerves about 7-10 pairs. Stipules $5\text{-}6 \times 2$ mm, lanceolate, acuminate, ciliate. Flowers subsessile, in dense 3-15 flowered axillary clusters. Bracts foliaceous, $6\text{-}9 \times 3\text{-}4$ mm, ovate-lanceolate, acuminate, hirsute. Calyx united $\pm$ halfway, lobes imbricate in bud, equal, $2\text{-}3 \times 1\text{-}1.5$ mm, ovate-lanceolate, acuminate, sparsely pubescent, margins reddish. Petals spathulate, macrescent, $3\text{-}4 \times 1.5\text{-}2$ mm, white with purple veins, veins prominent on innerside, base conical, cream coloured and without veins, margins hyaline. Stamens 5. Filaments united almost upto the apex, $\pm$ 2.5 mm long, glabrous. Anthers 1 mm long, basifixed, extrorse. Carpels 5, 3.5-4 mm. Ovary sessile, hispid. Styles 5, free or slightly connate at base. Capsules sub-globose, 4 mm in diam., hispid, reddish when young, longitudinally 5-grooved, septicidally dehiscent. Seeds $\pm$ 2.5×1.5 mm, ovate, angular or 3 faced, brown with a white spot at the tip. Testa smooth, minutely reticulate.

Specimens examined: KERALA. Along the streams, Kariavattom, Trivandrum, 8-11-1979, *P. V. Sreekumar s.n.* (MH); TAMIL NADU: Along ditches, on way to the millet breeding station, Coimbatore, 15-12-1979, *P. V. Sreekumar* 58038 (MH); near the railway station, Coimbatore, 23-1-1980, *P. V. Sreekumar* 58039 (MH).

BOTANICAL SURVEY OF INDIA,
COIMBATORE-3,
February 25, 1980.

P. V. SREEKUMAR
N. C. NAIR

38. A REASSESSMENT OF THE TAXONOMIC POSITION AND STATUS OF *AGLAIA BOURDILLONII* GAMBLE (MELIACEAE) WITH NOTES ON THE NOMENCLATURE OF RELATED TAXA

Beddome (1871), while illustrating *Aglaia roxburghiana* (Wt. *et* Arn.) Miq. in Flora Sylvatica, depicted two plants as plates 130A and 130B. Of these two illustrations, figure 130A is based on Beddome's Annamallay (Tamil Nadu) collection and Gamble (1915) described it as a variety namely, *A. roxburghiana* (Wt. *et* Arn.) Miq. var. *beddomei* Gamble. The figure 130B in FLORA SYLVATICA, based on a specimen from Attramallay ghats (Tamil Nadu) is given with the following note. "B is a variety from Tinnevelly hills (Attramallay ghats) a male tree with dessections of the flowers, this variety has leaves obovatespathulate, the dessections all from the male flowers, but the female flowers only differ in having a fertile ovary". Later Gamble (1915) based on the illustration 130B of Beddome (1871) and specimens of Bourdillon exactly matching with it at 'Madras Herbarium' (Gamble 1918) described the species. *A. bourdillonii.*

In the protologue of *A. bourdillonii,* Gamble (Anonymous, 1915) distinguished it from *A. minutiflora* Bedd., a species which he considered to be closely related to *A. bourdillonii.* However a comparison of Beddome's (1874) plate 193, which is the type of *A. minutiflora* with that of *A. bourdillonii* (*Bourdillon s.n.,* Acc. no. 9099, MH) shows that these two species differ considerably in their number of leaflets in a leaf (i.e. 15 leaflets per leaf in *A. minutiflora* and 5-7 leaflets in a leaf in *A. bourdillonii*) and in the length of the inflorescence (i.e. about 45 cm in *A. minutiflora* and about 15 cm in *A. bourdillonii*). Moreover the acuminate leaflets are stellate-tomentose in *A. minutiflora* whereas in *A. bourdillonii* the leaflets are obtuse or blunt at apex and scaly beneath. Again, in the key to the different species of *Aglaia* Lour. in Flora of the Presidency of Madras, Gamble (1915) considered *A. minutiflora* and *A. bourdillonii* as belonging to one group characterised by exserted stamens. But the stamens in *A. bourdillonii* are included in the corolla tube and this character is also depicted in Beddome's plate 130B. In fact, *A. bourdillonii* is very closely related to *A. roxburghiana* in its habit, size and shape of the leaves, nature of inflorescence and flowers with the stamens enclosed in the corolla tube. And perhaps it is because of these resemblences between the two taxa that Beddome (1871) considered his Attramallay collections as a variant of *A. roxburghiana* and not that of *A. minutiflora* for which he was having specimens at that time.

Regarding the taxonomic status of *A. bourdillonii,* authors like Harms (1940) and Choudhuri (1967) followed Gamble (1915) in treating it as a distinct species. However a study of the collections of *A. bourdillonii* and

A. roxburghiana at Central National Herbarium,, Botanical Survey of India (CAL), Herbarium Southern Circle, Botanical Survey of India, Coimbatore (MH) and Herbarium of the Presidency College, Madras (PCM) showed that *A. bourdillonii* differs from *A. roxburghiana* only in the nature of their inflorescence, the former possessing profusely branched longer and comparatively slender flowering branches, whereas in the latter the inflorescence is less branched, shorter and stouter exactly agreeing with the description given by Wight and Arnott (1834). Eventhough slight variations are noticed in the length of the petiole and shape of the leaves, such characters are of little taxonomic significance because of their overlapping nature in these two taxa. Hence it is considered here that *A. bourdillonii* can only rank a varital status under *A. roxburghiana* and this view also gets support from Beddome (1871) who first illustrated *A. bourdillonii* mentioning it only as variety of *A. roxburghiana.*

According to Backer and Bakhuizen van den Brink Jr. (1965) the correct name for *A. roxburghiana* (Wt. *et.* Arn.) Miq. is *A. elaegnoidea* (Juss.) Benth. Hence the following new combinations are also proposed here to render the nomenclature of *A. roxburghiana* var. *beddomei* Gamble and *A. roxburghiana* var. *courtallensis* Gamble up to date.

1. **Aglaia elaegnoidea** (Juss.) Benth. var. **beddomei** (Gamble) K.K.N. Nair comb. nov.—*A. roxburghiana* (Wt. *et* Arn.) Miq. var. *beddomei* Gamble, Fl. Presid. Madras 1:180, 1915.—*A. roxburghiana sensu* Bedd. Fl. Sylvat. t. 130A. 1871.
   Type: Flora Sylvatica t. 130A (Iconotype).
   Distribution: Andhra Pradesh, Karnataka, Kerala, Tamil Nandu.
2. **Aglaia elaegnoidea** (Juss.) Benth. var. **bourdillonii** (Gamble) K.K.N. Nair Stat. et comb. nov.
   A. bourdillonii Gamble, Bull. Misc. Inf. Kew 1915: 346-47. 1915 & Fl. Presid. Madras 1: 180. 1915; Harms in Engl. & Prantl. Pflanzenfam. (ed. 2) 19b: 146. 1940; Choudhuri, Bull. Bot. Soc. Bengal 21(1): 6.1967.—*A. roxburghiana sensu* Bedd. Fl. Sylvat. t. 130B. 1871.
   Type: Attramallay Ghat, *Bourdillon s.n.* (Acc. no. 9099, MH).
   Distribution: Tirunelveli hills (Tamil Nadu).
3. **Aglaia elaegnoidea** (Juss.) Benth. var. **courtallensis** (Gamble) K. K. N. Nair. comb. nov.—*A. roxburghiana* (Wt. *et.* Arn). var. *courtallensis* Gamble, Fl. Presid. Madras 1: 180. 1915.
   Type: Chokampatty, Tirunelveli hills, *without collector's name & number* (Acc. no. 9058, MH).
   Distribution: Tirunelveli hills (Tamil Nadu).

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K. K. N. NAIR

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CALCUTTA-700 016,
March 3, 1980.

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WIGHT, R. & ARNOTT, W. (1834): Prodromus Florae Peninsulae Indiae Orientalis. London.

39. TWO NEW COMBINATIONS OF THE GENUS *ASEMANTHIA* (STAPF) RIDLEY (RUBIACEAE)

Mussaenda Linn., one of the established genera of Rubiaceae with a number of species, is well characterised by one of the calyx lobes being usually deciduous and forming a large petaloid white or coloured leaf like structure. A closely related genus *Acranthera* Arn. ex Meissn. is referred by the more herbaceous form of the plants than the typical *Mussaenda* Linn. but was merged to *Mussaenda* Linn. by Baillon (1880) while Schumann (1891) maintaind it as a distinct species. Later Stapf (1894) recorded it as a well marked genus after the exclusion of the species like *Acranthera maingayi* Hk. f. and *A. griffithii* Hk. f. Simultaneously he (l.c.) has proposed a new Section *Asemanthia* Stapf under *Mussaenda* Linn. considering the taxa of *Acranthera maingayi* Hk. f., *A. griffithii* Hk. f. and *Mussaenda mutabilis* Hemsl. which differ in the bushy straggly growth of the plants, absence of enlarged calyx-lobes and finally the long corolla tube. Ridley (1940) has elevated it to a distinct genus with distribution to Malay Peninsula and the islands of Borneo but nearer to Indian *Mussaenda* Linn.

His treatment is as under;

Asemanthia maingayi (Hk. f.) Ridley in Kew Bull. 1940:600.1940; Basionym: *Acranthera maingayi* Hk. f. in Fl. Brit. Ind. 3:92. 1880; Synonym: *Mussaenda mutabilis* Hemsl. in Hook. f. Ic. Pl. 18: t. 1718, 1887; *Mussaenda maingayi* (Hk. f.) Stapf in Trans. Linn. Soc. (Sr. 2) 4: 172. 1894.

King (1903) has described a new variety *hirsuta* under *Mussaenda mutabilis* Hemsl. on the basis of densely velvety nature of stem and under surface of leaves especially along the nerves. Ridley (1923) has also described one more variety *montana* under this same taxon based on dwarf compact nature of the plant with smaller leaves. On examination of these varieties we suggest as *Mussaenda mutabilis* Hemsl. belongs to the genus *Asemanthia* (Stapf) Ridley, a new combinations for the two taxa as:

Asemanthia maingayi (Hk. f.) Ridley var. **hirsuta** (King) Sinha et Mitra comb. nov.;

Basionym: *Mussaenda mutabilis* Hemsl. var. *hirsuta* King in Jour. Asiat. Soc. Beng. 72(2): 182. 1903.

Syntype: Perak, *King's collector* 225 (CAL); Malacca, *Derry* 253 (CAL).

Asemanthia maingayi (Hk. f.) Ridley var. **montana** (Ridley) Sinha et Mitra comb. nov.;

Basionym: *Mussaenda mutabilis* Hemsl. var. *montana* Ridley in Fl. Mal. Peninsula 2:58. 1923.

Type: Malacca, Mount Ophir, Padang Batu, *Ridley* 3215 (CAL).

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A. K. SINHA
B. MITRA

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CONTENTS

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CONTENTS

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ENVIRONMENTAL PROTECTION IN INDIA—PROBLEMS AND PROSPECTS[1]

M. S. SWAMINATHAN[2]

In India all the basic life support systems are under serious strain and stress. Both the human and animal population pressures have reached a level now where the flora, fauna, soil and water and also the atmospheric conditions, are becoming more and more adversely affected. Consequently, the renewable base of agriculture is being eroded.

I have personally been a student only of the struggle for the conservation of genetic variability in domestic plants. I have not studied non-domesticated species. But I know that the problem is serious even among domesticated plants and animals. If the maintenance of natural variability in domesticated species of both animals and plants is such a difficult task, the order of effort needed in the case of non-domestic animals can well be imagined.

In India, where we have enormous amount of animal wealth in the form of cattle, sheep, goats, pigs and poultry, we find that it is becoming rather difficult even to get sometimes, really true specimens of some of our native indigenous cattle breeds. Take, for example, the ongole breed of work animal from Andhra Pradesh, a very famous breed, which has been used extensively in cross-breeding in Brazil and elsewhere; to-day one finds it very difficult to get a pure strain. In several cultivated plants, we had enormous variability in the past. In the north-eastern region alone, for instance, we collected over 5,000 strains of rice. Some of them later proved to be important donors of genes for resistance to new pests and diseases, which arise along with the changing ecology of rice cultivation consequent upon fertilization, dense crop canopies with little light penetration to the bottom of the plant and so on. The intensive production techniques of today are based on an altered micro-environment. The pest syndrome also changes with a change in agronomic methodology.

We have both, at the national and international levels today some institutional mecha-

[1] Lecture delivered at the inaugural meeting of the Species Survival Commission of the International Union for the Conservation of Nature and Natural Resources—New Delhi, 19 February, 1981.

[2] Member, Planning Commission, Yojana Bhavan, New Delhi-110 001.

nisms for the collection, utilisation and maintenance of genetic variability in some of the major crop plants. I refer to the International Board for Plant Genetic Resources which acts as an umbrella organisation for the collection and preservation of genetic material of the more important domesticated plants. More recently, there has been a move for organising a similar kind of umbrella organisation for the conservation of animal genetic resources.

As far as India is concerned, we have national organisations like the National Bureau of Plant Genetic Resources and in the Sixth Five Year Plan, which has just been approved, we have also provided funds for a National Bureau of Animal Genetic Resources and a National Bureau of Fish Genetic Resources. In addition, a Bureau of Forest Genetic Resources will be set up to conserve the enormous amount of bamboo, teak, neem, and many other important species occurring in India.

Thus, a limited amount of organised effort has been started in the area of preventing gene erosion. Even this has been a long struggle for the simple reason that, unlike soil erosion, which is visible to the eye, gene erosion is not seen and hence not understood. With thousands of years of human selection and even with modern techniques of induced mutation it will not be possible to get the wide spectrum of variability which one finds in nature. Natural variability is not only the product of mutation and recombination but also of natural selection. Hence when such variability is lost, we lose the fruits of thousands of years of natural selection. For sustaining agricultural advance and for ensuring that we have the capacity to withstand new problems such as new strains of pests which may arise, it is important to conserve our genetic wealth both in wild and domesticated plants and domesticated animals. In the north-eastern Himalayas for example, there are some domesticated animals like *Yak* and *Mithun*. They are both work and dairy animals. The great degree of soil damage arising from shifting cultivation is resulting in the endemic flora becoming dominated by plants which are non-edible to animals. This is almost the last step in the battle for plant species' survival. When demographic pressure on land increases, only those plants survive which are non-edible, for the obvious reason that they have a high selection value. In fact, this is why plants like *Ipomea carnea* and *Lantana* sp. are alone seen all along the railway lines or on both sides of the road. Edible wild plants do not survive because of uncontrolled grazing by animals. Today what is happening in the areas under shifting cultivation is that weeds like *Eupatorium* and *Mikenia* and others take over and yak and *Mithun* cannot eat them. Hence their stock is now dwindling. Gradually, therefore, for a wide variety of reasons, we find that variability in domesticated plants and semi-domesticated animals is tending to get eroded.

I have mentioned earlier that soil erosion at least attracts the attention of the finance man. Soil erosion he understands, because he can see; but the other erosions are not visible and therefore are not understood. Even species survival is a topic which many refuse to discuss because of the view, "What is wrong, it is all part of the process of evolution, some die, some survive." It is very difficult to talk in terms of 100 years from now among people who take a fairly short range view of things. In a democracy based on free elections, the Government looks for a four year or five year term, as the case may be, and, generally, therefore, a short term view of problems is the rule.

In 1980, after the new Government was elected, a small group of scientists and others was commissioned to go into the whole question of the adequacy of existing legislative and administrative arrangements for protecting the basic life support systems in India.

By and large, the conclusion of that Committee was that there is a considerable amount of legislative power within the Government, both Central and State. In other words, there has been a whole series of legislative measures, ending with the Wild Life Protection Act of 1972, which provide extensive legislative power to Government for restricting damage to fragile eco-systems and to natural assets. But, inspite of the existence of these legal provisions, what is actually happening in the field is quite the reverse. The National Forest Policy Resolution of the Government of India of 1952 wanted one-third of the country to be under forests, instead of 22% as was the case at that time. According to some of the experts connected with forest survey, the real forest canopy in India may now be hardly 11 to 12%. So, instead of reaching a higher level, we have all the time been losing ground. Habitat destruction is the starting point of wildlife destruction. We see this all the time, with the result that even an animal like the elephant has become an endangered species. Elephant killing is going on still inspite of all the legislation and restrictions. It is a very simple phenomenon. For example, in the Assam foothills, every year man makes inroads into the forests. When you cut more forests, then the elephant is forced to come out and it goes to a village. May be a man is killed, or damage takes place to property, and the elephant is named a rogue elephant and destroyed.

Natural habitat destruction in this country, I would say, is the most important cause of concern from the point of view of wildlife preservation. Some of you might have seen a recent book by George Schaller written after many years of travel in the Himalayas. This book, STONES OF SILENCE came out recently. I would quote one particular passage.

> "At most a few hundred Kashmir stags, a sub-species of red deer, survive in the Vale of Kashmir, their only home. Yet as recently as 1947 there were over 4,000, the animals having brought to the verge of extinction because no one cared. There are many species similarly threatened, all in need of some one concerned enough to fight for their needs. The fact that a living being can vanish from the earth solely because of man's improvidence and neglect is appalling and the utter finality of it touches the conciousness of far too few. I have met in the Himalayas many species without a future."

You know this situation only too well because you have all been working in this field.

But I do not agree with Schaller when he says no one is concerned about them. What I generally find is that there is now an awareness everywhere of this problem. Awareness has also led to *analysis,* like the Species Survival Commission's analysis and the red data book it produces which lists these endangered species, our own Wild Life Protection Act, World Conservation Strategy, Global 2000 report commissioned by the U.S. President and so on.

Analysis, unfortunately, is not followed by *action,* and that is where the chain is broken, because the normal logical sequence is awareness, analysis and appropriate action. But when we go to the third step, we find that legislative measures alone cannot provide the action forum which is needed. This, I find, is the greatest challenge, particularly to countries like India, which have a totally different set of economic problems than the affluent countries. Each country in terms of species survival may have its own problems. Here our most important problem is the demographic pressure of man and animal on land and water resources. The other components of the eco-destruction system are (a) careless technology; (b) greed of the rich; and (c) needs of the poor for fuel, fodder and food.

The Committee I referred to earlier has suggested, that we should have an implementing mechanism, an action mechanism, which is somewhat better structured than what we had so far. As a first step, the Government have set up a Department of Environment under the charge of the Prime Minister. It has been suggested to all the State Governments, as we have a federal Constitution, to set up similar departments of environment as a sort of co-ordinating body. The Environment Department will have its own advisers in all the major development Ministries and they will have a feed back relationship with the parent Department of Environment. We have in India so far only one other field with such an arrangement, namely, the Ministry of Finance and the Financial Adivsers, who are located in each spending Ministry, such as, Agriculture, Irrigation, Coal or Energy and so on, but who also owe their allegiance partly to the Department of Expenditure in the Ministry of Finance. It is a duality of function. We think that environment is so important in terms of development that a similar arrangement should be made, so that we have these people responsible to the Department of Environment on the one hand and to the Ministry on the other, so that the environmental impact assessment can be done with speed and care.

This structure has just come into existence and we hope that with the development of such a structure at the Government of India level, further damage to life support systems can be arrested and a systematic eco-restoration programme initiated. The National Committee on Environmental Protection and Co-ordination (NCEPC) has done during the last 10 years a considerable amount of work in terms of developing blueprints for bio-sphere reserves. The blueprint on the Nilgiri bio-sphere reserve, for instance, has brought to light the vast amount of wealth of animal, fish and plant life existing in this region. In fact, this region of Western Ghats and the region represented by the Silent Valley Reserve Forest in Kerala, are really veritable mines of biological wealth of great value. A new species of rice called *Oryza malampuzhensis* was described for the first time from this area. There are several reports of this kind, which have been prepared for the preservation of important centres of animal and plant life. For example, one of the finest marine national parks could be in the Mandapam-Rameswaram area in the coastal belt, particularly the Krusadi Islands. As a young student I had been to the islands to collect crustaceans for class room examination. It used to be such a beautiful place then. Two years ago when I again went there, I found a sea of change. I blame the zoology Professors and zoology students who over the years have ravished the area collecting specimens for their examinations and study. Unconsciously, over a period of time the whole area has been denuded of its wonderful wealth of species. Until recently, no one thought of preserving for posterity this paradise of crustaceans. The Mandapam Marine National Park is yet to come into existence.

There is a whole series of bio-sphere reserves for which the NCEPC has developed detailed operational blue-prints. More areas are also being declared as national parks. For example, the Valley of Flowers in Uttarkand will soon be developed as a national park. Even for the Silent Valley Area the Kerala Government has issued a notification, declaring it a National Park.

We have several areas which are being developed as Gene Sanctuaries. The idea behind a Gene Sanctuary is to protect an environment in which considerable genetic variability occurs in species of economic value. It could also be in terms of a pathogen. In the case of pathogens, these are called the "Hot spot Screening Location," where considerable variability in the pathogen occurs. For example, there is a famous Hot Spot Location in the Toluca Valley near Mexico City where there is considerable biotype variation in *Phytophthora infestans,* the fungus which was responsible for the Irish potato famine of the last century. Even the Indian potato revolution was facilitated by the opportunity to grow potato material at the hot spot location in Toluca valley for selection for resistance to infection with late blight. It is important, therefore, that we have these hot spot locations, which are the areas where one could select the genetic material and also preserve them. It is of particular importance for the poor countries, which cannot have expensive phytotrons or climate houses, where every environmental parameter can be reproduced artificially.

The north-eastern region is also the home of citrus, *Citrus indica.* Even what is called the Mandarin orange has its centre of variability in this area. We find there a considerable variability in *Citrus indica* in the Garo Hill region of Meghalaya. This area is now likely to be devastated as a result of the frequency of shifting cultivation becoming shorter and shorter. It has now become almost a five year circle, while earlier, it used to be 50 to 60 years shifting cultivation cycle. Therefore, a Citrus Gene Sanctuary, the first of its kind in this country, is being developed in the Garo Hills. Garo Hills is also the home of very interesting varieties of wild cotton such as cernum cotton, Sikkim and the north-eastern region is also the area where one finds very primitive races of rice, corn and maize. In fact, the primitive strains of maize found in Sikkim raise the question as to when corn came to India. It was not probably post-Columbus, but was apparently long before, since this kind of primitive maize closely resembles the types found in the excavations in Mexico. The ancestry of tetraploid cotton, *Gossypium hirutum* also suggests that plant exchange between the old and new worlds is one of great antiquity.

We had for the Indian Science Congress early this year, the focal theme of environment. A distinguished biologist from the North-Eastern Hill University, Shillong gave a paper on desertification in North Eastern India. This is an area which receives one of the highest rainfalls in India, and yet in terms of the denudation of the biological potential of the area it can be considered to be under a process of desertification. It is in this kind of ironical situation we find ourselves more and more now.

People now understand the importance of species survival. Although the awareness in terms of human welfare and human happiness exists, I do not think the realisation that conservation is another name for survival has gone home for the simple reason that the poor are not concerned with tomorrow, but with today. The hungry people want bread today, not tomorrow. Therefore until the basic human needs are satisfied, the substrate for the concept of development without destruction to take root will not exist.

We have given several suggestions in the VI Plan on operational mechanisms for action. We have, for example, suggested structured methodologies by which analysis can be converted into action at the field level. For example, an eco-development task force will be organised like the territorial army with ex-servicemen. Eco-development camps for both students and non-student youth coming from different parts of the country will be held in different parts of the country so that youth can participate in the establishment of national parks, marine national parks, gene sanctuaries and bio-sphere reserves. Over 50 per cent of our population is below the age of 25 and, therefore, they are the people who are going to determine the future of the country. Unless at that level there is more involvement, not only awareness but involvement in action, we cannot progress. We have now provided a methodology by which young boys and girls working in schools and colleges and even non-student youth can come and participate in the development of specific projects, so that by living together they understand the problems. The third aspect is that, apart from the Eco-development force and the student eco-development camps, we will try to provide appropriate support for local communities. The local communities could take care of their local habitats and environment, and wildlife protection. In other words, the protection of environmental assets will become a joint sector activity involving the people and Government.

In this country species survival, habitat survival or habitat protection and the conservation of our genetic resources will all have to be associated with some tangible benefits to the local community. One must learn from past errors. Take the case of the tribals. After all, the forest dweller is the tribal. Between him and the forester or the forest officer many a time there has been misunderstanding and even conflict. The forest dweller considers the forest officer almost an enemy, rather somebody who is trying to take away his traditional source of living, the traditional source of fuel, fodder, some minor forest produce. Even here disharmony has started between those who serve the forest and those who live out of the forest.

But these tribal communities have a number of advantages. They, by and large, still live according to the old joint family system in India. They are all fairly well-knit communities, and they can be greatly influenced for good or bad. I feel that even where the local inhabitants like tribals do not have the requisite educational qualifications, in all our game sanctuaries, wildlife reserves, bio-sphere reserves, national parks, the staff should be mainly from the local people. The local people should be trained for the job rather than told that they lack the requisite qualification. We have to see that they find some benefit out of them in terms of employment. Employment in this country is crucial because, our malnutrition problem today is better stated in terms of million man-years of jobs rather than million tonnes of foodgrains. Unless one has a job, there is no purchasing power and, if there is no purchasing power, there is no food. Hence, if we can relate the conservation movement in terms of tangible benefits of employment and purchasing power to the local community, the pre-requisites for a successful conservation movement would have been met. I would not say all the time it is necessary but once awareness comes, then automatically protection follows. May be, after 10 to 15 years, things will change; and people may evolve towards that stage. It was in the city of Leningrad during the German seige of World War II, that people did not think of consuming the genetic wealth of the Vavilov collection of potatoes, wheat, etc., although they died of hunger. They preferred to starve rather than erode the genetic stocks of wheat and potatoes, since they were aware that the genetic wealth is immortal, while the human being is a mortal. That a mortal should not do damage to something which ought to be immortal is a kind of awareness which will take time to permeate in a society, but we should develop the methodology by which this will happen.

The success of our survival movement will really depend upon our policy to demonstrate that this is a movement not only for tomorrow but that it is a movement which is essentially for today. The movement itself should become a process of wealth creation and employment generation. Some tangible benefits must be seen by the people.

This is why I always say that in poor countries the ecology movement must be based on concepts of economic ecology. In countries which are already well advanced where the quality of life is high, it is a question of protecting the already high standards of living which have been achieved. Here it is a question of providing the basic minimum needs, of calories, of clothing, of shelter. Economic ecology should show the way for accelerated economic advance on a sustainable basis.

Therefore, we find here contrasting requirements in relation to species survival work. The parameters under which it can succeed will be different. In one case, it can be *"don't"*, i.e. it can be regulatory mechanism; in the other case, it has to be *"do"* you will have to do this. "Don't" would not work; it has to be a series of "do"s. And that is where the economic ecology movement, which is to be the major spring board of action in poor countries, will have to have a plan of action for species survival, which in its operational content may be somewhat different, obviously, from those which we have today in affluent nations.

Our immediate task must be to stop further damage and the next task, at least in relation to the hill ecosystem, is to restore the damage done, to the extent possible, by the end of this century. In other words, these are the two kinds of tasks. However, the process of denudation is still going on, the process of restoration is yet to begin. If these two tasks, are performed well, then automatically they will take care of the problem of species survival. For this to happen, we need also an understanding among economists and financial experts that ecological economics has an added dimension in the calculation of cost, risk and return, namely, a time dimension extending to infinity. If we are able to bring about in each country a proper blend of ecological economics and economic ecology, we will find that the work of your commission will turn from the present mood of agony into one of enduring ecstacy.

OBSERVATIONS ON THE BIOLOGY OF *HIPPOSIDEROS LANKADIVA* KELAART, 1850 (CHIROPTERA, RHINOLOPHIDAE)[1]

H. R. Bhat and M. A. Sreenivasan[2]

Hipposideros lankadiva roosts in deserted temples and subterranean caves in association with certain other species of frugivorous and insectivorous bats. There is a year round fluctuation in their population in their roosts, depending upon the reproductive status of the colony. The species has a single estrous cycle each year, with pregnancy from February to May and parturition in May and June. The suckling period is estimated to be six to eight weeks. Males generally segregate from the females during later part of pregnancy or during nursing of the neonates. While foraging, females leave behind their neonates in the roost. At birth the male to female percentage is 55:45.

Hipposideros lankadiva is the largest *Hipposideros* found in Peninsular India and Sri Lanka with forearms of the adults measuring 80 to 90 mm. The subspecies entities given by Anderson (1908) for various forms are now clubbed together (Tate 1947, Ellerman and Morrison-Scott 1951, Brosset 1962). The information on the biology of this species has been summarised by Brosset (1962).

This communication presents some additional information on the biology of this species collected during a serological survey of bats in the Kyasanur Forest disease area and its neighbourhood between 1969 and 1978 (Bhat *et al.* 1978).

Material and Methods

The colonies were traced by searching the known ancient temples and by enquiring with villagers. Whenever possible, the colonies were visited periodically and the ecological data, associated species and approximate population size were recorded. Samples of specimens were collected with the help of sweepnets and mistnets, and their weight and reproductive status were recorded. For females, the status of mammae, false teats and lactation were recorded. Each adult female was dissected and the grossly visible embryos, when present, were removed along with the embryonic membranes and surrounding uterine wall and weighed. Depending upon the weight, colour and reproductive status each specimen was arbitrarily classified as neonate, juvenile or adult.

Observations

Colonies recorded:

Eleven colonies recorded during the study are listed with ecological details in table 1. Of the 11 colonies, those at Sampagaon, Bailhongal, Chandravalli, Banavara, Kamalashile and Manki were visited only once. Thigadi colony was first visited on October, 1969 and subsequently on 29 June, 1970, 12 February, 1971, 18 June, 1971 and 5 August, 1971. Yellapur colony was visited thrice. The colonies at Nislneer and Muroor are still under periodic observations.

[1] Accepted October 1979.

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Breeding cycle:

Because of the migratory habit of the species and the population fluctuation, it was not possible to make a monthly collection of adequate number of specimens from any colony throughout the year. However, the overall observations on several colonies and a number of collections made at Nislneer and Muroor have enabled us to construct an approximate picture of the breeding cycle of the species.

At Nislneer, 38 out of 53 adult females collected during February, March and April were in various stages of pregnancy (Table 2). The embryos weighed between 0.02 to 8.0 gm. The smallest embroys were seen in February and the largest in April. Three specimens carrying suckling babies and one lactating female were collected in May and June respectively. Juvenile specimens were seen between June and December. It was not possible to differentiate the juveniles from adults after December.

In all 149 adult females were collected from Gersoppa, Muroor and Kamalashile, of which 16 were pregnant, 91 were carrying suckling babies and 11 were lactating (Table 3). The March sample had the smallest embryos weighing an average of 0.75 gm, while the May sample had the largest weighing an average of 11.4 gm. Neonates were seen between the last week of May and middle of June. A few free flying juveniles were first seen in the first week of June. The pregnancy was invariably in the left uterus with the exception of two individuals.

The adult females including the pregnants weighed an average of 38.5 gm (31.8 to 45.8 gm). The adult males weighed an average of 44.0 gm (30.0 to 61.0 gm).

Associated species:

H. lankadiva was observed to share the habitat with seven other species of bats namely, *Rousettus leschenaulti*, *Eonycteris spelaea*, *H. speoris*, *Rhinolophus rouxi*, *R. lepidus*, *Miniopterus schreibersi* and *Megaderma lyra* (Table 1). In the mixed colonies *H. lankadiva* either occupied a separate area of the habitat or mixed freely with the associated species, particularly with *R. leschenaulti* and *H. speoris*.

Population fluctuation and Social habits:

During the first collection at Thigadi on 19 October 1969, the colony had about 3000 individuals of adults and juveniles. In February, 1971 the habitat was free from this species. In June 1971 the colony was in full strength with more than 3000 individuals consisting of juveniles and lactating females carrying neonates. The small colonies located at Sampagaon and Bailhongal appeared only during the rainy season from June to August, and consisted of adults. Ten specimens collected from Yellapur on 28 June 1970 were all males. Subsequently only one bat was seen on 27 March 1971 and none on 17 June 1971.

The Muroor cave, when first visited on 29 March 1972, did not have any *H. lankadiva*. During the second visit on 31 May 1972 a colony of about 200 females and 100 males was seen. Most of the females were carrying babies. The adult males occupied a separate part of the cave away from females. In the evening the bats started emerging at 19.15 hrs. While *Rousettus leschenaulti* was the first to emerge from the cave, *H. lankadiva* was the last to emerge. When the empty cave was surveyed at 20.15 hrs, three adults and a group of 86 neonates were seen. The neonates were deposited individually on the side wall with 10 to 20 cm spacing between each other. All neonates were with sealed eyelids. Majority of them had greyish brown fur and rest were naked. Of the 64 neonates 35 were males and 29 were females giving an approximate 55:45 male-female percentage.

TABLE 1

RECORDS OF COLONIES OF *H. lankadiva*

Sl. No.	Locality & District	First recorded on	Habitat	Estimated Number	Number collected	Associated species
1	Thigadi Belgaum	19-10-1969	Dome of a temple	3000	235	*Rousettus leschenaulti, Miniopterus schreibersi*
2	Yellapur North Kanara	28-6-1970	Deserted temple	20	10♂	*Rhinolophus rouxi*
3	Gersoppa North Kanara	15-3-1971	Deserted temple	50	15♂, 14♀	*Hipposideros speoris*
4	Sampagaon Belgaum	5-8-1971	Dome of a mosque	50	Nil	Nil
5	Bailhongal Belgaum	18-6-1971	Chimney of an oil mill	1	Nil	Nil
6	Chandravalli Chitradurga	25-6-1971	Subterranean tunnel	50	1 ♂ (Juvenile)	*Megaderma lyra*
7	Banavara Hassan	28-7-1971	Deserted temple	40	2 ♂ (Juvenile)	Nil
8	Muroor North Kanara	31-5-1972	Subterranean cave	50	6♂, 11♀	*Rousettus leschenaulti, Eonycteris spelaea, Hipposideros speoris*
9	Nislneer North Kanara	16-3-1973	Subterranean cave	500	2♂, 3♀	*Rousettus leschenaulti, Eonycteris spelaea*
10	Kamalashile South Kanara	10-4-1973	Subterranean cave	1000	10♀	*Rhinolophus lepidus*
11	Manki North Kanara	7-4-1975	Subterranean cave	20	Nil	*Hipposideros speoris*

TABLE 2

ANALYSIS OF SAMPLES OF *Hipposideros lankadiva* COLLECTED AT NISLNEER

Date	Adult females					Adult males	Neonates	Juveniles	Total
	Total No.	No. pregnant	Wt. of embryo (grams)	Suckling mothers	Lactating females				
16-3-73	3	3	0.1-1.1 (0.7)	—	—	2	0	0	5
22-4-73	8	6	5.4-8.0 (5.9)	0	0	5	0	0	13
17-5-73	3	0	—	3	—	15	3	0	21
9-6-73	0	—	—	—	—	8	0	0	8
19-7-73	0	—	—	—	—	6	0	0	6
27-8-73	0	—	—	—	—	13	0	0	13
4-10-73	0	—	—	—	—	0	0	0	0
30-10-73	0	—	—	—	—	0	0	0	0
29-11-73	1	0	—	0	0	1	0	0	2
28-12-73	1	0	—	0	0	0	0	1♀	2
31-1-74	0	—	—	—	—	0	0	0	0
28-2-74	13	9	0.05-0.15 (0.09)	0	0	0	0	0	13
28-3-74	7	6	0.6-1.4 (0.94)	0	0	0	0	0	7
29-4-74	0	—	—	—	—	0	0	0	0
28-5-74	0	—	—	—	—	0	0	0	0
28-6-74	1	0	—	0	1	3	0	3♀	7
24-7-74	0	—	—	—	—	7	0	0	7
23-8-74	0	—	—	—	—	8	0	2♀, 1♂	11
30-9-74	0	—	—	—	—	2	0	2♀, 2♂	6
31-10-74	0	—	—	—	—	0	0	0	0
26-11-74	0	—	—	—	—	0	0	1♀	1
30-12-74	0	—	—	—	—	1	0	0	1
30-1-75	0	—	—	—	—	0	0	0	0
3-3-75	15	14	0.02-0.2 (0.07)	0	0	3	0	0	18
7-4-75	1	0	—	0	0	0	0	0	1
8-5-75	0	—	—	—	—	0	0	0	0
Total	53	38	—	3	1	74	3	12	142

TABLE 3

ANALYSIS OF SAMPLES OF *Hipposideros lankadiva* COLLECTED FROM GERSOPPA, MUROOR AND KAMALASHILE

Locality	Date	Adult females					Adult males	Neonates	Juveniles	Total
		Total No.	No. pregnant	Wt. of embryos (grams)	Suckling mothers	Lactating females				
Gersoppa	15-3-71	9	5	0.5-1.0 (0.75)	0	0	11	0	0	20
,,	2-6-71	24	0	—	13	6	32	13	1♀, 3♂	73
,,	2-11-71	3	0	—	0	0	5	0	0	8
Muroor	31-5-72	9	0	—	4	5	4	2♀, 2♂	0	17
,,	3-6-72	15	0	—	15	—	0	7♀, 8♂	0	30
Kamalashile	10-4-73	10	7	1.9-3.0 (2.8)	0	0	0	0	0	10
Muroor	23-5-75	5	4	9.9-13.9 (11.4)	1	—	7	1	0	13
,,	16-6-75	38	0	—	38	—	0	18♀, 20♂	0	76
,,	1-6-78	20	0	—	20	—	0	9♀, 11♂	0	40
,,	20-1-79	0	—	—	—	—	0	0	0	0
,,	10-4-79	0	—	—	—	—	0	0	0	0
,,	20-8-79	16	0	—	0	0	15	0	2♀, 4♂	37
Total		149	16	—	91	11	74	91	10	324

The Nislneer colony, where two years study was done, had approximately 500 individuals on 22 April, 1972. On 17 May, 1972 the colony was depleted to about 250 individuals. Three females with neonates and 15 males were collected. On the same night the cave was examined at 20.30 hrs. Six naked neonates with sealed eyelids were clinging to the wall with a spacing of about 30 cm.

Homing:

Eleven bats trapped at Gersoppa on 15 March 1971 were marked by clipping a small triangular piece from the right or left ear. They were released at 8 and 13 miles from Gersoppa at 21 hrs. On 19 March one of the specimen, marked and released at a distance of 8 miles, was recovered. Again on 2 June two specimens released at the same place were recovered.

Discussion

Eleven colonies of *H. lankadiva* were recorded during the present study. The largest colony at Thigadi had about 3000 individuals. The species is as common as *H. speoris* and *H. bicolor*, the other two common species of *Hipposideros* found in the area. Apparently, the species is not so rare as presumed by Brosset (1962). Periodic and year round observations made on some of the colonies have revealed that the species does not stay permanently at one place. Maximum concentration takes place during the breeding season and the males have a tendency to segregate during the late pregnancy and parturition period. Contrary to the observation recorded by Brosset (1962), hibernating colonies were not observed during the study.

The species apparently follows the reproductive pattern of the majority of Microchiroptera (Wimsatt and Trapido 1952) with a mono-estrous restricted breeding season. Grossly visible embryos were first observed in the month of February and the neonates during the later half of May and earlier half of June. This suggests a gestation period of about 5 months. Each female produces only one young at each pregnancy which is generally conceived in the left uterus. While foraging, the females leave behind the neonates in the habitat and pick them up when they return. This is consistent with the observations made on some other species of bats (Bhat *et al.* 1973).

The segregation and migration of bats do not permit the determination of exact sex ratio (Gopalakrishna and Madhavan 1970). During the present study an approximate estimation was done on the suckling neonates and the male-female percentage of 55 to 45 was recorded. This aproximates with the estimation of sex ratio by Abdulali (1949).

Acknowledgements

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A LIST OF TAXA OF INDIAN FERNS NOT INCLUDED IN BEDDOME'S HANDBOOK TO THE FERNS OF BRITISH INDIA AND A SUPPLEMENT TO THE HANDBOOK TO THE FERNS OF BRITISH INDIA[1]

N. C. NAIR[2] AND R. D. DIXIT[3]

A list of additional fern taxa reported from India after the publication of Beddome's Handbook to the Ferns of British India (1883) and its supplement (1892) is provided with the authority of such reports and distribution in India.

It is nearing one hundred years since Beddome, who belonged to the forest service of the then Presidency of Madras from 1856 to 1882 presented a comprehensive summary of all the known Indian species of ferns in his HANDBOOK TO THE FERNS OF BRITISH INDIA, CEYLON AND MALAY PENINSULA (1883). His further observations enabled him to publish a supplement to his Handbook in 1892. After these monumental works several novelties have been discovered from various parts of Indian territory. Information about them and information about the heterosporous Indian ferns which Beddome (1883, 1892) did not include are scattered in numerous publications and the present paper is an attempt to bring together all these informations in the form of a list with its original citation and localities in India to make the task easier for any one who takes up the revision of ferns of India. For new records reported for the first time from India, the publication reporting this is also given in addition to the original citation. The list, which by no means can be claimed to be complete, is arranged in alphabetical sequence. Further additions will be reported subsequently.

In some cases synonyms are also provided to fix the identity.

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[1] Accepted March 1980.
[2] Botanical Survey of India, Southern Circle, Coimbatore-641 003.
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Adiantum indicum Ghatak in Bull. Bot. Surv. India *5*: 71, 1963.
Distribution: Orissa, Bengal.

Adiantum refractum Christ in Bull. Ac. Geogr. Bot. Mans. 1902: 224, 1902; Mehra and Bir in Res. Bull. (N.S.) Panjab Univ. *15* (Pt. I-II): 106, 1964.
Distribution: Lachen Valley, North Sikkim.

Adiantum thalictroides Willd. ex Schl. Abmbr. Pl. 5: 53, 1832; Nair et Ghosh in Journ. Bomb. nat. Hist. Soc. *75*: 246, 1978.
Distribution: Peninsular India.

Adiantum zollingeri Mett. ex Kuhn. in Ann. Mus. Lugd. Bot. *4*: 280, 1869; Ghatak in Bull. Bot. Surv. India *5*: 75. 1963.
Distribution: South India.

Alsophila henryi Bak. in Bull. Misc. Inf. Kew. 1898: 229, 1898. *Cyathea henryi* (Bak.) Copel. in Philipp. Journ. Sci. Bot. *4*: 38, 1909; Holtt. in Kew Bull. *19*: 478, 1965.
Distribution: Sikkim.

Angiopteris crassipes Wall. (Cat. no. 187. 1828 nomen) ex Presl, Suppl. Tent. Pterid. 23, 1845; Bitter in Engl. Pfl.-fam. 1, *4*: 438, 1900; Nishida in Hara Fl. East. Himal. 454, 1966.
Distribution: Ghorwa Sanichare.

Angiopteris salicifolia (Presl) de Vries, Monogr. 34, 1853: Bitter in Engl. Pfl.-fam. 1, *4*: 439, 1900; Nishida in Hara Fl. East. Himal. 454, 1966. *Psilodochea salicifolia* Presl, Suppl. Tent. Pterid. 28, 1845.
Distribution: Darjeeling.

Angiopteris wallichiana Pr. Suppl. 22, 1845; de Vries, Monogr. 27, 1853.
Distribution: Himalayas.

Angiopteris wightiana de Vries, Monogr. 28, 1853.
Distribution: India (Peninsula)

Antrophyum callifolium Bl. Enum. Pl. Java 111, 1828; Dixit et Nair in Journ. Indian Bot. Soc. *53*: 283, 1974.
Distribution: South Andamans.

Antrophyum henryi Hieron, in Hedw. 57: 208, 1915; Dixit et Nair in Journ. Indian Bot. Soc. *53*: 281, 1974.
Distribution: Arunachal Pradesh, Sikkim.

Arachniodes assamica (Kuhn) Ching. Acta Bot. Sin. *10*: 256, 1962. *Aspidium assamicum* Kuhn. Linn. *36*: 108, 1869. *Polystichopsis assamica* (Kuhn) Tagawa in Journ. Jap. Bot. *33*: 94, 1958. *Byrsopteris assamica* (Kuhn) Morton in Amer. Fern. Journ. *50*: 153, 1960.
Distribution: Assam.

Arachniodes carvifolia (Kunze) Ching in Act. Bot. Sin. *10*: 256, 1962; Nair in Bull. Bot. Surv. India 11: 186, 1969. *Aspidium carvifolium* Kunze in Bot. Zeit. 283, 1848, *Rumohra carvifolia* Ching in Sinensia 5: 60, 1934.
Distribution: Eastern India.

Araiostegia beddomei (Hope) Ching in Chien et Chun Fl. Republ. Pop. Sin. 2: 288, 1959; Panigr. in Bull. Bot. Surv. India 2: 313, 1960. *Davallia beddomei* Hope in Journ. Bomb. nat. Hist. Soc. *12*: 527, 1899.
Distribution: E. India.

Araiostegia perdurans (Christ) Copel. in Univ. Calif. Publ. Bot. *12*: 400, 1931; Ito in Hara Fl. East. Himal. 468, 1966. *Davallia perdurans* Christ in Bull. Herb. Bioss. *6*: 970, 1898.
Distribution: Himalayas.

Arthromeris lungtauensis Ching in Contr. Inst. Bot. Nat. Acad. Peiping 2: 98, 1933; Tagawa in Fl. East. Himal 490, 1966.
Distribution: E. Himalaya.

Arthromeris jarrettii Sastry et Chowdhury in Bull. Bot. Surv. India 11: 442, 1969.
Distribution: Subansiri District, N.E.F.A.

Asplenium affine Sw. forma **majus** Sledge in Kew Bull. 15: 408, 1962.
Distribution: South India.

Asplenium crinicaule Hance var. **sikkimense** Bir in Journ. Indian Bot. Soc. 43: 564, f. 9-12, 1964.
Distribution: Eastern Himalaya.

Asplenium decrescens Kunze, Linn. 24: 261, 1851.
Distribution: Nilgiri.

Asplenium elasticum Fee, Gen. 196, 1850-1852.
Distribution: India.

Asplenium falcatum Lam. var. **bipinnatum** Sledge in Bull. Brit. Mus. (Nat. Hist.) Bot. 3: 262, 1965.
Distribution: Western Ghats.

Asplenium indicum Sledge in Bull. Brit. Mus. (Nat. Hist.) 3: 264, 1965. *Asplenium planicaule* Wall. ex Mett. in Abhandl. Senckenb. Naturforsch. Ges. 3: 201, 1859 (non Lowe, 1858). *Asplenium laciniatum* sensu Bedd. Handb. Ferns Brit. India 154, 1883 pro parte non D. Don.
Distribution: Kerala, Kumaon to Assam.

Asplenium khasianum Sledge in Kew Bull. *15*: 397, 1962.
Distribution: E. Himalayas.

Asplenium laciniatum Don var. **acutipinna** Bir in Journ. Indian Bot. Soc. *43*: 558, f. 5-6, 1964.
Distribution: Darjeeling, Sikkim, N.E.F.A., Himalaya, South India.

Asplenium laciniatum Don var. **subintegrifolium** Hook. Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. 15: 157, 1964; Bir in Journ. Indian Bot. Soc. *43*: 558, f. 3-4, 1964.
Distribution: Darjeeling, North Sikkim.

Asplenium nidus Linn. var. **acutifolium** Bir in Journ. Indian Bot. Soc. *43*: 567, 1964.
Distribution: Sikkim.

Asplenium nitidum Sw. Syn. Fil. *84*: 280, 1806; Sledge in Bull. Brit. Mus. (Nat. Hist.) Bot. 3: 265, 1965. *Asplenium glaucophyllum* Alderw. van Rosenb. in Bull. Jard. Bot. Buitenz. Ser. 2, *7*: 6, 1912; Holtt. in Fl. Mal *2*: 440, 1954.
Distribution: South India, Himalayas.

Asplenium obscurum Blume, Enum. Pl. Jav. 2: 181, 1828; Sledge in Bull. Brit. Mus. (Nat. Hist.), Bot. *2*: 247, 1965. *Asplenium cristatum* Wall. Cat. 9. n, 211, 1829 nomen (non Lam. 1786).
Distribution: Nilgiri and Palni Hills and North India.

Asplenium paucivenosum (Ching) Bir in Bull. Bot. Surv. India *4*: 3, 1962; Mehra et Bir in Res. Bul. (N.S.) Panjab Univ. 15: 159, 1964. *Ceterach paucivenosa* Ching in Bull. Fan. Mem. Inst. Biol. *2*: 210, t. 28, 1931. *Ceterachopsis paucivenosa* Ching in Bull. Fan. Mem. Inst. Biol., Bot. Ser. *10*: 9, 1940.
Distribution: Darjeeling, North Sikkim.

Asplenium paucivenosum (Ching) Bir forma **majus** Bir in Amer. Fern. Journ. *62*: 46, 1972.
Distribution: Darjeeling, Sikkim.

Asplenium perakense Matthew et Christ, Journ. Linn. Soc. *39*: 214, 1909; Panigr. in Bull. Bot. Surv. India *2*: 314, 1960.
Distribution: E. India.

Asplenium planicaule Wall. var. **obtusa** Bir in Journ. Indian Bot. Soc. *43* (4): 561, f. 8, 1964.
Distribution: Darjeeling, North Sikkim, Shillong, Cherrapunjee, Orissa.

Asplenium planicaule var. **yoshinagae** (Mak.) Tagawa., Bir in Journ. Indian Bot. Soc. 43: 562, 1964. *A. yoshinagae* Mak. Phan. Pter. Jap. Ic. 3, t. 64, 1900.
Distribution: Himalayas.

Asplenium pseudolaserpitiifolium Ching ex Tardieu et Ching in Notul. Syst. (Paris) *5*: 150, 1936; Ito in Hara Fl. East. Himal. 488, 1966.
Distribution: Himalayas.

Asplenium rockii C. Chr. Contrib. U. S. Nat. Herb. *26*: 332, t. 27, 1931 et Ind. Fil. Suppl.

3: 37, 1934; Balkr. et Hazra in Bull. Bot. Surv. India *6*: 315, 1964.
Distribution: Assam, Andhra Pradesh.

Asplenium sarelii Hook. in Blakiston, Five months on the Yangtsze 363, 364, 1862; Bir et Sukla in Nova Hedwig. *16:* 477, 1968. *Asplenium saulii* Baker in Hook. et Baker Syn. Fil. ed. 2: 216, 1874; Hope in Journ. Bomb. nat. Hist. Soc. *13*: 661, t. 18, 1901 (excl. Syn. *A. pekinense* Hance).
Distribution: N. W. India.

Asplenium tenerum Forst. f., Florul. Ins. Austr. Prodr. 80, 1786; Sledge in Bull. Brit. Mus. (Nat. Hist.), Bot. *3*: 253, 1965. *Asplenium elongatum* Sw. Syn. Fil. 79, 1806; Hook. Sp. Fil. *3*: 117. 1860.
Distribution: South India.

Asplenium unilaterale Lam. var. **majus** (C. Chr.) Sledge in Bull. Brit. Mus. (Nat. Hist.) Bot. *3*: 246, 1965.
Distribution: North and south India.

Asplenium unilaterale Lam. var. **unilaterale** Mehra & Bir in Res. Bull. (N.S.) Panjab Univ. *15*: 157, 1964.
Distribution: North Sikkim.

Athyrium crenatum (Sommerf.) Rupr. ex Nyland. Spicil. Pl. Fenn. *2*: 14, 1844; Stewart, Bull. Torr. Bot. Club, *72*: 413, 1945. *Aspidium crenatum* Sommerf. vet. Ak. Handl. 1834: 104, 1835.
Distribution: Himalayas.

Athyrium aff. **flabellulatum** (Clarke) Tard-Blot.; Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. *15*: (Pt. I-II), 140, 1964.
Distribution: North Sikkim.

Athyrium himalaicum R. C. Ching ex Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. *15* (Pt. I-II): 137, 1964.
Distribution: North Sikkim, Eastern Himaayas.

Athyrium mackinnoni (Hope) C. Chr. Ind. Fil. 143: 1905; Stewart in Bull. Torr. Bot. Club 72: 414, 1945; Journ. Indian Bot. Soc. *30*: 139. 1951. *Asplenium mackinnoni* Hope in Journ. Bot. 34: 124, 1896; Journ. Bomb. nat. Hist. Soc. *14*: 122, 1902.
Distribution: Trans-Indus to Sikkim, Pahlgam.

Athyrium mehrae Bir in Nov. Hedw. *4*: 165; 1962; Mehra & Bir in Res. Bull. (N.S.) Panjab Univ. *15* (Pt. I-II): 140, 1964.
Distribution: Sikkim.

Ahyrium nigripes (Bl.) T. Moore Ind. Fil. 39, 1857; 98, 1858; Sledge in Ann. Mag. Nat. Hist. Ser. 12, 9: 454, t. 14, 1956; et Bull. Brit. Mus. Nat. Hist. 2: 285, 1962. *Aspidium nigripes* Bl. Enum. Pl. Jav. *2*: 162, 1828. *Asplenium nigripes* (Bl.) Hook. Sp. Fil. 3: 222, 1860; Hope in Journ. Bomb. nat. Hist. Soc. *14*: 119, 1902.
Distribution: Assam, Sikkim, Nilgiris.

Athyrium puncticaule (Bl.) Moore, Ind. Fil. 186, 1860; Sledge in Bull. Brit. Mus. Nat. Hist. Bot. *2*: 288, 1962.
Distribution: South India.

Athyrium rupicola (Hope) C. Chr. Ind. Fil. 145, 1905; Stewart in Bull. Torr. Bot. Club 72: 414, 1945. *Asplenium rupicola* Hope in Journ. Bomb. nat. Hist. Soc. *12*: 531, t. 5. 1899.
Distribution: Kashmir to Kumaon, Punjab, Simla.

Athyrium setiferum C. Chr. Ind. Fil. 146, 1905. *Asplenium tenellum* Hope in Journ. Bomb. nat. Hist. Soc. *12*: 529, t. 4, 1899 (non Roxb. 1816 nee Fee 1850-52).
Distribution: Himalayas, W. Nepal.

Athyrium solenopteris (Kunze) T. Moore var. **pusillum** (Kunze) T. Moore Ind. Fil. 187, 1860; Sledge in Ann. & Mag. Nat. Hist. Ser. 12, 9: 457, t. 15, 1956; et Bull. Brit. Must. Nat. Hist. 2: 287, 1962; Bir et Vasudeva in Journ. Bomb. nat. Hist. Soc. 68: 186, 1971.
Distribution: Nilgiris.

Athyrium subtriangulare (Hook.) Bedd. var. **sikkimense** Bir in Nova Hedw. *4*: 168, f. 9-11, 1962; Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. *15*: 143, 1964.
Distribution: North Sikkim.

Azolla imbricata (Roxb.) Nakai in Bot. Mag. Tokyo *39*: 185, 1925; Ito in Hara Fl. East. Himal. 500, 1966. *Salvinia imbricata* Roxb. ex Griff. in Calcutta Journ. *4*: 470, 1844.
Distribution: E. Himalaya.

Azolla pinnata R. Br. Prod. Fl. N. Holl. 167, 1810; Bak. Handb. 138, 1887; Eng. et Prantl No fl. 401, 1902; Tiwari in Journ. Indian Bot. Soc. *43*: 451, 1964; Panigr. in Bull. Bot. Surv. India *2*: 1960.
Distribution: Madhya Pradesh, Orissa, E. India.

Belvisia mucronata Sledge in Bull. Brit. Mus. Nat. Hist. Bot. *2*: 140, 1960.
Distribution: Western Ghats, Eastern India.

Bolbitis deltigera (Wall. ex Clarke) C. Chr. Ind. Fil. Suppl. *3*: 46, 1934; Nayar et Kaur, Bull. Nat. Bot. Gard. Lucknow *88*: 41, 1964. *Meniscium deltigerum* Wall. Cat. 59, 1828 ex Clarke in Trans. Linn. Soc. 2, Bot. 1: 572, 1880. *Campium deltigerum* (Wall. ex Clarke) Copel. in Phil. Journ. Sci. *37*: 387, f. 38, 1928.
Distribution: N. E. India.

Bolbitis kanarensis Nayar et Chandra in Amer. Fern. Journ. *54*: 19, 1964; Nayar and Kaur in Bull. Nat. Bot. Gard. Lucknow *88*: 48, 1964.
Distribution: Western slopes of the Western Ghats in Belgaum-Goa Region.

Bolbitis semicordata (Moore) Ching var. **incisa** Nayar et Chandra in Amer. Fern. Journ. *54*: 15, 1964; Nayar et Kaur in Bull. Nat. Bot. Gard. Lucknow *88*: 61, 1964.
Distribution: Kerala, North Kanara.

Bolbitis undulata (Wall.) Ching in C. Chr. Ind. Fil. Suppl. *3*: 50, 1934; Nayar et Kaur Comp. Bedd. Handb. Ferns Brit. India 102, 1974, *Notholaena undulata* Wall. Cat. 140, 1828.
Distribution: N. E. India.

Bolbitis virens (Wall. ex Hook. et Grev.) Schott. Gen. Fil. ad. t. 14. 1834; Nayar et Kaur in Bull. Nat. Bot. Gard. Lucknow *88*: 71, 1964. *Acrostichum virens* Wall. ex Hook. et Grev. Icon. Fil. t. 221, 1831. *Leptochilus virens* (Wall. ex Hook. et Grev.) C. Chr. Ind. Fil. 288, 1906.
Distribution: Western Ghats, Sikkim, Burma, Siam.

Botrychium daucifolium Wall. ex Hook. et Grev. var. **parvum** v. A. v. R. in Bull. Jard. Bot. Buitenz. *1*: 3, 1911; Suppl. Malayan Ferns 445, 1916. *Scepteridium daucifolium* Wall. ex Hook. et Grev. var. *parvum* (v. A. v. R.) Nishida in Journ. Jap. Bot. *41*: 319, 1966.
Distribution: Himalayas.

Botrychium lanuginosum Wall ex Hook. et Grev. var. **nepalense** (Nishida) Nair et Dixit comb. nov. *Japanobotrychium lanuginosum* (Wall.) Nishida ex Tagawa var. *nepalense* Nishida in Journ. Jap. Bot. *41*: 319, 1966.
Distribution: Himalayas.

Botrychium multifidum (Gmel.) Rupr. Beitr. Zur. Pflanzenkunde de Russ. Reiches. 11: 40, 1859; Panigr. et Dixit in Bull. Bot. Surv. India 9: 286-287, 1967, ssp. *multifidum*. *Osmunda multifida* Gmel. Nov. Comment, Acad. Petrop. *12*: 517, 1768. *Botrychium multifidum* var. *dichotomum* Farwell in Rep. Mich. Acad. Sci. 18: 87, 1916. *Sceptridium multifidum* (Gmel.) Nishida var. *multifidum* ex Tagawa in Journ. Jap. Bot. *33*: 200, 1958.
Distribution: Sikkim: Lachen Valley.

Cheilanthes dubia Hope in Journ. Bomb. Nat. Hist. Soc. 12: 528, 1899. *Aleuritopteris dubia* (Hope) Ching in Hong Kong Nat. *10*: 200, 1941.
Distribution: Dehra Dun and Mussorie.

Cheilanthes hancockii Bak. in Kew Bull. 1895: Ito in Hara Fl. East. Himal. 460, 1966.
Distribution: Himalayas, Kalimpong, Gangtok.

Cheilanthes keralensis Nair et Ghosh in Journ. Indian Bot. Soc. *55*: 52, 1976.
Distribution: Kiripara, Kanyakumari Dist.

Cheilanthes kuhnii Milde in Bot. Zeit. *25*: 149, 1867; Ito in Hara Fl. East. Himal. 460, 1966. *Aleuritopteris kuhnii* (Milde) Ching in Bull. Fan. Mem. Inst. Biol. Ser. 2, *1*: 272. 1949.
Distribution: Himalayas.

Christella harveyi (Mett.) Holtt. in Kew Bull. *31*: 306, 1976. *Aspidium harveyi* Mett. in Kuhn, Linnaea *36*: 115, 1869.
Distribution: Indian Botanic Garden, Calcutta (1972) under *Lastrea richardsii* var. *multifida* T. Moore.

Christella hokouensis (Ching) Holtt. in Kew Bull. *31*: 327, 1976. *Cyclosorus hokouensis* Ching in Bull. Fan. Mem. Inst. ser. 2, 1: 289, 1949. *Thelypteris hokouensis* (Ching) Reed in Phytologia *17*: 283, 1968.
Distribution: South Lushai.

Christella kumaunica Holtt. in Kew Bull. *31*: 318, 1976.
Distribution: Kumaun.

Christella lebeufii (Baker) Holtt. in Nayar et Kaur, Comp. Bedd. Handb. Ferns Brit. India with Suppl. 206, 1974 et Kew Bull. *31*: 332, 1976. *Polypodium lebeufii* Baker in Ann. Bot. 5: 461, 1891. *Dryopteris lebeufii* (Baker) C. Chr. Ind. Fil. 274, 1905. *Thelypteris lebeufii* (Baker) Panigr. in Notes Roy. Bot. Gard. Edinb. *33*: 498, 1975.
Distribution: Assam.

Christella malabariensis (Fèe) Holtt. in Kew Bull. 31: 317, 1976. *Nephrodium malabariense* Fèe 10 c Mem. 43, 1865. *Thelypteris malabariensis* (Fèe) Panigr. in Notes Roy. Bot. Gard. Edinb. *3*: 497, 1975. *Cyclosorus meeboldii* (Resenst.) Ching in Bull. Fan. Mem. Inst. Biol. Bot. *8*: 210, 1938. *Dryopteris meeboldii* Resenst. in Fedde, Report. *12*: 247, 1913. *Christella meeboldii* (Rosenst.) Holtt. in Nayar et Kaur, Comp. Bedd. Handb. Ferns Brit. India with suppl. 208, 1974.
Distribution: Southern India and North East India.

Christella papilio (Hope) Holtt. in Nayar et Kaur, Comp. Bedd. Handb. Ferns Brit. India with Suppl. 208, 1974 et Kew Bull. *31*: 322, 1976. *Nephrodium papilio* Hope in Journ. Bomb. Nat Hist. Soc. *12*: 625, t. 12, 1899. *Dryopteris papilio* (Hope) C. Chr. Ind. Fil. 282, 1905. *Cyclosorus papilio* (Hope) Ching in Bull. Fan Mem. Inst. Biol. Bot. *8*: 214, 1938. *Thelypteris papilio* (Hope) Iwats. in Mem. Coll. Sci. Univ. Kyoto B *31*: 175, 1965.
Distribution: Darjeeling, South India.

Christella semisagittata (Roxb.) Holtt. in Kew Bull. 31: 334, 1976. *Polypodium semisagittatum* Roxb. in Calcutta Journ. Nat. Hist. *4*: 491, 1844. *Thelypteris semisagittata* (Roxb.) Morton in Contrib. U.S. Nat. Herb. *38*: 360, 1974.
Distribution: Bengal, Assam.

Christella siamensis (Tagawa et Iwats.) Holtt. in Kew Bull. *31*: 332, 1976. *Thelypteris siamensis* Tagawa et Iwats. in Acta Phytotax. Geobot. *22*: 101, fig. 5, 1967.
Distribution: North-East India.

Christella subelata (Bak.) Holtt. in Kew Bull. *31*: 331, 1976. *Nephrodium subelatum* Bak. in Bull. Misc. Inf. Kew 1906: 11, 1906. *Nephrodium multilineatum* var. *assamicum* Bedd. in Journ. Bot. 31: 228, 1893. *Christella assamica* (Bedd.) Noltt. in Nayar et Kaur. Comp. Bedd. Handb. Ferns Brit. India with Suppl. 210, 1974.
Distribution: Assam.

Christella subpubescens (Bl.) Holtt. in Webbia 00: 000, 1976 et Kew Bull. *31*: 323, 1976.

Aspidium subpubescens Bl. Enum. Pl. Jav. 149, 1828.
Distribution: North-east India.

Christella zeylanica (Fèe) Holtt. in Nayar et Kaur, Comp. Bedd. Handb. Ferns Brit. India with Suppl. 208, 1974; et Kew Bull. 31: 334, 1976. *Nephrodium zeylanicum* Fèe, 10 e, Mem. 42, 1865. *Thelypteris srilankensis* Panigrahi in Notes Roy. Bot. Gard. Edinb. 33: 499, 1975. *Nephrodium extensum* var. *minor* Bedd. Ferns Brit. India t. 201, 1866.
Distribution: Nicobar.

Colysis latiloba (Ching) Ching in Bull. Fan. Mem. Inst. Biol. *4*: 330, 1933; Tagawa in Hara Fl. East. Himal. 490, 1966. *Polypodium latifolium* Ching in Bull. Fan. Mem. Inst. Biol. *2*: 21, Pl. 7, 1931.
Distribution: Himalaya and Assam.

Colysis macrophylla (Bl.) Presl Epim. Bot. 147, 1849; Thothathri *et al.* in Journ. Bomb. nat. Hist. Soc. 74: 249, 1977. *Grammitis macrophylla* Bl. Enum. Pl. Java 119, 1828.
Distribution: Great Nicobar Islands.

Colysis pothifolia (Hamilt. ex D. Don) Ito in Journ. Jap. Bot. *11*: 89, 1935. *Hemionitis pothifolia* Hamilt. ex D. Don Prodr. Fl. Nepal 13, 1825.
Distribution: E. India.

Colysis selliguea (Mett.) Ching in Sunyats. *5*: 261, 1940; Thothathri *et al.* in Journ. Bomb. nat. Hist. Soc. *74*: 251, 1977. *Polypodium selliguea* Mett. Pol. III: 214, 1857.
Distribution: Great Nicobar Islands.

Coniogramme caudata (Wall.) Ching in C. Chr. Ind. Fil. Suppl. III. 56, 1934; Ito in Hara Fl. East. Himal. 460, 1966. *Grammitis caudata* Wall. Cat. no. 4, 1828 (nomen nudum). *Coniogramme pubescens* Hieron, in Hedwig. 57, 314, 1916.
Distribution: Darjeeling, Himalayas.

Coniogramme falcata (Don) Salom, Nomenel. 139, 1888; Dixit et Das in Journ. Indian Bot. Soc. *56*: 255, 1977. *Diplazium falcatum* Don, Prodr. Nepal 13, 1825.
Distribution: Naga Hills, Arunachal Pradesh, Sikkim.

Coniogramme indica Fee. Mem. Fam. Foug. *10*: 22, 1865.
Distribution: Eastern India.

Coniogramme intermedia Hieron. in Hedw. 57: 301, 1916. var. **glabra** Ching, Ic. Fil. Sin. *4*: 143, 1935; Ito in Hara Fl. East. Himal. 461, 1966.
Distribution: Himalayas, Darjeeling.

Coniogramme intermedia Hieron. in Hedw. 57: 301, 1916 var. **villosa** Ching, Icon. Fil. Sin. *4*: t. 143, 1935; Ito in Hara Fl. East. Himal. 461, 1966.
Distribution: North Sikkim, N. India.

Coniogramme petelotii Tard.-Blot., Mus. Paris II, *5*: 334, 1933; Dixit et Das in Journ. Indian Bot. Soc. 56: 257, 1977. *C. subcordata* Ching in Fan Mem. Inst. Biol. *2*: 213, 1913 (non Copel. 1910).
Distribution: Meghalaya.

Coniogramma subcordata Copel. Leaflets Phil. Bot. 3: 823, 1910; Hieron, Hedw. 57: 326, 1916; Dixit et Das in Bull. Bot. Surv. India *17*: 185, 1975 (1978).
Distribution: Darjeeling, Sikkim.

Cornopteris biri Ching ex Bir in Nova Hedw. *7*: 502, 1964.
Distribution: Sikkim.

Crepidomanes bilabiatum (Nees et Bl.) Copel. Philip. Journ. Sci. *67*: 59, 1938; Sledge in Journ. Linn. Soc. Bot. *60*: 306, 1968. *Trichomanes bilabiatum* Nees et Bl. Nova Acta *11*: 123, 1823.
Distribution: S. India.

Crepidomanes latealatum (van den Bosh) Copel. in Philip. Journ. Sci. *67*: 60, 1938; Iwats. in Hara Fl. East. Himal. 456, 1966. *Didymoglossum latealatum* van den Bosch. in Ned. Kruid. Arch. *5*: 138, 1863; Copel. in Philip. Journ. Sci. *51*: 192, 1933.
Distribution: Endemic to Sikkim Himalaya.

Crypsinus chrysotrichus (C. Chr.) Tagawa in Acta Phytotax. Geobot, *14*: 193, 1952; Balak. et Chowdh. in Sci. & Cultr. *33*: 62, 1967. *Polypodium chrysotrichum* C. Chr. in Contrib. U.S. Nat. Herb. *26*: 320, t. 31, 1931.
Distribution: Himalayas.

Crypsinus echinoporous (Tag.) Tagawa in Acta Phytotax. Geobot. *14*: 193, 1952; Nishida in Journ. Coll. Arts & Sci. Chiba Univ. *4* (4): 579, 1966. *Phymatodes echinospora* Tagawa in Acta Phytotax. Geobot. *3*: 95, 1934.
Distribution: Himalayas.

Crypsinus engleri (Luerss.) Copel. Gen. Fil. 206, 1947; Nishida in Journ. Coll. Arts & Sci. Chiba Univ. *4*: 579, 1966. *Polypodium engleri* Luerssen in Engl. Jahrb. *4*: 361, 1883.
Distribution: Himalayas.

Crypsinus montanus Sledge in Bull. Brit. Mus. (Nat. Hist.) Bot. *2*: 145, 1960.
Distribution: South India.

Crypsinus quasidivaricatus (Hayata) Copel. Gen. Fil. 206, 1947; Tagawa in Hara Fl. East Himal. 492, 1966. *Polypodium divaricatum* Hayata in Bot. Mag. Tokyo *23*: 78, 1909; (non Fourn. 1872. *Polypodium quasidivaricatum* Hayata, Mat. Fl. Formos. 446, 1911, based on *Polypodium divaricatum* Hayata. *Phymatodes quasidivaricata* (Hayata) Ching in Contr. Inst. Bot. Nat. Acad. Peiping *2*: 83, 1933.
Distribution: Himalayas.

Crypsinus yakushimensis (Mak.) Tagawa in Acta Phytotax, Geobot. *14*: 194, 1952; Nishida in Journ. Coll. Arts & Sci. Chiba Univ. *4*: 579, 1966. *Polypodium engleri* Luers. var. *yakushimense* Makino in Bot. Mag. Tokyo *23*: 248, 1909.
Distribution: Himalayas.

Cyclosorus cylindrothrix (Rosenst.) Ching in Bull. Fan. Mem. Inst. Biol. Bot. *8*: 199, 1938; Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. *15* (Ph. I-II): 154, 1964. *Dryopteris cylindrothrix* Rosenst. Fedde Repert. Sp. Nov. 12: 346, 1913.
Distribution: Darjeeling.

Cyclosorus occultus (Hope) Ching in Bull. Fan. Mem. Inst. Biol. Bot. *8*: 228, 1938. *Nephrodium occultum* Hope in Journ. Bomb. nat. Hist. Soc. 12: 627, 1899.
Distribution: Tehri Garhwal.

Cyclosorus papilio (Hope) Ching in Bull. Fan. Mem. Inst. Biol. Bot. *8*: 214, 1938; Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. *15:* 154, 1964. *Nephrodium papilio* Hope in Journ. Bomb. nat. Hist. Soc. *12*: 625, t. 12, 1899 and *14*: 747, 1903.
Distribution: Darjeeling, North Sikkim.

Cyclosorus polycarpus (Bl.) Holtt. in Fl. Mal. *2*: 283, 1954; Thothathri *et al.* in Journ. Bomb. nat. Hist. Soc. *74*: 251, 1977. *Aspidium polycarpon* Bl. Enum. 156, 1828.
Distribution: Great Nicobar Islands.

Cystopteris dickieana R. Sim. in Gardn. & Farmers Journ. 308, 1848; Alston et Bonner in Amer. Fern Journ. *41*: 76, 1951 et Candollea *15*: 212, 1965; Bir et Trikha in Nov. Hedw. *24*: 22, 1974. *Cystopteris fragilis* subsp. *eufragilis* var. *baenitzeii* (Dorfl.) Warnst. in Aschers. Graebn. Syn. Mit. Eur. Fl. *1*: 17, 1896. *Cystopteris baenitzeii* Dorfler in Baenitz, Herb. Eur. n. 6510, 1891.
Distribution: Kashmir.

Cystopteris fragilis forma **granulosa** Bir et Trikha in Amer. Fern. Journ. *66*: 109, 1976.
Distribution: Himachal Pradesh, Kashmir.

Cystopteris fragilis forma **himalayensis** Bir et Trikha in Amer. Fern. Journ. *66*: fig. 3A, 3B, 1976.
Distribution: Gulmerg (Kashmir).

Cystopteris sikkimensis R. C. Ching ex Bir in Nova Hedw. 7:504, 1964; Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. *15* (Pt. I): 136, 1964.

Distribution: North Sikkim.

Dicranopteris linearis (Burm. f.) Underw. var. **altissima** Holtt. in Reinw. *4*: 276, 1957; Panigr. et Dixit in Sen. Mem. Vol. Bot. Soc. Bengal 475, 1969.

Distribution: Arunachal, Assam, Shillong, Lakhimpur, Khasia and Jaintia Hills, Louwlyndoh, Madhya Pradesh, Nilgiri, Malabar.

Dicranopteris linearis (Burm. f.) Underw. var. **demota** Holtt. in Reinw. 4: 275, 1957; Panigr. et Dixit in Sen. Mem. Vol. Bot. Soc. Bengal 475, 1969.

Distribution: Sikkim, Darjeeling (Lloyd Botanic Garden), Kurseong.

Dicranopteris linearis (Burm. f.) Underw. var. **latiloba** Holtt. in Reinw. 4: 277, 1957; Panigr. et Dixit in Sen. Mem. Vol. Bot. Soc. Bengal 474, 1969.

Distribution: Subansiri, Amji to Palin, Siang, Pang to Minguing, Kameng, Tirap, Shillong, Pongging to Jaru Hills, Duphla Hills, Khasia and Jaintia Hills.

Dicranopteris linearis (Burm. f.) Underw. var. **subferruginea** (Hieron.) Nakai in Bull. Nat. Sci. Mus. Tokyo 29: 66, 1950; Panigr. et Dixit in Sen. Mem. Vol. Bot. Soc. Bengal 472, 1969.

Distribution: Tirap, Laju Hills, Subansiri, Apatnang Valley, Assam, Khasia and Jaintea Hills, Kumaon, Nilgiri.

Dicranopteris linearis (Burm. f.) Underw. var. **sebastiana** Panigr. et Dixit in Bull. Bot. Surv. India 13: 162, 1971 (1973).

Distribution: Nilgiri, Madurai.

Dicranopteris linearis (Burm. f.) Underw. var. **subpectinata** (Christ) Holtt. in Reinw. 4 : 277, 1957; Panigr. et Dixit in Sen. Mem. Vol. Bot. Soc. Bengal 474, 1969. *Gleichenia subpectinata* Christ in Bot. Tidsskr. 25: 111, 1901; *Dicranopteris warburgii* (non *Gleichenia warburgii*) sensu Nakai in Bull. Nat. Sci. Mus. Tokyo 29, 1950; Ito in Hara Fl. East Himal. 456, 1966. *Gleichenia linearis* var. *alternana* sensu Holtt. (non Mett.) Fl. Mal. 2: 70, 1954.

Distribution: Andaman Islands, Himalayas.

Diplazium donianum (Mett.) Tardieu—Blot, Aspl. du Tonkin 58, t. 5, 1932; C. Chr. Ind. Fil, Suppl. 3: 73, 1934. *Asplenium donianum* Mett. Aspl. 177 no. 198 b, 1858. *Diplazium splendens* Ching in Bull. Fan, Mem. Inst. 2: 205, t. 21, 1931.

Diplazium polypodioides Bl. var. **brachylobum** Sledge in Bull. Brit. Mus. Nat. Hist. 2: 307. 1962.

Distribution: South India.

Diplazium simplicivenium Holtt. in Gard. Bull. Str. Settl. 11: 100-101, 1940; Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. 15 (I-II): 147, 1964. *Athyrium simplicivenium* (Holtt.) Holtt. Fl. Mal. 2: 573, 1954.

Distribution: North Sikkim.

Diplazium squamigerum (Mett.) Christ in Bull. Soc. Fr. 52, Mem. 1: 51, 1905; Stewart in Bull. Torr. Bot. Club 72: 416, 1945; Journ. Indian Bot. Soc. *30*: 139, 1951. *Asplenium squamigerum* Mett. in Ann. Lugd. Bot. *2*: 239, 1866; Hope in Journ. Bomb. nat. Hist. Soc. *14*: 259, 1902.

Distribution: North India, Pahlgam.

Diplazium sylvaticum (Bory) Sw. Synops. Fil. 92, 1806; Sledge in Bull. Brit. Mus. Nat. Hist. 2: 301, 1962 *Callipteris sylvatica* Bory in Voy. Mers. Afr. *1*: 282, 1804. *Atlantodia pinnata* Blanco in Fl. Filip. ed. 2, 571, 1845. *Athyrium pinnatum* (Blanco) Copel. in Philipp. Journ. Sci. Sect. C. 3, 297, 1908.

Distribution: North and South India.

Diplazium viridissimum Christ in Not. Syst. *1*: 45, 1909; Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. *15* (I-II): 147, 1964. *Athyrium macrosorum* Copel. in Leaflet Philip. Bot. *3*: 815, 1910.

Distribution: Lebong, Darjeeling.

Doodia dives Kunze, Bot. Zeit. 144, 1848; Bedd. Handb. Ferns Brit. India 137, 1883;

Bharg. in Bull. Bot. Surv. India *15*: 281, 1973.
Distribution: Nilgiri Dist.

Drymotaenium miyoshianum Makino in Bot. Mag. Tokyo *15*: 109, 1901; Dixit et Nair in Journ. Indian Bot. Soc. *54*: 256-258, figs. 1-6, 1975.
Distribution: E. India.

Dryopteris acutodentata Ching in Bull. Fan. Mem. Inst. Biol. Bot. *8*: 432. 1938. *Nephrodium kingii* Hope [non *Dryopteris kingii* (Bedd.) C. Chr.] in Journ. Bomb. nat. Hist. Soc. *12*: 621, 1899.
Distribution: Northern India.

Dryopteris blanfordii (Hope) C. Chr. Index Fil. 254, 1905; Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. ,*15* (Pt. I-II): 133 1964, Stewart in Bull. Torr. Bot. Club *12*: 405, 1945. *Nephrodium blanfordii* Hope in Journ. Bomb. nat. Hist. Soc. *12*: 624, t. 11, 1899.
Distribution: Darjeeling, Kashmir, Simla, Punjab.

Dryopteris costalisora Tagawa in Act. Phytotax. Geobot. *3*: 88, 1934; Ito in Hara Fl. East. Himal. 476. 476, 1966.
Distribution: E. Himalaya, Darjeeling.

Dryopteris fructuosa (Christ.) C. Chr. Index Fil. 267, 1905; Mehra et Bir in Res. Bull. (N.S.) Punjab Univ. *15* (Pt. I-II): 132, 1964. *Aspidium fructuosum* Christ in Bull. Soc. Fr. *52*: Mem. 1, 38, 1905.
Distribution: Lachen Valley, North Sikkim.

Dryopteris gamblei (Hope) C. Chr. Ind. 267, 1905. *Nephrodium gamblei* Hope in Journ. Bomb. nat. Hist. Soc. *12* (3): 533, 1899.
Distribution: Sikkim, Darjeeling, Assam, Shillong.

Dryopteris harae Ito in Hara Fl. East. Himal. 476, 1966.
Distribution: Sikkim Himalaya (endemic).

Dryopteris hasseltii (Bl.) C. Chr. Ind. Fil. 269, 1905; Ito in Hara Fl. East. Himal. 477, 1966. *Polypodium hasseltii* Bl. Fl. Jav. Fil. 195, t. 92, 1829. *Polystichopsis hasseltii* (Bl.) Holtt. Fl. Mal. *2*: 487, 1954.
Distribution: E. Himalaya (Nepal to Assam).

Dryopteris hexagonoptera (Mich.) C. Chr. Ind. Fil. 270. 1905; Stewart in Bull. Torr. Bot. Club 72: 411, 1945. *Polypodium hexagonopterum* Michx. Fl. Bor. Am. 2: 271, 1803. *Phegopteris hexagonoptera* Fèe, Gen. Fil. 243, 1850-52.
Distribution: Zanscar (a province of Ladak), North of Simla.

Dryopteris hypophlebia Hayata in Icon. Pl. Formos. 416, 1911; Ito in Hara, Fl. East. Himal. 477, 1966.
Distribution: Himalayas.

Dryopteris kawakamii Hayata, Mater. Fl. Formos. 416, 1911; Ito in Hara. Fl. East. Himal. 477, 1966.
Distribution: E. Himalaya.

Dryopteris laterepens (Trotter) C. Chr. Index Fil. 274, 1905; Stewart in Bull. Torr. Bot. Club *72*: 409, 1945. *Polypodium laterepens* Trotter ex Hope in Journ. Bomb. nat. Hist. Soc. *12*: 628, t. 14, 1899.
Distribution: North India.

Dryopteris ramosa (Hope) C. Chr. Ind. 287, 1905; Stewart in Bull. Torr. Bot. Cub. *72*: 406, 1945; Journ. Indian Bot. Soc. *30*: 138, 1951. *Nephrodium ramosum* Hope in Journ. Bot. *34*: 126, 1896; Journ. Bomb. nat. Hist. Soc. *14*: 740, 1903.
Distribution: Kashmir, Punjab.

Dryopteris reflexosquamata Hayata in Icon, Pl. Formos. *4*: 176, f. 114, 1914; Ito in Hara Fl. East. Himal. 478, 1966.
Distribution: Darjeeling, Himalayas.

Dryopteris repens (Hope) C. Chr. Ind. 288, 1905; Stewart in Bull. Torr. Bot. Club. *72*: 408, 1945. *Nephrodium repens* Hope in Journ. Bomb. nat. Hist. Soc. *12*: 535. 1899. *Nephrodium prolixum* Baker in Syn. Fil. 268, 1867.

Distribution: North India—Nepal, Sikkim, Bhutan, Shillong.

Dryopteris squamiseta (Hook.) O. Kuntze, Rev. Gen. Pl. *2*: 813, 1891; Ito in Hara Fl. East. Himal. 479, 1966. *Nephorium squamisetum* Hook. Sp. Fil. *4*: 140, t. 263, 1862.
Distribution: Himalayas.

Dryopteris yunnanensis (Christ) Copel. Gen. Fil. 122, 1947; Ito in Hara Fl. East. Himal. 479, 1966. *Aspidium yunnanense* Christ in Bull. Herb. Boiss. *6*: 965, 1898.
Distribution: Himalayas.

Dryopteris subimpressa Loyal in Nova Hedw. *16*: 467, 1968.
Distribution: Eastern Himalayas (Darjeeling.

Dryopteris submarginata Loyal in Nova Hedw. *16*: 465-466, 1968.
Distribution: Eastern Himalaya (North Sikkim).

Egenolfia keralensis Nayar et Kaur in Bull. Nat. Bot. Gard. *94*: 4, 1964.
Distribution: Kanthalur; Munnar (Kerala); Mercara, Coorg.

Elaphoglossum beddomei Sledge in Bull. Brit. Mus. Nat. Hist. *4*: 88, 1967.
Distribution: Nilgiri, Anamalay and Palghat Hills.

Elaphoglossum marginatum (Wall. ex Fèe) Moore, Ind. Fil. *8*: 11, 1857, 361. 1862; Sledge in Bull. Brit. Mus. Nat. Hist. Bot. *4*: 89, 1967. *Acrostichum marginatum* Wall. ex Fèe in Acrost. 31, 1845.
Distribution: South India.

Elaphoglossum nilgiricum Krajina ex Sledge in Bull. Brit. Must. Nat. Hist. *4*: 94, 1967.
Distribution: Endemic to Nilgiri Hills.

Elaphoglossum stigmatolepis (Fèe) T. Moore, Ind. Fil. *16*: 15, 1857; 368, 1862; Christ in Neue Denkschr. Schw. Ges. Naturw. *36*: 52, 1899; Sledge in Bull. Brit. Mus. Nat. Hist. *4*: 86, 1967. *Elaphoglossum ballardianum* Biswas in Bull. Brit. Mus. Nat. Hist. *4*: 86, 1967. *Elaphoglossum ballardianum* Biswas in Bull. Misc. Inf. Kew *1939*: 239, t. 1, f. 1, 1939.
Distribution: Nilgiri and Pulney Hills.

Elaphoglossum yunnanense (Bak.) C. Chr. Contr. U.S. Nation. Herb. *26*: 327, 1931; Ito, Tagawa et Iwats. in Hara Fl. East. Himal. 479, 1966. *Acrostichum yunnanense* Bak. in Kew Bull. *1898*: 233, 1898.
Distribution: Himalayas.

Gleichenia blotiana C. Chr. Bull. Mus. Hist. Nat. Paris II, *6*: 103, 1934; Panigrahi and Dixit in Bull. Bot. Surv. India *10*: 339, 1968. *Hicriopteris blotiana* Ching in Synyatsenia *5*: 279, 1940. *Diplopterygium blotianum* Nakai in Bull. Nat. Sci. Mus. Tokyo *29*: 49, 1950.
Distribution: Siang, Eyo to Tumbing; Tirap, Kheti-Inchha, Assam.

Gleichenia laevissima Christ in Bull. Ac. Inst. Geogr. Bot. III, *11*: 268, 1902; Panigrahi & Dixit in Bull. Bot. Surv. India *10*: 337, 1968, *Hicriopteris laevissima* Ching in Synyatsenia *5*: 280, 1940. *Diplopterygium laevissima* Nakai in Bull. Nat. Sci. Mus. Tokyo *29*: 52, 1950.
Distribution: Forests of the Eastern India.

Gleichenia volubilis Jung. Reis. Java *1*: 452, 1845; Panigarhi et Dixit in Bull. Bot. Surv. India *10*: 339, 1968. *Gleichenia glauca* var. *arachnoides* C. Chr. Index Fil. 320, 1095. *Hicriopteris volubilis* (Jungh.) Ching in Synyatsenia *5*: 280, 1940. *Diploterygium volubile* (Jungh.) Nakai in Bull. Nat. Sci. Mus. Tokyo *29*: 55, 1950.
Distribution: Assam, Khasi and Jaintia Hills, Mawphlong, Shillong, Bishnupur, Cherrapunji, Darjeeling.

Gonocormus diffusus (Bl.) van den Bosch, Hymen. Jav. 9, 1859; Iwats. in Hara Fl. East. Himal. 456, 1966. *Trichomanes diffusum* Bl. Enum. Pl. Jav. 225, 1828.
Distribution: Himalayas.

Holcosorus bisulcata (Hook.) Ching in Synvatsenia *5*: 265, 1940; Dixit et Nair in Proc. Ind. Acad. Sci. B. *86*: 385-387, 1977. *Grammitis bisulcata* Hook. Ic. Pl. t. 998, 1854.
Distribution: E. India.

Humata heterophylla (Sm.) Desv. Prodr. 323, 1825; Thothathri *et al.* in Journ. Bomb. nat. Hist. Soc. 74: 251, 1977. *Davallia heterophylla* Sm. Mem, Ac. Turin *5*: 415, 1793.
Distribution: Great Nicobar Island.

Idiopteris hookeriana Walker in Kew Bull. 3: 429, 1957.
Distribution: Malabar.

Lepisorus amaurolepidus (Sledge) Bir et Trikha in Bir et Vasudeva, Journ. Bomb. nat. Hist. Soc. *68*: 192, 1971; Bir et Trikha in Amer. Fern. Journ. *64* (2): 60, 1974; Bull. Bot. Surv. India 11: 266, 1969. *Pleopeltis amaurolepida* Sledge in Bull. Brit. Mus. (Nat. Hist.) 2: 136, 1960. *Polypodium gladiatum* Wall. Cat. 279, 1828 (nom. nudum; non *Polypodium gladiatum* Kze. 1834).
Distribution: Himalayas, Central India, South India.

Lepisorus amaurolepidus (Sledge) Bir et Trikha var. **longifolius** Bir et Trikha in Amer. Fern. Journ. *64*: 63, 1974.
Distribution: Nainital, Ranikhet.

Lepisorus angustus Ching in Bull. Fan. Mem. Inst. Biol. *4*: 86, 1933; Bir et Trikha in Bull. Bot. Surv. India *11*: 268, 1969. *Polypodium lineare* var. *thunbergianum* f. *caudatoatteanuata* Takeda in Notes Roy. Bot. Gard. Edinb. 8: 269, 1915. *Polypodium caudato-attenuatum* (Takeda) C. Chr. Ind. Fil. Suppl. III. 146, 1934. *Pleopeltis caudato-attenuata* (Takeda) Panigr. & Patn. in Curr. Sci. *34*: 127, 1965. *Lepisorus thunbergianus* (Kaulf.) Ching var. *angustus* (Ching) Kurata in Sci. Report Yokozuka City Mus. No. 11. 39, 1965.
Distribution: Eastern Himalaya.

Lepisorus contortus (Christ) Ching in Bull. Fan. Mem. Inst. Biol. Bot. *4*: 90, 1933; Bir et Trikha in Bull. Bot. Surv. India *11:* 271, 1969. *Polypodium contortum* Christ in Bot. Gaz. 51: 347, 1911. *Pleopeltis contorta* (Christ) Alston et Bonner in Candollea *15*: 209, 1956.

Lepisorus aff. **excavatus** (Bory) Ching in Mehra et Bir in Res. Bull. Panjab Univ. (N.S.) *15*: 168, 1964.
Distribution: Singhik, North Sikkim.

Lepisorus excavatus (Bory) Ching var. **himalayansis** Bir et Trikha in Amer. Fern. Journ. *64*: 58, 1974.
Distribution: Nainital.

Lepisorus excavatus (Bory) Ching var. **mortonianus** Bir et Trikha in Amer. Fern. Journ. *64*: 56, 1974.
Distribution: Nainital.

Lepisorus excavatus (Bory) Ching var. **scolopendrium** (Ham.) Ching in Bull. Fan. Mem. Inst. Biol. *4*: 69, 1933; Kitamura in Fauna Flora Nep. Himal. *1*: 80, 1952-53.
Distribution: Himalayas.

Lepisorus kashyapii (Mehra) Mehra et Bir in Res. Bull. Panjab Univ. (N.S.) *13*: 23, 1963; Bir et Trikha in Bull. Bot. Surv. India *11*: 271, 1969. *Polypodium kashyapii* Mehra Ferns of Mussoorie, Panjab Univ. Bot. Pub. *7*: 24, Fig. 5, 1939. *Pleopeltis kashyapii* (Mehra) Alston et Bonner in Candollea *15*: 208, 1956.
Distribution: Himalayas.

Lepisorus kuchenensis (Wu) Ching in Bull. Fan. Mem. Inst. Biol. *4*: 69, 1933; Mehra et Bir in Res. Bull. Panjab Univ. (N.S.) *15*: 168, 1964; Bir et Trikha in Bull. Bot. Surv. India *11*: 273, 1969. *Polypodium kuchenensis* Wu in Wu *et al.* Polypod. Yaoshan. 276, t. 129, 1932.
Distribution: Nepal, Sikkim, Darjeeling.

Lepisorus oligolepidus (Baker) Ching in Bull. Fan. Mem. Inst. Biol. *4*: 80, 1933; Bir et

Trikha in Amer. Fern. Journ. *64*: 50, 1974. *Polypodium oligolepidum* Baker in Gardn. Chron. n.s. *14*: 494, 1880.
Distribution: Uttar Pradesh.

Lepisorus oosphaerus (C. Chr.) Ching in Bull. Fan. Mem. Inst. Biol. *4*: 70, 1933; Bir et Trikha in Amer. Fern Journ. *64*: 58, 1974. *Polypodium oosphaerum* C. Chr. Contr. U.S. Nat. Herb. *26*: 334, t. 29, 1931. *Pleopeltis oosphaera* (C. Chr.) Panigr. et Patn. in Proc. Nat. Acad. Sci. India B. *34*: 482, 1964.
Distribution: Lushai Hills.

Lepisorus pseudonudus Ching in Bull. Fan. Mem. Inst. Biol. *4*: 83, 1933; Bir et Trikha in Bull. Bot. Surv. India *11*: 268, 1969. *Pleopeltis pseudonuda* (Ching) Panigr. & Patn. in Curr. Sci. *34*: 127, 1965.
Distribution: Assam, Khasi Hills, Tirap and Mameng.

Lepisorus sordidus (C. Chr.) Ching in Bull. Fan. Mem. Inst. Biol. *4*: 78, 1933; Bir et Trikha in Amer. Fern Journ. *64*: 58, 1974. *Polypodium sordidum* C. Chr. U.S. Nat. Herb. *26*: 320, 1931. *Pleopeltis sordida* (C. Chr.) Panigr. et Patn. in Curr. Sci. *34*: 127, 1965.
Distribution: Eastern Himalaya.

Lepisorus subconfluence Ching in Bull. Fan. Mem. Inst. Biol. *4*: 83, 1933; Bir et Trikha in Amer. Fern. Journ. *64*: 60, 1974. *Pleopeltis subconfluens* (Ching) Panigr. et Patn. in Curr. Sci. *34*: 127, 1965.
Distribution: Eastern Himalaya.

Lepisorus sublinearis (Baker) Ching in Bull. Fan. Mem. Inst. Biol. *4*: 78, 1933; Bir et Trikha in Amer. Fern Journ. *64*: 52, 1974. *Polypodium sublineare* Baker ex Takeda in Notes Roy. Bot. Gard. Edinb. *8*: 276, 1915.
Distribution: Assam, Manipur, Kohima.

Lepisorus suboligolepidus Ching in Bull. Fan. Mem. Inst. Biol. *4*: 77, 1933; Bir et Trikha in Amer. Fern. Journ. *64*: 52, 1974.
Distribution: Kashmir, Assam, Sikkim.

Lepisorus thunbergianus (Kaulf.) Ching in Bull. Fan. Mem. Inst. Biol. *4*: 88, 1933; Bir et Shukla in Nova Hedw. *21*: 200, 1971. *Pleopeltis thunbergiana* Kaulf. Wesen d. Ferrnkr 13, 1837. *Polypodium lineare* Thunb. Fl. Jap. 335, 1784 (non *Polypodium lineare* auct.)
Distribution: Huttoo Peak.

Lepisorus ussuriensis (Regel & Maack) Ching in Bull. Fan. Mem. Inst. Biol. *4*: 91, 1933; Bir & Trikha in Bull. Bot. Surv. India *11*: 268, 1969. *Pleopeltis ussuriensis* Regel et Maack in Mem. Acad. Sci. Petersb. VII. *4*: 40, 175, 1861. *Polypodium lineare* var. *ussuriense* C. Chr. Index Fil. 572. 1906.
Distribution: Himalayas.

Lindsaea himalaica Kramer in Gard. Bull. Singp. *26*: 43, 1972. *Lindsaea cultrata* (Willd.) Sw. var. *assamica* Hook. Sp. Fil. *1*: 204, 1846.
Distribution: Assam, Arunachal Pradesh, Manipur.

Lindsaea javanensis Blume, En. Pl. Jav. 219, 1972;Kramer in Gard. Bull. Sing. 26: 25, 1972. *Lindsaea flabellulata* Dryander var. *gigantea* Hook. Sp. Fil. *1*: 211, t. 63 c, 1846.
Distribution: Assam.

Lindsaea lucida Blume En. Pl. Jav. 216, 1828; Holttum, Fl. Mal. *2*: 328, 1954; Kramer in Blumea *15*: 567, 1968 et Gard. Bull. Sing. *26*: 44, 1972.
Distribution: Assam, Andaman, Bengal, Tamil Nadu.

Lindsaea odorata Roxb. var. **darjeelingensis** Sen et Sen in Amer. Fern Journ. *61*: 14, 1971.
Distribution: Darjeeling.

Lindsaea orbiculata (Lamk.) Mett. et Kuhn var. **commixta** (Tagawa) Kramer Fl. Mal. II, 1, 3: 207, 1971 et Gard. Bull. Sing. *26*: 22, 1972. *Lindsaea commixta* Tagawa in Acta. Phytotax. Geobot. *6*: 37, f. 3 H-J, 1937.

Distribution: Assam, Uttar Pradesh, Kerala.

Loxogramme grammitoides (Bak.) C. Chr. Ind. Fil. Suppl. *2*: 21, 1917; Tagawa in Hara Fl. East. Himal. 494, 1966. *Gymnogramme grammitoides* Bak. in Journ. Bot. *27*: 178, 1889.
Distribution: Darjeeling.

Loxogramme salicifolia (Makino) Makino in Bot. Mag. Tokyo *19*: 138, 1905; Tagawa in Hara in Fl. East. Himal. 495, 1966. *Gymnogramme salicifolia* Makino in Phan. Pter. Jap. Icon. III *1*: t. 34, 1899.
Distribution: Himalayas & Assam.

Lunathyrium acutum Ching in Acta Phytotax. Sin. *9*: 73, 1964.
Distribution: Eastern India.

Lunathyrium sikkimense Ching in Acta Phytotax. Sin. *9*: 72, 1964.
Distribution: Darjeeling.

Marsilea aegyptiaca Willd. Sp. Pl. *5*: 540, 1810; Gupta, Marsilea, Bot. Mon. 26, 1962.
Distribution: Orissa, Rajasthan.

Marsilea brachycarpa A. Br. Montsber. Ak. Berl. *1863*: 420, 1864; Gupta, Marsilea, Bot. Mon. 16, 1962.
Distribution: Bangalore, Kankanhalli.

Marsilea brachypus A. Br. Montsber. Ak. Berl. *1863*: 421, 1864, Gupta, Marsilea, Bot. Mon. 18, 1962.
Distribution: Nilgiris, Amritsar, Bank of Sutlej.

Marsilea condensata Baker in Journ. Bot. *1886*: 281, 1886; Gupta, Marsilea, Bot. Mon. 28, 1962.
Distribution: Rajasthan.

Marsilea gracilenta A. Br. Montsber. Ak. Berl. *1863*: 421, 1864: Gupta, Marsilea, Bot. Mon. 19, 1962.
Distribution: Concan, Kemnangudi.

Marsilea coromandelica Burm. f. Fl. Ind. t. 62. f. 3, 1768; Gupta, Marsilea, Bot. Mon. 20, 1962.
Distribution: Coromandel Coast; Tranquebar.

Marsilea maheshwarii Gopal in Amer. Fern Journ. 58: 70, 1968.
Distribution: Pondicherry.

Marsilea major (Haines) Chowdhury, Res. Living Pteridophytes, New Delhi, 49, 1971; Pter. Fl. Upper Gang. Pl. 24, 1973. *Marsilea minuta* Linn. var. *major* Haines, Botany of Bihar and Orissa (Rep. Ed.) *3*: 1272, 1961.
Distribution: Bihar.

Marsilea minuta Linn. Mant. 308, 1771; Gupta, Marsilea, Bot. Mon. 23, 1962. *Marsilea dentata* Roxb. (nomen).
Distribution: Throughout India.

Marsilea minuta Linn. var. **indica** Gupta, Marsilea, Bot. Mon. 25, 1962.
Distribution: Alwar, Bharatpur.

Marsilea poonensis Kolhatkar in Kew Bull. 1957: 293, f. 1. 1957.
Distribution: Poona.

Marsilea quadrifolia Linn. Sp. Pl. 1099, 1753; Gupta, Marsilea, Bot. Mon. 22, 1962.
Distribution: Kashmir.

Marsilea rajasthanensis Gupta, Marsilea, Bot. Mon. 29, 1962.
Distribution: Rajasthan (Ajmere, Jaipur).

Marsilea rajasthanensis Gupta var. **ballardii** (Gupta) Gupta, Marsilea, Bot. Mon. 30, 1962. *Marsilea ballardii* Gupta in Journ. Bomb. nat. Hist. Soc. 53: 289, 1955.
Distribution: Rajasthan (Ajmer, Udaipur, Kota).

Meringium holochilum (v.d. Bosch.) Copel. in Philip. Journ. Sc. *67*: 42, 1938; Panigr. in Bull. Bot. Surv. India *2*: 311, 1960. *Didymoglossum holochilum* v.d. Bosch. Pl. Jungh. 1: 561, 1856. *Hymenophyllum holochilum* (v.d. Bosch.) C. Chr. Ind. Fil. 362, 1905.
Distribution: Eastern India.

Meringium penangianum (Matt. et C. Chr. ex Christ.) Copel. in Philip. Journ. Sc. *67*:

41, 1938; Panigr. in Bull. Bot. Surv. India 2: 311, 1960. *Hymenophyllum penangianum* Matt. et C. Chr. ex Christ in Journ. Linn. Soc. *39*: 214, 1919.
Distribution: Eastern India.

Microlepia haflangensis Nayar et Kaur in Bull. Nat. Bot. Gard. *94*: 8, 1964.
Distribution: Haflong, Assam.

Microlepia hallbergii (d' Almeida) C. Chr. Ind. Suppl. III. 127, 1934. *Davallia hallbergii* d'Almeida in Journ. Indian Bot. Soc. 5: 19, 1926-27.
Distribution: Madura District.

Microlepia khasiyana Presl, Epim. 95, 1849; Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. 15 (Pt.-I-II): 117, 1964. *Davallia khasiyana* (Presl) Hook. Spec. Fil. 1: 173, t. 47A, 57A, 1856.
Distribution: Lebong (Darjeeling).

This is often treated as conspecific with *Microlepia strigosa* (Thb.) Presl. But the two are different.

Microlepia speluncae (Linn.) Moore var. **pubescens** (Hook.) Sledge in Kew Bull. 525. 1956; Panigr. in Bull. Bot. Surv. India *3*: 311, 1960.
Distribution: E. India.

Microlepia todayensis Christ in Philip. Journ. Sci. 3: 272, 1908; Into in Hara, Fl. East Himal. 463, 1966.
Distribution: E. Himalaya.

Microlepia wilfordii Moore, Ind. 299. 1861. *Davallia wilfordii* Baker, Syn. Fil. 98, 1867; Hope in Journ. Bomb. nat. Hist. Soc. *13*: 33, 1900. *Davallia rhomboidea* Hook. 2nd Cent., t. 48, 1860 (non Wall.).
Distribution: Kashmir.

Monochosorum henryi Christ in Bull. Herb. Boiss. *6*: 869, 1898. Ito in Hara Fl. East. Himal. 463, 1966.
Distribution: Himalayas.

Nephrodium pandum Hope in Journ. Bomb. nat. Hist. Soc. *12* (3): 623, 1899.
Distribution: N. E. India, Sikkim.

Nephrodium biserrata (Sw.) Schott. Gen. Fil. t. 3, 1834; Thothathri *et al.* Journ. Bomb. nat. Hist. Soc. 74: 251, 1977. *Aspidium biserratum* Sw. Schrad. Journ. Bot. *1800*: 32, 1801.
Distribution: Great Nicobar Islands.

Nephrolepis delicatula (Decne.) Pic.-Serm. in Webbia *23*: 181, 1968; Pic.-Serm, Estratto Dagli Annali Del Museo Civico Di Storia Naturale Di Genova, Vol. LXXVII—30 Luglio 275, 1968. *Nephrodium delicatulum* Decne. In Jacquem. Voy. Ind. Bot. *4*: 178, t. 179, 1844.
Distribution: Assam, Western and Southern India.

Nephrolepis paucifrondosa d' Almeida in Journ. Indian Bot. Soc. *5*: 51, t. 1-4. 1926
Distribution: South India.

Nephrolepis undulata (Afz. ex Sw.) J. Smith in Curtis Bot. Mag. 72: 35 bis. 1846; Pic.-Serm. Estrato Dagli Annali Del Museo Civico Di Storia Naturale Di Genova, Vol. *LXXVII*-30 Luglio 273, 1968. *Asplidium undulaum* Afz. ex Swartz. Schrad Journ. Bot. *1800*: 32, 1801.
Distribution: South India.

Onychium fragile Verma et Khullar in Nova Hedw. *9*: 85, 1965.
Distribution: Himalayas.

Onychium ipii Ching in Lingnan Sc. Journ. 15: 282, 1936; et Ic. Fil. Sinic. 4, t. 164, 1937; Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. *15* (Pt. I-II): 108, 1964.
Distribution: Chungthang (North Sikkim).

Ophioglossum gramineum Willd. var. **majus** (v.a.v.R.) Wieff. in Blumea 12: 324, f. 2b, photo 3, 1964, Panigr. et Dixit in Proc. Nat. Inst. Sci. 35: 251, f. 42, 94-97, 1969. *Ophioglossum inconspicum* (Rac.) v.A.V.R. var. *majus* v.A.v.R. in Bull. Dep. Agr. Ind. Neerl. 21: 9, 1908. *Ophioglossum gramineum* Christ. Nova Guinea 13, *8*: 164, 1909.

Distribution: West Bengal, Tripura.

Ophioglossum nudicaule Linn. f. var. **macrorrhizum** (Kunze) Clausen, Mem. Torr. Bot. Club 19: 150, 1938; Panigr. et Dixit in Proc. Nat. Inst. Sci. *35*: 254, 1969. *Ophioglossum macrorrhizum* Kunze in Die Farrnkrauter 1: 57, t. 29, f. 1, 1840.
Distribution: Madhya Pradesh, Gujarat, W. Bengal, Upper Gangetic Plain.

Ophioglossum petiolatum Hook. Exot. Fl. 1, t. 56, 1823; Panigr. et Dixit in Proc. Nat. Inst. Sci. *35*: 260, 1969.
Distribution: Uttar Pradesh, Madhya Pradesh.

Ophioglossum polyphyllum A. Braun apud Seubert, Fl. Azor. *17*: 1844; Pichi-Serm. in Webbia *9*: 632, 1954; Panigr. et Dixit in Proc. Nat. Inst. Sci. *35*: 255, 1969; Safui et Ghosh in Bull. Bot. Surv. India *17*: 160, 1975 (1978). *Ophioglossum cuspidatum* Milde in Bot. Zeit *22*: 107, 1864. *Ophioglossum aitchisonii* (Clarke) d'Almeida in Journ. Indian Bot. Soc. *3*: 63, f. 12-13, 1922; Clausen in Mem. Torr. Bot. Club *19*: 138, 1938. Mahabale in Bull. Bot. Surv. India 4: 71, 1962. *Ophioglossum lusitanicum* C.W. Hope (non Linn.) in Journ. Bomb. nat. Hist. Soc. *15*: 106, 1903. *Ophioglossum regulare* (Schlecht) C. Chr. Index Fil. 472, 1906. *Ophioglossum capense* Sw. sensu Chakravarty in Bull. Bot. Soc. Bengal *5*: 5, 1951.
Distribution: Uttar Pradesh (N. W. Himalayas); Cherat, Madhya Pradesh; Bastar; Sikkim.

Ophioglossum reticulatum Linn. forma **complicatum** (Miq.) Wieff. in Blumea *12*: 330, f. 1a, 1964; Panigr. et Dixit in Proc. Nat. Inst. Sci. India *35*: 260, 1969. *Ophioglossum moluccanum* f. *complicatum* Miq. Ann. Mus. Bot. Lugd. Bat. *4*: 290, 1868.
Distribution: Assam, Arunachal Pradesh, Sikkim.

Ophioglossum reticulatum Linn. forma **dilatatum** (Miq.) Wieff. in Blumea *12*: 329 f. IC, 1964; Panigr. et Dixit in Proc. Nat. Inst. Sci. *35*: 259, f. 55, 84, 1969. *Ophioglossum moluccanum* Schlecht. forma *dilatatum* Miq. in Ann. Mus. Bot. Lugd. Bat. *4*: 92, 1868.
Distribution: Uttar Pradesh—Mussorie.

Ophioglossum thermale Kumarov var. **nipponicum** (Miyabe et Kudo) Nishida in Tagawa in Journ. Jap. Bot. *33*: 202, 1958. *Ophioglossum nipponicum* Miyabe et Kudo in Tran. Sapporo Nat. Hist. Soc. *6*: 122, 1916. *Ophioglossum japonicum* Prantl in Ber. Deut. Bot. Ges. *1*: 353, 1883 (non Thunb.); Mahabale in Bull. Bot. Surv. India *4*: 71, 1962. *Ophioglossum angustatum* Clausen in Mem. Torr. Bot. Club *19*: 129, 1938.
Distribution: Clausen, Nishida and Mababale state that this taxon is present in India.

Osmunda cinnamomea Linn. Sp. Pl. *2*: 1066, 1753; Panigr. in Bull. Bot. Surv. India *2*: 310, 1960; Panigr. et Dixit in Journ. Indian Bot. Soc. *48*: 99, 1969.
Distribution: Arunachal Pradesh, Kameng Dist.

Osmunda japonica Thunb. in Nov. Act. Reg. Soc. Sci. Upsal. *2*: 209, 1780; Fl. Jap. 330, 1784; Panigr. et Dixit in Journ. Ind. Bot. Soc. *48*: 97, 1969; Ito in Hara Fl. East. Himal. 455, 1966.
Distribution: Uttar Pradesh, Assam, Bhutan, Darjeeling, Sikkim.

Osmunda claytoniana Linn. var. **vestita** (Wall.) Milde, Honogr. Gen. Osmund. 102, 1868, Ito in Hara Fl. East. Himal. 455, 1966. *Osmunda monticola* Wall. *B. vestita* Wall. Cat. no. 52, 1828 (nomen.) *Osmundastrum claytonianum* (Linn.) Tagawa var. *vestitum* (Wall.) Tagawa in Journ. Jap. Bot. *17*: 698, 1941.
Distribution: E. Himalaya.

Phymatodes banerjiana Pal et Pal in Amer. Fern. Journ. *53*: 103-104, 1963; Bir et Devi in Bull. Bot. Surv. India *10*: 214, 1968.
Distribution: Under cultivation in Bose Research Institute, Calcutta; Science College, Calcutta University, and Indian Botanic Garden, Sibpur, Howrah.

Pityrogramma austroamericana Domin in Spisy Prirod. Fak. Karlovy Univ. *88*: 7, 1928 et in Bull. Misc. Inf. Kew *1929*: 221, 1929; Panigr. in Kew Bull. *30*: 663, 1976.
Distribution: South India.

Pityrogramma calomelanos (Linn.) Link, in Handb. Gewachse *3*: 29, 1833; Panigr. in Bull. Bot. Surv. India *2*: 312, 1960; (excl. Syn. et Ref. Bedd. 104) et in Kew Bull. *30*: 660. 1976. Nair et Ghosh in Journ. Indian Bot. Soc. *54*: 104, 1975. *Acrostichum calomelanos* Linn. Sp. Pl. *2*: 1072, 1753.
Distribution: Throughout India except the drier parts.

Pityrogramma chrysophylla (Sw.) Link, Handb. Gewachse *3*: 19, 1833; Nair et Ghosh in Journ. Indian Bot. Soc. *54*: 106, 1975; Panigr. in Kew Bull. *30*: 664, 1976. *Acrostichum chrysophyllum* Sw. in Schrad. Journ. Bot. *1800*: 14, 1802.
Distribution: South India.

Pneumatopteris truncata (Poir.) Holtt. var. **loyalii** Holtt. in Blumea *21*: 314, 1973.
Distribution: Darjeeling.

Polypodium amoenum Wall. var. **xerophyticum** Mehra et Bir in Res. Bull. (N.S.) Punjab Univ. *15*: 166, 1964.
Distribution: Lachen Valley in Sikkim State, E. Himalaya.

Polypodium late-repens Hope in Journ. Bomb. nat. Hist. Soc. *12*: 628, t. 14, 1899.
Distribution: Himalayas, Sikkim.

Polypodium manmiense Christ in Bull. Herb. Boiss. *6*: 870, 1898; Ching. IC. Fil. Sinicarum 2, t. 94, 1934; Bir *et al.* in New Bot. *1*: 150, 1974.
Distribution: Eastern India, Himalayas.

Polypodium niponicum Mett. in Ann. Lugd. Bat. *2*: 222, 1866; Ching. IC. Fil. Sinicarum 2, t. 98, 1934; Bir *et al.* in New Bot. *1*: 148, 1974.
Distribution: Eastern India.

Polystichum duthiei (Hope) C. Chr. Ind. Fil. 72, 1905; 581, 1906. *Aspidium duthiei* Hope in Journ. Bomb. nat. Hist. Soc. *12*: 532, 1899.
Distribution: Himalayas.

Polystichum garhwalicum Nair et Nag in Journ. Jap Bot. *51*: 138, t. 1, 1976.
Distribution: Garhwal, Bashahr.

Polystichum heteropaleaceum Nair et Nag in Journ. Bomb. nat. Hist. Soc. *75*: 153, 1977.
Distribution: Shillong.

Polystichum levingei Nair in Bull. Bot. Surv. India *11*: 192, 1969.
Distribution: Darjeeling.

Polystichum longipinnulum Nair in Amer. Fern. Journ. 64: 15, 1974.
Distribution: Darjeeling, Khasia.

Polystichum neolobatum Nakai in Bot. Mag. Tokyo *39*: 118, 1925; Tagawa in Hara, Fl. East. Himal. 480, 1966.
Distribution: Himalayas.

Polystichum setiferum (Forsk.) Moore ex Woynar Mitt. Naturw. Ver. Steierm. *49*: 1811, 1913; Nair in Journ. Indian Bot. Soc. *51*: 93, 1972.
Distribution: North and South India.

Polystichum setiferum var. **crenatum** Nair in Amer. Fern. Journ. 64: 15, 1974.
Distribution: Punjab.

Polystichum stenophyllum Christ in Bull. Soc. Bot. France *52*: Mem. 1, 27, 1905; Tagawa in Hara Fl. East. Himal. 481, 1966.
Distribution: Himalayas.

Polystichum tsus-simense (Hook.) Sm. Journ. Hist. Fil. 219, 1875; Stewart in Bull. Torr. Bot. Club 72: 412, 1945. *Aspidium tsus-simense* Hook. Sp. Fil. *4*: 16. Pl. 220. 1862.

Aspidium luctuosum Kunze in Linnaea *10*: 548, 1835-6; Hope in Journ. Bomb. nat. Hist. Soc. 14: 474, 1902.
Distribution: Temperate Himalaya.

Pronephrium lakhimpurense (Rosenst.) Holtt. in Blumea 20: 1972. *Dryopteris lakhimpurensis* Rosenst. Meded. Rijkshorb. *31*: 7, 1917.
Distribution: N.E. India.

Pronephrium thwaitesii (Hook.) Holtt. in Blumea 20: 122, 1972. *Meniscium thwaitesii* Hook. Fil. Exot. sub t. 83, 1859.
Distribution: S. India.

Pseudophegopteris hirtirachis (C. Chr.) Holttum in Blumea *17*: 22, 1969. *Dryopteris hirtirachis* C. Chr. in Leveille, Cat. Pl. Yunan 104, 1916. *Thelypteris brunnea* var. *hirtirachis* Ching in Bull. Fan. Mem. Inst. Biol. *Bot 6*: 271, 1916.
Distribution: Darjeeling, North East India.

Pseudophegopteris rectangularis (Zoll.) Holttum in Blumea *17*: 19, 1969. *Polypodium rectangulare* Zoll. Syst. Verz. 37, 48, 1854. *Polypodium distans* Don var. *minor* Clarke in Trans. Linn. Soc. 2, Bot. 1: 545, t. 79, f. 1, 1880.
Distribution: North East India, Sikkim.

Pteridium capense (Thunb.) Krasser var. **densum** (Wall.) in Bull. Nat. Sci. Mus. No. *27*: 5, 1949; Kitamura, Fauna Fl. Nep. Himal. *1*: 78, 1952-53. *Pteris densa* Wall. Cat. 99, 1828.
Distribution: Himalayas.

Pteridrys syrmatica (Willd.) C. Chr. et Ching in Bull. Fan. Mem. Inst. Biol. Bot. *5*: 131, t. 11, 17, 1934; Sledge in Kew Bull. *27*: 424, 1972. *Aspidium syrmaticum* Willd. Sp. Pl. *5*: 237, 1810.
Distribution: S. India.

Pteris almeidiana Bole et Almeida in Journ. Bomb. nat. Hist. Soc. *74*: 320, 1977.
Distribution: Maharashtra.

Pteris confusa Walker in Evolution *12*: 88, f. 4, top middle, 1958 (nomen et fig.) et in Kew Bull. *14*: 329, fig. 5 a, t. 5, f. B. J., 1960; Nair et Ghosh in Journ. Bomb. nat. Hist. Soc. *73*: 441, 1976 (1977).
Distribution: Kerala.

Pteris furunculata N. C. Nair et S. R. Ghosh in Journ. Ind. Bot. Soc. *55*: 38, 1976.
Distribution: Kerala.

Pteris gongalensis Walker in Kew Bull. *14*. 328, f. 4, 4 a, t. 5, f. A.G. 1960; Nair et Ghosh in Journ. Bomb. nat. Hist. Soc. *13*: 441, 1976 (1977).
Distribution: Kerala.

Pteris heteromorpha Fèe, Gen. Fil. 127, 1852; Hook. Sp. Fil. *2*: 166, t. 127 B, 1858; Nair et Ghosh in Indian For. *104*: 374-376, 1978.
Distribution: Orissa.

Pteris linearis Poir. Enc. *5*: 723, 1804; Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. *15* (Pt. I-II): 114, 1964. *Pteris normalis* Don, Prod. Fl. Nepal 15, 1825. *Pteris nemoralis* Willd. Enum. 1073, 1809, Alston et Bonner in Candollea *15*: 202, 1956.
Distribution: Darjeeling.

Pteris multiaurita Agardh, Rec. Sp. Gen. Pteridis 12, 1839; Walker in Kew Bull. *14*: 323, 1960; Nair et Ghosh in Journ. Bomb. nat. Hist. Soc. *73*: 440, 1976 (1977).
Distribution: Nilgiris; Kallar to Ponmudi (Trivandrum Dist.); Kiripara and Kodayar (Kanyakumari Dist.); Kulathupuzha (Quilon Dist.)

Pteris nemoralis Willd. Enum. 1073, 1809 et Sp. Pl. 386, 1810; Alston et Bonner in Candollea *15*: 202, 1956; Nair et R. K. Ghosh in Journ. Ind. Bot. Soc. *54*: 48, 1975.
Distribution: Orissa, Kerala.

Pteris nepalensis H. Ito in Hara Fl. East. Himal. 466, 1966.
Distribution: Himalayas.

Pteris praetermissa Walker in Kew Bull. *14*: 327, f. 3. 3a, t. f, f. 1960; Nair et Ghosh

In Journ. Bomb. nat. Hist. Soc. *73*: 442, 1976 (1977).
Distribution: Kerala.

Pteris rigida Sod. Sert. Fl. Ecuad. II, 15, 1908 (non Swartz, 1806); Mehra et Bir in Res. Bull. (N.S.) Panjab Univ. *15*: (Pt. I-II): 114, 1964.
Distribution: Lebong (Darjeeling).

Pteris roseo-lilacina Hieron in Hedw. *55*: 350, 1914; Mehra et Bir in Res. Bull. (N.S.) Punjab Univ. *15*: 55, 1964; Nair et Ghosh in Journ. Bomb. nat. Hist. Soc. *73*: 424, 1977.
Distribution: Darjeeling, Ponmudi near Trivandrum.

Pteris setuloso-costulata Hayata, Icon. Fl. Formos. *4*: 241, f. 168, 1914; Ito in Hara Fl. East Himal. 467, 1966.
Distribution: E. Himalaya (Nepal, Sikkim).

Pteris tremula R. Br. Prodr. Fl. N. Holl. 154, 1810; Nair et Ghosh in Journ. Bomb. nat. Hist. Soc. *73*: 240, 1977.
Distribution: Shevaroy Hills.

Pyrrosia assimilis (Bak.) Ching in Bull. Chin. Bot. Soc. 1: 49, 1935. *Polypodium assimilis* Baker in Journ. Bot. *1875*: 201, 1875.
Distribution: Himalayas.

Pyrrosia ceylanica (Gies.) Sledge in Bull. Brit. Mus. Nat. Hist. *2*: 134, 1960. *Niphobolus ceylanicus* Gies. Farngatt. *Niphobolus* 216, 1901.
Distribution: Courg (Coorg).

Pyrrosia nayariana Ching et Chandra in Amer. Fern. Journ. *54*: 62, 1964.
Distribution: Manipur.

Pyrrosia pekinensis (C. Chr.) Ching in Bull. Chin. Bot. Soc. *1*: 51, 1935; Nishida in Journ. Coll. Arts Sci. Chiba Univ. *4*: 580, 1966. *Cyclophorus pekinensis* C. Chr. Fil. 200, 1905. *Polypodium davidii* Baker, Ann. Bot. *5*: 472, 1891.
Distribution: Himalayas.

Pyrrosia varia (Kaulf.) Farwell, Amer. Midl. Naturalist *12*: 302, 1931; Nishida in Journ. Coll. Arts. Ci. Chiba Univ. *4*(4): 580, 1966. *Niphobolus varius* Kaulfuss Enum. Fil. 125, 1824.
Distribution: Himalayas.

Salvinia auriculata Aubl. Hist. Pl. Guian *2*: 969, t. 367, 1775; Kammathy in Sci. & Cult. *34*: 396, 1968.
Distribution: Kerala.

Salvinia cucullata Roxb. [Wall. List. n. 399, 1828] ex Borry. Bel. Voy. Bot *2*: 6, 1833, Roxb. in Calc. Journ. *4*: 470, 1844; Panigrahi in Bull. Bot. Surv. India *2*: 1960.
Distribution: E. India.

Salvinia molesta Mitchell in Br. Fern. Gaz. *10*: 251, 1973; Cook et Gut PANS: *17*: 438, 1977.
Distribution: Kerala.

Salvinia natans (Linn.) All. Fl. Pedem. *2*: 289, 1785; Ito in Hara Fl. East. Himal. 500, 1966. *Marsilea natans* Linn. Sp. ed. 1, *2*: 1099, 1753.
Distribution: Widely distributed in the warm regions of Europe to S.E. Asia.

Schizolegnia indica Bole et Almeida in Journ. Bomb. nat. Hist. Soc. *74*: 325, 1977.
Distribution: North Canara.

Schizolegnia savantvadiensis Bole et Almeida in Journ. Bomb. nat. Hist. Soc. *74*: 325, 1977.
Distribution: Charatha, Savantwadi, Maharashtra.

Sphenomeris chinensis (Linn.) Maxon var. **divaricata** (Christ) Kramer in Blumea 15: 672,, 1968 et Gard. Bull. Sing. *26*: 5, 1972. *Odontosoria chinensis* (Linn.) J. Sm. var. *divaricata* Christ in Journ. de Bot. Ser. *2*: 23, 1909.
Distribution: Assam, Sikkim.

Sphaerostephanos subtruncatus (Bory) Holttum in Kew Bull. 26: 80, 1972. *Polypodium subtruncatum* Bory in Bel. Voy. Ind. Or.

Bot. *2*: 32, 1833. *Mesochlaena polycarpa* sensu Blatter et d' Almeida Ferns Bombay 41, a, b. 1922 non (Bl.) Bedd.
Distribution: South India, Bengal.

Stenogramma asplenoides J. Sm. ex Ching in Sinensia *7*: 94, t. 2, 1936.
Distribution: Khasia, Assam.

Stenogramma leptogrammoides Iwatsuki in Acta Phytotax. Geobot. *19*: 119, 1963.
Distribution: Sikkim.

Tapeinidium pinnatum (Cav.) C. Chr. Index Fil. 631, 1906; Kramer in Blumea *15*: 553, 1967 et Gard. Bull. Sing. *26*: 8, 1972. *Davallia pinnata* Cavanilles, Descr. 277, 1802 (non Mett. ex Kuhn, 1869) *Davallia serrata* Roxb. ex Griff. in Calc. Journ. *4*: 514, 1844 (non Willd. 1810).
Distribution: Kerala.

Thelypteris multilineata (Wall. ex Hook.) Morton var. *bhutanica* Nair in Bull. Bot. Surv. India *11*: 193, 1969.
Distribution: Bhutan.

Trichomanes latealatum (v.d. B.) Christ, Verh. Nat. Ges. Basel. *11*: 424, 1896; Ghatak in Bull. bot. Surv. India *6*: 93, 1964. *Didymoglossum latealatum* v.d.B. Ned. Kr. Arch- 5: 138, 1863.
Distribution: Shevaroy Hills (Tamil Nadu).

Trichomanes motleyi Bosch. Ned. Kruidk. Arch. 5: 145, 1961; Thothathri in Journ. Bomb. nat. Hist. Soc. 74: 251, 1977.
Distribution: Great Nicobar Islands.

Vandenboschia schmidiana (Zenk. ex Taschn.) Copel. in Philip. Journ. Sc. 67: 53, 1938. *Trichomanes schmidiana* Zenk. ex Tasch. Dissert. 34: t. 1, f. 1, 1843.
Distribution: Nilgiris.

Vittaria doniana Mett. in Hieron. in Hedw. 57: 204, 1915; Mehra et Bir in Res. Bull. (N.S.) Punjab Univ. 15 (Pt. I-II): 23, 1964.
Distribution: North Sikkim.

Vittaria ensiformis Sw. Gest. Nat. Fr. Berl. Neu. Schr. 2: 134, t. 7, 1799; Thothathri *et al.* in Journ. Bomb. nat. Hist. Soc. 74: 251, 1977.
Distribution: Great Nicobar Islands.

Vittaria ensiformis Sw. var. **latifolia** Holtt. Panigr. in Bull. Bot. Surv. India 2: 314, 1960.
Distribution: Eastern India.

Vittaria forrestiana Ching in Sinensia *1*: 191, f. 5, 1931; Ito in Hara Fl. East. Himal. 499, 1966.
Distribution: Himalayas.

Vittaria medisora Hayata, Icon. Pl. Formos. 5: 346, 1915; Ito in Pteridophyta, Univ. Tokyo 500, 1966.
Distribution: Himalayas.

Vittaria himalayensis Ching in Sinensia *1*: 190, f. 5 B, 1931; Bir et Mehra in Res. Bull. (N.S.) Punjab Univ. 15 (pt. I-II): 23, 1964.
Distribution: Himalayas.

Vittaria taeniophylla Copel. in Philip. Journ. Sci. 1: Suppl. II, 157, 1906; Ito in Hara Fl. East Himal. 500, 1966.
Distribution: Himalayas.

Vittaria ophiopogonoides Ching in Sinensia, 1: 186, fig. 5 A, 1931; Mehra et Bir in Res. Bull. (N.S.) Punjab Univ. 15 (Pt. I-II) 24, 1964.
Distribution: Himalayas.

Woodsia cycloloba Hand.-Mzt. Symb. Sin. *6*: 19, 1929; Ito in Hara Fl. East. Himal. 486, 1966.
Distribution: Himalayas.

Woodwardia unigemmata (Makino) Nakai in Bot. Mag. Tokyo 39: 103, 1925; Ito in Makino in Journ. Jap. Bot. 2: 7, 1918.
Distribution: Himalayas.

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REDEFINITION OF RHESUS MACAQUE—BONNET MACAQUE BOUNDARY IN PENINSULAR INDIA (PRIMATES : *MACACA MULATTA, M. RADIATA*)[1]

JACK FOODEN[2], ANIL MAHABAL[3] AND SUBHENDU SEKHAR SAHA[4]

(*With a text-figure*)

The rhesus-bonnet boundary is defined by a line joining the northern end of the Western Ghats, the Manjra Plateau and the northern end of the Velikonda Range, Eastern Ghats, not by the Tapti and Godavari Rivers as previously supposed. Mixed-species troops and an isolated bonnet enclave occur near the southeastern end of this boundary.

INTRODUCTION

The short-tailed rhesus macaque (*Macaca mulatta* Zimmermann, 1780) and the long-tailed bonnet macaque (*M. radiata* E. Geoffroy, 1812) are generally similar in ecological requirements and habits, and, as first noted by Jerdon (1867, p. 12), these two species replace one another geographically; the principle of competitive exclusion apparently applies to the distribution of these two macaques, which are members of different species groups and therefore are not particularly closely related within their genus (Fooden 1980, p. 1). The geographic range of *M. mulatta* is broad, extending from easternmost Afghanistan through Pakistan, northern India, Nepal and the northern part of the Indochinese Peninsula to southeastern China, whereas the range of *M. radiata* is restricted to peninsular India (Fooden 1980, fig. 1-3). The boundary between these two specific ranges that is routinely given in standard primatological references is the Tapti River in the west and the Godavari River in the east (Pocock 1939, pp. 38, 45; Ellerman and Morrison-Scott 1951, pp. 195, 197; Fiedler 1956, p. 173; Napier and Napier 1967, p. 403; Prater 1971, p. 35; Hill 1974, pp. 564, 705; Roonwal and Mohnot 1977, pp. 98, 192). This placement of the interspecific boundary is derived, without supplementary evidence, from the range limit extrapolations of Blyth (1863, p. 9) and Blanford (1888, pp. 14, 23), whose pioneering studies were based on the relatively few, and often imprecise, locality records then available. However, subsequently published information, ignored in current standard references, reveals that the range of *M. mulatta* extends south of both the Tapti River (Pocock 1939, p. 46; British Museum Spec. Nos. 31.1.11.1-3, Dangs) and the Godavari River (Rae in Southwick *et al.* 1961, p. 538; Spillett 1968, p. 8; Krishnan 1972, p. 541). In this paper we report on a 5-month survey, conducted mainly in the critical area south of the Tapti and Godavari Rivers, that we recently undertook in order to determine the actual interspecific boundary as precisely as possible.

METHODS

Our survey began on 25 December 1979 and ended on 18 May 1980. During this period

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[3] Zoological Survey of India, Pune.

[4] Zoological Survey of India, Calcutta.

we travelled 15,900 km. by jeep and auto back and forth across the interspecific frontier zone (Fig. 1). In order to locate monkey populations we consulted with divisional forest officers, range forest officers, local forest guards, villagers, farmers and other knowledgeable local people. All 72 original locality records reported here (Table 1, italicized locality numbers) are based on direct observation and identification of monkeys in the field by at least one of us. Documentary photographs of the monkeys in situ were taken at all but 4 of these localities (Table 1, Loc. Nos. *9, 31, 53, 76*). For each sighting we recorded the date, time, habitat, species, number of individuals observed, and age-sex composition of

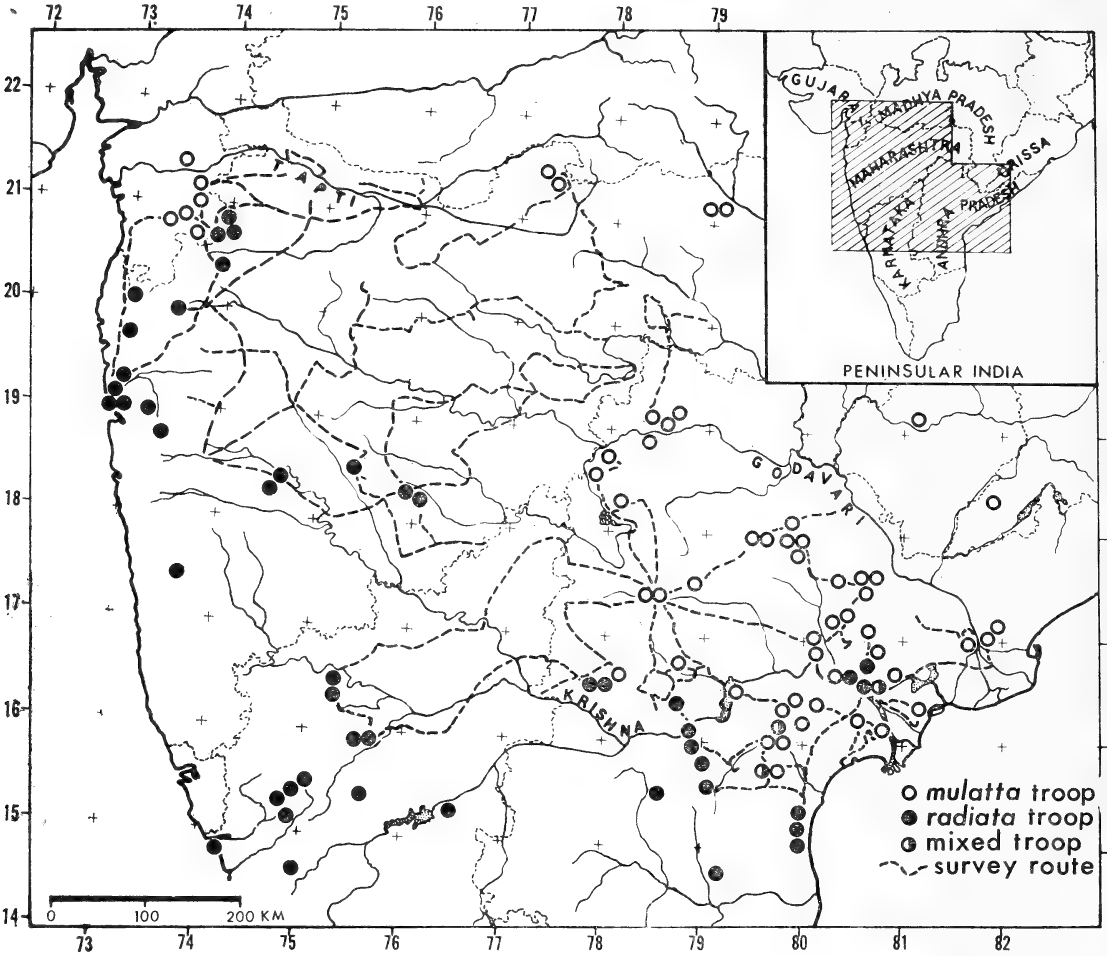

Fig. 1. Map showing distribution of marginal localities of *Macaca mulatta* and *M. radiata* in interspecific boundary area; for documentation, see Table 1. Double circles in side-by-side contact indicate that two or more macaque troops have been observed at the same locality. (Illustration by Mr. Manoj Kumar Sengupta, Zoological Survey of India, Calcutta).

the troop where possible. Altitude was estimated by use of a pocket altimeter or from physiographic maps. Geographic coordinates were estimated to the nearest minute from Survey of India maps at a scale of 1:1,000,000. Four troops (3 *M. mulatta,* 1 *M. radiata*) that reportedly are the result of recent human introduction have been excluded from our data pool (see Table 1, footnote).

RESULTS

Observations made during the course of our survey appear adequate to permit redefinition of the *M. mulatta—M. radiata* boundary (Fig. 1). Our northernmost *M. radiata* locality (Table 1, Loc. No. *53*) is at 20°47′N Lat. near the Arabian Sea, and our southernmost *M. mulatta* locality (Loc. No. *55*) is at 15°46′N Lat. near the Bay of Bengal. A diagonal line connecting these two localities serves reasonably well to delimit the boundary between the two species, except for an isolated *M. radiata* enclave to be discussed later. Physiographically, this diagonal line extends from the northern end of the Western Ghats to the Manjra Plateau to the northern end of the Velikonda Range of the Eastern Ghats. With the interspecific boundary fixed along this line, instead of along the Tapti and Godavari Rivers, the range of *M. radiata* is approximately 20 per cent smaller than previously supposed.

The northwestern part of the *M. mulatta—M. radiata* boundary, near the Gujarat—Maharashtra border, is clearly defined, with marginal localities of the two species separated by only 20-30 km (Fig. 1). The west-central part of the interspecific boundary, in central Maharashtra and northeastern Karnataka, is poorly defined because macaques are now absent in most of this area, which was intensively surveyed by us. (Unlike macaques, langurs, *Presbytis entellus,* are abundant in this area). The five isolated protected *M. radiata* localities that we discovered along the southern edge of this area (Table 1, Loc. Nos. *65-69*) suggest that macaques formerly were more widely distributed here but that they have been eliminated as a result of persecution and deforestation by humans. A possible indication of the former presence of *M. mulatta* in this boundary area where macaques are now absent is provided by the unmistakable depiction of a rhesus macaque in the King Sibi fresco, above the king's left shoulder, in Ajanta Cave No. 1 (20°33′N, 75°42′E). The southeastern part of the interspecific boundary, in central Andhra Pradesh, is again well defined, with marginal records of the two species separated by only 10-60 km. In this southeastern area the range of *M. mulatta* extends not only south of the Godavari River but also south of the Krishna River.

Near the southeastern end of the interspecific boundary we encountered two mixed-species troops. At Darsi (Table 1, Loc. No. *50*), which is our southernmost *M. mulatta* locality, we observed two *M. mulatta* troops and one mixed group composed of 3 *M. radiata* adult males and 1 *M. mulatta* subadult female; these 4 monkeys appeared to be playing together and were about 50 m from the nearest *M. mulatta* troop. At Kondra Mutla (Loc. No. *52*), 38 km NNE of Darsi, we observed a troop that included 22+ *M. mulatta* individuals and 1 *M. radiata* young adult male; local people informed us that 2 more *M. radiata* individuals, unseen by us, also are associated with this troop. Another mixed troop, consisting of 18 *M. mulatta* members and 1 *M. radiata* adult male, was observed in 1972 at Vijayawada (Loc. No. 51), 127 km NE of Darsi, by Koyama and Shekar (1981, p. 248). There is no evidence in this area of successful hy-

TABLE 1

MARGINAL LOCALITY RECORDS OF *Macaca mulatta* AND *M. radiata* IN PENINSULAR INDIA (Italicized locality numbers indicate observations made during the course of the present survey)a

Locality No.	Coordinates	Locality & Estimated altitude (m) State: District	Date (1979/1980)/ Time (h)	Habitat	No. of Monkeys observed	Estimated total no. in troop
		M. mulatta localities				
1	21°26′N, 77°17′E	Punch Bol (825) M: Amravati	31 Jan./1610-1640	forest	58	100
2	21°24′N, 77°20′E	Bhim Kund Point (875) M: Amravati	31 Jan./1310-1400	forest	*c*.24	100
3c	21°20′N, 73°30′E	Kerwada Forest (—) G: Surat	[1972-73]/—	forest	—	—
4	21°10′N, 79°05′E	Nagpur (300) M: Nagpur	30 Mar./1030-1415	garden	39 68	39 68
6	21°05′N, 73°38′E	Hadya (250) G: Surat	24 Jan./0950-1035	forest	28+	40
5	20°56′N, 73°37′E	Mahal, 2-5 km NW (200-275) G: Dangs	12 Mar./1410-1705	forest	30+	50
7	20°51′N, 73°33′E	Ghori Hill (325) G: Dangs	8 Jan./1050-1140	forest	*c*.20	20
8	20°48′N, 73°29′E	Sadard Devi, 1 km W (75) G: Valsad	9 Jan./0930-1010	forest	*c*.20	50
9	20°43′N, 73°38′E	Vasunia, 3 km W (420) G: Dangs	12 Jan./1505-1525	forest	5	—
10c	19°10′N, 81°10′E	Orcha (—) MP: Bastar	[1958-59]/ —	—	—	—
11	19°07′N, 78°42′E	Kausa Gutta (300) AP: Adilabad	25 Mar./1050-1105	forest	26	—
12	19°05′N, 78°30′E	Nirmal, 16 km E (360) AP: Adilabad	26 Mar./0915-0940	forest	90+	—
13	19°04′N, 78°37′E	Khanapur, 3-5 km W (350) AP: Adilabad	24 Mar./1735-1820	forest	18	18
14c	18°52′N, 78°20′E	Balkonda (—) AP: Nizamabad	[1972-73]/ —	—	—	—
15	18°42′N, 78°00′E	Ali Sagar (440) AP: Nizamabad	16 Apr./0855-0920	garden	37	45

TABLE (contd.)

Locality No.	Coordinates	Locality & Estimated altitude (m) State: District	Date (1979/1980) / Time (h)	Habitat	No. of Monkeys observed	Estimated total no. in troop
16	18°35′N, 77°53′E	Rudrur Agr. Station (440) AP: Nizamabad	16 Apr./1100-1105	farm	1	1
17d	18°22′N, 81°54′E	Malakanagiri (—) O: Koraput	[28 Aug. 1927]/ —	—	1	—
18	18°17′N, 78°10′E	Mustapur, 0.5 km E (560) AP: Nizamabad	15 Apr./1250-1315	forest	93+	100+
19	18°08′N, 79°53′E	Jakaram, 4 km SW (325) AP: Warangal	19 Apr./0850-0925	forest	78+	100
20	18°00′N, 79°35′E	Warangal (350) AP: Warangal	18 Apr./1555-1600	town	3	—
			19 Apr./0710-0730	temple	17	17
21	17°56′N, 79°58′E	Pakhal Lake, W side (340) AP: Warangal	19 Apr./1630-1640	park	33	50
			20 Apr./0730	park	9	—
			20 Apr./0855-0950	park	1	1
22	17°55′N, 79°57′E	Ashoknagar (340) AP: Warangal	19 Apr./1525-1605	temple	8	8
23	17°35′N, 80°20′E	Yellandu (200) AP: Khammam	20 Apr./1200-1210	town	11	11
24	17°34′N, 80°38′E	Kothagudem, 4 km N (100) AP: Khammam	20 Apr./1735-1755	Orchard	11	11
					9+	—
25	17°32′N, 78°55′E	Yadagiri Gutta (530) AP: Nalgonda	18 Apr./1040-1100	temple	5	100
26	17°32′N, 80°38′E	Kothagudem (100) AP: Khammam	20 Apr./1650-1715	town	23+	25
27	17°23′N, 78°29′E	Hyderabad (560) AP: Hyderabad	31 Mar./1510-1525	campus	7-8	12
			31 Mar./1600-1615	temple	15	15
			22 Apr./1830	campus	11+	—
28	17°13′N, 80°25′E	Tallada (100) AP: Khammam	21 Apr./1030-1050	roadside	12	12
29	17°11′N, 80°22′E	Wira, 1 km S (100) AP: Khammam	21 Apr./1130-1135	roadside	4	—
30	17°07′N, 80°37′E	Muttagudem (80) AP: Krishna	14 May/1205-1225	village	27+	—
31	17°03′N, 81°52′E	Rajahmundry, 13 km NE (75) AP: East Godavari	18 May/1100	farm	4	—
32	17°02′N, 81°41′E	Dommeru (40) AP: West Godavari	17 May/1045-1055	farm	24	25
33	17°02′N, 81°49′E	Rajahmundry, 3 km NE (50) AP: East Godavari	18 May/1030-1045	orchard	71+	100

TABLE (contd.)

Locality No.	Coordinates	Locality & Estimated altitude (m) State: District	Date (1979/1980)/ Time (h)	Habitat	No. of Monkeys observed	Estimated total no. in troop
34	16°56′N, 80°45′E	Mudhalaparava (120) AP: Krishna	14 May/1315-1340	orchard	195	250
35	16°55′N, 80°07′E	Jaggayyapet, 4 km N (75) AP: Guntur	21 Apr./1540-1555	village	18	18
36	16°53′N, 80°06′E	Jaggayyapet (50) AP: Guntur	21 Apr./1515-1530	village	4	—
37	16°42′N, 78°43′E	Charakonda (420) AP: Mahbubnagar	28 Apr./1755-1820 29 Apr./0950-1000	village	1	1
38	16°38′N, 80°58′E	Hanuman Junction (20) AP: Krishna	16 May/0945-1005	village	15+	25
39	16°37′N, 78°07′E	Velkicharla (500) AP: Mahbubnagar	9 Apr./1525-1635	village	68+	75
40	16°37′N, 80°33′E	Kondapalle (70) AP: Krishna	13 May/1715-1755	town	20	20
41d	16°33′N, 79°16′E	Siddeldar Hill (—) AP: Guntur	[2 Nov. 1963]/ —	temple	1	1
42	16°28′N, 79°56′E	Kotanemalipuri (100) AP: Guntur	9 May/1235-1250	village	12	—
43	16°23′N, 80°09′E	Sattenapalle (75) AP: Guntur	9 May/1625-1630	village	1	10
44	16°16′N, 81°13′E	Gokavaram (1) AP: Krishna	15 May/1100-1130	village	43+	—
45	16°14′N, 80°02′E	Narasaraopet, 2 km NW (75) AP: Guntur	9 May/1350-1430	roadside	25	25
46	16°14′N, 80°37′E	Tenali, 5.5 km W (10) AP: Guntur	10 May/1555-1630	farm	50+	—
47	16°12′N, 79°47′E	Angaluru (125) AP: Guntur	30 Apr./1130-1220	village	12	12
48	16°08′N, 80°52′E	Velatur (5) AP: Guntur	10 May/1230-1255	farm	18	18
49	16°03′N, 79°45′E	Vinukonda (150) AP: Guntur	30 Apr./1605-1810	town	46	50
		(150)	6 May/0815-0900	town	35+	40
				temple	*c.*50	50
50	15°46′N, 79°41′E	Darsi (100) AP: Ongole	6 May/1020-1045	village	6	6
					9+	—

TABLE (contd.)

Locality No.	Coordinates	Locality & Estimated altitude (m) State: District	Date (1979/1980) / Time (h)	Habitat	No. of Monkeys observed	Estimated total no. in troop
		Mixed-troop localities				
50	15°46′N, 79°41′E	Darsi (100) AP: Ongole	6 May/1025-1045	village	4+e	—
51c	16°32′N, 80°38′E	Vijayawada (80) AP: Krishna	[12 Nov. 1972]/ —	temple	19e	19
52	16°08′N, 79°46′E	Kondra Mutla (125) AP: Guntur	30 Apr./1825-1845	village	23+e	—
		M. radiata localities				
53	20°47′N, 73°55′E	Bhambai Hill (1000) G: Dangs	9 Mar./1000	forest	3	20
54	20°44′N, 73°54′E	Babur Ghat (800)	11 Jan./0935-1100 7 Mar./0905-0945	forest	10	50
55	20°43′N, 73°53′E	Mogar Bara Hill (950) G: Dangs	11 Mar./0850-0930	forest	7	—
56	20°24′N, 73°53′E	Saptashring (1200) M: Nasik	13 Jan./1255-1350	temple	6	25
57	20°03′N, 73°03′E	Ghambir Gadh (400) M: Thana	2 Jan./0930-0950	forest	*c.*20	20
58	19°56′N, 73°32′E	Trimbak (900) M: Nasik	20 Jan./0920-1015	temple	17	25
59	19°41′N, 72°58′E	Kohaj Killa (370) M: Thana	1 Jan./0935-0950	forest	2+	—
60d	19°14′N, 72°57′E	Yeur (—) M: Thana	[10 Aug. 1958]/ —	forest	1	—
61c	19°10′N, 72°55′E	Borivli Nat. Park (—) M: Bombay	[16 Sept. 1979]/ —	forest	12	12
62c,d	18°59′N, 73°16′E	Matheran (—) M: Alibag	[12 Jan. 1973]/ —	—	33	33
63	18°57′N, 72°56′E	Elephanta Island (75) M: Bombay	25 Dec./1510-1700	cave site	14 11	14 11
64c	18°45′N, 73°23′E	Khandala (—) M: Pune	[13 Oct. 1972]/ — [11 Jan. 1973]	forest	25-26	25-26
65	18°30′N, 75°25′E	Sonari (550) M: Osmanabad	19 Feb./1610-1630	temple	41+	100
66	18°21′N, 74°38′E	Ravangaon (550) M: Pune	11 Feb./1720-1745	village	20+	—

TABLE (contd.)

Locality No.	Coordinates	Locality & Estimated altitude (m) State: District	Date (1979/1980) / Time (h)	Habitat	No. of Monkeys observed	Estimated total no. in troop
67	18°19′N, 74°35′E	Shirsuphal (560) M: Pune	11 Feb./1600-1645	temple	*c*.100	100
68	18°17′N, 75°57′E	Ramling (630) M: Sholapur	12 Feb./1230-1340	temple	48+	50
69	18°15′N, 76°04′E	Upla (560) M: Osmanabad	18 Feb./1030-1100	village	13	—
70d	17°25′N, 73°40′E	Ghatmatha (—) M: Ratnagiri	[Dec. 1914]/ —	—	2	—
71	16°45′N, 80°38′E	Mailavaram (80) AP: Krishna	14 May/1000-1005	village	3	—
40	16°37′N, 80°33′E	Kondapalle (70) AP: Krishna	13 May/1705-1800	town	22	22
72	16°34′N, 78°03′E	Ghanapuram (500) AP: Mahbubnagar	9 Apr./1740-1845 11 Apr./0620-0625	village village	34 9-10	34 10
51	16°32′N, 80°38′E	Vijayawada (80) AP: Krishna	12 May/1155-1230	temple	35+	40
73	16°31′N, 75°18′E	Jamkhandi (570) K: Bijapur	6 Apr./1205-1320	town	31	31
74	16°24′N, 75°17′E	Jamkhandi, 11 km S (600) K: Bijapur	6 Apr./1410-1420	roadside	6	10
75	16°22′N, 78°44′E	Uma Maheswaram (670) AP: Mahbubnagar	25 Apr./0855-0930	temple	47+	50
76	16°05′N, 78°52′E	Srisailam (460) AP: Kurnool	5 May/0625-0630	forest	10	—
77	16°03′N, 78°53′E	Srisailam, 4 km SE (570) AP: Kurnool	25 Apr./1705-1725	temple	64+	75
78	15°57′N, 75°42′E	Badami (590) K: Bijapur	7 Apr./0815-1815	town	48	48
		(590)		cave site	42	42
		(650)		temple	1	—
		(600)		fort	24+	—
		(600)		temple	17	17
79d	15°48′N, 79°01′E	Malakondapenta (—) AP: Ongole	[14 May 1930]/ —	—	3	—
80	15°35′N, 79°08′E	Cumbum (280) AP: Ongole	8 May/0820-0845	town	43	43
81c	15°30′N, 78°30′E	Nandyal (—) AP: Kurnool	[17 Nov. 1972]/—	town	14	15

Locality No.	Coordinates	Locality & Estimated altitude (m) State: District	Date (1979/1980) / Time (h)	Habitat	No. of Monkeys observed	Estimated total no. in troop
82d	15°28′N, 75°02′E	Dharwar, 2300 ft. (700) K: Dharwar	[14 Nov. 1911]/—	—	4	—
83c	15°25′N, 74°55′E	Dharwar, 4.4-17.5 km SW (—) K: Dharwar	[1961]/—	roadside	[9 troops]	—
84c	15°25′N, 75°37′E	Gadag (—) K: Dharwar	[1911]/—	town	—	—
85c	**15°20′N**, 74°50′E	Dharwar, 18.4-29.5 km SW (—) K: Dharwar K: North Kanara	[1961]/—	forest	[3 troops]	—
86d	15°19′N, 76°28′E	Vijayanagar, 1500 ft. (450) K: Bellary	[4 Aug. 1912]/—	—	2	—
87	15°14′N, 80°02′E	Singarayakonda (35) AP: Ongole	6 May/1615-1640	village	10	10
88	15°12′N, 80°01′E	Ulavapad, 2 km N (10) AP: Ongole	6 May/1645-1705	roadside	19	19
89	15°11′N, 80°01′E	Ulavapad, 1 km N (10) AP: Ongole	6 May/1710-1720	roadside	13	13
90d	15°08′N, 74°56′E	Devikop, 2000 ft. (600) K: Dharwar	[21 Nov. 1911]/—	—	1	—
91c	14°48′N, 74°08′E	Karwar (—) K: North Kanara	—	forest	—	—
92c	14°45′N, 79°10′E	E. Ghats, near Nellore (—) AP: Nellore	—	—	1	—
93d	14°40′N, 75°00′E	Samasgi, 2000 ft. (600) K: North Kanara	[12 Mar. 1912]/—	—	6	—

a Four troops that reportedly are the result of recent human introduction are omitted from this table. Two of these, *M. mulatta* at Borivli National Park (19°10′N, 72°55′E) and Raj Bhavan compound, Bombay (18°56′N, 72°48′E) are discussed by Serrao and Amladi (1979, pp. 29, 32). The other two, *M. mulatta* at Paddavaram (16°01′N, 79°38′E; 5 May 1980) and *M. radiata* at Dornala (15°54′N, 79°07′E; 5 May 1980) were observed and investigated by us; local residents report that monkeys at Paddavaram were introduced in 1977 and those at Dornala were introduced in April 1980.

b Abbreviations: AP, Andhra Pradesh; G, Gujarat; K, Karnataka; M, Maharashtra; MP, Madhya Pradesh; O, Orissa.

c Literature records: Loc. Nos. 3, 14, 51, 62, 64, 81 (Koyama and Shekar, 1981, p. 5, Table 2); Loc. No. 10 (Jay 1965, p. 212); Loc. No. 61 (Serrao and Amladi 1979, p. 29); Loc. No. 64 (McCann 1933, p. 810); Loc. No. 83 (Koyama 1973, p. 225); Loc. Nos. 83, 85 (Sugiyama 1972, p. 255); Loc. No. 84 (Shortridge in Wroughton 1912, p. 1176); Loc. No. 91 (Krishnan 1972, p. 536); Loc. No. 92 (Jerdon 1867, p. 13).

d Records based on specimens preserved in museum collections, as follows: Bombay Natural History Society, Loc. Nos. 60, 62, 70, 79, 90, 93; British Museum (Natural History), London, Loc. Nos. 17, 70, 79, 82, 86, 93; Field Museum of Natural History, Chicago, Loc. Nos. 82, 93; Zoological Survey of India, Calcutta, Loc. Nos. 41, 82.

e Species composition of mixed troops: Loc. No. *50*, 1 *M. mulatta*, 3 *M. radiata;* Loc. No. *51*, 18 *M. mulatta*, 1 *M. radiata;* Loc. No. *52*, 22 + *M. mulatta*, 1 *M. radiata*.

bridization between *M. mulatta* and *M. radiata*, and, considering the strong differences between these species in male and female reproductive anatomy (Fooden 1980, p. 2), such hybridization would not be expected.

In the Vijayawada Hills area we observed three *M. radiata* troops that apparently are part of an enclave isolated within the range of *M. mulatta* (Fig. 1). At a temple in Vijayawada (Table 1, Loc. No. *51*) we saw a troop of 35+ *M. radiata* individuals. At Kondapalle (Loc. No. *40*), 15 km NW of Vijayawada, we saw one troop of 22 *M. radiata* individuals and one troop of 20 *M. mulatta* individuals; during the movement of these two troops they remained 10-50 m apart but there was no overt social interaction between them. At Mailavaram (Loc. No. *71*), 25 km N of Vijayawada, we saw 3 *M. radiata* adult females (1 pregnant) that apparently were part of a larger troop; local people informed us that a large *M. mulatta* troop also inhabits the outskirts of this village, but we were unable to locate it in the time available.

Interpretation

The distribution of *M. mulatta* and *M. radiata* revealed by our survey appears to be a natural one, without incongruities that would be expected if human introductions had played a major role (Fig. 1). It is not surprising that the Tapti, Godavari and Krishna Rivers are not boundaries between the ranges of these species; both species are known to be good swimmers (Blanford 1888, p. 14; Stonor 1944, p. 591; Krishnan 1972, pp. 539, 541), and *M. mulatta* occurs on both sides of the Ganges and Brahmaputra Rivers, which are longer and broader than the Tapti, Godavari and Krishna Rivers.

Evidence that the geographic relationship between these two species is not static is provided by observations at the southeastern end of the interspecific boundary. Mixed-species troops observed in this area suggest that young *M. radiata* males, which normally leave their natal troop before attaining sexual maturity (Fooden 1981), may occasionally join a nearby *M. mulatta* troop instead of joining a troop of their own species. The isolated *M. radiata* enclave in the Vijayawada Hills area suggests that *M. mulatta* has invaded territory formerly occupied by *M. radiata*; this interpretation assumes that the continuously distributed species (*M. mulatta*) has expanded its range and that the discontinuously distributed species (*M. radiata*) has lost ground. The timing of this inferred advance by *M. mulatta* and its encirclement of the marooned *M. radiata* population is unknown; presumably it occurred much more than 30-50 years ago, because local informants say that *M. mulatta* has been well established around Vinukonda (Table 1, Loc. No. *49*), near the southern tip of the range of this species, as far back as they can remember.

Despite minor oscillations along the interspecific boundary, the long-term persistence of *M. mulatta* in its northern range and *M. radiata* in its southern range presumably indicates that each species possesses a competitive advantage in its respective area, an advantage based on superior adaptation to some critical factor or factors in the environment. We have not been able specifically to identify these critical environmental factors. Other pairs of organisms exhibit a similar pattern of latitudinal replacement in the same part of India —for example, the Indian red jungle fowl (*Gallus g. murghi*) and grey jungle fowl (*G. g. sonnerati*) and sal (*Shorea* spp.) and teak (*Tectona grandis*) (Ali and Ripley 1969, p. 104; Das Gupta 1976, plates 4, 5, 8, 11); presumably, similar factors have operated to produce and maintain these similar distribution patterns. Climate, which obviously is related to latitude, probably is one important factor. We note that *M. mulatta* is replaced by another long-tailed macaque (*M. fascicularis*) in the Indochinese Peninsula (Fooden 1971, p. 28) at approximately the same latitude at which it is replaced by *M. radiata* in the Indian Peninsula.

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THE VEGETATION OF NAGZIRA WILDLIFE SANCTUARY AND ITS ENVIRONS (MAHARASHTRA STATE)[1]

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The paper gives an account of the vegetation of Nagzira wildlife sanctuary and its environs in Maharashtra State. Location, geology and climate is briefly discussed. 174 species comprising of about 47 families and 142 genera are listed (giving upto-date nomenclature and uses and local names).

Introduction

Nagzira wildlife sanctuary lies in Tirora range of Bhandara forest division in Bhandara district. The forests of Nagzira are well preserved and there are two perennial water reservoirs, one at Nagzira and the other at Thadezari. These two water reservoirs assure perennial water supply to wildlife in the area. Thousands of visitors visit this area every year. But so far no published account about the vegetation of the area is known. A passing reference to a very few plants from Bhandara district is made by Haines (1916)[3]. In the present paper the vegetation of Nagzira wildlife sanctuary and its environs is briefly discussed. A list of 174 species comprising of about 47 families and 142 genera is given (with upto-date nomenclature and uses local names if any).

Physical features

Situation and area:

The Nagzira wildlife sanctuary lies in Tirora range of Bhandara Forest Division in Bhandara district. The area is approachable by the Sakoli-Nagzira forest road branching off from the Great Eastern Highway at Sakoli about 100 kms from Nagpur and the Murdoli-Nagzira forest road about 25 kms from Gondia. The forests of the area extend over 131.75 sq. km.

Climate:

The climate of the area is quite pleasant during the greater part of the year. Only a little span of summer is very hot. The temperature varies between 6-5°C during January to 45°C during May. The average annual rainfall varies between 1,100 mm and 1,500 mm.

Vegetation:

The vegetation of the area is of mixed deciduous type. *Anogeissus latifolia* (Roxb.) ex DC. Bedd.; *Bauhinia racemosa* Lamk., *Bridelia retusa* (L.) Spreng; *Butea monosperma* (Lamk.) Taub; *Kydia calycina* Roxb.; *Mallotus philippensis* (Lamk.) Muell.-Arg.; *Sterculia urens* Roxb. form the top canopy in the forests.

The second layer of the forests is comprised of a mixture of a number of small trees and shrubs like *Clerodendrum serratum* (L.) Moon; *Diospyros melanoxylon* Roxb.; *Gardenia latifolia* Ait.; *Holarrhena antidysenterica* (Roth) A. DC.; *Lagerstroemia parviflora* Roxb. etc. The area is usually comprised of

[1] Accepted August 1979.

[2] Botanical Survey of India, Pune.

[3] Haines, H. H. (1916): Descriptive list of trees, shrubs and economic herbs of The Southern Circle, Central Provinces, Allahabad.

the lianas and climbers like *Acacia pennata* (L.) Willd.; *Aspidopteris cordata* (Heyne) A. Juss.; *Cocculus hirsutus* (L.) Diels; *Dioscorea bulbifera* L.; *D. pentaphylla* L.; *Hemidesmus indicus* (L.) R. Br.; *Ichnocarpus frutescens* (L.) R. Br.; *Smilax zeylanica* L. etc.

The ground flora is quite rich after the monsoon. The herbs, grasses, and a few undershrubs like *Abutilon indicum* (L.) Sweet; *Achyranthes aspera* L.; *Alternanthera sessilis* (L.) R. Br. ex DC.; *Alysicarpus vaginalis* (L.) DC.; *Amaranthus spinosus* L.; *Ammannia baccifera* L.; *Andrographis paniculata* (Burm.) Wall. ex Nees, *Buchnera hispida* Buch.-Ham.; *Canscora diffusa* R. Br.; *Cassia absus* L.; *Commelina benghalensis* L.; *Corchorus aestuans* L.; *Crotalaria hirta* Willd.; *C. linifolia* L. f.; *Cyanotis cristata* (L.) D. Don; *Cyperus iria* L.; *Dactyloctenium aegyptium* (L.) P. Beauv.; *Dichanthium annulatum* (Forsk.) Stapf; *Dipteracanthus prostratus* (Poir.) Nees, *Eclipta prostrata* (L.) L.; *Elephantopus scaber* L.; *Euphorbia hirta* L.; *E. prostrata* L.; *Heteropogon contortus* (L.) P. Beauv.; *Hibiscus lampas* Cav.; *Hybanthus enneaspermus* (L.) F. Muell.; *Melochia corchorifolia* L.; *Merremia emarginata* (Burm. f.) Hall. f.; *Peristrophe bicalyculata* (Retz.) Nees; *Plumbago zeylanica* L.; *Sida acuta* Burm. f.; *Scoparia dulcis* L.; *Triumfetta rhomboidea* Jacq.; *Vernonia cinerea* (L.) Less etc. are frequently met with.

PLANTS RECORDED FROM SPECIAL HABITATS

1. *The trees and shrubs recorded from the thick forest areas*:

Anogeissus latifolia (Roxb.) ex DC. Bedd.; *Acacia chundra* (Roxb.) Willd.; *Bauhinia racemosa* Lamk.; *Bridelia retusa* (L.) Spreng; *Buchanania lanzan* Spreng; *Cassia fistula* L.; *Cleistanthus collinus* Benth.; *Diospyros melanoxylon* Roxb.; *Emblica officinalis* Gaertn.; *Eriolaena hookeriana* Wt. & Arn.; *Grewia tiliaefolia* Vahl.; *Gardenia latifolia* Ait.; *Helicteres isora* L.; *Holarrhena antidysenterica* (Roth) A. DC.; *Kydia calycina* Roxb.; *Lagerstroemia parviflora* Roxb.; *Mallotus philippensis* (Lamk.) Muell.-Arg.; *Mitragyna parvifolia* (Roxb.) Korth; *Semecarpus anacardium* L. f.; *Sterculia urens* Roxb.; *Stereospermum suaveolens* (Roxb.) DC.; *Tectona grandis* L.; *Terminalia tomentosa* Wt. & Arn.; *Woodfordia fruticosa* (L.) Kurz.; *Xeromphis uliginosa* (Retz.) Mahesh. etc.

2. *Plant species recorded as undergrowth of the forests along the roads, paths and wastelands*:

Achyranthes aspera L.; *Alysicarpus vaginalis* (L.) DC.; *Amaranthus spinosus* L.; *Cassia absus* L.; *Corchorus aestuans* L.; *Crotalaria hirta* Willd.; *C. linifolia* L. f.; *Cyperus tenuispica* Steud.; *Datura innoxia* Mill.; *Desmodium triflorum* (L.) DC.; *Elephantopus scaber* L.; *Eragrostis unioloides* (Retz.) Nees; *Eriocaulon dianae* Fyson.; *Heliotropium ovalifolium* Forsk.; *Hemigraphis latebrosa* (Roth) Nees, *Heteropogon contortus* (L.) P. Beauv.; *Hybanthus enneaspermus* (L.) F. Muell.; *Leonotis nepetifolia* (L.) R. Br.; *Leucas biflora* R. Br., *Melochia corchorifolia* L.; *Rhynchosia minima* DC.; *Rungia pectinata* (L.) Nees, *Sida acuta* Burm. f., *Sida cordata* (Burm. f.) Borss.; *Tridax procumbens* L.; *Triumfetta rhomboidea* Lamk.; *T. rotundifolia* Lamk.; *Uraria picta* (Jacq.) Desv. ex DC.; *Urena lobata* L.; *Vernonia cinerea* (L.) Less.; *Vicoa indica* (Willd.) DC. etc.

3. *Plant species recorded along the degraded forests and scrub jungle*:

Abrus precatorius L.; *Abutilon indicum* (L.) Sweet; *Alternanthera sessilis* (L.) R. Br. ex DC.; *Andrographis paniculata* (Burm.) Wall. ex DC.; *Buchnera hispida* Buch.—Ham.; *Canavalia ensiformis* DC.; *Clerodendrum serratum* (L.) Moon; *Cocculus hirsutus* (L.)

Diels; *Coldenia procumbens* L.; *Corchorus aestuans* L.; *Desmodium triflorum* (L.) DC.; *Eclipta prostrata* (L.) L.; *Eragrostis tenella* (L.) P. Beauv.; *Grewia hirsuta* Vahl, *Hibiscus lampas* Cav.; *Helicteres isora* L.; *Paspalum scrobiculatum* L.; *Phyllanthus urinaria* L.; *Plumbago zeylanica* L.; *Rhynchosia minima* DC.; *Sida cordata* (Burm. f.) Borss; *Urena lobata* L. etc.

4. *Plant species recorded from water courses, ponds & marshy places*:

Ammannia baccifera L.; *A. multiflora* Roxb.; *Commelina benghalensis* L.; *Cyanotis cristata* (L.) D. Don, *Cyperus iria* L.; *Dactyloctenium aegyptium* (L.) P. Beauv.; *Echinochloa colonum* (L.) Link., *Eclipta prostrata* (L.) L.; *Hygrophila auriculata* (Sch.) Heine, *Ipomoea aquatica* Forsk.; *Limnophila indica* (L.) Druce, *Ludwigia octovalis* (Jacq.) Raven; *Melochia corchorifolia* L.; *Merremia emarginata* (Burm. f.) Hall. f.; *Polygonum barbatum* L. var. *gracile* (Dans.) Steward; *P. glabrum* Willd.; *P. plebeium* R. Br.; *Utricularia stellaris* L. etc.

Enumeration

In the following enumeration of the plant species, the nomenclature has been brought up to date. Only the original reference has been cited. Local names if any follow the citation in inverted commas. Brief notes along with uses if any are provided following the collection (field) numbers, which are of S. K. Malhotra, senior author and are deposited in the herbarium of the Botanical Survey of India, Poona. (*BSI*).

Menispermaceae

Cissampelos pariera L. Sp. Pl. 1031, 1753 var. **hirsuta** (DC.) Forman in Kew Bull. 22 : 356. 1968. *'Paharval'*. A climbing shrub. Decoction of the roots and leaves used as an antiseptic. 151131.

Cocculus hirsutus (L.) Diels. in Engl. Pflanzenr. 46: 236. 1910. *'Vasauvel'*. A straggling herb, frequent in the forests. Roots are used as a laxative. 145102.

Violaceae

Hybanthus enneaspermus (L.) F. Muell. Fragm. Phyt. Austr. 10: 81. 1876. *'Rattanpurus'*. Frequent weed in moist habitats. Plant is used as a tonic. 144847.

Malvaceae

Abutilon indicum (L.) Sweet Hort. Brit. 54. 1826. Herb or undershrub. Flowers yellow. Decoction of the leaves is taken to cure bronchitis. 151063.

Gossypium barbadense L. Sp. Pl. 693. 1753; *'Kapus'*. Shrub. Flowers pale white. Oil obtained from the seeds is edible. 145082.

Hibiscus lampas Cav. Diss. 3 : 154. t. 56, f. 2. 1787. *'Ran-bhendi'*. Shrub, frequent in the forests. Stem fibre is used for ropes. 144615, 144691.

H. rosa-sinensis L. Sp. Pl. 694. 1753; Shrub, occurring frequently. Flowers are considered useful for making dyes. 145128.

Kydia calycina Roxb. Pl. Cor. 3: 12. t. 215. 1811. *'Potremarra'*. Frequent tree. Flowers light pink. Wood is used as a timber. 151107.

Sida acuta Burman, Fl. Ind. 147. 1968. Common herb. Decoction of the roots is used in mild cases of debility. 151096, 151175.

S. cordata (Burm. f.) Borss. Blumea 14: 182. 1966. Herb, common in open forests. Leaves are used as vegetable. 145149, 151133.

Urena lobata L. Sp. Pl. 692. 1753. Frequent herb. Flowers light pink. Stem fibre is used for ropes. 144637, 145094, 145151.

STERCULIACEAE

Eriolaena hookeriana W. & A. Prodr, 1 : 70, 1834. *'Kungai'*. Tree, frequent in dense forests. Wood is used as a timber. 144642, 145132, 151130.

Helicteres isora L. Sp. Pl. 963, 1753. *'Muradphalli'*. Shrub, frequent in dense forests. Pods are fried, mixed with milk and given to children to kill intestinal germs. 145156, 151159.

Melochia corchorifolia L. Sp. Pl. 675, 1753. Common herb. Flowers light yellow. Leaves are used as a pot herb. 151099.

Sterculia urens Roxb. Pl. Cor. 1: 25, t. 24. 1795.*'Kurlu, Karu'*. Tree, frequent in dense forests. Bark yields a fibre which is used for making ropes. 151166.

TILIACEAE

Corchorus aestuans L. Syst. 1079. 1759. (non Forsk.). Herb, common in the waste lands. Seeds are used in stomach ache. 151123.

Grewia hirsuta Vahl Symb. 1: 34. 1790. *'Jiblikichetu'*. Shrub, frequent in the forests. Bark is used to check dysentery. 144663.

G. tiliaefolia Vahl, Symb. 1: 35. 1790. *'Dhaman'*. A small erect tree, frequent in the dense forests. Fruits are edible. 144666.

Triumfetta rhomboidea Jacq. Enum. Pl. Carib. 22. 1760. *'Anduli'*. Herb or undershrub, common in the open forests. Bark is used to check diarrhoea. 145077.

T. rotundifolia Lamk. Encycl. 3: 421. 1792. *'Mendurli'*. Herb or undershrub, common in the open forests. The plant is used as a demulcent. 145148, 151121.

MALPIGHIACEAE

Aspidopteris cordata (Wall.) A. Juss. Ann. Sci. Nat. Bot. ser. 2, 13: 267. 1840. Scandent shrub, frequent in the dense forests. 144661.

OXALIDACEAE

Biophytum sensitivum (L.) DC., Prodr. 1 : 690. 1824. Herb. Flowers yellow. Common in the waste lands. 144635, 151134.

RUTACEAE

Aegle marmelos (L.) Corr. Trans. Linn. Soc. London 5: 223. 1800. *'Bel'*. Tree, frequent in the open forests. Fruits are used in the treatment of diarrhoea. 151150.

RHAMNACEAE

Ventilago denticulata Willd. Ges. Naturf. Fr. Neue Schr. 3: 417. 1801. A large woody climber, frequent in dense forests. 145142, 151092.

Zizyphus mauritiana Lamk. Encycl. 3: 319. 1789. *'Ber'*. A large shrub, frequent in open forests. Fruits are edible. Leaves are used as fodder. 151171.

Z. oenoplia Mill. Gard. Dict. ed. 8, n. 3, 1768. *'Yeruni, Ironi'*. A large straggling shrub, frequent in open forests. Fruits are edible and the bark is used as a tan. 151170.

VITACEAE

Ampelocissus tomentosa (Roth.) Planch. J. Vigne. Am. 374. 1883. A woody climber, frequent in dense forests. 151144, 151158.

LEEACEAE

Leea edgeworthii Sant. in Rec. Bot. Surv. Ind. 16(1): 54. 1953. Undershrub, frequent in open and dense forests. Fruits are edible. 144789.

ANACARDIACEAE

Buchanania lanzan Spreng. J. Bot. (Schrader) 2: 234. 1800. *'Charoli'*. Tree, frequent in the dense forests. Fruits and seeds are edible.

Seeds purify the blood and is considered a brain tonic. 145068.

Semecarpus anacardium L. f. Suppl. 182. 1781. '*Biba*'. Tree, frequent in the dense forests. Seed oil is used as a protection against white ants. 144610.

FABACEAE

Abrus precatorius L. Syst. Nat. ed. 12, 472. 1767. '*Ganja*'. Perennial climber, frequent in dense forests. Leaves along with warm mustard oil is used to relieve pain due to swelling etc. 144632, 145100.

Alysicarpus bupleurifolius (L.) DC. Prodr. 2: 353. 1825. A slender perennial herb, frequent in the forests. 144649, 144701.

A. vaginalis (L.) DC. Prodr. 2: 353. 1825. A suberect much branched herb, common along the edges of forests. Roots are used to check cough. 151070.

Butea monosperma (Lamk.) Taub. in Engl. & Prantl, Pflanzenfam 3(3): 366. 1894. '*Palas*'. Tree, occurring frequently in the open forests. Flowers are applied as poultice to heal swellings etc. 145088.

Canavalia ensiformis DC. Prodr. 2: 404. 1825. '*Cavara*'. Climbing herb, frequent along the open forests. Pods are used as vegetable. 145099, 151088.

Crotalaria hirta Willd., Ges. Naturf. Freude Berlin Neue Schriften 4 : 217. 1803. Herb, frequent in the open forests. 151191.

C. linifolia L. f. Suppl. 322. 1718. Suffruticose herb, frequent in the forests. 144678.

Desmodium heterocarpon (L.) DC. Prodr. 2: 337. 1825. Herb, frequent in the scrub forests. 144625, 144643.

D. triflorum (L.) DC. Prodr. 2: 334. 1825. Herb, frequent in the open grasslands. Plant is used as a fodder. 144645, 145105.

Flemingia strobilifera (L.) Aiton, Hort. Kew ed. 2, 4: 350. 1812. Undershrub, frequent in the scrub forests. 144675, 145073, 145163.

Indigofera cassioides Rottl. ex DC. Prodr. 2: 225. 1825. Herb, frequent in the open grasslands. 145063, 151145.

Pseudarthria viscida (L.) Wt. & Arn. Prodr. 209. 1834. Herb, frequent in the scrub forests. Plant is used to check piles. 144621, 144662.

Rhynchosia minima (L.) DC. Prodr. 2: 385. 1825. Herb, frequent in the open grasslands. Leaves are used as a stimulent. 151066.

Teramnus labialis (L.) Spreng. Syst. 3: 235. 1926. Twining herb, common in the scrub and dense forests. Plant is used as a fodder. 144606, 151101, 151149.

Uraria lagopodioides (L.) Desv. ex DC. Prodr. 2: 324. 1825. Herb, rare along the edges of forests. 144647, 151136.

U. picta (Jacq.) Desv. ex DC. Journ. Bot. 1: 123. 1813. Herb, frequent in the dense and scrub forests. Fruits are used as an antiseptic. 144648.

CAESALPINIACEAE

Bauhinia purpurea L. Sp. Pl. 375. 1753. '*Kanchana*'. Tree, frequent along habitations. Leaves are used as fodder. 151102.

B. racemosa Lamk., Encycl. 1: 390. 1785. Tree, frequent in the dense forests. Fruits are edible. 144612.

Cassia absus L. Sp. Pl. 376. 1753. Herb, frequent along the open grass lands. Leaves are used against skin diseases. 144628.

C. fistula L. Sp. Pl. 377. 1753. '*Bahava*'. Tree, frequent in the dense and scrub forests. Wood is used as a timber. 144682, 140581, 151147.

Piliostigma malabaricum (Roxb.) Benth. Miq. Pl. Jungh. 261. 1852. Tree, frequent in dense forests. Bark is used for making ropes. 144633, 145065, 145138.

Mimosaceae

Acacia chundra (Rottl.) Willd. Sp. Pl. 4: 1078. 1806. *'Khair'*. Tree, frequent in dense and scrub forests. Wood is used as timber. 144611.

A. nilotica (L.) Del. subsp. **indica** (Benth.) Brenan, Kew Bull. 12: 84. 1957. *'Babhul'*. Tree, frequent along the edges of forest roads. Decoction of the leaves is used for sore throat. 145103.

A. pennata (L.) Willd. Sp. Pl. 4: 1090. 1806. Scandent shrub, frequent in dense forests. Leaves are used to check bleeding. 151139.

Pithecellobium dulce (Roxb.) Benth. London J. Bombay nat. Hist. Soc. 3: 199. 1844. Tree, frequent along the scrub forests. Seeds are edible. 145058.

Combretaceae

Anogeissus latifolia (DC.) Wall. ex Bedd. Fl. Sylv. t. 15. 1869. *'Dhavada'*. Tree, frequent in dense forests. Leaves are used for tanning. Wood is used for making tools etc. 144673, 145134, 151127.

Terminalia tomentosa Wt. & Arn. Prodr. 314. 1834. Tree, frequent in dense forests. Fruits are used for dyeing and tanning. 144688, 151128.

Lythraceae

Ammannia baccifera L. Sp. Pl. (ed. 2) 175. 1762. *'Bharayiambhul'*. Herb, common along moist habitats. Plant is used to check rheumatic pains. 144704, 145093.

A. multiflora Roxb. Fl. Ind. 1: 447. 1820. Herb, common in moist habitats. 144651.

Lagerstroemia parviflora Roxb. Pl. Cor. 1: 47, t. 66. 1795. *'Lendia'*. Tree, frequent along dense forests. The wood is used for furniture etc. 144680, 151153.

Woodfordia fruticosa (L.) Kurz. in JASB. 40: 56. 1871. Shrub, frequent in dense and scrub forests. Bark and leaves are used for tanning. 151145.

Onagraceae

Ludwigia octovalis (Jacq.) Raven subsp. **sessiliflora** (Mich.) Raven Kew Bull. 15 : 476, 1962. Herb, frequent on swampy soils. 145052.

Cucurbitaceae

Luffa acutangula (L.) Roxb. var. **amara** (Roxb.) C.B.Cl. in Fl. Brit. India 2: 615. 1879. *'Kadudodka'*. An extensive climber. Fruits are used as vegetable. 144605.

Rubiaceae

Gardenia latifolia Ait. Hort. Kew 1: 294. 1789. Tree, frequent in the dense and scrub forests. Wood is used for making toys. 145130, 151164.

Knoxia sumatrensis (Retz.) DC. Prodr. 4: 569. 1830. Herb, frequent in moist habitats. 144690.

Mitragyna parvifolia (Roxb.) Korth, Obs. Naucl. Ind. 19, 1839. *'Kadam'*. Tree, frequent in dense forests. Wood is used for agricultural implements. 144670, 145107.

Xeromphis uliginosa (Thunb.) Keay, Bull. Jard. Bot. Etal 28: 37. 1958. *'Karingud'*. Tree, frequent in scrub forests. Bark is used in diarrhoea. 144634.

Asteraceae

Blumea belangeriana DC. Prodr. 5: 444. 1836. Herb, frequent in moist habitats. 155146.

Eclipta prostrata (L.) Linn. Mant. Alt. 286, 1771. *'Bhangra'*. A common weed with white flowers. 145161.

Elephantopus scaber L. Sp. Pl. 814. 1753. Herb, frequent in dense forests. 144638, 145147.

Emilia sonchifolia (L.) DC. ex Wight, Contrib. Bot. Ind. 24, 1834. Herb, common along the moist habitats. Decoction of roots is used in bowel complaints. 145120, 151079.

Grangea maderaspatana (L.) Poir. in Lam., Encycl. Suppl. 2: 825. 1811. Herb, frequent along the moist habitats. Leaves are used to check stomach ache. 155141.

Sphaeranthus indicus L. Sp. Pl. 1314. 1753. *'Gorakhammundi'*. Herb, common winter weed in the fields after harvesting. Decoction of the plant is used to check cough. 145083.

Tridax procumbens L. Sp. Pl. 900. 1753. *'Ekdandi'*. Herb, common along the rocky habitats. Juice of the leaves is used for wounds etc. 145106, 151113.

Vernonia cinerea (L.) Less. Linnaea 4: 291. 1829. *'Osari'*. Herb, common weed of the wastelands. 145071.

Vicoa indica (Willd.) DC. in Wight, Contrib. 10, 1834. Herb, flowers yellow. Common in moist habitats. 145062, 151082, 151111.

Lobeliaceae

Lobelia alsinoides Lamk. Encycl. 3: 588. 1792. Herb, frequent in moist rocky habitats. 145154.

Plumbaginaceae

Plumbago zeylanica L. Sp. Pl. 151. 1753. *'Chitramula'*. Herb, frequent in the wastelands. Paste of the root with salt and water is applied for skin diseases. 145084.

Ebenaceae

Diospyros melanoxylon Roxb. Cor. Pl. 1: 236. t. 46. 1795. *'Tendu'*. Tree, frequent in the forests. Leaves are used for wrapping 'biddis'. 151169.

Oleaceae

Nyctanthes arbor-tristis L. Sp. Pl. 6. 1753. *'Parijat'*. Tree, frequent in dense forests. Flowers are used for making an orange coloured dye. 151151.

Apocynaceae

Holarrhena antidysenterica (Roxb.) A. DC. in DC.; Prodr. 8: 413. 1844. *'Kuda'*. Shrub, common in the dense forests. Leaves are used as a tonic. 149564.

Ichnocarpus frutescens (L.) R. Br. In Aiton, Hort. Kew ed. 2, 2: 69. 1811. *'Kantabharv'*. Climbing shrub, frequent along dense forests. Stems are used for making ropes. 144436.

Asclepiadaceae

Calotropis gigantea (L.) R. Br. in Aiton, Hort. Kew ed. 2, 2: 78. 1811. *'Madar'*. Shrub or undershrub, frequent in wastelands. Floss, obtained from the seeds is used as a stuffing. 145096.

Hemidesmus indicus (L.) R. Br. in Aiton, Hort. Kew ed. 2, 2: 75. 1811. Twining shrub, frequent in dense forests. Roots are used as demulcent. 144669.

Pergularia daemia (Forsk.) Chiov. Result. Sc. Miss. Sefan Paoli Soman. Ital. 1: 115. 1916. *'Utarni'*. Twining shrub, frequent in scrub forests. Juice of the leaves is applied in rheumatism. 151091.

Gentianaceae

Canscora diffusa (Vahl) R. Br.; Prodr. 451. in obs. 1810. Herb, frequent in moist habitats. Plant is used as a laxative. 151077, 151120.

Exacum pumilum Griesb. in DC. Prodr. 9: 46. 1845. Herb, frequent in moist habitats. 144616.

Boraginaceae

Coldenia procumbens L. Sp. Pl. 125. 1753. A frequent weed occurring in moist habitats. Fresh leaves are used against rheumatic swellings. 145165.

Heliotropium ovalifolium Forsk. Fl. Aegypt. —Arab. 38: 1775. Frequent weed along the edges of forests. 145157.

Trichodesma zeylanicum (N. Burman) R. Br. Prodr. 496. 1810. Frequent weed along the edges of forests. Paste of the leaves is applied to swellings. 151285.

Convolvulaceae

Ipomoea aquatica Forsk. Fl. Aegyp.—Arab. 44. 1775. *'Nalichibhaji'*. Ground trailing or floating herb. Leaves are eaten as vegetable. 151058, 151297.

Jacquemontia paniculata (Burm. f.) Hall. f. Bot. Jahrb. 16: 541. 1893. A slender twining herb. 145092.

Merremia emarginata (Burm. f.) Hall. f. Bot. Jahrb. 16: 552. 1893. A prostrate creeping herb, frequent in moist habitats. 144645, 145187.

Solanaceae

Datura innoxia Mill. Gard. Dict. n. 5. 1768. Herb, frequent in wastelands. Leaves are used to cure asthma. 151093.

Solanum surrattense Burm. f. Fl. Ind. 57, 1768. (excl. syn. Fl. Brit. India 4: 236. Pluk. et Raj.). A prickly diffuse, herb, common in wastelands. Leaves are used for rheumatism. 145032.

Scrophulariaceae

Buchnera hispida Buch.-Ham. ex D. Don. Prodr. Fl. Nepal 91. 1825. Herb, frequent in moist habitats. 151154.

Dopatrium junceum (Roxb.) Buch.-Ham. ex Benth. Scroph. Ind. 31. 1835. Herb, frequent in moist habitats. 144697.

Limnophila indica (L.) Druce, Bot. Exach. Club Soc. Brit. Isles 3: 420. 1914. Herb, common in moist habitats. Herb considered to be an antiseptic. 144705.

Lindernia parviflora (Roxb.) Haines, Bot. Bihar & Orissa 635 (665). 1922. Herb, frequent in moist habitats. 151076.

Scoparia dulcis L. Sp. Pl. 116, 1753. Frequent weed in wastelands. 144671.

Lentibulariaceae

Utricularia stellaris L. f. Suppl. 86. 1781. Herb, flowers yellow. Common in stagnant waters. 144703.

Bignoniaceae

Millingtonia hortensis L. f. Suppl. 291. 1781. An avenue tree. 151168.

Stereospermum suaveolens (Roxb.) DC. Prodr. 9: 211. 1845. *'Padal'*. Tree, frequent along the dense forests. Wood is used as timber. 151156.

Acanthaceae

Andrographis paniculata (Burm.) Wall. ex Nees in Wall. Pl. As. Rar. 3: 116. 1832. *'Dev Kirayath'*. Herb, frequent in moist habitats. Green leaves are used as tonic. 144631, 151100, 151167.

Blepharis maderaspatensis (L.) Heyne ex Roth, Nov. Pl. Sp. 320. 1821. Herb, frequent in scrub forests. 145075.

Dipteracanthus prostratus (Poir) Nees in Wall., Pl. As. Rar. 3: 81. 1832. Herb, frequent in moist habitats. Leaves are considered useful as a remedy for ear disease. 144657.

Hemigraphis latebrosa (Roth) Nees in DC. Prodr. 11: 723. 1847. Herb, frequent in dense forests. 145080, 145144, 151097, 151122.

Hygrophila auriculata (Sch.) Heine. in Kew Bull. 16: 172, 1962. A stout herb, frequent in wet places. 145091.

Justicia betonica L. Sp. Pl. 15, 1753; Clarke in Hook. f. Fl. Brit. India 4: 525. 1885. A diffusely branched undershrub. 144622.

Peristrophe bicalyculata (Retz.) Nees in Wall. Pl. As. Rar. 3: 113. 1832. Herb, frequent in dense forests. Plant is used as an antidote for insect bite. 145086, 151089.

Rungia pectinata (L.) Nees in DC., Prodr. 11: 469. 1847. Herb, common in the forests. 145067, 151098.

R. repens (L.) Nees in Wall. Pl. As. Rar. 3: 110. 1832. *'Ghati piltapapda'*. Herb, common in the forests. Plant is used to cure cough etc. 145121.

Verbenaceae

Clerodendrum serratum (L.) Moon, Cat. 46. No. 382. 1824; Spreng. Syst. 2: 758. 1825. *'Bharang'*. Shrub, frequent along the edges of forests. Leaves are used as vegetable. 144629.

Lantana camara L. var. **aculeata** (L.) Maldenke in Torreya 34: 9. 1934. Shrub, frequent in wastelands. Decoction of the plant is used in rheumatism. 151080.

Tectona grandis L. f. Suppl. 151, 1781. *'Sagwak'*. Tree, common in the forests. The wood is a good timber and is used for construction and is useful for making furniture etc. 145089.

Lamiaceae

Leonotis nepetifolia (L.) R. Br. Prodr. 504. 1810. Herb, frequent in the scrub forest and wastelands. Decoction of the leaves is used as tonic. 145085, 151086.

Leucas biflora R. Br. Prodr. 504. 1810. Herb. Flowers white. Frequent in the forests. 144664.

Pogostemon plectranthoides Desf., Ann. Mus-Natl. Hist. Nat. 2: 156. t. 6, 1808. Undershrub, frequent along the edges of forests. The plant is used as an insecticide. 145072, 151157.

Amaranthaceae

Achyranthes aspera L. Sp. Pl. 204, 1753. *'Aghada'*. Herb, frequent in scrub forests and wastelands. The plant ash is used externally for ulcers. Leaves are also used as pot herb. 151151.

A. bidentata Blume, Bijdr. 545. 1826. Herb, frequent in scrub forests and wastelands. 144630.

Alternanthera sessilis (L.) DC. Cat. Hort. Monsp. 77. 1813. Frequent weed in moist places. Plant is used in rheumatism. 144685.

Amaranthus spinosus L. Sp. Pl. 991, 1753. *'Kante Math'*. Common weed of wastelands. Plant is used as vegetable and also as fodder. 145097.

A. viridis L. Sp. Pl. ed. 2, 1405. 1763. Herb, common in moist places. Plant is used as fodder. 144604.

Polygonaceae

Polygonum barbatum L. var. **gracile** (Dans.) Steward, East As. In Contrib. Grey Herb. 88: 55. 1930. Herb, frequent in moist places. 144922.

P. glabrum Willd. Sp. Pl. 2 : 447, 1799. Herb, frequent in moist places. 151115.

P. plebeium R. Br. Prodr. 420. 1810. Herb, common weed of wastelands. 141558.

Euphorbiaceae

Bridelia retusa (L.) Spreng. Syst. veg. 3: 48. 1826. *'Kassie'*. Fruits are edible. Leaves are used as fodder. 151129.

Cleistanthus collinus Benth. in Gen. Pl. III. 268. 1880. *'Garari'*. Tree, frequent in the dense forests. Bark, leaves and fruits are used for tanning. 144708.

Chrozophora rottleri (Geis) Juss. ex Spreng. Syst. 3: 850. 1826. Densely hispid herb frequent in wastelands. 145138.

Emblica officinalis Gaertn. Fruct. 2: 122. 1791. *'Avala'*. Tree, frequent in the dense forests. Fruits are edible. Unripe fruits act as a laxative. 151135.

Euphorbia hirta L. Sp. Pl. 454. 1753. Common weed of wastelands. Decoction of the plant is used in asthma. 151114.

E. parviflora L. Syst. (ed. 10) 2: 1047. 1759. Frequent weed of wastelands. 145172.

E. prostrata Ait. Hort. Kew 2: 139. 1789. Frequent weed of wastelands. 145116.

Kirganelia reticulata (Poir.) Baill. Etud. Gen. Euph. 614. 1874. Undershrub, frequent in scrub forests. Roots are used for making red dye. 145101.

Mallotus philippensis (Lamk.) Muell. Arg. in Linnaea 34: 196. 1865. *'Raini'*. Tree, frequent in dense forests. The powdered fruit is used as a purgative. 145150.

Phyllanthus urinaria L. Sp. Pl. 982. 1753. Herb, frequent along the edges of forests. 144617.

Ricinus communis L. Sp. Pl. 1007. 1753. Shrub, frequent along the edges of forests. The seed cake is used as fertilizer. 145095.

MORACEAE

Ficus hispida L. f. Suppl. 442. 1781. Tree, frequent in the scrub forests. Fruits are edible. 145055.

ORCHIDACEAE

Habenaria plantaginea Lindl. Gen. & Sp. Orch. 323, 1835. Herb, frequent in the forests. 144623, 144627.

Vanda tessallata (Roxb.) Hook. ex G. Don in Loud., Hort. Brit. 372. 1830. Epiphytic herb, frequent. Roots are used in rheumatism. 145137.

ZINGIBERACEAE

Curcuma pseudomontana Grah. Cat. Pl. Bomb. 210. 1839. Herb, frequent on moist habitats. 144672.

Zingiber macrostachyum Dalzell, J. Hook. Bot. Kew Gard. Misc. 4: 342. 1852. Herb, frequent in moist habitats. 144699.

DIOSCOREACEAE

Dioscorea bulbifera L. Sp. Pl. 1033, 1753. Climber, frequent in scrub and dense forests. Roots are used as vegetable. 144646, 151067.

D. pentaphylla L. Sp. Pl. 1032, 1753. Climber, frequent in the dense and scrub forests. Roots are edible. 144640, 144700.

LILIACEAE

Iphigenia indica (L.) A. Gray in Kunth, Enum. 4: 213. 1843. Herb, frequent in the dense forests. 144624.

SMILACACEAE

Smilax zeylanica L. Sp. Pl. 1029. 1753. *'Jangli Ael'*. Scandent. Young branches and leaves are used as vegetable. 144654, 151160.

COMMELINACEAE

Amischophacelus axillaris (L.) Rolla Rao et Kammathy, J. Linn. Soc. Bot. 59: 306. 1966. Herb, frequent in the moist habitats. 144702.

Commelina benghalensis L. Sp. Pl. 41. 1753. Herb, frequent in moist habitats. Plant is used as a laxative. 144740.

Cyanotis cristata (L.) D. Don, Prodr. Fl. Nep. 46. 1825. Herb, frequent in moist habitats. 144636.

ERIOCAULACEAE

Eriocaulon dianae Fyson. J. Indian Bot. 2: 259, t. 11. 1921. Herb, frequent in moist grasslands. 144652.

CYPERACEAE

Cyperus flavidus Retz. Obs. Fasc. 5: 13. 1789. Herb, frequent in moist habitats. 145061.

C. iria L. Sp. Pl. 45. 1753. Herb, frequent in moist habitats. The culms are used for making mats. 144618.

C. tenuispica Steud. Syn. Pl. Glum. 2 : 11. 1855. Herb. frequent in moist habitats. 145179.

Fimbristylis bis-umbellata (Forskal) Bub. Dodec. 30, 1850. Herb, frequent in moist habitats. 144650.

F. dichotoma (L.) Vahl, Enum. Pl. 2 : 287. 1805. Herb. frequent in moist habitats. 144644, 144676.

F. miliacea (L.) Vahl, Enum. Pl. 2 : 287. 1805. Herb, frequent in moist habitats. 151060.

F. schoenoides (Retz.) Vahl, Enum. Pl. 2 : 286. 1805. Herb, frequent in moist habitats. 144693.

Kyllinga triceps Rottb. Descr. & Icon. 14, t. 4, f. 6 (excl. cit. Rheed.), 1773. Herb, frequent in moist habitats. 144681.

POACEAE

Aristida adscensionis L. Sp. Pl. 82. 1753. Herb, frequent in moist habitats. Plant is used as an antiseptic. 145145.

Dactyloctenium aegyptium (L.) P. Beauv. Ess. Agrost. 15: 1812. Herb, common in open grasslands. Plant is used as fodder. 145000.

Dichanthium annulatum (Forsk.) Stapf in Prain, Fl. Trop. Africa 9: 178. 1917. Herb, common in open grasslands. Plant is used as fodder. 145164.

Echinochloa colonum (L.) Link. Hort. Berol. 2: 209. 1833. Herb, frequent in moist habitats. Seeds are eaten. Plant is also used as fodder. 144686, 144698.

Elytrophorus spicatus (Willd.) A. Camus in Lecomte, Fl. Gen. Indo-Chine 7: 547. 1923. Herb, frequent in moist habitats. 155184.

Eragrostis gangetica (Roxb.) Steud. Syn. Pl. Glum. 1: 266. 1854. Herb, frequent in moist habitats. 145060.

E. poaeoides P. Beauv. Agrost. 162. 1812. Herb, frequent in moist habitats. 145061.

E. tenella (L.) P. Beauv. ex Roem. et Schult. Syst. veg. 2: 576. 1817. Herb, frequent in open grasslands. 145009.

E. unioloides (Retz.) Nees ex Steud. Syn. Pl. Glum.: 264. 1854. Herb, common in open grasslands. 144358.

Hackelochloa granularis (L.) O. Ktze. Rev. Gen. Pl. 976. 1891. Herb, frequent in moist habitats. 145087.

Heteropogon contortus (L.) P. Beauv. ex Roem. & Schultes Syst. Veg. 2: 836. 1817. Herb, common in open grasslands. 145069.

Iseilema laxum Hack. in DC. Mon. Phan. 6: 682. 1889. Herb, frequent in moist habitats. Plant is used as fodder. 145139.

Panicum notatum Retz. Obs. Bot. 4: 18. 1786. Herb, frequent in moist habitats. 145079.

Paspalum scrobiculatum L. Mant. 29. 1767. Herb, frequent in moist habitats. Plant is used as an insecticide. 145016.

Pseudanthistiria heteroclita (Roxb.) Hook. f. Fl. Brit. India 7: 219. 1897. Herb, frequent in moist habitats. Plant is used for thatching. 144684.

Themeda quadrivalvis (L.) O. Kuntz Rev. Gen. Pl. 2 : 794. 1891. Tall grass, frequent in moist habitats. Grass is eaten by deer. 145087.

Vetiveria zizanioides (L.) Nash in Small. Fl. Southeast U.S. 67. 1903. '*Vala*'. Tall grass, frequent in the open grasslands. Plant is used for making curtains etc. 145039.

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BEHAVIOUR OF *LISSEMYS PUNCTATA* (REPTILIA, TESTUDINATA, TRIONYCHIDAE) IN A DRYING LAKE IN RAJASTHAN, INDIA[1]

WALTER AUFFENBERG[2]

(*With two text-figures*)

INTRODUCTION

Recent studies have shown that many freshwater turtles regularly leave the water for extended periods of time. Gibbons (1970) has suggested that the terrestrial activity of normally aquatic turtle species is an important aspect of their population dynamics. Some of these movements are associated with a number of different factors, such as ontogenetic stages (Gibbons and Coker 1977) and breeding (Gibbons 1969, Gibbons and Greene 1978), but most commonly with seasonal temperature changes (all of the above, plus Bennett, Gibbons, and Franson 1970, Bennett 1972, and Wygoda 1979). Though the aquatic faunas of shallow lakes and ponds are frequently faced with extremely lowered water tables, only the studies by Bennett (1972) and Wygoda (1979) have specifically addressed the question of the association of turtle movement with drought conditions. Both studies were concerned only with members of the family Kinosternidae—a group well known to leave pools and rivers during drought, particularly in xeric habitats. There are casual references to the same habit in Australian pleurodires (Worrell 1963), and I have seen pelusines do the same in East Africa. This study is, to my knowledge, the first published account that shows this behaviour in a member of the family Trionychidae.

The turtle here reported to have these habits is *Lissemys punctata punctata*, the Indian flapshell. Normally plentiful in shallow lakes and marshes, this widespread turtle is often found in situations that are dry several months of each year and is frequently seen walking about on land. Minton (1966) found one digging out of the soil and presumed that individuals of this species often burrow to escape desiccation. Deraniyagala (1939) reported that they apparently come out of the water to feed on the shore at night. Beyond this, no other observations on the terrestrial activity of trionychids have been published. This study makes it clear that *Lissemys punctata* is very well adapted, both morphologically and behaviourally to drought conditions. These adaptations are undoubtedly the reason for its wide distribution in even the more arid parts of India and Pakistan. The observations suggest that much more remains to be learned concerning the physiology of this species, particularly in respect to water loss.

The Study Area: The study was conducted in the Keoladeo Ghana Sanctuary, near Bharatpur, Rajasthan, India, during October and November, 1979. Normally this large basin (2835 hectares) is nearly filled with a shallow lake during the summer monsoon, usually being reduced to about 700 hectares during the winter months. However, there was very little rain during the summer of 1979, and this monsoon failure resulted in the lake being re-

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duced to about 124 hectares during this study, with the water depth continuously reducing by as much as 2 cm per day. The result was the almost complete disappearance of water—a phenomenom that had not occurred in the sanctuary since 1941.

The entire basin is divided into nine impoundment areas, the water levels of which are regulated in normal seasons by flood gates and water shunted into the system via the Ghana Canal from the nearby dam forming the Ajan Bund.

Methods: On each of 46 nearly consecutive days I went to different parts of the sanctuary for purposes related to another project. While doing so, I necessarily made long circuits around the receding water edge, over the dried lake bottom, and along the raised causeways forming the impoundment boundaries. All *Lissemys punctata* seen, whether dead or alive, in or out of the water, were collected at that time, measured (straight midline carapace and plastral lengths) to the nearest millimeter, weighed to the nearest tenth of a gram, and sexed on the basis of proportionate tail length (tail of male longest). Each turtle was then marked by lightly notching the soft edge of the carapace with a pocket knife and released in the same spot immediately thereafter.

Twelve hauls were made with a 2 m minnow seine in three large ponds that still had a water depth greater than 50 cm. Two workers were also hired to wade and with their hands feel the entire bottom mud of eight large shallow ponds. These two techniques yieded 20 *Lissemys punctata* and provided data on the number and size of turtles still remaining in the drying ponds. A total of 104 individuals were found on the land surface, either walking about or killed by predators. Thus the study is based on 124 *Lissemys punctata* from the Keoladeo Ghana lake.

In addition to *Lissemys punctata*, the lake basin also contained at least one adult of *Trionyx gangeticus* and three adults of *Kachuga tectum*. These species are not included in the analyses and discussions below.

Water depth and temperature were recorded each day at three different stations on the dwindling lake, and temperatures on the bottom were recorded at or near the place the turtle was found whenever convenient. Air shade temperatures at an elevation of 10 cm above the ground surface were taken every day at the same location near the Forest Lodge Hotel (within the sanctuary) at 1300 hours. The time when each turtle was found was recorded; its direction of travel was determined with a compass and, along with its position, plotted on a large map of the shoreline.

Abbreviations: N = number, OR = overall range, SD = standard deviation, PL = plastral length, X = arithmatic mean, P = probability, df = degrees of freedom, and wt = weight.

Results

Population Characteristics: Of 124 *Lissemys punctata* processed, 104 were found on land and 20 in shallow water.

Males comprise almost exactly 50% of the sample taken from the water (N = 20), so that the sex ratio is probably 1:1. However, of those turtles found on land the males comprise only 39.5%, the sex ratio of these moving turtles being heavily skewed in favour of the females (1:1.5). The reason for this remains unknown, for none of the females had any shelled eggs (as determined by palpation).

Males are smaller than females (♂♂ PL OR = 17.2-21.1 cm, X = 19.0 cm, SD = ± 1.3 cm, N = 41; ♀♀ PL OR = 12.7-27.1 cm, X = 22.3 cm, SD = ± 4.5 cm, N = 65; t test = 2.81, df = 102, P = 0.005), and, not unexpected, lighter weight (♂♂ wt OR 1.0-2.1 kg, X = 1.5 kg, SD = ± 0.34 kg, N = 39; ♀♀ PL OR =

0.6-3.2 kg, X = 2.2 kg, SD ± 0.88 kg, N = 61). For all the individuals examined (N = 124) the PL OR = 12.5-27.1 cm, X = 20.2 cm, SD = ± 3.14 cm.

Predation and Size: Eggs are laid in late summer in India (fall in Burma, Smith 1931). Thus, very young turtles were expected in the sanctuary in October-November, at least in the remaining pools. However, none was found; presumably because they had all been eaten by predators, of which various waterfowl species are probably most important. The low water table undoubtedly led to a predation level significantly higher than normal, particularly in the smaller turtle size classes. The same result was found in a study of the water snake *Xenochrophis piscator* conducted at the same time and place (Auffenberg, in press).

While individuals representing several large size classes were frequently found wandering over dry land, it was the smallest classes that were most commonly preyed upon (PL OR preyed individuals 8.9-12.8 cm, X = 11.3 cm, SD ± 1.66 cm, N = 21; t test between these and all uneaten ones found on land [N = 31] = 2.84, df = 100, P = 0.01).

As far as could be determined, these smaller turtles were attacked and killed by one or more white vultures (*Neophron percnopterus ginginianus*). In addition to this vulture species, the king vulture (*Torgos calvus*) and white-backed vulture (*Gyps bengalensis*) also occur in the same sanctuary. However, these two species feed exclusively on carrion, while *Neophron* is reported to feed on live insects and amphibians as well (Ali and Ripley 1968). On one occasion a single *Torgos calvus* joined a group of *Neophron percnopterus*, and all of them fed on a large dead *Lissemys punctata*.

Because of the extent to which *Lissemys*

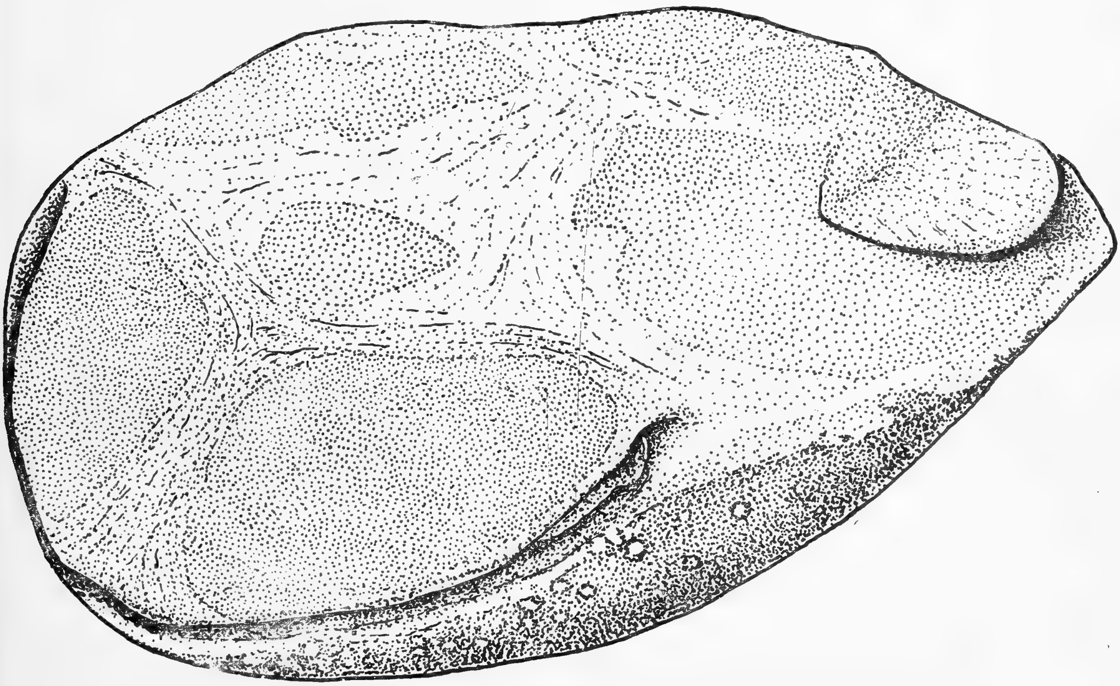

Fig. 1. Adult *Lissemys punctata* turned onto it's carapace, showing flaps over hind limbs and ability of the front plastral lobe to be closed completely.

punctata can close its shell (Fig. 1), it is remarkably adapted among soft-shelled turtles in being able to protect itself from much predation. As in the turtle genera *Kinosternon* (Kinosternidae), *Terrapene* (Emydidae), and *Pelusios* (Pelomedusidae), the anterior plastral lobe can be pulled up tightly against the underside of the anterior carapace rim, completely closing the anterior shell opening. In addition, the posterior edge of the carapace contains a partial series of peripheral bones (lacking in other trionychids) that serve as insertions for muscles enabling this part of the carapace to be pulled downward around the base of the tail, where the posterior tip of the plastron is also flexed upward to enclose this area from below. Finally, the hind legs are further protected by a hinged cartilaginous flap on each side. The total effect is to produce a more or less completely enclosed boney and cartilaginous box into which entry is very difficult at best and impossible for many likely predators.

The weakest part of the entire mechanism is apparently at the hind leg flaps. The bill of the white vulture is very narrow and proportionately longer than that of the other two Bharatpur species. Thus it is more easily inserted into the narrow, slit-like aperture at the flaps over the hind legs of this turtle species (Fig. 2). The bills of the other species of hawks, eagles, and kites that might possibly prey on these turtles are also apparently too short to accomplish this.

One or more white vultures may stand for hours over a closed turtle, periodically biting at the flaps until the muscles that hold them closed become fatigued so that the flap can no longer be tightly closed. The bill is then inserted into the slit-like opening, tearing away at the flesh of the hind limbs. No longer able to crawl away, even if offered an opportunity to do so, the turtle slowly dies. The concomitant relaxation of the other shell closure muscles allow the vultures to eventually remove the head and neck, limbs and viscera. When finished with the carcass, the vultures leave only an empty shell, which is sometimes later nibbled at by either jackals or porcupines.

Additionally the turtles exude a viscous yellow fluid, similar to egg yolk in both color and consistency, from pores on the plastral bridge in both the axillary and inguinal areas. The smell is very objectionable, but difficult to describe. The taste is probably vile as well. It is quite probable that the normally long time taken by vultures to kill these turtles is related to these secretions, for the contents of the glands are eventually emptied and the constant pulling and tugging of the turtle through the grass may serve to remove the secretion.

On one occasion, a single individual of *Neophron percnopterus* was observed to pick up a small stone, hop to a nearby live *Lissemys punctata* and drop it onto the carapace. This was repeated several times. Though the

Fig. 2. Head and bill shape in the vultures *Neophron percnopterus* (left) and *Torgos calvus* (right).

effect on the turtle seemed negligible, the behaviour of the vulture is very interesting. Stone-dropping behaviour has been noted previously in this same vulture species (Alcock 1972), though in that case the stones were dropped on bird's eggs.

If during their movements over land the turtles reach thick grass or forested areas, they wedge themselves into debris under tussocks, roots, or fallen logs, burying themselves to a depth of 3-6 cm, measured to the top of the carapace. Here they apparently aestivate until the next rainy season. During this phase of their dry season strategy they are sometimes found and eaten by foraging wild pigs (*Sus scrofa*). These are common in the Keoladeo Ghana Sanctuary, but their level of predation on the aestivating turtles remains unknown. Only two crushed and scattered carcasses of turtles that had been killed and eaten by wild pigs were found.

Two *Lissemys punctata* were found in an extremely weakened condition after, on the basis of surrounding signs, struggling for perhaps several days to free themselves from thick drying mud. In both cases it was obvious that water buffalo had stepped on them, forcing them deep into the stiff, tenaceous mud at the edge of the drying ponds.

The level of predation during drought in this lake basin is probably higher than it would be naturally, for the large number of grazing bovines allowed in the sanctuary had eaten or trampled practically all of the normally available cover surrounding the shoreline, as well as in the water itself. Thus the turtles were probably more exposed than in a less heavily grazed environment.

Unfortunately, I was not able to remain at the sanctuary until the last remaining pools dried completely, so have no data bearing on the total number of turtles eaten, or the proportionate number that could be expected to survive the drought.

Distance from Water and Headings: Because the water is the source of all turtles found walking on the land, one would expect a Poisson distribution with respect to the distance between the turtles and the shoreline. However, this is not the case, suggesting that those individuals walking on land near the water frequently re-enter it. Those farther away have a much smaller chance of re-entering the water, and the frequency distribution is clearly skewed in that direction. No individuals found walking on causeways with water on either side of them were included in the following analyses of distance or direction. Only those found in the open or at causeways with water on only one side ($N = 86$) were included.

The distances from the shoreline at which the 86 turtles were found varied from 3 to 1050 m, with the average being 237 m ($SD = \pm 78$ m). There was no significant difference between the sexes and shoreline distance, though smaller individuals were generally found closer to the remaining pools ($PL < 18$ cm, $OR = 5\text{-}410$ m, $X = 113.8$ m, $N = 32$; $PL > 18$ cm, OR 3-1050 m, $X = 321.6$ m, $N = 54$; t test $= 2.66$, $df = 84$, $P = < 0.005$).

There is no apparent tendency in compass headings of those individuals found over 25 m from the closest shoreline ($N = 67$), but at shorter distances the major headings are clearly away from the shoreline. Thus, the flat, almost featureless lake basin surface seems to offer few, if any, reliable landmarks to the walking turtles, for movements once the shoreline is left several metres behind seem completely random.

Conditions during which turtles left the water: Deraniyagala (1939) stated that *Lissemys punctata* came ashore at night. However, as far as I could determine, all terrestrial movement of the turtles at Keoladeo Ghana occurred between 0900 and 1639 hours. Within this period, no definitive peak(s) could be demonstrated. Nor was there any terrestrial activity during the few light showers in November, probably because these were associated with cold fronts passing through the area.

Mean maximum air temperatures in the shade 10 cm above the ground surface varied from 36°C in October, through 32.2°C for November, to 30.1°C for the first week and a half of December (after which the study was terminated). Mean daytime minima in the shade for the same periods were 24°C, 21°C, and 20.2°C respectively. The majority (87%) of all emergences were noted at shade air temperatures of from 29.6°C to 36.7°C, though minimum daytime temperatures were as low as 14.8°C and maximum as high as 38.1°C. Water temperature during days on which turtles emerged to walk over the basin surface varied from 15.2°C to 48.0°C, with 90% of the emergences occurring when water temperatures were above 35.0°C.

Pond size was apparently not a factor in emergences, for individuals released in a small pool only 3.3 m in diameter, but 52 cm deep and provided with a good growth of aquatic weeds, remained there throughout the project. However, the water depth and vegetation in this pool (also protected from wallowing water buffaloes) kept the water temperature below 32.0°C during the entire study period, even on days with high insolation. Thus water temperature is probably the most important factor in determining emergences in drying pools, and this is greatly affected by water depth (which was being reduced as much as 2.1 cm per day during parts of November; less before and after that time) and vegetative cover, which in turn is affected by the grazing water buffaloes.

Discussion

Bennett *et al.* (1970) believed that by moving away from drying ponds kinosternid turtles may reduce the high predation level that would probably occur if they burrowed in higher concentrations in the pond bottom. Wygoda (1979) has shown that predators do, indeed, find turtles buried in the dry pond floor. The present study suggests that predation level for especially the smaller turtles becomes significantly increased with reduction of water level. Entrapment in the mud may also be more common at low water levels. In this study bovines trampling the shallows apparently trapped some individuals, and some Pleistocene fossils from Florida clearly show that some buried turtles become permanently sealed into hardening bottom deposits (author's fieldnotes).

On the other hand, predation levels are also high during the emigration phase, when both birds and mammals often attack and kill particularly the smaller turtles. Burrowing by all turtles probably reduces both predation and desiccation during dry periods (Bennett *et al.* 1970), though in at least *Lissemys* some predation by especially large mammals continues during this phase.

Apparently some turtle species leave and re-enter the water on an annual cycle, regardless of water level (Gibbons 1969, 1970; Gibbons and Coker 1977), though kinosternids (Bennett 1972, Wygoda 1979), some chelids (Worrell 1963), and the trionychid *Lissemys* regularly leave the water during drought. Very few data are available regarding the conditions that cause the turtles to leave the water. However, water depth, temperature, and amount of cover are here suggested as the most important factors leading to emergence, (as has been shown in some emydids: Bennett *et al.* 1970, Gibbons 1970, Gibbons and Coker 1977). How common this habit is in *Lessemys punctata* is unknown, though it is clear that it is well adapted to contend with drought in at least the more xeric parts of its habitat. At Bharatpur, *Lissemys punctata* moves farther from water in its terrestrial activity than any other aquatic turtles studied so far. Apparently it does not exhibit a tendency for mass directional movement away from the water, as has been demonstrated in several other species.

Most immigrants of *Lissemys punctata* are females, the same as in some other studies of emigrating turtles, though the ratio may be reversed during some months of the year (Gibbons 1969). Wygoda (1979) and Gibbons and Coker (1977) believed that the proportionately larger number of females on land may be related to nesting behaviour, though this may not be the case in *Lissemys*, for the females of this population had apparently all laid their eggs many months previously. The sex ratio of *Lissemys* in the ponds, however, was 1:1, suggesting that females may be more common than males in the entire population. Skewed sex ratios in turtles have been reported in the literature for several species and the entire matter has been reviewed by Gibbons (1970). However, more data are required on the sex ratio of *Lissemys punctata* in relatively undisturbed environments before skewed ratios can be clearly demonstrated in this species.

Though several vultures are found at Bharatpur, only *Neophron percnopterus* attacks and kills live turtles. Chapman (*in* Meinertzhagen 1959) reported that both this vulture and *Gypaetus barbatus* feed on live turtles. Land tortoises comprise the major food of *G. barbatus* in several areas and the turtles are killed by dropping them on rocks from a great height. The present paper is apparently the first reference to *Neophron percnopterus* dropping stones on the shells of turtles. However, I can hardly believe that they expect to break the shell or have ever had any luck doing so. The behaviour may be more important in stimulating the turtle to stop walking away.

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THE TIMING OF BREEDING SEASON AND INTERBREEDING BETWEEN THE COLOUR PHASES IN THE INDIAN REEF HERON, *EGRETTA GULARIS* (BOSC)[1]

R. M. NAIK[2], B. M. PARASHARYA[2], B. H. PATEL[3], AND A. P. MANSURI[2]

The Indian Reef Heron, *Egretta gularis* (Bosc) occurs on the coast of West Africa, the Red Sea area and the western coast of the Indian Ocean (Ripley *in press*). Though the bird is not uncommon on the northern shores of the Arabian Sea, coast of Pakistan, western coast of India, Laccadive Islands and Sri Lanka (Sálim Ali and Ripley 1968), only four of its breeding sites in the Indian region have so far been recorded. It was found breeding near Chilaw, Sri Lanka, "about a hundred years ago" by Layard (Henry 1971), but its breeding in Sri Lanka has apparently not been recorded since then (Henry, loc. cit). Eates (1926) observed it breeding in Karachi (1954) observed it in Kandla Creek, Kutch, and Kirkpatrick (1961) observed it near Nellore (Andhra Pradesh). Since there are no records of the breeding of this heron in between the sites so far recorded, it is presumed that the bird "possibly migrates locally to special areas" (Sálim Ali and Ripley 1968).

In view of the fact that only a few observations have been made on the breeding of the Reef Heron in India, it is not surprising that numerous gaps exist in our knowledge of this bird's Indian populations. A look at Table 1 will reveal that the breeding period recorded by Eates (loc. cit.). Sálim Ali (loc. cit.) and Kirkpatrick (loc. cit.) vary widely with no definite trend, and because of this, any generalization regarding the timing of the breeding season of this bird in India has been a difficult proposition. Secondly, the white and dark (grey) phases of the bird have been known to interbreed in Africa, but there has

TABLE 1

NESTING OF THE INDIAN REEF HERON IN THE INDIAN REGION

Locality	Nesting period	Authority
1. Chilaw (7°37′N, 79°53′E.)	May and June	Layard (as quoted by Henry, 1971)
2. Karachi (24°51′N, 67°04′E.)	First week of March to early June	Eates (1926)
3. Kandla (23°N, 70°10′E.)	August and September	Sálim Ali (1954)
4. Nellore (14°27′N, 80°02′E.)	Around April and May	Kirkpatrick (1961)
5. Gogha	February to August-September	Present report

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been no evidence of such happenings in India (Sálim Ali and Ripley 1968).

The observations reported here were made in Gogha and Bhavnagar. The latter is a flourishing coastal city (21°46′N, 72°11′E) on the gulf of Khambat. Gogha, at one time a thriving port but now a small town of about 1,300 houses with a population of about 7000 people, is located 19 km southeast of Bhavnagar and spread over a strip of land jutting out to a point in the gulf of Khambat.

Observations

We (R.M.N. and B.H.P.) accidentally found the Indian Reef Heron nesting in Gogha first in February 1979; and some of us paid four successive visits later on to observe the bird nesting there until the first week of September. The main nesting colony was located in a grove of trees within an enclosed quadrangle of the mamlatdar's office. No other birds except a pair of crows nested in these trees during the study period. Our inquiries with the old staff of the office revealed that the herons have been nesting there at least for the last fifteen years. Pradumn Desai, a keen naturalist residing in Bhavnagar had seen the herons nesting there (in the quadrangle of mamlatdar's office) several years back.

One of us (B.M.P.) observed the heron nesting also in Bhavnagar during the last week of July 1979; here, the bird was nesting in a mixed heronry of the Cattle Egret (*Bubulcus ibis*), Night Heron (*Nycticorax nycticorax*), and White Ibis (*Threskiornis aethiopica*) in a school compound. The earlier field notes of one (B.M.P.) of us indicate the nesting of the heron in Bhavnagar in the previous years as well; the heron was observed nesting there with Cattle Egret, Night Heron and White Ibis in July 1973 and also in August 1974.

All the nesting colonies observed by us in Gogha and Bhavnagar were in urban areas; the Karachi colony observed by Eates (loc. cit.) was also in urban areas, whereas the Kandla colony observed by Sálim Ali (loc. cit.) was on a tide-swept island in a creek.

The bird can use a wide variety of trees for nesting. The trees used by the birds we observed nesting, were the peepul *Ficus religiosa. Ficus tsila* and neem *Melia azadirachta* (syn. *Azadirachta indica*). Eates (loc. cit.) observed the birds nesting on the peepul, jujube *Zizyphus jujuba,* Portia tree *Thespesia populnea,* Manila Tamarind *Pithecolobium dulce* and Jambun *Eugenia jambolina.* Kirkpatrick (loc. cit.) observed the bird breeding in *Ficus* trees and Sálim Ali (loc. cit.) in mangroves.

We could record the timing of the heron's breeding season at Gogha. On our first visit to Gogha, we saw many pairs of the heron engaged in courtship and nest-building activities on 23 February 1979. We (R.M.N. and B.H.P.) paid a second visit to the place on 6 April 1979, when we could spend more time watching the herons nesting there in three groups: (1) The largest concentration of 86 nests located in a grove of 9 trees, was in the quadrangle of the mamlatdar's office, (2) another group of 17 nests was located on a roadside tree, and (3) the third group of 6 nests was on a roadside Tamarind tree. All the nests (total hundred and four) were attended by the parents; some pairs were engaged in nest-building whereas most others were either incubating or feeding the chicks. We (R.M.N. and A.P.M.) paid a third visit to Gogha on 5th June, 1979, when we found the birds nesting only in the quadrangle of mamlatdar's office, there being no trace of the nests or the herons in the other two places where we had found them nesting earlier. In the heronry, there were about 75 nests of which a few appeared deserted and the rest had chicks; most of the chicks were grown up and perching or hopping around on branches. Only in five nests, the small chicks were being brooded by the parents. One of us (B.M.P.) paid a visit to Gogha on the 9th and 26th of August 1979, and again on the 2nd of September 1979. There were 3 nests with eggs, 1 with chicks and a few deserted nests on 9 August, whereas there were 2 nests with chicks and a deserted nest on 26 August, and a few grown up chicks perching around two empty nests on 2nd September.

We observed in Gogha that the mates within a nesting pair were usually of the same colour phase, that is both the mates were either dark or white. However, we found evidences that some interbreeding between the two phases also occurs. In one pair that we observed nest-building for about half an hour, one mate was white while the other was dark. In another nest, we observed a parent in the white phase relieving its mate in dark phase from the duty of incubating eggs.

Discussion

The Indian Reef Heron is a common sight throughout the year on the sea coast near Gogha and Bhavnagar. The herons we observed breeding there were apparently derived from the local population. The herons have been breeding in Gogha and possibly also in Bhavnagar since many years, but, the breeding was not reported until now. We have some unconfirmed reports suggesting that the herons breed also in Porbandar and Surat (both in Gujarat) as well. It is quite probable, therefore, that the heron populations at least on the coast of Gujarat, if not all along the Indian coast, are largely sedentary and that many of the bird's breeding sites have remained hitherto unreported.

The herons in Gogha, had a long nesting season spanning a period from February to August-September, the peak period having been from February to June. Nesting period of the heron recorded elsewhere by the earlier workers falls within this period (Table 1). Apparently the herons have a long nesting season all along the sea coast from Pakistan to Sri Lanka; the mildness of the maritime climate and a ready availability of marine food over a long period, would favour a long breeding season.

The occurrence of the heron's peak breeding in the summer contrasts sharply with that of the Little Egret (*Egretta garzetta*) occurring in the monsoon. The Little Egret, like the other egrets, spoonbill and ibises, seeks its animal food inland and is consequently dependent on the monsoon for an increased supply of food needed for the reproduction. The difference in the timing of breeding between the Indian Reef Heron and the Little Egret would reduce the chances of possible introgression between these two closely related species.

During the heron's peak breeding period in summer, the other Ciconiiformes (with a possible exception of the Night Heron) that may compete with the Indian Reef Heron for the nesting sites, are not breeding. One should expect the heron, therefore, to breed in their heronry exclusively during the summer. On the other hand, several species of Ciconiformes and the other birds, like Cormorants, may compete with the heron for the nesting sites and one may find the herons breeding in the mixed heronry during that season. This explains the fact that Sálim Ali (loc. cit.) who had seen the herons breeding during the monsoon found it breeding in the mixed heronry, whereas Eates (loc. cit.) and Kirkpatrick (loc. cit.) who saw the herons breeding in summer found them breeding exclusively. In

Gogha, we saw the herons breeding in exclusive heronry throughout its breeding season from February to August. The only other colonial tree-nester that bred any time during this period in Gogha was the Spoonbill, but it had segregated from the Indian Reef Heron for nesting.

On the African coast, the dark and white phases of the heron are known to interbreed and the form intermediate between the two has been described. In view of the fact that interbreeding between the dark and white phases occurs also within an Indian population of the heron, the forms intermediate between the two phases would be expected to occur in India as well, though so far not recorded.

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ALPINE FLORA OF TUNGNATH IN GARHWAL HIMALAYA[1]

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The present communication is an account of Angiosperms collected from an alpine area (Tungnath) in Garhwal Himalaya during the years 1977-1978. Tungnath is one of the most important peaks situated in front of the famous Chaukhamba and Kedarnath peaks, in between 30°30′N and 79°15′E. The dominant families of this zone are Ranunculaceae, Fumariaceae, Caryophyllaceae, Rosaceae, Saxifragaceae, Apiaceae, Asteraceae, Gentianaceae, Scrophulariaceae, Polygonaceae, Orchidaceae, Liliaceae and Poaceae. A total number of 280 species and 157 genera represented by 50 families have been recorded.

INTRODUCTION

The Himalayas are a reservoir of many natural resources, of which the vegetational aspect is predominant. Although several workers took interest in the collection and presentation of Himalayan flora even before the 19th century (Burkill 1965) and upto recently (Rau 1975), still a comprehensive account, specially on the exploration of alpine plants on regional basis is lacking. Royle, Coventry and Blatter studied the beautiful plants of Western Himalaya (Rau 1975) laying more emphasis on the Kashmir valley in the extreme west of the Himalayas. Duthie (1906) presented the revised catalogue of plants of Kumaon and adjacent portions of Garhwal, originally based on the collections made by Strachey and Winterbottom during 1846 to 1849, including the works of Wallich, Royle, Falconer, Blinkworth and Thomson. Holdsworth and Smythe, members of the British Kamet Expedition collected plants from Bhyundar valley, 'The Valley of Flowers' (Smythe 1932 and 1938). Recently Rau (1961) has made comprehensive collections from different altitudes of north Garhwal. Rau (1975) has also published an extensive compilation of high altitude flowering plants of Western Himalaya.

GEOGRAPHY AND CLIMATE

The approximate bearings of Tungnath region are 30°30′N and 79°15′E. The explored area is a moist alpine zone ranging from 3250 to 4600 m above sea level. As usual in alpine zones in India the climatic conditions include dense frost, fog, heavy hailstorms, extremely low temperature, high light intensity, high wind velocity and lower Oxygen and Carbon dioxide concentration. There are sharp fluctuations regarding these weather conditions even in the same day. Low rainfall is generally reported from other alpine areas but comparatively high rainfall was observed in this area. Total rainfall from June to September during 1978 was recorded 163.57 cm and maximum rainfall was 51.77 cm in the month of July. Minimum and Maximum atmospheric temperature during the study period was -6 and 28°C respectively.

VEGETATION

The alpine vegetation of this part has many characteristic features in connection with the

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separation zone from timber line, seasonal succession and distributional pattern. Some important plants which separate the alpine zone from timber line are *Clematis barbellata, C. montana, Berberis edgeworthiana, Hypericum hookerianum, Rhododendron campanulatum, R. arboreum* in south facing slopes and *Anemone rivularis, Thalictrum chelidonii, Paeonia emodi, Thlaspi cochleariforme. Syringa emodi, Skimmia laureola, Geum urbanum, Sorbus foliolosa, Angleca glauca, Trillium govanianum,* in north-west facing slopes. Some temperate plants, e.g. *Rhododendron arboreum, Dipsacus mitis* and *Lysimachia* spp. are also well adapted to the harsh alpine conditions.

On the basis of distribution the alpine plants represent distinct habitats. They are found on exposed dry rocks, crevices, ravines and on much fertile loamy soils constituting the alpine meadows.

The plant species which appear soon after the snows melt, are *Primula denticulata, Oxygraphis polypetala* and *Gentiana* spp. immediately followed by *Ranunculus* spp., *Caltha palustris, Gagea lutea* and *Anemone obtusiloba,* and species of *Potentilla, Pedicularis, Senecio, Saussurea, Polygonum* and others during July-August. In the late flowering season in alpine zone *Delphinium vestitum, Selinum vaginatum, Pleurospermum densiflorum, Tanacetum longifolium, Taraxacum officinale* are observed. Some plants like *Oxygraphis polypetala, Ranunculus* spp. and *Gentiana* spp. reflower at the end of season during October-November. Periodical changes in the flowering resulted in the appearance of beautiful matted meadow of blue, violet, red, pink, yellow and white colour during different months of the favourable season. The general mode of perennation of plants is through rhizomes, rootstocks, runners, suckers, bulbs and bulbils.

Enumeration of species

This work is primarily a record of alpine plants collected during the years 1977 and 1978. In this work Bentham and Hooker's system of classification has been followed with some modifications particularly in splitting of the families as proposed by Hutchinson (1959). An attempt has been made to incorporate nomenclature changes. Local names of the plants where available have been given after the botanical names and localities with altitude have also been mntioned. Field number of each specimen is given in bracket and the specimens are preserved in the Herbarium of Botany Department, Garhwal University, Srinagar.

DICOTYLEDONS

Ranunculaceae

Aconitum balfourii Stapf (Loc.-Mitha bish) Tall erect herb with blue flowers. Tungnath, 3500 m. Sept. 1977 (2658).

A. heterophyllum Wall. ex Royle (Loc.-Atish) Erect herb with dull green purple veined flowers. Tungnath, 3500 m. Sept. 1977 (2634).

Anemone narcissifolia Linn. var. **polyanthes** Finnet & Gagnep. (Loc.-Kakrya)
Hairy herb with white flowers. Tungnath, 3500 m. June 1977 (2694).

A. obtusiloba D. Don (Loc.-Chotu Kakrya) Herb with white and blue flowers. Tungnath, 3500 m. June 1977 (2700).

A. rivularis Buch.-Ham.
Herb with white flowers. Below Tungnath, 3250 m. June 1977 (2693).

A. vitifolia Buch.-Ham.
Herb with whitish flowers. Tungnath, 3500 m. Sept. 1977 (2606).

Caltha palustris Linn.
Herb with bright yellow flowers. Tungnath, 3500 m. May 1977 (2695).

Clematis barbellata Edgew.
Climbing shrub with dull purple backed flowers. Rawanshila, 3250 m. June 1978 (2833).
C. montana Buch.-Ham. ex DC.
Climbing shrub with white flowers. Rawanshila, 3250 m. June 1978 (2831).
Delphinium vestitum Wall. ex Royle
Hairy herb with blue flowers. Tungnath, 3500 m. Oct. 1977 (2681).
Oxygraphis polypetala (Royle) Hook. f. & Thoms.
Small herb with bright yellow flowers. Tungnath, 3500 m. May and Oct. 1977 (2702).
Ranunculus hirtellus Royle
Herb with bright yellow flowers. Tungnath, 3500 m. May and Sept. 1977 (2612).
R. hyperboreus Rottb.
Small creeping herb with yellow flowers. Tungnath, 3500 m. June 1978 (2805).
Thalictrum alpinum Linn.
Small herb with greenish drooping flowers. Tungnath, 3500 m. June 1978 (2827).
T. chelidonii DC.
Tall herb with the bulbils in the leaf axils. Zabrya, 3250 m. Oct. 1978 (2758).
T. pauciflorum Royle
Herb on rocks with greenish flowers. Tungnath, 3500 m. Sept. 1978 (2701).

Paeonaceae

Paeonia emodi Wall. ex Royle (Loc.-Chandra)
Tall erect herb with white flowers. Chakdhar, 3250 m. June 1978 (2759).

Berberidaceae

Berberis edgeworthiana Schneid. (Loc.-Chotra)
Shrub with yellow flowers and ovoid red berries. Rawanshila, 3250 m. July 1978 (2676).
B. jaeschkeana Schneid. (Loc.-Kingorh)
Spiny shrub with yellow flowers and red berries. Tungnath, 3500 m. July 1978 (2803).
B. kumaonensis Schneid. (Loc.-Jhuru)
Procumbent shrub with yellow flowers and ovoid red berries. Tungnath, 3500 m. July 1978 (2760).

Circaeasteraceae

Circaeaster agrestis Maxim.
Small herb bearing minute greenish flowers at the terminal rosette of leaves. Tungnath, 3500 m. Aug. 1978 (2625).

Papaveraceae

Meconopsis aculeata Royle (Loc.-Kalyari)
Prickly herb with blue purple flowers. Tungnath, 3500 m. Aug. 1978 (2816).
M. robusta Hook. f. & Thoms.
Prickly herb with light yellow flowers. Tungnath, 3500 m. Aug. 1978 (2823).

Fumariaceae

Corydalis cashmeriana Royle
Delicate herb with sky blue flowers. Tungnath, 3500 m. June 1978 (2705).
C. falconeri Hook. f. & Thoms.
Herb with yellow flowers. Tungnath, 3500 m. June 1977 (2706).
C. govaniana Wall.
Herb with terminal dense many yellow flowered racemes. Tungnath, 3500 m. June 1977 (2703).
C. meifolia Wall.
Herb with purple tipped yellow flowers. Above Tunganth, 4600 m. Sept. 1978 (2763).
C. vaginans Royle
Delicate herb with yellow flowers. Tungnath, 3500 m. June 1977 (2704).

Brassicaceae

Arcyosperma primulifolium (Thoms.) O. E. Schulz

Herb, with white flowers on rocks. Tungnath, 3500 m. June 1977 (2707).

Capsella bursa-pastoris (Linn.) Medik. (Loc.-Botlya)
Herb with white flowers. Chakdhar, 3250 m. June 1978 (2764).

Cardamine scutata Thunb .
Glabrous herb with white flowers. Tungnath, 3500 m. July 1977 (2608).

Draba gracillima Hook. f. & Thoms.
Hairy herb with small yellow flowers. Tungnath, 3500 m. June 1978 (2812).

Thlaspi cochleariforme DC.
Spreading herb with white flowers. Tungnath, 3500 m. May 1978 (2765).

VIOLACEAE

Viola biflora Linn.
Glabrous herb with yellow flowers. Tungnath, 3500 m. June 1977 (2708).

V. canescens Wall. (Loc.-Banafsa or Dundi-birali).
Stoloniferous herb with lilac flowers. Rawanshila, 3250 m. May 1978 (2766).

CARYOPHYLLACEAE

Cerastium holosteoides Fries. (Loc.-Badyalu)
Herb with white flowers. Tungnath, 3500 m. Aug. 1978 (2890).

Gypsophila cerastiodes D. Don
Spreading herb with purple streaked white flowers. Tungnath, 3500 m. June 1977 (2709).

Lychnis nutans Benth.
Glandular herb with purple flowers. Tungnath, 3500 m. July 1977 (2604).

L. pilosa Edgew.
Hairy herb, with solitary terminal purple flowers on rocks. Tungnath, 3500 m. Sept. 1978 (2888).

Sagina saginoides (Linn.) Karsten
Small decumbent herb with white flowers. Tungnath, 3500 m. Aug. 1978 (2889).

Stellaria alsine Grimm
Spreading herb with small green flowers. Tungnath, 3500 m. Aug. 1978 (2843).

S. cherleriae (Fisch.) Williams
Densely tufted herb with small white flowers. Tungnath, 3500 m. Sept. 1977 (2670).

S. patens D. Don
Decumbent herb with white flowers. Tungnath, 3500 m. Aug. 1978 (2767).

HYPERICACEAE

Hypericum hookerianum W. & A.
Small shrub with golden yellow flowers. Daun, 3300 m. Aug. 1977 (2639).

H. nepaulense Choisy
Diffused herb with yellow flowers. Daun, 3300 m. July 1977 (2710).

GERANIACEAE

Geranium wallichianum Sw. (Loc.-Ratanjot)
Spreading herb with pink purple flowers which are streaked at the base. Tungnath, 3500 m. Sept. 1977 (2643).

G. polyanthes Edgew. & Hook. f.
Herb with pink flowers. Tungnath, 3500 m. Aug. 1978 (2768).

BALSAMINACEAE

Impatiens brachycentra Kar. & Kir. (Loc.-Chaula)
Erect herb with pinkish white flowers. Tungnath, 3500 m. Sept. 1977 (2669).

I. roylei Walp.
Herb with light pink flowers. Tungnath, 3500 m. Sept. 1978 (2769).

RUTACEAE

Skimmia leureola Sieb. & Zucc.
Glabrous aromatic shrub with yellow flowers. Chakdhar, 3250 m. June 1978 (2770).

Fabaceae

Astragalus himalayanus Klotzsch
Hairy herb of alpine meadows; Tungnath, 3500 m. Oct. 1978 (2891).

Parochetus communis Buch.-Ham. ex D. Don
Herb with blue flowers. Tungnath, 3500 m. Oct. 1978 (2680).

Piptanthus nepalensis D. Don
Shrub with yellow flowers. Tungnath, 3500 m. June 1977 (2711).

Rosaceae

Aruncus dioicus (Walter) Fern.
Erect herb with white flowers. Tungnath, 3500 m. Aug. 1978 (2820).

Cotoneaster acuminatus Lindl.
Shrub with white flowers and red oblong fruits. Tungnath, 3500 m. July 1978 (2834).

C. microphyllus Wall. ex Lindl. (Loc.-Ruens)
Procumbent much branched shrub with white flowers and red globose fruits. Tungnath, 3500 m. June 1977 (2719).

Fragaria daltoniana Gay. (Loc.-Kailashikaphal)
Stoloniferous herb with white solitary flower and elongate ovoid bright scarlet fruit. Tungnath, 3500 m. July 1978 (2893).

F. vesca Linn. (Loc.-Gandakafal)
Herb with white flowers and sub-globose scarlet fruit. Tungnath, 3500 m. July 1978 (2894).

Geum elatum (Royle) Hook. f.
Herb with yellow flowers and much hairy hooked seeds. Chandrashila, 3750 m. July 1977 (2720).

G. urbanum Linn.
Herb with yellow flowers and hairy seeds. Chakdhar, 3250 m. July 1978 (2753).

Potentilla arbuscula D. Don
Shrub with yellow flowers. Tungnath, 3500 m. June 1977 (2721).

P. argyrophylla Wall. ex Lehm.
Herb covered with soft silky white hairs and yellow flowers. Chandrashila, 3750 m. June 1978 (2810).

P. atrosanguinea Lodd.
Herb with dark crimson flowers. Tungnath, 3600 m. June 1977 (2715).

P. eriocarpa Wall. ex. Lehm.
Glabrous herb with yellow flowers. Tungnath, 3500 m. Sept. 1977 (2671).

P. fulgens Wall. ex Hook. (Loc.-Bajradanti)
Hairy herb with yellow flowers. Tungnath, 3500 m. June 1977 (2716).

P. gelida C. A. Mey.
Spreading glandular aromatic herb with yellow flowers. Rawanshila, 3450 m. June 1978 (2802).

P. leuconota D. Don
Herb with subumbellate yellow flowers. Tungnath, 3500 m. July 1978 (2752).

P. microphylla D. Don
Herb forming moss like tufts with yellow flowers. Tungnath, 3500 m. June 1977 (2713).

P. polyphylla Wall. ex Lehm.
Herb with yellow flowers. Tungnath, 3500 m. June 1978 (2718).

Rosa sericea Lindl. (Loc.-Safed Gulab)
Prickly shrub with white flowers and red fruits. Tungnath, 3500 m. July 1978 (2837).

Rubus nutans Wall. (Loc.-Kailashi Hisar)
Herb with a woody rootstock, white flowers and scarlet drupelets. Tungnath, 3500 m. Aug. 1978 (2751).

R. pedunculosus D. Don (Loc.-Hisar)
Large rambling prickly shrub with light pink flowers and pink drupelets. Tungnath, 3500 m. Aug. 1978 (2844).

Sibbaldia cuneata Hornem. ex O. Ktze.
Procumbent herb with small pale yellow flowers. Tungnath, 3500 m. June 1977 (2714).

S. micropetala (D. Don) Hand.-Mazz.
Spreading herb with small yellow flowers. Tungnath, 3500 m. June 1977 (2712).

Sorbus foliolosa (Wall.) Spach (Loc.-Thelaka)
Small tree with white flowers and red fruits.

Tungnath, 3500 m. July 1978 (2838).
Spiraea canescens D. Don (Loc.-Chhari)
Shrub with white flowers. Tungnath, 3500 m. June 1978 (2717).
S. bella Sims.
Shrub with pink flowers. Rawanshila, 3450 m. June 1978 (2829).
S. vestita Wall. ex G. Don
Tall erect herb with white flowers and green achenes. Zabrya, 3250 m. Aug. 1978 (2750).

SAXIFRAGACEAE

Astible rivularis Buch.-Ham.
Erect hairy herb with greenish-yellow flowers. Tungnath, 3500 m. July 1978 (2895).
Bergenia stracheyi (Hook. f. & Thoms.) Engl. (Loc.-Pakhan bhed)
Procumbent glabrous herb with white flowers. Chandrashila, 3750 m. July 1978 (2817).
Chrysosplenium tenellum Hook. f. & Thoms.
Annual procumbent glabrous herb with green yellow flowers. Tungnath, 3500 m. June 1978 (2806).
Parnassia affinis Hook. f. & Thoms.
Small glabrous herb with white flowers. Tungnath, 3500 m. Aug. 1977 (2611).
P. nubicola Wall. ex Royle
Herb with white solitary terminal flowers. Chandrashila, 3750 m. Aug. 1977 (2621).
Saxifraga brachypoda var. **fimbriata** (Wall.) Engl. & Irmsch.
Small erect herb with spinulose leaves and golden yellow flowers. Tungnath, 3500 m. Aug. 1977 (2614).
S. brunoniana Wall. ex Sternb.
Tufted herb with yellow flowers. Tungnath, 3500 m. Aug. 1978 (2761).
S. diversifolia Wall. ex DC. var. **parnassifolia** (D. Don) Engl.
Erect herb with yellow flowers. Tungnath, 3600 m. Aug. 1978 (2613).
S. filicaulis Wall. ex DC.
Small herb with yellow flowers. Tungnath, 3500 m. Sept. 1978 (2771).
S. hispidula D. Don
Small hispid herb with golden yellow flowers, Tungnath, 3500 m. Aug. 1978 (2762).
S. pallida Wall. ex DC.
Small herb with white flowers. Tungnath, 3500 m. July 1977 (2603).

GROSSULARIACEAE

Ribes glaciale Wall.
Trailing shrub with pink flowers. Tungnath, 3500 m. Aug. 1978 (2807).

CRASSULACEAE

Sedum linearifolium Royle
Glabrous herb with white flowers. Above Tungnath, 4600 m. Sept. 1978 (2772).
S. linearifolium var. **sinuatum** (Royle) R. Hamet
Glabrous herb with light pink flowers. Tungnath, 3500 m. Aug. 1977 (2615).
S. quadrifidum Pall.
Tufted herb with dark pink flowers. Tungnath, 3500 m. June 1977 (2722).
Sempervivum acuminatum Decne.
Glabrous and fleshy herb with light purple rose flowers. Tungnath, 3500 m. Oct. 1977 (2686).

ONAGRACEAE

Circaea imaicola (Asch. et Magn.) Hand.-Mazz.
Erect glabrous herb with white flowers. Tungnath, 3500 m. Aug. 1977 (2626).
Epilobium royleanum Hausskn.
Erect herb with pink flowers. Tungnath, 3500 m. Sept. 1977 (2666).

APIACEAE

Acronema tenera Edgew.
Small herb with oblong fruits which are nar-

rowed upwards. Tungnath, 3500 m. Sept. 1977 (2609).

Angelica glauca Edgew. (Loc.-Chora)
Tall herb with white flowers. Tungnath, 3400 m. Aug. 1978 (2754).

Bupleurum longicaule Wall. ex DC.
Erect glabrous herb with blackish flowers. Tungnath, 3500 m. Aug. 1977 (2618).

Chaerophyllum acuminatum Lindl.
Hairy herb with oblong fruits narrowed at the tip. Tungnath, 3500 m. June 1977 (2724).

Heracleum brunonis (DC.) C. B. Clarke
Hairy erect herb with white flowers. Tungnath, 3500 m. Aug. 1977 (2628).

Osmorhiza aristata Makino & Yabe.
Erect herb with oblong fruits. Zabrya, 3250 m. Sept. 1978 (2755).

Pleurospermum densiflorum (Lindl.) C. B. Clarke (Loc.-Taggar)
Erect herb with white margined bracteoles and ellipsoid fruits. Tungnath, 3500 m. Sept. 1978 (2617).

Salinum candollei DC. (Loc.-Moor)
Tall erect herb with white flowers. Tungnath, 3500 m. Sept. 1977 (2629).

S. vaginatum C. B. Clarke (Loc.-Bhootkeshi)
Erect glabrous herb with white flowers. Tungnath, 3500 m. Sept. 1978 (2756).

Trachydium roylei Lindl.
Small herb with white bracteoles and glistening blackish fruits. Tungnath, 3500 m. Sept. 1978 (2757).

Vicatia coniifolia DC.
Erect glabrous herb with ovoid fruits narrowed at the apex. Tungnath, 3500 m. Aug. 1978 (2773).

CAPRIFOLIACEAE

Lonicera myrtillus Hook. f. & Thoms.
Procumbent shrub with white flowers and blue ellipsoid berries. Tungnath, 3500 m. July 1978 (2840).

Viburnum foetens Decne.
Large shrub with white and light pink flowers and red ovoid drupes. Tungnath, 3500 m. May 1978 (2774).

RUBIACEAE

Galium asperuloides Edgew.
Glabrous herb with white flowers. Tungnath, 3500 m. Aug. 1978 (2813).

G. mollugo Linn. (Loc.-Kura)
Rambling herb with minute white flowers. Tungnath, 3500 m. Sept. 1978 (2775).

G. pauciflorum Bunge
Small herb with minute white flowers. Tungnath, 3500 m. June 1978 (2847).

VALERIANACEAE

Nardostachys jatamansi DC. (Loc.-Jatamansi or Masi)
Aromatic herb with dull white flowers. Tungnath, 3500 m. Aug. 1977 (2723).

Valeriana hardwickii Wall.
Erect herb with white flowers and hairy achenes. Tungnath, 3500 m. Aug. 1977 (2623).

DIPSACACEAE

Dipsacus mitis D. Don
Tall erect herb with white heads. Tungnath, 3500 m. Sept. 1978 (2777).

Morina longifolia Wall. ex DC. (Loc.-Kandara)
Prickly herb with deep pink flowers, Tungnath, 3500 m. Sept. 1978 (2818).

Triplostegia glandulifera Wall. ex DC.
Erect glandular herb with white flowers. Tungnath, 3500 m. Sept. 1977 (2667).

ASTERACEAE

Adenocaulon bicolor Hook. f.
Hairy erect herb with white flowers. Zabrya, 3250 m. Sept. 1978 (2781).

Anaphalis contorta Hook. f. (Loc.-Buglya)
Erect woolly herb with small dense dirty-white heads. Tungnath, 3500 m. Aug. 1978 (2782).
A. cuneifolia Hook. f. (Loc.-Buglya)
Erect herb with black centred white heads. Tungnath, 3500 m. Aug. 1977 (2673).
A. royleana DC. (Loc.-Buglya)
Woolly herb with black centred white heads. Tungnath, 3500 m. Aug. 1977 (2645).
Brachyactis menthodora Benth.
Tall erect herb with pale blue flowers. Tungnath, 3500 m. Sept. 1978 (2778).
Carpesium cernuum Linn.
Hairy erect herb with yellow drooping heads. Chakdhar, 3250 m. Aug. 1978 (2779).
Circium verutum (D. Don) Spreng. (Loc.-Kandaru).
Prickly erect herb with purplish white heads. Tungnath, 3500 m. Sept. 1978 (2780).
Cicerbita cyanea (D. Don) Beauv.
Erect herb with purplish heads and white pappus. Zabrya, 3250 m. Sept. 1978 (2790).
C. macrorhiza (Royle) Beauv. (Loc.-Karhatu)
Glabrous herb on rocks with purple heads. Tungnath, 3500 m. Sept. 1978 (2789).
C. violaefolia (Decne.) Beauv. (Loc.-Karhatu)
Glabrous herb with purple heads and white pappus. Tungnath, 3500 m. Oct. 1977 (2675).
Doronicum roylei DC.
Tall erect herb with yellow flowers. Tungnath, 3500 m. Aug. 1977 (2646).
Erigeron alpinus var. **multicaulis** Hook. f.
Erect herb with purple flowers. Tungnath, 3500 m. Aug. 1977 (2672).
Gerbera kunzeana Braun & Aschers.
Herb with long peduncled heads and pale pappus. Tungnath, 3500 m. Oct. 1978 (2785).
G. lanuginosa Benth. (Loc.-Kabas)
Small herb with white solitary heads. Tungnath, 3500 m. June 1978 (2783).
Jurinea macrocephala (DC.) C. B. Clarke (Loc.-Bish Kandara)
Stemless herb with sessile purplish heads. Tungnath, 3500 m. Aug. 1978 (2819).
Leontopodium himalayanum DC.
Tufted woolly herb with white flowers. Above Tungnath, 4600 m. Sept. 1978 (2784).
Ligularia amplexicaulis DC. (Loc.-Kalank)
Robust herb with yellow corymbose heads. Tungnath, 3500 m. Aug. 1977 (2635).
L. arnicoides DC. (Loc.-Jarhil)
Tall erect herb with yellow drooping heads. Tungnath, 3500 m. Sept. 1978 (2791).
Myriactis nepalensis Less.
Erect slightly hispid herb with light purple heads. Tungnath, 3500 m. June 1978 (2808).
M. wallichii Less.
Erect hairy herb with purplish brown heads. Tungnath, 3500 m. Sept. 1978 (2796).
Saussurea hypoleuca Spreng.
Erect herb with solitary globose dark purple heads. Tungnath, 3500 m. Oct. 1977 (2682).
S. leontodontoides (DC.) Lipsch.
Stemless herb on rocks with purple heads. Tungnath, 3500 m. Oct. 1977 (2683).
S. obvallata (DC.) Sch.-Bip. (Loc.-Brahm kamal)
Aromatic herb with hemispherical black tipped heads. Above Tungnath, 4600 m. Oct. 1978 (2786).
S. piptathera Edgew.
Erect herb with purple dense terminal corymbose heads. Tungnath, 3500 m. Sept. 1978 (2787).
S. taraxacifolia Wall. ex DC.
Prostrate aromatic herb with purple heads. Tungnath, 3500 m. Sept. 1977 (2622 and 2684).
Senecio alatus Wall. ex DC.
Pubescent herb with dirty brown pappus. Tungnath, 3500 m. Sept. 1978 (2792).
S. chrysanthemoides DC.
Erect glabrous herb with yellow flowers. Tungnath, 3500 m. Aug. 1977 (2633).
S. graciliflorus DC.
Tall glabrous herb with yellowish brown heads.

Tungnath, 3500 m. Sept. 1978 (2793).

S. kunthianus Wall. ex DC.
Aromatic erect herb with yellow flowers. Tungnath, 3500 m. Aug. 1977 (2634).

S. levingii C. B. Clarke
Tall glabrous herb with yellowish brown heads. Tungnath, 3500 m. Sept. 1978 (2794).

S. rufinervis DC.
Robust herb with small brownish yellow heads. Tungnath, 3500 m. Sept. 1978 (2795).

Tanacetum longifolium Wall. ex DC. (Loc.-Guggul)
Aromatic herb with yellow corymbose heads. Tungnath, 3500 m. Sept. 1977 (2661).

Taraxacum officinale Weber (Loc.-Karhatu)
Prostrate glabrous herb with yellow solitary heads. Tungnath, 3500 m. Sept. 1977 (2660).

Campanulaceae

Campanula argyrotricha Wall. ex DC.
Procumbent hairy herb with sky blue flowers. Tungnath, 3500 m. Oct. 1977 (2678).

Cyananthus integer Wall. ex Benth.
Procumbent glabrous herb on rocks with blue flowers. Tungnath, 3500 m. Oct. 1977 (2697).

C. lobatus Wall. ex Benth.
Decumbent herb with blue flowers. Tungnath, 3500 m. Aug. 1977 (2616).

C. microphyllus Edgew.
Glabrous trailing herb with blue flowers. Tungnath, 3500 m. Oct. 1977 (2677 and 2627).

Ericaceae

Cassiope fastigiata D. Don
Tufted small shrub with drooping white flowers. Tungnath, 3500 m. June 1977 (2725).

Gaultheria tricophylla Royle (Loc.-Bhuinla)
Prostrate small shrub with white flowers and blue berries. Tungnath, 3500 m. June 1977 (2726).

Rhododendron anthopogon D. Don (Loc.-Kodya)
Small shrub with dull yellow flowers. Tungnath, 3500 m. June 1977 (2727).

R. arboreum Sm. (Loc.-Burans)
Tree with red flowers. Tungnath, 3500 m. June 1978 (2797).

R. barbatum Wall. ex G. Don
Tree with deep red flowers. Rawanshila, 3300 m. June 1978 (2798).

R. campanulatum D. Don (Loc.-Simaru)
Small tree with light pink flowers. Tungnath. 3500 m. June 1977 (2728).

R. lepidotum Wall. ex G. Don
Shrub with dark pinkish-red flowers. Tungnath, 3500 m. June 1977 (2729).

Primulaceae

Lysimachia japonica Thunb.
Small herb with white flowers. Zabrya, 3250 m. June 1978 (2825).

L. prolifera Klatt.
Creeping herb with light pink flowers. Tungnath, 3500 m. Aug. 1977 (2687).

Primula denticulata Sm.
Herb with dark purple to pale lilac flowers. Tungnath, 3500 m. Aug. 1977 (2821).

P. petiolaris Wall.
Mealy herb with purple flowers. Tungnath, 3500 m. May 1978 (2799).

P. reidii Duthie (Loc.-Hainsandari)
Herb, with solitary white flowers on rocks. Tungnath, 3500 m. Aug. 1978 (2845).

Oleaceae

Syringa emodi Wall. ex G. Don
Small tree with oblong pointed tipped capsules. Zabrya, 3250 m. Sept. 1978 (2800).

Gentianaceae

Gentiana argentea Royle ex D. Don
Small herb with blue flowers. Tungnath, 3500 m. June 1977 (2731).

G. carinata Griseb.
Herb with dense glabrous leaves and terminal clustered blue flowers. Tungnath, 3500 m. June 1977 (2824).

G. leucomelaena Maxim.
Prostrate herb with long exserting capsules. Tungnath, 3500 m. June 1978 (2824).

G. stipitata Edgew.
Prostrate herb with greenish white flowers. Tungnath, 3500 m. Oct. 1977 (2679).

Swertia ciliata (G. Don) B. L. Burtt (Loc. Chirayata)
Erect herb with purplish white flowers pink at the base. Tungnath, 3500 m. Oct. 1977 (2674).

S. cuneata D. Don
Erect herb with light purple flowers. Tungnath, 3500 m. Aug. 1977 (2631).

S. speciosa D. Don (Loc.-Chirayata).
Tall erect herb with greenish flowers. Tungnath, 3500 m. Aug. 1977 (2632).

S. tetragona C. B. Clarke
Erect herb with whitish flowers. Tungnath, 3500 m. Sept. 1978 (2853).

Boraginaceae

Cynoglossum wallichii G. Don (Loc.-Lichkura)
Hairy herb with blue flowers. Tungnath, 3500 m. Aug. 1978 (2601).

Hackelia uncinata (Benth.) C.E.C. Fischer
Laxly hairy herb with dark blue and pink flowers. Tungnath, 3500 m. Aug. 1978 (2652).

Lindelofia longiflora (Benth.) Bail.
Hairy erect herb with dark blue and pink flowers. Tungnath, 3500 m. Aug. 1978 (2656).

Onosma emodi Wall.
Densely hairy herb with light pink tipped flowers. Tungnath, 3500 m. Aug. 1978 (2854).

Scrophulariaceae

Euphrasia platyphylla Pennell
Small herb with white pink streaked flowers. Tungnath, 3500 m. Aug. 1978 (2619).

Falconeria himalaica Hook. f.
Decumbent glabrous herb, with blue flowers on rocks. Tungnath, 3500 m. July 1977 (2688).

Hemiphragma heterophyllum Wall.
Prostrate diffused herb with dimorphic leaves, rosy flowers and red fruits. Tungnath, 3500 m. May 1978 (2826).

Pedicularis hoffmeisteri Klotzsch
Glabrous herb with yellow flowers. Tungnath, 3500 m. Aug. 1977 (2641).

P. porrecta Wall. ex Benth.
Decumbent glabrous herb with pink flowers. Tungnath, 3500 m. July 1977 (2846).

P. gracilis Wall.
Tall erect herb with rose purple flowers white at the base. Tungnath, 3500 m. July 1978 (2640).

Picrorhiza kurrooa Royle ex Benth. (Loc.-Katuki or Karui)
Spreading herb with bluish flowers and bladdery white seeds. Tungnath, 3500 m. June 1978 (2809).

Scrophularia calycina Benth.
Glabrous tall erect herb with light green flowers. Tungnath, 3500 m. July 1978 (2836).

Veronica cana Wall.
Erect hairy herb with light blue flowers. Tungnath, 3500 m. July 1977 (2689).

V. macrostemon Bunge ex Ledeb.
Hairy herb with terminal crowded subsessile white flowered racemes. Tungnath, 3500 m. July 1978 (2647).

Orobanchaceae

Boschniakia himalaica Hook. f. & Thoms.
Parasite on *Rhododendron campanulatum* with dense flowered ochreous brown racemes and tuberous base. Rawanshila, 3250 m. June 1978 (2776).

Lentibulariaceae

Utricularia orbiculata Wall.
Small herb with white flowers yellow at the base. Tungnath, 3500 m. Aug. 1977 (2620).

Lamiaceae

Clinopodium umbrosum (M. Bieb.) Koch
Herb with purple flowers. Daun, 3250 m. Sept. 1977 (2659).
Elsholtzia strobilifera Benth.
Hairy aromatic herb with pale purple flowers. Tungnath, 3500 m. Sept. 1977 (2668).
Phlomis bracteosa Royle ex Benth.
Tall stout herb with blue-purple flowers. Tungnath, 3500 m. Aug. 1977 (2605).
Prunella vulgaris Linn.
Ascending herb with violet-purple flowers. Tungnath, 3500 m. Aug. 1978 (2855).
Salvia hians Royle ex Hook.
Viscidly hairy tall erect herb with blue flowers. Tungnath, 3500 m. Aug. 1977 (2630).
S. nubicola Sweet.
Viscidly hairy erect herb with yellow flowers. Zabrya, 3250 m. Sept. 1978 (2856).
Teucrium royleanum Wall.
Hairy herb with purple flowers. Daun, 3250 m. Sept. 1978 (2857).

Plantaginaceae

Plantago brachyphylla Edgew. (Loc.-Isabgul)
Glabrous rosette herb with oblong black seeds. Tungnath, 3500 m. June 1978 (2832).

Polygonaceae

Oxyria digyna Hill (Loc.-Kailashi almorha)
Glabrous herb with green-pink flowers. Tungnath, 3500 m. Sept. 1977 (2665).
Polygonum affine D. Don
Herb with crowded red flowers. Above Tungnath, 4600 m. Sept. 1978 (2858).
P. alpinum All. (Loc.-Sarain).
Tall erect herb with white flowers. Tungnath, 3500 m. Sept. 1977 (2663).
P. amplexicaule D. Don
Large glabrous herb with red flowers. Tungnath, 3500 m. June 1977 (2733).
P. delicatulum Meissn.
Tufted glabrous herb with minute axillary greenish flowers. Tungnath, 3500 m. Aug. 1977 (2644).
P. emodi Meissn.
Creeping glabrous herb with red flowers. Tungnath, 3500 m. July 1977 (2607).
P. filicaule Wall. ex Meissn. (Loc.-Tufrya)
Slightly hairy herb with whitish and pink flowers which are sometimes tinged pink. Tungnath, 3500 m. Aug. 1977 (2699).
P. macrophyllum D. Don (Loc.-Kukhri)
Erect herb with terminal red spikes. Tungnath 3500 m. July 1977 (2691).
P. nepalensis Meissn.
Glabrous herb with terminal greenish and pink heads. Tungnath, 3500 m. Aug. 1977 (2637).
P. perpusillum Hook. f.
Small herb with pink flowers. Tungnath, 3500 m. July 1978 (2852).
P. rumicifolium Royle ex Bab. (Loc.-Kanthla)
Erect herb with dull pink flowers. Tungnath, 3500 m. June 1978 (2841).
P. sinuatum Royle
Creeping glabrous herb with pink flowers. Tungnath, 3500 m. Aug. 1977 (2636).
P. sphaerocephalum Wall. ex Meissn.
Creeping herb rooting at the nodes with white flowers. Chakdhar, 3250 m. June 1977 (2692).
P. vaccinifolium Wall. ex Meissn .
Creeping woody shrub with rose-red flowers. Tungnath, 3500 m. Sept. 1977 (2662).
P. viviparum Linn.
Herb with pink solitary erect spike lower portion of which is replaced by bulbils. Tungnath, 3500 m. Aug. 1977 (2732).

Rheum emodi Wall. ex Meissn. (Loc.-Dolya or Archa)
Tall erect herb with white flowers. Tungnath, 3500 m. June 1978 (2804).
R. moorcroftianum Royle
Tall erect herb with pinkish flowers. Above Tungnath, 4200 m. Aug. 1978 (2859).
Rumex nepalensis Spreng. (Loc.-Khulya)
Erect herb with green flowers. Tungnath, 3500 m. July 1978 (2860).

EUPHORBIACEAE

Euphorbia pilosa Linn. (Loc.-Daya)
Erect glabrous herb with yellow green flowers. Chakdhar, 3250 m. June 1977 (2690).
E. stracheyi Boiss. (Loc.-Dudhya Bish)
Prostrate herb with yellow green flowers. Tungnath, 3500 m. June 1977 (2698).

URTICACEAE

Parietaria debilis Forst.
Straggling herb with minute greenish flowers. Tungnath, 3500 m. Sept. 1978 (2861).
Pilea wightii Weddel var. **roylei** Hook. f.
Small creeping herb with minute pinkish flowers. Tungnath, 3500 m. Aug. 1978 (2842).

BETULACEAE

Betula utilis D. Don (Loc.-Bhooj or Bhojpatra)
Tree with peeling bark and hanging catkins. Chandrashila, 3750 m. July 1978 (2862).

SALICACEAE

Salix lindleyana Wall. ex Anderss.
Prostrate creeping shrubby herb with green yellow catkins. Tungnath, 3500 m. July 1977 (2738).

MONOCOTYLEDONS

ORCHIDACEAE

Cypripedium elegans Reichb. f.
Hairy, two leaved delicate herb with pink solitary flower. Tungnath, 3500 m. June 1978 (2835).
Goodyera fusca Hook. f.
Herb with fleshy leaves and white flowers. Tungnath, 3500 m. Sept. 1977 (2664).
G. repens R. Br.
Glabrous herb with white flowers. Tungnath, 3500 m. Sept. 1978 (2863).
Habenaria fallax King & Pantl.
Glabrous herb with greenish flowers. Tungnath, 3500 m. Aug. 1977 (2655).
H. latilabris Hook. f.
Erect herb with green flowers. Daun, 3250 m. Aug. 1978 (2864).
Herminium gramineum Lindl.
Herb with yellowish flowers. Tungnath, 3500 m. Aug. 1978 (2865).
Malaxis muscifera (Lindl.) O. Ktze.
Glabrous herb with minute yellowish green flowers. Tungnath, 3500 m. June 1977 (2736).
Orchis chusua D. Don
Glabrous herb with purple flowers. Tungnath, 3500 m. July 1977 (2610).
O. latifolia Linn. (Loc.-Hathajorhi)
Erect herb with palmate tubers and purple flowers. Tungnath, 3500 m. July 1977 (2735).
O. spathulata Reichb. f. ex Hook. f.
Glabrous herb with whitish purple flowers. Tungnath, 3500 m. June 1977 (2737).
Peristylus elisabethae (Duthie) P. F. Hunt
Small glabrous herb with white flowers. Tungnath, 3500 m. Aug. 1978 (2866).

SCITAMINACEAE

Roscoea alpina Royle
Herb with dark purple flowers. Tungnath, 3500 m. Aug. 1978 (2867).

HAEMODORACEAE

Aletris nepalensis Hook. f.
Herb with white flowers. Tungnath, 3500 m. Aug. 1978 (2868).
Ophiopogon intermedius D. Don
Glabrous herb with white drooping flowers. Chakdhar, 3250 m. Aug. 1978 (2869).

IRIDACEAE

Iris kumaonensis Wall. ex G. Don
Glabrous herb with blue flowers. Chandrashila, 3750 m. July 1978 (2801).

LILIACEAE

Allium stracheyi Baker (Loc.-Pharan)
Herb with white flowers. Tungnath, 3500 m. Sept. 1978 (2870).
A. wallichii Kunth (Loc.-Lainka)
Tall herb with dark purple flowers. Tungnath, 3500 m. Sept. 1977 (2657).
Clintonia udensis Trautv. var. **alpina** (Kunth ex Baker) Hara
Glabrous herb with white flowers. Tungnath, 3500 m. June 1978 (2839).
Fritillaria roylei Hook.
Herb with yellow-green solitary flowers. Tungnath, 3500 m. May 1977 (2744).
Gagea lutea Schultz. f. (Loc.-Naunya)
Delicate glabrous herb with yellow flowers. Tungnath, 3500 m. June 1977 (2743).
Lloydia alpina Salisb.
Herb with white flowers. Tungnath, 3500 m. June 1977 (2740).
L. longiscapa Hook. f.
Herb with white flowers which are pink at the base. Tungnath, 3500 m. June 1977 (2739).
Nomocharis nana (Kotzsch) E. H. Wilson
Herb on rocks with bluish-purple flowers. Tungnath, 3500 m. June 1978 (2850).
Polygonatum geminiflorum Decne.
Glabrous herb with white flowers. Tungnath, 3500 m. June 1978 (2872).
P. verticillatum All.
Glabrous herb with dirty white flowers. Tungnath, 3500 m. June 1978 (2871).
Smilacina purpurea Wall.
Stoloniferous herb with purple pink flowers. Tungnath, 3500 m. June 1977 (2742).
Smilax elegans Wall.
Small glabrous shrub with greenish-white flowers. Rawanshila, 3400 m. June 1978 (2828).
Trillium govanianum Wall. ex Royle
Herb with dark pink tepals and yellow stamens. Below Tungnath, 3250 m. May 1977 (2741).

JUNCACEAE

Juncus elegans Royle ex D. Don
Herb with white flowers. Tungnath, 3500 m. Aug. 1977 (2649).
J. himalensis Klotzsch & Garcke
Glabrous herb with dark brown flowers. Above Tungnath, 4600 m. Sept. 1978 (2873).
J. membranaceus Royle ex D. Don
Glabrous herb with white flowers. Tungnath, 3500 m. July 1977 (2745).
Luzula multiflora (Retz) Lef.
Hairy herb with brown flowers. Tungnath, 3500 m. June 1978 (2830).
L. spicata DC.
Herb with dark brown flowers. Above Tungnath, 4600 m. Sept. 1978 (2874).

ARACEAE

Arisaema intermedium Blume
Erect herb with green white striped spathe. Tungnath, 3500 m. July 1978 (2875).
A. jacquemontii Blume
Herb with green spathe. Tungnath, 3500 m. June 1978 (2851).
A. wallichianum Hook. f. (Loc.-Meen)
Herb with dark purple white striped spathe. Tungnath, 3500 m. June 1978 (2848).

Cyperaceae

Carex inanis Kunth.
Grass with grey green spikes. Tungnath, 3500 m. June 1977 (2749).
C. setigera D. Don
Grass with brownish spikes. Tungnath, 3500 m. June 1977 (2748).
Kobresia nitens C. B. Clarke
Grass with greenish spikes. Tungnath, 3500 m. June 1977 (2746).

Poaceae

Agrostis canina Linn.
Grass with purple-green panicles. Tungnath, 3500 m. July 1977 (2642).
A. munroana Aitch. & Hemsl.
Grass with greenish spikes. Tungnath, 3500 m. Aug. 1978 (2876).
A. pilosula Trin.
Grass with green panicles. Tungnath, 3500 m. July 1978 (2654).
A. stolonifera Linn.
Erect grass with purplish spikelets. Tungnath, 3500 m. Aug. 1978 (2877).
Danthonia cachymeriana Jaub. & Spach. (Loc.- Mamcha)
Densely tufted grass with light pale spikelets. Tungnath, 3500 m. Aug. 1977 (2651).
Deyeuxia pulchella (Griseb.) Hook. f.
Tufted grass with dark purple-green spikelets. Tungnath, 3500 m. Aug. 1978 (2653).
D. scabrescens (Griseb.) Munro ex Duthie
Tall grass with light purple spikelets. Tungnath, 3500 m. Aug. 1978 (2879).
Festuca gigantea Vill.
Loosely tufted grass with pale green spikelets. Tungnath, 3500 m. Aug. 1978 (2880).
F. kashmiriana Stapf
Tufted grass with green panicles. Tungnath, 3500 m. Aug. 1978 (2881).
F. rubra Linn.
Erect grass with two nodes and green spikelets. Tungnath, 3500 m. Aug. 1978 (2882).
F. valesiaca Schleich.
Tufted grass with pale green spikelets. Tungnath, 3500 m. Aug. 1978 (2883).
Helictotrichon virescens (Nees ex Steud.) Henr.
Tall erect slender grass with green spikelets. Tungnath, 3500 m. Aug. 1977 (2650).
Poa alpina Linn.
Densely tufted grass with greenish panicles. Tungnath, 3500 m. Aug. 1978 (2884).
P. annua Linn.
Stoloniferous glabrous grass with green panicles. Tungnath, 3500 m. Aug. 197 7(2696).
P. nepalensis Wall. ex Duthie
Erect grass with long pedicelled green spikelets. Tungnath, 3500 m. Aug. 1978 (2885).
P. pagophila Bor
Grass on rocky slopes with long pedicelled purple spikelets. Tungnath, 3500 m. Aug. 1978 (2886).
P. supina Schrad.
Erect glabrous herb with pale green spikelets. Tungnath, 3500 m. Aug. 1978 (2887).
Trisetum clarkei (Hook. f.) R. R. Stew.
Tall erect slender grass with shining green spikelets. Tungnath, 3500 m. Oct. 1977 (2685).

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THE FOOD HABITS OF THE INDIAN HARE, *LEPUS NIGRICOLLIS*, IN CHATRI FOREST, AMRAVATI, MAHARASHTRA[1]

J. H. SABNIS[2]

This study has attempted to ascertain the food of the Indian Hare by an examination of its faecal pellets collected in a square kilometre in the Chatri forest near Amravati, Maharashtra. 73.34% of the food has been found to consist of various grasses and the rest of other plants, all with a high moisture content.

INTRODUCTION

In the wild, it is very difficult to determine the food of herbivores except by watching and/or killing them. One important and relatively unworked method in India is by faecal analysis (Koppikar and Sabnis 1976, 1979). Although the hare has been a part of the Indian countryside for hundreds of years and has been known to compete for food with domestic stock and wild herbivores, the influence which they exert on vegetation has received scant attention. The need for studying the eco-biology of wild herbivores in general and the hare *Lepus nigricollis* in particular prompted me to undertake this investigation of the food spectrum and its habitat on the basis of epidermal remains of plants found in its faeces. This paper presents data on the food preferences and the relation of their abundance or otherwise with the population of the animal.

METHODS

The study was commenced in October 1978 in the Chatri forest and continued upto June 1979. Five trips per month, 45 in all, were made at approximate intervals of about a week, and fresh samples collected over an area of one square kilometre.

The plants occurring in the area were collected and identified. A set of illustrations showing the structural pattern of the epidermis of each kind of leaf was prepared by peeling the surface and mounting on slides in glycerine. The structural peculiarities of the epidermis were drawn with a camera lucida. From each set of droppings, five pellets were soaked in water for 2 days, allowed to disintegrate and then thoroughly mixed. The epidermal remains were teased out and mounted on temporary glycerine slides and then compared and matched with the illustrations by microscopic examination. The plant remains in 25 sets of droppings were examined and identified each month and used for calculating the monthly percentage of the different species consumed.

At approximately monthly intervals, five pasture samples were cut to ground level, weighed on a spring balance and then sorted by hand into component species in the laboratory. Each plant species was then weighed and dried in an oven for determining its water content.

OBSERVATIONS

Physiography. The study area in the Chatri forest near Amravati, Maharashtra State,

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(20°56′N. 77°47′E.) has on its eastern side a hilly tract of reserved and open forest rising above *c* 400 m. Chatri forest and the area studied form the westward slope of these hills. with an elevation between 350 to 400 m. The climatic conditions are uniform throughout the year. The average rainfall is 653 mm per year. The minimum and maximum temperatures fluctuate between 10°C and 20°C during winter and 35°C and 45°C during summer.

Vegetation. The habitat is a degraded dry deciduous forest due to biotic or bio-edaphic interferences. (This feature is characteristic of Chatri hare habitat). The hills in general appear barren but a few areas have patchy vegetation. There is comparatively thicker forest on the eastern side.

Dry deciduous scrub forests is available at the base of the hillocks, where there is intense grazing by wild and domestic animals, and which has resulted in deciduous shrub. The permanent species are *Acacia leucophloea, A. catechu, Zizyphus jujuba, Mimosa hamata, Gymnosporia montana, Butea monosperma* and *Lantana camara.*

The common ephemeral species are represented by *Triumfetta rhomboidea, Solanum xanthocarpum, Heylandia latebrosa, Indigofera linifolia, Ludwigia parviflora, Tridax procumbens, Euphorbia pulcherrima, Crotalaria hirsuta, Justicia simplex, Ocimum canum, Atylosia scarabaeoides, Enicostema littorale, Vicoa auriculata,* and *Cassia tora.*

The grasses are represented *Iseilema anthephorides, Ischaemum pilosum, Digitaria royleana, Setaria tomentosa, Cynodon dactylon* and *Aristida adscensionis.*

i) *Production of pasture*

The procedure is detailed under 'Methods' above and an attempt was made to study the plots nautrally grazed upon by wild and domestic animals. The dry weight of the pasture was ascertained to compare the amount of pasture available at different times but no attempt was made to calculate the sustaining capacity of the habitat. No sample area was used a second time. The data in Table I represents the total weight of plant cover on the ground sampled.

TABLE I

WEIGHT (IN GM) OF PASTURE IN SAMPLE AREAS (60 × 60 CM) GRAZED UPON BY HARE AND CATTLE

Condition of Habitat	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
(Moderately) grazed	290	250	235	225	230	215	188	165	187
Medium grazed	256	135	125	125	115	115	85	69	70
Over-grazed	70	48	30	49	35	25	21	22	27

ii) *Water content of palatable plants*

The differences in the water content of the different plants had considerable influence on their palatability for the hare. Table II lists the seasonal variations in water content of the plants grazed upon. The water content of some plants falls below 60% in late winter and summer (March to June) when it appears from data available that it is insufficient, and prompts the hare to change its food.

In summer, this leads to an active search for anything green (and at this time almost anything that was green was eaten) and the summer grasses were subject to severe grazing pressure. This behaviour is supported by presence of fresh faecal matter being largely located on the banks of the dry streams, which held patches of green grass.

The number of droppings varies in different months and suggests that it may be due to changes in population numbers caused by local

TABLE II

PERCENTAGE OF WATER CONTENT OF PALATABLE PLANT

Species	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Iseilema anthephorides	68.42	65.35	66.49	63.68	65.35	54.37	54.38	—	—
Ischaemum pilosum	82.76	78.84	78.55	64.46	66.73	55.35	53.58	52.58	50.62
Cynodon dactylon	60.83	58.68	65.67	62.37	56.69	55.85	54.37	58.33	62.67
Heylandia latebrosa	82.57	75.65	66.33	59.66	—	—	—	—	—
Euphorbia pulcherrima	85.50	79.35	76.54	78.39	75.65	72.58	72.33	68.69	64.33
Indigofera linifolia	66.38	63.87	63.45	62.31	62.16	61.33	60.19	60.35	58.89
Ludwigia parviflora	—	—	—	—	72.72	68.18	66.29	62.33	60.87
Sonchus arvensis	89.79	74.19	75.49	73.38	72.72	75.15	68.71	58.66	58.26

migration. Fresh faecal pellets which glisten because of a mucus covering are olive green. They turn to black in a week's time and older ones are bleached to pale grey or almost white. Each set consisted of 11 to 30 pellets and comparison with rectal pellets taken in freshly killed animals confirmed that the rectum is fully evacuated in every single defaecation. The presence of more than one set of fresh droppings in small area therefore indicates the presence of more than one individual. The droppings of the young can be separated by their smaller size—adults 1.3 cm in length and 395 mg in weight, cf. 3 mm and 75 mg in the young .

is no clear-cut breeding season, and young may be found throughout the year. Mr. H. Abdulali (Pers. Comm.) confirms that in his experience he has seen pregnant females shot during December to March.

Food:

Table IV reveals the variety of plants eaten by the hare. A few species of grass are the most constant food of the hare, and were found in 77.34 per cent of the faeces examined. The occurrence of their own hair is no doubt due to their constant habit of licking and cleaning their body.

Immediately after the monsoon, the period October to December is rich in food for the hare, and vegetation is still in the growing state. Not all the plants in the environment were found in the faeces. The predominant grass species are *Iseilema anthephorides, Ischaemum pilosum, Digitaria royleana.* Other plants grazed upon are *Heylandia latebrosa, Indigofera linifolia* and *Cynthocline lyrata.* Species observed to have been grazed by hare

TABLE III

MONTHLY POPULATION IN PERCENTAGE OF ADULT AND YOUNG ANIMALS ON BASIS OF PELLET SIZE

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Adult	62.66	50	62.05	53.13	75.13	68.00	68.79	70.28	62.05
Young	37.84	50	37.05	46.87	24.83	32.00	31.21	29.72	37.05

From Table III it will be noted that the number of young (estimated on the proportion of small droppings) increases from 37.84 in October to 46.87 in January but then drops to 29.72 in May. The Wild Animals (Protection) Act, 1971 in Maharashtra protected the hare along with other Small Game from 1st April to 30th September, but it is evident that there

TABLE IV

FREQUENCY OF OCCURRENCE OF DIFFERENT ITEMS IN THE FAECES OF 225 HARE, OCT.-MAY

Species	Frequency in faeces %
A Grass, all species	77.34
Iseilema anthephorides	50.00
Digitaria royleana	20.00
Ischaemum pilosum	50.00
Setaria tomentosa	16.66
Aristida adscensionis	6.66
Cynodon dactylon	36.66
B Other Plants	22.66
Heylandia latebrosa	26.66
Indigofera linifolia	55.00
Cynthocline lyrata	50.00
Ludwigia parviflora	35.00
Sonchus arvensis	10.00
Euphorbia pulcherrima	28.33
Tridax procumbens	36.66
Zizyphus jujuba seed	18.33
Hairs of hare	38.33

TABLE V

SEASONAL VARIATION IN PERCENTAGE OF FOOD PLANTS BASED ON FAECAL ANALYSIS (25 SETS PER MONTH)

Food Items	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Grass									
Iseilema anthephorides	100	85.71	71.43	100	62.05	40	—	12.05	—
Ischaemum pilosum	71.42	57.14	57.14	75	37.05	20	22.22	—	—
Digitaria royleana	57.14	42.85	42.85	25	50	—	11.11	62.05	—
Setaria tomentosa	—	—	—	—	—	—	33.33	37.05	12.50
Cynodon dactylon	—	—	—	—	—	—	66.66	62.05	62.50
Aristida adscensionis	—	—	—	—	37.05	20	—	—	—
Other plants									
Heylandia latebrosa	57.14	71.42	71.43	—	—	—	—	—	—
Indigofera linifolia	42.85	57.44	57.14	75	62.05	60	55.55	50	50
Cyathocline lyrata	28.56	42.85	28.57	75	50	60	22.22	75	62.05
Ludwigia parviflora	—	—	—	—	50	80	33.33	—	75
Sonchus arvensis	—	—	—	50	37.50	20	—	50	—
Euphorbia pulcherrima	—	—	—	50	—	60	44.44	50	50
Tridax procumbens	—	—	57.14	50	37.50	25	33.35	50	52.05
Zizyphus jujuba seed	—	—	—	75	50	50	—	—	—
Hairs of hare	28.56	37.05	42.85	25	25	40	44.44	37.05	37.50

during the period of investigation from October to June are given in Table V. The food preference is more or less similar for the winter months.

The summer is the driest and most critical period. The entire terrain goes dry. The hare has to travel long distances in search of green food. The patchy green grassy vegetation is now available only on the banks of dry streams intermittently at distances of 100 to 500 metres.

The predominant summer grass is *Cynodon dactylon,* and the plants *Euphorbia pulcherrima, Ludwigia parviflora, Indigofera linifolia,* and *Tridax procumbens* are now largely consumed. The importance of availability appears to be illustrated in the seasonal variations in the kind of plants consumed by them.

Discussion

It is usually more satisfactory to measure in one specimen the percentage volume of each food item against the total content (McAtee 1912). This procedure has the advantage of showing accurately what an animal has ingested but the disadvantage that the animal must usually be killed, thus the information obtained is about only one meal or part of meal. Nevertheless considerable information on the food habits of animals has been obtained in this manner (Henderson 1927, McAtee 1912, Davison 1940, Indurkar and Sabnis 1976, and Sabnis and Kolhatkar 1977).

There are usually indigestible parts in all kinds of food and these indigestible or undigested parts are eliminated from the body. The contents of faecal droppings or regurgilated pellets can be identified by differences in shape, size, colour or histological and hair structure (Dusi 1949, Koppikar and Sabnis 1977).

The droppings must as far as possible be collected fresh as they quickly disintegrate in wet weather. However as far as plant tissue remains are concerned these do not offer any such difficulty. A considerable advantage of pellet analysis is the possibility of a continuous diet analysis of the same animal or species through long periods of time without disturbance to its normal behaviour (Dalk 1935, Erington 1932, and Koppikar and Sabnis 1979). Among methods so far described above the faecal analysis is best suited for food studies of species which it is not desired to kill in large numbers.

The present study carried out over a short period does not claim to establish the quantities or overall food of the hare, but it is hoped that the data indicating seasonal preferences of vegetable food will assist further studies of this and other herbivores which have been sadly neglected in this country.

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TEACHING OF BOTANICAL NOMENCLATURE THROUGH PRACTICAL APPLICATION—AN URGENT NEED[1]

A. N. HENRY AND M. CHANDRABOSE[2]

Teaching of Botanical Nomenclature is carried out in several Universities of India through a few lectures that are mostly historical in view point, as opposed to practical. It is suggested that a very effective way of training botanical students in nomenclature is by the 'case method' of the International Code of Botanical Nomenclature. Solutions including process and investigation of three sample nomenclature cases are given in this paper.

Systematic Botany or Systematics embraces the whole field of systematic work and is broadly divisible into two parts: *Taxonomy* deals with the placement of an individual plant into a taxonomic group or taxon, and the assignment of the taxon into the general system of classification which is, of course, phylogenetic in nature; and *Nomenclature* deals with the determination or selection of the correct name to be applied to a known taxon in conformity with the International Code of Botanical Nomenclature. Systematic work is correctly and fully done only when both these steps or stages (*viz.* taxonomic and nomenclatural) are properly carried out. Nomenclature thus forms an inseparable and important part of Systematic Botany. Undoubtedly, nomenclature serves taxonomy.

The International Code of Botanical Nomenclature, is derived mainly from the Laws of Botanical Nomenclature proposed by Alphonse de Candolle in 1867. These laws, in their turn, are mainly based on the various aphorisms and pronouncements clearly stated by Linnaeus in his *Fundamenta Botanica* (1736) and explained in great detail in *Critica Botanica* (1737). The text of the current edition of the "Code" (Stafleu *et al.* 1978) is based upon the decisions reached by the Nomenclature Section of the Twelfth International Botanical Congress held in Leningrad from 3rd to 10th July, 1975. It is the product of the intense study by specialists in the field of botanical nomenclature, who for nearly a century have been studying the problems connected with the naming of plants. In various botanical congresses held generally at an interval of about five years, every effort was made to make the system work satisfactory in all respects and to secure a stable and uniform system of plant nomenclature by way of suitable amendments to the Code, including amendments in the list of *nomina conservanda* which are often the result of considerable dedication and laborious bibliographic research.

In various floras of India published up to the early part of 20th century, much attention was not paid to the selection of the correct names of plants. Relevant synonymy was also invariably omitted. These have caused much confusion in the identity and nomenclature of several common Indian plants. A break-through in floristic research in India was noticed in 1953 when Santapau published his FLORA OF KHANDALA ON THE WESTERN GHATS OF INDIA adopting the correct identity and nomenclature of the plants treated therein and also

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[2] Botanical Survey of India, Coimbatore-641002.

by citing relevant synonymy. Several regional/district floras of India published since then, have followed suit. The plant names given in these floras no doubt vary considerably from the old floras. The majority of the recent name changes of Indian plants are due to strict application of the International Code of Botanical Nomenclature, while others are either due to the better understanding of the identity of the plant or even to the proper judgement of the taxonomic status of the species. Hence identity and nomenclature are equally important and they should go side by side in fixing the correct names of plants.

Santapau (1965) stressed that the "Code" should be included in the curriculum of atleast such post-graduate students who take up any of the branches of plant systematics for their special study. It is gratifying to note that in recent times it has gained increased recognition and this is reflected by a large number of colleges and universities in India that include it in their syllabi. Normally taxonomic part is taught at length by lectures, laboratory work and on field excursions; but nomenclature is usually covered briefly in a few lectures that are mostly historical in view point, as opposed to practical. These lectures, no doubt, are of value, but the student does not gain a detailed knowledge of the laws of the Code, and this creates difficulty for him to follow the nomenclatural/taxonomic synonymy given in recent floras/monographs and to arrive at the correct names of plants. While naming the plants, he still uses the incorrect names given in the old out-dated floras. Hence a very effective way of training botanical students in nomenclature is by the *case method* of the International Code of Botanical Nomenclature. Harold St. John, as early as 1958, stressed this aspect in his "Nomenclature of Plants". Each student should be able to investigate and evaluate the validity of the publication cited, search for synonymy in classical books/literature and for pertinent facts such as basionyms, homonyms, tautonyms and to understand the terms often used such as *comb. nov.* and *nom. nov.*

Solutions including process and investigation of three sample nomenclature cases are given below:

Ophioxylon serpentinum Linn. Sp. Pl. 1043. 1753.

Ophioxylon trifoliatum Gaertn. Fruct. Sem. Pl. 2: 123. 1791.

Rauvolfia serpentina (Linn.) Benth. ex Kurz, For. Fl. Burma 2: 171. 1877.

The earliest of these names is *Ophioxylon serpentinum* which is found in Linnaeus' Species Plantarum—1753. There on page 1043 Linneaeus validly published this name (according to Art. 32 to 45 of the International Code of Botanical Nomenclature). Further, according to Art. 13, valid publication of names for Spermatophyta and Pteridophyta, begins from 1st May, 1753 (Linnaeus, Species Plantarum ed. 1.). In Linnaeus' Species Plantarum the placing of the epithet in the margin opposite the name of the genus clearly indicates the combination intended (Art. 33). Bentham (in Genera Plantarum 2: 697. 1876) appears to have been the first in uniting *Ophioxylon* Linn. (Sp. Pl. 1043. 1753; Gen. Pl. ed. 5. 467. 1754) and *Rauvolfia* Linn. (Sp. Pl. 208. 1753; Gen. Pl. ed. 5. 98. 1754), after adequate comprehension of the generic characteristics of both the genera. The issue is of course a taxonomic one. He adopted the name *Rauvolfia* for the combined genus and this name is accordingly to be retained (Art. 57.2). Bentham did not really effect the transfer of the species *Ophioxylon serpentinum* Linn. to *Rauvolfia*.

Rauvolfia serpentina (Linn.) Benth. ex Kurz was a combination based on the oldest epithet-bringing synonym (basionym)—*Ophioxylon serpentinum* Linn. (Art. 33.2.). When a species is transferred to another genus but retains its epithet the author of the basionym (who published this as a legitimate name) must be cited in parentheses, followed by the author who effected the combination (Art. 49). Kurz in his *Forest Flora Burma* 2: 171. 1877 first validly published the combination by directly giving reference to the basionym, but ascribed it to Bentham. According to recommendation 46C. I, the correct author citation is the name of the publishing author (Kurz), but the name of the other person followed by the connecting word *ex* may be inserted before the name of the publishing author, if desired (i.e. Benth. ex Kurz).

Another question of some concern is the orthography of the generic name. Plumier followed by Linnaeus consistently used the Latin version of Rauwolf's name and named the genus as *Rauvolfia*. But Willdenow in his Species Plantarum and following him several others including authors of Indian floras spelt the generic name as *Rauwolfia*. However, according to Art. 73, the original spelling of Linnaeus (intentional latinisation of Rauwolf's name) *viz. Rauvolfia* is to be preserved.

In 1791, Gaertner (Fruct. Sem. Pl. 2: 123) validly published the name—*Ophioxylon trifoliatum*. However, this name became superfluous (Art. 63), as Gaertner's plant already had an earlier, validly published name—*O. serpentinum* Linn. (1753).

Hence, the correct name of 'Sarpagandha' is *Rauvolfia serpentina* (Linn.) Benth. ex Kurz.

Another case involving both identity and nomenclature is discussed below:

Entada pursaetha DC. Prodr. 2: 425. 1825.
Mimosa entada Linn. Sp. Pl. 518. 1753.
Entada rheedii Spreng. Syst. 2: 325. 1825.
Entada monostachya DC. Prodr. 2: 425. 1825.
Entada scandens auct. non Benth. 1841; Gamble, Fl. Pres. Madras 417. 1919.

Most of the earlier Indian floras report the occurrence of *Entada scandens* (Linn.) Benth. in India. However, recent critical studies undertaken by way of 'type method' have revealed that the true *Entada scandens* (Linn.) Benth. which is synonymous to *Entada phaseoloides* (Linn.) Merrill does not occur in India, but is found only in Amboina in the Moluccas; and the correct identity of the common *Entada* occurring in India should be *Entada pursaetha* DC.

Now investigation of the nomenclature case reveals:

The earliest of these names is *Mimosa entada* which was validly published in Linnaeus' Species Plantarum p. 518. 1753. Augustin de Candolle (1825) while transferring this species to the genus *Entada,* could not retain the specific epithet "entada" as the resulting binary name "*Entada entada*" is a tautonym which is inadmissible according to Art. 23. Hence he proposed a new name *Entada monostachya* DC. (in his Prodr. 2: 425). The three competing names for this species in the genus *Entada* viz. *E. pursaetha* DC., *E. rheedii* Spreng. and *E. monostachya* DC. all date from 1825. Brenan (Kew Bull. 1955: 164. 1955) appears to have been the first to unite all the above three species; he adopted the name *Entada pursaetha* DC. for the combined species, and this name is accordingly to be retained (Art. 57.2).

Now regarding the citation of the misapplied name: according to Recommendation 50D.1, the name *E. scandens* as a misidentification should not be included in the synonymy of *E. pursaetha* but added after it. Further, the misapplied name, i.e. *Entada scandens* should be indicated by the words *auct. non* followed by the name of the original author (Benth.) and the bibliographical reference of the misidentification, i.e. reference to Gamble, Fl. Pres. Madras or any other floras as the case may be which have misidentified the plant.

The correct identity and nomenclature of the common Indian species of *Entada* is, therefore determined as *Entada pursaetha* DC.

Another nomenclature case involving the proper judgement of the taxonomic status of two genera is given below:

In most of the older floras, the genera *Abelmoschus* Medicus, Malv. 46. 1787 and *Hibiscus* Linn. Sp. Pl. 693. 1753; Gen. Pl. ed. 5. 310. 1754 are treated as congeneric (i.e. synonymous). However, K. Schumann (in Engler & Prantl, Nat. Pflanzenfam. 3(6): 47. 1895) and following him several monographers treated them as distinct based mostly on the nature of the calyx: spathaceous, irregularly 2 to 3-lobed and caducous in *Abelmoschus;* and campanulate, cupular, regularly 5-lobed or truncate with minute teeth, and persistent in *Hibiscus.*

Consequently several species of *Hibiscus* including *H. esculentus* Linn. were transferred to genus *Abelmoschus*:

Abelmoschus esculentus (Linn.) Moench, Meth. Pl. 617. 1794.

Hibiscus esculentus Linn. Sp. Pl. 696. 1753.

Hibiscus longifolius Willd. Sp. Pl. 3: 827. 1800.

Abelmoschus esculentus (Linn.) Moench was a combination based on the oldest epithet-bringing synonym (basionym)—*Hibiscus esculentus* Linn. (Art. 33.2). Moench in his *Methodus Plantas* (1794) first validly published the combination by directly giving reference to the basionym. The author of the basionym is cited in parantheses, followed by the author who effected the combination (Art. 49).

In 1800, Willdenow (Sp. Pl. 3: 827) validly published the name *Hibiscus longifolius.* However, this name became superfluous (Art. 63) as Willdenow's plant already had a prior validly published name—*H. esculentus* Linn. (1753).

Hence the correct name of 'bhindi' is *Abelmoschus esculentus* (Linn.) Moench.

The solutions of even these simple nomenclature cases bring the student in contact with several of the fundamental botanical publications. The correct interpretation depends on an understanding of the principles of priority, synonymy, regulation governing the binominal system, and other concerned Articles and Recommendations of the International Code of Botanical Nomenclature. Several other cases can be digested and solved in a similar way and certainly the study will aid in giving the student a sounder training in Botany. Only after investigation and evaluation of a few cases, he evinces interest in comparing the old and recent floras for name changes and in course of time will be able to fix for himself the correct identity and nomenclature of the common local plants in conformity with the rules of the International Code of Botanical Nomenclature.

It may be stated that name changes are annoying to ecologists, foresters, economic botanists and other plant users including teachers of Botany, who feel that the names ought to be stabilised. Stabilization is not fixation: stabilization should be achieved only through the application of the International Code of Botanical Nomenclature.

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SOME FRESH-WATER OLIGOCHAETA FROM BOMBAY CITY AND ENVIRONS[1]

K. Vanamala Naidu[2] & K. Abhinender Naidu[3]

(*With fifty-eight text-figures*)

Introduction

Stephenson (1923) has listed the known species of oligochaetes from the nine regions of the Indian sub-continent, in which the Western region, comprising of Goa to Cutch, the ghats to the sea has only 5 species of fresh-water oligochaetes known, all belonging to family Naididae. The other eight regions have the following number of species of fresh-water oligochaetes noted against them.

	Aeolos-omatidae	Naidiade	Tubific idae	Phrae odril idae	Total
1. North Western Territory	2	15	2	0	19
2. North Eastern Frontier Region	0	0	2	0	2
3. Western Himalaya Region	0	5	0	0	5
4. Indo-gangetic Plain	1	16	2	0	19
5. Burma, Andaman & Nicobar	0	3	1	0	4
6. Main Peninsular Area	0	4	2	0	6
7. Southern Region	0	5	2	0	7
8. Sri Lanka (Ceylon)	1	3	1	1	6

Naidu (1961 and 1966) tabulated the fresh-water oligochaetes then known to the above nine regions, in which no additions were observed in respect of N.W. Territory, Western Himalayan Region, N.E. Frontier Region, Main Peninsular Area, Western Region and Sri Lanka, while in three other regions, *viz.* Indo-Gangetic Plain it had increased from 19 to 22 species, Burma, Andaman and Nicobar from 4 to 6 species, and Southern Region from 7 to 51 species.

The fresh-water oligochaetes known from the Western Region at present are:

1. *Chaetogaster langi* Bretscher, 1896 from Satara
2. *Chaetogaster limnaei bengalensis* Annadale, 1905 from Khandala
3. *Nais communis* Piguet, 1906 from Khandala
4. *Aulophorus furcatus* (Muller, 1773) from Bombay and Khed
5. *Pristina longiseta longiseta* Ehrenberg, 1828 from Bombay

With a view to study the fresh-water oligochaetes of Bombay, one of us (K.V.N.) made some collections in the summer of 1965 in and around Bombay city. In addition Dr. U. Obai-

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LOCALITIES FROM WHICH F.-W. OLIGOCHAETES WERE COLLECTED, LATES OF COLLECTION, ETC.

Name of locality	Species collected	Type of worm	Date of collection	Name of the collector
1. Vehar Lake	1. *Aeolosoma hemprichi*	3 non-sexual	28.4.65	K.V.N.
	2. *Chaetogaster crystallinus*	2 non-sexual	29.4.65	K.V.N.
	3. *Dero cooperi*	3 non-sexual	29.4.65	K.V.N.
	4. *Pristina evelinae*	3 non-sexual	29.4.65	K.V.N.
	5. *Pristina proboscidea*	4 non-sexual	29.4.65	K.V.N.
	6. *Dero nivea*	5 non-sexual	3.5.65	K.V.N.
	7. *Branchiura sowerbyi*	3 non-sexual	28.4.65 29.4.65	K.V.N.
	8. *Pristina longiseta longiseta*	2 non-sexual	29.4.65	K.V.N.
2. Powai Lake	1. *Chaetogaster crystallinus*	3 non-sexual	1.5.65	K.V.N.
	2. *Dero digitata*	11 non-sexual	28.4.65 1.5.65 24.4.65 20.5.65	K.V.N. U.O.H.
	3. *Dero cooperi*	6 non-sexual	28.4.65	K.V.N.
	4. *Dero zeylanica*	3 non-sexual	2.5.65	K.V.N.
	5. *Dero indica*	4 non-sexual	20.5.65	U.O.H.
	6. *Aulophorus hymanae*	3 non-sexual	1.5.65	K.V.N.
	7. *Allonais gwaliorensis*	3 non-sexual	28.4.65	K.V.N.
	8. *Allonais rayalaseemensis*	4 non-sexual	28.4..65	K.V.N.
	9. *Pristina synclites*	5 non-sexual	28.4.65 20.5.65	K.V.N. U.O.H.
	10. *Pristina longiseta longiseta*	4 non-sexual	28-4-65	K.V.N.
	11. *Pristina proboscidea*	3 non-sexual	28.4.65 5.5.65	K.V.N.
	12. *Aulodrilus pluriseta*	8 sexual	1.5.65	K.V.N.
3. Bandra Tank	1. *Dero cooperi*	2 non-sexual	1.5.65	K.V.N.
	2. *Dero nivea*	2 non-sexual	1.5.65	K.V.N.
	3. *Dero digitata*	2 non-sexual	1.5.65	K.V.N.
	4. *Aulophorus furcatus*	6 non-sexual	1.5.65	K.V.N.
	5. *Aulophorus michaelseni*	5 non-sexual	1.5.65	K.V.N.
	6. *Allonais gwaliorensis*	4 non-sexual	1.5.65	K.V.N.
	7. *Pristina longiseta longiseta*	6 non-sexual	1.5.65	K.V.N.
	8. *Branchiura sowerbyi*	3 non-sexual	1.5.65	K.V.N.
	9. *Limnodrilus hoffmeisteri*	2 sexual	1.5.65	K.V.N.
4. Castle Mill Pond, Thana	1. *Dero digitata*	3 non-sexual	22.4.65	U.O.H.
	2. *Dero cooperi*	3 non-sexual	22.5.65	U.O.H.
	3. *Aulophorus hymanae*	5 non-sexual	22.5.65	U.O.H.
	4. *Allonais gwaliorensis*	6 non-sexual	22.5.65	U.O.H.
	5. *Allonais rayalaseemensis*	3 non-sexual	22.5.65	U.O.H.
5. Railway Station Pond, Thana	1. *Aulophorus hymanae*	5 non-sexual	22.5.65	U O.H.
	2. *Allonais rayalaseemensis*	3 non-sexual	22.5.65	U.O.H.
	3. *Allonais gwaliorensis*	5 non-sexual	22.5.65	U.O.H.

6.	Bio-filter Purification Works, Dadar	1. *Aeolosoma bengalense*	4 non-sexual	20.5.65	U.O.H.
		2. *Dero digitata*	2 non-sexual	20.5.65	U.O.H.
		3. *Allonais rayalaseemensis*	4 non-sexual	20.5.65 22.5.65	U.O.H.
		4. *Pristina synclites*	3 non-sexual	20.5.65	U.O.H.
7.	Fish Tank, Colaba	1. *Limnodrilus hoffmeisteri*	2 sexual	28.4.65	K.V.N.

dulla Hussainy (U.O.H.) of Melbourne, Australia, then working at the Zonal Laboratory of National Environmental Engineering Research Institute, Bombay, had made some collections of fresh-water ologochaetes and sent them for examination. All these collections when studied, revealed the existence of 21 species of fresh-water oligochaetes, 2 Aeolosomatids, 15 Naidids and 4 Tubificids. Of these 2 species are already known for the Western Region and hence 19 species are new to this region. They are :
1. *Aeolosoma bengalensis* Stephenson, 1911, 2. *Ae. hemprichi* Ehrenberg, 1831, 3. *Chaetogaster crystallinus* Vejdovsky, 1883, 4. *Dero digitata* (Muller, 1773), 5. *D. coopri* Stephenson, 1932, 6. *D. nivea* Aiyer, 1930, 7. *D. indica* Naidu, 1962, 8. *D. zeylanica* Stephenson, 1913, 9. *Aulophorus hymanae* Naidu, 1963. 10. *A. michaelseni* Stephenson, 1923, 11. *Allonais gwaliorensis* (Stephenson, 1920), 12. *A. rayalaseemensis* Naidu, 1963, 13. *Pristina evelinae* Marcus, 1943, 14. *Pr. proboscidea* Beddard, 1896, 15. *Pr. synclites* Stephenson, 1925, 16. *Branchiura sowerbyi* Beddard, 1892, 17. *Limnodrilus hoffmeisteri* Claparede, 1862, 18. *Aulodrilus pluriseta* (Piguet, 1906) and 19. *A. pigueti* Kowalewski, 1914. With the addition of these 19 species, the Western Region now has a total of 24 species of fresh-water oligochaetes.

Material and Methods

Aquatic plants, decaying leaves, wood, etc., algae and bottom mud samples from different water sources in Bombay city and from the Vehar Lake and Powai Lake were collected and placed in beakers submerged in water for a day. The worms from them settled on the walls of the beakers near the surface of the water. The worms were examined under the compound microscope in living condition for the number and characters of the setae, colour of epidermal glands, shape of the prostomium, position and shape of stomach, pigmentation of the body, number and shape of the gills, position of the dorsal blood vessel and contractile lateral vessels, presence or absence of coelomocytes, shape and position of spermathecae, atria, etc. They were later narcotised and preserved in formalin for further study of length and diameter of the worms, number of segments, position of fission zones, etc.

Systematic Section

Aeolosomatidae

1. **Aeolosoma bengalense** Stephenson, 1911. (Figs. 1-2).

Stephenson, 1923, p. 41. Aiyer, 1926, p. 131-136, fig. 1-3; 1929, p. 18. Michaelson and Boldt, 1932, p. 589. Marcus, 1944, p. 16-17, fig. 2A-B. Herlant-Meewis, 1954, p. 80. Yamaguchi, 1953, p. 280-281, fig. 1. Dioni, 1961, p. 112. Naidu, 1961, p. 648-649, fig. 1A-B; 1965a, p. 16; 1966, p. 209, 222. Costa, 1967, p. 39. Bunke, 1967, p. 229-235, fig. 17-18.

length (preserved) = 0.9-1.0 mm; diameter (preserved) = 0.15 mm; s (number of segments) = 12-14; n (number of segments behind which budding zone forms) = 8-10.

Worms pale white, transparent with variously shaped dirty yellow and greenish yellow epidermal glands in integument. Prostomium rounded, wider than body diameter. Hair setae (Figs. 1-2) all bayonet shaped, unequal, longer in dorsal bundles than in ventral bundles, 2-3 long seta per bundle of 200-300 μ and 2-4 short setae of 150-200 μ long dorsally, 2-3 of 100-150 μ and 80-100 μ long ventrally. Intestine dilated in $\frac{1}{2}$ IV—$\frac{1}{2}$ IX, narrow behind.

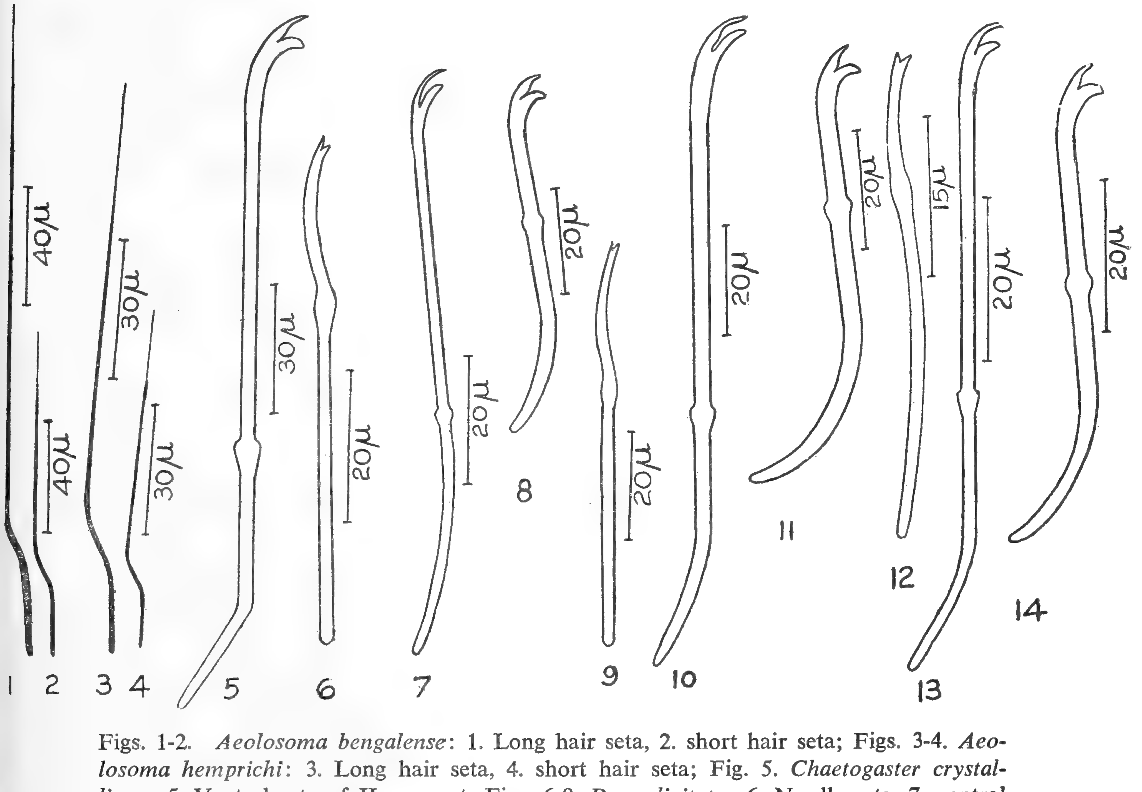
Distribution in Indian sub-continent: Sri Lanka (Ceylon); Travancore, Cuddapah, Bangalore (S. India); Nagpur (C. India); Calcutta (E. India); now reported from Bombay (W. India).

Further distribution: Germany (Europe); China, Java, Japan (Asia); Canada (N. America); Brazil, Paraguay, Uruguay (S. America).

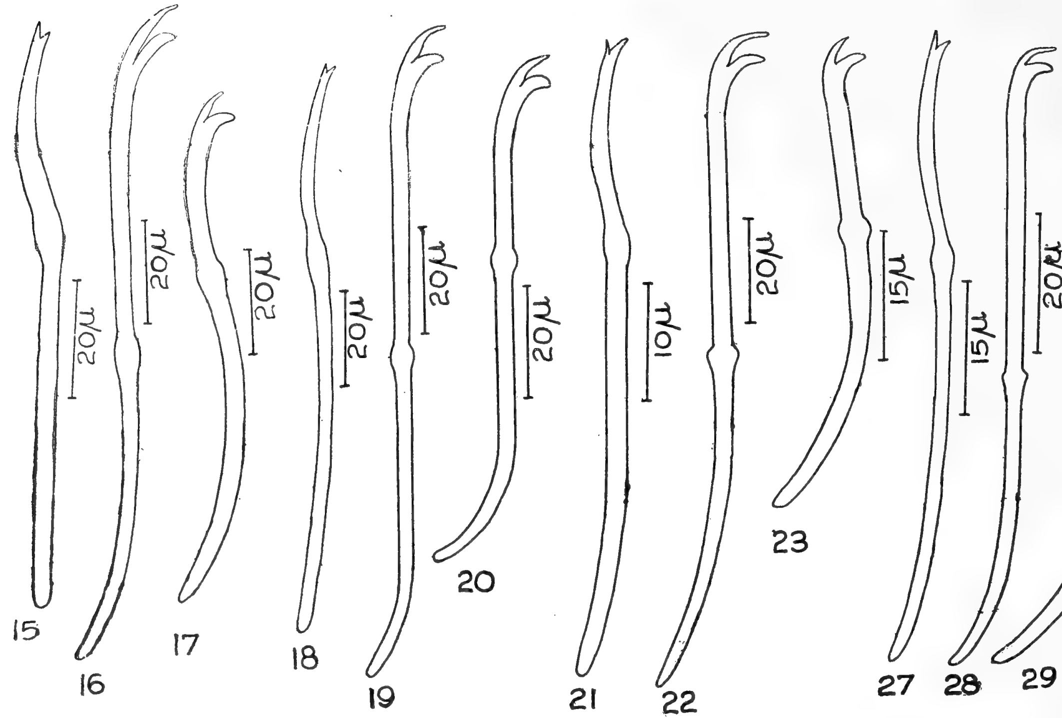
2. **Aeolosoma hemprichi** Ehrenberg, 1831. (Figs. 3-4).

Naidu, 1961, p. 650-651, p. 2A. Cekanovskaya, 1962, p. 144-145, fig. 69, 70 A. Bucher, 1965, p. 97, fig. 1-6. Bunke, 1967, p. 194-198, fig. 1-2, 62-63, 65. Costa, 1967, p. 39. Ercolini, 1969, p. 11-12. Brinkhurst, 1971, p. 126. Van Der Land, 1971, p. 670-672.

l = 0.4-0.8 mm (Single), 1.5-2.0 mm (Chains); d = 0.05-0.07 mm; s = 12-15; n = 7-10.



Figs. 1-2. *Aeolosoma bengalense*: 1. Long hair seta, 2. short hair seta; Figs. 3-4. *Aeolosoma hemprichi*: 3. Long hair seta, 4. short hair seta; Fig. 5. *Chaetogaster crystallinus*: 5. Ventral seta of II segment; Figs. 6-8. *Dero digitata*: 6. Needle seta, 7. ventral seta of II, 8. ventral seta of posterior segment; Figs. 9-11. *Dero cooperi*: 9. Needle seta, 10. ventral seta of II, 11. ventral seta of posterior segment; Figs. 12-14. *Dero nivea*: 12. Needle seta, 13. ventral seta of II, 14. ventral seta of VII.



Figs. 15-17. *Dero indica*: 15. Needle seta, 16. ventral seta of III, 17. ventral seta of middle segment; Figs. 18-20. *Dero zeylanica*: 18. Needle seta, 19. ventral seta of II. 20. Ventral seta of middle segment; Figs. 21-23. *Aulophorus furcatus*: 21. Needle seta, 22. ventral seta of II, 23. ventral seta of VII; Figs. 27-29. *Aulophorus michaelseni*: 27. Needle seta. 28. ventral seta of II, 29. ventral seta of middle segment.

Worms small, transparent with spherical orange-red epidermal glands. Prostomium rounded, wider than body diameter with lateral sensory ciliated pits. Setae are all hair setae (Figs. 3-4), bayonet shaped, bundles with short and long setae, long setae 1-3 of 80-120 μ, short setae 1-4 of 40-80 μ long. Intestine dilated in IV-VI. First pair of nephridia between II and III.

Distribution in Indian sub-continent: Travancore, Cuddapah, Bellary, Kakinada (S. India); Lahore (Pakistan).

Extralimital distribution: Europe, Asia, Africa, Australia, North and South America.

NAIDIDAE

Sub-family CHAETOGASTRINAE Sperber, 1948

3. **Chaetogaster crystallinus** Vejdovsky, 1883. (Fig. 5).

Sperber, 1948, p. 68-71, fig. 7 E, K, Pl. I, fig. 3, Pl. II, fig. 1-3. Naidu, 1962a, p. 135-137, fig. 6A-H. Brinkhurst, 1963, p. 17, fig. 2d; 1964, p. 202, fig. 1D. Cekanovskaya, 1962, p. 207-208, fig. 120, 121. Liang, 1964, p. 643. Costa, 1967, p. 40. Brinkhurst and Jamieson, 1971, p. 311-312, fig. 7.1 L-N. Ali and Issaque, 1975, p. 55.

l = 4-5 mm (Chains); d = 0.3-0.4 mm; s = 14-17; n = 8-9.

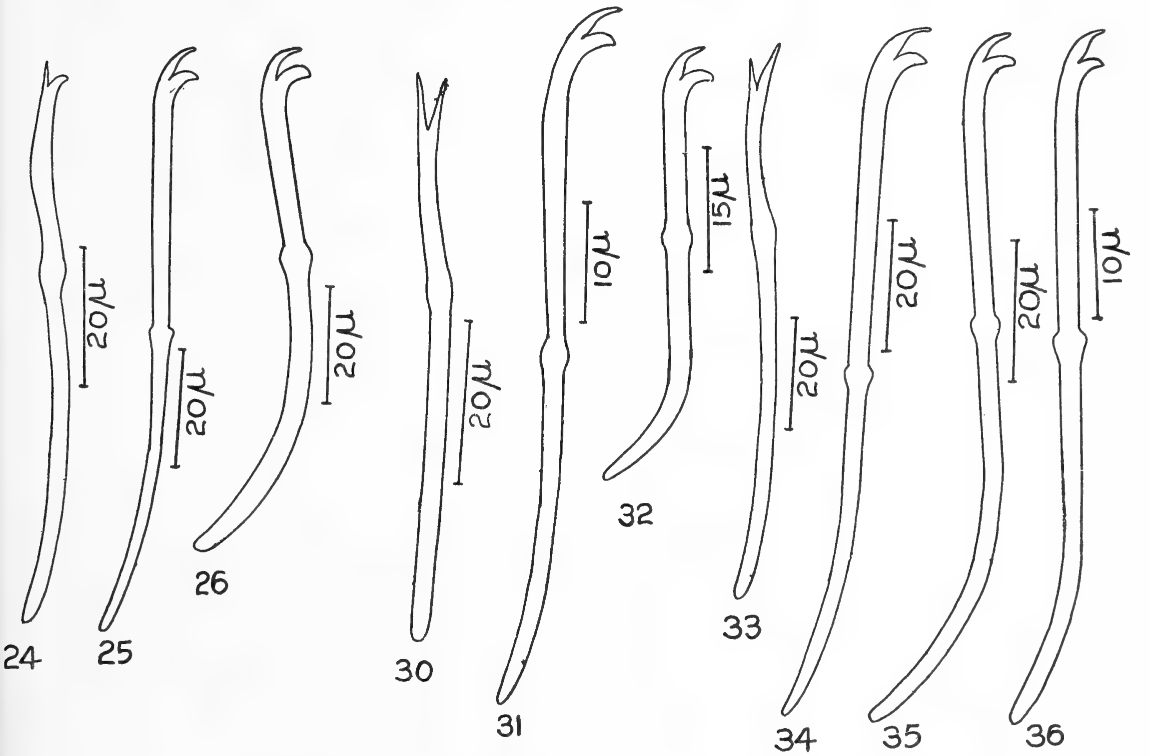
Worms are transparent. Prostomium inconspicuous with a median incision. Dorsal setae and ventral setae of III-V are absent. Ventral setae (Fig. 5) in II 5-8 per bundle, 130-160 μ long, in others 2-6 per bundle, 90-120 μ long. Stomach in V-VII with 20-24 transverse ducts. Brain with a statocyst.

Distribution in Indian sub-continent: Sri Lanka (Ceylon); Cuddapah, Bangalore (S. India); Calcutta (N. India); Dacca (Bangladesh).

Extralimital distribution: Europe, Asia, Africa, N. America.

NAIDINAE Lastockin, 1924
Dero Oken, 1815
Subgenus *Dero* Oken, 1815

4. **Dero digitata** (Muller, 1773). (Figs. 6-8). Sperber, 1948, p. 165-178, fig. 19A-E, 27A, Pl. XIV, fig. 2-5, Pl. XV-XVIII, fig. 1-3, 6; 1958, p. 49. Cekanovskaya, 1962, p. 170-171, fig. 89. Naidu, 1962b, 531-533, fig. 13 A-H. Brinkhurst, 1964; p. 212-213, fig. 2B. Hrabe, 1966, p. 377-378, fig. 10-16. Ercolini, 1969, p. 16-18, fig. 6-8, 17-19; 1970, p. 276-279, fig. 2-7. Brinkhurst and Jamieson, 1971, p. 365-



Figs. 24-26. *Aulophorus hymanae*: 24. Needle seta, 25. ventral seta of II, 26. ventral seta of VII; Figs. 30-32. *Allonais gwaliorensis*: 30. Needle seta, 31. ventral seta of II, 32. ventral seta of X; Figs. 33-35. *Allonais rayalaseemensis*: 33. Needle seta, 34. ventral seta of II, 35. ventral seta of VIII; Fig. 36. *Pristina longiseta longiseta*: 36. ventral seta of III.

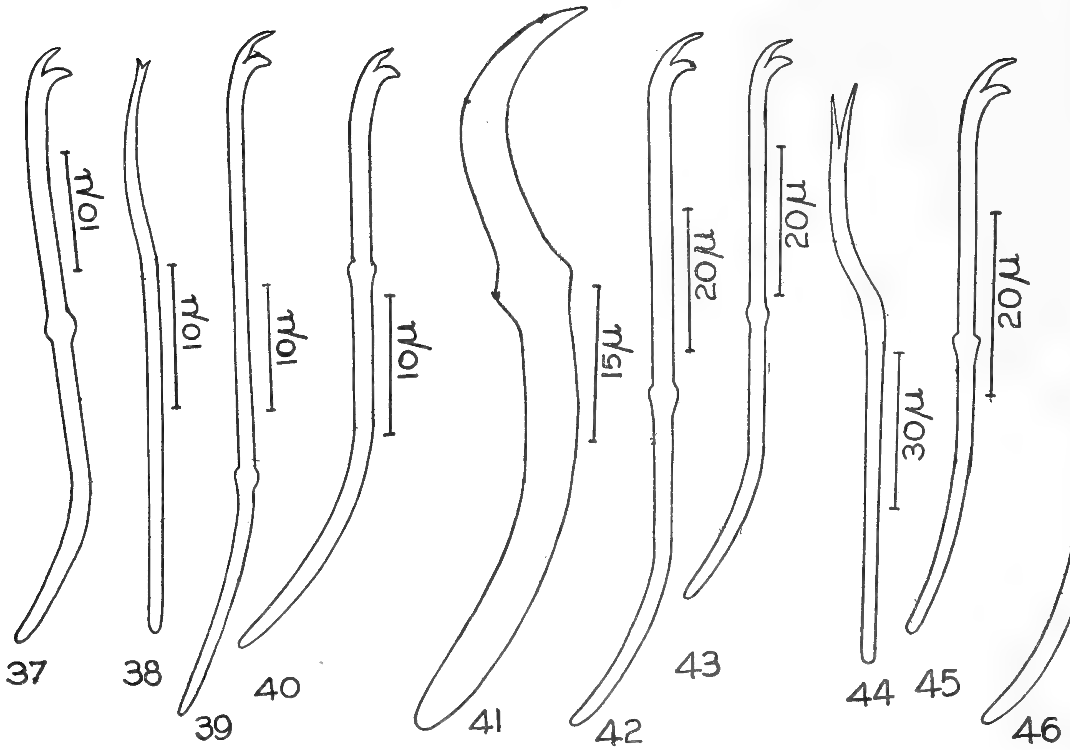


Fig. 37. *Pristina longiseta longiseta*: 37. ventral seta of VIII; Figs. 38-40. *Pristina evelinae*: 38. Needle seta, 39. ventral seta of II, 40. ventral seta of X, 41. giant seta of V; Figs. 42-43. *Pristina proboscidea*: 42. ventral seta of II, 43. ventral seta of posterior segment; Figs. 44-46. *Pristina synclites*: 44. Needle seta, 45. ventral seta of II, 46. ventral seta of middle segment.

367, fig. 7.13 D-H. Brinkhurst, 1971, p. 120, fig. 3L. Ali and Issaque, 1975, p. 57. Ali and Zaman, 1976, p. 90-91, fig. 4 A-E.

l = 5-7 mm; d = 0.25-0.30 mm; s = 28-35; n = 19-22.

Worms with orange-red pigment granules in integument with concentration in branchial fossa. Dorsal setae from VI, 1 hair seta, bayonet-shaped, 170-200 µ long and 1 bifid needle seta (Fig. 6), 60-66 µ long, nodulus 1/3 from distal end, distal tooth 1½ times as long as proximal. Ventral setae (Figs. 7-8) in II-V, slender and less curved, 90-100 µ long, nodulus proximal, teeth parallel, distal tooth 1½ times as long as proximal; in others, 3-4 per bundle, thick and more curved, 66-76 µ long, nodulus distal, tooth diverging, distal tooth thinner, slightly longer or equal to proximal. Branchial fossa with 4 pairs of gills. Stomach in IX-X. Dorsal vessel mid-dorsal in II-V and lateral to left from VI on. Contractile lateral vessels in VI-XI.

Distribution in Indian sub-continent: Trivandrum, Kottayam, Cuddapah, Bellary, Bangalore (S. India); Dacca (Bangladesh).

Extralimital distribution: Europe, Asia, Africa, Australia, N. and S. America.

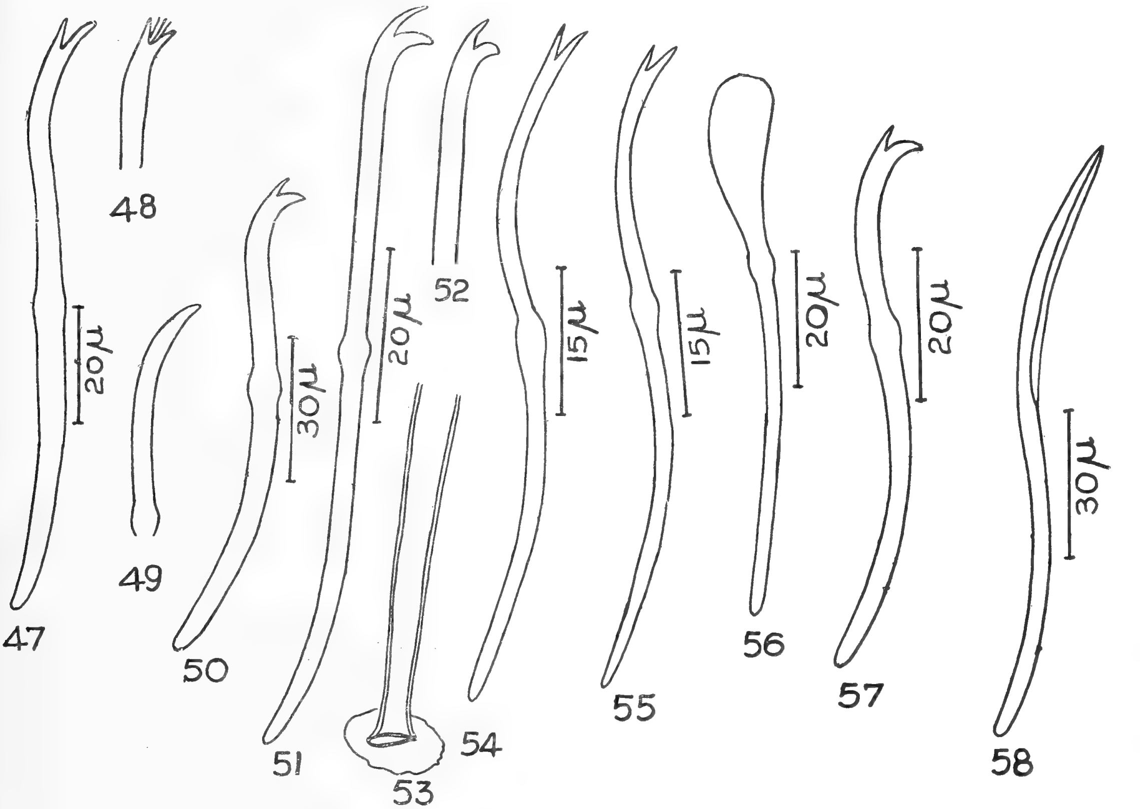
5. **Dero cooperi** Stephenson, 1932. (Figs. 9-11).

Sperber, 1948, 170-180. Naidu, 1962b, p. 538-540, fig. 16 A-I, Brinkhurst, 1966, p. 138. Costa, 1967, p. 43. Brinkhurst and Jamieson, 1971, p. 369, fig. 7.14 B-E.

l = 3.5-5.0 mm; d = 0.25-0.30 mm; s = 30-50; n = 20-26.

Worms with red pigment spots lateral to dorsal bundles. Dorsal setae from VI, 1 hair seta and 1 needle seta per bundle. Hair setae 180-210 μ long; needle setae (Fig. 9) bifid, 72-75 μ long, nodulus distal, teeth short and equal. Ventral setae (Figs. 10-11) 3-5 per bundle, in II-V slender, less curved, 100-120 μ long, nudulus proximal; in others thick, more curved, 70-75 μ long, nodulus distal, distal tooth thinner, equal to or longer than proximal. Branchial fossa with 4 pairs of gills. Stomach in IX-X. Dorsal vessel mid-dorsal in II-V, lateral to left from VI. Contractile lateral vessels in VI-X.

Distribution in Indian sub-continent: Sri Lanka (Ceylon); Cuddapah, Bangalore (S. India); Agra (N. India); Lahore (Pakistan). *Extralimital distribution*: Africa, Europe, S. America.



Figs. 47-50. *Branchiura sowerbyi*: 47. bifid needle seta, 48. pectinate needle seta, 49. ventral seta of II, 50. ventral seta of X; Figs. 51-53. *Limnodrilus hoffmeisteri*: 51. Dorsal seta, 52. ventral seta, 53. chitinous penial tube; Figs. 54-55. *Aulodrilus pluriseta*: 54. Needle seta, 55. ventral seta; Figs. 56-58. *Aulodrilus pigueti*: 56. Needle seta, 57. ventral seta, 58. penial seta.

6. **Dero nivea** Aiyer, 1930. (Figs. 12-14). Sperber, 1948, p. 184-186, fig. 196, pl. XVIII, fig. 4; 1958, p. 49, fig. 5-7. Naidu, 1962b, p. 540-541, fig. 17 A-C; 1965a, p. 17. Cekanovskaya, 1962, p. 173-174. Brinkhurst, 1964, p. 214, fig. 4D. Costa, 1967, p. 44. Brinkhurst and Jamieson, 1971, p. 370-371, fig. 7.14 J-M. Brinkhurst, 1971, p. 120, fig. 3 M.

l = 3-4 mm; d = 0.14 mm; s = 20-28; n = 14-16.

Dorsal setae begin in VI, 1 hair seta and 1 needle seta per bundle. Hair setae are 95-110 μ long; needle setae bifid (Fig. 12), 40-45 μ long, nodulus distal, teeth equal and small. Ventral setae (Figs. 13, 14) 2-4 per bundle, 60-70 μ long, in II-V slender and less curved, nodulus proximal, distal tooth longer than proximal; in others thick and curved, nodulus distal, teeth equally long, distal thinner than proximal. Branchial fossa with 3 pairs of gills. Stomach in VIII. Dorsal vessel mid-dorsal in II-V, lateral to left from VI. Contractile lateral vessels in VI-VIII.

Distribution in Indian sub-continent: Sri Lanka (Ceylon); Trivandrum, Ouralpatti, Tandikondi, Cuddapah (S. India).

Extralimital distribution: Europe, Asia, Africa, Australia, N. America.

7. **Dero indica** Naidu, 1962. (Figs. 15-17). Naidu, 1962b, p. 533-536, fig. 14 A-G; 1966, p. 215, 222. Brinkhurst and Jamieson, 1971, p. 367-368, fig. 7.13 I-M. Ali and Issaque, 1975, p. 58.

l = 6-8 mm; d = 0.3-0.4 mm; s = 32-60; n = 24-30.

Dorsal setae begin in VI, 2 hair setae and 2 needle setae anteriorly, 1 each per bundle posteriorly. Hair setae 200-300 μ long; needle setae bifid (Fig. 15), 85-105 μ long, nodulus 1/3 from distal end, distal tooth longer and thinner than proximal. Ventral setae (Fig. 16, 17) 2-5 per bundle, of II-V slender and less curved, 110-130 μ long, nodulus proximal to middle, distal tooth $1\frac{1}{2}$ times as long as proximal; in others 80-100 μ long, nodulus distal, distal tooth thinner and longer than proximal. Branchial fossa with 4 pairs of gills. Stomach in IX-X. Dorsal vessel mid-dorsal in I-V, lateral to left from VI. Contractile lateral vessels in VI-X.

Distribution in Indian sub-continent: Cuddapah, Bangalore (S. India); Dacca (Bangladesh).

8. **Dero zeylanica** Stephenson, 1913. (Figs. 18-20).

Sperber, 1948, p. 178-179. Naidu, 1962b, p. 536-538, fig. 15 A-K. Brinkhurst and Jamieson, 1971, p. 368, fig. 7.13 N-P, 7.14 A. Ali and Issaque, 1975, p. 58.

l = 6-9 mm; d = 0.4-0.45 mm; s = 40-70; n = 18-25.

Dorsal setae begin in VI, 3 (4) hair setae and 3 (4) needle setae per bundle anteriorly, decreasing to 1 each per bundle posteriorly. Hair setae 220-300 μ long; needle setae (Fig. 18) bifid, 100-125 μ long, nodulus distal, teeth fine, distal tooth longer than proximal. Ventral setae (Figs. 19, 20) 2-6 per bundle, in II-V slender and less curved, 110-120 μ long, nodulus median, distal tooth $1\frac{1}{2}$-2 times as long as proximal; in others thick, curved, 80-95 μ long, nodulus distal, distal tooth longer or equal to proximal. Gills 4 pairs. Stomach in IX-X. Dorsal vessel mid-dorsal anteriorly, lateral to left from VI. Contractile lateral vessels in VI-X.

Distribution in Indian sub-continent: Kandy (Sri Lanka); Trivandrum, Cuddapah, Bangalore (S. India); Dacca (Bangladesh).

Sub-genus *Aulophorus* Schmarda, 1861.

9. **Aulophorus furcatus** (Muller, 1773). (Figs. 21-23).

Sperber, 1948, p. 191-194, fig. 20 b-d; 1958, p. 49. Cekanovskaya, 1962, p. 175, fig. 93. Naidu, 1963a, p. 899-902, fig. 20 A-G. Hrabe, 1966, p. 381-382, fig. 29-32. Costa, 1967, p. 45. Ercolini, 1969, p. 19-21, fig. 13-15, 23;

1970, p. 281-285, fig. 11-15. Brinkhurst and Jamieson, 1971, p. 376-377, fig. 7.17 A-D. Brinkhurst, 1971, p. 120, fig. 4A. Ali and Issaque, 1975, p. 58.

l(p) = 2-4 mm; d(p) = 0.22 mm; s = 30-40; n = 16-20.

Dorsal bundles from V and 1 hair seta and 1 needle seta; hair setae 130-150 μ long; needle setae bifid (Fig. 21) 48-56 μ long, nodulus 1/3 from distal end, distal tooth thinner and shorter than proximal. Ventral setae (Figs. 22-23) 2-4 per bundle, in II-IV slender and less curved, 62-70 μ long, nodulus median, distal tooth $1\frac{1}{2}$ times longer than proximal; in others 48-60 μ long, nodulus distal, distal tooth thinner and equal or longer than proximal. Branchial fossa with 1 pair of palps and 3 pairs of gills. Stomach absent. Coelomocytes absent. Dorsal vessel mid-dorsal in I-V, lateral to left from VI. Contractile lateral vessels in VI-X.

Distribution in Indian subcontinent: Sri Lanka (Ceylon); Trivandrum, Ouralpatti, Tandikondi, Madras, Cuddapah, Kakinada, Bellary, Bangalore (S. India); Dacca (Bangladesh).

Extralimital distribution: Europe, Asia, Africa, Australia, N. and S. America.

10. **Aulophorus hymanae** Naidu, 1963 (Figs. 24-26).

Naidu, 1963a, p. 905-908, fig. 22 A-F; 1965a, p. 17; 1966, p. 216, 222. Costa, 1967, p. 46. Brinkhurst and Jamieson, 1971, p. 377-378, fig. 7.17 E-H. Ali and Issaque, 1975, p. 58.

1 (p) = 8-10 mm; d(p) = 0.4 mm; s = 50-80; n = 22-35.

Dorsal bundles from V with 1 hair seta and 1 needle seta. Hair setae 220-270 μ long; needle setae (Fig. 24) 72-80 μ long, bifid, nodulus 1/3 from distal end, distal tooth thinner and longer than proximal. Ventral setae (Figs. 25, 26) 2-5 per bundle, in II-IV slender and less curved, 90-100 μ long, nodulus median, distal tooth $1\frac{1}{2}$ times longer than proximal; in others thick and curved, 72-88 μ long, nodulus distal, distal tooth thinner and about equal in length to proximal. Branchial fossa with 1 pair of palps and 3 pairs of gills. Coelomocytes absent. Stomach absent. Dorsal vessel mid-dorsal in I-V, lateral to left in others. Contractile lateral vessels in VI-XI.

Distribution in Indian sub-continent: Sri Lanka (Ceylon); Cuddapah, Bangalore (S. India); Dacca (Bangladesh).

Extralimital distribution: Singapore (Asia).

11. **Aulophorus michaelseni** Stephenson, 1923. (Figs. 27-29).

Stephenson, 1923, p. 93-94, fig. 35. Aiyer, 1930, p. 43, fig. 18. Naidu, 1963a, p. 902-904, fig. 21 A-E; 1965, fig. p. 17; 1966, p. 216, 222. Ercolini, 1969, p. 21-22, fig. 24-25; 1970, p. 285-288, fig. 16-19, 29, 31.

1 (p) = 4-5 mm; d(p) = 0.3 mm; s = 40-50; n = 23-26.

Dorsal bundles from V with 1 hair seta and 1 needle seta; hair seta 175-230 μ long, needle setae (Fig. 27) bifid, 64-70 μ long, nodulus distal, distal tooth thinner and longer than proximal. Ventral setae (Figs. 28-29) 2-4 per bundle, in II-IV slender and less curved 80-98 μ long, nodulus proximal, distal tooth $1\frac{1}{2}$ times longer than proximal; in others 60-74 μ long, nodulus distal, distal prong thinner and about equal to proximal. Branchial organ with a pair of slender palps and 4 pairs of gills. Coelomocytes present. Stomach absent. Contractile lateral vessels in VII-X.

Distribution in Indian Sub-continent: Kandy (Sri Lanka); Trivandrum, Cuddapah, Bangalore, Bellary (S. India).

Extralimital distribution: Singapore (Asia); Somalia (Africa).

12. **Allonais gwaliorensis** (Stephenson, 1920). (Figs. 30-32).

Sperber, 1948, p. 205-206; 1958, p. 50, fig. 10-12. Naidu, 1963a, p. 919-921, fig. 27 A-F; 1965, p. 20, fig. 1a. Ercolini, 1970, p. 292-296, fig. 38-42. Brinkhurst and Jamieson, 1971, p. 387, fig. 7.20 D-G.

l = 4-10 mm; d = 0.2 mm; s = 24-60; n=29. Dorsal bundles from VI with 1-2 hair setae and 1-2 needle setae; hair setae 140-180 μ long; needle setae bifid (Fig. 30) 60-68 μ long, nodulus weak 1/3 from distal end, distal tooth longer than proximal. Ventral setae (Figs. 31-32) 4-6 per bundle, in II-V thinner and less curved, 56-65 μ long, nodulus middle, distal tooth longer than proximal; in others thick and curved, 50-56 μ long, nodulus distal, distal tooth thinner about equal in length to proximal. Coelomocytes present. Stomach in IX-X. Dorsal vessel mid-dorsal in I-VI and lateral to left in others. Contractile lateral vessels in VI-VIII.

Distribution in Indian sub-continent: Cuddapah, Kakinada (S. India); Gwalior (C. India).

Extralimital distribution: China, Sunda Island, Singapore (Asia); Madagascar, Somalia (Africa).

13. **Allonais rayalaseemensis** Naidu, 1963. (Figs. 33-35).

Naidu, 1963a, p. 917-919, fig. 26A-F; 1965, p. 19; 1966, p. 217, 223. Costa, 1967, p. 46.

l = 16-20 mm; d = 0.35-0.4 mm; s = 90-120; n = 48-54.

Dorsal setae from VI, 1-2 hair setae and 1-2 needle setae per bundle. Hair setae 240-370 μ long; needle setae (Fig. 33) bifid, 90-106 μ long, nodulus distal, distal tooth thinner and half as long as proximal. Ventral setae (Figs. 34, 35) 4-7 per bundle, 85-105 μ long, in II-V nodulus about middle, distal tooth longer than proximal; in others nodulus distal, distal tooth thinner and longer than proximal. Coelomocytes present. Stomach in XI-XII. Dorsal vessel mid-dorsal in I-V and lateral to left in others. Contractile lateral vessels in VI-XI.

Distribution in Indian sub-continent: Sri Lanka (Ceylon); Cuddapah, Bellary, Kakinada (S. India).

Sub-family Pristininae Lastockin, 1924

14. **Pristina longiseta longiseta** Ehrenberg, 1828. (Figs. 36-37).

Sperber, 1948, p. 236-237, pl. XXI, fig. 2, 6. Naidu, 1963b, p. 216-219, fig. 34 A-K. Costa, 1967, p. 47.

Pristina longiseta Ehrenberg. Liang, 1964, p. 650. Brinkhurst and Jamieson, 1971, p. 402-403, fig. 7.21 J, 7.25 E-I. Brinkhurst, 1971, p. 124, fig. 4 G.

l = 2-3 mm (single), 4.5 mm (chains); d = 0.12 mm; s = 22-28; n = 14-17.

Prostomium with a median proboscis. Dorsal bundles from II with 1-3 hair setae and 1-3 needle setae. Hair setae of III especially long, non-serrate, 650-720 μ long, of others serrate 200-300 μ long. Needle setae simple pointed distal part gently curved, 35-50 μ long, without nodulus. Ventral setae (Figs. 36, 37) 3-7 per bundle, in II longest, 62-66 μ long, nodulus proximal; in others 48-56 μ long, nodulus median to distal, distal tooth twice as long as proximal in II, III and thinner and longer than proximal in others. Stomach in anterior half of VIII, pear-shaped with intracellular canal Coelomocytes present. Dorsal vessel mid-dorsal. Contractile lateral vessels in II-VII.

Distribution in Indian sub-continent: Bheemnagar, Trivandrum, Ouralpatti, Tandikondi, Cuddapah, Bangalore (S. India); Bombay (W. India); Gwalior (C. India); Calcutta (E. India); Lahore (Pakistan).

Extralimital distribution: Europe, Asia, Africa, Australia, Paraguay (S. America).

15. **Pristina evelinae** Marcus, 1943. (Figs. 38-41).

Sperber, 1948, p. 232, fig. 25. Naidu, 1963b, 214-216, fig. 33A-D. Costa, 1967, p. 48. Brinkhurst and Jamieson, 1971, p. 401-402, fig. 7.24 H, 7.25 A-D.

l = 2-4 mm; d = 0.13 mm; s = 18-24; n = 13-16.

Prostomium with a median proboscis. Dorsal bundles from II with 1 hair seta and 1 needle seta. Hair setae 90-165 μ long; needle setae (fig. 38) bifid, 35-40 μ long, nodulus 1/3 from distal end, teeth fine and short. Ventral setae (Figs. 39, 40) 4-7 per bundle, in II longest 50-55 μ long, in III shortest, 38-40 μ long, in V giant setae (Fig. 41) 70-77 μ long, in others 42-46 μ long; in II nodulus proximal, distal tooth is longer than proximal, in others nodulus distal, distal tooth thinner and equal to proximal. Stomach in $\frac{1}{2}$ VII-VIII, pear shaped with intra-cellular canals. Dorsal vessel mid-dorsal. Contractile lateral vessels in VI and VII.

Distribution in Indian sub-continent: Sri Lanka (Ceylon); Trivandrum, Cuddapah, Bangalore (S. India).

Extralimital distribution: Brazil (S. America).

16. **Pristina proboscidea** Beddard, 1896. (Figs. 42-43).

Sperber, 1948, p. 239-240. Naidu, 1965a, p. 20-21. Ercolini, 1970, p. 302-304, fig. 27-28, 47-49. Brinkhurst and Jamieson, 1971, p. 405-406, fig. 7.21 N-Q. Brinkhurst, 1971, p. 124, fig. 4 F.

Pristina proboscidea f. *typica* Beddard. Ali and Issaque, 1975, p. 59. Ali and Zaman, 1976, p. 91, fig. 2 A-D.

l = 3-5 mm; d = 0.35-0.40 mm; s = 28-35; n = 16-20.

Prostomium with proboscis. Dorsal bundles from II with 1-3 serrated hair setae of 300-400 μ long and 1-4 simple pointed needle setae of 46-50 μ long, without nodulus. Ventral setae (Figs. 42, 43) 3-7 per bundle, distal tooth longer than proximal, in II 94-100 μ long and thick, in others 65-76 μ long and thin. Stomach in anterior half of VIII, pear shaped with intra-cellular canals. Coelomocytes present. Dorsal vessel mid-dorsal.

Distribution in Indian sub-continent: Sri Lanka (Ceylon); Trivandrum (S. India); Dacca (Bangladesh).

Extralimital distribution: Europe, Asia, Australia, Africa, N. and S. America.

17. **Pristina synclites** Stephenson, 1925. (Figs. 44-46).

Sperber, 1948, p. 225. Naidu, 1963b, 208-210, Fig. 30 A-D. Brinkhurst and Jamieson, 1971, p. 397, fig. 7.23 C-E.

l = 4-6 mm; d = 0.3-0.35 mm; s = 40-60; n = 18-22.

Prostomium with proboscis. Dorsal bundles from II with 1-2 hair setae, smooth 200-300 μ long and 1-2 bifid needle setae (fig. 44) 70-98 μ long, nodulus weak 1/3 from distal end, distal footh shorter than proximal. Ventral setae (Figs. 45, 46) 2-4 per bundle, in II-III 62-66 μ long, in others 73-84 μ long, distal tooth thinner and about equal to proximal, nodulus middle in II-IV and distal in others. Stomach in $\frac{1}{2}$ VII-VIII. Dorsal vessel mid-doral. Contractile lateral vessels in IV-VII.

Distribution in Indian sub-continent: Cuddapah, Bellary, Bangalore, Mysore (S. India).

TUBIFICIDAE

Sub-family Banchiurinae Hrabe, 1966

18. **Branchiura sowerbyi** Beddard, 1892. (Figs. 47-50).

Cekanovskaya, 1962, p. 291-292, fig. 184, 185. Naidu, 1965b, p. 473-475, fig. 4 a-j. Brinkhurst and Jamieson, 1971, p. 563-564, fig. 8.36 D-F. Brinkhurst, 1971, p. 114, fig. 2 H. Ali and Issaque, 1975, p. 60. Ali and Zaman, 1976, p. 92-93, fig. 9 A-F.

l = 30-40 mm; d = 1.0-1.1 mm; s = upto 150. Dorsal bundles start in II, 3-4 hair setae of 200-280 μ long and 3-6 needle setae of 85-100 μ long anteriorly, hair setae decrease in number and disappear about the middle, needle setae (Figs. 47, 48) are simple pointed and bifid anteriorly, bifid and pectinate in later segments, distal tooth is thinner and shorter than proximal. Ventral setae (Figs. 49, 50) 6-8 simple pointed setae anteriorly, 4-6 bifid setae in the middle decreasing to 1-2 setae posteriorly per bundle, nodulus distal, 70-110 μ long. Posterior third of the worm has mid-dorsal and mid-ventral tubular gills with vascular loops. Stomach absent. Dorsal vessel lateral mostly and mid-dorsal in I-VI. Lateral contractile vessels in IX and X.

Distribution in Indian sub-continent: Madras, Cuddapah (S. India); Calcutta, Manipur (E. India); Agra, Lucknow (N. India); Lahore (Pakistan); Dacca (Bangladesh). Now reported from Bombay (W. India).

Extralimital distribution: Europe, Lake Inle (Burma), Asia, Africa, Australia, N. and S. America.

Sub-family TUBIFICINAE Eisen, 1879.

19. **Limnodrilus hoffmeisteri** Claparede, 1862. (Figs. 51-53).

Naidu, 1965b, p. 477-479, fig. 6a-g; 1965a, p. 21. Brinkhurst, 1971, p. 112-113, fig. 2D. Brinkhurst and Jamieson, 1971, p. 464-467, fig. 8.3 M; 8.4 C, H, I; 8.5 E. Ali and Issaque, 1975, p. 59. Ali and Zaman, 1976, p. 91, fig. 5A-D.

1 = 24-30 mm; d = 0.6-0.8 mm; s = upto 120. Dorsal and ventral setae (Figs. 51 and 52) are all alike, 6-8 per bundle anteriorly and decreasing to 1-2 posteriorly, 66-90 μ long, nodulus distal, distal tooth thinner and longer or shorter than proximal. Stomach absent. Contractile lateral vessels in VIII-IX. Clitellum in XI-XII. Vasa deferentia are long and coiled, atrium small spindle shaped, ejaculatory duct ending with chitinous penial sheath (Fig. 53) 8 times as long as wide. Spermathacae in X, club-shaped and curved.

Distribution in Indian sub-continent: Kandy (Sri Lanka); Adoni, Bellary, Cuddapah, Bangalore (S. India); Calcutta, Belgachi (E. India); Lahore (Pakistan); Dacca (Bangladesh).

Extralimital distribution: Europe, Asia, Africa, Australia, N. and S. America.

sub-family AULODRILINAE Brinkhurst and Jamieson, 1971

20. **Aulodrilus pluriseta** (Piguret, 1906). (Figs. 54-55).

Cekanovskaya, 1962, p. 225, fig. 135. Naidu, 1965b, p. 466-467, fig. 2 a-e. Brinkhurst, 1971, p. 114, fig. 2 I. Brinkhurst and Jamieson, 1971, p. 525-526, fig. 8.23 J-N. Ali and Zaman, 1976, p. 92, fig. 10 A-F.

1 = 10-16 mm; d = 0.5 mm; s = 70-100. Dorsal bundles from II with 4-8 hair setae of 100-160 μ long and 6-8 bifid needle setae (Fig. 54) of 60-74 μ long, nodulus distal, distal tooth shorter than proximal. Ventral setae (Fig. 55) 6-10 bifid setae of 50-65 μ long nodulus distal, distal tooth shorter and thinner than proximal. Stomach absent. Lateral contractile vessels in VI. Hind part of the worm is without setae and highly vascularised. Clitellum in VI-VIII. Atria spherical with thick eversible pseudopenes. Spermathecae in VI, ampullae cylindrical and thin walled, its duct thin walled. Penial setae absent.

Distribution in Indian sub-continent: Sri Lanka (Ceylon); Travancore, Bellary (S. India); Burhanpur (C. India); Dacca (Bangladesh). Now reported from Bombay (W. India).

Extralimital distribution: Europe, Asia, Australia and N. America.

21. **Aulophphorus pigueti** Kowalewski, 1914. (Figs. 56-58).

Brinkhurst and Jamieson, 1971, p. 526-527, fig. 8.23 I.

Aulodrilus remex Stephenson. Stephenson, 1921, p. 753-757, fig. 2-6, Pl. XXVIII, 1923, p. 107-108, fig. 42-44. Aiyer, 1925, p. 35, fig. 5; 1929, p. 81-86, p. IV, fig. 1-9. Naidu, 1965b, p. 470-473, fig. 3A-E. Lauzanne, 1969, p. 100. Ali and Issaque, 1975, p. 60.

1(p) = 10-16 mm; d(p) = 1.0 mm; s = about 100.

Worms are reddish, posterior third pale yellow without setae and highly vasculised. Dorsal setae begin in II with bayonet-shaped hair setae 85-115 μ long and needle setae (Fig. 56) simple pointed, bifid and oar-shaped, 60-80 μ long, nodulus distal. Ventral setae (fig. 57) are bifid, 55-80 μ long, nodulus distal, upper tooth thinner and shorter than lower tooth. Stomach absent. Lateral vessels in VI. Clitellum in $\frac{1}{2}$ VI-$\frac{1}{2}$ VIII (2 segments). Atria are elongate ovoid with prostate glands opening a little in front of short ejaculatory duct. Male pores open close to each other ventrally in a genital fossa in VII. Spermathecae are ovoid. Penial setae (Fig. 58) 1-2 per bundle in VII.

Distribution in Indian sub-continent: Sri Lanka (Ceylon); Travancore, Adoni, Bellary, Cuddapah (S. India); Burhanpur (N. India); Dacca (Bangladesh).

Extralimital distribution: Europe; China in Asia; Lake Tchad in Africa; Australia; Lake Eire in N. America; Brazil in S. America.

Summary

Twenty-one species of fresh-water oligochaetes belonging to three families Aeolosomatidae, Naididae and Tubificidae from Bombay city and environs of the Western region are described. Of these nineteen species are new to the Western region.. With the addition of these, the total number of species known for the Western region has increased from 5 to 24 species. The descriptions of the species include details of size of worm, number of segments, length and position of nodulus of the setae, etc. Geographical distribution in Indian sub-continent and in the world is given.

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WEEDY ELEMENTS IN THE FLORA OF CHANDRAPUR DISTRICT, MAHARASHTRA STATE[1]

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In the present paper, weedy elements of Chandrapur district are presented which are classified into different categories depending on their habitat and nature.

Introduction

During the plant exploration of Chandrapur district, most of the weeds occurring in the area were found harmful for the growth of various crops and fruit trees in the district. A lot of man-power and valuable time is wasted in weeding out such elements. Hence it was thought worthwhile to record the various weeds occurring in different habitats of the district for the benefit of Agricultural Scientists who may experiment with weedicides.

Chandrapur district of Maharashtra State, has an area of about 24, 118 sq. km. of which 14.36 lakh hectares, i.e. about 60% of geographical area is under forest and 5.42 lakh hectares, i.e. 22% of the total area is cultivable land. The area under irrigation is 18% of the total cultivable area. The main crops of the district are paddy and rabi jowar. In 1961-62 the district had 159086-159581 hectares under paddy while jowar occupied 30.02% (1961 census) of the gross cropped area of the district as against 30.95% for the State. Some other crops like wheat, cotton and maize are also common.

The important pulses in the district include horsegram, gram, blackgram and greengram. These and other minor pulses together occupied 14.67% of the gross cropped area during the period from 1957-58 to 1959-60 in the district as against 10.69% of the State. Under narcotics in 1963-64 the tobacco crop occupied only 261.022 hectares in the tahsil Gadchiroli and Chandrapur tahsils also have large area under tobacco.

In addition, Linseed and *Sesamum* are the most important oil seeds that are produced in the district and all the oilseeds together occupy 12.35% of the gross cropped area of the district as against 8.18% for the State between 1957-58 and 1959-60. Besides there are several vegetable crop fields throughout the district. Brinjal and other green vegetables in 1961-62 occupied an area of 337.103 hectares in the district. They are followed by onion and sweet-potatoes etc.

Material and methods

While investigating the plant wealth of Chandrapur district, some efforts were made to identify the weeds in the field and the relevant data like their habitat, local name, flowering, fruiting period etc. were obtained along with the sample specimens which were labelled and housed in the herbarium of Western Circle (*BSI*), Poona.

Results and discussion

As weeds are a menace to the cultivated fields an attempt has been made to keep a record of weedy elements of the district which are classified into various heads like crop-weeds, weeds of vegetable gardens, gardens and orchards, weeds of road-sides, rail-track sides, wastelands, aquatic and parasities. How-

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[2] Botanical Survey of India, Pune-1.

ever the common weeds which occur everywhere are not repeated under different heads. The weeds recorded amounts to nearly 200 species belonging to 150 genera and about 60 families. The following are the ten dominant families recorded in the area:

Fabaceae, Asteraceae, Poaceae, Cyperaceae, Euphorbiaceae, Amaranthaceae, Convolvulaceae, Acanthaceae, Scrophulariaceae, and Malvaceae.

Weeds of crop fields:

In the cultivated fields, weeds observed in paddy, wheat, Jower and cotton etc. were:

DOMINANT: *Anagallis arvensis* Linn., *Borreria articularis* (Linn.) F. N. Will., *Caesulia axillaris* Roxb., *Celosia argentea* Linn., *Cyperus iria* Linn., *C. rotundus* Linn., *Desmodium triflorum* (Linn.) DC., *Emelia sonchifolia* (Linn.) DC., *Eragrostis unioloides* (Retz.) Nees, *Euphorbia hirta* Linn., *Indigofera linifolia* Retz., *Ischaemum indicum* (Houtt.) Merr., *Merremia tridentata* (Linn.) Hall. f., *Mollugo pentaphylla* Linn., *Murdannia spirata* (Linn.) Brenan, *Oryza rufipogon* Griff., *Polygala erioptera DC.*, *Polygonum plebeium* R. Br., *Portulaca oleracea* Linn., *Sorghum halepense* (Linn.) Pers., *Sphaeranthus indicus* Linn., *Striga angustifolia* (D. Don) Saldanha. *Tribulus terrestris* Linn.

FREQUENT: *Ageratum conyzoides* Linn., *Amberboa ramosa* (Roxb.) Jafri, *Digera muricata* (Linn.) Mart., *Enicostema hyssopifolium* (Willd.) C. B. Roy, *Eragrostis ciliaris* (Linn.) R.Br., *Eriocaulon dianae* Fyson, *E. quinquangularis* Linn., *Hedyotis nudicaulis* Wt. & Arn., *Indigofera cordifolia* Heyne, *Oxalis corniculata* Linn., *Polygala chinensis* Linn., *Setaria glauca* (Linn.) P. Beauv.

UNCOMMON: *Ammannia baccifera* Linn., *A. multiflora* Roxb., *Alternanthera sessilis* (Linn.) R. Br. ex DC., *Bacopa monnieri* (Linn.) Pennell, *Biophytum sensitivum* DC., *Cassia mimosoides* Linn., *C. pumila* Lamk., *Corchorus aestuans* Linn., *Cyanotis cristata* (Linn.) D. Don, *Cyperus difformis* Linn., *Digitaria adscendens* (H.B.K.) Henr., *Echinochloa colonum* (Linn.) Lamk., *Eleusine indica* (Linn.) Gaertn., *Fimbristylis littoralis* Gaud., *Melochia corchorifolia* Linn., *Paspalum scrobiculatum* Linn., *Physalis minima* Linn., *Setaria pallida-fusca* (Sch.) Stapf et C. E. Hubb., *S. tomentosa* (Roxb.) Kunth., *Vernonia cinerea* (Linn.) Less.

RARE: *Goniocaulon glabrum* Cass., *Solanum nigrum* Linn.

The weeds like *Centaurium centuroides* (Roxb.) Rolla Rao et Hem., *Hoppea dichotoma* Willd., *Hydrolea zeylanica* (Linn.) Vahl, *Lindernia ciliata* (Colsm.) Pennell were often observed growing only in the harvested fields.

Weeds of vegetable crop fields:

DOMINANT: *Cleome viscosa* Linn., *Goniogyne hirta* (Willd.) Ali, *Trianthema portulacastrum* Linn.

FREQUENT: *Atylosia scarabaeoides* (Linn.) Benth., *Bergia ammannioides* Roxb. ex Roth, *Evolvulus alsinoides* Linn., *Grangea maderaspatana* (Linn.) Poir., *Lobelia alsinoides* Lamk., *Malachra capitata* (Linn.) Linn., *Rhynchosia minima* DC., *Solanum surattense* Burm. f., *Zornia gibbosa* Span.

RARE: *Cyperus michelianus* (Linn.) Link. ssp. *pygmaeus* (Rottb.) Aschers & Greabn., *Helioropium indicum* Linn., *Indigofera astragalina* DC., *I. glandulosa* Roxb. ex Willd. *Launaea fallax* (Jaub. & Spach) Kuntze, *Rorippa indica* (Linn.) Hiern., *Trichodesma indicum* R. Br., var. *amplexicaule* Cooke; *T. sedgewickianum* Banerjee.

Weeds of gardens and orchards:

DOMINANT: *Alysicarpus vaginalis* (Linn.) DC., *A. monilifer* (Linn.) DC., *Barleria prionitis* Linn., *Boerhavia diffusa* Linn., *Bidens* *biternata* (Lam.) Merr. et Sherff, *Borreria pusilla* (Wall.) DC., *Chenopodium album* Linn., *Cleome gynandra* Linn., *Commelina benghalensis* Linn., *Euphorbia geniculata* Orteg., *E. thymifolia* Linn., *Gomphrena celosioides* Mart., *Lagascea mollis* Cav.

FREQUENT: *Crotalaria linifolia* Linn. f., *C. albida* Heyne ex Roth, *C. medicaginea* Lamk., *Corchorus fascicularis* Lamk., *Cardiospermum halicacabum* Linn., *Amaranthus spinosus* Linn., *Argemone mexicana* Linn., *Cassia tora* Linn., *Chrozophora prostrata* Dalz., *Croton bonplandianum* Baill., *Cyperus pumilus* Linn., *Dactyloctenium aegyptium* (Linn.) P. Beauv. *Datura fastuosa* Linn. var. *alba* Cl., *Eclipta prostrata* (Linn.) Linn., *Glinus lotoides* Linn., *Hibiscus lobatus* (Murr.) O. Ktze, *Hybanthus enneaspermus* (Linn.) F. N. Muell., *Hyptis suaveolens* (Linn.) Poit., *Lantana camara* var. *aculeata* (Linn.) Mold., *Leucas cephalotes* Spreng., *Martynia annua* Linn., *Oldenlandia corymbosa* Linn., *Pavonia odorata* Willd., *P. zeylanica* Cav., *Polycarpon prostratum* (Forsk.) Asch. & Schweinf., *Tephrosia purpurea* Pers., *Tridax procumbens* Linn., *Urena lobata* Linn., *Xanthium strumarium* Linn., and also the weeds like *Abutilon indicum* (Linn.) Sweet, *Acanthospermum hispidum* DC., *Adhatoda vasica* (Linn.) Nees, *Apluda mutica* Linn., *Calotropis gigantea* (Linn.) R. Br., *Cassia occidentalis* Linn., *Coldenia procumbens* Linn., *Dicanthium annulatum* (Forsk.) Stapf, *Dipteracanthus prostratus* (Poir.) Nees, *Echinops echinatus* Roxb., *Indigofera linnaei* Ali, *Ipomoea eriocarpa* R. B., *I. hederifolia* Linn., *I. nil* (Linn.) Roth, *Lepidagathis cristata* Willd., *Leonotis nepetifolia* (Linn.) Ait. f., *Melanocenchris jacquemontii* Jaub. et Spach., *Opuntia elatior* Mill., *Pedalium murex* Linn., *Pergularia daemea* (Forsk.) Chiov., *Peristrophe bicalyculata* (Retz.) Nees, *Phyllanthus asperulatus* Hutch., *P. maderaspatensis* Linn., *Pupalia lappacea* (Linn.) Juss., *Rungia repens* (Linn.) Nees, *Saccharum spontaneum* Linn., *Scirpus articulatus* Linn., *Scoparia dulcis* Linn., *Sebastinia chameleon* (Linn.) Muell.-Arg., *Sesamum mulayanum* Nair, *Sopubia delphinifolia* (Linn.) G. Don, *Tephrosia hirta* Buch.-Ham., *Triumfetta rhomboidea* Jacq., *Verbascum chinense* (Linn.) Sant.

RARE: *Flaveria trinervia* (Spreng.) C. Mohr., *Parthenium hysterophorus* Linn., *Amischophacelus axillaris* (Linn.) Rolla Rao et Kammathy, *A. cucullatus* (Roth) Rolla Rao et Kammathy, *Corchorus capsularis* Linn., *C. olitorious* Linn., *Crotalaria orixensis* Willd., *C. prostrata* Rottl. ex Willd.

Aquatic and marshy weeds:

COMMON: *Ceratophyllum demersum* Linn., *Cyperus allulatus* Kern, *Hygrophila auriculata* (Sch.) Heine, *Ipomoea aquatica* Forsk., *I. carica* (Linn.) Sweet, *Limnophila aquatica* (Roxb.) Alston, *Marsilea minuta* Linn., *Najas indica* (Willd.) Cham., *Nelumbo nucifera* Gaertn., *Phyla nodiflora* (Linn.) Green, *Pistia stratiotes* Linn.

FREQUENT: *Aeschynomene aspera* Linn., *A. indica* Linn., *Cyperus kyllinga* Endl., *Dentella repens* (Linn.) J.R. & G. Forst., *Limnophyton obtusifolium* (Linn.) Miq., *Ludwigia hyssopifolia* (G. Don) Exell, *L. perennis* Linn., *Monocharia vaginalis* (Burm. f.) Presl. ex Kunth, *Nymphaea nouchali* Burm., *N. stellata* Willd., *Nymphoides cristatum* (Roxb.) O.K., *N. indicum* (Linn.) O.K. *Ottelia alsinoides* Pers., *Sesbania bispinosa* (Jacq.) FawCett et Rendle, *Smithia conferta* Sm.

RARE: *Aponogeton natans* (Linn.) Engl. & Krause and *Myriophyllum spathulatum* Blatt. & Hall.

Parasites:

Among the parasities the abundant ones were

Cuscuta reflexa Roxb., and *Cassytha filiformis* Linn. while *Dendrophthoe falcata* (Linn.) Etting was frequently met with and *Viscum articulatum* Burm. and *V. nepalense* Spreng. were rarely seen.

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FOOD OF JUVENILE *GARRA MULLYA* (SYKES)* (FAMILY CYPRINIDAE)[1]

V. S. Somvanshi[2] and S. S. Bapat[3]

(*With two text-figures*)

The study on food of juvenile *Garra mullya* (Sykes) includes observations made on 146 juveniles collected from Kham river near Aurangabad.

Percentage composition of main food items of juveniles did not show marked seasonal differences. Variations in the percentage composition of different food items were noticed in relation to growth of juveniles. Study on the percentage of prevalence indicated that the juveniles preferred diatoms, algae and higher plants as their food. Juveniles of *G. mullya* were found to be herbivorous bottom feeders.

Introduction

Many fishes are known to change their food and feeding habits during their life histories and in different seasons. Information on food and feeding habits of juvenile *G. mullya* in relation to growth and seasons is not available. Therefore, an attempt was made to study variations in food and feeding habits of *G. mullya* juveniles.

Material and Methods

A total of 146 juvenile specimens of *G. mullya* ranging in size between 21 and 55 mm were collected from Kham river near Aurangabad. Fish were brought to the laboratory every week, their length measured and the alimentary canal was preserved in 5% formalin. The analysis of gut contents was carried out by two methods (i) Qualitative, the identification of food items and (ii) Quantitative, their percentage composition in the gut. Occurrence method described by Hynes (1950) and Pillay (1952) under the numerical methods was followed for the calculation of prevalence of various food items.

Results and Discussion

(I) *Qualitative study of food*:

The food items found in the guts of juvenile *G. mullya* were:

(1) Higher plants: Pieces of leaves and roots of higher aquatic plants.

(2) Algae: Pieces of filamentous algae like *Spirogyra, Ulothrix, Zygnema, Oscillatoria* and *Cosmarium*.

(3) Diatoms: *Asterionella, Fragillaria, Synedra, Tabellaria, Navicula, Cymbella, Pinnularia* and *Nitzschia*.

(4) Debris: Decomposing organic matter mixed with mud and sand.

(II) *Quantitative study of food*:

Seasonal changes in the percentage composition of main food items taken by juvenile *G. mullya*:

Fig. 1. shows the variations in percentage of main food items in different months.

* The valid name for this fish is currently *Discognathus mullya*—Eds.

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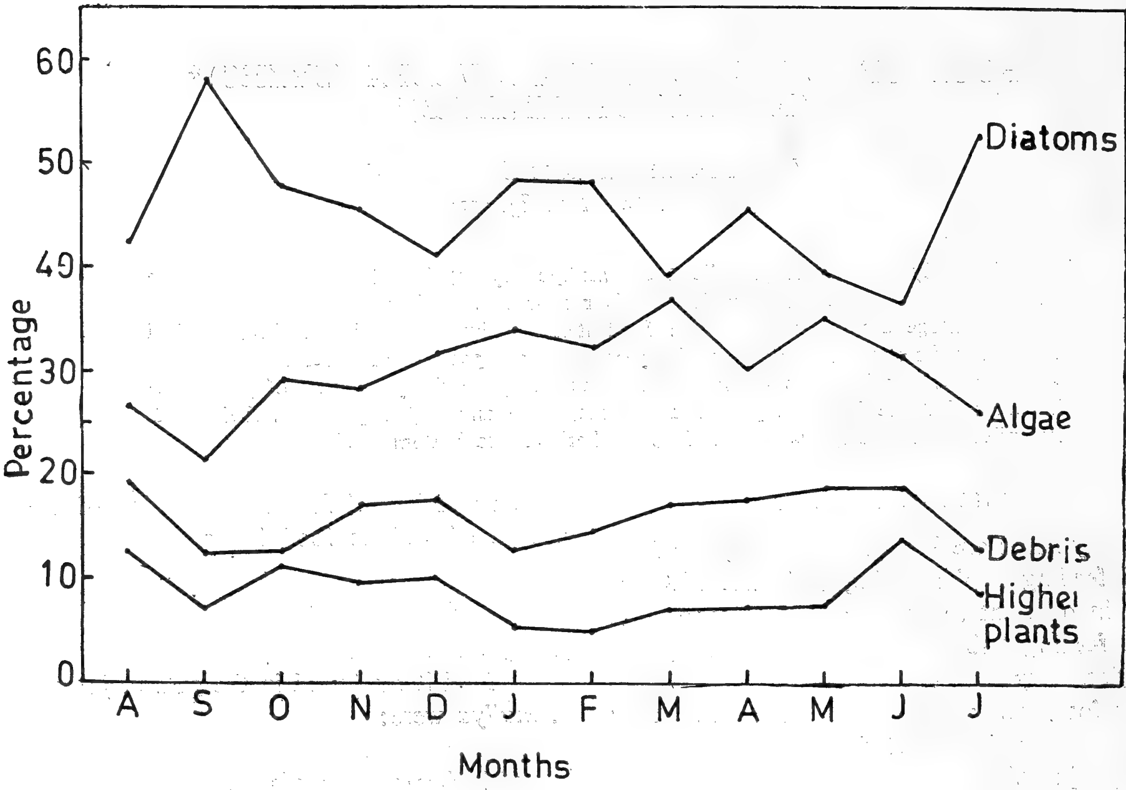

Fig. 1. Monthwise changes in the percentage composition of main food items of juvenile *G. mullya.*

Higher plants were seen in lower proportion than the other food items, fluctuating from 4.8 in February to 13.8 in June. There are comparatively low values during January to May and high values during June to December (except in September). The percentage of algae varied from 21.7 (in September) to 36.7 (in March) and is next to diatoms in predominance. Diatoms form the major food. The higher percentage of diatoms throughout the year suggests that the juveniles feed on these. The percentage of diatoms changed from 36.7 (in June) to 58.3 (in September). Along with other food items, juveniles also take in debris. The percentage of debris was found to fluctuate between 12.3 (in September) and 19.3 (in August).

Average percentage of different food items of juveniles for the year are: diatoms 45.4, algae 30.1, higher plants 8.6, and debris 15.8.

Changes in the percentage composition of main food items of juveniles in relation to growth:

The intake of food items varies during different stages of growth in fishes. The data were analysed for 5 mm length groups as shown in Fig. 2.

Higher plants were taken by all the size groups in varying percentages, their values

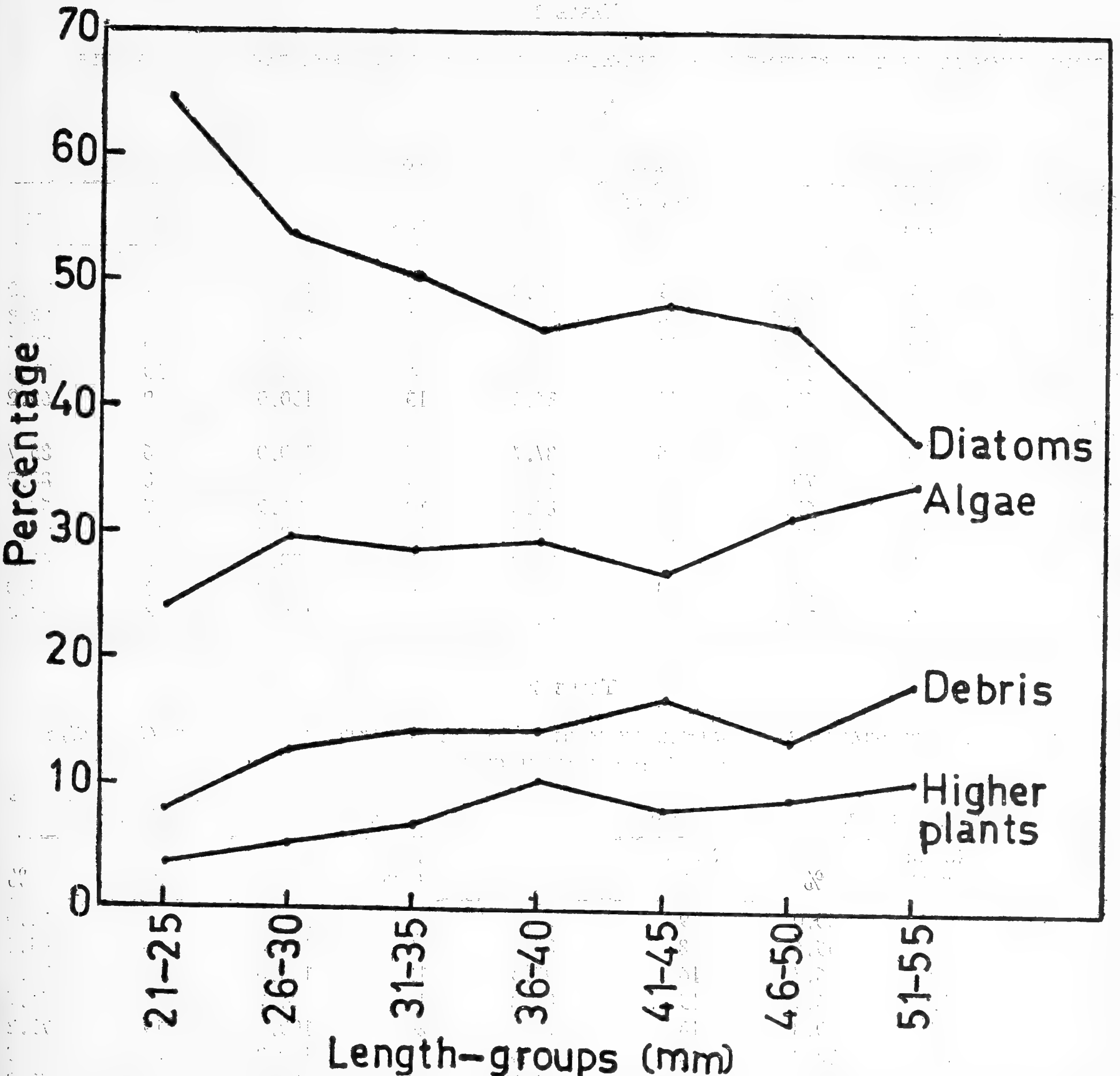

Fig. 2. Percentage composition of main food items of juvenile *G. mullya* in each 5 mm length group.

fluctuating between 3.7 (in 21-25 mm length group) and 10.6 (in 51-55 mm length group). In general the percentage of this food item increases with the increase in length. However, high percentage of higher plants (10.4) was noticed in 36-40 mm length group. Algal matter is consumed in varying percentages in all the length groups. The percentage of algae varied from 23.9 (in 21-25 mm length group) to 34.2 (in 51-55 mm length group). The intake of algae increases with the growth of juveniles, however, lower values were record-

TABLE 1

SEASONAL CHANGES IN THE PERCENTAGE OF PREVALENCE OF MAIN FOOD ITEMS TAKEN BY JUVENILE *G. mullya*

Year and Month	Higher plants		Algae		Diatoms		Debris	
	No. of guts	%	No. of guts	%	No. of guts	%	No. of guts	%
1973								
August	9	75.0	9	75.0	12	100.0	9	75.0
September	12	70.6	14	82.8	17	100.0	10	58.8
October	12	66.7	15	83.3	17	94.4	10	55.6
November	9	64.3	13	92.9	14	100.0	10	71.4
December	9	69.2	11	84.6	13	100.0	9	69.2
1974								
January	6	85.7	6	87.7	7	100.0	6	85.7
February	7	70.0	8	80.0	9	90.0	8	80.0
March	9	69.2	11	84.6	10	76.9	7	53.9
April	13	76.5	13	76.5	15	88.2	12	70.6
May	8	80.0	9	90.0	9	90.0	6	60.0
June	3	75.0	3	75.0	4	100.0	3	75.0
July	8	72.7	9	81.8	11	100.0	4	36.4

TABLE 2

CHANGES IN THE PERCENTAGE OF PREVALENCE OF MAIN FOOD ITEMS TAKEN BY JUVENILE *G. mullya* IN EACH 5 MM LENGTH GROUP

Length group (mm)	Higher plants		Algae		Diatoms		Debris	
	No. of guts	%	No. of guts	%	No. of guts	%	No. of guts	%
21-25	6	60.0	9	90.0	10	100.0	5	50.0
26-30	5	55.6	8	88.9	9	100.0	4	44.4
31-35	10	66.7	14	93.3	15	100.0	11	73.3
36-40	13	76.5	15	88.2	16	94.1	11	64.7
41-45	17	70.8	18	75.0	24	100.0	19	79.2
46-50	24	82.8	21	72.4	29	100.0	20	69.0
51-55	32	76.2	34	81.0	36	85.7	31	73.8

ed in 31-35 mm (28.6) and 41-45 mm (26.8) length groups. Diatoms form a main food item of juveniles. The percentage composition of diatoms fluctuated between 64.7 in 21-25 mm length group and 37.3 in 51-55 mm length group. As the length of the juveniles increases the percentage of diatoms decreases, showing thereby that the smaller sized juveniles feed mainly on diatoms, and as they grow algal percentage increases. Debris percentage was found to increase with the increase in the length of the juveniles. The percentage of debris was found to vary form 7.8 in 21-25 mm length group to 18.0 in 51-55 mm length group. An abrupt fall was, however, noticed in 46-50 mm length group.

(III) *Percentage of prevalence*:

Number of guts containing a particular food item either in each month or in each 5 mm length group is expressed as percentage of prevalence.

Seasonal changes:

The variations in the percentage of prevalence are shown in Table 1, which would give an idea of availability of the food items and the preference given to them by the juveniles in different months.

Higher plants were found in guts of *G. mullya* juveniles in all the months. The frequency of occurrence was found to vary from 64.3 (in November) to 85.7% (in January). Algae were consumed throughout the year. The percentage of prevalence of algae varied from 75.0 (in June and August) to 92.9 (in November). The percentage of prevalence or occurrence of diatoms is highest of all the food items taken by the juveniles. The percentage of pervalence fluctuated between 76.9 (in March) and 100.0 (in most of the months) showing thereby that most juvenile *G. mullya* consume diatoms. The average frequency of occurrence of debris was found to be lower than that of the other food items. The values varied from 36.4 (in June) to 85.7% (in January).

Changes in relation to growth:

It can be seen from Table 2 that higher plants are present in guts of juveniles in all size groups. The frequency of occurrence of this food item varied from 55.6 in 26-30 mm length group to 82.8% in 46-50 mm length group. Algae were also present in guts of individuals in all size groups. Their percentage of prevalence fluctuated between 72.4 in 46-50 mm length group and 93.3 in 31-35 mm length group. The percentage of diatoms was highest of all the other food items in all size groups. Their values ranged from 85.7 in 51-55 mm length group and 94.1 in 36-40 mm length group to 100.0% in the remaining length groups. In all the five length-groups each gut was found to contain diatoms, thereby showing the affinity of the fish for this food item. Debris was taken by the juveniles in all the length groups. The percentage of occurrence of debris was found to vary from 44.4 in 26-30 mm length group to 79.2 in 41-45 mm length group.

Thus it can be stated that as the juveniles grow from 21 to 55 mm length, the percentage of higher plants, algae and debris in their food increases whereas the percentage of diatoms decreases. It can be inferred that diatoms form a favourite food item of juveniles, and algae and higher plants come next. As the percentage of prevalence of debris is the least of all the food items and there is no consistent increase of this food item in the guts of juveniles during the rainy season when the waters are turbid with a high load of suspended silt, it can be said that it is not a food item which is favoured by the juveniles. Hence, debris must be accidentally swallowed together with the other food items.

The inferior mouth and the long alimentary canal suggest that juveniles of *G. mullya* are bottom feeders and purely herbivorous in their habit.

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MATERIAL FOR THE FLORA OF MAHABALESHWAR

P. V. BOLE AND M. R. ALMEIDA

[*continued from Vol. 77* (3): 464]

BALSAMINACEAE

Impatiens Linn.

1. Plants scapigerous .... *I. acaulis*
1. Plants non-scapigerous 2
 2. Flowers yellow .... *I. dalzellii*
 2. Flowers pink or purple..................3
  3. Herbs ± 1 metre tall......*I. pulcherrima*
  3. Herbs ± 0.5 metre tall...............4
   4. Leaves alternate ....*I. balsamina*
   4. Leaves opposite 5
    5. Lamina with two glands at base .... *I. kleinii*
    5. Lamina without glands.........6
     6. Pedicels glabrous .... *I. oppositifolia*
     6. Pedicels hairy 7
      7. Hairs on pedicels rufous....................... *I. tomentosa*
      7. Hairs on pedicels not rufous, only hairy lines.................... *I. pusilla*

1. **Impatiens acaulis** Arn. in Hook. Comp. Bot. Mag. 1: 325; 1835; Dalz. & Gibs. 42; FBI 1: 443; Nairne, 43; Birdwood, 404; Woodrow, 11: 266; Cooke, 1: 170 (180): Santapau, 289 & 400; Puri & Mahajan, 120.

I. scapiflora Hook. in Bot. Mag. 64, t. 3587, 1837; (non Heyne, 1820); Graham, 34; Birdwood, 9.

This is a beautiful scapigerous species attached to precipitous rocks below the waterfalls.

FLOWERS: July-October; FRUITS: August-December.

LOCAL NAME: Lahan Tirda.

2. **Impatiens dalzellii** Hook. f. & Thomson, in J. Linn. Soc. Lond. 4: 123, 1860; Dalz. & Gibs. 43; Birdwood, 9; Nairne, 44; Birdwood, 404; Woodrow, 11: 266; Cooke, 649 & 1: 173 (183); Blatter 36: 312; Santapau, 289 & 440; Puri & Mahajan, 120.

This is a common monsoon herb with yellow flowers. It grows in forest undergrowth in loose soil and disappears soon after monsoon.

FLOWERS & FRUITS: August-October.

LOCAL NAME: Pivla Tirda.

3. **Impatiens pulcherrima** Dalz. in Hook. J. Bot. 2: 37, 1850; Hook. Bot. Mag. t. 4615, 1837; Dalz. & Gibs. 44; FBI 1: 458; Nairne, 44; Cooke, 650 & 1: 175 (185); Woodrow, 11: 266.

This is a tall and showy balsam; fairly common and gregarious along the Fitzgerald Ghat.

FLOWERS & FRUITS: August-January.

LOCAL NAME: Motha Tirda.

4. **Impatiens balsamina** Linn. Sp. Pl. 938; 1753; Graham, 34 (p.p.); Dalz. & Gibs. 44 (p.p.); Nairne, 44; Santapau, 400; Puri & Mahajan, 120.

I. balsamina var. *vulgaris* Hook. f. in FBI 1: 454, 1874.

This is a rare species collected from roadsides on way to Panchgani.

FLOWERS & FRUITS: July-September.

LOCAL NAME: Tirda.

5. **Impatiens balsamina** var. **rosea** (Lindl.) Hook. f. in Fl. Brit. Ind. 1: 454, 1874; Birdwood, 9: Blatter, 36: 314.

I. rosea Lindl. Bot. Reg. t. 27, 1841.

I. balsamina var. *brevicalcarata* Cooke, Fl. Pres. Bombay, 1: 174, 1901.

This is a common and gregarious species of balsam, all over Mahabaleshwar. It appears sometimes in July and lasts until November. Its rosy mauve flowers which are produced in profusion make it a conspicuous species in the latter part of the monsoon.

FLOWERS & FRUITS: July-November.

LOCAL NAME: Ran Tirda.

6. **Impatiens kleinii** Wight & Arn. Prodr. 140, 1834; Dalz. & Gibs. 43; Nairne, 44; Wight, Icon. t. 884; Cooke, 1: 171 (181); Birdwood, 120; Blatter 36: 311; Santapau, 290.

A rare plant along Fitzgerald Ghat.

FLOWERS & FRUITS: August-September.

LOCAL NAME: Tirda.

7. **Impatiens oppositifolia** Linn. Sp. Pl. 937, 1753; Graham, 34; Wight, Icon. t. 883; Dalz. & Gibs. 43; Nairne, 44; FBI. 1: 448, Birdwood, 9 & 404; Woodrow, 11: 266; Cooke, 1: 172 (182); Blatter, 36: 312.

I. rupicola Hook. f. in Kew Bull. 1910: 292, 1910; Blatter, 36: 310.

This is common and gregarious species, in forest clearings and under trees, as well as in open rocky situations. The dark pink-purple flowers are very conspicuous during rainy season.

FLOWERS & FRUITS: August-September.

LOCAL NAME: Tirda.

8. **Impatiens pusilla** Heyne ex Hook. f. & Thomson, in J. Linn. Soc. 4: 122, 1860; Blatter, 36: 312.

I. inconspicua auct. (non Benth. ex Wight & Arn. Prodr. 139, 1834); Graham, 34; Birdwood, 9; Cooke, 649, & 1: 171 (182); Santapau, 289.

I. inconspicua var. *pusilla* Hook. f. in F.B.I. 1: 448, 18.

A common herb among the grasses in wet places, very variable species.

FLOWERING & FRUITING: August-October.

LOCAL NAME: Tirda.

9. **Impatiens tomentosa** Heyne ex Dalz. & Gibs., Bombay Flora, 43, 1861; Wight, Icon., t. 749; Nairne. 45.

This species is included on the authority of Nairne.

10. **Impatiens lawii** Hook. f. & Thomson in J. Linn. Soc. 4: 122, 1860; FBI 1: 448; Nairne, 45; Cooke, 1: 172 (183); Blatter 36: 312.

There is one specimen of this species from Mahabaleshwar in B.S.I. (Poona) Herbarium, collected by R. K. Bhide.

FLOWERS & FRUITS: August-November.

TROPAEOLACEAE

Tropaeolum Linn.

1. **Tropaeolum majus** Linn. Sp. Pl. 343, 1753.

A cultivated plant occasionally found in private gardens.

CONNARACEAE

Connarus Linn.

1. **Connarus monocarpus** Linn. Sp. Pl. 678, 1753; Graham, 35; Dalz. & Gibs. 53; FBI. 2: 50, Birdwood, 11, 1897.

This species is included here on authority of Birdwood only.

Rourea Aublet (nom. cons.)

1. **Rourea minor** (Gaertn.) Alston, in Trimen, Handb. Fl. Ceylon 6:67, 1931; Leenh, in Van Steenis, Fl. Malesiana, Ser. 1, 5:514, 1958.

Aegiceras minus Gaertner, Fruct. 1:216, t. 46, 1788.

R. santaloides (Vahl) Wight & Arn., Prodr. 144, 1844; *Connarus santaloides* Vahl, Symb. 4: 84, 1794.

This species is reported here on authority of Birdwood.

RUTACEAE

1. Trees .... *Evodia*
1. Shrubs 2
   2. Unarmed shrubs 3
      3. Leaves with 5 or less leaflets.......... .... *Glycosmis*
      3. Leaves with more than 5 leaflets........ .... *Murraya*
   2. Armed shrubs 4
      4. Leaves trifoliate .... *Toddalia*
      4. Leaves unifoliate 5
         5. Erect shrubs .... *Atalantia*
         5. Scandently climbing shrubs .... *Paramignya*

Atalantia Corr.

1. **Atalantia racemosa** Wight & Arnott, Prodr. 91, 1834; FBI 1: 512; Cooke, 1: 187 (199); Talbot, 1:201, 125; Blatter, 36:310; Santapau, 40.

A. monophylla Graham, Cat. Bombay, Pl. 23, 1939; (non Corr. nec. DC. 1824); Dalz. & Gibs. 28; Lisboa, 210; Nairne, 48; Cooke, 1: 187 (199); Blatter, 36: 310; Puri & Mahajan, 121.

This is a common species at Mahabaleshwar. Lodwick Point, Tiger path, Fitzgerald Ghat, Koyna Valley.

FLOWERS: October-December;

FRUITS: March-August.

LOCAL NAMES: Makad Limbu, Ran Limbu.

Evodia Forst.

1. **Evodia lunu-ankenda** (Gaertn.) Merrill, in Phil. Journ. Sci. 7: 378, 1912, Santapau, 307.

Fagara lunu-ankenda Gaertn. Fruct. 1: 334, t. 68, f. 9, 1788. *Zanthoxylum triphyllum* Graham, Cat. 36, 1839; Dalz. & Gibs. 45.

E. roxburghiana Benth. Fl. Hongkong, 59, 1861; FBI 1: 487; Lisboa, 210; Cooke, 1: 177 (188); Talbot, 1: 185, t. 113; Blatter, 36: 315; Puri & Mahajan, 122.

Usually a tree up to 10 metre tall, but on way to Wada there are a few trees which reach 15 metres height. Though it is not found in abundance anywhere, it is a well distributed species.

Table lands, Rotunda Ghat, Lodwick point, Lingmala, Chinaman's falls, Fitzgerald Ghat.

FLOWERS: April-June;

FRUITS: August-December.

LOCAL NAME: Tikatna.

Glycosmis Corr.

1. **Glycosmis arborea** (Roxb.) DC. Prodr. 1: 538, 1824.

Limonia pentaphylla Retz., Obs. Bot. 5: 24, 1788; [non *Glycosmis pentaphylla* (Roxb.) DC.] *L. arborea* Roxb. Pl. Cor. t. 85, 1798. *G. pentaphylla* auct. [non (Roxb.) DC. 1824]; Graham, Cat. Bombay pl. 23; Dalz. & Gibs. 29; Nairne, 47; FBI 1: 499; Cooke, 1: 181 (192); Talbot, 1: 191, t. 117; Blatter, 36: 317; Puri & Mahajan, 121.

A rare species at Mahabaleshwar, which is only known from Dr. T. Cooke's Collection.

FLOWERS & FRUITS: October-June.

LOCAL NAME: Kirmira.

Murraya Linn. (nom. cons.)

1. Leaflets 3-7; flowers few, ± 3 cm long........ .... *M. paniculata*
1. Leaflets 11-25; flowers numerous, ± 1 cm. long .... *M. koenigii*

1. **Murraya koenigii** (Linn.) Spreng, Syst. 2: 315, 1826; FBI 1 : 503; Lisboa, 210; Nairne, 47; Cooke, 1: 182 (193); Talbot, 1 : 193; Blatter, 36: 318; Puri & Mahajan, 121.

Bergera koenigii Linn. Mant. 1: 565, 1767; Graham, 24: Dalz. & Gibs. 29.

A small tree very common along Fitzgerald Ghat. Occasionally found on the plateau.

FLOWERS: March-April;

FRUITS: March-June.

LOCAL NAME: Kari patta, Kari nim.

LOCAL USES: Leaves used for flavouring curries and chutnies.

2. **Murraya paniculata** (Linn.) Jack. in Misc. 1: no. 5, 31, 1820; Graham, 24; Dalz. & Gibs. 29: Blatter, 36: 317.

Chalcas paniculata Linn. Mant. 1: 68, 1767.

Murraea exotica Linn. Mant. 2: 563, 1771; Graham, 24; Wight, Icon. t. 96; Nairne, 47; Cooke, 1: 182 (193); Puri & Mahajan, 120.

M. exotica var. *paniculata* (Jack.) Birdwood, in J. Bombay nat. Hist. Soc. 10; 404, 1897.

There is only one specimen of this species, collected from south of Mahabaleshwar.

Paramignya Wight

1. **Paramignya monophylla** Wight, Ill. 1: 109, t. 42, 1840.

A shrubby straggling climber seen only once on the slopes of Lodwick point, from Dhobi falls.

Toddalia Juss.

1. **Toddalia asiatica** (Linn.) Lamk. Ill. 2: 116, 1797, Blatter, 36: 316; Santapau, 38.

Paullinia asiatica Linn. Sp. Pl. 365, 1753.

T. aculeata Pers. Syn. 1: 249, 1805; Graham, 37; Dalz. & Gibs. 46; FBI 1: 479; Birdwood, 404; Cooke 1: 179 (190); Talbot 1: 189, t. 115.

Limonia oligandra Dalz. in Kew J. Bot. 2: 258, 1850; Dalz. & Gibson, 28.

A rare shrub found only between Dhobi falls and Lodwick point. Leaves prominently gland-dotted.

FLOWERS: August-January.

ICACINACEAE

Nothapodytes Blume

1. **Nothapodytes foetida** (Wight) Sleumer, Notizbl. Bot. Gart. Berlin Dahlem, 15: 247, 1940; Howard in J. Arnold Arbor. 23: 70, 1942.

Stemonurus foetidus Wight, Icon. t. 955, 1845.

Mappia foetida (Wight) Miers. Contrib. 1: 64, 1851; Ann. Mag. Nat. Hist. ser. 2: 9, 395, 1853; FBI 1: 589; Birdwood, 405; Cooke, 1: 225 (239); Talbot 1: 267, t. 158; Santapau, 47.

M. oblonga Miers, Contrib. 1: 65, 1851; Dalz. & Gibs. 28: FBI. 1: 589; Birdwood, 405.

Common tree at Mahabaleshwar. The powerful foetid smell of flowers attracts the attenion of insects as well as human beings.

FLOWERS: August-December;

FRUITS: December-January.

LOCAL NAME: Ghanera.

Chinaman's falls, Dhobi falls, Lodwick point, Madhu Kosh, Bhilar.

HIPPOCRATEACEAE

1. Style overtopping the stamens......*Loeseneriella*
1. Style shorter than the stamens........*Reissantia*

Loeseneriella A. C. Smith

1. **Loeseneriella obtusifolia** (Roxb.) A. C. Smith, in Amer. J. Bot. 28: 440, 1941 & J. Arn. Arbor. 26: 169, 1945.

Hippocratea obtusifolia Roxb. Fl. Indian 1: 170, 1820; Graham, 27; Woodrow, 11: 270; Talbot 1: 282, t. 282, t. 167, Cooke, T. 1: 234 (249).

Less common than *Reissantia indica*, found near Fitzgerald Ghat.

FLOWERS & FRUITS: November.

LOCAL NAME: Dahshir.

Reissantia Halle

1. Inflorescence terminal............. *R. grahamii*
1. Inflorescence axillary.................*R. indica*

1. **Reissantia grahamii** (Wight) Ding Hon, in Blumea, 12: 33, 1963.

Hippocratea grahamii Wight, Ill. 134, 1838 & Icon. t. 380, 1840; FBI 1: 624; Dalz. & Gibs. 32; Cooke 1: 235 (249); Talb. 1: 283, t. 168.

An extensive climber over 10 metre long near Lodwick point. Only two plants were seen in this area.

FLOWERS & FRUITS: March-May.

Lodwick point, Fitzgerald Ghat.

2. **Reissantia indica** (Willd.) Halle, Mem. Inst. Franc. Afrique Noire n. 64 : 85, 1962.

Hippocratea indica Willd. Sp. Pl. 1: 93, 1797; Graham, 27: Dalz. & Gibs. 32: FBI 1: 624; Nairne, 58; Cooke, 1: 235 (250); Talbot, 1: 285, t. 169.

Found at Fitzgerald ghat in abundance but it is scarcely seen on the plateau.

FLOWERS: April; FRUITS: June-August.

LOCAL NAME: Kazurati.

MELIACEAE

1. Leaves simple........................ *Turraea*
1. Leaves pinnately compound................ 2
   2. Seed not winged..................... *Melia*
   2. Seed winged .... *Toona*

Melia Linn.

1. **Melia azedarach** Linn. Sp. Pl. 384, 1753; Graham, 30; FBI 1: 544; Nairne 53; Cooke 1: 205 (218).

This is a beautiful tree due to its light blue flowers which are produced in large panicles. It is cultivated near Bhilar estate.

FLOWERS & FRUITS: April-May.

LOCAL NAME: Bakain nim.

Toona Roem.

1. **Toona ciliata** Roem. Syn. Hesp. 139, 1846; Santapau, 45.

Cedrela toona Roxb. ex Rotll. & Willd. in Ges. Naturl. Fr. Neue Schr. 2: 198, 1803; Graham, 246; Dalz. & Gibs. 38; Nairne, 54; Birdwood, 405; Cooke 1: 217 (230); Talbot, 1: 249, tt. 148-9.

Planted at Bhilar in a private estate.

FLOWERS: January-April;

FRUITS: March-May.

LOCAL NAME: Tooni, Thorla nim.

Turraea Linn.

1. **Turraea villosa** Benn. in Benn. Br. Pl. Jav. Rar. 182, 1840; FBI 1: 542; Cooke, 1: 204 (216); Talbot 1: 224, t. 124; Santapau, 42.

T. virens Graham Cat. Bombay Pl. 1839 (non Linn., 1771); Dalz. & Gibs. 36; Nairne, 53.

A shrub reported by several collectors but it is not seen on the plateau except at lower altitudes in Koyna valley.

FLOWERS: May-June.

FRUITS: June-December.

LOCAL NAME: Kapur Bhendi, Panduri.

OPILIACEAE

Cansjera Juss.

1. **Cansjera rheedii** Gmel. Syst. 2: 280, 1791; FBI 1: 582; Cooke, 1: 223 (237); Talbot, 1: 262, t. 155; Sautapau, 47.

Climbing scandent shrub found on lower ghat slopes and in valleys.

FLOWERS: October-December.

FRUITS: November-March.

LOCAL NAME: Taroli.

CELASTRACEAE

1. Armed shrubs or small trees.........*Maytenus*
1. Unarmed shrubby climbers............*Celastrus*

Celastrus Linn.

1. **Celastrus paniculata** Willd. Sp. Pl. 1: 1125, 1798; Graham, 38; Dalz. & Gibs. 47; FBI 1: 617; Nairne, 57; Birdwood, 405; Cooke, 1: 231 (245); Talbot, 1: 276, t. 163; Santapau, 48.

A straggling climber frequently found on the Kelghar Ghat, on Satara Road.

FLOWERS: December-March.
FRUITS: March-September.
LOCAL NAME: Kangni.

Maytenus Molina

1. **Maytenus wightiana** Babu, Bull. Bot. Surv. India, 10: 349, 1969.

Gymnosporia rothiana (Wight. & Arn.) Laws, in FBI 1: 619, 1875; Nairne, 57; Birdwood, 405; Cooke, 1: 232 (246); Talbot, 1: 278, t. 164.

Celastrus rothiana Wight & Arn. Prodr. 159, 1834. (non Schultes, 1820); Dalz. & Gibs. 47 & 318.

Celastrus emarginata Graham, Cat. Bombay pl. 39, 1839.

Maytenus rothiana (Walp.) Ramam. in fl. Hassan Dist. 320, 1976.

Common small tree in the forest areas. Attractive when in beautiful red coloured fruits. Generally emarginate, acute or obtuse leaves are seen on one and the same twig.

Ramamoorthy (l.c.) makes a new combination based on Walper's name stating an example under article 72 of I.C.B.N. But he has misinterpretated article 72 and the example used under that article. The article and example cited under the article are applicable only to the names which have been intentionally published as nomen novum only. Walper did not publish a new name but he clearly made a new combination in the new genus. Combinations based on illegitimate names have to be rejected.

Chinaman's falls, Yenna Lake, Babington pt., Lingmala, Lodwick pt.

FLOWERS & FRUITS: March-November.
LOCAL NAME: Aukli.

RHAMNACEAE

1. Unarmed shrubs 2
   2. Erect shrubs .... *Rhamnus*
   2. Climbing shrubs .... *Ventilago*
1. Armed shrubs 3
   3. Leaves hairy, 3-nerved .... *Zizyphus*
   3. Leaves glabrous, smooth; with single main nerve .... *Scutia*

Rhamnus Linn.

1. **Rhamnus wightii** Wight & Arn. Prodr. 164, 1834; Dalz. & Gibs. 50: FBI 1: 639; Nairne, 61; Cooke, 1: 244(259); Talbot, 1: 300.

A rare glabrous shrub 2-3 m tall, seen only at Kate's point on very precipitous rocks.

FLOWERS & FRUITS: January-April.

Scutia Commers

1. **Scutia myrtina** (Burm. f.) Kurz., J. Asiat. Soc. Bengal, 44: 168, 1875; Santapau, 52.

Rhamnus myrtinus Burm. f., Fl. Ind. 60, 1768.

Scutia indica Brongn. in Ann. Soc. Nat. Ser. 1, 10; 363, 1827; Graham, 39; Dalz. & Gibs. 50: FBI 1: 640; Lisboa 211; Nairne, 60; Birdwood, 406; Cooke, 1: 244 (260); Talbot, 1: 302, t. 179.

Rhamnus circumscissus Linn. f. Suppl. 152, 1781.

Very common straggling armed shrub with shining leaves and curved spines, on forest fringes. It is popularly called 'wait a bit' plant on account of its spines which catch clothes of hurrying visitors who walk close to this species.

Madhu Kosh, Rippon Hotel, Chinaman's falls, Lodwick point, Yenna lake.

FLOWERS & FRUITS: March-December.
LOCAL NAME: Chimat.

Ventilago Gaertn.

1. **Ventilago bombaiensis** Dalz. in Hook. Kew J. Bot. 3: 36, 1851; Dalz. & Gibs. 48: FBI 1: 631; Nairne 59; Birdwood, 406; Cooke, 1: 239 (254); Talbot, 1: 293; Santapau, 49.

Straggling unarmed climber scandent over forest trees. Flowers green. Rare on the plateau, Fitzgerald Ghat.

FLOWERS: December-February.

LOCAL NAME: Toran.

Zizyphus Juss.

1. **Zizyphus rugosa** Encycl. 3 : 319, 1789; Graham, 30; Dalz. & Gibs. 49: FBI 1: 636; Lisboa, 211; Nairne 60; Birdwood, 406; Cooke, 1: 243 (258); Talbot, 1: 298, t. 177, Sedgwick, in J. Bombay nat. Hist. Soc. 45: 74, 1919; Santapau, 51.

A prickly rambling shrub, with very long terminal inflorescence. Common all over especially in the open forests.

Falkland point, Lodwick point, Chinaman's point, Fitzgerald Ghat.

FLOWERS: December-March.

FRUITS: March-April.

LOCAL NAME: Toren.

AMPELIDACEAE

Cissus Linn.

1. Leaves simple 2
   2. Erect shrubs, tendrils nil......*C. woodrowii*
   2. Scandent shrubs, tendrils leaf opposed......3
      3. Leaves glabrous variegated... *C. discolor*
      3. Leaves tomentose............*C. repanda*
1. Leaves 5-foliate ....*C. elongata*

1. **Cissus woodrowii** (Stapf) Santapau, Kew Bull. 1948: 276, 1948; Santapau, 53.

Vitis woodrowii Stapf ex Cooke Fl. Bombay Pres. 1: 248, 1902.

C. vitiginea Dalz. & Gibs. Bomb. Fl. 40, 1861 (non Roxb.)

A shrub 1.5-2 metres tall. Very common on exposed hill slopes along Kelghar ghat on Satara Road.

FLOWERS & FRUITS: June.

LOCAL NAME: Girnul.

2. **Cissus discolor** Blume, Bijdr. 181, 1825; Dalz. & Gibs. 40; Santapau, 52.

Vitis discolor Dalz. in Hook. Kew J. Bot. 2: 39, 1850; FBI 1: 647; Nairne, 63; Birdwood, 906; Cooke, 1: 250 (266); Talbot, 1: 309.

A scandent climber with leaves which are green on the dorsal surface and metallic red on the ventral surface. Frequent along the Fitzgerald Ghat.

FLOWERS: August-October.

LOCAL NAME: Telicha Vel.

3. **Cissus repanda** Vahl Symb. 3: 18, 1794; Graham, 32; Dalz. & Gibs. 39; Santapau, 53.

Vitis repanda Wight & Arn. Prod. 125, 1824; FBI 1: 271; Nairne, 62; Cooke, 1: 215 (267); Talbot, 1: 312, tt. 184-5.

Young foliage of this species is brightly coloured. This species is collected from Fitzgerald Ghat only.

FLOWERS & FRUITS: April-June.

LOCAL NAME: Gendal.

4. **Cissus elongata** Roxb. Fl. Ind. 1: 411, 1820; Santapau, 53.

Vitis elongata Wall. ex Wight & Arn. Prodr. 128, 1824; FBI 1: 658; Cooke, 1: 265 (273); Talbot, 1: 320, t. 190.

A glabrous climber very common all over Mahabaleshwar among shrubs and bushes. This is the commonest species of this area. Size and margins of the leaves are very variable.

FLOWERS: May-June; FRUITS: August-October.

Pratapsingh Park, Tiger's Path, Kate's point, Wilson point, Fitzgerald Ghat.

Vitis Linn.

1. **Vitis vinifera** Linn. Sp. Pl. 202, 1753; FBI 1: 652.

A woody climber with bifid tendrils. Cultivated for its edible fruits in Dr. Hakim's estate at Bhilar.

FLOWERS: December: FRUITS: March.

LEEACEAE

Leea Linn.

1. **Leea indica** (Burm. f.) Merrill, in Phil. J. Sci. Bot. 14: 245, 1919; Santapau, 55.

Staphylea indica Burm. f. Fl. Ind. 75, t. 24, f. 2, 1768.
Aquilicia sambucina Linn. Mant. 2: 211, 1771.
Leea staphylea Roxb. Fl. Ind. 1: 658, 1832; Graham, 33; Dalz. & Gibs. 41.
L. sambucina Willd. Sp. Pl. 1: 1177; FBI 1: 666 (p.p.); Nairne, 64; Cooke, 1: 260 (277); Talbot, 1: 327, t. 194.

A frequent shrub on Fitzgerald Ghat.
FLOWERS: March-June; FRUITS: May-December.
LOCAL NAME: Dinda.

SAPINDACEAE

1. Climbers or scandent shrubs....... *Allophyllus*
1. Trees 2
  2. Fruit when ripe ± 1 cm. long............ .... *Dimocarpus*
  2. Fruit when ripe ± 3-4 cm. long......*Litchi*

Allophyllus Linn.

1. **Allophyllus serratus** (Roxb.) Radlk. in Pfreich. 98: 562, 1921; Santapau, 56.
Ornitrophe serrata Roxb. Pl. Corom. 1: 44, t. 61, 1795.
Schmidelia cobbe Graham, Cat. Bombay pl. 29, 1839.
Cardiospermum schmiedelia Dalz. & Gibs. Bombay Fl. 34, 1861.
A. cobbe Hiern., in Fl. Br. Ind. 1: 7, 674, 1875 (p.p.); Lisboa, 211; Nairne, 65; Birdwood, 406; Cooke, 1: 265 (282); Talbot, 1: 334, t. 197.

A villous, trifoliate, scandent shrub, often climbing on medium size trees. Common all over Mahabaleshwar. Flowers white, profusely produced in pendulous spikes during late summer and last till early monsoon.

Petit Road, Lodwick point, Kelgar Ghat, Tiger's path.

DIMOCARPUS Loureiro

1. **Dimocarpus longan** Lour., Fl. Cochinch. 233, 1790; Leenhouts, Blumea, 19: 122, 1971,
Nephelium longana (Lamk.) Camb. in Mem. Mus. Par. 18: 30, 1829; Graham, 29: Dalz. & Gibs. 35; FBI 1: 688; Birdwood, 406; Nairne, 66; Cooke, 1: 267 (285); Talbot, 1: 338, t. 200.

A handsome tree, 10-15 m tall with pinnate leaves. Common on Fitzgerald Ghat.
FLOWERS & FRUITS: April-May.
LOCAL NAME: Wumb.

Litchi Sonner.

1. **Litchi chinensis** Sonner. Voy. Ind. 3: 255, 1782; Benthal, in Trees of Calcutta, 124.
Nephelium litchi Camb. in Mem. Mus. Par. 18: 30, 1829; Nairne, 66.
Dimocarpus litchi Lour. Fl. Cochinch. 233, 1790.

A small tree with paripinnate leaves and 4-12 leaflets in each leaf. Fruits red or pink when ripe. Cultivated for its edible delicious fruits, at Bhilar and on sides of Yenna river.
FLOWERS & FRUITS: May.

Turpinia Vent.

1. **Turpinia pomifera** DC. Prodr. 2: 3, 1825, Birdwood, 11, 1897.

This species is reported here on authority of Birdwood.

ANACARDIACEAE

Mangifera Linn.

1. **Mangifera indica** Linn. Sp. Pl. 200, 1753; Lisboa, 211; Birdwood, 406; Nairne, 67; Cooke, 1: 273 (291); Talbot, 1: 348; Santapau 58.

Occasionally found on the plateau, where it does not bear fruits. Trees in the valleys are taller but bear inferior quality fruits.

FLOWERS: February-March; FRUITS: May-June.

LOCAL NAME: Amba.

Distribution: Chinaman's falls, Lodwick point, Fitzgerald Ghat.

MORINGACEAE

Moringa Lamk.

1. **Moringa oleifera** Lamk., Encycl. Meth. Bot. 1: 398, 1785.

M. pterigosperma Gaertner, Fruct. 2: 314, 1791; Nairne, 70; FBI 2: 45; Cooke, 1: 282 (301).

A cultivated medium-size tree. Pods and leaves used for vegetables and curries.

FLOWERS: January-April.

LOCAL NAME: Shevga.

FABACEAE

1. Pods jointed 2
 2. Stamens 5 + 5 in two rows........*Smithia*
 2. Stamens 10, united or 9 + 1..............3
  3. Leaves pinnate .... *Zornia*
  3. Leaves simple or imparipinnate........4
   4. Pods turgid ....*Alysicarpus*
   4. Pods flat .... *Desmodium*
1. Pods not jointed 5
 5. Anthers spiculate .... *Indigofera*
 5. Anthers obtuse 6
  6. Leaflets toothed .... *Cicer*
  6. Leaflets entire 7
   7. Style bearded below the stigma......8
    8. Main rachis or entire leaflets modified into tendrils ....*Pisum*
    8. Main rachis not modified into tendril 9
     9. Leaves trifoliate 10
      10. Stigma oblique 11
       11. Keel spiral .... *Phaseolus*
       11. Keel not spiral .... *Vigna*
      10. Stigma not oblique .... *Spenostylis*
     9. Leaves imparipinnate consisting more than 3 leaflets.......... .... *Tephrosia*
   7. Style not bearded below the stigma 12
    12. Leaves simple or imparipinnate 13
     13. Anthers not uniform.......14
      14. Flowers yellow .... *Crotalaria*
      14. Flowers blue or purple ....*Mucuna*
     13. Anthers uniform 15
      15. Leaflets always alternate .... *Dalbergia*
      15. Leaflets opposite 16
       16. Pods one seeded.... 17
        17. Climbers .... *Paracalyx*
        17. Trees .... *Pongamia*
       16. Pods many seeded 18
        18. Leaves gland-dotted 19
     19. Pods turgid....... *Flemingia*
     19. Pods compeassed.... *Atylosia*
    18. Leaves not gland-dotted 20
      20. Leaves simple .... *Nogra*
      20. Leaves trifoliate 21
       21. Flowers yellow .... *Dumasia*
       21. Flowers red or purple 22
        22. Climbers ....*Canavalia*
        22. Trees .... *Erythrina*
    12. Leaves multifoliate ...... *Derris*

Smithia Ait.

1. Calyx rigid with parallel veins.............2
 2. Flowers purple .... *S. purpurea*
 2. Flowers yellow 3
  3. Stems with dense spreading bristles.... .... *S. setulosa*
  3. Stems glabrescent 4
   4. Leaves 6-20 mm long, flowers conjested at the nodes........... *S. conferta*
   4. Leaves 25-35 mm long, flowers in lax racemes .... *S. sensitiva*
1. Calyx membranaceous; veins anastomosing 5

5. Flowers in globose terminal heads .... *S. pycnantha*
5. Flowers in racemes 6
6. Bracteoles equal in length..............7
7. Leaflets 2 pairs ....*S. bigemina*
7. Leaflets 3-4 pairs ....*S. blanda*
6. Bracteoles unequal in length.......................... *S. agharkari*

1. **Smithia purpurea** Hook. Bot. Mag. t. 4283, 1847; Dalz. & Gibs. 64: Birdwood, 407; F.B.I. 2: 149; Nairne 83; Cooke, 1: 337 (359); Santapau, 68.

This is the only purple flowered *Smithia* found at Mahabaleshwar or rather in Western India. Frequently seen on rocky slopes along the Yenna lake.

FLOWERS & FRUITS: September-December.
LOCAL NAME: Berki.

2. **Smithia setulosa** Dalz. in Kew J. Bot. 3: 208, 1851; FBI 2: 149; Dalz. & Gibs. 63; Birdwood, 407; Nairne 82; Cooke, 1: 337 (359); Santapau, 68.

An erect herb, common in open places. This species is easily identified by large flowers and prominent bristly hairs on the stem.

FLOWERS: September-October;
FRUITS: October-November.

3. **Smithia conferta** Sm. in Rees, Cycl. 33, no. 2, 1819; Cooke, 1: 336 (358); Santapau, 67.

S. geminiflora Roth, Nov. Pl. sp. 352, 1821.
S. geminiflora var. *conferta* Baker, in FBI 2: 149, 1876.

Common in marshy ground. Flowers yellow to saffron coloured.

Wilson point; Lingmala; Near Rippon Hotel.
FLOWERS: September-December;
FRUITS: October-February.

4. **Smithia sensitiva** Ait. Hort. Kew 3: 496, 1789; Graham, 48; Dalz. & Gibs. 63; FBI 2: 148; Nairne, 82 (p.p.); Cooke, 1: 335 (357); Santapau 67.

Rare species at Mahabaleshwar, though the commonest *Smithia* down in Konkan. Only one specimen is collected from Chinaman's falls area.

FLOWERS & FRUITS: August-October.

5. **Smithia pycnantha** Benth. ex Baker, in Fl. Brit. Ind. 2: 150, 1876; Nairne, 82; Cooke 1: 338 (360); Santapau, 68.

This species closely resembles *S. bigemina,* but differs from it in having globose terminal heads of flowers.

FLOWERS & FRUITS: September-October.

6. **Smithia bigemina** Dalz., in Kew J. Bot. 3: 208, 1851; Dalz. & Gibs. 64; FBI 2: 149; Nairne 83; Cooke, 1: 338 (360); Santapau, 68.

Gregarious species forming large carpets of yellow flowers, on open rocky grounds and in rice-fields. The standard petal is streaked with two prominent red lines.

Dhobi falls, Kate's point, Lodwick point.
FLOWERS: June-October;
FRUITS: September-January.

7. **Smithia blanda** var. **racemosa** Baker, in Fl. Brit. Ind. 2: 151, 1876; Birdwood, 407; Cooke, 1: 338 (361); Santapau, 69.

S. racemosa Heyne ex Dalz. & Gibs. Bombay Fl. 63, 1861.
S. hirsuta Dalz. in Hook. J. Bot. 3: 135, 1851; Dalz. & Gibs. 63.
S. humilis Benth. ex Cooke, Fl. Pres. Bombay, 1: 339, 1901.

Quite frequent in rocky soils and on earthen embankments along the road sides. Collected from Kate's point.

FLOWERS: September; FRUITS: October.
LOCAL NAME: Mothi Berki.

8. **Smithia agharkari** Hemadri, in Indian Forester 97: 67, 1971.

An erect annual herb 9-20 cm. tall. Stems dichotomously branched. Leaves paripinnately compound. Inflorescence of terminal and axillary simple racemes. Bracteoles greenish, in unequal pairs. Fruits 3-4 mm. in diameter.

A rare herb among the grasses on open plateaus.

Wilson Point.

FLOWERS & FRUITS: September-October.

Zornia Gmel.

1. **Zornia gibbosa** Span. in Linnaea 15: 192, 1841; Santapau, 57.

Z. diphylla auct. plur. (non Pers, 1807); Baker, in FBI 2: 147, 1876; Nairne, 81; Cooke, 1: 334; Santapau, 66.

Z. angustifolia Graham, Cat. Bombay pl. 48, 1839 (non Smith).

A rare species in waste grasslands and fallow land.

FLOWERS: August-October.

FRUITS: October.

Specimen Collected: Laxman (Api. Res. Centre) — s.n.

Alysicarpus Neck

1. Leaves orbicular .... *A. beddomei*
1. Leaves elliptic, oblong or ovate..............2
    2. Calyx 3-4 mm long, pods 4-6 jointed...... .... *A. parviflorus*
    2. Calyx 7-12 mm long; pods 2-4 jointed......3
        3. Inflorescence 4-7 cm long....*A. racemosus*
        3. Inflorescence 13-27 cm long............ .... *A. belgaumensis*

1. **Alysicarpus beddomei** Schindler, in Fedde Repert. Beih. 49: 244, 1928.

A. rotundifolius Prain, in J. Asiat. Soc. Bombay, 66: 385, 1897.

Desmodium rotundifolium Baker, in FBI 2: 172, 1876; Cooke, 1: 357 (381); Santapau, 73.

Very common on grassy hill slopes all over.

Fitzgerald Ghat, Lingmala, Bhilar.

FLOWERS & FRUITS: October-November.

2. **Alysicarpus parviflorus** Dalz. in Hook. Kew J. 3: 211, 1851.

Desmodium parviflorum (Dalz.) Baker, in FBI 2: 172. 1876; Cooke, 1: 358 (381); Santapau, 74, (non Mart. Galeott. 1843).

D. alysicarpoides K. v. Meeuwen, in Reinwardtia, 6: 246: 1962.

The species approaches *Desmodium* and Dr. T. Cooke is of the opinion that this is a link species between *Alysicarpus* and *Desmodium.* We have not seen specimen of this species from Mahabaleshwar. Lee, in Bombay Gazetteer, vol. 19 reports it from Mahabaleshwar.

3. **Alysicarpus racemosus** Benth., in Linnaea 24: 642, 1851.

A. belgaumensis var. *racemosus* Baker, in FBI 2: 160, 1876; Cooke, 1: 330 (373).

Found mixed with *A. belgaumensis* but much less frequent on grassy slopes. Flower colours vary from white to blue.

Yenna lake, Lodwick point, Lingmala, Bhilar.

FLOWERS & FRUITS: October.

4. **Alysicarpus belgaumensis** Wight, Icon. t. 92, 1838; Dalz. & Gibs. 65; FBI 2: 160; Cooke 1: 349 (372); Santapau, 70.

Abundant in open places during monsoon and post-monsoon periods, all over Mahabaleshwar. Flowers blue, or sometimes white.

FLOWERS & FRUITS: September-November.

LOCAL NAME: Dhampta.

Desmodium Desv.

1. Leaves unifoliate, petiole winged .... *D. triquetrum*
1. Leaves usually trifoliate................... 2
    2. Erect herbs .... *D. laxiflorum*
    2. Trailing herbs .... *D. triflorum*

1. **Desmodium laxiflorum** DC. in Ann. Sci. nat. (Paris) ser. 1, 4: 100, 1825; Prodr. 2: 335, 1825; FBI 2: 164; Cooke, 1: 353 (376); Santapau, 71.

D. recurvatum Graham, ex Wight, Icon. t. 374, 1840.

Hedysarum recurvatum Roxb. Fl. Ind. 3: 358, 1832.

H. diffusum Roxb. l.c. (non Willd., 1802).

Frequent on hill slopes along Fitzgerald ghats.

FLOWERS & FRUITS: August-December.

2. **Desmodium triflorum** (Linn.) DC. Prodr. 2: 334, 1825; Graham, 49; Dalz. & Gibs. 67; FBI 2: 173; Cooke, 1: 355; Santapau, 72.

Hadysarum triflorum Linn. Sp. Pl. 749, 1753.

Weed in cultivated fields and in waste-lands.

FLOWERS & FRUITS: August-December, sometimes in hot seasons.

LOCAL NAME: Ran Methi.

3. **Desmodium triquetrum** (Linn.) DC. Prodr. 2: 326, 1825; FBI 2: 163; Graham, 49; Dalz. & Gibs. 66; Nairne 84; Cooke, 1: 355 (378); Santapau, 72.

Hedysarum triquetrum Linn. Sp. Pl. 746, 1753.

At the foot of the Fitzgerald Ghat among grass.

FLOWERS & FRUITS: August-December.

Indigofera Linn.

1. Leaves simple.................... *I. dalzellii*
1. Leaves compound .... *I. cassioides*

1. **Indigofera dalzellii** Cooke, Fl. Bombay Pres. 1: 311, 1902.

I. triquetra Dalz. in Hook. Kew J. Bot. 2: 36, 1850; (non May 1836); Dalz. & Gibs. 58; FBI 2: 93.

A prostrate herb among the grasses at Bhilar.

FLOWERS: July-September.

FRUITS: October-November.

2. **Indigofera cassioides** Rottl., ex DC. Prodr. 2: 225, 1825; Ali, in Bot. Notiser. 111; 569, 1958.

I. pulchella auct. (non Roxb., 1832); Dalzell & Gibson, Bombay Fl. 60, 1861; Lisboa, 212; Birdwood, 407; Nairne, 79; Cooke, 1: 320 (341).

I. gibsonii Graham, Cat. Bombay Pl. 46, 1839.

Common shrub along the edges of forests and on exposed slopes of hills. The stem is often covered with galls with soft velvety covering of a purple colour.

Lingmala, Bhilar, Fitzgerald Ghat, Kelgar Ghat.

FLOWERS: October-January.

FRUITS: December-April.

LOCAL NAME: Narda.

Cicer Linn.

1. **Cicer ariatinum** Sp. Pl. 738, 1753; FBI 2: 176; Cooke, 1: 408; Santapau, 88.

Cultivated and mostly used for local sale of raw green fruits. Cultivation begins with starting of hot season.

LOCAL NAME: Chana, Harbhara.

Pisum Linn.

1. **Pisum sativum** Linn. Sp. Pl. 727, 1753.

Extensively cultivated at Mahabaleshwar for its fruits which form an article of major trade to the markets of Bombay and Pune.

FLOWERS: September-December.

FRUITS: October-December.

LOCAL NAME: Matar, Vatani.

Phaseolus Linn.

1. Stipules medifixed 2
    2. Erect plants, 60-210 cm tall................
    .... *P. khandalensis*
    2. Prostrate or twining plants.......*P. radiatus*
1. Stipules basifixed .... *P. lunulatus*

1. **Phaseolus khandalensis** Santapau, in Kew Bull. 276, 1948; Santapau, 68.

P. grandis Dalz. in Dalz. & Gibs. Bombay Fl. 72, 1861; FBI 2: 202; Nairne, 89; Cooke, 1: 375 (400); (non Wall. 1832, nec Benth. 1844).

A rare species. The pods are eaten by local people.

FLOWERS: September-October.

FRUITS: October-November.

2. **Phaseolus radiatus** Linn. Sp. Pl. 725, 1753; Santapau, 69.

P. sublobatus Roxb. Fl. Ind. 3: 288, 1832; Cooke, 1: 373 (402).

P. trinervius Heyne ex Graham, Cat. Bombay Pl. 51, 1839; Dalz. & Gibs. 71; FBI 2: 203; Birdwood, 407; Nairne, 89.

Cultivated; the source of the pulse, Mung, of commerce.

FLOWERS: September-October.

FRUITS: October-December.

3. **Phaseolus lunulatus** Linn. Sp. Pl. 724, 1753; Graham, 51; FBI 2: 200; Cooke, 1: 377 (402).

Lima bean of commerce. Cultivated at Chinaman's falls.

FLOWERS & FRUITS: October-March.

Vigna Savi

1. **Vigna vexillata** (Linn.) A. Rich. in Sagra, Hist. Cuba, Bot. 440, 1845; FBI 2: 206; Birdwood, 407; Nairne, 89.

Phaseolus vexillatus Linn., Sp. Pl. 724, 1753.

V. capensis Walp., in Linnaea, 13: 533, 1839; Cooks, 1: 379 (404); Santapau, 80.

Common in undergrowth, especially noticeable during the middle of the monsoon season. Kate's point, Chinaman's falls, Wilson point, Dhobi's falls, Lingmala.

FLOWERS: August-October.

FRUITS: October-November.

LOCAL NAME: Halunda.

Sphenostylis E. May

1. **Sphenostylis bracteata** (Baker) Gillet, in Kew Bull. 20: 103; 1966, Santapau, 328.

Dolichos bracteatus Baker, in FBI 2: 210, 1876; Cooke, 381 (406).

D. ghaticus Sant. & Panth. in J. Bombay nat. Hist. Soc. 53: 502, 1956.

Common and prominent during monsoon along the Fitzgerald Ghat, climbing on bushes of the forest edges.

FLOWERS: August-September;

FRUITS: September-October.

Tephrosia Pers.

1. **Tephrosia tinctoria** Pers. Syn. 2: 329, 1807; FBI 2: 111; Cooke, 1: 324 (345); Santapau, 65.

T. tinctoria var. *intermedia* Baker, in FBI 2: 112, 1876; Cooke, 1: 324.

Frequent at Bhilar in grasslands and in the woods between Mahabaleshwar and Panchgani.

FLOWERS & FRUITS: October-December.

LOCAL NAME: Guli.

Crotalaria Linn.

1. Pods glabrous 2
    2. Stipules present 3
        3. Stem terete, not striate or fluted .... *C. mysorensis*
        3. Stem fluted and subglabrous .... *C. retusa*
    2. Stipules absent 4
        4. Pods distinctly exerted 5
            5. Prostrate or erect herbs............6
                6. Corolla exerted .... *C. filipes*
                6. Corolla not exerted......*C. vestita*
            5. Shrubs or undershrubs.......*C. albida*
        4. Pods included or scarcely exerted........................ *C. nana*
1. Pods silky or hairy........................7
    7. Erect or trailing herbs..........*C. triquetra*
    7. Shrubs or undershrubs...........*C. juncea*

1. **Crotalaria mysorensis** Roth, Nov. Pl. Sp. 338, 1821; FBI 2; 70; Cooke, 1: 294 (314); Santapau, 61.

Frequent in exposed situations on the Fitzgerald Ghat and on way to Panchgani. Flowers yellow. The whole plant is covered with brownish shining tomentum.

FLOWERS & FRUITS: October-November.

2. **Crotalaria retusa** Linn. Sp. Pl. 715, 1753; FBI 2: 575; Birdwood, 407; Nairne 75; Cooke, 1: 299 (318); Santapau, 62.

C. leschenaultii Graham Cat. 44, 1839 (non DC. 1824); Dalz. & Gibs. 54; Lisboa, 211; Birdwood, 407.

The commonest and most showy species belonging to the genus at Mahabaleshwar. Flowers bright yellow.

Lodwick point, Madhu Kosh, Lingmala, Bhilar, Chinaman's falls.

FLOWERS: September-December.

3. **Crotalaria filipes** Benth. in Hook. London J. Bot. 2: 475, 1843; Dalz. & Gibs. 56: FBI 2: 66; Cooke, 1: 292 (312); Santapau, 60.

A spreading herb producing tiny multicoloured flowers. Usually found mixed among the grasses in open grasslands.

FLOWERS: September-December.

FRUITS: December-February.

4. **Crotalaria vestita** Baker, in Fl. Br. Ind. 2: 67, 1876; Birdwood, 407; Cooke 1: 293 (313); Santapau, 61.

Occasional among the grasses. Collected from Elephinstone point.

FLOWERS & FRUITS: October-January.

5. **Crotalaria albida** Heyne ex Roth., Nov. Pl. Sp. 333, 1821; FBI 2; 71; Cooke 1: 295 (315): Santapau, 62.

C. epunctata Dalz. in Kew J. Bot. 3: 210, 1851, Dalz. & Gibs. 56.

Frequently seen among the undergrowth of forest along Fitzgerald Ghat.

FLOWERS & FRUITS: October-February.

LOCAL NAME: Ban Methi.

6. **Crotalaria nana** Burm. f. Fl. Ind. 156, t. 48, f. 2, 1768; Dalz. & Gibs. 56; Birdwood, 407; Cooks, 1: 296 (315); Santapau, 62.

C. umbellata Wight ex Graham Cat. Bombay pl. 45, 1839; Dalz. & Gibs. 56.

Found on the grassy slopes of higher elevations. In vegetative conditions it resembles *C. mysorensis.*

Lingmala, Canaught peak, Bhilar.

FLOWERS & FRUITS: September-October.

7. **Crotalaria triquetra** Dalz. in Hook. Kew. J. Bot. 2: 34, 1850; Dalz. & Gibs. 56; Birdwood, 407; Cooke, 1: 295 (314); Santapau, 61.

Stems and branches triquetrous. Frequently seen among the grasses between Mahabaleshwar and Panchgani.

FLOWERS & FRUITS: December at times up to April.

LOCAL NAME: Ghati.

8. **Crotalaria juncea** Linn. Sp. Pl. 714, 1753; Dalz. & Gibs. 54; FBI 2: 79; Nairne 76; Cooke 1: 301 (320); Santapau, 63.

Frequently seen growing among the grasses. The shining golden silky hairs aid the identification of this species. Cultivated for fibre and for green manure.

FLOWERS: October-December;

FRUITS: January-February.

LOCAL NAME: Sunn.

Mucuna Adans.

1. Pods obliquely plaited, one seeded.. *M. monosperma*
1. Pods not plaited, 4-6 seeded.........*M. prurita*

1. **Mucuna monosperma** DC. Prodr. 2: 406, 1825; Dalz. & Gibs. 70; FBI 2: 185; Nairne 87; Cooke, 1: 364 (388).

In dense jungle of Fitzgerald Ghat, climbing over small trees. The fruits are covered profusely with golden to reddish stinging hairs. The fruit surface is reticulately plaited or with ridges.

FLOWERS: November-December.

FRUITS: December.

LOCAL NAMES: Mothi Kuvli, Iona garvi.

2. **Mucuna prurita** Hook., Bot. Misc. 2: 384, 1830; Dalz. & Gibs. 70; Santapau, 74.

M. pruriens auct. (non DC. 1825) Baker, Fl. Brit. Ind. 2: 187, 1876; Nairne 87; Cooke, 1: 365 (389).

Found only at the foot of Fitzgerald Ghat.

FLOWERS & FRUITS: August-December.

LOCAL NAME: Kavach, Kuili.

Dalbergia Linn.

1. Erect trees........................ *D. latifolia*
1. Scandent or climbing shrubs.................. .... *D. sympathetica*

1. **Dalbergia latifolia** Roxb. Pl. Cor. 2: 7, t. 113, 1798; Graham, 55; Dalz. & Gibs. 77; FBI 2: 231; Birdwood, 407; Nairne, 92; Cooke, 1: 396 (422); Santapau, 85.

A rare tree at Lingmala.

FLOWERS: October-April.

FRUITS: March-May.

2. **Dalbergia sympathetica** Nimmo ex Grah., Cat. Bombay Pl. 55, 1839; Dalz. & Gibs. 78; FBI 2: 234; Birdwood, 407; Nairne 92; Cooke, 1: 398 (424); Santapau, 85.

Frequent near the foot of Fitzgerald Ghat.

FLOWERS: November-January.

FRUITS: December-March.

LOCAL NAME: Pudgul.

Paracalyx Ali

1. **Paracalyx scariosa** (Roxb.) Ali, in Univer. Stud. Karachi 5 (3): 95, 1968.

Cylista scariosa Roxb., Corom. Pl. 5 (1): 64, t. 92, 1795; Graham, 54; Dalz. & Gibs. 74; FBI 2: 219; Birdwood, 407; Nairne, 91; Cooke, 1: 386 (412); Santapau, 84.

Frequent on the hill-slopes and along the Fitzgerald Ghat.

FLOWERS: November-February.

FRUITS: January-April.

Pongamia Vent.

1. **Pongamia pinnata** (Linn.) Pierre, Fl. For. Cochinch. sub. t. 385, 1899; Merr. Inter. Rumph. Amboin. 271, 1917; Santapau, 86.

Cytisus pinnatus Linn. Sp. Pl. 741, 1753.

P. glabra Vent. Jard. Mal. 1: 28, t. 28, 1803; Graham, 53; Dalz. & Gibs. 77; FBI 2: 240; Lisboa, 212; Birdwood, 407; Cooke, 1: Nairne 92; 402 (429).

Introduced tree at Mahabaleshwar, but it is not well established in this area.

FLOWERS: June-September and January-April.

FRUITS: September-November and March-May.

LOCAL NAME: Karanj.

Flemingia Ait. (nom. cons.)

1. Shrubs or undershrubs...........*F. strobilifera*
1. Trailing herbs ....*F. neilgheriensis*

1. **Flemingia strobilifera** (Linn.) R. Br. ex Ait., Hort. Kew. 2; 4: 350, 1812; Graham, 51; Dalz. & Gibs. 75; FBI 2: 227 (excl. vars.); Birdwood, 407; Cooke, 1: 390 (416).

Hedysarum strobiliferum Linn., Sp. Pl. 764, 1753.

Maughania strobilifera (Linn.) St. Hill ex Li, in Arn. J. Bot. 31: 227, 1944; Mukherjee, J. Bot. Soc. Bengal, 6: 10, 1952; Santapau, 84.

Usually common in shady undergrowth of the forests.

FLOWERS & FRUITS: December-April.

2. **Flemingia neilgheriensis** Wight ex Cooke, Fl. Bombay Pres. 1:393, 1902.

Maughania neilgheriensis (Benth.) H.L. Li, in J. Bot. 31 (4): 227, 1944.

F. vestita var. *neilgheriensis* Benth. ex Baker, in Fl. Brit. India, 2: 230, 1876.

Rather rare in rocky ground near the park and on slopes near the lake.

Atylosia Wight & Arn.

1. Leaves obovate .... *A. lineata*
1. Leaves linear-oblanceolate.............*A. sericea*

1. **Atylosia lineata** Wight & Arn. Prodr. 258, 1834; FBI 2: 213; Lisboa, 212; Birdwood, 407; Nairne 90; Cooke, 1: 382 (408); Santapau, 83.

A. lawii Wight, Icon. t. 93, 2838; Graham, 53; Dalz. & Gibs. 74: Lisboa, 212.

Fairly common on open slopes along Lingmala and on way to Panchgani.

Distribution: Bhilar, Lingmala.

FLOWERS & FRUITS: January-May.

2. **Atylosia sericea** Benth. ex Baker, in Fl. Brit. Ind. 2: 213, 1876; Birdwood, 407; Cooke, 1: 383 (408); Santapau, 83.

A gregarious shrub growing on open grasslands between Mahabaleshwar and Panchgani and also at Lingmala.

FLOWERS & FRUITS: October-April.

Spec. seen: L. J. Sedgwick—4744.

Nogra Merr.

1. **Nogra simplicifolia** (Dalz.) comb. nov.

Galactia simplicifolia Dalz., In Kew J. Bot. 3: 209, 1851; Dalz. & Gibs. 69.

Grona dalzellii Baker, in Fl. Brit. Ind. 2: 191, 1876; Cooke, 1: 368 (392).

A rare species found among the forest undergrowth.

FLOWERS & FRUITS: September-October.

Dumasia DC.

1. **Dumasia villosa** DC., Mem. Legum. 257, t. 44, 1825; FBI 2: 183; Birdwood, 407; Cooke, 1: 361.

D. congesta Graham ex Wight & Arn., Prodr. 206, 1840.

Rather rare species occasionally found on exposed rocky grounds or in grasslands.

Canavalia DC.

1. **Canavalia microcarpa** (DC.) Piper, in Proc. Bot. Soc. Wash. 30: 177, 1917; Chatterjee, in J. Ind. Bot. Soc. 28: 92, 1949.

Lablab microcarpus DC. Prodr. 2: 402, 1825.

C. turgida Graham ex Miq. Fl. Ind. Bot. 1: 215, 1855.

C. enciformis Baker var. *turgida* Baker, FBI 2: 196, 1876; Birdwood, 407.

This species has been reported by Woodrow from Western scrap of Mahabaleshwar, under *C. stocksii* Dalz. (J. Bombay nat. Hist. Soc. 11: 424, 1897). D. Chatterjee does not recognise this species and prefers to keep it merged under common *Canavalia* found in Western India, which is mentioned above.

FLOWERS & FRUITS: October.

Erythrina Linn.

1. **Erythrina stricta** Roxb. Fl. Ind. 3: 251, 1832; Graham, 54; Dalz. & Gibs. 70; FBI 2: 189; Cooke, 367 (391); Santapau, 75.

Micropteryx stricta Walp. in Linnaea 13: 740, 1839.

There are a few trees along Fitzgerald Ghat.

FLOWERS: February-May.

FRUITS: June-July.

LOCAL NAME: Pangara.

Derris Lour.

1. **Derris scandens** (Roxb.) Benth. in J. Linn. Soc. 4: suppl. 103, 1860; FBI 2: 240; Nairne, 93; Cooke, 1: 404 (430); Santapau, 87.

Dalbergia scandens Roxb. Cor. Pl. 2: t. 102, 1798; Graham, 55.

Brachypterum scandens Benth. in Ann. Wien. Mus. 2: 101, 1840; Dalz. & Gibs. 76.

Commonly found near the banks of water springs or near marshy places, in bloom at the beginning of the monsoon.

FLOWERS: June-August.
FRUITS: July-December.
LOCAL NAME: Mothi Sirili.

CAESALPINIACEAE

1. Leaves simply pinnate 2
   2. Corolla with 5 perfect petals .... *Cassia*
   2. Petals 0 .... *Saraca*
1. Leaves bipinnate or unifoliate and bilobed 3
   3. Prickly straggler .... *Wagatea*
   3. Trees .... *Bauhinia*

Cassia Linn.

1. **Cassia fistula** Linn. Sp. Pl. 377, 1753; Graham, 62; Dalz. & Gibs. 80; Birdwood, 408; Woodrow, 11: 427; Nairne, 96; Cooke, 1: 417 (444); Santapau, 90.

C. rhombifolia Roxb. Fl. Ind. 2: 334, 1832; Wight, Icon. t. 269.

Not a common tree. Often seen in the valleys near human habitation and along the sides of streams. In hot season the tree becomes leafless and bears bright yellow flowers in drooping racemes which make it very conspicuous and attractive.

FLOWERS: March-June.
FRUITS: All round the year.
LOCAL NAME: Bahava.

Saraca Linn.

Saraca asoka (Roxb.) De Wilde, Blumea 15: 393, 1968.

Jonesia asoca Roxb. in As. Res. 4: 355, 1795; Graham, Cat. Bombay Pl. 62, 1839. Dalz. & Gibs. 82; Wight, Icon. t. 206, 1839. *Saraca indica* (non Linn. Mant. 1: 98; 1767) auct., Bedd., Fl. Sylv. t. 57, 1870; FBI 2: 271; Nairne, 98; Cooke, 1: 429 (456); Santapau, 92.

Cultivated at Dr. Hakim's Bhilar estate. This is a very beautiful tree.

FLOWERS: March-June.
FRUITS: June-September.

Wagatea Dalz.

1. **Wagatea spicata** Dalz. in Kew Journ. Bot. 3: 89, 1851; Dalz. & Gibs. 80; FBI 2: 261; Birdwood, 408; Woodrow, 11: 427; Nairne, 96; Cooke, 1: 416 (443); Santapau, 90.

C. digyna Graham cat. 60, 1839 (non Rottl. 1803).

Armed woody climber, common on the Fitzgerald Ghat, between 6th and 7th milestones. Very attractive when in bloom with yellowish red flowers grouped in conelike spikes.

FLOWERS: December-January.
LOCAL NAME: Wagati.

Bauhinia Linn.

1. Leaves less than 3 cm. .... *B. galpinii*
1. Leaves more than 3 cm. .... *B. racemosa*

1. **Bauhinia galpinii** N. E. Brown, in Garden Chron. 9: 748; 1891.

A shrub with small leaves. Cultivated at Bhilar.

FLOWERS & FRUITS: March-June.

2. **Bauhinia racemosa** Lamk. Encycl. 1: 390, 1783; Graham, 64; Dalz. & Gibs. 82; FBI 2: 276; Birdwood, 408; Woodrow, 11: 428; Nairne, 99; Cooke, 1: 431 (459); Santapau, 92.

Not common. Few trees are found near Bhilar, between Mahabaleshwar and Panchgani.

FLOWERS: March-June.
FRUITS: November.
LOCAL NAME: Apta.
LOCAL USE: Leaves used locally as bidi wrappers.

MIMOSACEAE

1. Stamens definite 5-10................ *Mimosa*
1. Stamens indefinite 2
   2. Stamens free .... *Acacia*
   2. Stamens monadelphous .... *Albizzia*

Mimosa Linn.

1. **Mimosa hamata** Willd. Sp. Pl. 4: 1033, 1805; Nairne, 102; Cooke, 1: 442 (471); Santapau, 83.

This species has been included here on the basis of single collection of H. M. Chibber, on 17th March, 1908. It has not been located by anybody else.

Acacia Willd.

1. Erect trees or shrubs............ *A. latronum*
1. Climbing shrubs 2
   2. Leaflets 12-30 pairs 3
      3. Pods thick, wrinkled when dry........ .... *A. sinuata*
      3. Pods thin, not wrinkled when dry...... .... *A. torta*
   2. Leaflets 40-50 pairs.............*A. pennata*

1. **Acacia sinuata** (Lour.) Merr. in Trans. Amer. Phil. Soc. N.S. 24: 186, 1935.

Mimosa sinuata Lour., El. Cochinch. 653, 1790.

M. concinna Willd., Sp. Pl. 4: 1039, 1805.

A. concinnum (Willd.) DC., Prodr. 2: 464, 1825; Graham, 59; Dalz. & Gibson, 87; FBI 2: 296; Birdwood, 408; Nairne, 104; Cooke, T. 1: 450; Santapau, 96.

Acland in his manuscripts has noted this species from Chinaman's falls. This straggling climber is commonly met with on the lower ghats.

FLOWERS: March-July.

FRUITS: Most of the year.

LOCAL NAME: Chikakhai.

2. **Acacia latronum** Willd. Sp. Pl. 4: 1077, 1805; Graham, 58: Dalz. & Gibs. 87; FBI 2: 296; Woodrow, 11: 492; Nairne, 103; Cooke, 1: 449 (478).

Included here on the basis of specimen collected by H. M. Chibber (deposited at B.S.I.).

3. **Acacia pennata** Willd. Sp. Pl. 4: 1090, 1805; Nairne, 104; Cooke, 1: 451 (480); Talbot, 1: 494.

Rather rare species, occurs along the Fitzgerald Ghat.

FLOWERS & FRUITS: June-August.

4. **Acacia torta** (Roxb.) Craib. in Kew Bull. 410, 1915; Santapau, 97.

Mimosa torta Roxb. Fl. Ind. 2: 566, 1832.

A. caesia Wight & Arn. Prodr. 278, 1834 (non Willd. 1805).

This is the commonest Acacia at Mahabaleshwar and has been identified as *A. intsia,* in some of the previous works.

Lingmala, Bhilar, Chinaman's falls, Fitzgerald Ghat.

FLOWERS: April-November.

FRUITS: April-January.

LOCAL NAME: Chilari.

Albizzia Durazz

1. Pinnae 6-20 pairs, leaflets less than 1 cm, in breadth .... *A. chinensis*
1. Pinnae 2-6 pairs, leaflets exceeding 1 cm. in breadth .... *A. lucida*

1. **Albizzia chinensis** (Osb.) Merrill, in Am. J. Bot. 3: 575, 1916; Santapau, 98.

Mimosa chinensis Osbeck, Dag. Ostind. Resa 233, 1757.

M. stipulata Roxb. Hort. Beng. 40, 1814 (nom. nud.).

Acacia stipulata (Roxb.) DC. Prodr. 2: 469, 1825.

Albizzia stipulata Boivin, in Encycl. 19 Siecl. 2: 33, 1838; Dalz. & Gibs. 88; FBI 2: 300; Nairne, 105; Cooke, 1: 453 (483), Talbot 1: 499.

Small tree found frequently on Fitzgerald Ghat.

FLOWERS: April-June.

2. **Albizzia lucida** (Roxb.) Benth. in Hook. Lond. J. Bot. 3: 86, 1844; FBI 2: 299; Cooke, 1: 455 (484); Santapau, 98.

Mimosa lucida Roxb. Fl. Ind. 2: 544, 1832.

Introduced tree frequently seen at Lingmala. Dr. J. C. Lisboa (p. 212) has reported *A. odoratissima,* from Mahabaleshwar. In our opinion imperfect specimen of this species has led to this misidentification, as that species does not occur in this locality.

FLOWERS & FRUITS: April.

Spec. seen: Santapau—12509.

ROSACEAE

1. Ovary superior; ripe carpels not enclosed in the calyx tube 2
 2. Carpels solitary .... *Prunus*
 2. Carpels many 3
  3. Ovules 2, pendulous; calyx ebracteate; prickly shrubs .... *Rubus*
  3. Ovules solitary, erect; calyx bracteolate; herbaceous plants .... *Fragaria*
1. Ovary inferior; the ripe carpels enclosed in the calyx tube 4
 4. Prickly shrubs with compound leaves and adnate stipules .... *Rosa*
 4. Unarmed trees or shrubs with simple leaves and lateral stipules .... *Pyrus*

Prunus Linn.

1. Calyx 5-lobed 2
 2. Flowers peduncled; pericarp 2- valved...... .... *P. amygdalus*
 2. Flowers sessile; pericarp indehiscent........ .... *P. persica*
1. Calyx 8-12 lobed ....*P. ceylanica*

1. **Prunus amygdalus** Stock. Bot. Nat. Med. 3: 101, 1812.

Rarely cultivated in gardens, but does not fruit well.

FLOWERS: October-November.

LOCAL NAME: Badam.

2. **Prunus ceylanica** Miq. Fl. Ind. Bot. 1: 366, 1856.

Pygeum ceylanicum Bedd. Fl. Sylv. t. 59, 1870.

P. wighteanum Blume, in Flora, 41: 256, 1858.

Pygeum gardneri Hook. f. in FBI. 2: 321, 1878; Nairne, 106; Cooke, 647; Birdwood, 13; Cooke 1: 458 (488); Talbot, 1: 505, tt. 286-7; Puri & Mahajan, 122; Santapau, 399 & 306.

Pygeum acuminatum Graham, Cat. Bombay Pl. 1839 (non Colabr. 1819); Wight, Icon. t. 993.

Pygeum zeylanicum Dalz. & Gibs. Bombay Pl. 89, 1861; (excl. syn.; non Gaertn. 1788); Lee, 19.

A common middle size tree ± 15 m tall. According to the local people the bark of this tree causes itching and produces blisters on human body if used as fire wood.

FLOWERS: November.

FRUITS: January-February.

LOCAL NAMES: Daka, Kaula, Kogal.

3. **Prunus persica** (Linn.) Stockes, Bot. Mat. Med. 3: 100, 1812; Benth. & Hook., Gen. Plant. 1: 609, 1865; Birdwood, 13.

Amygdalus persica Linn. Sp. Pl. 472, 1753.

This species is cultivated at Mahabaleshwar. The fruit is used for preparation of Jam and Stew.

FLOWERS: October-November.

LOCAL NAME: Alu.

Rubus Linn.

1. Leaves simple.................*R. moluccanus*
1. Leaves compound .... *R. niveus*

1. **Rubus moluccanus** Linn. Sp. Pl. 1197, 1753; Nairne, 106; Cooke, 1: 459 (488); Puri & Mahajan, 122.

R. rugosus Sm. in Res. Cyclop, 30: no. 34, 1819; Graham, 64: Wight, Icon. t. 225; Cooke, 649; Birdwood, 13.

This species is confined to the ravines below old temple.

FLOWERS: May.

LOCAL NAME: Indian Black berry. (Birdwood).

2. **Rubus nivens** Thunb. Dissert. 9. f. 3, 1781 (non Wall. ex G. Don, 1831).

R. lasiocarpus Sm., in Rees. Cyclop. 30: no. 6, 1819; Graham, 64; Wight, Icon. t. 232; Lisboa, 213; Nairne, 106; Cooke, 649 & 1: 460 (489); Birdwood, 13; Puri & Mahajan, 122.

This species is now extensively cultivated in gardens especially near Yenna Lake. Fruits used for preparation of Jam.

FLOWERS: November.

COMMON NAME: Mahabaleshwar Raspberry.

Fragaria Linn.

1. **Fragaria vesca** Linn. sp. Pl. 494, 1753. Birdwood, 13; Cooke, 462 (492); Puri & Mahajan, 123.

F. elatior Graham, Cat. Bombay Pl. 64, 1839. (non W. & A. 1834), Nairne, 106.

Very extensively cultivated especially along the banks of Yenna River. Fruits are used for Jam.

FLOWERS: March-June.

COMMON NAME: Strawberry.

Rosa Linn.

1. **Rosa multiflora** Thunb. Fl. Jap. 214, 1784; Bot. Mag. t. 1059; Birdwood, 13.

An introduced species of wild rose. Quite common below Yenna lake and on sides of Yenna river.

FLOWERS: Throughout the year.

LOCAL NAME: Junglee gulab.

Pyrus Linn.

1. Flowers fascicled or subumbellate .... *P. malus*
1. Flowers in few flowered corymbs .... *P. communis*

1. **Pyrus communis** Linn. Sp. Pl. 479, 1753; Cooke, 1: 462 (492); Puri & Mahajan, 123.

This species occurs in cultivation below forest officer's bunglow, near Lingmala, but the fruit size and quality is not good and is of little value.

FLOWERS: March-April.

COMMON NAME: Pear.

2. **Pyrus malus** Linn. Sp. Pl. 479, 1753.

A rarely cultivated tree. Does not bear fruits.

FLOWERS: March-April.

COMMON NAME: Apple.

CRASSULACEAE

Kalanchoe Adans.

1. Corolla reddish purple; calyx glabrous, with triangular lobes .... *K. pinnata*
1. Corolla white; calyx glandular hairy, with lanceolate lobes .... *K. olivacea*

1. **Kalanchoe pinnata** (Lamk.) Pers. Syn. 446, 1805; Santapau, 88.

Cotyledon pinnatum Lamk. Encycl. 2: 141, 1786.

Bryophyllum pinnatum (Lamk.) Oken. Allg. Naturgesh. 3: 1966, 1841; Santapau, 293.

B. calycinum Salisb. Par. London, t. 3, 1805 & Bot. Mag. t. 1409, 1811; FBI 2: 413; Graham, 82; Cooke, 1: 465 (494).

Quite frequently seen along the edges of forest and on sides of streams.

FLOWERS: January.

LOCAL NAMES: Ahiravana-Mahiravana, Zakhamhayat, Panphuti, Ghai-pat, phanphul.

2. **Kalanchoe olivacea** Dalz. in Dalz. & Gibs. Bombay Fl. 313, 1861.

A rare species on way to Panchgani. Flowers white with a pink tinge on rocky ledges.

FLOWERS: October-December.

(To be continued)

NEW DESCRIPTIONS

A NEW SPECIES OF *HOMALIUM* JACQ. (FLACOURTIACEAE) FROM BURMA[1]

M. P. Nayar and G. S. Giri[2]

(*With a text-figure*)

A new species of *Homalium* from Burma is described and illustrated and a key is presented for the Sect. *Pierrae* of the genus *Homalium*.

Homalium burmanicum sp. nov.

Affinis *H. grandiflorae,* sed foliis lanceolatis, apice foliorum gradatim acuminatis, floribus longe pedicellatis, pedicellis 10-13 (15) mm longis, filamentis staminorum glabris differt.

Arbor. Ramuli teretes, glabri. Folia alterna, 8-13 cm longa, 3-4 cm lata, lanceolata, ad basin subcuneata vel subrotundata apice gradatim acuminata, margine integera, 20-22 nervia, venulis transversis conspicuis, reticulatis, supra et subtusque glabra, nitida, coriacea; petiolus 10-12 mm longus, glaber. Inflorescentia, axillares vel terminales, laxe racemosa 14-15 cm longa, dense brunneo-tomentosa. Flores 6-meri, majusculi, albi (teste collectore); bracteae parvae, deciduae; pedicellus 10-13-(15) mm longus, supra ad medium articulatus, brunneo-tomentosus. Calycis tubus obconicus, 6-lobatus, lobis 8-10 mm longis, 4-4.5 mm latis, ovatolanceolatus, apice acutis, graciliter venatis, dense tomentosis. Petala 6, 8-9 mm longa, 3-3.5 mm lata, ovatolanceolata, apice acuta, puberula. Stamina 60-72, 10-12 singlo petalo opposita, filamentis glabris 6-7 mm longis, antheris 0.5 mm longis. Discus glanduliferus, glandulis 6, bilobis tomentosis, intra sepalum ornatis. Ovarium 5 mm longum, dense tomentosum, 6-8 carinatum, styli 6-8, liberi; stigmate inconspicuo.

Typus: Burma, Tenasserim, Forest Dept. No. 784 (Holotypus CAL).

Trees. Branches terete, glabrous. Leaves alternate, $8\text{-}13 \times 3\text{-}4$ cm, lanceolate, base subrotundate or sub-cuneate, apex gradually acuminate, margin entire, 20-22 nerved, transverse veins conspicuous, reticulate, glabrous, shining; petiole 10-12 mm long, glabrous; Inflorescence, axillary or terminal, laxely racemose, 14-15 cm long, densely brownish tomentose. Flowers 6-merous, white (ex collector); pedicel 10-13-(15) mm long, brownish tomentose, jointed above the middle; bracts small, deciduous. Calyx tube obconical, 6-lobed, sepals 8-10 mm $\times$ 4-4.5 mm, ovate-lanceolate, apex acute, finely veined, densely tomentose. Petal 6, 8-9 mm $\times$ 3-3.5 mm, ovate-lanceolate, apex acute, puberulous. Stamens 60-72, 10-12 opposite to each petal, filaments glabrous, 6-7 mm long, anther 0.5 mm long. Disc glands 6, bilobed tomentose, opposite to the sepals. Ovary 5 mm long, densely tomentose, 6-8 ridged; styles 6-8, free; stigma inconspicuous.

Distribution: BURMA: Tenasserim, Forest Dept. No. 784 (Type, CAL); Tavoy, *Seimgyi* 955 (CAL).

[1] Accepted December 1979.

[2] Central National Herbarium, Botanic Garden P.O., Howrah-711 103.

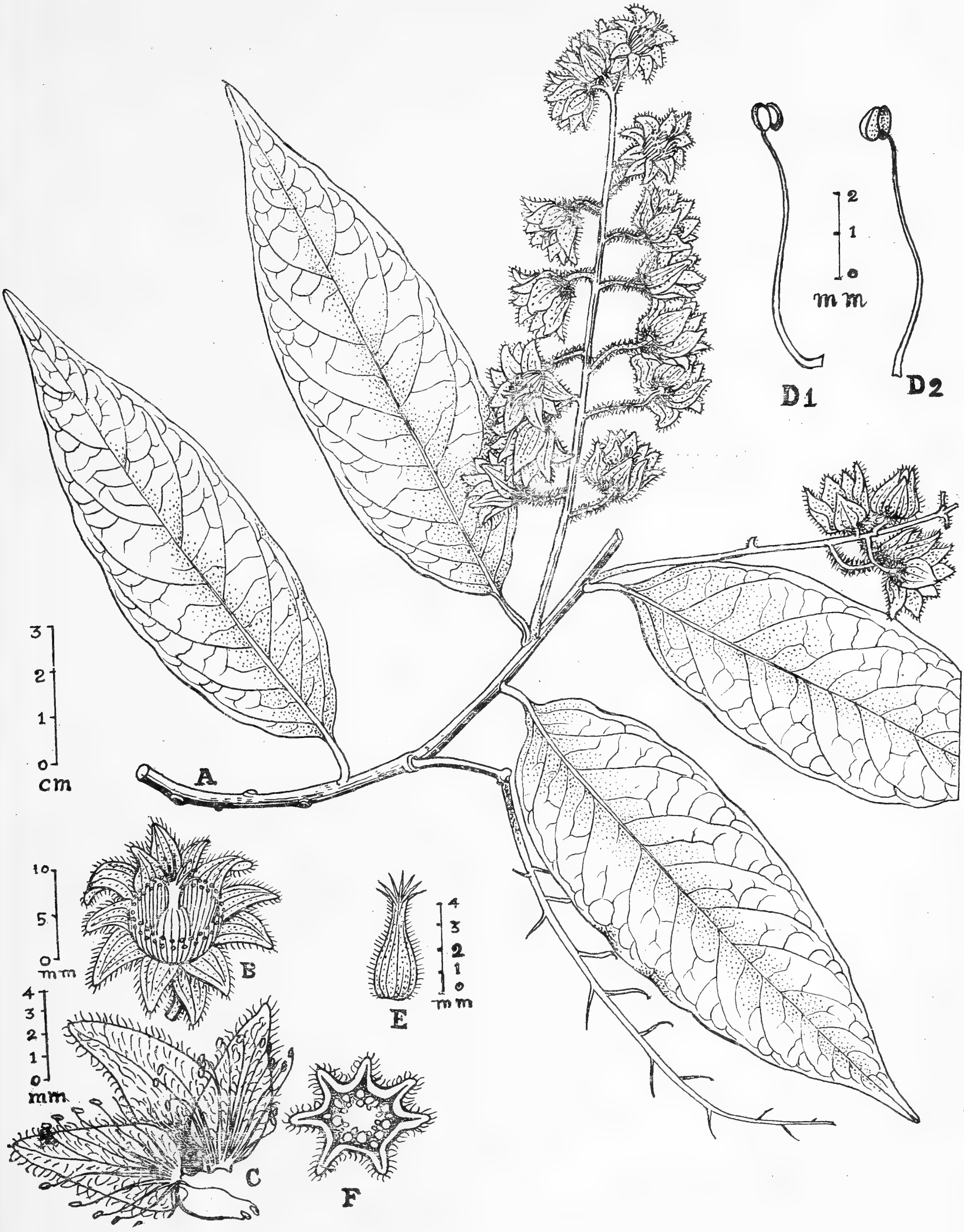


Fig. 1: *Homalium burmanicum* sp. nov.
A. Natural size of the plant; B. Flower; C. 2 petals and a sepal showing attachment of stamens and gland; D_1 and D_2. Stamens; E. Gynoecium; F. Cross section of Ovary.

This species is closely allied to *H. grandiflorum* Benth., but differs in having lanceolate leaves with acuminate apex and subcuneate base, long pedicellate flowers, pedicel 10-13-(15) mm long and glabrous staminal filaments. In *H. grandiflorum,* the leaves are ovate-elliptic to elliptic-oblong, abruptly acute or obtuse apex, rounded base, shortly pedicellate flowers, pedicels 2-3 mm long and pilose staminal filaments.

The species belongs to the Sect. *Pierrae* and can be distinguished from other species of the Sect. *Pierrae* of genus *Homalium* by the following key:

1. Bracts fan shaped broadly rounded with mucronate apex, persistent........*H. dictyoneuron*
1. Bracts ovate, apex obtuse, deciduous:
   2. Flowers subsessile to sessile during anthesis, in fruit pedicel 1 mm long. Inflorescence condensed .... *H. gitingense*
   2. Flowers pedicellate. Inflorescence lax:
      3. Pedicel 2-3 mm during anthesis, in fruit pedicel 2-8 mm long.
         4. Leaves ± ovate elliptic to elliptic-oblong, abruptly acute or obtuse at the apex .... *H. grandiflorum*
         4. Leaves lanceolate or oblong-ovate gradually narrowed at the apex........ .... *H. minhassae*
      3. Pedicel 10-13 mm long during anthesis, in fruit pedicel 12-16 mm long............ .... *H. burmanicum*

ACKNOWLEDGEMENT

We wish to thank Director, Botanical Survey of India for all facilities.

A NEW *HOMALIUM* JACQ. (FLACOURTIACEAE) FROM SOUTH INDIA[1]

A. N. HENRY AND M. S. SWAMINATHAN[2]

(*With three text-figures*)

Homalium jainii sp. nov.

Pertinet ad *Homalium* sect. *Pierrea* (Hance) Warb. *H. grandiflorum* Benth. affinis sed foliis anguste oblongis vel elliptico—lanceatis, gradatim verrus apicem acuminatis differt. Etiam *H. minahassae* Koord. affinis at foliis multo minoribus, anguste oblongis vel elliptico—lanceatis differt.

Holotypus (*Henry* 68929, CAL) et isotypi (*Henry* 68929, MH—acc. no. 107307—107316) in silvis semper virentibus in ditione Kanniyakumari in statu Tamilnaduensi, India die 5-10-1980 ad altitudinem *c.* 1000 m lecti sunt.

[1] Accepted May 1981.

[2] Botanical Survey of India, Coimbatore.

Falls within *Homalium* sect. *Pierrea* (Hance) Warb., and allied to *Homalium grandiflorum* Benth. but differs in leaves being narrowly oblong to elliptic—lanceate and gradually acuminate at apex; also allied to *Homalium minahassae* Koord. but differs in having much smaller and narrowly oblong to elliptic-lanceate leaves.

Trees up to 30 m tall; branches glabrous. Leaves 4-11 × 1.5-4.5 cm, alternate, narrowly oblong to elliptic—lanceate, somewhat coriaceous, glabrous, shining, subentire, gradually acuminate at apex, narrowed into the petiole or obtuse at base; nerves 7-9 pairs, veins distinctly reticulate on both sides; petioles 6-12 mm long, grooved. Flowers 10-12 mm across, greenish yellow, 6-9-merous, scattered in shortly

Figs. 1-3. *Homalium jainii* sp. nov.
1. Flowering twig. 2. Flower. 3. Part of Flower.

grey-tomentose simple racemes up to 20 cm long; pedicels up to 10 mm long, articulated; bracts *c.* 4×2 mm, ovate-oblong, subacute, grey-tomentose, caducous. Calyx-tube *c.* 4 mm long, obconic, grey-tomentose; sepals 5-8×1.5-3 mm, oblong to spathulate, obtuse at apex, nerved, tomentose, accrescent. Petals 4-7 × 1.5-3 mm, triangular-oblong, similar to the sepals but remaining shorter, tomentose, connivent after anthesis. Disc-glands obovate, slightly lobed, opposite each sepal, velvety. Stamens in fascicles of 6-7 before each petal: 3 between the disc-glands and the rest inserted on the base of petals above the level of disc-glands; filaments 4-5 mm long, sparsely pilose. Ovary tomentose; styles 6-9. (Figs. 1-3).

Holotype (*Henry* 68929, CAL) and isotypes

(*Henry* 68929, MH—acc. no. 107307-107316) were collected in the dense evergreen forests on the way to Muthukuzhivayal from Balamore in Kanniyakumari District, Tamil Nadu, India at an altitude of about 1000 m on 5-10-1980.

Rare in dense evergreen forest, up to 1000 m; also noticed along streams and river-beds in rocky places.

Our observations reveal that this tree flowers very rarely. It is of interest to note that its allied species—*Homalium grandiflorum* Benth. distributed in Indo-China, Thailand, Lower Burma, Malay Peninsula and Borneo is also reported to flower once in 25 years only.

Homalium sect. *Pierrea* (Hance) Warb. was so far represented by five species distributed mostly in Philippines, Thailand, Indo-China, Lower Burma, Malay Peninsula, Java, Borneo and Celebes. Hence the discovery of *H. jainii* Henry & Swamin. in the Western Ghats of Peninsular India extends the distribution of sect. *Pierrea* to the mainland of India which is of phytogeographical interest.

We are pleased to dedicate this species to Dr. S. K. Jain, Director, Botanical Survey of India, Howrah for his significant contributions to Indian Botany.

ACKNOWLEDGEMENTS

We are thankful to Dr. H. Sleumer, Rijksherbarium, Leiden for his valuable opinion on the specimen and for kindly sending his unpublished, abbreviated key to species of *Homalium* sect. *Pierrea;* Rev. C. J. Saldanha for rendering the latin translation; Mr. M. Chandrabose, Systematic Botanist, for the drawing and helpful comments; Dr. J. L. Ellis, Systematic Botanist for kindly verifying the sheets of *Homalium* spp. in CAL; and Dr. N. C. Nair, Joint Director for facilities and encouragement.

DRIMIA RAZII SP. NOV. (LILIACEAE) FROM MAHARASHTRA, INDIA[1]

M. Y. ANSARI[2]

(*With eight text-figures*)

Following Jessop [in Journ. S. Afr. Bot. 43(4): 265-319. 1977], Ansari *et* Raghavan [in J. Bombay nat. Hist. Soc. 77(1): 172. 1980] have suggested new combinations for the three Indian species of the genus *Urginea* Steinh., under the genus *Drimia* Jacq. ex Willd. A new species is being described here:

Drimia razii sp. nov.

Drimia polyanthae (Blatt. et McC.) Ansari et Raghavan affinis in racemo pedicello et capsula sed differt foliis perangustis, carnosis, erectisque, scapo perbrevi, lobis perianthii longioribus, obscure brunneolis, stylo gracili, capsula oligosperma. Differt a *D. congesta* (Wt.) Ans. et Ragh. in foliis, scapis bracteisque, lobis perianthii longioribus, filamentis quam antheris longioribus.

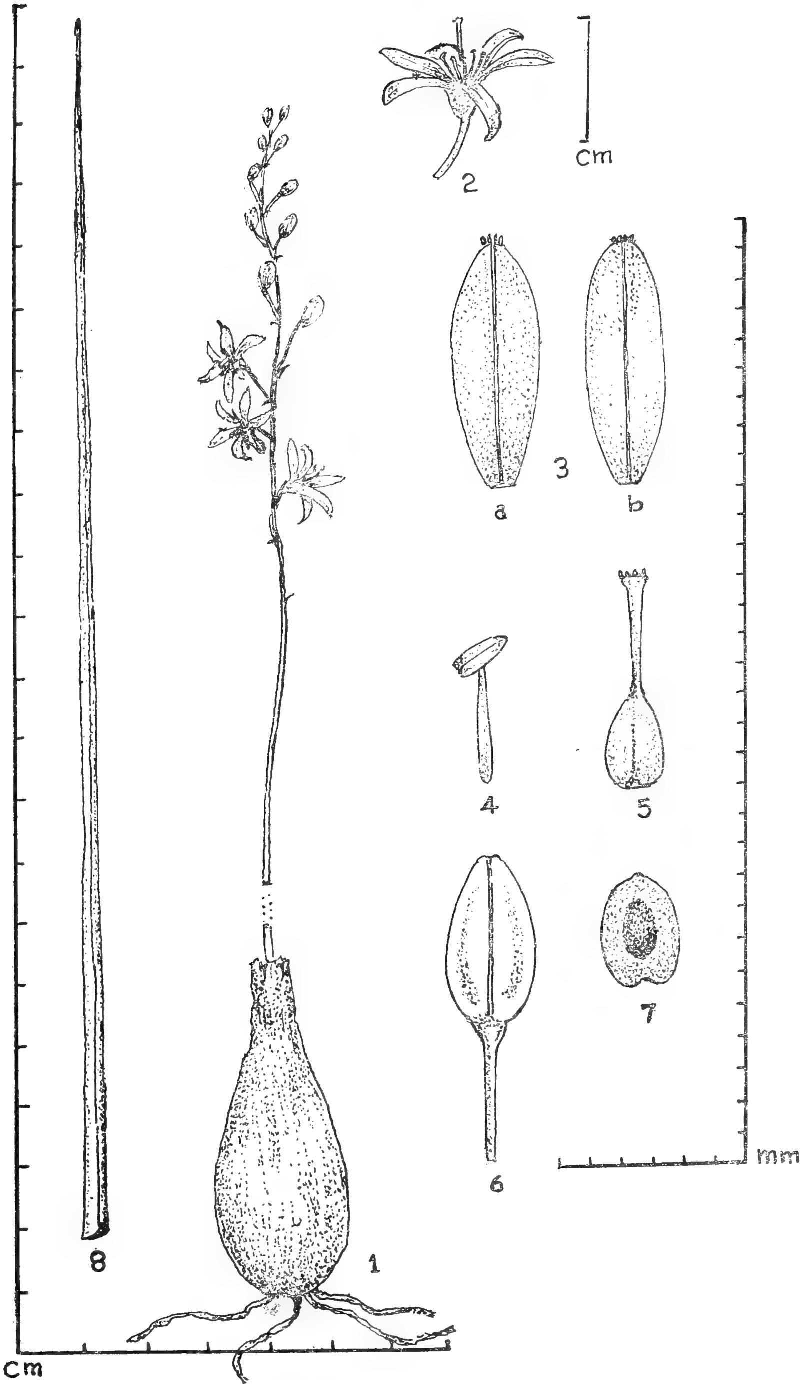
Holotypus (*Ansari* 104878A) et isotypi (*Ansari* 104878 B-F) lecti ad Dive ghat in dist. Pune, ditione Maharashtra die 15-iii-1970; holotypus positus in *CAL;* isotypi 104878 B & C in *BSI;* D in *CAL;* E in *K;* F in *BLAT*.

Drimia razii sp. nov.

Similar to *Drimia polyantha* (Blatt. *et* McC.) Ansari *et* Raghavan in its raceme, pedicels

[1] Accepted April 1981.

[2] Botanical Survey of India, Western Circle, Pune-411 001.



Figs. 1-8: *Drimia razii* sp. nov.

1. Plant with a bulb, scape and inflorescence; 2. Flower; 3. Outer and inner (3a, 3b) perianth lobes; 4. Stamen; 5. Ovary with style and stigma; 6. Capsule with pedicel; 7. Seed; 8. An oblique view of a leaf.

and capsules, but differs in its leaves being very narrow, fleshy, erect; scape very short; perianth lobes longer, dull-brownish; style slender; capsule few seeded. Also differs from *D. congesta* (Wt.) Ans. *et* Ragh. in its leaves, scapes and bracts; perianth lobes longer; filaments longer than anthers.

The holotype (*Ansari* 104878A) and isotypes (*Ansari* 104878 B-F) were collected at Dive ghat (near Pune) in Pune Dist., Maharashtra on 15-iii-1970. The holotype is deposited at *CAL;* isotypes 104878 B & C at *BSI;* D in *CAL;* E in *K;* F in *BLAT*.

Bulbous herbs, scapigerous, hysteranthus; bulbs 5-7 × 3.5-4.0 cm, ovate or subglobose. Leaves (after flowering) 20-25 × 0.2-0.3 cm, erect or ascending, narrowly linear, fleshy, grooved above, broadest at base, acute at apex, glabrous. Scapes up to 15 cm long, slender, terete, shorter than the leaves. Inflorescence 10-15 cm long, dense raceme, 10-25-flowered. Flowers ascending, with perianth lobes reflexed when fully opened, dull brownish; bracts 1.5 × 1.0 mm, spurred, evanescent (falling off after flowers open); pedicels 5-8 mm long, glabrous. Perianth 6, in two whorls of 3 each and each lobe 8-9 × 2.5-3.0 mm, elliptic-oblong or oblong, 2-nerved, the outer perianth broader with the tip acute than the inner with the tip broadly obtuse, both shortly bearded at apex. Stamens 5.5-7.0 mm long, free, opposite each perianth lobes; filaments 4-5 mm long, broadening in the middle or towards base, tapering above, glabrous; anthers 1.5-2.0 mm long, ovate-oblong, longitudinally dehiscing. Pistil syncarpous, carpels 3, ovary 2.5-3.0 × 2 mm, ovate, sessile, superior, style 3-4 mm long, elongated, narrowed at base, broadening upward, stigma trilobed, obconic, tips minutely bearded. Capsule 8-10 × 5-6 mm, ovate or elliptic-ovate, trilocular, 5-6 seeded; seeds 6-7 × 4 mm, broadly ovate or subglobose, winged, black.

Fls: March-April. *Frts.*: April.

This species grows on exposed rocky areas and gravelly slopes on top of Dive ghat, situated between Pune and Saswad. The leaves appear during monsoon after the flowering is over in dry season. It is so far endemic to Maharashtra.

Etymology:

This species is named in honour of Prof. Dr. B. A. Razi, Ex-Head, Department of Botany, University of Mysore, Karnataka who has been closely associated with the study of the Flora of Western & Southern India, particularly the Flora of Pune district.

ACKNOWLEDGEMENTS

I am grateful to the Director, Botanical Survey of India, Howrah, and Deputy Director, Western Circle, Botanical Survey of India. Pune for their keen interest in the present studies. I am also indebted to Dr. D. B. Deb, Deputy Director, Indian Botanic Garden, Howrah for kindly confirming the species as new and to Dr. N. C. Majumdar, Systematic Botanist, Botanical Survey of India, Howrah for kindly providing the Latin diagnosis.

A NEW SPECIES OF *DENDROBIUM* SW. (ORCHIDACEAE) FROM SOUTH INDIA[1]

M. CHANDRABOSE, V. CHANDRASEKARAN AND N. C. NAIR[2]

(*With ten text-figures*)

Dendrobium anamalayanum sp. nov.

Affinis ad *D. nanum* Hook. f. tamen differt labello non unguiculato, late obovato, lobo mediano rhomboideo-ovato, lobis lateralibus distinctis et disco 3- dendtato apice.

Holotypus *Chandrabose* 57259 (CAL) et isotypi *Chandrabose* 57259 (MH. Acc. No. 101248, 101249, 107842, 107843) lecti apud Kavarkal, Anamalai, Dist. Coimbatore in statu Tamil Nadu die 22-7-1978; et paratypi *Chandrabose* 69048 (MH. Acc. No. 107844, 107845, 107846) lecti apud Konalar, Anamalai, Dist. Coimbatore in statu Tamil Nadu die 16-11-1980.

Dendrobium anamalayanum sp. nov.

Allied to *Dendrobium nanum* Hook. f. but differs in having the lip not clawed, broadly obovate, mid-lobe rhomboid-ovate, side-lobes distinct and disc 3- toothed at apex.

Herbs; pseudobulbs 2-3 $\times$ 1.5-2 cm, greenish pink, ovoid, covered with membranous sheaths. Leaves 2-7.2 $\times$ 0.6-2 cm, elliptic-oblong or elliptic-lanceolate, glabrous, acute, sheathing at base. Scape up to 12 cm long, 5- many flowered. Flowers $\pm$ 16 mm across, white with pink tinge; bracts 6-9 $\times$ 1.5 mm, lanceolate, 5-nerved, glabrous; pedicels with ovary up to 1.1 cm long, faintly grooved above. Dorsal sepal $\pm$ 1.1 $\times$ 0.4 cm, obliquely oblong or oblong-obovate, obtuse at apex; lateral sepals $\pm$ 1.1 $\times$ 0.4 cm, falcately oblong-lanceolate, subacute, united to form a mentum. Lateral petals $\pm$ 1.2 $\times$ 0.4 cm, oblanceolate, obtuse at apex. Lip $\pm$ 9 $\times$ 9 mm, broadly obovate in outline, 3-lobed with broad sinuses in between the lobes; side-lobes distinct, tooth-like; mid-lobe $\pm$ 6 mm broad, rhomboid-ovate, distantly serrulate; disc fleshy, broadened and 3-toothed at apex. Column short, foot long; anther $\pm$ 1 $\times$ 1.5 mm, 2-loculed; pollinia four, $\pm$ 1 mm long, oblong, compressed. Capsules $\pm$ 2 $\times$ 1.1 cm, ellipsoid, obtusely trigonous, obscurely ribbed. (Figs. 1-10).

The holotype *Chandrabose* 57259 (CAL) and isotypes *Chandrabose* 57259 (MH. Acc. No. 101248, 101249, 107842, 107843) were collected in Kavarakal, Anamalai, Coimbatore District, Tamil Nadu on 22-7-1978; and paratypes *Chandrabose* 69048 (MH. Acc. No. 107844, 107845, 107846) were collected in Konalar, Anamalai, Coimbatore District, Tamil Nadu on 16-11-1980.

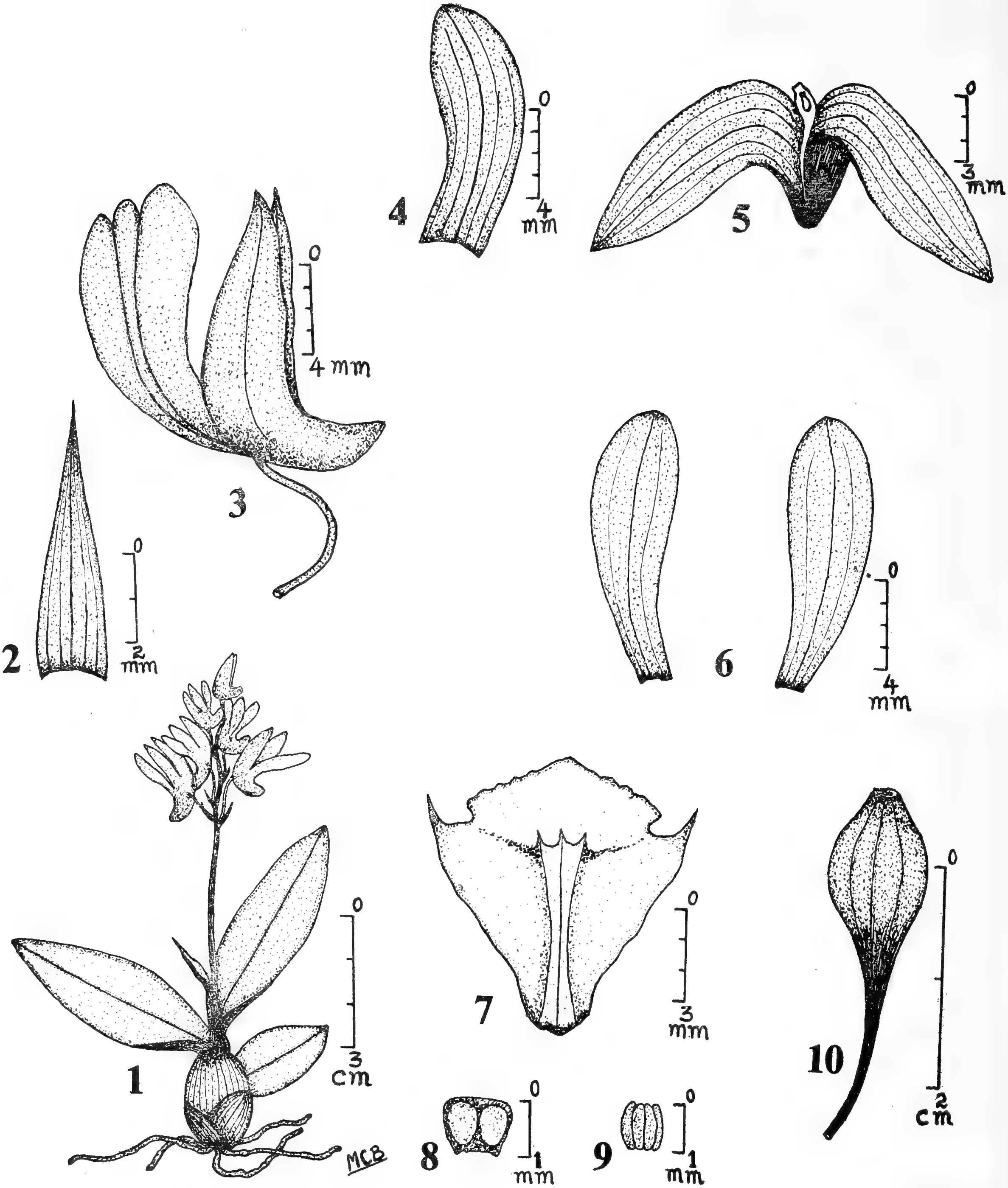
A common epiphyte on trees in the evergreen forests and sholas at an altitude ranging from 1450 to 1975 m. The gregarious flowering of the plants with their white flowers is an eye-catching and attractive sight throughout the forest.

ACKNOWLEDGEMENTS

Our sincere thanks are due to Dr. G. Seidenfaden, Botanical Museum and Herbarium, Denmark for helpful suggestion and to Rev. Fr. K. M. Matthew, S.J., Rapinat Herbarium, St. Joseph's College, Tiruchirapalli for rendering latin translation.

[1] Accepted May 1981.

[2] Botanical Survey of India, Coimbatore-3.



Figs. 1-10: *Dendrobium anamalayanum* sp. nov.
1. A plant; 2. Bract; 3. Flower; 4. Dorsal sepal; 5. Lateral sepals with column; 6. Lateral petals; 7. Lip; 8. Anther; 9. Pollinia; 10. Capsule.
(For description see p. 575).

DIMERIA COPEANA, A NEW GRASS FROM KERALA, INDIA[1]

P. V. SREEKUMAR, V. J. NAIR AND N. C. NAIR[2]

(*With nine text-figures*)

Dimeria copeana sp. nov.

Affinis *Dimeria trimenii* Hook. f.; differt in foliis latioribus, ligulis apicibus fimbriatis, racemis longioribus rachidibus perangustis trigonis scabrimarginatis, lemmatibus flosculorum inferorum margine ciliis et aristis longioribus.

Holotypus: Alleppey Dist., Thrikkunnapuzha, 13-3-1980, *P. V. Sreekumar* 66736 (CAL), isotypi in K et MH.

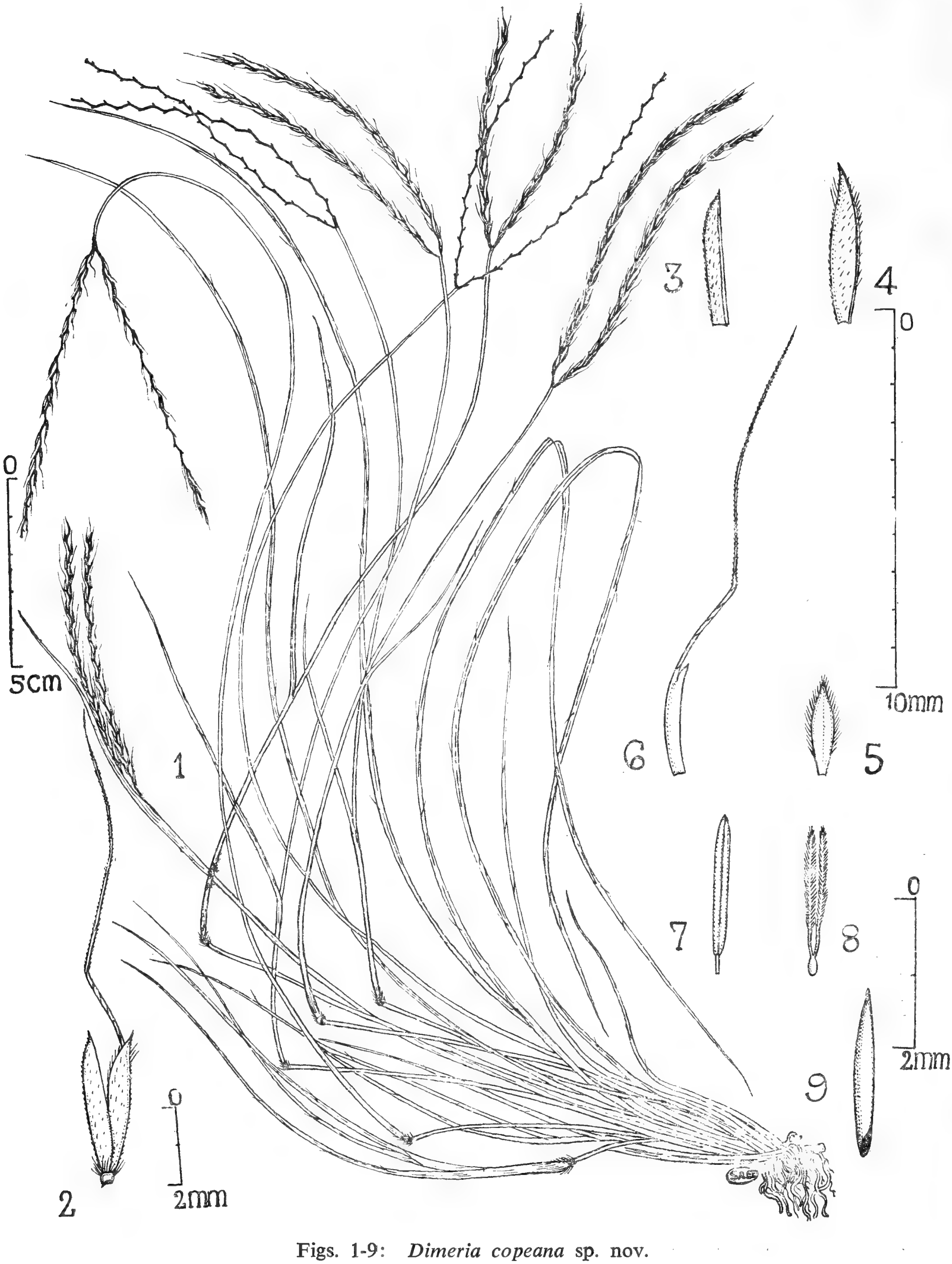
TABLE

Dimeria trimenii Hook. f.	*Dimeria copeana* sp. nov.
1. Leaf blades up to 15 cm long, ± 0.5 mm, boad, villous on both surfaces	Blades 20-40 cm long, 1-2 mm broad, villous only on upper surface
2. Sheaths longer than the internodes	Sheaths shorter than the internodes
3. Ligules rounded at apex	Ligules fimbriate at apex
4. Racemes up to 6.5 cm long	Racemes 8-10 cm long
5. Rhachis of the racemes flat, 1-1.5 mm wide	Rhachis trigonous, at the most 0.5 mm wide
6. Margins of rhachis thickly pilose	Margins scabrid
7. Spikelets oblong-acute, densely hairy	Spikelets oblanceolate, sparsely hairy
8. Lower glumes densely hairy	Lower glumes glabrous or scabrid
9. Upper glumes densely hairy, margins ciliate	Upper glumes sparsely hairy, margins not ciliate
10. Margins of the lemmas of the lower florets entire	Margins of the lemmas of the lower florets long ciliate
11. Awns up to 8 mm long	Awns 10-12 mm long

Tufted, stoloniferous, perennial. Culms 20-45 cm, capillary. Nodes bearded. Leaves 20-40 × 0.1-0.2 cm, linear, acuminate, sparsely villous on upper surface. Sheaths shorter than the internodes, glabrous or very sparsely villous at base. Ligule a small membrane, fimbriate at apex. Racemes 2, 8-10 cm long, slender. Rhachis 0.25-0.5 mm wide, trigonous, more or less zig-zag, obscurely winged, scabrid on the margins. Spikelets 3.5-4.5 mm long, 2 flowered, oblanceolate, firmly compressed, adpressed to the rachis, sparsely hairy. Callus 0.25-0.5 mm long, hairy. Lower glumes 3-4 mm long, oblong, acute, coriaceous, scabrid. Upper glumes 4-4.5 mm long, elliptic, acute, straight on the back and slightly curved towards the tip, scabrid, margins hyaline, villous. Lower floret empty, lemma *c.* 2.5 × 0.6 mm, oblanceolate, acute, one nerved, hyaline, ciliate on the margins above, epaleate. Upper floret bisexual, lemma 3-3.5 mm long, epaleate, oblong, acute, shortly bifid at apex, hyaline, awns 8-10 mm long, slender with a dark column and pale scabrid bristle. Stamens 2; anthers *c.* 2 mm long, narrow, linear; filaments short. Ovary *c.* 0.3 mm long, ovate. Styles 2, each *c.* 0.4 mm long, slender. Stigma *c.* 10 mm long, feathery. Grain *c.* 2.25 × 0.3 mm, oblong, acute towards tip, compressed.

[1] Accepted May 1981.

[2] Botanical Survey of India, Coimbatore-641 003.



Figs. 1-9: *Dimeria copeana* sp. nov.
1. Habit; 2. Spikelet; 3. Lower glume; 4. Upper glume; 5. Lower lemma; 6. Upper lemma; 7. Stamen; 8. Pistil; 9. Grain.

Holotype: Alleppey Dist., Thrikkunnapuzha, 13.3.1980, *P. V. Sreekumar* 66736 (CAL). Isotypes in K and MH.

This species is allied to *Dimeria trimenii* Hook. f. but markedly differs from it in the characters shown in the Table.

The species is named after Dr. T. A. Cope of The Herbarium, Royal Botanical Garden, Kew, without whose valuable opinion this work would not have been possible.

ACKNOWLEDGEMENT

We thank Dr. R. Sundararaghavan, Regional Botanist (Kew), for his help.

A NEW GENUS AND SPECIES OF ALGA FROM KARNATAKA (INDIA)[1]

S. P. HOSMANI[2] AND S. G. BHARATI[3]

(*With a text-figure*)

During an investigation of fresh water algae of Karnatak State, the present taxon was collected along with other algae at Haliyal (Karwar Road). This taxon does not bear any resemblance to the genera *Scenedesmus* or *Oocystis* and is, therefore, described as a new genus and species.

Sceneoocystis Gen. nov.

Colonia e sex cellulis composita, plana libere natans; cellulae rotundate, in duobus ordinibus dispositae, lateraliter se contingen tes, spatiaperspicua inter cellulas praebentes. Cellulae singulae duas vel tres incrassationes marginales habentes; chloroplastus parietalis diffusus.

Sceneoocystis karnatakensis sp. nov.

Proprietas generalis proprietati generis similis. Colonia 120 μ long, 72 μ lat., cellulae 34-40 μ diam.

Habitatio. Stagnum parvum ad locum Haliyal on Karwar Road dictum. Tempus collectionis m. Feb., d. 13, 1966.

Specimen typicum in Departmento Botanico Universitatis Karnatak, Dharwar-3, sub. num. (82) 3 cum inconibus originalibus depositum. Haec forma e genere *Oocysti* differt ut cellulae in duobus ordinibus lineariter dispositae, necnon colonia intra membranum cellulae-matris obsoletam non inclusa.

Haec forma *Oocysti* similis ut incrassationes marginales quae nodulis polaribus generi *Oocysti* propriis fortasse consimiles habet.

Generi *Scenedesmo* consimilis ut coloniam

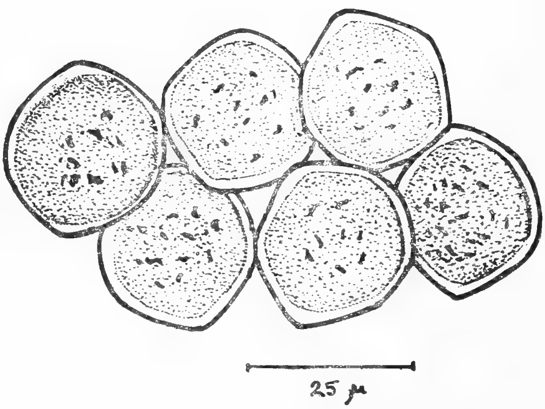


Fig. 1. *Sceneoocystis karnatakensis* sp. nov.

[1] Accepted March 1981.

[2] *Present Address*: Department of Post-graduate Studies and Research in Botany, University of Mysore, Manasa Gangotri, Mysore 570 006.

[3] Department of Botany, Karnatak University, Dharwar 580 003.

planum, cellulis binis, et spatiis inter duos cellularum ordines habet.

Quamobrem forma ut genus novum consideratur.

Colony of 6 cells, flat, free floating, cells rounded, arranged in two rows and in lateral contact, with distinct space between cells. Individual cells have two to three marginal thickenings. Chloroplast parietal, diffused.

Sceneoocystis karnatakensis sp. nov.

General characters are same as of the genus. Colony, 120 μ long, 72 μ broad, D. 34-40 μ. This form differs from the genus *Oocystis* in having cells that are linearly arranged in two rows and also that the colony is not enclosed within the old mother cell wall.

It resembles *Oocystis* in having marginal thickenings which may be similar to the polar nodules common in the genus *Oocystis*. It resembles the genus *Scenedesmus* in having a flat colony with cells arranged in multiples of two, and with gaps between the two rows of cells.

Habitat: From a small pond at Haliyal, on Karwar road. 13-2-66.

The specimen is deposited in the Botany Department, Karnatak University, Dharwar-3, Under Coll. No. (82) 3. According to Prescott (personal communication) one needs to determine the reproductive features in this form. The number of pyrenoids are also not clearly visible as the cells present a diffused appearence. Tentatively, therefore the above new name is given, as it may be altogether a new genus in the Order *Chlorococcales*, and Family *Scenedesmaceae*, Sub-family *Scenedesmoideae*.

ACKNOWLEDGEMENTS

Thanks are due to Prof. G. W. Prescott for kindly going through the iconographs and suggestions on the new taxon and also to Miss Hannah Croasdale for the Latin diagnosis. Thanks are also due to Prof. M. S. Chennaveeriah, Head of the Department of Botany, Karnatak University, Dharwar-3, for the facilities afforded.

REVIEWS

STONES OF SILENCE. By George B. Schaller. Sketches by Jean Pruchnik and photographs by George B. Schaller. pp. 292 (23 × 15 cm) with 14 colour photographs, 6 maps and many illustrations in Black-and-White. New Delhi, 1980. Vikas Publishing House Pvt. Ltd. Price Rs. 100/-.

George Schaller's STONES OF SILENCE like his other books, whether scientific treatise or travelogue is eminently readable. The book is the report of a scientific study and a personal pilgrimage to the "remote and passionless" mountains of the Himalayas. A haunting of the most desolate reaches of nature in search of the "lonely world beyond the ridges". For as Tagore said "The traveller has to knock at every alien door to come to his own and one has to wander through all the outer worlds to reach the innermost shrine at the end". It is in essence the story of his journeys to the Himalayas to study the sheep and goats and the "in between" species like the Tahr and Bharal. The Himalayas have the largest number of sheep and goats, all living at "the limit of existence" in the high hills. The scientific report on this study was published under the title MOUNTAIN MONARCHS.

From the Hindu Kush to the Karakorams and the Great Himalayan range further east Schaller ranged in his quest. For as Schaller says in the context of the endangered Kashmir Stag. "The fact that a living being can vanish from this earth solely because of man's improvidence and neglect is appalling, and the utter finality of it touches the consciousness of far too few. I have met many species without a future, and each time had the forlorn hope that somehow I might be able to extend their existence for at least a few years. Pen and camera are weapons against oblivion, they can create an awareness for that which may soon be lost forever, and if this book has a main purpose, it is to induce others to care for the dying mountain world of the Himalaya."

The book chronicles the extend to which the Himalayas have been devasted but no species or habitat is irrevocably lost, but the future is bleak. I quote "To me the most startling discovery was the extent to which the mountains have been devastated by man. Forests have become timber and firewood, slopes have turned into fields, grass has vanished into livestock and wildlife into the bellies of hunters. The future of some animals and plants is now in jeopardy. However, the earth is remarkably resilient, and habitats can recover if species have not been exterminated. Some day man may want to rebuild what he has squandered, and to do that he must save all species, he must maintain the genetic stock. This can best be done in reserves where the fauna and flora can prosper with little or no interference from man. In the not too distant future much of world's biological endowment may well be found in reserves, in islands of habitat surrounded by biologically depleted environments. However, species cannot always be maintained in a reserve: it has been found that the natural extinction rate in small, isolated habitats is remarkably high, that a Noah's Ark in which species are saved two by two is not possible, for chance alone would eliminate some. Large reserves are needed, especially for such animals as markhor, which migrate seasonally, and for snow leopard, which roam widely in search of prey".

One more quotation from the book is necessary and this is in the context of baiting for tigers which inspite of carefully documented scientific evidence that it does not affect the behaviour of tigers is still officially frowned on in India.

The tiger according to Schaller is "Far from being asocial, irascibly avoiding contact, tigers may meet, sometimes casually on a trail, at other times to share a kill. Solitary but not asocial, the tigers are part of a small community in which all resident members know each other and retain contact by roaring and leaving their scent on bushes and tree trunks. In India, where there are more tiger experts than tigers, my interpretation of the cat's society was coolly received, a few dismissing my observations and others accusing me of creating an abnormal situation, of luring in and concentrating tigers from far away by tying out an inordinate number of buffalo baits. In vain I pointed to my book THE DEER AND THE TIGER which notes that only the same few resident tigers came to kills and that far from baiting profusely I used only sixteen small buffalo over a period of sixteen months, not enough to affect the habits of this tiger population. Then in 1973 and 1974 Charles McDougal, who has for years devoted himself to tigers in the Chitawan National Park of Nepal, also observed adults together at kills, with, for example, an adult male, a young male, and two tigresses sharing meat on occasion. His well-documented book, THE FACE OF THE TIGER, presents the best available account of the tiger's social life.

A remarkably well documented and readable book offering one an overall view of the conservation situation on the Himalayas and an insight to a dedicated naturalist.

J. C. DANIEL

BIRDS OF AFRICA. A bird photographer in East Africa, John Karmali. Foreword by Roger Tory Peterson. pp. 191 (33 × 25 cm) including 72 colour plates and many black & white illustrations. London, 1980. Collins, St. James's Place.

There is no dearth of new books on birds and most of them are illustrated with photographs in black-and-white and in colour. But this is exceptional and outstanding for even Roger Tory Peterson in his foreword, in addition to saying that "there is no part of the world where the bird enthusiast or the bird photographer can enjoy a happier or more successful holiday than in East Africa" pays a handsome tribute to the author.

After the preface and introduction, both well written, there follow 37 chapters on different groups of birds, e.g. Ostriches, Pelicans, Cormorants, Darters, Flamingos, Ducks and Geese, Game Birds etc. etc., all well illustrated in both colour and black-and-white.

Several species are endemic to Africa but others occur in India too. The accompanying text contains many items of information which would be of interest to bird students in all parts of the world. While the ostrich was exterminated in Asia almost 200 years ago, its destruction in Syria and Arabia is more recent having no doubt been assisted by the rifle and the jeep. Ostrich farming undertaken in South Africa in the last century resulted in over half a million birds being in captivity at the turn of the century. Though the demand for ostrich feathers has decreased and lead to a consequent drop in prices, ostrich farming is still a profitable business though the number of birds in captivity is now under 50,000. Ostrich skins are still used to make wallets and handbags.

White pelicans show considerable differences of colour between the sexes and their largest colony is said to consist of 40,000 birds. The bright colours of the bill, head and other unfeathered parts of some of the storks and other birds have been startlingly captured by the camera and notes on the Greater and Lesser Flamingos both of which nest in the Rann in India contain items of interest which draw attention to how much work remains to be done in Indian conditions.

The Fulvous Tree Duck (*Dendrocygna bicolor*) which is now one of the rarer ducks in India, presumably takes the place of the Lesser Whistling Teal in Africa and is quite common. Similarly many of the notes on species closely related to those occurring in India add to their interest and one cannot help drawing attention to the picture of the Two-banded Courser *Rhinoptilus africanus* which superficially resembles Jerdon's Courser which has not been seen in India for 80 years. The colour pattern is distinctive and it is hoped that some naturalists will tour the area where it was found and try and locate some birds. It is unlikely that this species like the Pink-headed Duck should have been shot out.

The barbets and hornbills include species which live largely on the ground.

The chapters dealing with the passerines are shorter and less comprehensive, but here also there is much of interest and I can only leave it to the reader to examine this excellent book personally and to judge and learn for himself.

The author when passing through Bombay in November 1980 spoke to members of the Bombay Natural History Society on the Birds of East Africa. The slides accompanying the talk confirmed, if such confirmation was necessary, that in addition to being an accomplished bird photographer and naturalist he was also an artist.

HUMAYUN ABDULALI

FRESH WATER ANIMALS OF INDIA—AN ECOLOGICAL APPROACH. By G. T. Tonapi. pp. 341 (24 × 16 cm) with many illustrations. New Delhi, 1980. Oxford & IBH Publishing Co. Price Rs. 19.50.

To attempt to write a compact book dealing with the vast and varied freshwater fauna of a subcontinent like India is no mean task, which must have daunted many a zoologist till now. Indian zoologists are fortunate that Professor G. T. Tonapi, Head of the Zoology Department, University of Poone, has completed this Herculean task.

While zoologists would be disappointed if they expect a treatise on the lines of the famous U.S. work "Fresh Water Biology" by W. T. Edmondson (more popularly known as by Ward & Whipple), in that the present book is not a guide to the identification of each and every species of aquatic animal found in Indian fresh waters, Professor Tonapi has gone a step ahead by including, in his book, very useful chapters on history of hydrobiology, biotic features, ecological zones, and adaptations. Although necessarily precise, the lucid definitions in common usage by hydrobiologists are thrown open to the college-level zoologist. In today's era where every other zoologist tends to climb on the bandwagon of "ecology", these chapters really do justice to Tonapi's use of the book's subtitle—"an ecological approach". The endings to each chapter, in the form of "In retrospect and prospect" or "In perspective" offer concrete suggestions to future workers on this field.

Although most useful to the graduate-level collegian, the many neat drawings will also help the field naturalist to be able to have a fairly accurate guess at the identification of specimens in the field. Although basically an entomologist, Tonapi has not succumbed to the temptation of giving undue weightage to insects. He has fairly allotted adequate space to the different phyla, albeit having to be necessarily brief in such little known groups as, say, Gasrotricha or Tardigrada.

Now for the minus points of the book.

By affecting to write in a mellifluous language, Tonapi is sure to lead the zoologist with only a fair knowledge of English to a state of confusion. I came across as many as three instances on a single page (page 4):

"Knowledge of parasites using the aquatic media for their transactions into the hosts has warned the dangers of eclipsing the knowledge of fresh water animals."

OR

"Lentic environments are developed due to multiple effects of physical and biotic forces."

OR

"This environment has different ecology in a number of ways."

Similarly, I had to read the first paragraph of Tonapi's Epilogue (on page 316) thrice before I could gather its meaning. The sentence reads: "The preceding account has exposed and it has now become frank that only an atomic fraction of a vast, unlimited unprobed possibilities exist for making several multi-directional thrusts to reap the benefits of fresh water ecology."

In a few cases, the author has lapsed into downright ungrammatic English, e.g. "The... otter occurring throughout the country is *Lutra* and which dominates the central India." (page 299).

There are also a few instances of simplistic generalizations, or even incorrect statements. Thus on page 15, Tonapi states, "Pure water bodies appear nearly black as they absorb all light components of spectrum." Or, on page 6, "Trouts, planarians and insects larvae are found in definite zones of water temperature *below* and *above* 19°C" (italics mine). Once again, on page 5, there is the statement, "*Bottom* contains soft quaking mud which supports the *floating* surface vegetation." (once again, italics mine).

Editing of the book, especially towards the end, is slipshod and many typographical mistakes have crept in. In only one chapter I could find *bangalensis* (bottom of page 257), *sethnai* Kulkarny (p. 258), *C. Striatus* (p. 259), *Ioramy* (p. 261), and *Tetradon* (p. 263), instead of *bengalensis, setnai* Kulkarni, *C. striatus, goramy,* and *Tetrodon*. Again, in the chapter on Birds, "grebe" has been thrice misspelt on page 295 as "greeb", and "sandpiper" (page 297) as "snadpiper".

These are very minor errors. A rather grave drawback is the absence of recent literature quoted by Tonapi. Almost all the references, except his own, are earlier to the 60's; this may have been because the manuscript was prepared way back and then kept in "cold storage" until retrieved in the early 80's.

One also wishes that Tonapi would have stuck to the usage of line drawings throughout the book. The eight photographic plates between pages 232 and 233 detract from the value of the excellent line drawings elsewhere.

In spite of these few lapses, Professor Tonapi deserves congratulations for fulfilling a long felt need by preparing this valuable book, which is a "must" for all college libraries throughout the country, and in the personal collections of the zoologist or naturalist who dabbles in hydrobiology. So its real failing would then lie not with the author, but with users who do not heed the author's statement that "this book does not help zoologists to identify organisms", or that "mere body of facts does not constitute knowledge". If the book awakens enough interest in a naturalist to go looking for the animals described there in the lakes and streams nearby, or if it suffices the collegian to roughly identify a perplexing animal, the book will have accomplished its mission. I especially appreciate the author's modesty, as the many humble statements in his Prologue asking forgivance for any shortcomings in the book will doubtless take away any sting in a reviewer's caustic comments. After all, as Professor Tonapi, quoting Don Carlos, so correctly emphasizes, "Nothing would ever be written if a man waited till he could write so well that a reviewer could find no fault with it".

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MISCELLANEOUS NOTES

1. DENSITY AND DIET-DEPENDENT GROWTH RATES OF *BANDICOTA BENGALENSIS* UNDER LABORATORY CONDITIONS

(*With two text-figures*)

Although growth and development patterns of several species of rodents are known (e.g., Calhoun 1963, Jackson and Barbehenn 1962, Bentley and Taylor 1965, Spillett 1969), the effects of population density and diet on growth have not been recorded in terms of ecological growth rates. A preliminary study along these lines was carried out on the Indian mole rat (*Bandicota bengalensis* Gray) under laboratory conditions.

Pregnant females were captured in paddy (rice) fields by excavating burrows. The mothers and their litters (some of which were born during transfer) were placed in individual metal cages provided with nest boxes containing bedding material. Sufficient quantities of "rat and mice" feed (Hindustan Lever, India) and water were always present. The litter weight was taken (to the nearest 1 g) one month after birth and thereafter every ten days using a trible-beam balance. Thirty-day-old litters were separated into four size groups and fed on diets of rice (*Oryza sativa*) or ragi (*Eleusine coracana*) for 70 days (Fig. 1). Food eaten was expressed as grams consumed per 100 g body weight. The instantaneous coefficient of growth (ICG) rate of each litter was computed by slightly altering the following formula (Odum 1971).

$$r = \ln \frac{Nt - \ln No}{t} \quad \text{or} \quad \frac{dN}{N}$$

where the average rate of weight gain per organism per time replaced average weight of change in number of organisms per time per organism. The ICG rates at 21, 25, 30, 35, 40 and 45 days were plotted against litter density (Fig. 2).

The weights of the animals ranged from 16-22 g at the time of weaning (30 days) to 90-150 g at the end of experimental period (100 days). These figures on animal weights are quite close to Spillett's observations (1969) for this species.

The rates of solid food intake and growth were maximum after weaning but with in-

TABLE 1

WEIGHTS OF MALE AND FEMALE BANDICOOT RATS SUPPLIED WITH DIFFERENT FOODS

	Males				Females			
	No.	weight at 40 days (g)	weight at days (g)	80weight gain ( )	No.	weight at 40 days (g)	weight at 80 days (g)	weight gain
Group fed on rice	5	40 ± 8	93 ± 15	130	4	44 ± 6	77 ± 4	80
Group fed on ragi	1	31	112	261	1	47	127	157
Group fed on pellets	—	—	—	—	1	27	135	400

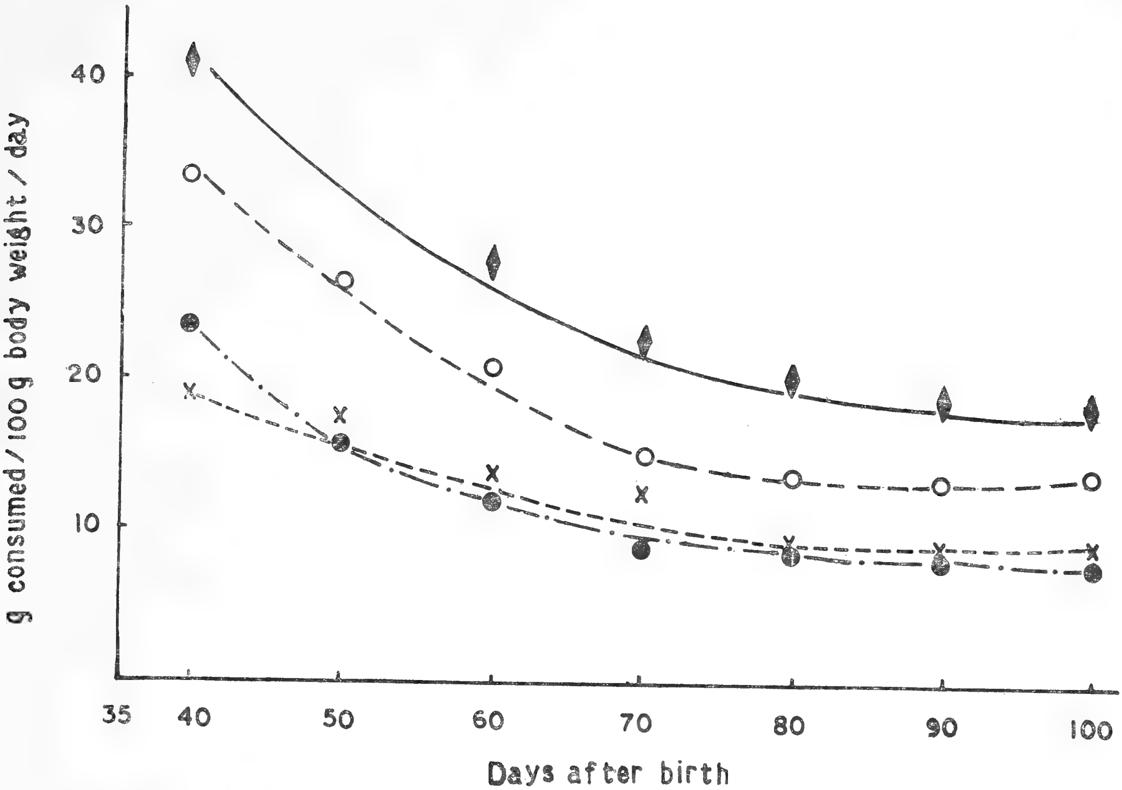

Fig. 1. Rate of food consumption of different density of *B. bengalensis* litters.
●——.——● 4 rats fed on rice
◆——◆ Single rat fed on rat feed
O—— —— —— O 2 rats fed on ragi
× — — — — × 5 rats fed on rice

creases in age declined (Figs. 1 and 2). No marked difference in the weight gain of two sexes was seen up to 40 days growth; but at 80 days, the rice-fed males were heavier than similarly reared females. Such a relation was not seen in ragi-fed group (Table 1).

Jackson and Barbehenn (1962) and Wirtz (1973) observed that older *Rattus exulans* females gained weight at a slower rate than males. Norway rats, too, exhibited large differences in mean weights between the sexes at 20 weeks of age (Calhoun 1963, and Hirata and Nass 1973). Bentley and Taylor (1965) reported similar differences between 35 and 42 days in *Rattus rattus*. Spillett's (1969) observations show that from birth to 30 days bandicot rat females grew faster, males gained weight more rapidly after 50 days. He also reported that adult males at 170-190 days in the wild weighed 225.5 g; females, 203 g.

Growth rates after 40 days are considered for discussion, since the period of transition from liquid to solid food is 25 to 40 days. Density of the litter inversely affected growth rates (Fig. 2), supporting the observations of McCance and Widdowson (1974). The growth

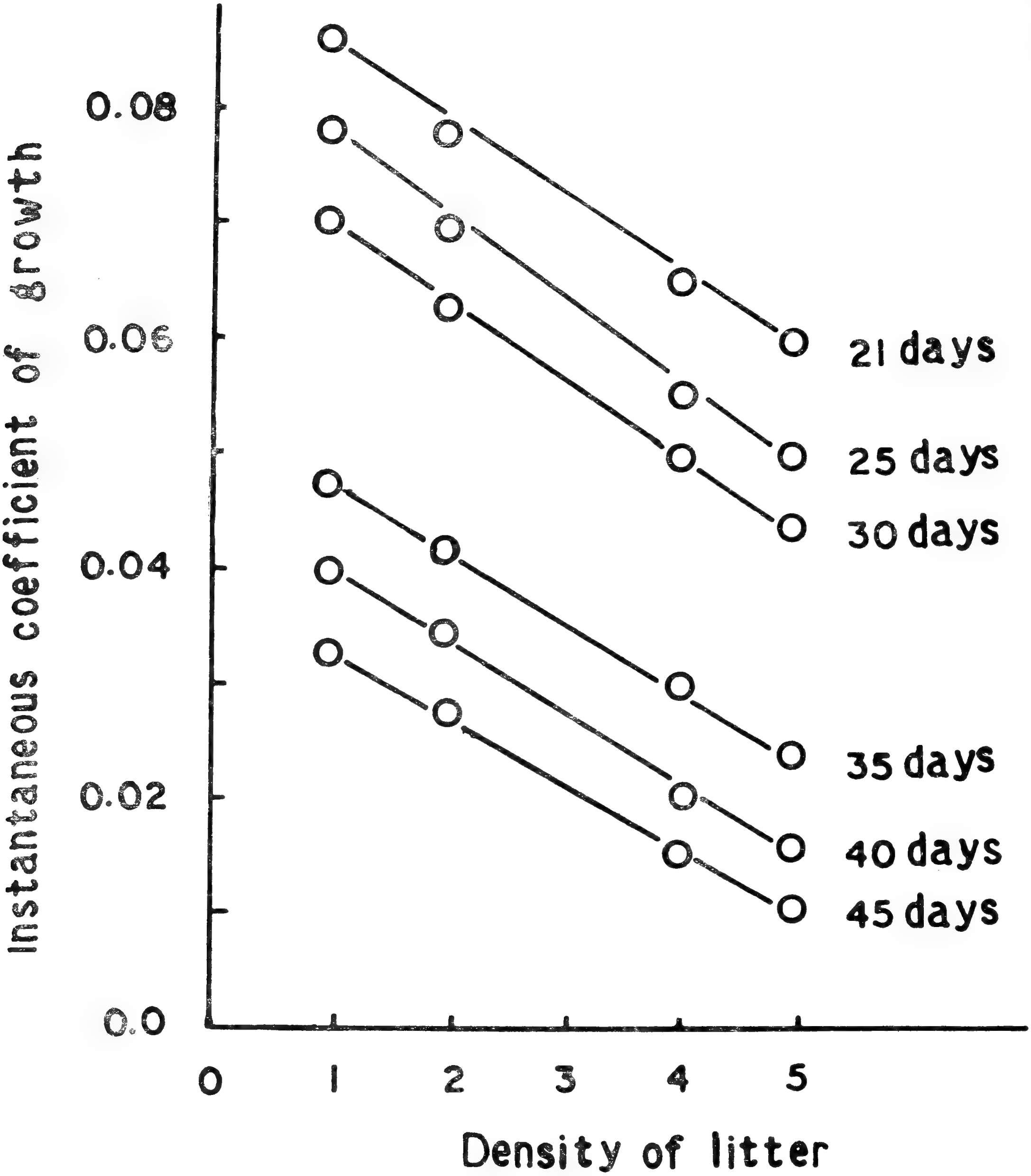

Fig. 2. Growth rates of different density litters of *B. bengalensis* at different periods of growth.

rate was greater in a non-competitive situation than in competitive conditions. Though Bentley and Taylor (1965) failed to establish a linear correlation between density of the litter and mean weight, they did observe that in 3 out of 4 comparisons the mean individual weight was greater in a smaller-sized litter at 28 days.

In addition to density, the diet also seemed to affect growth rates. The single rat was fed nutritionally balanced pellets and hence its greater growth. Ragi is more nutritious than rice (Aykroyd 1976); the litterlings fed on it showed a slightly higher rate of growth than those fed on rice. The number of animals used for the present study was quite small, but the general trend observed supports Jackson and Barbehenn's (1962) view that nutritional and environmental influences on size and maturation in rats are more important than genetic factors. Merely having animals in a cage with sufficient food under standard laboratory condtions does not insure uniform growth.

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2. SOME OBSERVATIONS ON BEHAVIOUR OF RODENTS DURING SOLAR ECLIPSE

(*With a text-figure*)

Behaviour of five rodent species was studied during the solar eclipse which occurred on the 16th February, 1980, from 2.28 p.m. to 4.49 p.m. the greatest phase being at 3.42 p.m. at Jodhpur. Rodents were studied in the field, in the rattery and in cages kept in open sun and in the laboratory. For the sake of comparison, the rodent behaviour was also observed during the same period on two days prior to the eclipse in identical situations. All the activities were recorded on a time scale (Fig. 1).

Behavioural patterns of the Indian gerbil, *Tatera indica indica* (nocturnal), the Desert gerbil *Meriones hurrianae* (diurnal), the House rat, *Rattus rufescens* (nocturnal) and the Soft-furred field rat, *Rattus meltada pallidior* (nocturnal) remained conceivably unchanged between the 'control' days and on the eclipse day.

Pillai (1956) also studied the effect of solar eclipse (which occurred on 14 December, 1955) on the zoo animals at Trivandrum. He found that animals either captive or free display little or no responsive behaviour.

However, noticeable changes in the periodicity of a number of behavioural activities were observed in case of the diurnal Bush rat, *Golunda ellioti gujerati*. Two males and two females were maintained in laboratory cages in the sun. The duration and/or frequency of almost all the activities except grooming declined significantly when compared with those on the prior days (Table 1).

Though the difference in duration of feeding increased on the eclipse day but it was not statistically significant. However, a significant shift of this activity from 3.45 to 4.30 p.m. on ordinary days ($P < .02$) to 2.15 to 3.15 p.m. ($P < .001$) on the eclipse day occurred indicating that rodents fed before the maximum phase of eclipse and ceased their feeding activity thereafter.

Another significant change observed was in

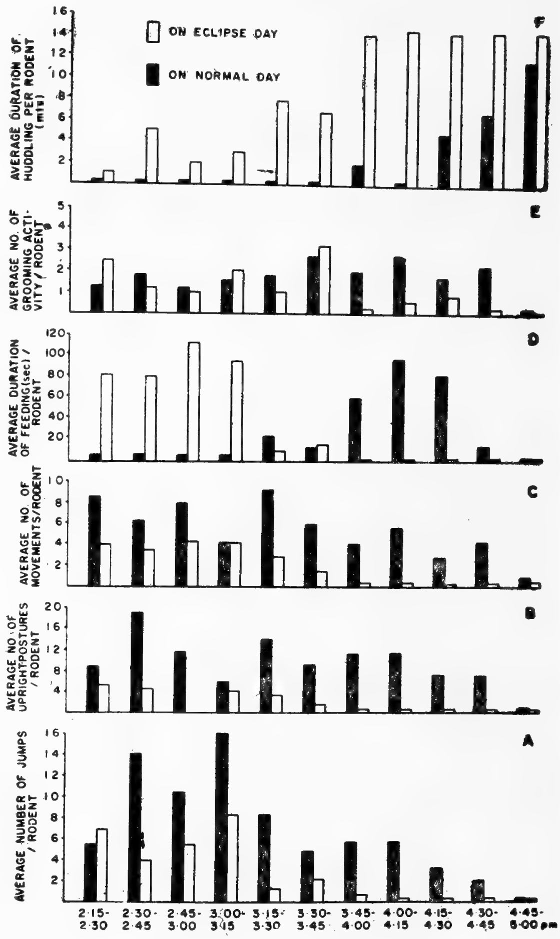

Fig. 1. Comparison between various parameters of activities performed by *Golunda ellioti* on eclipse and normal day from 2.15 to 5.00 p.m.

TABLE 1

FREQUENCY AND OR DURATION OF VARIOUS BEHAVIOURAL ACTIVITIES OF *Golunda ellioti* ON THE ECLIPSE DAY

Activity	Mean frequency/duration of activity		Level of probability
	normal day	eclipse day	
Jumps on the cage wall	7.0 ± 1.50	2.63 ± 0.92	$P < 0.02$
Exploration (upright postures)	9.63 ± 1.45	2.20 ± 0.67	$P < 0.001$
Movements in the cage	5.22 ± 0.79	1.70 ± 0.60	$P < 0.001$
Total duration of feeding (in sec.)	27.99 ± 10.64	37.27 ± 14.00	(NS)
Grooming (in numbers)	2.15 ± 0.33	1.13 ± 0.31	$P < 0.05$
Huddling (in min.)	2.36 ± 1.20	9.03 ± 1.74	$P < 0.01$

their huddling behaviour which on the eclipse day increased considerably ($P < 0.01$). It was observed at 2.15 p.m.; prior to the beginning of eclipse and after 3.15 p.m. huddling gradually increased and interestingly from 3.45 p.m., the greatest phase of the eclipse, to 5 p.m. the animals remained huddled over one another in the corner of the cage, almost without performing any vital activity. Such a behaviour was not observed on earlier days. During the maximum phase of eclipse (3.30-3.45 p.m.) in contrast to decline in other activities, grooming was performed at a higher frequency and faster rate (Fig. 1).

It is interesting to observe that only *G. e. gujerati* behaved in a different manner during eclipse whereas there was no apparent change in any other rodent species.

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I am grateful to Dr. H. S. Mann, Director, Central Arid Zone Research Institute, Jodhpur for providing necessary facilities and encouragement and to Dr. Ishwar Prakash, Coordinator and Principal Animal Ecologist, All India Coordinated Research Programme on Rodent Control and Research, for the preparation of this note.

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3. APPARENT ALLOMATERNAL CARE IN AN INSECTIVOROUS BAT *HIPPOSIDEROS SPEORIS*

Analyses of mother-infant relations pave the way for a better understanding the extent of social organization in bats (Bradbury 1977). The process of mother-infant relationship becomes a little complex in the case of bats, since their food and feeding habits necessitate long foraging sojourns away from the roost every night. Hence in most cases the mothers leave behind their young ones in the roost and retrieve them only on return from foraging, implying that the mothers recognize their own infants individually (Gould 1971). Studies on one of the microchiropteran species *Hipposideros speoris* living in a cave near Madurai (9°58′N. 78°10′E.) revealed that the mothers recognized and retrieved only their own respective infants by acoustical and olfactory means (unpublished observations).

We observed two off-beat and unusual phenomena on two occasions in the course of our experiments with captive bats reared in laboratory cages and in an outdoor flight chamber. We consider that such phenomena resemble some kind of allomaternal care as defined by Wilson (1975). On the first occasion, a volant young male was seen clinging to as well as suckling from an adult female which had experienced a stillbirth on the previous day. This was observed to happen for two consecutive days at early morning hours in our laboratory cages (50 × 50 × 50 cm) maintained for the purpose of study on spatial memory in these bats. The position of the young bat clinging to the ventral surface of the female was upside down as in normal cases.

The second phenomenon was observed in an outdoor flight chamber (26′ × 12′ × 15′) in the course of our experiments on mother/infant relationship. Five pregnant females were caught on 4-11-80 which gave birth while being reared in the cage. *Hipposideros speoris* is a continuous breeder. These were individually marked with different coloured celluloid split rings before being released into the outdoor cage. The temperature (27°C) and humidity (95%) conditions of the cave were simulated to a certain extent by constructing a thatched roof over the top and by maintaining a pool of water inside the flight cage. During day hours the animals retreated into the darker recesses of the cage and after sunset flew around actively foraging on the insects that were attracted to the fluorescent light fitted inside the cage.

The bats survived well under these conditions and gave birth to young ones within 1-25 days of capture. As was observed in the cave, in our captive conditions also, the bats left the infants behind while foraging, visited them at random during the night hours and retrieved them only at early morning hours. The process of a rigid mother/infant bond was also observed in these animals for many days, until on 1.12.80 mother No. 3 was seen carrying two young bats, one (a 20-day male) it's own and the other (a 25-day female) originally the offspring of mother No. 1. Though the actual retrieval of these two young by the female was not observed directly, we sighted mother No. 3 carrying both the young ones at 0400 h in the morning. Though at first the young ones were found clinging one over the other on to the ventral surface of the female, later they hung side by side. Mother No. 3 carried both the young bats till 0502 h when it deposited both the infants on the roost wall and continued foraging. Though mother No. 1 —the mother of the female infant stopped foraging and settled down for roosting, *c* 1 metre from its infant, she did not show any visible sign of recovering the infant, which was seen to emit continually faint audible vocalizations at the mother. The mother responded finally only at 0740 h and as soon as the infant joined the mother, it started to suckle. Similarly mother No. 3 also retrieved it's baby only at 0930 h.

We conclude that the mothers do not voluntarily seek out other infants for nursing directly, even though they do not reject the stray infants that somehow manage to reach them. However these bats differ from *Rhinopoma hardwickei* in which the mothers do not even accept their own infants after an experimental separation and they go to the extent of active rejection by attacking their own infants thus experimentally separated. Adoptions in the true sense are not uncommon in a few social animal groups such as primates (Poirier 1968), elephants (M. Gadgil, personal communication) and lions (Schaller 1972). In a microchiropteran bat *Myotis thysanodes* communal raising of young ones and the presence of guardian females have been reported (O'Farrell and Studier 1973). Indiscriminate nursing was noticed in the mexican free-tailed bat, *Tadarida basiliensis mexicana* by Davis *et al.* (1962). Recently Porter (1979) reported that the harem males of leaf-nosed bat *C. perspicillata* guard the infants during night hours and chase the mothers until they reunite with their young ones. Since we have not noticed any comparable apparent adoption in any of the 7 species of microchiropteran bats in and around Madurai as we report here for *H. speoris,* we do not wish to rule out the possibility that this behaviour might eventually express itself only under stress or as an artifact under captive conditions. If such apparent tolerance of mothers to stray young ones is manifested in the natural environment also, it is of adaptive value in the sense that in an eventuality of mothers getting killed the orphaned infants could survive by the grade of 'adoption'.

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4. IMPORTANCE OF FRUITS IN THE DIET OF CHITAL IN DRY SEASON

During a study on the ecology and behaviour of dholes *Cuon alpinus* Pallas 1811 in Bandipur Tiger Reserve, rumen contents of seven freshly killed chital were collected. Of these, five samples were collected in March, the peak dry month, and two samples after the onset of rains and sprouting of grasses (Table).

Following inferences could be made from the data. 1) During the dry season, because of the availability, chital consumed considerable amount of fruit which varied from 13 to 70 per cent of their total rumen content weight. 2) *Emblica officinalis* and *Xeromphis spinosa* were the commonly eaten fruits. 3) After the rains, fruits in the diet of chital decreased and this may be due to their scarcity and the availability of tender grass.

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(For Table, see page 595.)

5. SOLAR ECLIPSE—NOTES ON BEHAVIOUR OF EGRETS

A camouflaged observation post was set up on the foreshore of Tummalagudem village tank which is located 48 km from the line of total eclipse. We scouted the area and located the roost of cattle egrets and little egrets in a grove consisting of *Acacia arabica and Tamarindus indicus.* The shallow tank and the neighbouring paddy fields are the favourite feeding grounds of egrets.

Our study of the roosting behaviour of egrets commenced on 14th February, 1980, that is two days in advance of the total solar eclipse day. Small groups of cattle egrets and little egrets flew from their feeding grounds to their roost. Some of them directly landed on the branches while others circled over the trees twice or thrice before landing. Some of the birds flew from one tree top to another before finally settling down. Soon after landing, the egrets started producing low grating croaks and the crescendo increased gradually as more and more arrived to roost. It is a mixed colony of egrets and herons. The bird chorus lasted for nearly 30 minutes before silence and darkness engulfed the scene.

On the next day, before dawn we reached the roost and recorded the first call of cattle egret at 5.49 a.m. With the day breaking at 6.15 a.m. the first egret took off at 6.17 a.m. and flew directly towards the tank. At 6.19 a.m. the egrets flew off in small parties, in the direction of the paddy fields and tank and by 6.35 p.m. the roost was deserted.

The little egrets (*Egretta garzetta*) and cattle egrets (*Bubulcus coromandus*) assembled at the centre of the waterspread area dotted with reeds and vocalised for about 30 minutes. Slowly they spread out towards the tank margin for foraging. A few flew from one area of the tank to another.

It was dusk and the egrets started arriving at the roost either singly or in small parties. Huge flocks arrived at 6.20 p.m. and after circling over the area thrice, they alighted on the tree tops like swarms of locusts and soon after, indulged in low-key vocalisation. By 7 p.m. the vocalisation subsided and gradually silence descended on the scene.

On the momentous eclipse day (16-2-1980) twilight came at 5.56 a.m. We recorded the

TABLE

OCCURRENCE OF FRUITS IN THE RUMEN CONTENTS OF CHITAL

Date of chital kill	Particulars of the chital killed	Total rumen weight	Weight of rumen content	Number and weight of different fruits		% of fruit weight in total rumen content weight
06/03/77	Fawn	800 gm	500 gm	55—*Emblica officinalis*—	350 gm	70%
22/03/77	Stag—age class VI— 90 cm velvet antlers	6.110 kg	5.25 kg	138—*Emblica officinalis*—	400 gm	16%
				20—*Xeromphis spinosa*—	400 gm	
				3—*Terminalia bellerica*—	60 gm	
24/03/77	Stag—age class V— 90 cm velvet antlers	6.05 kg	4.625 kg	140—*Emblica officinalis*—	925 gm	31%
				20—*Xeromphis spinosa*—	400 gm	
				5—*Terminalia bellerica*—	100 gm	
29/03/77	Stag—age class VI— 89 cm hard antlers	5.8 kg	3.25 kg	75—*Emblica officinalis*—	450 gm	32%
				25—*Xeromphis spinosa*—	600 gm	
20/03/77	Stag—age class V— 88 cm velvet antlers	6.23 kg	5.5 kg	94—*Melia dubia*—	650 gm	13%
				2—*Emblica officinalis*—	15 gm	
				4—*Xeromphis spinosa*—	50 gm	
				3—*Zizyphus xylopyrus*—	15 gm	
28/04/77	Stag—age class VI— 78 cm velvet antlers	8 kg	6.5 kg	5—*Xeromphis spinosa* + 5 *Terminalia chebula*—	100 gm	1.5%
09/05/78	Stag—age class V— 76 cm hard antles	8 kg	6.5 kg	1—*Xeromphis spinosa* + 5 *Terminalia chebula*—	.030 gm	0.46%

first croak of egrets at 5.57 a.m. The egrets continued their occasional vocalisation. At 6.17 a.m. the little egrets and later the cattle egrets started to fly either singly or in groups of 2, 3, 4, 7 etc. A minute later, a mixed flock of egrets and pond herons took off. Little later, a third group took to wings and by 6.33 a.m. the entire mixed colony had left for their favourite feeding grounds.

The egrets had collected in two groups at the southern end of the tank margin. The larger group consisted of little egrets, cattle egrets and a sprinkling of grey herons. The smaller group consisting of 30 egrets had assembled near the reeds. Since 7.12 a.m., they have been vocalising. At 9.36 a.m., the bigger group slowly thinned out spreading evenly towards North and West. At 11.10 a.m., a small party of cattle egrets coming from the fields, alighted on the tamarind trees abutting the tank bund. A little later another party arrived and landed on the same trees. With the increasing heat, the birds moved to the tank margin and rested while some flew off and landed on the tamarind trees.

At 12 noon, the mercury touched 89°F and by 12.30 p.m. it shot upto 90°F. Egrets standing in water were still feeding while those on the grassy tank continued to rest. At 1.00 p.m., the thermometer recorded 90.5°F and the feeding by egrets continued. The temperature rose to 92.5°F at 1.30 p.m. but came down to 90°F at 2 p.m. The eclipse began exactly at 2.30 p.m. when the mercury touched 92.5°F. The sky was clear and there was no perceptible change in bird activity. At 3 p.m., the thermometer recorded 91.5°F. The eastern sky which was a hue of light grey and crimson red became dull at 3.20 p.m. and the thermometer recorded 89.5°F. No change was noticed on bird activity at 3.30 p.m. When the mercury touched 88.5°F. There was dawn twilight effect at 3.40 p.m. When the temperature abruptly came down to 86.5°F. At 3.45 p.m. the sky became duller and near darkness abruptly enveloped the whole scene at exactly 3.46 p.m. when the mercury touched 84°F. The egrets abruptly took to wing and flew in the direction of the roosting place. Two parties flew directly to the tamarind trees on the tank bund. It was unmistakable that the birds flew restlessly but vocalisation was distinctly absent. The sun came out in all brightness at 3.48 p.m. and we could clearly see the egrets alighting at the roosting place.

Our team member stationed near the roost reported that at 3.47 p.m. flocks of egrets arrived and circled over the area twice or thrice. While they were preparing to land, the sun came out in blinding brilliance causing confusion. One party of egrets landed on babul trees, another on tamarind trees while the third alighted on the nearby paddy fields. While circling, the birds looked restless but there was no vocalisation indicating fright. Two groups which circled over the roost returned to the shallow tank as sudden light bathed the whole landscape.

About 100 yards from our observation post, we noticed three pairs of little egrets fighting and making loud noise which attracted a small party of egrets. The birds were jumping and pecking at each other and the fighting lasted a few minutes. A little later, they returned to the same place and restarted the fight. At 4.28 p.m. we saw a group of egrets take off from the roost and after circling head towards the paddy fields. A few birds remained at the roosting place.

We hastily reached the place of roosting at 5.50 p.m. A flock of egrets arrived at 6.10 p.m. At 6.30 p.m. a huge flock of little egrets and cattle egrets came from the tank feeding ground, circled and landed on the babul trees. Soon after, they started vocalisation in low tone. Another flock arrived three minutes later followed by a second. The vocalisation increased in intensity. The last group landed at 6.38 p.m. and by 7 p.m. the birds ceased vocalisation and settled down for the night.

Returning to the roost on 17th morning, we continued our observations. At 5.49 a.m. we recorded the first call of egrets. The low tone croaks mixed with occasional quacking of pond herons could be heard till 6.10 a.m. At 6.17 a.m. one egret took off and flew southwards towards the tank followed by another. Three minutes later, the third, fourth and fifth took off. From 6.16 a.m. small groups of egrets started off, one after another and by 6.35 a.m., all the birds had gone leaving the roost totally empty.

The following are the interesting sidelights of our observations of bird behaviour.

1) Little egrets are the most voiciferous and while in company, indulge in occasional pecking and fighting. Cattle egrets are less noisy and quarrelsome.
2) Most of the time, little egrets and cattle egrets hunt in company.
3) Little egrets and cattle egrets roost in mixed colonies in the same trees.
4) Egrets are the earliest risers followed by grey herons.
5) Exactly at 6.17 a.m., the egrets started flying singly or in small parties of 2, 3, 4, 7, etc.

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S. ASHOK KUMAR

6. ON THE OCCURRENCE OF LONG-DISTANCE MOVEMENT IN THE YELLOW-WATTLED LAPWING, *VANELLUS* (=*LOBIPLUVIA*) *MALABARICUS* (BODDAERT)

Of the Asian species of the genus *Vanellus* (Brisson), most are known to be migratory to a certain extent. The degree to which movement occurs can be very variable between and within species; northern populations may migrate long distances south from their breeding grounds, whereas southern con-specific populations may be entirely sedentary (this occurs, for example, in the Common lapwing, *Vanellus vanellus*). Other species may be described as "resident", showing only local (usually seasonal) movement within a defined breeding area; this is the case with the Red-wattled lapwing, *V. indicus,* and Spurwinged plover, *V. spinosus,* (although the latter has occurred in Western Europe in recent years; Blotzheim *et al.* 1975). *V. malabaricus* has been thought to be one of the most sedentary species, showing short-distance seasonal migratory or nomadic movement, but tending to remain within the limits of its breeding area.

The breeding range of this species extends throughout the south of the Indian subcontinent and Sri Lanka, north to West Bengal and Bangladesh. Occasional stragglers have been reported from the Nepal Valley although breeding is not thought to occur there (Ali & Ripley 1969). It has not been thought to occur east of the Ganges River, although Oates (1883) notes one specimen collected from Burma "in recent years"; it does not appear to have been reported from that country subsequently and is unlisted by Smythies (1953). While information is by no means complete, limited by a shortage of observers, this species does not appear to have been recorded previously in South-east Asia (Wells; pers. comm.) and is unlisted by King *et al.* (1975).

The occurrence of an individual of this species on the campus of Universiti Pertanian Malaysia, some ten miles outside Kuala Lumpur, was thus unexpected. This individual associated with local wintering flocks of Lesser golden plovers, *Pluvialis dominica,* moving with groups of this species between grass playing-fields and a drained marshland area, both open dry areas as typically preferred by this species. It was first observed on 8th December 1979 by the authors, and subsequently seen by other local ornithologists. It was not seen after April 1980 which suggests that it left with the northward migration of Lesser golden plovers.

The bird was immediately distinguishable from the Greyheaded lapwing, *V. cinereus,* which has occurred previously, by the large conspicuous yellow wattles around the base of the bill, a dark crown with narrow white eye-stripe extending to the nape and a wing pattern showing white only on the base of the secondaries. The possibility of the bird being an escape was investigated and subsequently discarded. This thus appears to be an example of long-range movement previously unrecorded for this species.

It seems likely that the bird associated with flocks of Lesser golden plovers moving south from their North Siberian breeding grounds and followed them down into peninsular Malaysia. This implies either that Lesser golden plovers may migrate south into India and subsequently move laterally, broadly following the coastline; or that the lapwing wandered some distance east from its normal range before linking up with the migrating flocks. The bird could thus have moved outward following the Indian monsoon, joining the movement of Lesser golden plovers in mid-September and arriving in Malaysia towards the end of the month. That it remained undetected for so long reflects the shortage of local observers, and implies that this could well be a rare, rather than a unique occurrence. It is possible that occasionally *V. malabaricus* wanders widely as has been recorded for *V. cinereus* (Smith 1976, White 1975) and is not exclusively sedentary as has been previously thought.

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Royal Society of the Protection of Birds,
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7. THE SOUTHERN GREEN PIGEON (*TRERON PHOENICOPTERA CHLORIGASTER* BLYTH) IN KUTCH

While sitting in the varandah of the 'Darbari Utara' (i.e. the Maharaos residence at Mata-no-Madh), in the morning of the 30th Jan. 1980, I saw this bird flying away from a Peepul Tree within the compound, flushed apparently by a crow, where it had been eating the fruit. The pigeon flew away from the compound, but not before I could identify it positively. In the past, I had shot several of them for the table, near Mitiyala (in the former State of Bhavnagar) close to the Gir Forest; and could therefore, recognise and identify the bird immediately.

Later in the day, I casually mentioned this sighting to my Father, with whom I was camping at Mata-no-Madh; and he advised that as the Southern Green Pigeon was not reported from Kutch. I should obtain a specimen for positive identification.

The following morning at about the same time, I saw the bird once more, and collected it.

Subsequent enquiries at Mata-no-Madh revealed that a pair of these birds have been noticed in the grove of trees near the Chachara Kund (which is a Sacred bathing Tank situated near the Darbari Utara), for quite some time.

According to the BIRDS OF SAURASHTRA by R. S. Dharmakumarsinhji, the main habitat of this bird in Saurashtra is in the Gir Forest and it is merely a rare straggler in Wankaner and Dhrangadhra. In the BIRDS OF KUTCH by Sálim Ali, it is just listed in the Appendix on page 171.

M. K. S. HANVANT SINHJI

SHARAD BAGH,
BHUJ-KUTCH,
February 1, 1980.

8. POSSIBLE INTERSPECIFIC HYBRIDS BETWEEN *COLUMBA LIVIA* AND *C. RUPESTRIS*

Returning from Leh by jeep through Ladakh and down to Kargil and the Zoji La Pass I noticed that the common pigeon, the Rock Dove (*Columba livia*) seems now to have worked its way up the roads which have been constructed in the past 20 years. The highway leading from the Zoji La right up through the Lamayuru area and above to an altitude of 12,000 feet (3658 m) was notable for frequent flocks or small groups of Rock Doves. By contrast, the Hill Pigeon *Columba rupestris* normally seen only in barley fields at higher altitudes seems now to descend along the roadway in nearby cultivation to 11,000 feet (3353 m).

In the Lamayuru area at 11,500 (3505 m) to 12,000 (3658 m) feet on July 3rd we noticed while driving along the road frequent groups of pigeons flying up and off the road in family aggregations of three or four. On one occasion a group of four birds included three Hill Pigeons, *rupestris,* and one gray tailed *livia.* On another occasion a bird with a gray tail, at rest, on flying up showed white inner margins to the outer tail feathers above the presence of the darker band. I believe that in these mixed parties of white-banded tailed *rupestris* and gray-banded tailed *livia* there is a possibility of hybridization, and that the bird I saw with white inner margins to the outer tail feathers was in fact a hybrid between the two species. Examination of specimens in collections in museums in New York, Chicago and Washington where collections from Ladakh are housed failed to reveal the presence of such a suspected hybrid. However, the altitudinal separation of the species, at least until recently, would tend to militate against the collection of such a specimen. I would urge visitors to the Ladakh area to watch out for mixed flocks of these two common species at intermediate altitudes and carefully note the presence of partially white-tailed birds such as I have described. It would seem quite likely that hybrids could occur in such an increasing, overlapping range.

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S. DILLON RIPLEY

9. SOME OBSERVATIONS ON A NEST OF THE COMMON CROW-PHEASANT, *CENTROPUS SINENSIS* (STEPHENS)

The common crow-pheasant, *Centropus sinensis* (Stephens), locally known as *'Kamadi kukkar'*, is a common Indian bird and one of the few non-parasitic members of the Cuckoo family in India. Whistler (1963) and Ali (1976) have given notes on various habits of this bird. There is little information regarding its breeding biology. Ali and Ripley (1969) have mentioned that even the incubation period and other details of the breeding biology of the crow-pheasant are unknown. The following account summarises the observations made on a nest of this bird in Punjab. This communication will add some information to the existing knowledge about this bird.

A nest of the common crow-pheasant was discovered in a *'kahi'* (*Saccharum spontaneum*) bush at village Bias Pind, district Jullundur (Punjab) while surveying that area for the nests of the blackthroated weaverbird, *Ploceus benghalensis* (Linnaeus), in *'kahi'*.

Nest:

On 19th June, 1979 a 'helmet' of the black-throated weaverbird was located on a *'kahi'* bush with the owner male working on it. The crow-pheasant started building its nest in the same bush on 20th June. On the first day of its construction, the nest was a large, elongated, loose sphere in the centre of the bush made by binding the leaves of the same bush. On the next day, more leaves were found to be incorporated in the structure and a lateral opening was distinguishable on the western side of the thick wall. The 'helmet' of the black-throated weaverbird was also incorporated into the nest. In building the nest, both members of the crow-pheasant pair took active part. The birds went on incorporating leaves into the nest structure even after the laying of the first egg. The nest was completed on 23rd June i.e., in three days. It was built of the leaves of the *'kahi'* bush only, without any other material. The completed nest measured 28×25 cm internally, with the entrance hole measuring 15×19 cm. It was placed at a height of 1.4 m from the ground.

Eggs:

The first egg was laid on 22nd June and subsequently four eggs were laid at intervals of one, two, two and three days respectively. The clutch comprising of five eggs was completed on 30th June. Each freshly laid egg was marked by me with a lead pencil, measured with a vernier callipers and weighed with a two-pan field balance true to 50 mg. The measurements of the egg number 2 could not be taken as it slipped from hand and was broken after having been weighed. The eggs were white, chalky and oval. Mean size of four eggs was $34.78 \pm 2.05 \times 30.03 \pm 1.39$ mm and mean weight of five eggs was 18.88 ± 2.81 g each.

Incubation period:

Out of the four eggs in the nest, only three hatched. Egg number 1 hatched after 18 days, number 4 also after 18 days and number 5 after 16 days. Egg number 3 did not hatch and was not removed from the nest by the birds till the last day of observation. The mean incubation period of 3 eggs was 17.33 ± 1.15 days.

Nestlings:

The nestlings in the nest were observed daily and notes were made on their morphological appearance. Unfortunately, these observations could not be completed as the two nestlings present in the nest were missing (most probably due to predation) on 22nd July when nestling number 1 was 12 days old and number 2 was 7 days old. Nestling number 3 had already vanished from the nest on 17th July when it was only one day old. The description of the nestlings upto eleven days of age is given below.

The newly hatched nestling is black with eyes closed. The beak is soft. Upper mandible is black with pinkish edges and bent tip. An egg-tooth is distinguishable on dorsal surface of the upper mandible about 2 mm from its tip. Lower mandible and throat are skin coloured. Legs and claws are soft and somewhat grey. Two toes of the foot point forwards and two backwards. The entire dorsal surface of body and the forelimbs are covered with long (about 22 mm), white, hairlike down. The down on the fore limbs is somewhat shorter. Ventral surface of the body is also black with centre of the belly pinkish. There is no down on the ventral body surface.

Eyes opened when the nestling was 4 days old. Primaries, secondaries and their coverts started coming through the skin on the fifth day of age. No other feather tract was distinguishable in the 5-day old nestling. Nine-day old nestling had fully opened eyes and with the feathers of the head, spinal, humeral, femoral, crural, ventral and rectal tracts came through the skin. In all the feather tracts, the feathers came through the skin exactly below the white hairlike down and then the down is borne on the tips of the feather drums. The feather drums of none of the tracts had opened in the nine-day day nestling. The nestling was not able to sit on its feet and continued to balance its weight on its belly. In the eleven-day old nestling, tips of the drums of primaries became flattened at their tips indicating that they were ready to open.

Weight of nestlings:

The nestlings were weighed daily in the morning, and their weights upto eleven days of age was obtained. These data show that the mean weight of the newly hatched nestling was 16.083 g ($n=3$) which is less than the mean weight of the egg. Within eleven days, the nestlings attained 175 g of weight.

Food of nestlings:

On 17th July, when nestling number 1 was taken out of the nest, the tail of a lizard was found in its mouth. While pulling out, it got broken and the lizard could not be identified. On 21st July, one of the parent birds was observed bringing a lizard to its nest. When it entered the nest it was disturbed and the bird could not feed the lizard to the nestling and dropped it in the nest in its hurry. It was a decapitated lizard, of *Calotes* sp.

These observations reveal that this nest of the crow-pheasant was completed in three days and both members of the pair took active part in nest building. Five eggs were laid in the nest. The incubation period extended from 16 to 18 days (average 17.33 ± 1.15 days). The young ones are altricial and nidicolous. The parents fed the young on animal food including *Calotes* lizards. Nesting success was poor, probably due to predation.

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10. 'HELPERS' AMONG THE BLACK DRONGO (*DICRURUS ADSIMILIS*)

Cooperative breeding, in which group members, other than breeding pair, take part in feeding and protecting the nestlings, has been observed in many species of group territorial birds (see Skutch 1961; Zacharias and Mathew 1977; Emlen 1978; Gaston 1978). Helpers in Black drongo have not been recorded (e.g., Shukkur and Joseph 1980). On 23rd March, 1980, while following a group of Whiteheaded babblers *Turdoides affinis* in Sivakasi (9°27′N, 77°49′E), we saw two helpers or 'auxillaries' (Emlen 1978) assisting two adult drongos in feeding 3 young.

Sex identification of the adults was not possible. The four adults were differentiated based on differences in the forked tails: one had a cleft in the left half of the forked tail, another had a cleft in the right half, the third had a perfectly forked tail and the fourth had white spots on the ventral side of its evenly forked tail. The fledglings, seen on an *Albizzia lebbek* tree at a height of 8 m, had stumpy rectrices. In order to assess the number of times fledglings were fed the young were assigned names A, B and C, as per their perching position. The number of insects fed to each fledgling was recorded from 1151 to 1740 hrs. Afterwards, as the fledglings moved from perch to perch it was given up.

The adults brought grasshoppers, damselflies, butterflies and larvae from distances over 50 m and also caught insects flying close to the tree. The adults collectively fed the fledglings 81 times between 1151 and 1848 hrs. Two types of feeding were recorded. Out of the total 81, 66 times the adults came with food and perched on branches at a distance of 2 m from the fledglings. On seeing the adult, fledglings begged for food characterised by begging call, vigorous wing shake and open mouth. The fledgling which begged more got the food. In the second type of feeding, which occurred 15 times, the adult flew to and fed a fledgling of its own choice unmindful of the intense begging calls of others. Once an adult brought a large grasshopper and gave it to fledgling B, but B was not able to swallow it and the prey fell down. The adult caught the prey in mid air and fed it to C.

A blackwinged kite (*Elanus caeruleus*) which flew over the area 30 m from the tree, was chased but the babbler group was tolerated to feed in and near the tree.

The fledglings after 1740 hrs. moved from tree to tree either alone or with the adults and covered a total of 85 m. At 1900 they roosted in an *Albizzia lebbek* tree where the babblers had already gone to roost at 1846. Last feeding of a drongo chick was at 1848. We have already recorded in the study area that drongos commence feeding earlier than other birds. The late feeding and early morning activity of drongos accord with Aschoff's rule (Daan and Aschoff 1975). Probably the helpers were chicks of an earlier brood.

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11. INSECTIVOROUS BIRDS ASSOCIATED WITH THE RICE ECOSYSTEM AT MADURAI

The principal agroecosystem around the Agricultural College and Research Institute, Madurai is the rice ecosystem fed by the Periyar-Vaigai irrigation system. The double and single cropping lands receive the canal water from June to February. The rains are received in the months of August-November and the water is stored in the tanks. The tanks also facilitate the presence of a rich aquatic biome in this area. From June to February or even to the middle of March there will be some crop of rice in the fields. The invertebrate fauna of the rice ecosystem include the pest forms such as the brown planthopper, green and white jassids, leafroller, stemborer, gallfly etc. and non-pest forms like water beetles, water bugs, odonates, and a variety of other insects, earthworms and crabs. The tanks also harbour fishes, frogs, crabs and aquatic insects. Naturally these conditions attract a host of insectivorous birds to this ecosystem. A detailed observation was made on the insectivorous avian fauna visiting the rice ecosystem between May, 1979 and February, 1980 and the results are discussed below.

The observations were made at the Agricultural College farms, Chittankulam tank, Othakadai, Uthangudi, Ulaganeri, and the watersheds on the Madurai-Melur road extending upto Chittampatti. The field specimens were then and there compared with the authenticated guides by Fletcher and Inglis (1926), Ali (1941), Ali and Ripley (1969 and 1970) and Ganguli (1975) for nomenclature. The birds are classified in the following categories.

1. Very common: Seen on all the days in large numbers
2. Common: Seen on all days in less numbers
3. Less common: Seen on all days in less numbers at restricted places
4. Rare: Occasionally seen in singles or very few numbers.

The results are presented in Table 1. Among the birds the black drongo, *Dicrurus adsimilis* appears to be the most predominant insect hunter of the ecosystem. These birds usually perch on some convenient supports and capture their prey by sudden gliding sweeps. They were reported to feed more on injurious insects (Fletcher and Inglis 1926 and Thirumurthi and Abraham 1975). The myna, *Acridotheres tristis* also appears to be more useful and specific to insects. They always search on

TABLE 1

House Swift	*Apus affinis*	Very common
Palm Swift	*Cypsiurus parvus*	Very common
Green Bee-eater	*Merops orientalis*	Less common
Bluetailed Bee-eater	*Merops philippinus*	Less common
Indian Roller	*Coracias benghalensis*	Very common
Hoopoe	*Upupa epops*	Rare
Black Drongo	*Dicrurus adsimilis*	Very common
Grey Drongo	*Dicrurus leucophaeus*	Less common
Common Myna	*Acridotheres tristis*	Very common
Indian Tree Pie	*Dendrocitta rufa*	Rare
House Crow	*Corvus splendens*	Very common
Jungle Crow	*Corvus macrorhynchos*	Common
Redvented Bulbul	*Pycnonotus cafer*	Common
Common Babbler	*Turdoides caudatus*	Very common
Paradise Flycatcher	*Terpsiphone paradisi*	Rare
White Wagtail	*Motacilla alba*	Less common
Koel	*Eudynamys scolopacea*	Less common
Common Indian Nightjar	*Caprimulgus asiaticus*	Rare
Cattle Egret	*Bubulcus ibis*	Common
Pond Heron	*Ardeola grayii*	Very common
Night Heron	*Nycticorax nycticorax*	Common
Black bittern	*Dupetor flavicollis*	Less common
Yellow Bittern	*Ixobrychus chinensis*	Less common
Goldenbacked Woodpecker	*Dinopium benghalense*	Rare
Purple Sunbird	*Nectarinia asiatica*	Common
Indian Peacock	*Pavo cristatus*	Common

the ground for their prey. They are active throughout the day more in the non-cropped areas and harvested fields. The two species of the swifts could be also useful as reported by Thirumurthi and Krishnadoss (1981) for managing specific pest outbreaks. The wood-pecker, peacock, wagtail and babbler are less important as specific predators. The crows help to eradicate the pupae and soil insects at the time of ploughing and after the harvest. The majority of the Ciconiiformes are active around water. However, the pond heron, *Ardeola grayii* also visits the rice fields.

Among the birds the drongo, myna, swifts, roller and the pond heron are useful in the natural control of rice pests and their management, and hence deserve to be protected and encouraged.

ACKNOWLEDGEMENT

We wish to thank Dr. S. Jayaraj, the Director of Research, Tamil Nadu Agricultural University for his suggestions and for the facilities provided.

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12. A QUEER NESTING SITE OF BANK MYNA, *ACRIDOTHERES GINGINIANUS*

During the month of May, 1979, on my way to Dehra Dun from Corbett National Park by road I saw a number of a huge stacks of crushed and dried sugarcane laid on open fields, stored presumably for firing the "Gur Bhattis" (jaggery making plants) in the coming season. Long rows of round holes on the side of one of them in a field 4 kilometres south-east of Afzalgarh (Distt. Bijnour, U.P.) attracted my attention. On closer scrutiny the holes turned out to be those of a nesting colony of Bank Mynas. I could count as many as 171 nest holes in this rather large stack measuring approximately 12 m × 6 m × 5 metres. The sun was bright and warm at 11.30 a.m. Most birds were sitting near the nest holes with their beaks open.

Normally the Bank Myna builds its nest in holes in mud banks. Sálim Ali & Ripley (Vol. 5 page 182) describe nesting sites of this species as "steep earth bank of rivers, sides of disused brick kilns, kutcha wells and the like; commonly also stuffed within deep-holes in revetment of masonry bridges, and down shafts of brick-lined wells often shared out with house sparrows and pigeons".

The soft stacks of crushed dried sugarcane had apparently been utilised by the Bank Myna population for nesting in the area for want of the usual mud banks in the plain, tube-well-irrigated countryside. The improvised nesting site speaks highly of the adaptability of the species.

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13. THE 'BALLING' OF CROWS

The two of us were waiting at the Manali bus stand (Distt. Kulu, Himachal Pradesh) on 6th October 1980 for the bus for Delhi to leave. The time was 5-15 p.m. and a warm afternoon sun slanted over the western mountains to light up the autumnal glow of high altitude broad-leaved forests against a lovely sky full of expressive clouds in the wake of the previous few days of rain and cold.

Suddenly there was a tumultous noise of more than three hundred large crows circling effortlessly with considerable grace above us. The spectacle of their aerial mastery was breathtaking! The circling mass of sleek black birds seemed to have located a late afternoon thermal and they rapidly spiralled high up almost to become specks. Here they collected into a tight rotating mass of birds in the manner of 'balling' House Swifts. After a couple of minutes of this singular manouvre the birds separated and the flock drifted towards some Deodars high up on the eastern mountain slopes.

A roosting flock? A wintering group just arrived? One of our members Mr. Suresh Jain had found a dead crow the skin of which was brought to the Society for identification. It was identified as the jungle crow *Corvus macrorhynchos*.

LAVKUMAR KHACHER

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NARESH CHATURVEDI

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14. OCCURRENCE OF THE REDHEADED BUNTING (*EMBERIZA BRUNNICEPS* BRANDT) IN BOMBAY

March 2, 1980 while watching birds with Humayun Abdulali at the Golf Course in Colaba.

A yellow sparrow-sized bird was flushed almost underfoot. As H.A. turned to look it flew away towards a clump of trees. The brief glimpse was enough to elicit a guess of 'finch or bunting' from him. We followed and came upon three feeding almost hidden in grass three or four inches high. We were able to observe them at leisure. Not all of them had the same intensity of chestnut on the head and on the chin and bib. There were another five feeding a little further on. They all had some yellow on the undersides. Those with brighter chestnut heads had a stronger shade of yellow underneath. The beak was distinctly conical and the tail slightly but noticeably forked.

H.A. was almost certain it was the Redheaded Bunting and the following day he confirmed the identification stating that the:

> The Redheaded Bunting (*Emberiza brunniceps* Brandt) is a winter visitor to India, fairly common in Gujarat and in the Deccan as far south as Cudappah, Mysore and Coimbatore. There are, however, no records of this species from the Bombay area where the Blackheaded Bunting (*E. melanocephala* Scopoli) with which it is often associated, is common particularly in the Konkan during February and March.

On March 4, one Redheaded Bunting was seen in the same area. It was not shy. The yellow rump was easily visible when it hopped onto a water pipe. When feeding on the ground the yellow rump is concealed by the folded wings. Further away towards the seaward end of the Course a party of thirteen was seen. Four had rich chestnut heads, the colour extending below the chin into an untidy bib. The rest were grey-brown near the beak and fading into a dull grey at the outer limits of the crown and throat but all showed some yellow below. Seven were seen in the same area on April 11, and four on May 6.[1]

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12 REVATI,
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June 10, 1980.

[1] As a postscript the birds have been again found in the same area in March 1981 on two occasions —in groups of three and four.

15. AGE AT ONSET OF SEXUAL MATURITY IN MALE INDIAN MUGGER (*CROCODYLUS PALUSTRIS*, LESSON) REARED UNDER IDEAL HUSBANDRY CONDITIONS IN CAPTIVITY

INTRODUCTION

Captive crocodiles maintained under ideal husbandry conditions show extremely rapid growth (see below and Bustard, Singh & Choudhury, in press). It might be expected that this would lead to early onset of sexual maturity. Whitworth (1971) cites an instance of a female alligator (*Alligator mississippiensis*) which exhibited an extremely rapid rate of growth in captivity, and mated, nested and produced eggs at 4 years of age, i.e. over five years younger than the normal age of sexual maturity in the wild (McIlhenny 1934 and Cott 1961). Joanen and McNease (1975) also concluded that in the alligator sexual maturity is dependent on size rather than age, and Nichols & Chabreck (1980) consider that enhanced feeding, leading to much faster growth, can result in earlier breeding in the alligator.

This paper investigates the relationship between growth rate and attainment of sexual maturity in a crocodile species—the Indian mugger (*C. palustris*).

Materials and Methods

A group of five hatchling mugger was obtained from Hoggenakal Water Falls (12°7′N, 77°80′E) on Cauvery River in Dharmapuri District of Tamil Nadu, and brought to the Gharial Research and Conservation Unit at Tikerpada, District Dhenkanal, Orissa, for captive rearing on 14 August 1975. This group had hatched during April 1975. They were reared under the rearing conditions described by Bustard (1975) and Bustard, Singh and Choudhury (in prepn.).

Tikerpada and the adjacent Mahanadi River are in the natural habitat of the mugger and three wild individuals are known to presently inhabit the adjacent stretch of the Mahanadi which during the floods comes to within 25 m of the Research Centre.

Results

Growth was rapid under the ideal husbandry conditions prevailing (Bustard, Singh and Choudhury, in prepn.) and presumed breeding size of 1.62 to 1.73 m was obtained by four males after two years and six months by which time the penes of the males were greatly enlarged (at least 10 cm). No female mugger of comparable size were available in the Unit to conclusively prove copulation and successful insemination of females at this age. However, strong corroborative evidence of their sexual maturity was obtained from the following indirect evidence:

1. From December 1977, a wild female mugger living in the adjacent stretch of the Mahanadi river was repeatedly attracted to the rearing enclosure at the centre which held the males (mean length 1.64 m). This behaviour was very frequent in December 1977 and January to February 1978, (the 1977/78 breeding season) and again from November 1978 to January 1979 (when this female was captured) (Singh 1979, Singh and Bustard, in prepn.). The attraction is considered to result from olfactory stimuli from the male mugger in the Centre which may have reached the female in the river via water drained out of the pools.

The attractiveness of these male mugger to the female in the adjacent river suggests that they had attained sexual maturity by the age of two years and six months.

2. Following her capture, frequent courtship and mating was observed during February 1979 by the two males of May 1975 stock retained at the Centre. This is further strong evidence that the two males were sexually mature. However, at the time of these actual matings (following the capture of the female) the males were three years and eight months old and between 1.7 to 2.1 m length.

No eggs resulted from these matings in the 1979 breeding season. However, this could be due to sexual incompatibility or other factors (Singh and Bustard, in prepn.) and not due to inability of the males to successfully inseminate the female.

Discussion

Taken together, the above data suggest that these two male mugger had probably attained sexual maturity at $2\frac{1}{2}$ years old (mean length 1.64 m) and certainly by about $3\frac{1}{2}$ years old (mean length 2.09 m). It is our belief that these mugger could have successfully mated had suitable females been present during the December 1978—February 1979 mating season at an age of three years and six to eight months.

The youngest definitely recorded breeding age for the female Indian mugger at present is six years (Choudhury, in prepn.) and six or seven years (Whitaker, pers. comm.).

These data indicate that attainment of sexual maturity, in atleast some races of the Indian mugger, can occur remarkably quickly. This finding has two important implications:

(a) A practical application in the development of crocodile farms. A crucial handicap in the use of saltwater crocodile (*Crocodylus porosus*) is that individuals of this species take approximately 10 years (12 to 15 years; Yangprapakorn 1971) to reach sexual maturity. This means that a long period has to be devoted to building up the captive breeding herd before any breeding takes place. The fast breeding, of at least some mugger strains, would overcome this difficulty. Growth in captivity in this species can also be excellent (Bustard, Singh & Choudhury, in prepn.).

(b) Ecological resilience of the species. If, under ideal conditions in the wild, early onset of sexual maturity and breeding is a possibility, the survival prospects for the species will be enhanced. Indeed, early onset of sexual maturity in the mugger, as compared to the much larger gharial (*Gavialis gangeticus*) and saltwater crocodile (*Crocodylus porosus*), a phenomenon seen in most if not all of the smaller crocodilian species, is undoubtedly one reason for the better survival of this species in India at the end of the heavy hunting phase.

These limited data are noteworthy as they are based on the 'grow and release' technique (Bustard 1974, 1975) under which crocodiles are grown under ideal husbandry conditions for quick release back into the wild. Most captive crocodiles in Indian and overseas zoos are kept under distinctly suboptimal husbandry conditions and as a result exhibit greatly reduced growth compared to what is possible. Consequently the onset of sexual maturity may be retarded by many years. Unfortunately such data come to be accepted as the norm.

The whole topic of size/age/sex relationships is in need of attention (Bustard, in prepn.). It is not known if there is an age or size 'over-ride' in crocodilians, that is, if crocodilians have to attain a certain *age* before they can breed irrespective of their size. The above data suggest that breeding can perhaps be speeded up following very fast juvenile growth and that there is probably not an absolute age 'over-ride'. These results are more noteworthy since they are achieved with males which one might expect to attain sexual maturity later than females, a point also made by Cott (1961), Yangprapakorn (1971) and B. C. Choudhury (pers. comm.). This is clearly a topic on which further research is required. Data are being assembled by our group on all three species of Indian crocodilians but this will take some years.

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16. GHARIAL ATTACKS ON MAN

Malcolm Smith (1931) stated of the gharial, "Very occasionally they will attack man, but they are not much feared on this account."

In over 6 years' experience, we know personally of only one attack on man by a gharial. The details of this attack are set out below together with information on three other 'attacks' which we have been told about during survey trips.

On 14th November 1979 at Tasera on the Mahanadi river in the Satkoshia Gorge Sanctuary of Orissa, an old man, Sankara Behera, aged 55 years, had his left arm caught by a young male gharial, 3-3.7 m in length, while Sankara was washing his utensils in the water from the river bank. The gharial, probably waiting to emerge at this preferred basking spot, was not observed by Sankara as the water was turbid due to waves washing the bank. The old man was either pulled or slipped into the river but the gharial did not retain its hold on his arm. Fortunately the old man's son, Barju Behera seeing the predicament of his father, came to his rescue in a canoe and pulled him by his hair into the boat. As the son dragged his father into the boat the gharial again caught the man by his right thigh and released him immediately. The man was hospitalised and recovered.

Both of us have seen Sankara subsequently and can testify to the extensive scars on the left forearm and right thigh resulting from lacerations caused by the fish-holding (piercing) teeth of the gharial's elongated jaws.

Information on three other attacks, all in Orissa, reported to us, is set out below:

1. A female gharial was known to be guarding its nest on the river bank at Naraj on Mahanadi river. The attack took place prior to 1974, when a visitor to the riverside village went down to the water's edge after nightfall to take his bath in the river. The local villagers knew and avoided that exact spot where the female gharial was guarding its nest, located in the sandbank near the water's edge. The visitor, unaware of the nest, approached this site and had his ankle 'nipped' by the nest-guarding female. No injury was sustained—probably the gharial was merely trying to warn him away from the nesting site as is known to occur in *C. porosus* (Bustard and Choudhury 1980).

2. Around 1974 a local fisherman, also from Naraj village was bitten in the chest area when he dived under water to release his fishing nets which had become snagged on what he thought to be some rocks. He was immediately released and sustained only minor injuries.

3. A similar incident happened about twentyfive years ago to a fisherman near Talchar on the banks of the River Brahmani,

formerly a good gharial habitat. The man survived the injuries and died only in 1979.

The above incidents, and their rarity, confirm Malcolm Smith's statement, and also indicate how a human death in a crocodilian habitat can be interpretated as being 'only' due to crocodilian attack. Had the son not rescued his father in the instance described by us, the old man would have drowned as he was unconscious, probably from shock. This would have led to the gharial being blamed for the man's death and perhaps even accused of eating him.

We would be interested to learn of other authenticated instances of gharial attacks on man.

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17. A NOTE ON THE SLENDER CORAL SNAKE, *CALLOPHIS MELANURUS*

During the course of snake collection in district Dhar, we obtained specimens of the coral snake *Callophis melanurus*.

Specimens were collected in the early morning during the months of November and December 1980. Collection during morning hours indicates that the snakes are most active during night hours. The collected specimens measured 20 to 30 cm in length and 4 to 5 cm in circumference. This snake is unique in appearance. The head and neck are black in colour having two distinct spots on the top of the head and rest of the body is light pink in colour. The tail has two black rings—one ring at the tail base and other at the tail tip. Poison fangs are well developed. Males are longer than females.

For studying the general biology of the snakes, specimens were kept in large aquaria with a surface of sand. The animals burrowed into the sand, just keeping their heads above the sand. Excited animals curled their tail up and waved it. A few petridishes were kept filled with water for drinking purpose. Worm snakes *Typhlops braminus* were provided as food. Coral snakes fed on worm snakes.

In Maharashtra it is believed that if this snake bites at night, the victim will die before day break. Hence it is known as "Raat" (= night).

So far this snake has not been reported from Madhya Pradesh. Hence, this report is first from (Dhar) Madhya Pradesh.

Presence of Coral snake, *Callophis melanurus* at Dhar district suggests that these sankes are not only located in the regions mentioned above, but also in the Malwa region of Madhya Pradesh.

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18. ON A COLLECTION OF COBITID LOACHES OF THE GENUS *NOEMACHEILUS* VAN HASSELT FROM POONCH VALLEY (JAMMU AND KASHMIR)

Cobitid loaches of the genus *Noemacheilus* van Hasselt (sub-family: Noemacheilinae) are typical rheophilous teleosts which prefer pure- oxygen-rich waters with sandy or gravelly bottoms and are met with in the rivers and streams of mountainous Asia, Bulgaria, Macedonia, Europe, Turkey, the Transcaucasian region and England. During the course of extensive collections of aquatic fauna undertaken by me in Poonch Valley from 1971 to 1973 six species of *Noemacheilus* were collected, out of which three species are being reported from Poonch Valley for the first time.

Species	Locality	Previous record from Poonch Valley
1. *Noemacheilus botia* (Ham.)	Ponch River	Das & Nath (1971)
2. *N. gracilis* Day	Poonch River and Sooran torrent	Sharma & Sharma (1974)
3. *N. kashmirensis* Hora	Poonch River and Sooran torrent	Sharma & Sharma (1974)
*4. *N. rupicola* McCl.	Poonch River and canals	—
*5. *N. marmoratus* (Heckel)	Sooran torrent	—
*6. *N. vittatus* (Heckel)	Sooran torrent	—

* New Record.

Noemacheilus botia (Ham.) occurs in Sind, Punjab, Assam, the upper regions of the Ganges and Jumna, the Nurbudha, as well as Ceylon (Day 1878). Singh (1964) recorded it from the Doon Valley while Khan & Kamal (1979) reported this species from River Kosi (Bihar). There is no record of this species from Kashmir Valley so far and the only previous report of its occurrence in Jammu & Kashmir State is by Das & Nath (1965) and Das & Nath (1971), who reported it from Poonch Valley. Subsequently, Malhotra, Jyoti & Dutta (1975) recorded it from the fish ponds at Gadigarh (Jammu).

N. gracilis Day is a high altitude cobitid which inhabits the head waters of the Indus (Day 1878). Silas (1960) and Das (1965) reported it from Kashmir Valley, while Sharma & Sharma (1974) recorded it from Poonch

River and adjoining streams. The latest record of this species is from Ladakh by Talwar (1978).

N. kashmirensis Hora is endemic to Kashmir Valley (Silas 1960). It was reported by Sharma & Sharma (1974) from Poonch Valley for the first time but has not been reported from Jammu (Tawi) so far.

N. rupicola McCl. is abundant in Kashmir Valley (Das 1965) and the Doon Valley (Singh 1964). Khan & Kamal (1979) reported it from River Kosi (Bihar). It is the most abundant cobitid loach of Poonch Valley, being found in Poonch River, rivulets, ponds, pools, tanks as well as large drains and rice fields. There being no previous record of this species from Poonch Valley, the present report is an extension of range of this species. It has not been recorded from Jammu (Tawi) so far.

N. marmoratus (Heckel) is a basically lacustrine species, which is abundant in Kashmir lakes (Silas 1960, Das 1965). It was collected from Sooran torrent (Poonch Valley) by me and is a new record for that region.

N. vittatus (Heckel) is also endemic to Kashmir Valley (Silas 1960) but has not been recorded from any part of Jammu Province so far. The present report of the occurrence of this species in Poonch Valley (Sooran torrent) is, therefore, a new record for Jammu Province.

A comparison of the ichthyofauna of Kashmir Valley with that of Poonch Valley reveals that there is a relatively low endemicity of the fish fauna in the river systems of Poonch Valley. Probably a geologically-sufficient time lapse has not occurred for the fishes in Poonch Valley to evolve into new species, which offers a sharp contrast to the ichthyofauna of the older river systems of Kashmir region (Das & Nath 1965, 1971).

ACKNOWLEDGEMENTS

I am thankful to Dr. A. G. K. Menon, Dy. Director, Southern Regional Station, Zoological Survey of India, Madras and Dr. A. K. Datta of the Zoological Survey of India, Calcutta, for confirming the identification of the present collection.

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19. OCCURRENCE OF *ZEBRIAS JAPONICUS* (BLEEKER) (SOLEIDAE: PISCES) IN THE BAY OF BENGAL, OFF VISAKHAPATNAM

(*With a text-figure*)

Eight species of the genus *Zebrias* Jordan and Snyder, 1900, have so far been recorded from Indian waters (Day 1878, Norman 1928, Talwar & Chakrapani 1967, Rama Rao 1967, Yazdani 1976, Joglekar 1976, Oommen 1977). Another species identified as *Zebrias japonicus* (Bleeker), was collected from the trawl catches off Visakhapatnam. The only other region of its occurrence is Japan (Talwar & Chakrapani 1967) and Taiwan waters (Chen and Weng 1965). As it is recorded for the first time from India, a short description is given (Fig. 1). Synonymy of the species is given by Chen & Weng (1965).

Material: One specimen measuring 100.0 mm in standard length, from trawl catches, off Visakhapatnam on 28-10-79.

Counts: D. 85; A. 72; P. (eyed) 9; P. (blind), 5 (rudimentary); V. 5; C. 17; L. 1. 95; Vertebrae 44 (from radiograph).

Measurements: In standard length: Head length 5.5; Body depth 2.9; In head length: Snout length 3.6; Eye diameter 3.6; Pectoral fin length (eyed) 2.0.

Description: Body elongate, elliptical, gradually tapering posteriorly; head small; eyes separated, upper eye slightly in advance of lower eye. Interorbital space about half of eye diameter. Anterior nostril on ocular side a long tube, backward, reaching anterior border of lower eye, posterior shorter than anterior, covered by a flap. Mouth moderate, curved; Papillae are present on blind side from upper lip to dorsal fin beginning with series of fringes along opercular margin. Teeth developed on blind side only. Scales rough, strongly ctenoid on both sides. Head and interorbital space covered with scales. One straight lateral line on

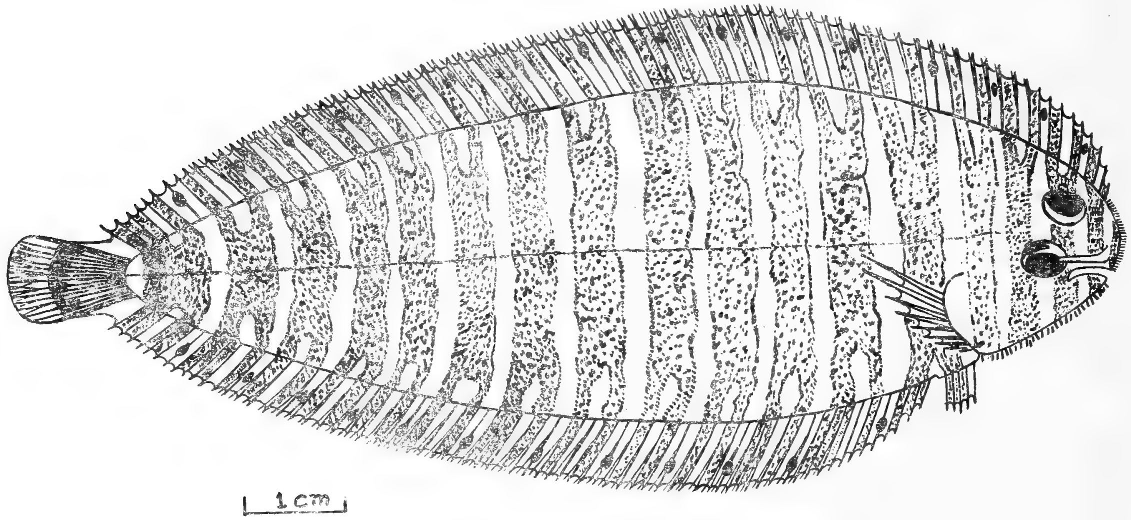

Fig. 1. *Zebrias japonicus* (Bleeker).

both sides. Dorsal fin beginning on dorsal profile above upper eye. Dorsal and anal rays branched up to half their length, excepting anteriormost and posteriormost. Dorsal and anal partially confluent with caudal. Caudal fin rounded, rays (excluding upper and lower two) branched. Pectoral fins asymmetrical with unbranched rays; small and rudimentary on blind side. The upper rays of right pectoral prolonged. Pelvics symmetrical.

Coloration: Colour in formalin pale brown, with 18 cross bars from caudal to head, which are wavy and forked on dorsal and anal fins. A black spot on the dorsal and anal fins between the extensions of the cross bars. Dorsal and anal fins on blind side bluish black; caudal black, edge milky white. Blind side white.

Remarks: The description of the specimen under report agrees with that given by Chen & Weng (1965) for *Z. japonicus* from Taiwan. It also agrees with the counts of lateral line scales and caudal rays; and morphometric measurements of the body depth and head length mentioned for the Japanese specimen by Talwar & Chakrapani (1967). The present specimen however differs from the Taiwan specimen in having more number of dorsal, anal, caudal, pectoral fin rays and lateral line scales (78,65,16,4 and 85 respectively in Taiwan specimen). These differences may be attributed to geographic variation.

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20. BOTANY AND ENTOMOLOGY AS SUPPLEMENTARY SCIENCES

In my paper "Moth Migration in Mombasa —1955/1977" (1979, *J. Bombay na. Hist. Soc., 75* (3): 618-624) I wrote that larvae of the suspected lymantriid migrant, *Sapelia tavetensis* Holl., had once been found on an unidentified tree belonging to the Bombacaceae. This is wrong, and the tree has now been positively identified as *Sterculia foetida* L. (Sterculiaceae), a native of southern India and Sri Lanka.

The final identification of this tree is an interesting example of how the two sciences, botany and entomology, can supplement each other.

The tree, obtained as a seedling from a local nursery garden was unnamed and for many years a keen botanist friend and myself have puzzled over its identification. The fruit, form of growth and digitate leaves all pointed to the Bombacaceae, the flower was *Sterculia*-like, but no East African Sterculiaceae has digitate leaves. Finally, one of the two recorded food-plants, *Ochromus lagopus* belongs to the Bombacaceae, and there was no record of any Sterculiaceous food-plant.

A recent paper by M. Edmunds "Contrasting methods of survival of two sympatric cotton stainer bugs (Hem., Pyrrhocoridae) in Ghana during food shortage" (1979, *Entomologist's mon. Mag., 114*: 241-244) recorded that both *Dysdorcus veelkeri* Schmidt and *Odontopus sexpunctatus* Castelnau fed on fallen fruits of *Sterculia foetida* (presumably introduced) in Ghana. In my garden a number of Pyrrhocorids feed on the seeds of *Calotropis procera* (Asclepiadaceae) and, when these are not available, feed on the fruits of the mystery tree. This suggested that it might, after all, belong to the Sterculiaceae, and a detailed and intensive search in available botanical literature finally produced the definite identification of *Sterculia foetida* L.

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21. NOTES ON THE CARPENTER ANT *CAMPONOTUS IRRITANS* (SMITH)

The Carpenter Ant (*Camponotus irritans*) is fairly common in the Indian desert, being extra-ordinarily tolerant of heat. This highly predaceous insect is of considerable ecological and biological interest. The observations made on this insect from March 1978 to October 1979 in the Indian desert are reported here.

Its nest colonies are largely found on calcareous soils, preferably small mounds of such soil in sandy biotopes and so also in stony and rocky areas. The nest colony is usually solitary but at favourable sites three or more nests colonies were observed three metres apart. The opening of the nest measures about 0.5 cm × 4.0 cm. The ant is an active predator, capturing insects even five times larger than itself. As soon as it comes across a prey it at once catches it and begins to drag it to its colony, the prey unsuccessfully struggles to escape but dies on the way while being taken to the nest colony. The Common Black carpenter ant (*Camponotus compressus*) is the most common prey, the next are termites, small beetles (largely *Protaetia cuprea*) and caterpillars of moths and larvae of several insects. It was noted that cannibalism is also prevalent, injured or weak ants are caught and taken into the nest colony.

Its daily activity is paradoxical to normal practices of other animals. It begins to move out after sunrise and becomes more active with rising of temperature up to 50°C, whereas most of animals in the desert take shelter when temperature rises above 35°C and solar radiation above 40 cal/cm^2 hr. It is further noteworthy that it ceases to be active and goes underground when solar radiation is below 30 cal/cm^2 hr. In the winter it remains active during the mid-day when temperature rises above 28°C or solar radiation above 40 cal/cm^2 hr.

It takes out excavated soil in wet pellet form and drop these out of the mouth of the nest as does other ants. Co-operation for dragging of a large sized prey was lacking.

It was noted that it dislikes rain and plugs the mouth of the nest with sand during rain. When accumulated water level rises to the mouth of the nest another opening is made at a higher level nearby and if necessary the nest colony is shifted to a nearby elevated site.

Its eggs and youngs were observed largely in the premonsoon season, i.e. late in June.

Babblers (*Turdoides caudatus* and *T. striatus*), crows (*Corvus splendens* and *C. macrorhynchos*), *Calotes versicolor* and *Varanus* spp. etc. were observed preying on the carpenter ant.

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22. ACTIVITY AND ABUNDANCE OF FLOWER VISITING INSECTS OF ALMOND (*PRUNUS AMYGDALUS* BATSCH) AT LUDHIANA (PUNJAB)

Almond is an important fruit crop of hill regions of India. In the Punjab plains also this crop gave encouraging results at the almond orchard of the Punjab Agricultural University, Ludhiana. Due to this, the area under this crop is increasing in the Punjab. The almond flowers are 2.5 to 3.8 cm in diameter and have a single pistil with two ovules. The flower is self incompatible and, thus, the cross pollination of the flowers is a must for obtaining the almond crop. Secondly the pollen is also not wind blown, which leads to more dependence on insect pollinators.

Taking this in view, the flower visiting insects of almond at the almond orchard of the Punjab Agricultural University at Ludhiana were recorded from 9.00 a.m. to 5.30 p.m. at hourly intervals. There were 5 replications and each tree served as one replication. The observations were recorded for 5 minutes on each tree. The observations were repeated thrice at weekly interval in March 1979, which was a peak flowering season of the year under study.

The honeybees, i.e. *Apis mellifera* Linn., *A. dorsata* Febr. and *A. florea* Fabr. were the dominant flower visitors. The maximum population was that of *A. dorsata* (Table 1). Some dipterous flies also visited the flowers but their

TABLE 1

ACTIVITY AND ABUNDANCE OF FLOWER VISITING INSECTS OF ALMOND DURING MARCH, 1979

Name of species	9 h	10 h	11 h	12 h	13 h	14 h	15 h	16 h	17 h	Total
	Number of insects/5 trees at									
Apis mellifera	0	2	9	12	16	12	13	12	10	86
Apis dorsata	7	16	44	33	33	12	21	11	7	184
Apis florea	1	1	6	5	6	4	1	2	1	27
Total	8	19	59	50	55	28	35	25	18	297

number was negligible. In the earlier reports on almond pollination honeybees have been reported practically the only pollinating insects of economic importance (Muttoo 1950, Purdie and Winn 1965, McGregor 1976). The period of maximum activity of all the three species of honeybees was from 11.00 a.m. to 1.00 p.m. *A. dorsata* started visiting the flowers in sufficient numbers even at 9.00 a.m. than the other species of bees. *A. mellifera* was active even upto 5.00 p.m. The activity of all the flower visiting insects was very low on cloudy days.

In conclusion, honeybees were the only dominant flower visiting insects of almond at Ludhiana.

ACKNOWLEDGEMENTS

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23. BUTTERFLIES OF ARUNACHAL PRADESH

Altitudinal zones of the Eastern Himalayas have their own fauna. The ecosystem varies from west to east and the altitudinal zones are sharply defined and telescoped into tightly packed tiers of life zones. Considering the importance of North Eastern Himalaya as a gateway for oriental biota in the peninsula a thorough ecological survey of the area is essential especially in the face of rapid man made environmental changes. One such expedition was organised jointly by the Bombay Natural History Society and the Smithsonian Institution, Washington D.C. for the avifaunal survey of the Arunachal Pradesh. During the survey party also collected butterflies from this area.

In the past butterflies of North Eastern India had been studied by several persons but very little collection had been made from Tirap division. [Varshney & Chanda (1971) *Ind. Mus. Bull.* 6(1) 28-53]. The present report deals with the small butterfly collection made by Mr. S. A. Hussain and Mr. Rex Pimento in 1979 at Tirap division. Tirap Frontier division is in the extreme east of Arunachal Pradesh adjoining the Kachin District of Burma over the Patkai range of hills. Collection was done at Miao *c.* 300 m from 3rd to 8th March and Bhimraj (40th mile camp from Miao) from 10th to 25th March, 1979.

Family : DANAIDAE

1. **Danaus aglea** (Kluk) Glassy Tiger. Common.
Distribution : Assam, Burma.
2. **Danaus melaneus** (Cramer) Chocolate Tiger. Common.
Distribution : Sikkim to Assam and Burma.
3. **Danaus sita** (Kollar) Chestnut Tiger. Not rare.
Distribution : Shillong, Khasi Hills, Assam and Burma.
4. **Danaus melissa** (Cramer) : Dark Blue Tiger. Common.
Distribution : Kulu to Burma and Assam.
5. **Euploea mulciber** (Cramer) Striped Blue-Crow. Common.
Distribution : Assam and Burma.

Family : SATYRIDAE

6. **Lethe bhadra** M. Tailed Labyrinth. Rare.
Distribution : Sikkim to Burma.
7. **Lethe sinoryx** Hew. Tailed Red Forester. Rare.
Distribution : Sikkim to Burma.
8. **Ypthima baldus** F. Common Fivering. Very Common.
Distribution : Chaneba to Assam and Burma.
9. **Orsotrioena medus** F. Nigger. Common.
Distribution : Sikkim to Assam and Burma.
10. **Elymnias hypermnestra** Linn. Common Palmfly. Common.
Distribution : Bengal, Assam and Burma.

Family: NYMPHALIDAE

11. **Apatura ambica** Kollar Indian Purple Emperor. Not rare.
Distribution : Burma.
12. **Euthalia kesava** (Moore) Powdered Baron. Common.
Distribution : Sikkim to Assam and Burma.
13. **Limenitis daraxa** (Doubl.) Green Commander. Not rare.
Distribution : NE India, Burma.
14. **Pantoporia selenophora** (Kollar) Staff sergeant. Rare.
Distribution : Assam, Bihar, Burma.
15. **Neptis hordonia** Stoll Common Lascar. Common.
Distribution : Dehra Dun to Assam, Burma.
16. **Precis almana** (Linn.) Peacock Pansy. Common.
Distribution : Throughout India and Burma.
17. **Vanessa cardui** (Linn.) Painted Lady. Very common.
Distribution : Throughout India, Assam and Burma.
18. **Cethosia biblis** (Drury) Red Lacewing. Common.
Distribution : Nepal, Sikkim, Bhutan, Assam and Burma.

19. **Ergolis merione** (Cramer) Common.
Distribution: Assam and Burma.

Family: ERYCINIDAE

20. **Abisara neophron** (Hewitson) Tailed Judy. Not rare.
Distribution: Nepal, Hills of NE India, Burma.

Family: LYCAENIDAE

21. **Castalius rosimon** (Fab.) Common Pierrot. Common.
Distribution: Throughout India and Burma.
22. **Heliophorus epicles** (Fruh.) Purple sapphire. Common.
Distribution: Kumaon to Assam and Burma.
23. **Cheritra freja** (Fab.) Common Imperial. Common.
Distribution: Kumaon to Assam and Burma.

Family: PAPILIONIDAE

24. **Papilio protenor** (Carmer) Not rare.
Distribution: Assam and Burma.
25. **Papilio helenus** (Linn.) Red Helen. Common.
Distribution: Mussoorie to Assam and Burma.
26. **Graphium sarpedon** (Linn.) Common Blue Bottle. Common.
Distribution: Kashmir to Assam and Burma.
27. **Leptocircus curius** F. White Dragontail. Not rare.
Distribution: Assam and Burma.

Family: PIERIDAE

28. **Pieris canidia** (Spairman) Indian Cabbage White. Very Common.
Distribution: Himalaya and Hills of Assam and Burma.
29. **Pieris brassicae** (Linn.) Large Cabbage White. Very Common.
Distribution: Assam.
30. **Ixias pyrene** (Linn.) Yellow Orange Tip. Common.
Distribution: North West Himalayas to Assam and Burma.
31. **Dercas verhuelli** (Doub) Tailed Sulphur. Not rare.
Distribution: Sikkim to Assam and Burma.

Family: HESPERIDAE

32. **Baoris farri** (Moore) Paint Brush Swift. Not rare.
Distribution: Sikkim, Bengal, Bihar, Assam to Burma.
33. **Polytremis eltola** (Hewitson) Yellow Spot Swift. Common.
Distribution: Assam.

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24. NEW RECORD OF *HELIOTHIS PELTIGERA* DENIS AND SCHIFFERMULLER ON SUNFLOWER

Sunflower (*Helianthus annuus* Linn.) is a new introduction as an oilseed crop in the Punjab State. Because of its unique organoleptic and other properties it can be exploited for a variety of purposes. A detailed bibliography of insects associated with this crop throughout the world had been reported (Rajamohan 1976). Twenty nine species of insects and one species of mite had been reported feeding on sunflower in Tamil Nadu (Rangarajan *et al.* 1973); 42 species of insects, 2 mites and one bird from Punjab (Sandhu *et al.* 1973). *Heliothis peltigera* was recorded causing damage to sunflower during April-May in 1978 and 1980 at Ludhiana (Punjab).

Occurrence of *H. peltigera* on sunflower is a first report from India. The larvae feed on leaves and flower heads. One to six larvae were observed feeding on a single head. Infestation was comparatively more in the semi-opened heads. Fully-opened heads and closed flower heads had fewer larvae in them. Initially the larva attacked the bracts and later started feeding on developing seeds. Advanced stage larvae bored deep into the flower head.

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25. NOTES ON THE MATING BEHAVIOUR IN *LACCOTREPHES GRISEUS* GUER AND *L. ROBUSTUS* STALL (HETEROPTERA: NEPIDAE)

(*With a text-figure*)

INTRODUCTION

Information pertaining to the mating behaviour of aquatic insects, in particular Nepidae, is meagre except for the passing observations by Rao (1969) on *Laccotrephes griseus* Guer. In the course of the bio-ecological studies of South Indian aquatic Hemiptera of the family Nepidae, it was found that various factors-visual, tactile and chemical-play an important role in the pre-mating and mating as well as the ovipositing behaviour of many species of aquatic insects. The present paper deals with the ethology of mating in two common South Indian Nepidae *Laccotrephes griseus* Guer and *L. robustus* Stal.

Materials and methods

Adults and nymphs of *L. griseus* and *L. robustus* were collected during the months of October and November 1978 from temporary and permanent ponds around Madras and reared in trays of 31 × 24 × 7 cm provided with a 2.5 cm layer of mud at the bottom and 1.5 cm thickness of water above the substratum. The trays were provided with aquatic plants or straw, making the medium as nearly natural as possible. The insects were fed regularly on mosquito larvae. The water in the tray was renewed at intervals of three days. In order to assess the role of visual sense in the act of mating, the compound eyes of adults were painted with white dye. Antennae were amputated to find out their role in mating.

Observations

Mating instinct begins 4 or 6 days after the final moult. Prior to mating, the male of *L. griseus* exhibits a specific dancing behaviour. It lifts up its right raptorial foreleg so as to contact the left foreleg of the female and rubs against it. Rubbing continues until the female responds. If the female does not respond, the male swims away. A positive response from the female is the raising of its left foreleg towards the male, a unique nuptial dancing follows. The left and the right raptorial forelegs of the couple are pushed and pulled alternately. This process lasts from 3 to 5 minutes, whereupon the male slides fast along the female till it contacts the genitalia and mounts at once. The female is observed to brush its genital segments with the help of its posterior pair of legs. On mounting the female, the male holds her by the forelegs in the region of the 2nd and 3rd thoracic legs and copulation ensues. When in copula, interruption by another male elicits an aggressive behaviour from the couple. The copulating male as well as the female use their third pair of legs to chase away the intruder by pushing and kicking. The sexual excitement of the male is such that it often mounts 4th or 5th nymphal instars only to be dismounted at once. In laboratory experiments, when more than one male is exposed to a female, competition follows and the stronger one succeeds in mounting the female. Often the unsuccessful males interfere with the copulating pair so much that the latter is forced to separate.

The duration of copulation is, on an average, 15 minutes in *L. griseus* and 19 minutes in *L. robustus* (vide Table 1). The minimum and maximum duration of copulation in the former are 12 and 18 minutes respectively, and 15 to 22 minutes respectively in the latter. The frequency of mating appears to be higher at night between 9 and 12 p.m. (Fig. 1) correlated with the nocturnal habit of these species. Phoresic behaviour in mating is not noticed in *L. robustus* while it is quite common in *L. griseus*.

Table 1

Duration of copulation in the species of Nepidae

Species	Time taken in minutes			
	Range	SD	Maximum	Minimum
L. griseus	14-16	16 ± 3.1	18	12
L. robustus	18-20	19.6 ± 1.28	22	15

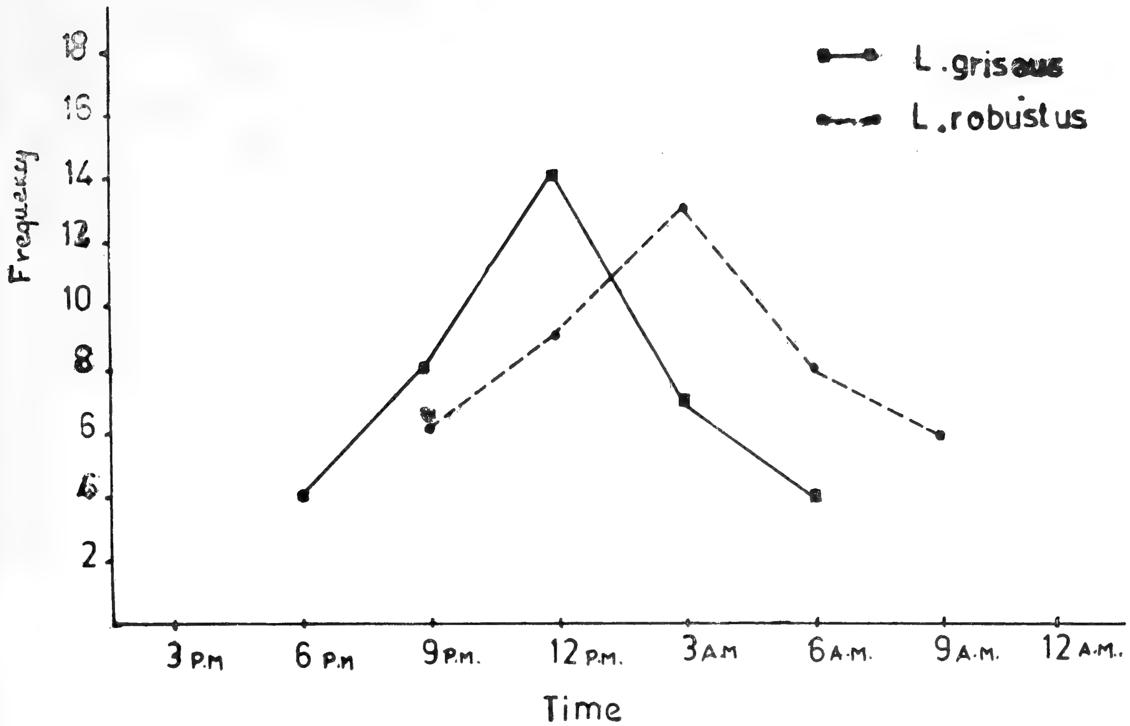

Fig. 1. Peak of copulation in two species of Nepidae.

Tactile sense appears to play but a minor role in the mating prelude, for males with amputated antennae behave very much like normal forms although the time taken to explore the female appears to be a little longer. On the other hand, the visual sense appears to be of immense value in the recognition of opposite sexes. Males with their compound eyes painted with white dye are found to wander aimlessly and contact the females accidentally. Once they establish contact, the sequence of courtship behaviour is found to be normal.

Oviposition

The selection of site for egg-laying and the oviposition behaviour are quite distinct in *L. griseus* and *L. robustus*. Oviposition commences 6-8 days after copulation in *L. griseus,* while in *L. robustus* the preoviposition period appears to be longer, being 11-13 days. In both the species, the females appear to be very active in searching for a suitable place for egg-laying. *L. griseus* lifts its ovipositor and taps the soil apparently to test the suitability of the soil, while this behaviour is lacking in *L. robustus*. Once a suitable site is selected, the female of *L. griseus* opens and closes the valves of its ovipositor rhythmically and lays the eggs in groups of 8-12. The eggs adhere to its sides by means of a slimy substance which it secretes, and are then inserted one by one into the smooth soil by bending the tip of the abdomen. The eggs are arranged compactly and regularly with their anterior filamentous ends projecting outwards like a bouquet. In contrast to this behaviour, *L. robustus*, which lays, on an average, 16 eggs at a time, shows no preference to the nature of soil nor does it show any specificity in the process of oviposition. After oviposition is accomplished, the females of both the species become exhausted and passive and they resume their mating activity in two days.

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REFERENCE

RAO, T. K. R. (1969): Bioecological studies on some aquatic Hemiptera. Ph.D. thesis. Madras University.

26. *CYSTIPHORA TARAXACI* KIEFFER (DIPTERA: CECIDOMYIIDAE) MINING THE LEAVES OF *TARAXACUM OFFICINALE* WEBER (COMPOSITAE) IN KASHMIR

Members of the gall-midge genus *Cystiphora* Kieffer are exclusively restricted to Compositae and have not been recorded from any other host. The genus so far was considered to be confined to Europe and north America (Delfinado and Hardy 1973). This is the first report of its occurrence in India.

I have come across larvae of *Cystiphora taraxaci* making small circular mines, 2-4 mm across, below the cuticle on the under-surface of the leaves of the common meadow dandelion, *Taraxacum officinale* in Kashmir. On the dorsal leaf surface, the mines are represented by bright reddish-purple pustules which are slightly raised above the general leaf surface. The central area of the pustules is of a lighter shade. Although generally these pustules are randomly distributed over the leaf surface, they sometimes have the tendency to aggregate towards the terminal portion of the leaf.

The mines are locally common and sometimes are so abundant that it is rare to find an unaffected plant. Ecologically, these mines are regarded as intermediate forms between mines and the galls, and can be equally considered under either of these categories (Hering 1951).

Each mine contains a single pale coloured larva which later turns orange-yellow as it attains maturity. The larva lies sluggishly in the centre of the mine and apparently lives on the sap seeping constantly from the wound made by it in the leaf tissue. Pupal period lasts from 8-9 days. There are 3-4 overlapping generations under field conditions during the period June-Sept. The midges over-winter as pupae.

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27. OCCURRENCE OF PALEARCTIC LEECH *HEMICLEPSIS MARGINATA ASIATICA* MOORE IN RENUKA LAKE, HIMACHAL PRADESH

The genus *Hemiclepsis* Vejdovky, 1883 is represented in the Indian sub-region by only two subspecies *viz.*, *Hemiclepsis marginata marginata* (Muller) and *Hemiclepsis marginata asiatica* Moore; the former race is widely distributed whereas the latter is so far known only from its type locality Srinagar (Kashmir) from slow running hillstreams (Moore 1924, Soota 1959). *Hemiclepsis m. asiatica* is an intermediate form between *Hemiclepsis m. marginata* a common European form and *Hemiclepsis m. casmiana* Oka, the only other sub-species of the genus known from far east (Harding & Moore 1927).

The present find of *Hemiclepsis m. asiatica* in Renuka (Himachal Pradesh) is of considerable zoogeographical significance, for it extends the distribution of this subspecies from palearctic region of Kashmir Valley in the great Himalayan range to the oriental region in the Shivalik range.

Material examined:

(i) 1 ex., Parshuram Tank, Renuka, Distt. Sirmour, H.P., 6. iv. 1970, Coll. M. Chandra (Attached to submerged stones).

(ii) 5 exs., South bank of Renuka lake, Renuka, Distt. Sirmour, H.P., 5.iv.1970, Coll. M. Chandra.

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28. A NOTE ON SOME NEW HOSTS OF *OROBANCHE AEGYPTIACA* PERS.

Orobanche aegyptiaca Pers. of family Orobanchaceae, is an erect, pale brown, scapigerous, root parasite with many blue, sessile flowers arranged in lax spike. The different species of *Orobanche* parasitise many cultivated plants such as hemp, tobacco, tomato and many leguminous as well as cruciferous plants. Maheshwari[1] collected *O. aegyptiaca* Pers. on the roots of *Ammi majus* Linn. from Delhi.

In the present investigation *O. aegyptiaca* was recorded for the first time parasitising the roots of *Parthenium hysterophorus* Linn., *Datura metal* Linn. and *Nicotiana plumbaginifolia* Viv., which were growing along the banks of river Kshipra and its tributaries near Ujjain (23°11′N, 75°47′E). Its presence on the roots of *Parthenium* is rather interesting in the light of present day investigations on the phytoallelopathic potential of its root exudates as it is spreading at a fast rate by eliminating other species growing in its association. It appears that root exudates of *Parthenium* do not inhibit seed germination and seedling growth of *Orobanche,* in turn these stimulate the seedling growth of it. *Nycotiana plumbaginifolia* where it was host for *Orobanche,* was in association of *Parthenium,* while *Datura metal* was growing in isolation. Host parasite relationship between these plants is of great interest and needs further experimentations.

I am thankful to Prof. L. P. Mall, Head, School of Studies in Botany, Vikram University, Ujjain, for encouragement. I am also thankful to CSIR for financial assistance.

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[1] Maheshwari, J. K. (1963): The Flora of Delhi. CSIR, New Delhi.

29. A NOTE ON *SABIA PANICULATA* EDGEW. EX HOOK. F. & THOMS. (SABIACEAE) FROM WEST BENGAL

The genus *Sabia* Coleb. has over 55 species in the Indian sub-continent and East Asia to Solomon Island. Of these, India has 10 species of which five occur in West Bengal being particularly confined to the northern part of the state. Of the 5 species distributed in West Bengal, this paper describes *Sabia paniculata* Edgew. ex Hook. f. & Thoms.—a species of botanical interest. This has not been recorded earlier from West Bengal by D. Prain (1903). Cowan & Cowan (1929) listed the occurrence of the taxon in the state along with the other 4 species, but without mentioning precise locality. Biswas (1966) recorded 4 species from Darjeeling district, except *S. paniculata.* A study of the herbarium specimens in CAL and pertinent literature, shows that the occurrence of the species in West Bengal needed further investigation. With this in mind, the senior author collected a number of specimens of the taxon from different localities in Jalpaiguri district during his field studies on the flora of the district. Since the collection of the taxon referred to by Cowan & Cowan

(1929), there has been a long gap in the collection of plant materials. The present record of the taxon by the Senior author from a few localities in the plains of Jalpaiguri district is interesting, as it records extended distribution towards the plains of Jalpaiguri District from Darjeeling and Assam ranges. A brief description of the species together with correct nomenclature, flowering and fruiting time, distribution and ecological notes are given.

Sabia paniculata Edgew. ex Hook. f. & Thoms., Fl. Ind. 1:211 (1855); Brandis, For. Fl. 117 (1874); Hook. f., Fl. Brit. India 2:3 (1879); Duthie, Fl. Up. Gang. Plain 1:171 (1903), repr. ed.; Duthie, Cat. Pl. Kumaon 38 (1906); Burkill in Rec. Bot. Surv. India 4:103 (1910); Haines, Bot. Bih. & Ori. 1:226 (1921), repr. ed.; Osmaston, For. Fl. Kumaon 132 (1927); Cowan & Cowan, Trs. N. Beng. 44 (1929); Kanjilal *et al.*, Fl. Assam 1 (2): 326 (1934); Gupta, Fl. Nainitalensis 70 (1968); Kanai in Ohashi, Fl. East. Himal., Bull No. 8, 3rd report. 78 (1975).

Slender climbing shrub with glabrous, dark grey branches. Leaves 10.5-17.5 × 3.2-5.5 cm., alternate, oblong-lanceolate or elliptic, entire, base rounded or acute, petioled, coriaceous, dark-green and oily-shining on the upper surface, pale and strongly reticulate below, main nerves 6-8 pairs, arched, slightly reddish along the midrib below. Flowers 3-5 mm. across, yellowish, arranged in lateral leaf-bearing and pilose long panicles. Sepals ovate-elliptic, 1-nerved, densely hairy. Petals oblong or ovate-oblong, 3-nerved. Stamens included; filaments ligulate. Fruit with solitary or two drupelets, ± 8 mm. across, orbiular, compressed, base kidney-shaped, reddish-green, pitted and ridged on the margin.

Type: Sub-tropical Himalaya, Garhwal, *Edgeworth* s.n.! Kumaon, *Madden* s.n.! (Syntypes—K. *non vidi*).

Flowering & fruiting: February to April.

Specimens examined: WEST BENGAL: Jalpaiguri, North Bholka, Bholka range (6.12.1975), *Sikdar* 4178 (CAL); Titi-2, Madarihat Range (3.5.1976), *Sikdar* 4506 (CAL); Darjeeling, Kurseong (May, 1915); *Modder* 58 (CAL).

Distribution: INDIA (West Bengal, Bihar, Uttar Pradesh), NEPAL and BURMA.

Restricted to the northern tract in West Bengal from the plains upto 1500 m., rather common in the eastern forest ranges of Jalpaiguri district upto Assam border. It usually grows along shady, moist, areas of the semi-evergreen forests especially near the foot-hills.

ACKNOWLEDGEMENT

We are grateful to Deputy Director, Central National Herbarium, Howrah for encouragement and facilities.

J. K. SIKDAR
R. B. GHOSH

CENTRAL NATIONAL HERBARIUM,
BOTANICAL SURVEY OF INDIA,
HOWRAH-711 103,
July 3, 1980.

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30. SOME NOTEWORTHY PLANTS FROM WEST BENGAL

During recent floristic surveys (1975-1977) of the Jalpaiguri and Midnapore districts, several species collected were new distributional records for West Bengal. The following four species which have now extended their distributional range to the northern and southern tracts of West Bengal are discussed alongwith correct nomenclature, diagnostic features and field notes. Specimens cited have been deposited in the Central National Herbarium (CAL).

VITACEAE

Cissus assamica (Laws.) Craib. in Kew Bull. 1911: 31. 1911; Mukerjee in Rec. bot. Surv. India 20 (2):61. 1973. *Vitis assamica* Laws in Hook. f., Fl. Brit. India 1:648. 1875; Prain, Bengal Plants 1:237. 1903 (repr.); Kanjilal *et al.*, Fl. Assam 1 (ii):291. 1936; Ghosh & Ghosh in Bull. bot Soc. Bengal 31:80. 1977.

A slender glabrous climber with simple tendril; leaves orbicular or cordate, shortly acuminate, margin bristly-serrate; flowers greenish-white on slender pedicels; fruit juicy, black at maturity; seeds small, smooth.

Jalpaiguri district-Bania, Chilapata forest range, rare in the semievergreen forest, fr., 17 Sept. 1975, *Sikdar* 570. *Midnapore district*-Balibhasa, Manikpara forest range, occasional in the forest outskirts preferably in moist shady localities, fr., 19 Nov. 1976, *Maji* 7694; Mayurjharna, Banspahari forest range, rare climbing over the bushes, fl., 1 Jul. 1976, *Maji* 3155.

The species restricted to Eastern India, and has so far been known to occur in Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Sikkim and Tripura. Recently it has been recorded by Mukerjee (l.c.) from Bhutan. Prain (l.c.) mentioned its distribution in Chittagong (Bangladesh). Recently its occurrence in the northern tract of West Bengal has been mentioned by Ghosh & Ghosh (i.c.) based on V. Narayanswami's collection from Jalpaiguri district without giving precise locality and description. Hence the present collections establishes its occurrence further in West Bengal and also shows further extension of the range of its distribution into the plain of southern tract of West Bengal.

CONNARACEAE

Connarus paniculatus Roxb. (Hort. Beng. 49. 1814, *nom. nud.*) Fl. Ind. 3:139. 1832; J. D. Hooker in Fl. Brit. India 2:52. 1876; Prain, Bengal Plants 1:254. 1903 (repr.); Kanjilal *et al.*, Fl. Assam 2:2. 1938; Leenhouts in Fl. Males. Ser. I, 5:533. 1958; Sengupta in Rec. bot. Surv. India 20 (2): 66. 1973.

Large, much-branched woody climber; leaves 2-3 jugate, glabrous, leaflets elliptic-oblong or elliptic-lanceolate, entire; inflorescence broadly paniculate, ferruginous-tomentose; capsule semi-obovoid, base narrowed into a short stipe.

Midnapore district—Tapoban, Chandabila forest range, rare in dry mixed forests along streams, climbing over *Ardisia solanacea, Dalbergia tamarindaefolia,* etc., fr., 4 Mar. 1976, *Maji* 2934 & fl., 15 Nov. 1976, *Maji* 4235.

It occurs in South China, Indo-China, Hainan, Malay Peninsula, Bhutan and Assam, Tripura, Meghalaya, Mizoram, Nagaland in India, Prain (l.c.) recorded it from Chittagong (Bangladesh). Though Leenhouts (l.c.) mentioned its occurrence in Bengal, presumably from the present day area of Bangladesh, yet it is still not recorded from the present day from West Bengal. However, a single specimen collected by Wm. Roxburgh in cultivated condition from Indian Botanic Garden, Howrah, indicates its only existence in West Bengal. So, the recent collection in wild condition from the above mentioned locality is worthy of record for its extension of distribution in the plains of West Bengal.

Fabaceae

Crotalaria humifusa Grah. (in Wall. Cat. no. 5421. 1831-32, *nom. nud.*) ex Benth. in Hook. Lond. Journ. Bot. 2:476. 1843; J. G. Baker in Hook. f., Fl. Brit. India 2:67. 1876; Kanjilal *et al.*, Fl. Assam 2:11. 1938; Munk in Reinwardtia 6(3):205. 1962; H. Ohasi in Hara, Fl. East. Himal. 146. 1966; K. P. Biswas, Plants Darj. & Sikkim Himal. Vol. I., 270. 1966.

Prostrate, much-branched, densely villous herb; leaves simple, ± round-oblong, obtuse, sessile, glaucous beneath; flowers in axillary and terminal lax-flowered, leaf-opposed racemes, yellowish; pods oblong, 4-6 seeded.

Jalpaiguri district-Mahakalguri, Alipurduar, fl., 28 Oct. 1891, *Heywood* 113. *Midnapore district*-Bhulabhada, Banspahari forest range, rare on moist rock under partial shade along a stream associated with *Oldenlandia corymbosa, Juncus prismatocarpus, Hemigraphis latebrosa, Crotalaria prostrata* etc., fl., 17 Nov. 1976, *Maji* 7332.

It is distributed in Bhutan, Burma, Thailand, Indo-China, Malaysia and in India known so far from Sikkim, Assam, Manipur, Meghalaya, Uttar Pradesh, Tamil Nadu and Kerala. Biswas (l.c.) reported it as an occasional plant in the middle hill forests of Darjeeling and Sikkim hills. Ohasi (l.c.) mentioned this species from Nepal. On scrutiny of the herbarium material of the taxon (in CAL), we came across one specimen of the species collected by E. A. Heywood in 1891 from Jalpaiguri district and as such that specimen is included here as the new additional locality in North Bengal. It is interesting that the recent collection of the species from the plains of Southern Bengal indicates that it has succeeded in spreading southwards in West Bengal plains through Jalpaiguri district. It may be possible to locate it in other intervening zones of West Bengal.

Moraceae

Phyllochlamys spinosa Bur. in DC. Prodr. 17:218. 1873; J. D. Hooker in Fl. Brit. India 5:488. 1888; Prain, Bengal Plants 2:727. 1903 (repr.); Haines, Bot. Bihar & Orissa 3:860. 1922 (repr.).

Small evergreen gnarled tree, armed with sharp spines; leaves elliptic or obovate, acuminate, irregularly serrate; flowers dioecious; fruit obovoid, splitting into 2-valves.

Jalpaiguri district-Rajabhatkhawa, rare in the semievergreen forest, fr., 6 Jun. 1976, *Sikdar* 8132. *Midnapore district*-Baura, Nayagram forest range, rare in the scrub jungle along the river Subarnarekha, fl., 21 Apr. 1976, *Mali* 7765.

It has been reported so far from Bihar, Decan Peninsula, South India, Andaman Islands in India and Sri Lanka and Malaya Islands. Prain (l.c.) and Haines (l.c.) have recorded it from Orissa. It is assumed that the present recording of the species in West Bengal indicates its further north-eastwards extension from Bihar and Orissa ranges.

Acknowledgements

We are grateful to Dr. M. P. Nayar, Deputy Director, Central National Herbarium, Howrah for encouragement and providing facilities and to Prof. R. S. Rao, Department of Botany, Andhra University for his valuable guidance. Thanks are also to Dr. R. B. Ghosh, Systematic Botanist, Central National Herbarium, for kindly going through the manuscript.

CENTRAL NATIONAL HERBARIUM,
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April 9, 1980.

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REFERENCE

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31. NOTES ON TWO RARE AND INTERESTING PLANTS FROM SOUTH INDIA

(*With three text-figures*)

The paper presents the description of hitherto undescribed fruits and seeds of *Lasianthus dichotomus* Wight, a rare and endemic species which was collected after a lapse of over 100 years; and records the occurrence of *Pueraria phaseoloides* (Roxb.) Benth. for the first time in South India.

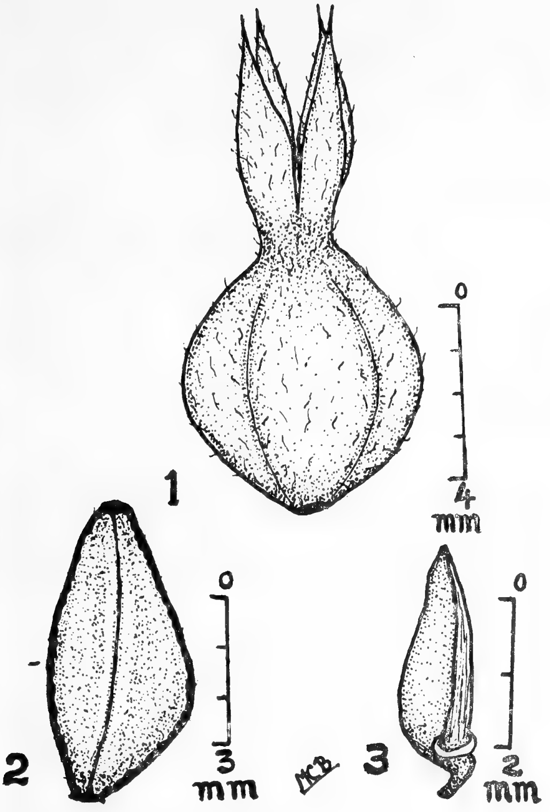
Lasianthus dichotomus Wight in Calc. J. nat. Hist. 6: 508. 1846; Bedd. Ic. t. 13. 1868-74; Hook. f. Fl. Brit. India 3: 191. 1880; Gamble, Fl. Pres. Madras 648. 1921 & 2: 457. 1957 (repr. ed.). *Mephitidia dichotoma* (Wight) Walp. Ann. 2: 761. 1852. [RUBIACEAE].

R. Wight (1846) described this species from Western Ghats in Tirunelveli District, Tamil Nadu without describing the fruits. While studying the specimens of *L. dichotomus* Wight represented at Madras Herbarium (MH), a subsequent collection made by R. H. Beddome in 1869 was noted. It is of interest that this rare and endemic species could be relocated from Mahendragiri peak of Tirunelveli District in 1972, after a lapse of over 100 years. R. H. Beddome (loc. cit.) has not made any mention about the fruits of this species. Further, J. D. Hooker (1880) stated...*"Drupe* not seen". The same lacuna in the description has continued in the critical flora of Gamble (1921). Interestingly, we could find the fruits of this species in some of the specimens in MH. These sheets have been critically studied so as to supplement the description with the fruits and seeds for a better understanding of this species.

Drupes 6-7 $\times$ 5-6 mm, subglobose, sparsely pilose or glabrescent, with persistent calyx lobes; pyrenes $\pm$ 6 $\times$ 3 mm, 3-4, triquetrous, crustaceous, often rugose dorsally, 1-seeded. Seeds $\pm$ 3 $\times$ 1 mm, black, narrowly ovate-oblong, dorsally convex, ventrally flat, glabrous. (Figs. 1-3).

Specimens examined: TAMIL NADU. Tirunelveli Dt.: Shevagherry, *Wight s.n.* (in fl., acc. no. 26414 Type material, MH); *Wight s.n.* (in fl. & young fr., acc. no. 26416 Type material, MH); Chokkampatty hills, in fl. & fr., *Collector? s.n.* (acc. no. 26417, MH); Tinnevelly, in fl., 1869, *Beddome s.n.* (acc. no. 26415, MH); Way to Mahendragiri peak, in fl. & fr., 8-2-1972, 1550 m, *Sharma* 40033 (MH).

Pueraria phaseoloides (Roxb.) Benth. in J. Linn. Soc. 11: 125. 1867; Baker in Hook. f. Fl. Brit. India 2: 199. 1876; Kanjilal *et al.*, Fl. Assam 2: 82. 1938; Duthie, Fl. Up. Gang. Pl. 1: 216. 1960 (repr. ed.); Haines,



Figs. 1-3. *Lasianthus dichotomus* Wight: 1. Drupe; 2. Pyrene—inner view; 3. Seed—side view.

Bot. Bih. Or. 2: 295. 1961 (repr. ed.); Prain, Beng. Pl. 1: 282. 1963 (repr. ed.); Backer & Bakhuizen, Fl. Java 1: 632. 1963; Thothathri in Rec. bot. Surv. India 20(2): 81. 1973; Babu, Fl. Dehra Dun 159. 1977. *Dolichos phaseoloides* Roxb. Fl. Ind. 3: 316. 1832. [PAPILIONACEAE].

Roxburgh (1832) states..."From Mr. Kerr at Canton in China, the seeds were received into the Botanic Garden in 1804; where the plants thrive well...". Baker (loc. cit.) and Kanjilal *et al.* (loc. cit.) have recorded its distribution from Eastern Himalayas in India. Duthie (loc. cit.) has recorded its distribution from Dehra Dun, N. Oudh extending from Garhwal eastwards in Tropical Himalayas and Bengal in India. Haines (loc. cit.) reports its occurrence from the jungles of Purneah in Bihar.

During the botanical exploration in the mountainous region of Quilon District, Kerala, this species was collected from the dense evergreen forests in Angamuzhi, Ranni R.F. at an altitude of 250 m. The identity of this species was confirmed at Central National Herbarium (CAL), Howrah. The common occurrence of this large climbing shrub in this area forms a new distributional record for South India. As only one species, *i.e. P. tuberosa* (Roxb.) DC. has been so far reported from South India, an artificial key has been provided for distinguishing the two species occurring now in South India.

KEY TO THE *Pueraria* DC. SPECIES OCCURRING IN SOUTH INDIA

Flowering when leafless; pods 3-7.5 × 0.5-0.8 cm, narrowly oblong, compressed, constricted between seeds, bristly hairy .... *P. tuberosa*

Flowering with the leaves; pods 5-10 × 0.3-0.4 cm, linear, subterete, not constricted between the seeds, adpressed pubescent .... *P. phaseoloides*

A short description for *P. phaseoloides* (Roxb.) Benth. has also been furnished below to facilitate easy identification.

Climbing shrubs; branches slender, twining, brown pubescent. Leaves pinnately trifoliolate; leaflets 5-12 × 4-11 cm, subrhomboid to broadly ovate, entire, adpressed pubescent, subacute or acute, mucronate at apex, cuneate or rounded at base; stipels linear-lanceolate; petioles 5-10 cm long; stipules lanceolate. Flowers ± 2 cm long, white with violet tinge, many, shortly pedicelled, in long-peduncled, axillary racemes 20-30 cm long. Pods 5-10 × 0.3-0.4 cm, linear, subterete, straight or reflexed, adpressed pubescent, 12-20 seeded.

Specimens examined: KERALA. Quilon Dt.: Angamuzhi, Ranni R. F., in fl. & fr., 22.11.1976, *Chandrabose* 49161 (MH).

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BOTANICAL SURVEY & INDIA,
SOUTHERN CIRCLE,
COIMBATORE-641 003,
March 10, 1980.

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32. A NOTE ON THE OCCURRENCE OF *HYPOCHOERIS RADICATA* L. (ASTERACEAE) IN N. W. HIMALAYAS

Like other successful invading weeds of Asteraceae *Hypochoeris radicata* L. is also getting a foothold in the Indian subcontinent. This European species has already spread in Eurasia and is also naturalised in South America and parts of Australia and North America.

In India the genus is represented by another species namely *H. glabra* L. and is known to occur only in the Nilgiris. The first report of distribution of *Hypochoeris radicata* L. was made by Panigrahi and Kammathy (1960) from Meghalaya and Assam where it is a common weed. Later on Kammathy (1963) recorded the species also from the Nilgiri Hills in South India.

While undertaking explorations in the district Tehri (Garhwal) the senior author collected the species from Pratapnagar at an altitude of 2500 m and it is naturalised in the area. With the present discovery of the species from a locality far away from the earlier reports of distribution shows that it is likely to to spread throughout the Himalayan tract in course of time.

In order to invite reports of further distribution and to facilitate an easy identification, the species is described with key characters and ecological notes.

Key Characters: *Leaves* sinuate toothed, bristly hairy on both surfaces. *Heads* yellow ligulate, 2-3 cm in diameter. *Pappus* feathery, the peripheral ones shorter than the inner whorl. *Receptacle* flat naked.

Hypochoeris radicata L. sp. Pl. 2 : 811-1753; Butcher, R. W. *New Illust. British Fl. 2*: 528. *pl.* 1324. 1961; Ross Craig, S. *Draw. British Pl. pt* 18 (4): *pl.* 21. 1963; Panigrahi & Kammathy in *Mem. Indian Bot. Soc. 3*: 200-210. 1960.

Description: A long rooted, perennial laticiferous herb. *Leaves* rosulate, sessile 4-12 cm, oblong lanceolate, sinuate or irregularly pinnately lobed., *Scapes* 7-25 cm, leafless, branched, green, hollow, striated. *Heads* 20-30 mm diameter. *Involucral bracts* 4-7 mm with membranous margins; inner 10-20 mm long, linear, midnerve bristly hairy, imbricate. *Ray florets* linear, apex toothed; *disc florets,* tube slender, unequal. *Style & Stigma* spinulose. *Achenes* 4-5 mm long, horizontally striated and vertically ribbed, muricate above; *beak* 3-5 mm, stout.

Occasional on open sunny slopes; Pratapnagar (Tehri Garhwal, N. W. Himalayas) 2500 m, 24.2.1979. *Goel* 65717; *Fls. & Frs*: Feb. to May; *Chr. No*: 2n = 8.

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NORTHERN CIRCLE,
DEHRA DUN,
Februay 26, 1980.

A. K. GOEL
U. S. BHATTACHARYYA

REFERENCES

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33. NEW INDIAN RECORD OF *ARDISIA PARDALINA* MEZ (MYRSINACEAE)

(*With a text-figure*)

Carl Mez (1902) in his monograph on the family Myrsinaceae described a new species *Ardisia pardalina* from Philippines. During the course of our study on the Indian Myrsinaceae we came across an unidentified specimen which after critical study appeared to be *Ardisia pardalina* Mez. The plant so far is not recorded in India. It is a very interesting species among the Indian *Ardisia* so far studied as regards the glands on the leaf. Mez in his key established the subgenus *Crispardisia* based on the marginal albuminous glands on the leaves. Within the subgenus he described 2 species with the elongated glands namely *A. pardalina* and *A. sinuato-crenata.* But *A. pardalina* can be easily separated from its ally by the entire leaves whereas in *A. sinuato-crenata* the leaves are sinuate-crenate. Mez also described another species *A. oldhami* (l.c.) with large glands (not elongated) which was merged later on by Walker with *A. virens* Kurz. (Walker in Philippine Journal of Science 73:82. 1940). But he however did not mention the species *A. pardalina.* The specimens of *A. pardalina* Mez from Philippines are available in Herb. CAL. As no diagram is available a short description along with a diagram is given.

Ardisia pardalina Mez in Engl. Pflanzenreich 9 (iv.236) 148. 1902.

Shrub, glabrous, smooth. Leaves lanceolate 12-15 cm × 2.5-3.5 cm., base cuneate apex acute or obtuse, membranous, glabrous, midrib raised beneath, lateral nerves many pairs, nerves prominent beneath, gland dotted, glands elongated, scattered, margin entire, recurved with albuminous glands; petioles ± 12 mm long, glabrous, canaliculate. Inflorescence axillary, peduncles 40-60 mm long, slender, few flowered, paniculately umbellate. Pedicel 6-8 mm long, glabrous. Sepals 5, ovate-acute 1.5-2 mm × 1 mm large gland dotted, persistent. Fruit globose 7-8 mm diameter, reddish brown, large gland dotted.

Fruit—January.

Distribution—INDIA: Rengging, Assam, 860 m, 25 Jan. 1912, *I. H. Burkill* 36251 (CAL).

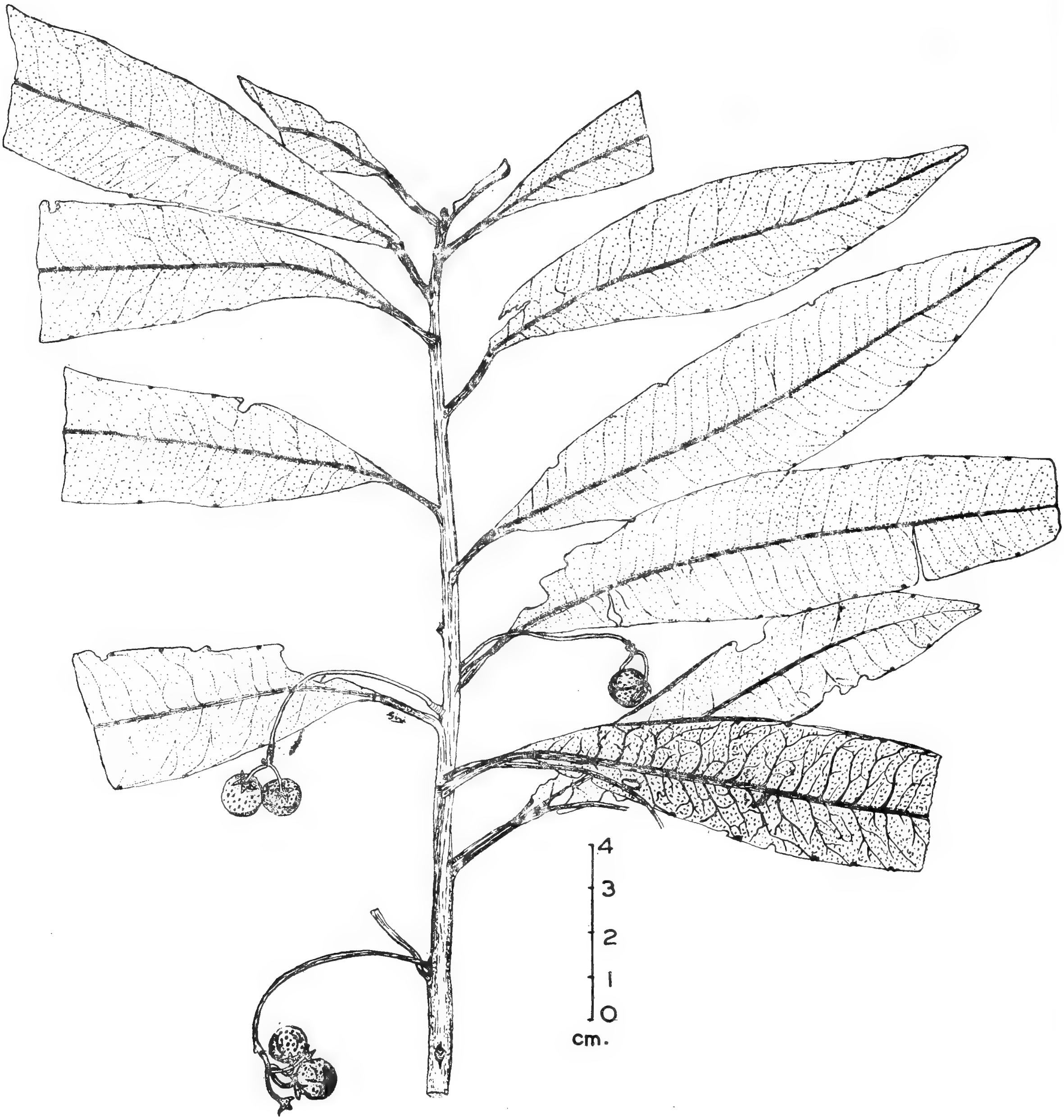

Fig. 1. *Ardisia pardalina* Mez.

PHILIPPINES: Mayon volcano, Albay province, Luzon, Sept. 1928 *M. Ramos* 75720; Bangui to Claveria, Ilocos norte province, Luzon, Aug. 1918, *M. Ramos* 33045.

CENTRAL NATIONAL HERBARIUM,
BOTANICAL SURVEY OF INDIA,
HOWRAH,
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G. S. GIRI
M. P. NAYAR

34. *ACANTHUS CARDUACEUS* GRIFFITH—A SCARCELY KNOWN ENDEMIC PLANT FROM WEST BENGAL

(*With a text-figure*)

While collecting in the Jalpaiguri district during 1975-1976, the senior author noticed a robust scandent shrub with deeply pinnatifid, spinescent leaves and white flowers arranged in compact terminal raceme. This plant could be easily identified as *Acanthus carduaceus* described by Griffith in 1837-38 based on his own collections from Oongar, Bhutan. According to Griffith the species is a typical *Acanthus,* of the same series as the Mediterranean species which has no representative in Asia. Griffith met with it only twice in Bhutan at Bhoomlungtun and Oongar. After Griffith, this species has been collected by I. E. White in 1905 again from Bhutan at Punakha and for the first time from India by K. P. Biswas in 1934 after a gap of about 97 years. But unfortunately this extension of distribution was not recorded. Yamazaki in his 2nd report in 1971 on the Flora of Eastern Himalaya, recorded after 37 years from Birch Hills of Darjeeling at alt. 2200 m. The present collection from Jalpaiguri district confirms its occurrence in West Bengal.

A detailed description of the species together with its Pollen morphology is presented below:

Acanthus carduaceus Griff., Itin. Notes, 144. 1837-38 & Icon. Pl. Asia. t. 427. 1854; Anderson in Jour. Linn. Soc. 9 : 500. 1867; Clarke in Hooker's Fl. Brit. Ind. 4 : 480. 1884; Yamazaki in Hara's Fl. East. Himal. Report 2 : 122. 1971.

A robust shrub of about 2.5 m high, somewhat scandent; leaves large, 30-45 cm long, pinnatifid with toothed spinous lobes; inflorescence a terminal raceme, 15-28 cm long, compact with bracts and bracteoles; bracts four-sided, ovate-lanceolate, 2-3 cm × 1-2 cm, acuminate, dentate; bracteoles 2, lanceolate, 1-1.5 cm × 0.5-0.8 cm, acuminate, ciliate; flowers white, 2.5-3 cm long, subsessile to shortly pedicelled, 2-3 mm long; calyx of 4 sepals, heteromorphic, lanceolate to elliptic-lanceolate, 1.2-2 cm × 0.5-0.8 cm, acuminate, ciliate throughout, outer 2 sepals larger than inner 2 sepals, anterior sepal shortly 2-toothed; corolla 5-lobed, minutely tubular, 5-6 mm union, free part expanded, posterior lobes 3, broader, rounded and with slightly crenate margin, anterior lobes 2, smaller, placed laterally, rounded, both throat and base villous, hairs silky; stamens 4, didymous, filament 1 cm long, stout and fleshy, swollen towards base, anthers about 3 mm long, oblong, 2-celled with longitudinal splitting; ovary ellipsoid, glabrous, style 1.5-1.7 cm long, linear, glabrous, stigma pointed, glabrous; capsule oblong, with a pointed tip, 1.5-2 cm long, obtusely 4-angular, glabrous,

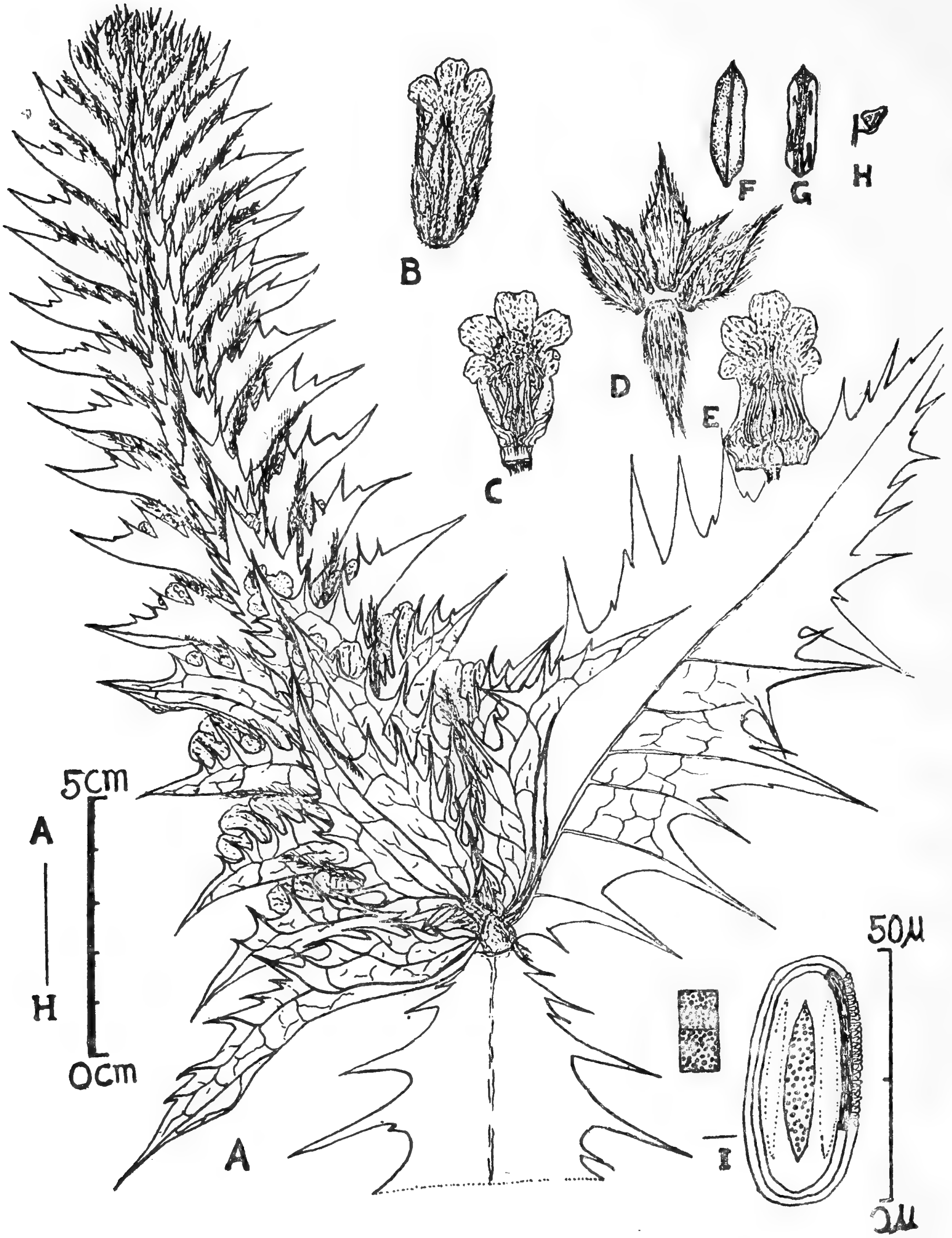

Fig. 1. *Acanthus carduaceus* Griff.: A. Inflorescence with leaves; B. Flower; C. Corolla; D. Bracts and Calyx; E. Corolla split to show stamens and carpel; F. Capsule; G. One valve of capsule; H. Seed; I. Pollen.

deep-brown, shiny, loculicidal dehiscence; seeds 4, 2-in each half, triangular, 0.6-0.8 cm diam., compressed laterally, glabrous, purple brown (fig. 1, A-H).

Pollen: Prolate, 41-49 μm × 22-24 μm; 3 colpate, colpa tapering, margin not entire, 21-32 μm × 4-4.5 μm, granulated; Exine 2.5 μm; Columella short, straight, indistinct; sexine ± 1 μm; nexine ± 1.5 μm; semitectate, finely reticulate; lumi 1 μm, muri 0.5 μm, some free bacula present in the lumi (fig. 1, I).

Flowering: November. *Fruiting*: March.

Type: Bhutan, Oongar, *Griffith* 688 (CAL).

Specimens Examined: BHUTAN: East Himalaya, Bhutan, without any precise locality, *Ex herb. East India Company 6146* (CAL); Punakha, 18.4.1905, I. E. White 37 (CAL). WEST BENGAL: Jalpaiguri Dist., Buxaduar, Ramiti, 29.11.1975, *Sikdar* 4034 (CAL); Buxaduar, way to Sinchula, 1450 m, 2.3.1934, *K. Biswas* 2032 (CAL).

We have came across collection of uncertain localities deposited at (CAL). The first one is labelled "*Herb. Hort. Bot. Calcuttensis* (Flora of Sikkim), *Ribu & Rhamoo* s.n." but has a remark about its collection locality by S. K. Mukerjee (on 6th Nov. 1941) as "this has been recorded from Bhutan and from Torsa Valley in Chumbi". The second collection by *K. Thothathri* 63 (Acc. No. 339558) is most probably from Bhutan as he visited Bhutan.

Distribution: Bhutan, West Bengal.

Yamazaki (l.c.) has included Sikkim in its distribution but no representative collection was cited by him. It is not known to occur any where in Sikkim.

Rare, growing on rocky crevices on the Buxaduar hill slopes at ± 1400 m altitude.

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We are indebted to Prof. R. S. Rao, Dept. of Botany, Andhra University, Waltair, for his valuable suggestion in this preparation. We are also thankful to the Deputy Director, Central National Herbarium for consultation of materials housed there in. Thanks are also due to Mr. M. S. Mondal, B.S.I. for his help in preparation and study of pollen.

CENTRAL NATIONAL HERBARIUM,
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HOWRAH 711 109,
January 24, 1980.

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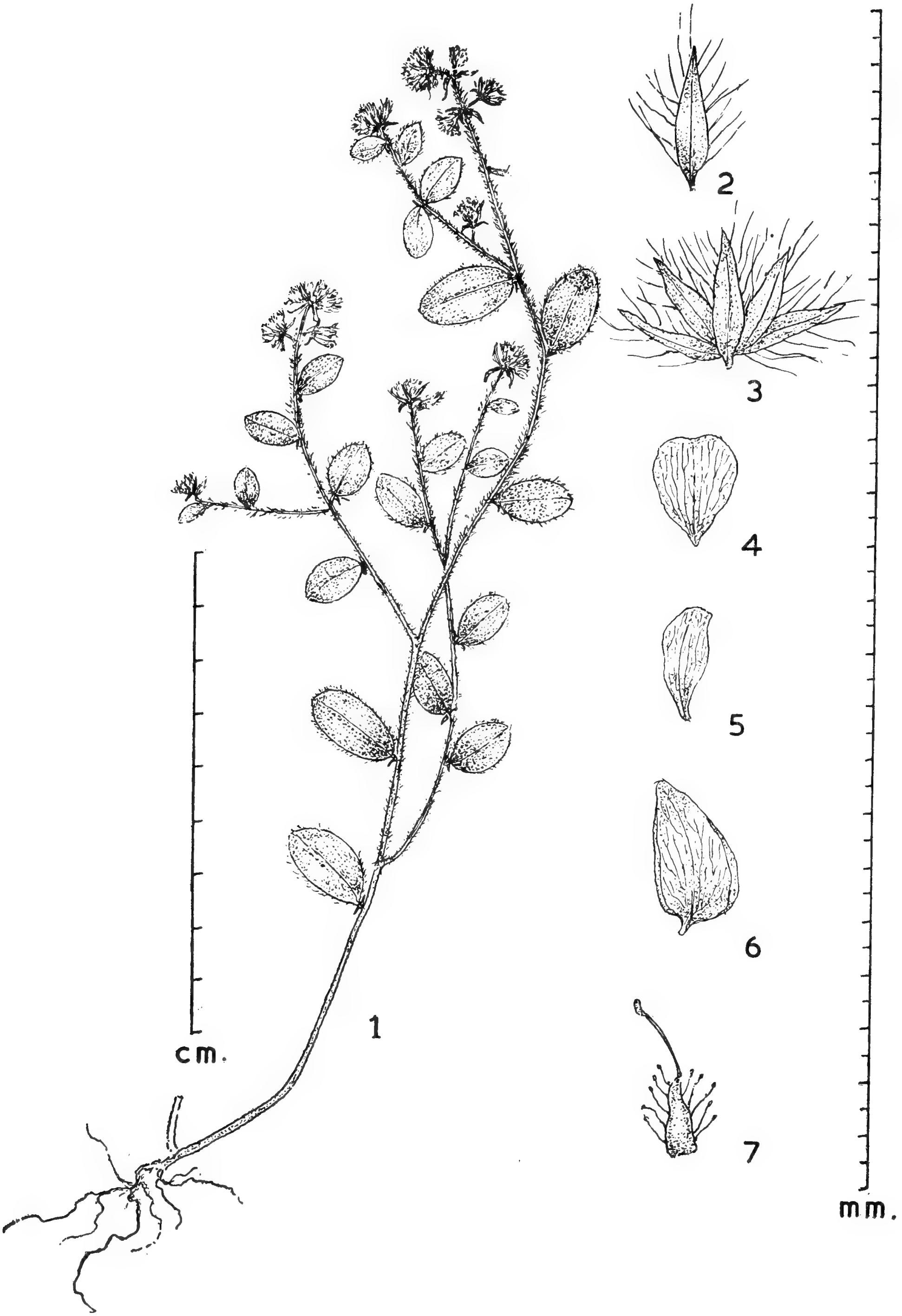
G. G. MAITI

35. A NOTE ON THE OCCURRENCE OF *CROTALARIA ACICULARIS* BUCH.-HAM. IN KARNATAKA AND MAHARASHTRA

(*With seven text-figures*)

Cooke (1901-08) and Haines (1916) did not record *Crotalaria acicularis* Buch.-Ham. from Maharashtra State. However, Gamble (1916) has recorded this species from N. Circars in Ganjam in dry forest lands and Western Ghats in Anamalai hills and Travancore. The localities cited by the earlier workers are neither from Karnataka nor Maharashtra.

The identity of herbarium specimen (*Rao* 95536) housed in the herbarium of Western Circle (*BSI*) collected earlier from Coorg district identified as *Crotalaria albida* was critically examined and found to be *Crotalaria acicularis* Buch.-Ham. only, and is therefore a



Figs. 1-7. *Crotalaria acicularis* Buch.-Ham.: 1. Entire plant; 2. bract; 3. calyx; 4. standard petal; 5. wing petal; 6. keel petal; 7. Androecium ensheathing gynoecium.

new record for Karnataka State.

Critical studies on "crotalaria" from Chandrapur district shows the occurrence of *Crotalaria acicularis* Buch.-Ham. in Maharashtra also. The plant (*Malhotra* 138567) collected from Palmalgotta in Bhamragarh forest division (Chandrapur district) serves as a new record for Maharashtra State thus extending its distribution further north.

In view of its rarity and absence of any known published illustration of the plant, a line drawing is given along with a brief description.

Crotalaria acicularis Buch.-Ham. in Wall. Cat. 5390, 1831-32. Baker in Hook. f. Fl. Brit. India 2: 68. 1876.

A prostrate herb with spreading branches thinly clothed with silky hairs. Leaves nearly sessile, obtuse, glaucous green, membranous, rounded at the apex, slightly cordate at base. Stipules persistent, reflexed. Flowers yellow. Pods small, oblong, glabrous.

ACKNOWLEDGEMENTS

We are thankful to Dr. B. D. Sharma, Deputy Director, Western Circle, Pune for encouragement and to the Director, Botanical Survey of India, Howrah for providing facilities.

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE, PUNE,
May 19, 1980.

S. K. MALHOTRA
SIRASALA MOORTHY

36. NEWLY RECORDED AND REDISCOVERED FERNS AT MT. ABU, RAJASTHAN

Mt. Abu situated at 24°36′N and 22°43′E forms the south western extremity of the Aravali Range and is the highest point between the Himalayas and the Nilgiris (height 1727 m above mean sea level at Guru Shikhar, the highest peak of this range). Due to heavy rainfall compared to other parts of Rajasthan it possesses a rich vegetation of the humid subtropical type with the largest concentration of pteridophytes in Rajasthan.

Bhardwaja *et al.* (1978) in their recent survey of pteridophytic localities of Rajasthan mentioned that some of these ferns have now been observed during a botanical trip to Mt. Abu in August-September 1979. Besides, *Araiostegia pseudocystopteris* (Kze.) Copel a fern belonging to Davalliaceae has also been observed for the first time at Mt. Abu. This note describes the distribution and morphology of these rediscovered and new fern taxa at Mt. Abu.

Araiostegia pseudocystopteris (Kze.) Copel.: This fern was collected from Guru Shikhar and is a new record for Rajasthan. The Mt. Abu material bears the following morphological features.

Rhizome creeping on the moist surfaces of rocks, sympodial, brown, densely covered with spreading, cordate scales. Fronds alternate arising from an involucral cup like structure formed by densely overlapped, spreading scales on short lateral branches. Stipe 7-15 cm long, grooved, sparsely covered with scales. Fronds sagittate, lowest pinnae opposite and all other pinnae alternate. Each pinna broadly lanceolate 3-4 pinnatifid, lower pinna 5-7 cm long, upper most 1-1.5 cm long. Segments very acute, texture thin. Sori on veins, ventral intercalary, usually single sorus per pinnule, as broad as the segment. Involucre complete, prominent and translucent white. Sporangia 7-12 per sorus. Spores reniform with a honey-combed exine.

This species has so far been reported from Dalhousie to Nepal (Beddome 1892) and Nainital (Loyal & Verma 1960). According to these authors it grows as a common epiphyte on moss covered trunks of *Cedrus* and other large trees. The Rajasthan material thus differs from that of the Himalayan material in being lithophytic and larger in size. Moreover occurrence of scales sparsely throughout the length of stipe and an exine with a honey-combed pattern are additional features of the Rajasthan material of this fern.

Dryopteris cochleata (Don) C. Chr.: After Bir & Verma (1963) described some specimens of this fern collected from Sunset point by S. K. Sharma of Ajmer, Mital (1969) also referred to the same collection of sterile specimens of this fern at the same locality. It has now been collected with fertile fronds for the first time on way to Palanpur point and Sunset point. As mentioned by Bir & Verma (1963) it is the only fern at Mt. Abu with dimorphic fronds. The sterile fronds are large (1.5 m long) with broad upper pinnae and lobed lower pinnae. Fertile fronds consist of contracted, narrow pinnae covered with shining white scales and ramenta. The sori are large, paired and with a prominent convex involucre. The fertile fronds are produced after the end of rainy season, i.e. September.

Cyclosorus dentatus (Forsk.) Ching.: Though reported by earlier workers (Kanodia & Deshpande 1962, Bir & Verma 1963, Mital 1969, Sharma & Bohra 1977) but Bhardwaja *et al.* (1978) could not locate this fern till 1976. It has now been observed growing on way to Kodra Dam and Guru Shikhar valley. It forms a close thicket with *Hypodematium crenatum* (Forsk.) along streams in the forest flora of Guru Shikhar valley.

Pteris vittata Linn.: Though this fern was reported by Bir & Verma (1963) to be common around Nakki lake, later workers (Mital 1969, Bhardwaja *et al.* 1978) could not find this fern subsequently at this spot in Mt. Abu. It has now been found again, growing near the margins of streams on way to Palanpur point and Kodra Dam.

Ferns like the endemic *Asplenium pumillum* var. *hymenophylloides* (Fee) Clarke, *Adiantum capillus-veneris* Linn. *A. phillipense* Linn., *Actiniopteris radiata* Link., taxa of *Athyrium complex, Isoetes* sp. and *Ophioglossum* spp. recorded by Bhardwaja *et al.* in 1975 & 1976 were found to be growing widely from Anadra point to Achal Garh and Guru Shikhar. We could also collect new forms of the genus *Asplenium* and *Cheilanthes* which are yet to be identified and are under investigation in this laboratory. The material of all the above collections has been lodged in the Herbarium of the Pteridophyte Biology Lab., Deptt. of Botany, Govt. College, Ajmer.

A striking feature of this botanical exploration of Mt. Abu was our observation of a drastic and continuing decrease in the population densities of individual species of pteridophytes for which besides deforestation, the spread of *Lantana camara* seems to be responsible. This shrub started to be introduced at Mt. Abu in late sixties has been exerting allelopathic effect on the pteridophytic vegetation as confirmed by experiments conducted (details published elsewhere) in this laboratory. This work has indicated beyond any doubt the allelopathic potential of this obnoxious weed on fern spore germination and early gametophytic growth.

Earlier, restricted to municipal limits of Mt. Abu. *Lantana camara* has now spread up to Traver's tank forest and the ferns which were observed in abundance here at this spot in 1976 have receded to higher altitudes towards Achal Garh and Guru Shikhar. It is important that this obnoxious plant should be eradicated or there will be extinction of pteridophytes from this richest locality for these plants in Rajasthan.

ACKNOWLEDGEMENTS

Thanks are due to Prof. B. N. Nayar, Calicut University, Kerala for confirming the identification of *Araiostegia pseudocystopteris* and *Dryopteris cochleata*. The University Grants Commission, New Delhi provided financial assistance for this survey.

PETRIDOPHYTE BIOLOGY LAB.,
DEPT. OF BOTANY,
GOVERNMENT COLLEGE,
AJMER-305 001,
RAJASTHAN,
March 13, 1980.

T. N. BHARDWAJA
C. B. GENA
TEJINDER TAKKER
RANJEET KAUR
C. WADHWANI

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ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1979-80

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Mr. Duleep Matthai	*New Delhi*

HONORARY SECRETARY'S REPORT FOR THE YEAR 1979

This report covers the activities of the Society in the 96th year of its existence.

Membership

Our membership continues to increase slowly. The total of 973 at the end of 1976 had grown to 1241 at the end of 1979, so that the target of 1500 by the centenary year 1983 is not unrealistic. We now have 660 ordinary members paying annual subscriptions and 305 life members who have preferred to pay a single sum (at present Rs. 750). There is large scope for increasing the number of Corporate members, now only 180. However, the overall position, leaves something to be desired. With the number of new members coming in (e.g. 186 in 1978) our total strength would be far greater, but for the large number of drop outs every year. It may help to reduce the drop out rate, if those who introduce new members would keep a list, and check on their renewals, at least for the first three years. Details of membership for the past quinquennium, showing members fully paid up on 31st December of each year, are given in the statement below:

	1976	1977	1978	1979	1980
Ordinary members	531	512	541	640	660
„ Corporate members	188	190	180	184	180
Life members	246	246	257	274	305
Compound Corporate members	1	1	2	9	9
Student members	10	20	39	96	83
Honorary members	4	4	4	4	4
Forest Department Nominees	36	—	—	—	—
	1016	973	1023	1207	1241
Members elected in 1979, but not paid			14		
Members paid in 1978, but not paid for 1979			217		

Publications

Journal:

Our Journal continues to publish authoritative contributions to the Natural History of the Oriental Region. The December 1978 issue, published during 1979, was a bumper one of 388 pages celebrating the completion of 75 volumes since its inception in 1886. In contains the first part of the President's history of the Society. 'Apart from the persons responsible for the material well-being of the Society, the Founders and the Builders,' Dr. Sálim Ali writes, 'I have selected a number of others, the Guardians—scientists, field naturalists and sportsmen—who by their researches and their experiences and writings, or by their prowess as hunters, or their zeal as nature conservationists have aided substantially in the evolutionary process of the Society.' Two other issues were published during the year, a Supplement to Volume 74 to clear the backlog of botanical papers, and Volume 75(2). Prompt publication of scientific papers is very desirable, and though our Journal is not as slow as many others of international repute, special efforts are being made to publish regularly.

Hornbill:

The first issues of *Hornbill,* a newsheet to provide more popular and topical reading, and accounts of our activities, for our members, were cyclostyled. The magazine is now elegantly printed, well illustrated and issued quarterly. The first new issue appeared in November 1976 to celebrate our President's 80th birthday, but manufacturing expenses are rising so rapidly that we may be compelled to cease publication, unless more support by way of advertisements is available. Members are requested to help in obtaining advertisements from firms known to them.

Books:

During the year the following sales were made:

The Society's two best-selling publications, Sálim Ali's BOOK OF INDIAN BIRDS and S. H. Prater's BOOK OF INDIAN ANIMALS remained out of print throughout the year. Sales of other publications in 1978 and 1979 were:

	Sales in 1978	Sales in 1979	Balance stock 31-12-1979
Some Beautiful Indian Trees	133	147	2484
Glimpses of Nature in India Booklet	217	142	2147
Checklist of the Birds of Maharashtra	110	148	208

Books under preparation:

THE BOOK OF INDIAN BIRDS
By Sálim Ali:

The 11th edition will be published in 1980 and contains descriptions of 16 additional species (making 296 in all) with four new colour plates. Price Rs. 60.

THE BOOK OF INDIAN ANIMALS
By S. H. Prater:

The 4th new edition will be published in 1980. Price Rs. 60.

GRASSES OF WESTERN INDIA
By T. Hodd (1st edition):

A handy field guide for the identification of Grasses of Western India, with illustrations for all the species described should be available by end 1980, or early in 1981.

A SYNOPSIS OF THE BIRDS OF INDIA & PAKISTAN
By Dillon Ripley (2nd edition):

This definitive work on bird taxonomy of the Indian region is a required reference for any study on Indian birds. The revised 2nd edition now in press is expected to be ready by end 1980.

SOME BEAUTIFUL INDIAN CLIMBERS AND SHRUBS
By Bor & Raizada (2nd edition):

This popular treatise on the wild and cultivated shrubs and climbers occurring in India is an excellent ready reference for members and others interested in the country's flora and the indigenous and exotic cultivars. The second edition, now in the press, is expected to be ready by the end of 1980.

Encyclopedia of Indian Natural History, Centenary Publication 1883-1983:

Work on the Encyclopedia is proceeding satisfactorily under the direction of the General Editor. We hope to produce a book that should arouse the interest of students and others in the natural environment making them aware and appreciative of rivers, rocks, plants and animals and all other forms of life around them.

CONSERVATION

The Society continued to take an active part in the Conservation Movement in the country through its association with State and Central Wildlife Boards, and through its members and staff serving on the International Union for Conservation of Nature and Natural Resources, the World Wildlife Fund, and the International Council for Bird Preservation.

Fossil-bearing rocks at Worli, Bombay:

Bombay city has the unusual distinction of having fossil-bearing rocks within its municipal limits. Several fossils of frogs have been located in this area. However, there is a danger that the fossiliferous rocks will be built over. The Society has for several years been making efforts to preserve the area and it is likely that at least a part will be saved.

Chail Reserve for Cheer Pheasants, Himachal Pradesh:

The Society strongly supported the recommendation made by Dr. Antony Gaston of Cambridge University that the Chail area be preserved a reserve for Cheer Pheasants.

Namdapha Wildlife Sanctuary, Arunachal Pradesh:

One of the results of the visit of Dr. Sálim Ali and Dr. Dillon Ripley to Arunachal Pradesh is a strong recommendation to the Government of India for the preservation of the Namdapha area as a natural sanctuary. A dam is proposed to be constructed within the sanctuary area and we hope that our efforts to prevent this will be successful.

Silent Valley:

The Society continued to support the campaign for the preservation of the Silent Valley in collaboration with Save Silent Valley Committee and other organisations.

14th *General Meeting of the IUCN at Ashkhabad, U.S.S.R.* (1978):

The Curator of the Society attended the general assembly as a Co-Chairman of the Asian Elephant Group and also represented the Society at the assembly. At the instance of the Society the IUCN General Assembly adopted resolutions urging the Government of India to preserve Silent Valley and Kalakkad evergreen forests in the Western Ghats and to take action for the conservation of the Asian Elephant and its habitats in India.

Asian Elephant Specialist Group:

The Survival Service Commission's Asian Elephant Group, which had the Society's Curator as Chairman, continued to be active in organising conservation action and protection measures for the elephant in India in assessing the data obtained from the surveys. The studies are being funded by the World Wildlife Fund.

Endemic Flora of Kalakkad:

An appeal was made to the Government of Tamil Nadu to preserve the Kalakkad Forest in view of the number of species of endemic plants which have been recorded from the area. These forests are threatened by a proposed dam.

Seminars & Conferences

At the invitation of the organisers, the Curator attended the seminar on Tropical Ecology at the University of Kuala Lumpur and presented a paper on the status of the Asian Elephant.

The Honorary Secretary attended the Asia Pacific Non-Governmental Organisations Environment Conference on Regional Cooperation for Development without destruction, in Colombo, Sri Lanka, in October 1979.

The Curator attended a workshop on status of the elephant at the Agricultural University of Kerala, Trichur.

Members' Activities

Bird Counts:

The monthly roadside count of birds at the Borivli National Park on the last Sunday of each month was continued. The collection of data to record the fluctuations in the bird fauna over a period of time is the primary aim.

Nature Walks:

This programme also assists in recruiting more members for the Society and in fostering interest in natural history among members and others.

Nature walks were organised in Borivli National Park and elsewhere for bird-watching, vegetation studies and general natural history. A large number of members participated.

Nature Camp:

A camp was organised in October-November at the Point Calimere Sanctuary in Tamil Nadu. 58 members participated. The main programme was the teaching of bird banding techniques. The groups were led by Dr. R. B. Grubh and Mr. P. B. Shekar of the Society's staff.

Research and other activities funded from field work funds

The field work funds available at the Society supported the following activities:

Salim Ali/Loke Ornithological Research Fund:

During the year the fund supported the field studies of two research students. Mr. S. A. Yahya studied 'The Ecology of Barbets' and Mrs. K. R. Lalitha studied 'Comparative Ecology of Drongos with special reference to Ecological isolation among them'.

Salim Ali Conservation Fund:

Arunachal Pradesh:

1. Dr. Sálim Ali and Dr. Dillon Ripley surveyed Namdapha area in Arunachal Pradesh.
2. Mr. H. K. Divekar, Dr. R. B. Grubh and Mr. P. B. Shekar surveyed further areas of the Wild Buffalo habitat in east Maharashtra and presented a report on its endangered situation.

Pirojsha Godrej Fund:

Frog-mouth study: Financial assistance was extended from the fund for a survey of the status of the Frogmouth *Batrachostomus moniliger*, in the evergreen forests of Kerala. The bird was considered to be rare and there were very few records, but Dr. Sugathan reports that the species is not uncommon in particular habitats. His report will be published in a future issue of the Journal.

Charles McCann Vertebrate Zoology Fund:

Mr. J. H. Sabnis of the Marathwada University was offered assistance for studying 'Food habits of the tiger' on the basis of scat analysis.

DORABJI TATA FIELD WORK FUND:

Survey of Tahr: Financial assistance was extended to Dr. Satish Chandra Nair of the Kerala University, for the study of Nilgiri Tahr in the Eravikulam area.

Bird Survey, Bandipur: Financial assistance was extended to Dr. Reza Khan from Bangladesh for a survey of the bird fauna of Bandipur Sanctuary.

RESEARCH FUNDED BY GOVERNMENT & GOVERNMENTAL AGENCIES

The project 'Determination of ecological disturbances in Agricultural & adjoining lands caused by removal of *Rana tigrina* and *Rana hexadactyla* for export' conducted by Mr. H. Abdulali funded by the Indian Council of Agricultural Research was completed, and the final report was submitted to the Council.

Computer Analysis of Bird Banding Data:

Data for 1,09,250 birds ringed by the Bombay Natural History Society during the years 1959 to 1973 was fed into the computer. The remaining items of work to be done in order to complete the programme are: 1. Feed the remaining 1½ lakhs of data. 2. Prepare different programmes for each of the objectives specified in the project. 3. Obtain answers from the computer for each of the questions asked by the programmer. 4. Analyse these answers in terms of the objectives listed in the project and prepare reports. The work up to item 3 is expected to be completed before the end of 1980.

The immediate results of the Computer Analysis attempt is that we have identified many deficiencies in our earlier data collecting system so that we have been able to develop a more advanced system for future bird banding studies.

APPROVED FIELD PROJECTS

Bird Hazard Project:

At the request of the Aeronautics Research & Development Board of the Ministry of Defence, the Bombay Natural History Society drew up a project proposal for a study of bird hazards at Indian aerodromes. The objective was to reduce bird hazards in and around airfields and make flying safer. The work was to commence at two airfields during 1980. The Society agreed to undertake the research for a year, and, if found productive, to continue for another four years.

The Government of India has approved financing of the following projects from PL-480 funds. These projects will come into operation in 1980.

1. *Studies on the movement and popualtion structure of Indian avifauna*:
   The project calls for extensive field work in selected habitat types. The bird fauna, both resident and migratory, of a wide variety of biotopes in the plains and hills of the subcontinent will be sampled. The areas covered in earlier research will be the main study areas with particular emphasis on Bharatpur and Point Calimere.

2. *Avian Ecology Research Station, at Keoladeo Ghana Sanctuary, Bharatpur*:
   The project plans to study the ecology of the large numbers and variety of waterbird species breeding at the Ghana and assembling during winter. The proposed research station would be the first of its kind in India and the research conducted

there would provide a basis for research and management of other important waterfowl reserves in the country.

The Government of Tamil Nadu has approved the financing of the following project. This will also come into operation in 1980.

An ecological reconnaissance of Vedaranyam Swamp, Thanjavur District, Tamil Nadu with special reference to habitat preference and habitat partitioning by migrant/resident waders:

The Vedaranyam—Muthupet—Adhirampattinam swamp-belt is one of the major and important refuges of migratory as well as resident water birds in the peninsula. Every winter (October-March) over 90 species of birds (both Passerine and wading) arrive and spread along the swamps and forested tracts along the seaboard. The State Government has proposed to develop the entire 24,000 hectare swamp as an integrated marine chemical complex and as an expression of its anxiety about the possible effect of such a project on the ecology of the area has asked the Society to undertake a two-year study, in collaboration with the forest Department and with financial assistance from the Salt Corporation of Tamil Nadu, to assess the seasonal population dynamics of water birds and based on the above studies, to advise the State Governement on the conservation aspect of the Swamp.

Donations

Chenkim Loke Foundation *for* Sálim Ali Nature Convervation Fund	Rs. 18,209.56
Pirojsha Godrej Foundation *for* Pirojsha Godrej Fund	Rs. 10,000.00
Dr. Sálim Ali *for* Sálim Ali Nature Conservation Fund	Rs. 5,000.00
Dr. Sálim Ali *for* Publication Fund	Rs. 5,000.00
Anonymous *for* Charles McCann Vertebrate Zoology Fund	Rs. 2,100.00
Dr. C. V. Kulkarni *for* Staff Welfare Fund	Rs. 1,000.00
Gabriel India Ltd. *for* Silent Valley Conservation	Rs. 3,000.00
Mr. S. Chaudhuri *for* Charles McCann Vertebrate Zoology Fund	Rs. 600.00
For General purpose:	
Mr. G. V. Bedekar	Rs. 2,000.00
World Wildlife Fund-India	Rs. 5,000.00
Mrs. A. H. Patel	Rs. 1,500.00
Mrs. D. S. Variava	Rs. 2,000.00
Mrs. J. P. Sidhwa	Rs. 1,500.00
M/s. B. R. Films	Rs. 500.00
Mr. Kenhelm W. Scott	Rs. 201.92
Mr. J. Strickland	Rs. 164.34

Donations to the Society of more then Rs. 250/- qualify for reduction of income-tax under section 80G of the Income-tax Act 1961.

Reference Collection

During the year 665 specimens were received at the Society as donations.

Mammals	13
Birds	503
Reptiles	26
Amphibians	30
Insects	93
Total	665

Nature education scheme

In 1979 250 schools were contacted and 97 actually participated in different activities.

Besides, 110 trainee teachers and 65 college students took advantage of our programmes. A series of lectures and practical demonstration on maintenance of aquaria was held for biology teachers.

An exhibition on 'The need to preserve wildlife' was arranged during wildlife week.

MEETINGS

January, 12: *Talk*:
'Malaria and its mosquito vectors in an urban area' by Dr. Rachel Reuben.

January, 19: *Film show*:
'Last of the Wild'.

February, 17: *Lecutre*:
'Wildlife and Wildlife Management in the Nilgiris' by E. R. C. Davidar.

February, 10-11: *Nature Trip*:
Bhimashankar.

March, 5: *Talk*:
'Tiger to spider' by S. P. Shahi.

March, 10-11: *Field Trip*:
Matheran.

April, 1: *Field Trip*:
Tungareshwar Temple Road.

April, 13-15: *Field Trip*:
Mahabaleshwar.

May, 13: *Field Trip*:
Along Yewoor Road.

June, 4: *Lecutre*:
'Chipko' agitation against deforestation in Garhwal by Shri S. Bahuguna.

June, 17: *Field Trip*:
Khandala—Khopoli.

July, 15: *Field Trip*:
Chenna to Yewoor.

August, 23: *Film Show*:
1. The Magic Square;
2. Waddensea, Birds' Paradise;
3. Sos Sagnes.

August, 25-27: *Field Trip*:
Bhandardara.

September, 12-13: *Film Show*:
1. Kites are flying;
2. The Lonely Level.

October, 14: *Nature Walk*:
Goregaon to Vihar dam.

November, 11: *Nature Walk*:
Tungareshwar.

December, 1-2: *Nature Walk*:
Tansa Lake Sanctuary.

REVENUE & ACCOUNTS

The financial situation of the Society is still unsatisfactory. The year's working showed a deficit of Rs. 36,418.31.

STAFF

The Committee wishes to record its appreciation of the willing cooperation of the staff in the activities of the Society.

Regd. No. F 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

BOMBAY PUBLIC TRUSTS ACT, 1950

SCHEDULE VIII VIDE RULE 17(1)

BALANCE SHEET FOR THE YEAR ENDED 31ST DECEMBER 1979

FUNDS AND LIABILITIES		
Trust Fund or Corpus:		
Life Membership Fund (Individual):		
Balance as per last Balance Sheet	1,34,298.03	
Add: Amount received during the year	17,286.00	
	1,51,584.03	
Less: Amount transferred to Corporate Life Membership fund	11,200.00	1,40,384.03
Corporate Life Membership Fund:		
Add: Amount transferred from Ordinary Life Membership fund as above	11,200.00	
Add: Amount received during the year	12,500.00	23,700.00
Fixed Assets Fund:		
Balance as per last Balance Sheet	87,458.00	
Add: Value of Fixed Assets purchased during the year from Govt. of India grant	28,376.41	
	1,15,834.41	
Less: Transferred to Income and Expenditure account on account of depreciation for the year	14,944.16	1,00,890.25
General Reserve Fund:		
Balance as per last Balance Sheet		37,952.71
Carried over		3,02,926.99

ASSETS		
Immovable Properties:		Nil
Investments: (At appropriated value)		
50, 8% Convertible Bonds each of Rs. 100/- of Ahmedabad Manufacturing and Calico Printing Co. Ltd. fully paid	2,130.20	
202, 8% Redeemable Bands each of Rs. 116/- of Ahmedabad Manufacturing and Calico Printing Co. Ltd. fully paid	9,982.95	
Government Securities: (At cost)		
3% Conversion loan 1946/86 of the face value of Rs. 25,000.00 (Market value Rs. 15,500.00)	25,000.00	
$5\frac{1}{2}$% Govt. of India loan 2000 of the face value of Rs. 2000/- (Market value Rs. 1,790.00)	2,000.00	
In Fixed Deposit with Maharashtra State Road Transport Corporation Rs. 20,000.00	20,000.00	59,113.15
Motor Cars, Motor Cycle & Auto Cycle:		
Balance as per last Balance Sheet	9,295.02	
Less: Depreciation during the year	1,858.99	7,436.03
Carried over		66,549.18

FUNDS AND LIABILITIES

Brought over		3,02,926.99
Building Fund:		
Balance as per last Balance Sheet		4,697.68
Publication Fund:		
Balance as per last Balance Sheet	88,827.12	
Add: Sale proceeds of Glimpses of Nature booklet published under WWF/Volkart Foundation grant	838.50	
Donation received during the year	5,000.00	94,665.62
Other Earmarked Funds:		
As per Schedule 'A'		8,60,026.15
Provision for Capital Losses:		
Balance as per last Balance Sheet		4,528.38
Provision for Depreciation on Investments:		
Balance as per last Balance Sheet		9,266.10
Liabilities:		
For expenses	95,266.57	
For advance subscriptions	3,801.79	
For Sundry Credit Balances	18,023.33	
For Library Deposits	350.00	1,17,441.69
Carried over		13,93,552.61

ASSETS

Brought over		66,549.18
Furniture, Fixture and Equipment:		
Balance as per last Balance Sheet	83,102.86	
Add: Purchased from Govt. of India grant during the year	28,376.41	
Other additions during the year	395.09	
	1,11,874.36	
Less: Depreciation during the year	13,085.17	98,789.19
Loans: (Unsecured considered good)		
To employees		275.00
Advances: (Unsecured considered good)		
To employees	7,636.54	
To others	13,314.59	
To Bird Hazard to Indian Aerodromes Porject	4,752.80	
To Studies on the movement & population structure of Indian avifauna	1,293.35	
To Nature Education Scheme	2,286.15	29,283.43
Stocks: (A) Publication (as per inventory taken & certified by the Curator)	44,644.65	
(B) Cost of publication under preparation		
1. Book of Indian Birds	1,438.15	
2. Book of Indian Animals	25,684.77	
3. Book on Bundle of Feathers	600.00	
4. Book on Synopsis of Birds of India & Pakistan	473.85	72,841.42
Carried over		2,67,738.22

FUNDS AND LIABILITIES	Rs.	ASSETS	Rs.	Rs.
Brought over	13,93,552.61	Brought over		2,67,738.22
		Income Outstanding:		
		Interest accrued	17,091.92	
		Supplies & services	76,001.97	
		Grant Govt. of Maharashtra for 1979-80	1,25,709.00	2,18,802.89
		Cash and Bank Balances:		
		A. *In Current Account with*:		
		i) Grindlays Bank Ltd. M. G. Road, Bombay	33,432.28	
		ii) Grindlays Bank Ltd., London (£627.41 converted at Rs. 17.65)	11,073.78	
		iii) Chartered Bank, Bombay	8,875.65	
		In savings Account with:		
		i) Grindlays Bank Ltd., M. G. Road, Bombay	24,233.16	
		ii) Bank of India, Mueum Savings Branch, Bombay	52,278.68	
		B. *In Fixed Deposit with*:		
		i) Bank of India, Bombay (consisting of Rs. 36,000/- of Dr. Sálim Ali/Loke Wantho Ornithological Research Fund & Rs. 3000/- for Col. Burtons Nature Conservation Fund)	39,000.00	
		ii) Chartered Bank, Bombay (including Rs. 30,000 of Pirojsha Godrej Foundation Fund)	42,400.00	
		iii) Grindlays Bank, Bombay (including Rs. 60,000 of Dr. Sálim Ali/Loke Wantho Ornithological Research Fund & Rs. 29,000 of Charles McCann Vertebrate Zoology Field Work Fund	95,000.00	
Carried over	13,93,552.61	Carried over	3,06,293.55	4,86,541.11

FUNDS AND LIABILITIES		ASSETS		
Brought over	13,93,552.61	Brought over		4,86,541.11
		Cash and Bank Balances: (contd.)	3,06,293.55	
		C. *In Monthly Certificate with*: Bank of India consisting of Rs. 1,25,000/- of Dr. Sálim Ali/ Loke Wantho Ornithological Research Fund & Rs. 3,75,000/- of Dr. Sálim Ali Nature Conservation Fund & Rs. 10,000/- of Pirojsha Godrej Fund	5,25,000.00	8,31,293.55
		Income and Expenditure Account:		
		Balance as per last Balance Sheet	39,299.64	
		Add: Excess of expenditure over income as per Income & Expenditure Account	36,418.31	75,717.95
Total	13,93,552.61	Total		13,93,552.61

Sd/- SALIM ALI
President,
Bombay Natural History Society

Sd/- A. N. D. NANAVATI,
Honorary Secretary,
Bombay Natural History Society

As per our report of even date
Sd/- HABIB & COMPANY
Chartered Accountants

Sd/- C. V. KULKARNI
Honorary Treasurer,
Bombay Natural History Society

BOMBAY, 31*st July*, 1980.

SCHEDULE 'A'

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF BALANCE SHEET AS AT 31ST *DECEMBER*, 1979

Name of the Fund/Grant (1)	*Balances 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/returned during the year* (6)	*Refunds/ Adjustments* (7)	*Total of columns 6 & 7* (8)	*Balance as at 31 December 1979 (5 minus 8)* (9)
(1) Field Work Fund (Sir Dorabji Tata Trust)	2,169.14	—	—	2,169.14	1,870.00	—	1,870.00	299.14
(2) Staff Welfare Fund	2,244.33	1,000.00	—	3,244.33	—	—	—	3,244.33
(3) Dr. Sálim Ali/Loke Wantho Ornithological Research Fund	2,21,136.52	—	—	2,21,136.52	—	—	—	2,21,136.52
(4) Col. Burton's Nature Conservation Fund	4,475.34	300.00 (Interest)	—	4,775.34	—	—	—	4,775.34
(5) Charles McCann Vertebrate Zoology Field Work Fund	25,173.95	2,700.00 330.50 2,700.00 (Interest)	—	30,904.45	931.42	—	931.42	29,973.03
(6) Scholarship fund under Dr. Sálim Ali/Loke Wantho Ornithological Research Fund Investment	8,368.27	22,100.00 (Interest)	—	30,468.27	20,654.74	—	20,654.74	9,813.53
(7) Grant Govt. of India, Dept. of Science & Technology for Plan Expenditure (Bird Data Analysing on Computer) 1978-79 (contd.)	15,985.11	20,000.00	—	35,985.11	23,132.50	—	23,132.50	12,852.61
Carried over	2,79,552.66	49,130.50	—	3,28,683.16	46,588.66	—	46,588.66	2,82,094.50

Name of the Fund/Grant (1)	*Balances 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/returned during the year* (6)	*Refunds/ Adjustments* (7)	*Total of columns 6 & 7* (8)	*Balance as at 31 December 1979 (5 minus 8)* (9)
Brought over	2,79,552.66	49,130.50	—	3,28,683.16	46,588.66	—	46,588.66	2,82,094.50
(8) Grant Govt. of India, Dept. of Science & Technology for Encyclopedia of Natural History 1976-77, contd. 1977-78, contd. 1978-79, contd. 1979-80	15,248.38	—	—	15,248.38	9,417.73	—	9,417.73	5,830.65
(9) Grant Govt. of India, Dept. of Science & Technology for Steel Cabinets 1977-78, contd. 1978-79	28,376.41	—	—	28,376.41	28,376.41	—	28,376.41	—
(10) Grant Govt. of India, Dept. of Science & Technology for Publication of Some Beautiful Indian Climbers & Shrubs 1977-78, contd. 1978-79, contd. 1979-80	35,716.34	—	—	35,716.34	—	—	—	35,716.34
(11) Pirojsha Godrej Foundation Fund	30,000.00	10,000.00	—	40,000.00	—	—	—	40,000.00
(12) Grant Indian Council of Agricultural Research for Determination of Ecological Disturbances in Agricultural & adjoining lands caused by removal of Rana tigrina & Rana hexadactyla for export	—	13,300.00	—	13,300.00	11,710.81	1,520.50 (ICAR) 68.69 (BNHS)	13,300.00	—
Carried over	3,88,893.79	72,430.50	—	4,61,324.29	96,093.61	1,589.19	97,682.80	3,63,641.49

Name of the Fund/Grant (1)	Balances as per last Balance Sheet (2)	Additions/ Amounts received during the year (3)	Transfers from other Funds (4)	Total of colums 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 1979 (5 minus 8) (9)
Brought over	3,88,893.79	72,430.50	—	4,61,324.29	96,093.61	1,589.19	97,682.80	3,63,641.49
(13) Field Work Fund under Pirojsha Godrej Foundation Fund Investment	1,065.54	3,450.00 (Interest)	—	4,515.54	2,640.00	—	2,640.00	1,875.54
(14) Projector Fund received from members	1,614.16	—	—	1,614.16	200.00	—	200.00	1,414.16
(15) Dr. Sálim Ali Nature Conservation Fund	3,52,542.10	23,209.56	—	3,75,751.66	—	—	—	3,75,751.66
(16) Conservation Fund under Dr. Sálim Ali Nature Conservation Fund Investment	17,026.25	36,122.50 (Interest)	—	53,148.75	23,810.88	—	23,810.88	29,337.87
(17) I.U.C.N. Elephant Survey Grant	12,572.87	27,399.70	—	39,972.57	28,229.10	—	28,229.10	11,743.47
(18) Indian Institute of Science, Bangalore for Publication of Special Issue of Journal	26,366.00	—	—	26,366.00	—	—	—	26,366.00
Carried over	8,00,080.71	1,62,612.26	—	9,62,692.97	1,50,973.59	1,589.19	1,52,562.78	8,10,130.19

Name of the Fund/Grant	*Balances as per last Balance Sheet*	*Additions/ Amounts received during the year*	*Transfers from other Funds*	*Total of columns 2,3&4*	*Spent/returned during the year*	*Refunds/ Adjustments*	*Total of columns 6 & 7*	*Balance as at 31 December 1979 (5 minus 8)*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Brought over	8,00,080.71	1,62,612.26	—	9,62,692.97	1,50,973.59	1,589.19	1,52,562.78	8,10,130.19
(19) Dr. Sálim Ali Conservation Fund for Silent Valley Campaign expenses	—	3,000.00	—	3,000.00	1,831.94	—	1,831.94	1,168.06
(20) *Grant from Government of Maharashtra*:								
1. *Grant for* 1978-79 For establishment & Building Maintenance	14,707.30	—	—	14,707.30	14,707.30	—	14,707.30	—
2. *Grant for* 1979-80 For establishment & Building Maintenance	—	1,21,709.00	—	1,21,709.00	72,981.10	—	72,981.10	48,727.90
Total	8,14,788.01	2,87,321.26	—	11,02,109.27	2,40,493.93	1,589.19	2,42,083.12	8,60,026.15

BOMBAY NATTRAL HISTORY SOCIETY

BOMBAY PUBLIC TRUSTS ACT, 1950

SCHEDULE IX [VIDE RULE 17(1)]

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31*ST DECEMBER* 1979

EXPENDITURE

To	*Expenses in respect of Properties*:		
,,	Rates, taxes and cesses	—	
	Repairs and maintenance	3,975.32	3,975.32
,,	*Building Maintenance Expenses*:		
	(As per contra)		
	Met out of the Maharashtra Govt. gant for 1979-80		8,000.00
,,	*Establishment Expenses*:		
	Salaries including D.A. etc. from Govt. of Maharashtra grant (As per contra)		
	For 1978-79	14,707.30	
	For 1979-80	64,981.10	
	Salaries including D.A. etc. (other than above)	1,24,384.85	
	Society's contribution to Staff Provident Fund	5,698.00	
	Payment for ex-gratia payment to Retired Employees	600.00	
	Postages	5,147.15	
	Printing & Stationery	10,552.93	
	Advertisement	194.00	
	Telephone Rental & Cell charges	6,928.65	
	Carried over	2,33,193.98	11,975.32

INCOME

By	*Rent*: (Accrued & Realised)		—	
,,	*Inteterest*: (Accrued & Realised)		—	
	On securities	3,134.56		
	Less: Income tax deducted at source	546.00	2,588.56	
	On Fixed deposits	71,092.24		
	Less: Income tax deducted at source	230.00	70,862.24	73,450.80
,,	*Donations general in cash*:			13,061.26
,,	*Donations towards specific purpose*:			
	Charles McCann Vertebrate Zoology Field Work Fund		2,700.00	
	Sálim Ali Nature Conservation Fund		23,209.56	
	Sálim Ali Nature Conservation Fund for Silent Valley Campaign expenses		3,000.00	
	Pirojsha Godrej Foundation Fund		10,000.00	
	Staff Welfare Fund		1,000.00	
	Publication Fund		5,000.00	44,909.56
,,	*Grants*:			
	(a) *Govt. of Maharashtra*			
	i. For 1979-80 Establishment and Building Maintenance		1,21,709.00	
	ii. For 1979-80 Educational Activity		4,000.00	
	Carried over		1,25,709.00	1,31,421.62

EXPENDITURE

Brought over		11,975.32
To *Establishment Expenses*: (contd.) B/f.	2,33,193.98	
Bank charges	489.60	
Meeting expenses including talks, film shows etc.	2,337.40	
Conveyance & travelling expenses (local)	1,475.63	
Motor cars, motor cycles repairs and maintenance	4,258.00	
Society's prospectus	875.00	2,42,629.61
,, *Audit Fees*:		1,000.00
,, *Amount written off*:		
Bad debts		903.67
,, *Miscellaneous expenses*:		
General charges	2,436.64	
Insurance premium	204.00	
Repairs to furniture & equipment	302.00	
Fund raising expenses	6,888.00	
Legal expenses	50.00	9,880.64
,, *Depreciation*:		
On furniture & equipment	13,085.17	
On motor cars, motor cycles & auto cycle	1,858.99	14,944.16
,, *Amounts transferred to Reserve or Specific funds*:		
Grants transferred to relevant funds	1,80,888.20	
Donations towards specific funds transferred to relevant account in the Balance Sheet	44,909.56	
Carried over	2,25,797.76	2,81,333.40

INCOME

Brought over		1,31,421.62
By *Grants*: (contd.) B/f.	1,25,709.00	
(b) *Govt. of India*:		
i. Dept. of Science & Technology for 1979-80 Journal printing expenses	20,000.00	
ii. for 1979-80 Bird Data Computer Analysing Study	20,000.00	
(c) *Indian National Science Academy* for 1979-80 Journal Printing	5,000.00	
(d) *Indian Council of Agricultural Research* for 1979-80 Frog Project. Received Rs. 13,300.00 less refunded Rs. 1,520.50	11,779.50	
(e) Grant IUCN/WWF for Elephant Survey	27,399.70	2,09,888.20
By *Income from Subscriptions and Entrance Fees*:		
Membership subscription	42,921.36	
Student membership subscriptions	920.00	
Corporate membership subscriptions	17,324.98	
Forest Dept. nominees subscriptions	2,450.00	
Subscription to Journal (Non-members)	16,598.04	
Entrance fees	5,375.00	85,589.38
,, *Income from Publications*:		
Journal sales	719.00	
Glimpses of Nature Booklets	838.50	
Checklist Birds of Maharashtra	330.50	1,888.00
Carried over		4,28,787.20

EXPENDITURE

	Brought over		2,81,333.40
To	*Specific funds*: (contd.) B/f.	2,25,797.76	
	Sale proceeds of Glimpses of Nature booklet transferred to publication fund	838.50	
	Sale proceeds of Checklist of Birds of Maharashtra transferred to Charles McCann Vertebrate Zoology Field Work fund	330.50	
	Interest on Fixed Deposits transferred to respective funds	64,672.50	2,91,639.26
,,	*Expenses on Objects of the Trust*: *Educational*: from respective funds (As per contra)		
	1. Expenses towards research scholarship & other expenses on Ornithological research out of Scholarship fund under Dr. Sálim Ali/ Loke Wantho Ornithological Research Fund Investment	20,654.74	
	2. Expenses on field staff salaries & other expenses relating to Bird Data Computer Analysing Study out of grant Govt. of India, Department of Science & Technology for 1978-79 and 1979-80	23,132.50	
	3. Expenses on steel cabinats for specimens out of grant Govt. of India, Dept. of Science & Technology 1978-79	28,376.41	
	Carried over	72,163.65	5,72,972.66

INCOME

	Brought over		4,28,787.20
By	*Surplus on sale of books*:		
	Book of Indian Birds	21,479.85	
	Book of Indian Animals	236.40	
	Some Beautiful Indian Trees	2,512.00	
	Identification of Poisonous Snake Charts	152.00	
	Other publications	4,789.65	
	Nature calenders	21,920.97	
		51,090.87	
	Add: Surplus on packing charges	77.42	51,168.29
,,	*Miscellaneous Income*:		
	Fees for the use of Society's transparencies	500.00	
	Other receipts	14,788.38	15,288.38
,,	*Administrative Fees*:		
	For handling various funds during the year debited to respective funds		8,892.60
,,	*Profit on Foreign Exchange*:		
	Due to change in exchange rates on our account with Grindlays Bank Ltd. London		404.03
	Carried over		5,04,540.50

EXPENDITURE			
Brought over			5,72,972.66
To *Expenses on Objects of the Trust*: (contd.) B/f.		72,163.65	
4. Expenses on Encyclopedia of Natural History Publication out of grant Govt. of India, Dept. of Science & Technology 1979-80		9,417.73	
5. Expenses on Frog Project met out of grant from Indian Council of Agricultural Research (Rs. 1,520.50 refunded)		11,710.81	
6. Expenses relating to:			
a) Publication of Hornbill Newsletter	16,807.71		
b) Arunachal Pradesh Research Trip	2,619.30		
c) Library Book purchase	1,000.00		
d) Other expenses met out of interest on Dr. Sálim Ali Nature Conservation Fund	3,383.87	23,810.88	
7. Expenses on IUCN/WWF Elephant survey met out of grant from IUCN/WWF		28,229.10	
8. Expenses for field Research under interest on Pirojsha Godrej Foundation fund investment		2,640.00	
9. Expenses incurred on Film Projector		200.00	
Carried over		1,48,172.17	5,72,972.66

INCOME		
Brought over		5,04,540.50
To *Transfer to Specific Funds*:		
Depreciation on fixed assets transferred to fixed assets fund (as per contra)	14,944.16	
Expenditure on Establishment and Building maintenance transferred to Govt. of Maharashtra grant (as per contra)	87,688.40	
Expenditure on specific objects transferred to relevant funds/ grants (as per contra)	1,52,805.53	2,55,438.09
Deficit for the year		36,418.31
Carried over		7,96,396.90

EXPENDITURE				INCOME	
Brougth over			5,72,972.66	Brought over	7,96,396.90
To *Expenses on Objects of the Trust*: (contd.) B/f.		1,48,172.17			
10. Expenses for field studies under Charles McCann Vertebrate Zoology Field Work Fund		931.42			
11. Expenses on field studies under Dorabji Tata Trust field work fund		1,870.00			
12. Expenses on Silent Valley campaign met out of Dr. Sálim Ali Nature onservation fund		1,831.94	1,52,805.53		
B) Journal expenses		54,270.26			
C) Field study programmes and other local field study trips		3,995.43			
D) *Library account*:					
Subscription to other Societies	2,621.93				
Purchase of books	4,282.97				
Book binding exp.	1,286.80				
	8,191.70				
Less: met from Dr. Sálim Ali Nature Conservation fund interest	1,000.00	7,191.70			
E) Maintenance of Reference Collection		5,161.32	70,618.71		
Total			7,96,396.90	Total	7,96,396.90

Sd/- SALIM ALI
President,
Bombay Natural History Society

Sd/- A. N. D. NANAVATI,
Honorary Secretary,
Bombay Natural History Society

As per our report of even date
Sd/- HABIB & COMPANY
Chartered Accountants

Sd/- C. V. KULKARNI
Honorary Treasurer,
Bombay Natural History Society

BOMBAY, 31*st July*, 1980.

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and payments account for the year ended 31st December 1979

RECEIPTS			PAYMENTS		
To *Balance as at 1st January 1979*:			By Salary Nature Education Organiser		10,548.30
With Grindlays Bank Ltd., Bombay on Current Account	756.95		„ Printing and Stationery		811.50
With Bombay Natural History Society Bombay	1,099.55		„ General charges		1,461.60
With Nature Education Organiser	531.89	2,388.39	„ *Balance as at 31st December, 1979*		
„ *Grants*:			1. With Grindlays Bank Ltd., Bombay on Current Account	2,167.00	
Government of Maharashtra for the year 1978-79		10,000.00	2. Cash on hand with Nature Education Organiser	200.00	2,367.00
Sale of Nature Study booklets:		732.16			
Advance from Bombay Natural History Society, Bombay		2,286.15			
Total		15,406.70	Total		15,406.70

Sd/- SALIM ALI
President,
Bombay Natural History Society

Sd/- A. N. D. NANAVATI,
Honorary Secretary,
Bombay Natural History Society

Sd/- C. V. KULKARNI
Honorary Treasurer,
Bombay Natural History Society

As per our report of even date
Sd/- HABIB & COMPANY
Chartered Accountants

BOMBAY, 31*st July*, 1980.

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1979-80 HELD AT THE B.E.S.T. CONFERENCE HALL, ORMISTON ROAD, COLABA, BOMBAY, ON SATURDAY, THE 18TH OCTOBER 1980 AT 5.00 P.M.

The following were present:

1. Mr. Humayun Abdulali
2. Dr. C. V. Kulkarni
3. Dr. Sálim Ali
4. Mr. O. S. Fernandes
5. Dr. A. N. D. Nanavati
6. Mr. G. V. Bedekar
7. Mr. R. E. Hawkins
8. Mr. Bansi Mehta
9. Mr. D. J. Panday
10. Mr. Vivek Matthai
11. Mr. David Fernandes
12. Mr. K. K. Vajifdar
13. Dr. P. J. Deoras
14. Mr. V. G. Govekar
15. Capt. Dhun Mehta
16. Mr. S. R. Nayak
17. Mr. R. H. Tehsin
18. Miss M. M. Haribal
19. Miss A. A. Kaikini
20. Mr. Dilip Patil
21. Mr. J. P. Irani
22. Mrs. Phillippa Mukherjee
23. Prof. P. V. Bole
24. Dr. A. R. Almeida
25. Mr. Chandrakant Wakankar
26. Mr. Deepak Patwardhan
27. Mr. G. K. Amte
28. Miss Renee Borges
29. Mr. K. R. Kothary
30. Mr. S. P. Godrej
31. Mr. Ulhas Rane

At the request of the President (Dr. Sálim Ali), Mr. G. V. Bedekar, Vice President, took the Chair and conducted the proceedings.

The Chairman welcomed the members, particularly Mr. Humayun Abdulali (who had recently been assaulted and robbed at the Borivli National Park near Bombay) and added that a representation has been made to the Chief Minister of Maharashtra regarding better protection of visitors to the park and regarding general questions of demarcation, operation etc. of the park.

Agenda Item (1): The report* of the Committee for the year 1979 which had been circulated was taken as read and the Honorary Secretary (Dr. Nanavati) in inviting comments on the report gave a brief account of the activities at the Society since the end of the year of report, particularly the field projects which had been sanctioned for a period of five years with financial assistance from PL-480 funds. The projects would enable the Society to widen activities in ecological studies and to train more young scientists in undertaking research on field problems. The year 1979 is 96th year of the Society's existence.

Dr. P. J. Deoras wished to know details of the work and the questions about Computer Analysis of bird banding data. Mr. Humayun Abdulali supported Dr. P. J. Deoras. The Chairman explained that while the recovery data only related to approximately 3,000 birds, the data that was being fed into the Computer related not only to ring recoveries but also to several other parameters which would provide information on several points of interest. Bird migration has several mysterious aspects and all kinds of information about it would add to our knowledge. Dr. Deoras was requested to

**See* p. 643.

visit the Society and acquaint himself with the Computer Programmes objectives and draft questions being put to the Computer.

Dr. Deoras asked for information about the Curator's activities in the Asian Elephant Group of the Survival Service Commission of the IUCN. The Curator (M. J. C. Daniel) requested Dr. Deoras to visit the Society so that copies of the reports and papers presented at meetings and seminars on the activities of the group can be given to him.

Mr. Humayun Abdulali raised the issues of the paucity of staff for normal work at the Society and the additional work for various projects being undertaken by the Society. He complained that the staff was not responding to his queries for identification of material and specimens etc. sent to the Society. Mrs. Mukherjee stated that her queries about various matters and identification of specimens were being answered but it was necessary to remind and expedite the staff. Mr. D. Fernandes stated that he had no complaint in this behalf, and found that the staff was cooperative. The Honorary Secretary stated that every effort is being made to answer members' queries but in some cases owing to circumstances beyond the control of the staff, delays did occur. He assured the members that all efforts would be made to avoid delays as far as possible.

Mr. Humayun Abdulali and Dr. P. J. Deoras felt that the members of the Society were not being involved in the various projects being undertaken by the Society. The Honorary Secretary reiterated that the Society always welcomed and continues to welcome the cooperation of members and their offers of participation in all projects undertaken by the Society, and that proposals for new projects would receive careful consideration by the executive committee. The initiative in such matters must come from interested members.

In summing up, the Chairman pointed out that the Society cannot allow itself to stagnate and must enter new fields and widen its interests in fields in which it has expertise and it may be necessary to use Society's experienced staff to train and guide new recruits in various activities of the Society. It would therefore be to the Society's advantage to undertake such field programmes, though they strained the staff.

The Committee's report for 1979 was approved.

Agenda Item (*2*): The balance sheet and the statement of accounts 1979 were presented* by the Honorary Treasurer (Dr. C. V. Kulkarni), who explained that the deficit of Rs. 36,418.31 for the year was due to lack of availability of the Birds and Animals publications for sale and the increase in staff salaries and general rise in prices of all items. He added that with the publications on Birds and Animals being ready for sale in new editions and the support from other fields of activities, the finances of the Society are expected to improve but efforts to enrol new members on a large scale must continue.

Mr. Vivek Matthai suggested that the format of the Society's calendar should be changed to make it more attractive, and enhance the sales. The Chairman stated that this matter is under constant review by the Committee and concrete proposals from members would be welcome.

Mrs. Mukherjee wished to know about damage to the roof which necessitated an immediate expenditure of Rs. 20,000/-. The Honorary Treasurer explained that from time to time small leaks in the roof had developed (in the Society's building which is about twenty years old) and were attended to but the situation has suddenly deteriorated, during the last monsoon (of 1980) and urgent steps became

**See* p. 650.

necessary. The members would be glad to know that the Governments of both Maharashtra and India had responded promptly to the appeal for assistance made by the President of the Society and requisite repairs would be carried out, it is hoped, before the monsoon of 1981.

Mrs. Mukherjee enquired about the cost of the Society's Journal and opined that the Society's Journal was not of interest to a number of the Society's members who are more interested in "Hornbill". She suggested for consideration whether to such members only the Hornbill may be sent and whether the question of a membership (at reduced fees) without Journal may also be examined. Mr. David Fernandes supported the view that a non-Journal membership would be of benefit to the Society. The Chairman stated that this complex matter had been considered by the Executive Committee on several occasions in the past, that the costs of the Journal were mainly on composing and printing, and much saving would not result from reduction in number of copies, and that under the rules despatch of the Journal to members was obligatory. The Committee would however consider specific porposals received in this matter.

The accounts were approved.

Agenda Item (3): Appointment of Auditors and fixing their remuneration. The Honorary Treasurer expressed appreciation of the services rendered by the Society's Auditors Messrs Habib & Co. and proposed that they be requested to continue as Society's auditors for the year 1980 on a remuneration of Rs. 1000/-. The proposal was seconded by Dr. Nanavati and was unanimously approved.

There being no other business, the meeting terminated with a vote of thanks to the Chair and was followed by exhibition of a film on African Wildlife, kindly arranged by the World Wildlife Fund—India.

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater, 4th edition (reprint). 28 plates in colour by Paul Barruel and many other monochrome illustrations. Rs. 60.00
(*Price to members Rs.* 55)

The Ecology of the Lesser Bandicoot Rat in Calcutta, by James Juan Spillett. Rs. 10

Birds

The Book of Indian Birds, by Sálim Ali. 11th (revised) edition. 74 coloured and many monochrome plates. Rs. 60.00
(*Price to members Rs.* 55)

Checklist of the Birds of Maharashtra, by Humayun Abdulali, 2nd edition. Rs. 4

Checklist of the Birds of Delhi, Agra and Bharatpur, by Humayun Abdulali & J. D. Panday. Rs. 3.00

Snakes

Identification of Poisonous Snakes, Wall chart in Gujarati, and Marathi. Rs. 5

Plants

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 3rd edition (Reprint). Rs. 40.00
(*Price to members Rs.* 35)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. 2nd edition. (*in Press*)

Miscellaneous

Glimpses of Nature Series Booklets:

1. Our Birds I (with 8 coloured plates) in Kannada — Rs. 0.62
2. Our Beautiful Trees (with 8 coloured plates) in Hindi — Rs. 0.62
3. Our Monsoon Plants (with 8 coloured plates) in Hindi and Marathi. — Rs. 0.80
4. Our Animals (with 8 coloured plates) in English, Gujarati, and Hindi — Rs. 1.25

Glimpses of Nature in India (with 40 coloured plates) in English Rs. 7.50
(*Price to members Rs.* 5)

Back numbers of the Society's Journal. Rates on application.

The Society will gratefully accept back numbers of the *Journal*, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Entrance Fees:

Ordinary and Life Members	Rs. 25
Student Members	Rs. 10

Subscription:

(*a*) Ordinary individual Members	Rs. 60
(*b*) Ordinary Corporate Members	Rs. 125
(*c*) Ordinary Members resident outside India	Rs. 95
Life Members	Rs. 800
	(Rs. 250 after 20 years)
Compound Corporate Members	Rs. 1500
Student Members (without Journal)	Rs. 15
Annual subscription to Journal	Rs. 135

Members residing outside India should pay their subscription by means of orders on their Bankers to pay the amount of the subscription to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £ 6.50 should be paid annually to the Society's London Bankers—The Grindlays Bank Ltd., 13, St. James's Sq., London SW1Y 4LF. Account No. 1101091.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

CONTENTS

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