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OBSERVATIONS ON THE OVIPOSITION BEHAVIOUR IN *APOCRYPTA BAKERI* JOSEPH (TORYMIDAE: HYMENOPTERA)[1]

U. C. ABDURAHIMAN AND K. J. JOSEPH[2]
(*With two text-figures*)

Apocrypta bakeri Joseph is a cleptoparasite of the agaonid, *Ceratosolen marchali* Mayr, breeding in the receptacles of *Ficus hispida* L. Observations on the process of oviposition and the related behaviour of these torymid wasps are briefly given and discussed. The presence of the abdominal keel, formed of the telescopically arranged basal segments is a unique feature and facilitates the penetration of the ovipositor across the fig wall. The eggs are deposited only in those ovaries of *Ficus* where the agaonid, *C. marchali* has deposited its egg and injected the secretion from its poison glands. The presence of these 'internal host factors' possibly detected by the sensillae present at the tip of the ovipositor of *A. bakeri* inform this insect about the suitability or otherwise of the fig ovary for oviposition and serve as factors determining successful oviposition.

INTRODUCTION

The oviposition behaviour in different genera of fig-inhabiting torymids has been very little investigated. Joseph (1953) observed the process of egg-laying in *Sycoscapteridea* (=*Neosycoecus*) *indica* Joseph. He gave a detailed account of the process of oviposition and the factors determining the same in *Philotrypesis caricae* L., cleptoparasite of *Blastophaga psenes* L. developing in the syconia of *Ficus carica* L. (Joseph 1958 & 1959). Ansari (1966) studied the process of oviposition in *Parakoebelea stratheni* (=*glomeratus*) Joseph. The present paper embodies the results of our study of the oviposition behaviour in *Apocrypta bakeri* Joseph, which develops as a cleptoparasite of the agaonid, *Ceratosolen marchali* Mayr, breeding in the receptacles of *Ficus hispida* L. It is for the first time that the oviposition behaviour of a species of the genus *Apocrypta* is studied.

[1] Accepted July 1977.
[2] Department of Zoology, University of Calicut, Kerala 673635.

Material and Methods

Mature gall figs of *Ficus hispida* were brought to the laboratory. The females of *Apocrypta bakeri* eclosed were reared in the laboratory, feeding them with diluted honey. Tender figs of appropriate stage, freshly collected from the tree were provided to these females for oviposition.

Ovipositing females were observed under the Stereomicroscope for studying the various stages of oviposition and related behavioural aspects. The path taken by the ovipositor inside the fig was traced by cutting the ovipositor at its basal part at the time of oviposition and then by following its course by dissection of the fig wall.

Field observations on the oviposition behaviour in *A. bakeri* were also made to supplement our study in the laboratory.

Observations and Results

In nature, oviposition is more frequent in the morning hours, normally between 6 A.M. and 10 A.M. As many as eight females were observed in the act of oviposition on the same fig. The large scale eclosion of the females in the early morning is one of the probable reasons why a large number of females were observed ovipositing during the morning hours. Under laboratory conditions, the females readily showed oviposition behaviour during the day when suitable tender figs were provided.

The oviposition behaviour in *A. bakeri* can be conveniently divided for our study purpose into 3 different stages.

a) *Selection of a suitable area for insertion of the ovipositor*:

The females on eclosion remain for a while on the fig surface. No distinct pre-oviposition period was observed, and many females accomplished oviposition soon after their eclosion. On the surface of the tender figs, the insect wanders in search of a suitable spot to insert the ovipositor. This search is aided by the antennae, the tips of which are kept in contact with the fig surface as the insect moves along (Fig. 1a). It would seem therefore, that certain olfactory cues perceived by the antennae initially inform the insect about the suitability or otherwise, of the spot to be selected for insertion of the ovipositor. The insect now raises the abdomen to the maximum height possible by straightening the hind legs. Along with this the abdomen is elevated from its normal position. Simultaneously, the seven basal abdominal segments that constitute the ventral abdominal keel are stretched and this part of the abdomen now further brought perpendicular to the thorax (Fig. 1b). The remaining segments of the abdomen along with the terminal ovipositor are now folded down and the tip of the ovipositor is brought in contact with the selected spot, aided by the hind legs (Fig. 1c). Now the insect undertakes a detailed examination of the spot where its ovipositor has touched the fig surface. This seems to be done by means of the sensory setae present at the tip of the ovipositor and its sheaths. On several occasions the insect was found to abandon the initially chosen site and recommence its search for another suitable site.

b) *Penetration of the ovipositor and deposition of the eggs*:

When the suitable spot is finally selected the hind legs are slowly bent downwards and the hypopygium is lowered in stages as the ovipositor pierces and penetrates into the wall of the fig (Figs. 1d & 1e). The penetration of the ovipositor down the fig wall is also aided by the force exerted by waves of contraction of the abdomen starting at its base and travelling rhythmically towards its tip. With the further

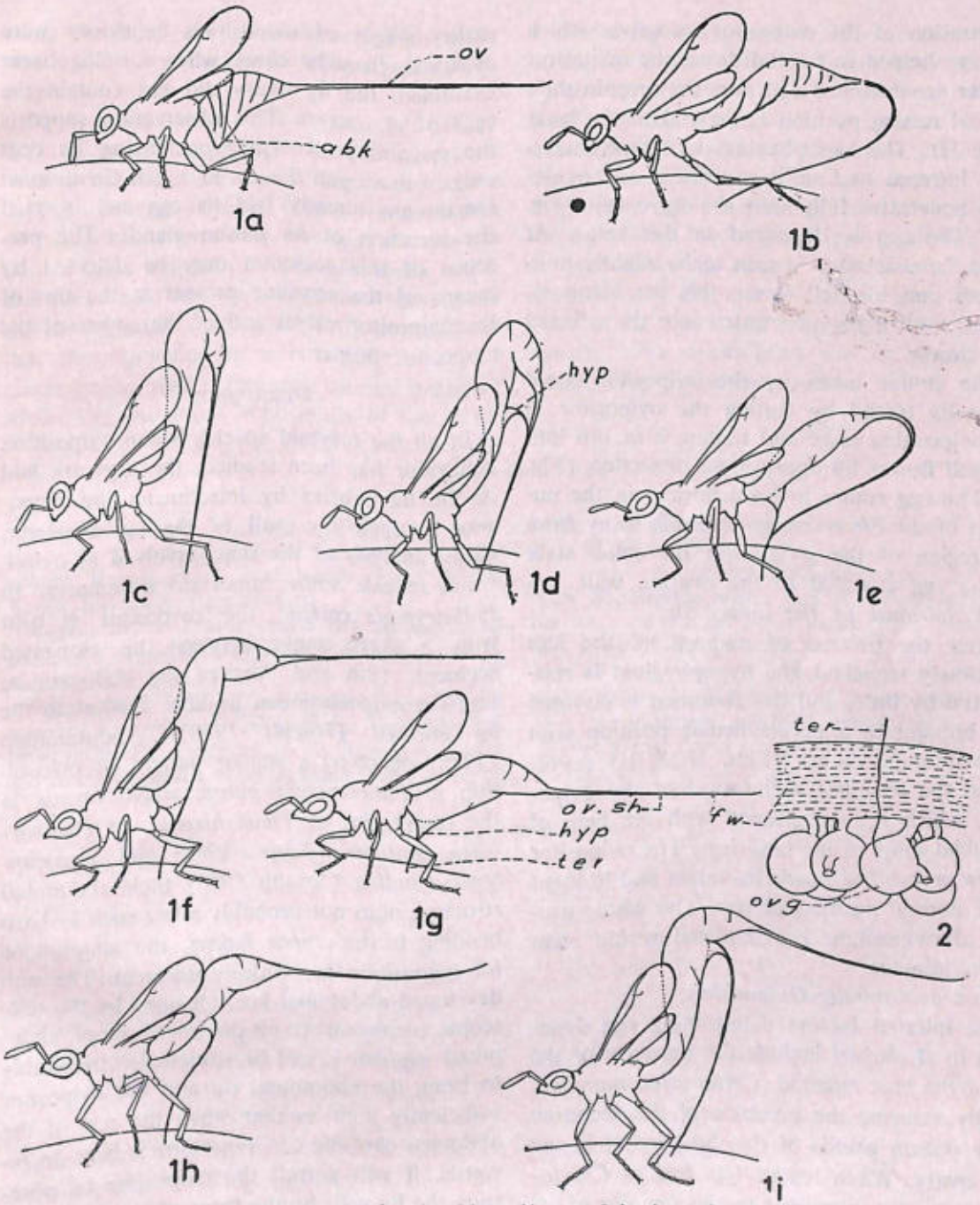

Fig. 1a-1i. Different stages of oviposition. (1a-1c: Selection of a suitable spot for oviposition on the syconium; 1d-1e: Penetration of the ovipositor across the fig wall; 1f-1g: egg laying; 1h-1i; withdrawal of the ovipositor). Fig. 2. Section of a part of the fig showing the path taken by the ovipositor into a *Ficus* ovary.

Abbreviations: abk—abdominal keel; fw—Fig wall; hyp—hypopygium; ov—ovipositor; ov. sh—ovipositor sheaths; ov. g—ovarian gall; ter—terebra (penetrating stylets of the ovipositor).

penetration of the ovipositor its valves which till now helped to fix and direct the ovipositor proper are detached and now they regain their normal resting position horizontal to the body (Fig. 1f). The hypophygium is now considerably lowered and in this position the ovipositor penetrates fully into the fig ovary (Fig. 1g). The egg is deposited in this stage. At times the ovipositor is seen to be slightly pulled out and inserted again, this act being repeated until it has penetrated into the selected gall flower.

The course taken by the ovipositor could be easily traced by cutting the ovipositor in the ovipositing stage and tracing it *in situ* into the gall flower by appropriate dissection (Fig. 2). The egg comes to be deposited in the nucellus of the *Ficus* ovary, normally away from the region of the style, with the small stalk of the egg attached to the ovarian wall.

c) *Withdrawal of the ovipositor*:

After the process of oviposition, the legs are slowly stretched, the hypophygium is raised little by little, and the abdomen is elevated and brought to a perpendicular position with respect to the thorax (Figs. 1h & 1i) resulting in the complete withdrawal of the ovipositor, which is then cleaned with the help of the tibial spurs of the hind legs. The ovipositor is now ensheathed inside its valves and brought to its normal position of rest. The whole process of oviposition is completed within eight to ten minutes.

Factors determining Oviposition:

The internal factors determining egg deposition in *A. bakeri* include the presence of the egg of the host agaonid, *Ceratosolen marchali*, thereby assuring the presence of the secretion of the poison glands of this host insect in the same ovary. When tender figs free of *Ceratosolen* eggs were provided to the females of *A. bakeri*, no eggs were laid eventhough the earlier stages of oviposition behaviour were observed. In some cases, when such figs were examined, the fig ovary did not contain the eggs of *A. bakeri*. This observation supports the possibility of *Apocrypta* laying its eggs only in those gall flowers in which *Ceratosolen* female has already laid its egg and injected the secretion of its poison glands. The presence of this secretion may be detected by means of the sensillae present at the tips of the ovipositor valves and of the stylets of the ovipositor proper.

Discussion

In all the torymid species where oviposition behaviour has been studied, the eggs are laid in the fig ovaries by introducing the ovipositor through the wall of the fig. However, closer analysis of the steps involved in oviposition reveals some important differences. In *Philotrypesis caricae*, the ovipositor is bent with a sharp angle between the elongated segments (8th and 9th) of the abdomen so that the ovipositor can be kept vertical to the fig surface (Joseph 1958). Abdurahiman (1972) observed a similar pattern of oviposition in *Philotrypesis pilosa*, which breeds in the receptacles of *Ficus hispida*. In *Parakoebelea stratheni* (Ansari 1966) and *Sycoscapteridea indica* (Joseph 1953) their abdominal structure does not probably allow such a sharp bending. In *Apocrypta bakeri*, the adaptations for oviposition are entirely different. The well developed abdominal keel (formed by the telescopic arrangement of the seven basal abdominal segments), can be stretched considerably to bring the abdominal tip and the ovipositor sufficiently high so that when the rest of the abdomen carrying the ovipositor is bent downwards, it will permit the ovipositor to penetrate the fig wall by the force of rhythmic contractions exerted upwards and downwards

along the "∩" shaped abdomen. This organisation is a unique feature of the genus *Apocrypta*.

In *Sycoscapteridea indica*, Joseph (1953) did not mention about the exact nature of ovaries of *Ficus infectoria* where the insect deposits its eggs. Ansari (1966) claimed that in *Parakoebelea stratheni*, the eggs are always laid in those ovaries of *Ficus glomerata* which did not contain any other eggs. In *Philotrypesis caricae*, Joseph (1958) showed conclusively that the egg-laying in a particular ovary of *Ficus carica* was dependent on the presence of the egg and more importantly of the secretion of the poison gland of *Blastophaga psenes* in the same ovary. It has been also suggested by the same author that the presence of the latter internal host factor is responsible for stimulating the sensory structures present at the extremity of the valves and stylets of the ovipositor, thus "informing" the torymid on the suitability for oviposition or otherwise of the particular fig ovary. The present studies also showed the role of these same factors (in this case brought about by *Carsolen marchali*) in determining the successful oviposition by *Apocrypta bakeri*.

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A CONTRIBUTION TO THE FLORA OF MANIPUR[1]

U. SHUKLA[2] AND A. K. BAISHYA[3]

The paper describes 49 genera and 53 species of flowering plants reported as new records for the State of Manipur. It also gives a list of 13 Cryptogams recently collected from Manipur. The collection of *Platycerium wallichii* from forests of Manipur appears to be the first report of its occurrence within India.

The only noteworthy work on the Botany of Manipur State is by Deb (1961), who collected intensively in this region and published a list of 2007 taxa of flowering plants.

The present work is based on authors own collections in Manipur during April-May, 1975. The grasses have been described elsewhere.

Platycerium wallichii commonly called the 'Stag-horn fern' which is earlier reported from Malay Peninsula and Tenasserium has been collected from Moreh, on the border of Burma, well within Indian territory. It is fairly common as epiphyte and is being reported here for the first time from India. *Andrographis, Evolvulus, Grangea, Holarrhena, Mosla, Pongamia, Sonchus, Sparaganium, Sphaeranthus, Stachytarpheta* and *Wrightia* are new genera for the State.

In the following enumeration, species are arranged alphabetically under their respective families which are also listed alphabetically. For each species precise locality, date of collection and field number have been given. Field numbers without collectors name are all collections of *Shukla*. Altitude of the locality, name of plants in Manipuri language and local uses, when available are provided.

[1] Accepted November 1977.

[2] Botanical Survey of India, Central Circle, Allahabad.

[3] Botanical Survey of India, Eastern Circle, Shillong-793 003.

PHANEROGAMS

ACANTHACEAE

Andrographis ovata Benth.
Herb, flowers whitish.
Only one plant seen.
Moreh, 8.5.1975, 63678.

AMARANTHACEAE

Alternanthera philoxeroides (Mart.) Griseb.
Creeping and trailing herb, stem hollow, inflorescence silvery white.
Very common in water, wasteland and in marshes in and around Keibul. Apparently this species is not used locally. In Meghalaya, however, it is used as a leaf vegetable. Keibul Lamjao, on floating island (750 m), 26.4.1975, *Jain* 63320; Keibul (750 m), 28.4.1975, *Jain* 63389; Near Logtak (750 m), 29.4.1975, *Jain* 63453.
This species is a native of Brazil and seems a very recent introduction and now naturalised in various places.

Alternanthera repens (Linn.) O. Ktze.
Trailing herb, inflorescence white.
Growing on marsh and gravelly soil.
Logtak, Tongbram village (750 m), 29.4.1975, *Jain* 63451.
The species is a native of America but now naturalised in many parts of India. Its first report in India was from near a railway line on Monkey hill plateau in Khandala

ghats. Subsequently collected in eastern India in 1941 and 1957.

AMARYLLIDACEAE

Crinum amoenum Roxb.
Herb about 50 cm tall, flowers white in terminal whorl. In large numbers in a shady place on a hillock. Tipaimukh road, Mission compound (1350 m), 6.5.1975, 63650.

APOCYNACEAE

Holarrhena antidysenterica (Linn.) Wall. ex DC.
Small tree upto 2 m high. Flowers white, scented.
Moreh, 8.5.1975, 63674.

Wrightia tomentosa (Roxb.) R. et S.
About 7 m tall tree. Flowers pale yellow, scented.
In roadside ravine.
Moreh, Indo-Burma road, 9.5.1975, 63727.

ASTERACEAE

Erigeron bonariensis Linn.
Herb upto 45 cm tall.
Not common.
Tongbram village, Near Logtak Lake (750 m), 29.4.1975, *Jain* 63469.

Grangea maderaspatana (Linn.) Poir. *Local name*: 'Laibongon'.
Herb, inflorescence yellow.
Very common on roadside. Decoction used for giving bath in case of Eczema and other skin diseases.
Keibul, on way to floating island (750 m). 26.4.1975, *Jain* 63314.

Lactuca gracilis DC.
Churachandpur, Tipaimukh road (1250 m). 2.5.1975, 63546; Ngaram village, near Thanga (750 m), 29.4.1975, *Jain* 63458.

Sonchus asper (Linn.) Hill *Local name*: 'Khomthopi'.
Herb upto 60 cm tall, ray-florets white.
Keibul, in moist places (750 m), 28.4.1975, *Jain* 63441.

Sonchus wightianus DC. subsp. **wightianus** DC.
Small rosette herb with glabrous stem, inflorescence yellow.
Churachandpur, Tipaimukh road (1250 m), 2.5.1975, 63554.

Sphaeranthus indicus Linn.
Spreading herb. Very common in wastelands.
Keibul (750 m), 28.4.1975, *Jain* 63397.

BORAGINACEAE

Heliotropium ovalifolium Forsk.
Low prostrate herb, flowers white, seeds black. Common in open fields in damp patches.
Churachandpur, Tipaimukh road (1250 m), 2.5.1975, 63548.

COMMELINACEAE

Commelina appendiculata C.B. Cl.
Small herb, flowers blue, bracts villous. Not common.
Churachandpur, behind Beat Office (1260 m), 2.5.1975, 63563.

CONVOLVULACEAE

Evolvulus nummularis Linn.
Creeping herb, flowers white. Very common on roadside.
Moreh, Indo-Burma road, 9.5.1975, 63722.

CYPERACEAE

Cyperus brevifolius (Rottb.) Hassk.
Small sedge. Common near stream.
Seprameina, 12.5.1975, 63785.

Verma (1971) reported it from all regions in eastern India except Manipur.

Fimbristylis aestivalis (Retz.) Vahl *Local name*: 'Kankhanchabei'.

A very variable species, 15 - 40 cm tall. Common in marshy places and floating island.

Keibul (750 m), 26.4.1975, *Jain* 63311; Keibul Lamjao, 27.4.1975, *Jain* 63378 & 63379. Verma (1971) does not report it from Manipur.

EUPHORBIACEAE

Croton bonplandianum Baill.

Herb upto 75 cm tall, male flowers white. Common in wasteland and roadside.

Imphal-Dimapur road (795 m), 11.5.1975, 63747.

Euphorbia hirta Linn. *Local name*: 'Pakhamba-maton'.

Trailing herb, inflorescence pedunculate.

Logtak - Tongbram village (750 m), 29.4.1975, *Jain* 63490.

LABIATAE

Mosla ocymoides Buch. - Ham. ex Benth.

Small herb, flowers violet. Common in roadside nala.

Churachandpur, near Churachandpur College (1250 m), 1.5.1975, 63536.

LAURACEAE

Beilschmiedia brandisii Hook. f.

Tree upto 7 m tall, fruits dark violet. Not common.

Koubru Leikha, 12.5.1975, 63794.

LYTHRACEAE

Ammannia multiflora Roxb.

Small herb, entire plant purplish. Common in moist places and dried-up paddy fields. Churachandpur, Tipaimukh road 2 Km (1250 m), 2.5.1975, 63556; Seprameina, 12.5.1975, 63792.

MIMOSACEAE

Acacia farnesiana Willd. *Local name*: 'Chingonglei'.

Inflorescence yellow, fruits 7-10 cm long. Common. Powder of seeds with water used in Cholera.

Near Logtak Lake (750 m), 29.4.1975, *Jain* 63449; Imphal-Dimapur road, 1 Km (795 m), 11.5.1975, 63758.

Albizzia odoratissima Benth. Local name: 'Uin'.

Tree in buds.

Tongbram village, near Logtak Lake (750 m), 29.4.1975, *Jain* 63447.

MORACEAE

Maclura cochinchinensis (Lour.) Corner

Scandent spiny shrub, 4-5 m tall in the ravines. Rare.

Churachandpur, near Horticultural Sub-Station (1250 m), 4.5.1975, 63614.

MYRSINACEAE

Ardisia solanacea (Poir.) Roxb.

Shrub upto 4 m tall, flowers white to light or dark purple. Common along river bank. Moreh, 8.5.1975, 63710 & 63711.

MYRTACEAE

Syzygium formosum (Wall.) Masamune

Tree about 10 m tall.

Moreh, 8.5.1975, 63709.

Syzygium griffithii (Duthie) Merr. & Parry.

Tree about 5 m tall. Common in rocky soil. Fruits edible.

Moreh, 8.5.1975, 63676.

ONAGRACEAE

Epilobium angustifolium Lamk.
Small herb, flowers yellow. On road side.
Saikot village (1450 m), 5.5.1975, 63622.

ORCHIDACEAE

Cirrhopetalum guttulatum Wall. ex Hook. f.
Epiphytic on *Albizzia* sp., flowers purple. Rare.
Tipaimukh road, 11 km (1350 m), 6.5.1975, 63655.

Coelogyne graminifolia Par. & Reichb. f.
Herb hanging down from rocks, in fruits. Not common.
Moreh, 8.5.1975, 63687.

Coelogyne suaveolens Hook. f.
Epiphytic herb, flowers white.
Common.
Moreh, 8.5.1975, 63698.

Dendrobium williamsonii Day et Reichb. f.
Epiphytic herb, flowers white. Common.
Moreh, 8.5.1975, 63693.

Eria fragrans Reichb. f.
Epiphytic herb, fruits green, elongated. Common inside the forest.
Moreh, 8.5.1975, 63701.

Geodorum densiflorum Schlechter
Terrestrial herb, flowers white. Not Common.
Saikot (1450 m), 5.5.1975, 63646.

Renanthera imschootiana Rolfe
Epiphytic herb, flowers deep red.
Stated to be common in Koubru forest.
Imphal-Dimapur road, 11 km, Orchid nursery (795 m), 11.5.1975, 63776.

Sarcanthus filiformis Lindl.
Epiphytic herb on *Ficus* sp., flowers small, purplish. Not common.
Maullum (1375 m), 3.5.1975, 63590.

PAPILIONACEAE

Pongamia pinnata (Linn.) Pierre
Road side tree upto 10 m high, flowers light purple. Possibly introduced.
Imphal-Dimapur road, 7 km (795 m), 11.5.1975, 63760.

POLYGONACEAE

Polygonum hydropiper Linn.
Herb upto 50 cm tall, flowers white. Growing on marshy places.
Logtak-Tongbram village (750 m), 29.4.1975, *Jain* 63492.

Rumex maritimus Linn. *Local name*: 'Torongkhonchak'.
Herb, fruiting perianth armed as well as unarmed.
Common on road side. Leaves applied on Ring worm infection.
Keibul Lamjao (750 m), 26.4.1975, *Jain* 63327.

POTAMOGETONACEAE

Potamogeton octandrum Poir.
Aquatic floating herb. Common.
Thanga-Logtak (750 m), 29.4.1975, *Jain* 63456.

PRIMULACEAE

Lysimachia javanica Bl.
Annual herb, about 75 mm tall, flowers white. Common in moist places.
Churachandpur-Imphal road, 2 km (1250 m). 4.5.1975, 63601.

RUBIACEAE

Canthium gracilipes Kurz. *Local name*: 'Heibi'.

Small tree in young fruits. Not common.
Keibul (750 m), 28.4.1975, *Jain* 63401.

Wendlandia coriacea DC.
Shrub upto 2.5 m tall, inflorescence dried-up. Growing on hill slopes.
Saikot (1450 m), 5.5.1975, 63631.

SOLANACEAE

Datura suaveolens Willd. *Local name*: 'Savaidak'.
Herb upto 1.5 m tall, flowers white.
Common in wasteland.
Imphal-Dimapur road, 10 Km. (795 m), 11.5.1975, 63762.

Solanum khasianum C.B.Cl. *Local name*: 'Singkhaga'.
Prickly herb, fruits 2.5 cm diameter, yellow. Fruits were seen being fed to captive barking deer.
Keibul Lamjao (750 m), 26.4.1975, *Jain* 63339.

TILIACEAE

Grewia elastica Royle
Shrub; petals dull white, stamens yellow. Common on hill slopes.
Saikot (1450 m), 5.5.1975, 63642.

Grewia sapida Roxb.
Low herb, branching from the base. Common. Ripe fruits edible.
Keibul, behind Forest Office (750 m), 30.4.1975, 63521.

Triumfetta rhomboidea Jacq.
Shrub about 75 cm tall, flowers small, yellow. Common in open fields.
Churachandpur, near Horticultural Sub-Station (1250 m), 4.5.1975, 63603.

TYPHACEAE

Sparaganium simplex Huds.
Tall herb. Not common.
Keibul Lamjao (750 m), 26.4.1975, *Jain* 63324.

VERBENACEAE

Clerodendrum viscosum Vent.
Shrub upto 2 m high, calyx red, fruits black. Common on road side.
Moreh, 8.5.1975, 63670.

Stachytarpheta indica Vahl
Herb upto 1 m tall, flowers white. Common on road side.
Seprameina, 12.5.1975, 63781.

ZINGIBERACEAE

Curcuma zedoaria Rosc.
Herb in inflorescence, bracts red, flowers yellow, anthers tailed. Common.
Churachandpur, behind Beat House (1260 m), 30.4.1975, 63522; Muallum (1375 m), 3.5.1975, 63576.

CRYPTOGAMS

CYCADACEAE

Cycas pectinata Griff.
Woody shrub on hill slope. Rare.
Keibul, behind Forest Beat Office (750 m), 30.4.1975, 63805.

EQUISETACEAE

Equisetum debile Roxb. ex Vancher
Erect rhizomatous herb, 20 cm—1 m tall. Not common. Occassionally met with in moist shady places.
Moreh, 8.5.1975, 63712; Imphal-Dimapur road, 1 Km (795 m), 11.5.1975, 63774.

LYGODIACEAE

Lygodium japonicum (Thunb.) Sw.
Herb, growing on hill slopes. Not common.

MARSILEACEAE

Marsilea minuta Linn.
Aquatic herb in roadside ditch. Not common.
Keibul, near Wild Life Office (750 m), 30.4.1975, 63499.

Marsilea minuta Linn. var. **indica** Gupta
Herb about 5 cm tall in sporocarp .Abundant in dried up road side depression. Growing in patches forming a continuous mat.
Imphal-Dimapur road (795 m), 11.5.1975, 63764.

POLYPODIACEAE

Platycerium wallichii Hook. 'Stag-horn fern'
Epiphytic, fronds dichotomously forked, hanging downwards, sori at the undersurface of the fork. Fairly common.
Moreh, 8.5.1975, 63668.
Panigrahi (1961) stated that this taxon is likely to occur in eastern India. He cited Beddome (1883) where distribution is shown as Malay Peninsula, Tenasserium. The present collection from Moreh, is therefore, a new record for India.

Pyrrosia nuda (Gies.) Ching
Herb, erect or hanging down from rocks and trees, sori marginal. Very common.
Moreh, 8.5.1975, 63681.

PTERIDACEAE

Pteridium aquilinum (Linn.) Kuhn
Herb upto 1 m tall on rocky soil. Not common.
Keibul, behind Beat Office (750 m), 30.4.1975, 63518.

Pteris cretica Linn.
Herb upto 75 cm tall, sori continuous and marginal. Not common.
Churachandpur, behind Beat Office (1276 m), 2.5.1975, 63564.

Pteris quadriaurita Retz.
Herb upto 1.5 m tall, sori marginal. Rare.
Muallum (1375 m), 3.4.1975, 63572.

Sphenomeris chinensis (Linn.) Maxon var. **tenuifolia** (Sw.) N. C. Nair.
Common on road side hill slopes.
Imphal-Dimapur road (795 m), 11.5.1975, 63757.

SALVINIACEAE

Salvinia nutans Hoffm.
Small floating herb, leaves glandular, small. Not common.
Keibul Lamjao (750 m), 2.4.1975, *Jain* 63373.

SELAGINELLACEAE

Selaginella amblyphylla Alston
Herb. Common on road side hill slopes.
Koubru-Leikha, 12.5.1975, 63798.

Inspite of the work of Deb (1961) and present additional records, Manipur must be considered as an underexplored state. Further intensive work may bring to light many hitherto unreported species. Even species new to science may be expected.

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DRY SKIN PREPARATIONS OF FROGS AND TOADS AS AIDS FOR THEIR TAXONOMY[1]

The paper describes the modified method of preparation of anuran dry skins. It also discusses in detail, for the first time, utility of the dry skin preparations as an additional, important, convenient and very useful means of amphibian taxonomy. For the purposes of discussion, black and white photographs of dry skin preparation of one species each of *Bufo*, *Microhyla* and *Philautus* and four species of *Rana* have been taken into account. Wherever necessary differences in the male and female of a species have also been presented.

S. Y. Paranjape[2] and Leela Mulherkar[3]

(*With eight text-figures*)

Introduction

The method developed by Kincaid (1948) for preserving the colour pattern of the skins of frogs is very useful (Knudsen 1966). It appears to have been used by both of them solely from the point of view of colour preservation.

It is known that, besides the skin colour, the nature of the skin and its marking patterns, the nature of fingers and toes, the extent of webbing, separation of metatarsals by the web and nature of the metatarsal tubercles happen to be some of the characters of taxonomic importance in the anuran classification. These characters, being essentially external ones, are far more valuable than other internal characters, in visual indentification of the species during field work (Paranjape and Mulherkar 1979).

From this point of view, the earlier 'skin technique' has been modified to a certain extent with a view to retaining those—characters as far as possible. Our observations, discussed later, indicate that the modified method is taxonomically quite useful. Besides, such dry skin preparations are very convenient for demonstration, projection, etc. and that the characters can be studied any time in and out of the season, irrespective of the availability of the amphibian under study.

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Material and Method

To prepar an album of dry skins the following procedure is followed:

The frog (or toad) is etherised. It is then quickly skinned by taking incision mid-ventrally along the body and carrying it on to the limbs. The skin along the jaws and on the head region is separated from the body, as it is somewhat firmly attached. Elsewhere, the skin being loosely attached to the body presents very little difficulty in its separation. The incisions along the limbs are continued upto $\frac{1}{2}$ or $\frac{3}{4}$ of the palm and the sole regions. Thereafter, the skin on the digits (i.e. fingers and toes) is removed by gently pulling of the separated skin, in the manner similar to

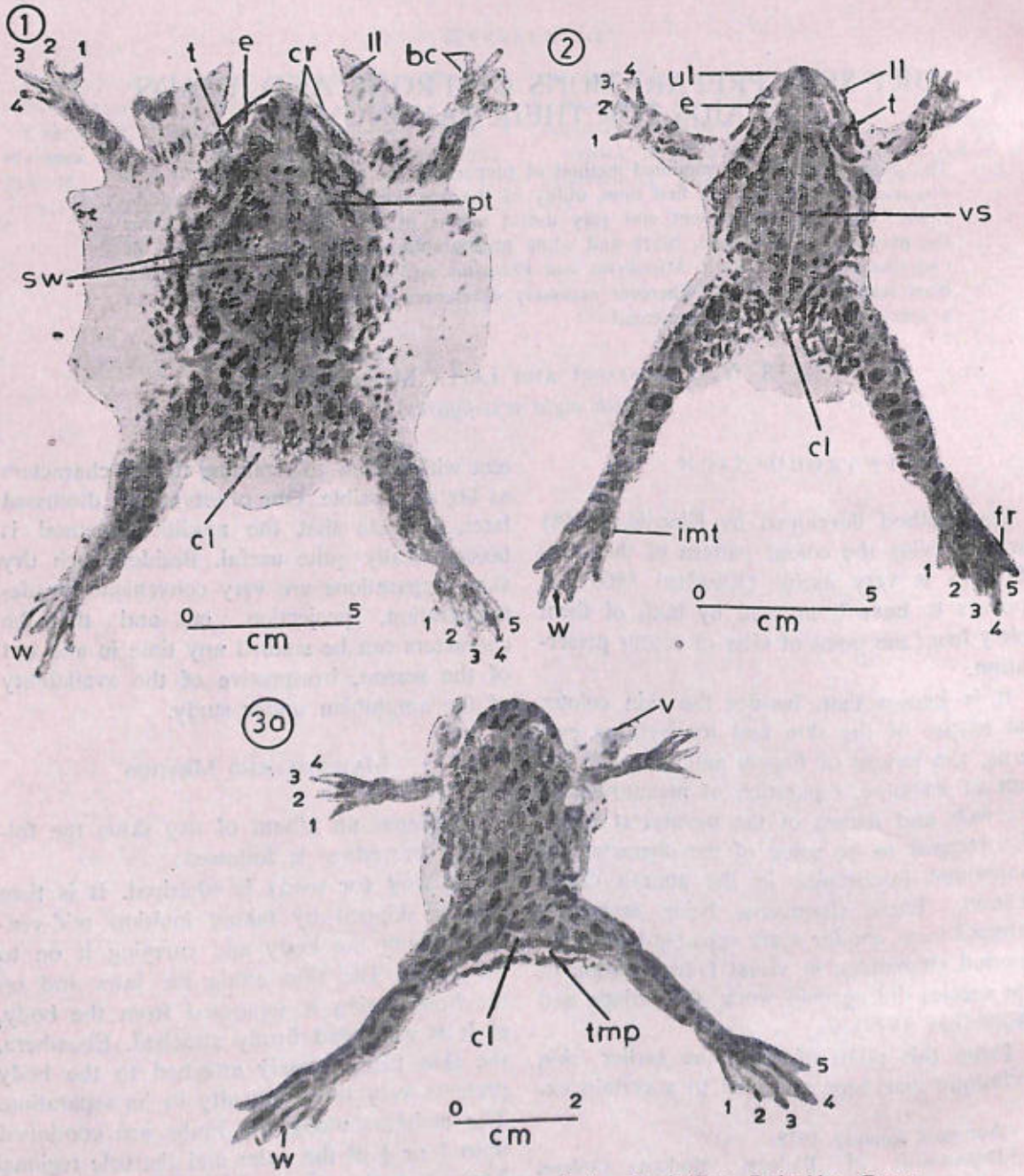

Fig. 1. *Bufo melanostictus* Schneider; Common Indian Toad (Fam. Bufonidae, Genus *Bufo*). Fig. 2. *Rana tigerina* Daud. Indian Bull Frog (Fam. Ranidae, Genus *Rana*, Subgenus *Rana*). Fig. 3a. *Rana cyanophlyctis* Schneider. Skipper Frog (Fam. Ranidae, Genus *Rana*, Subgenus *Rana*). A male.

Abberviations: bc, black cornifications; cl, cloacal aperture; cr, cranial ridges; e, eye; fr, fringe; imt, inner-metatarsal tubercle; ll, lower lip; sw, two series of warts; t, tympanum; tmp, typical marking pattern; ul, upper lip; v, vocal sac; vs, vertebral streak; w, web.

the removal of a sock. The entire skin is then spread by floating it in water. The everted skin on the digits needs either very careful turning outside in or extending of the incision to each digit. With the support of the phalanges thus lost, this region presents difficulty in the spreading. The extension of the web along the digits, which has taxonomic importance (Boulenger 1920; Daniel 1963), is also not effectively spread.

In order to overcome these difficulties and depending upon the size of the animal, metacarpals/metatarsals were either partly or wholly retained together with the phalanges, by adjusting the extent of the incisions in the palm/sole regions. For example in large sized specimens they were partly, proximally cut. In small and delicate specimens these bony structures were entirely retained. It has been observed that retention of the phalanges not only facilitates proper spreading of the web, but also preserves the nature of the digit and its tip. Similarly by retaining the metatarsals the extent of separation of the outer metatarsals can be studied. Alongwith these characters careful retention of the vocal sacs, outer and inner metatarsal tubercles, when present, aids further in enhancing the value of the dry skin preparation from the taxonomic point of view. Thus Kincaid's method is modified by us (Paranjape and Mulherkar 1977).

The rest of the procedure regarding spreading, mounting, preservation of the dry skin preparation etc., was mostly followed as described by Knudsen (1966). However, the shape of the trunk region is particular in certain families of frogs. The trunk is rather short, much broad in the middle and shows a sudden posterior narrowing in frogs belonging to Microhylidae and Rhacophoridae. With the usual mode of spreading (Figs. 1-4 & 6-8) it was noticed that the typical shape is not clearly visible. Therefore the mode of spreading was also modified in the case of a microhylid frog (Fig. 5). In this preparation the limbs were so positioned as to simulate their natural arrangement as far as possible. The result was found to be encouraging and to this extent also the earlier method has been modified by us.

The modified method besides retaining the skin-colour, ensures retention of other external characters of taxonomic importance as can be seen from the discussion.

Discussion

Various external characters that are retained in the modified method enable in classifying anuran amphibia. Some specific-examples are as follows:

1. Nature of the skin: In this character, whether the skin is warty, tuberculate, granular or smooth is taken into account. For example, the skin is distinctly warty or heavily tuberculate in toads (Fig. 1). It is generally smooth (Fig. 2) or granular in frogs. (Most of the frogs belonging to the genus *Rana* dorsally bear longitudinal skin-folds or ridges. They are of varying lengths and give a characteristic wrinkled appearance. Due to flattening and pressing this character cannot be retained in the dry skin preparations). Further observation of the skin of toad indicates presence of a pair of large parotoid glands (Fig. 1) that are always present in most of the toads (absent in the genus *Ansonia*) and absent in frogs. Further, the presence of two series of heavy, roundish, black-tipped warts, prominent cranial ridges, tips of fingers and toes and tubercles on palm crowned with dark black cornifications indicate that the toad-skin is of an adult of *Bufo melanostictus* (Fig. 1). It can be noted here that these characteristic black

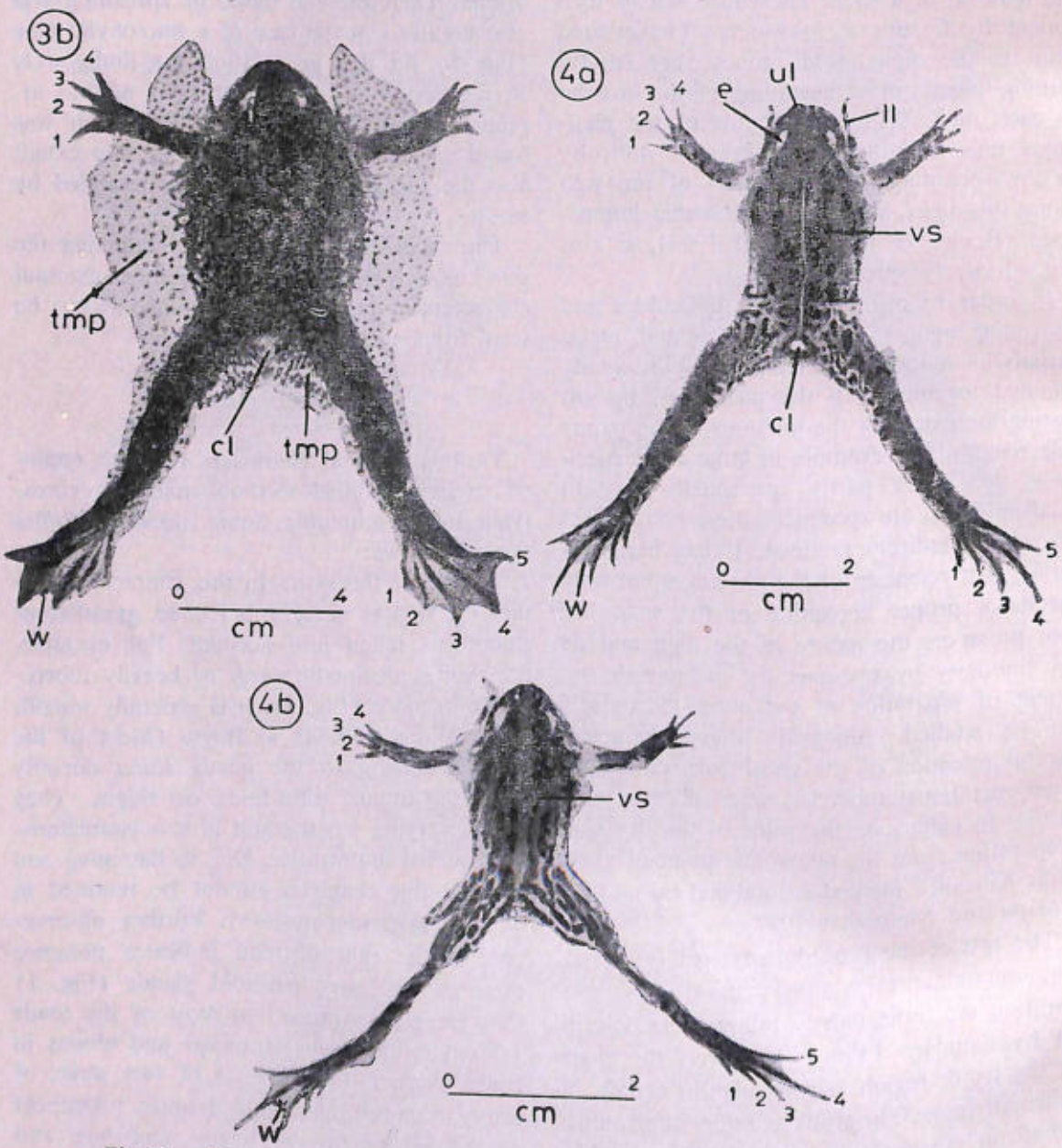

Fig. 3b. *Rana cyanophlyctis* Schneider. Skipper Frog. A female. Fig. 4a & 4b. *Rana limnocharis* Weign. Indian Cricket Frog or Grass Frog (Fam. Ranidae, Genus *Rana*, Subgenus *Rana*).

Abbreviations: cl, cloacal aperture; e, eye; tmp, typical marking pattern; ul, upper lip; vs, vertebral streak; w, web.

cornifications are peeled off and thus lost in preserved specimens (Daniel 1963). They are, however, nicely retained in the preparation mentioned above.

2. *Colour and marking patterns*: These are also of taxonomic importance which are seen in actual dry skin preparations. However, in black and white photographic reproduction provided here, only the marking pattern can be described here. Frog's skin is invariably variously marked with spots, bars, patches on the dorsal side. They show considerable size and pattern variation in the different species. Ventrally the skin is creamy or yellowish white and at times mottled or stippled. From the nature of spots one can readily distinguish three species of the genus *Rana*, namely, *R. tigerina* (Fig. 2) from *R. cyanophlyctis* (Fig. 3) or from *R. limnocharis* (Fig. 4). Further it can be seen that spots in the form of transverse bands are practically spread across the hind-limbs in *R. tigerina* while they are not band-like and do not reach across the hind-limbs in *R. cyanophlyctis* and *R. limnocharis*. By colour and marking pattern the male and female of a species can also be identified. For example, the male of *R. cyanophlyctis* (besides its small size and bluish vocal sacs) bears a white band with dark edges on the back of the thighs (Fig. 3a). Although white spots are present in the female of this species a continuous band is wanting in it. Similarly skin of the female of *R. cyanophlyctis* ventrally shows a dotted appearance (Fig. 3b), especially so, during the breeding season. The male lacks such an appearance (Fig. 3a). Sometimes the marking pattern is so typical of a species that a mere look enables one to visually identify it reasonably correctly, in the field. For example, there is a characteristic blackish-brown mark that begins between the eyes and touching them. It extends posteriorly, shows deep emarginations as it broadens and finally it spreads over the thighs in the form of two stripes. It is flanked by relatively uniform greyish coloration. This is characteristic of *Microhyla ornata* (Fig. 5). A rhacophorid frog, *Philautus bombayensis*, shows considerable colour variation but generally shows a dice-box shaped mark on the dorsal side of the trunk. It has a faint coloured band-like mark slightly constricted in middle, broad at the ends and it is flanked by dark coloration (Figs. 6, 7). In routine preservation not only the colour but this marking pattern also generally fades away.

Presence of certain marks also helps in identification. For example, there is seen in some forms a V shaped mark extending between the eyes. It is narrow, acutely pointed and more V-like in *R. limnocharis* (Fig. 4a) while broad, obtusely pointed in *P. bombayensis* (Fig. 7). Similarly marking pattern of lips is also useful. For example, in *R. tigerina* (Fig. 2) the upper lips shows a light canthal streak with blackish elongated spots and the lower shows large black spots. In *R. limnocharis* the lips bear dark bars (Fig. 4a).

The mid-dorsal vertebral streak is yet another marking pattern that aids in identification. It may be absent altogether, as is the case in *R. cyanophlyctis* (Fig. 3) or may be present. If present it may be complete, that is extending from the snout to vent or may be incomplete, that is reaching the vent but not the snout. Similarly, it may be narrow or broad. The streak can also be of different coloration. For example, in *R. tigerina* (Fig. 2) the vertebral streak is narrow, complete and pale yellowish-white in colour. in *R. limnocharis* (Fig. 4a) it is narrow, generally incomplete and pale yellowish-white in couour. In another type of *R. limnocharis* (Fig. 4b) it is however, complete, broad and pinkish

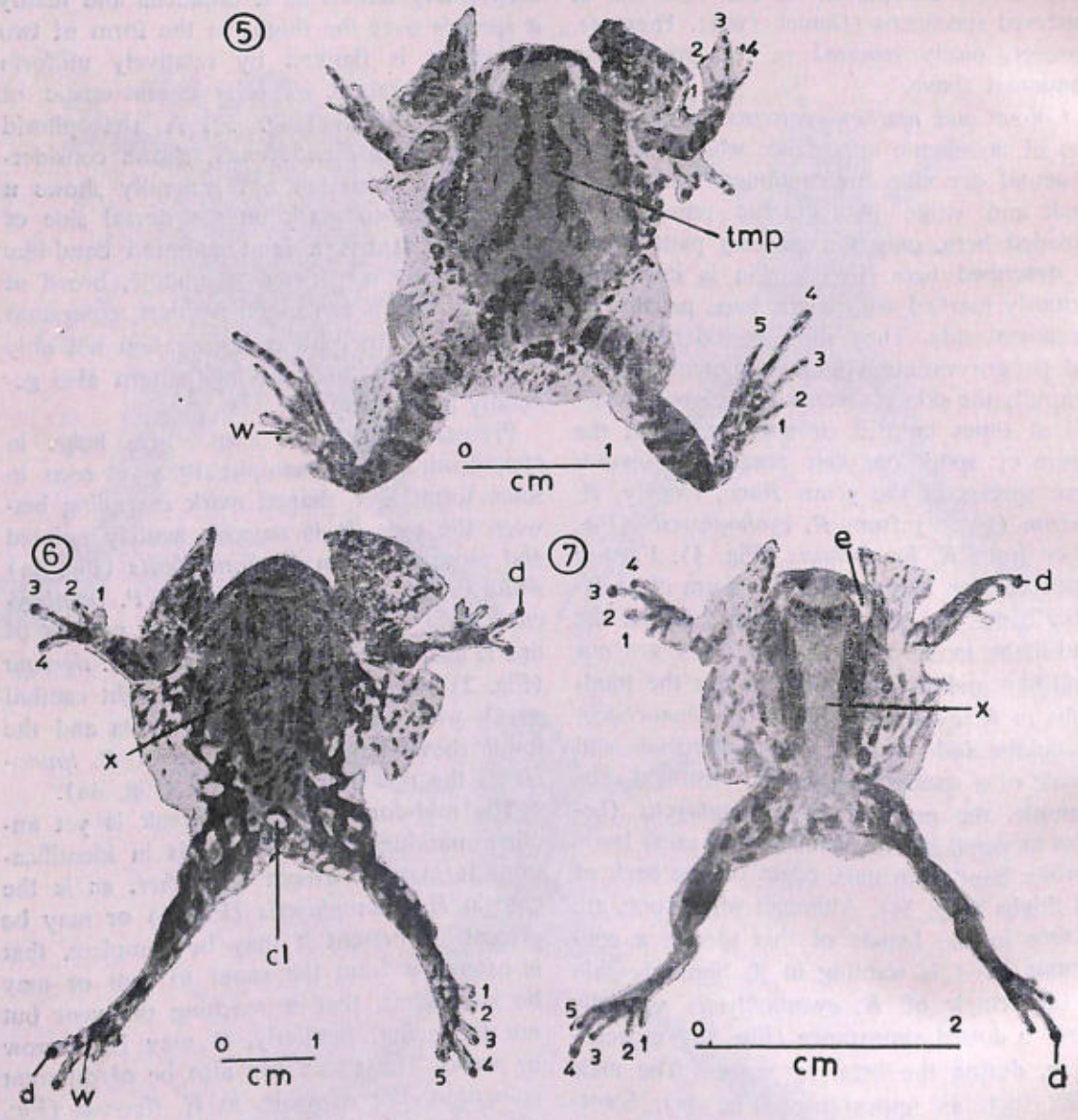

Fig. 5. *Microhyla ornata* Dum. & Bibr. Narrow-mouthed frog. (Fam. Microhylidae, Genus *Microhyla*). Figs. 7 & 8. *Philautus bombayensis* Gunth. (Fam. Rhacophoridae). *Abbreviations*: cl, cloacal aperture; d, disc; e, eye; tmp, typical marking pattern; w, web; x, area of the disc-boxlike mark.

brown in colour.

3. Fingers: These are also helpful in identification. The tips of the fingers may be with or without discs. They may be long and slender or short and thickly set. The relative lengths of the 1st and 2nd fingers is also a diagnostic character.

For example the fingers (as also the toes) bear somewhat oval adhesive discs in *R. temporalis* (Subgenus: *Hylorana*, genus: *Rana*) (Fig. 8). This is an adaptation for its rocky-stream dwelling or semi-arboreal habitat. The fingers (as also the toes) in tree-frogs (Fam. Rhacophoridae) possess circular adhesive discs, as can be seen in *P. bombayensis* (Figs. 6 & 7).

The first finger is nearly as long as or a little longer than the second in *R. temporalis*, *R. limnocharis*. It is generally longer in *R. tigerina*, distinctly so in the Indian burrowing frog, *R. breviceps* (Subgenus: Tomopterna). It is more or less of equal length in *R. cyanophlyctis* and quite short in *M. ornata*.

4. Toes and webbing pattern: Reference has already been made (in 3) whether the tips of the toes are with the discs or not. Other toe-features of relatively minor importance are whether they are long and slender or some-

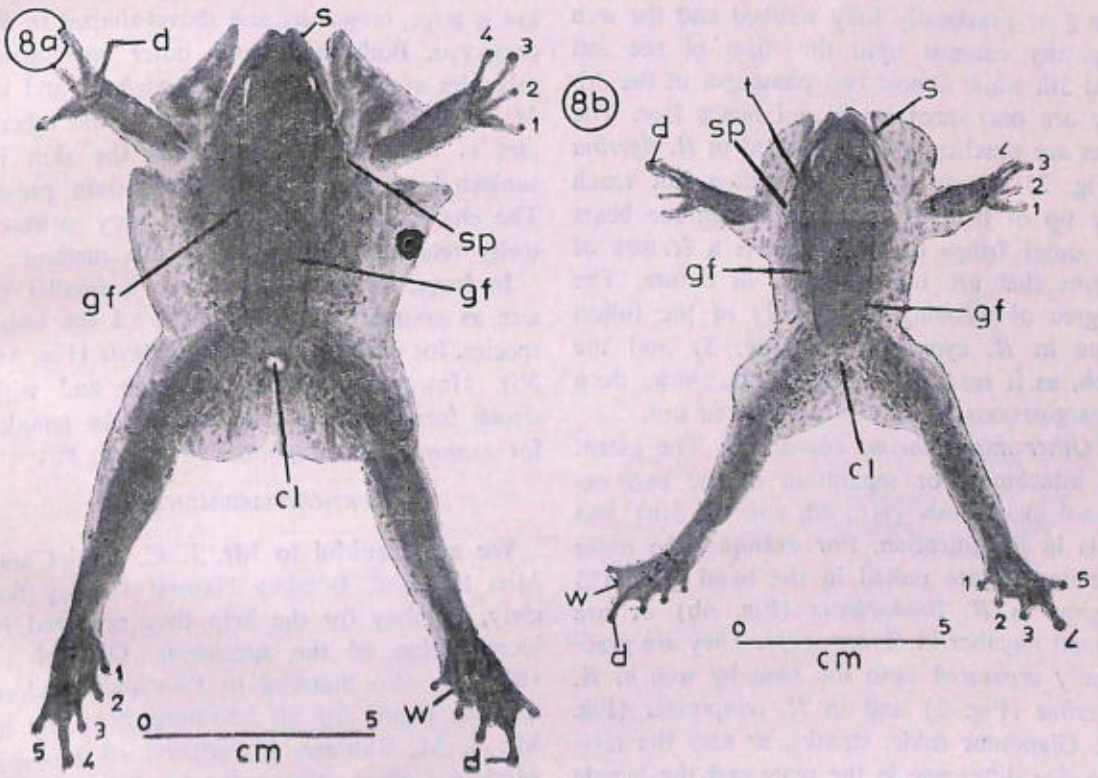

Fig. 8. *Rana temporalis* Boulr. (Fam. Ranidae, Genus Rana, Subgenus *Hylorana*). 8a—male, 8b—female.

Abbreviations: cl, cloacal aperture; d, disc; gf, glandular fold; s, light streak on lip; sp, spot at the angle of jaws; t, tympanum; w, web.

what stout, whether the tips are somewhat rounded or not.

The extent of webbing forms a very important diagnostic character (Daniel 1963). We feel that in our modified method mentioned earlier, this valuable character is beautifully expressed. For example, the webbing is rudimentary in *M. ornata* (Fig. 5) and is rather poor in *B. melanostictus* (Fig. 1) although the degree of webbing is of $\frac{1}{4}$ or of $\frac{1}{2}$ type. In *P. bombayensis* (Figs. 6, 7) the disced toes are not more than 1/3 webbed. In *R. limnocharis* (Fig. 4) the toes are generally half webbed with three phalanges of the 4th toe free. In *R. temporalis* (Fig. 8) the toes are $\frac{3}{4}$ or practically fully webbed and the web typically extends upto the discs of the 3rd and 5th while almost two phalanges of the 4th toe are uncovered by it and hence free. The toes are practically fully webbed in *R. tigerina* (Fig. 2). However, the web does not reach the tip of the 3rd toe and the 5th toe bears an outer fringe of web. This is a feature of forms that are more aquatic in nature. The degree of webbing is typically of the fullest type in *R. cyanophlyctis* (Fig. 3) and the web, as it reaches all the toe-tips shows deep emarginations when toes are spread out.

5. Other miscellaneous characters: The extent of attachment or separation of the two external metatarsals (viz., 4th and the 5th) also aids in identification. For example, the outer metatarsals are united in the basal $\frac{1}{2}$ or 1/3 region in *R. limnocharis* (Fig. 4b) or are bound together in *R. breviceps*. They are practically separated upto the base by web in *R. tigerina* (Fig. 2) and in *R. temporalis* (Fig. 8). Glandular folds, streaks, as also the relative size difference in the male and the female are also useful in identification. For example, in *R. temporalis* there are seen two dorso-lateral, glandular folds. Each extending from above the tympanum to cloaca on that side. The two folds enclose between themselves a fairly broad, light-coloured oval patch on the back (Fig. 8b). In the same frog there runs along the border of the upper lip a light, dirty-whitish streak that also posteriorly forms a similar spot near the angle of the jaws (Fig. 8a).

The nature of inner and outer metatarsal tubercles is also useful in identification. For example, the inner metatarsal tubercle is relatively small and obtuse in *R. tigerina* (Fig. 2) but is large, crescentic and shovel-shaped in *R. breviceps*. Both inner and outer metatarsal tubercles are present in *R. limnocharis* and in *M. ornata*. However, the nature of the tubercles is not well retained when the skin is subjected to pressure in a herbarium press. The character, is therefore, not very satisfactorily retained, in general, in this method.

In frogs, in general, the male is smaller in size as compared to the female of the same species, for example, *R. cyanophlyctis* (Fig. 3a, 3b). However, the male is large and with strong fore-limbs, as compared to the female, for example, *R. temporalis* (Figs. 8a, 8b).

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We are thankful to Mr. J. C. Daniel and Miss S. Isaac, Bombay Natural History Society, Bombay for the help they rendered in identification of the specimens. One of us (SYP) is also thankful to Principal, Modern College, Poona for his encouragement and to Mr. S. M. Katdare, Department of Biology, Modern College, Poona for his help.

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A CONTRIBUTION TO THE VASCULAR FLORA OF VENKATAGIRI HILLS AND ENVIRONS[1]

B. SURYANARAYANA[2]

Floristic information on Venkatagiri Hills (in the Eastern Ghats) and environs is wanting except for rare references in *Flora of the Presidency of Madras* (Gamble 1957). This report covers plants collected during 1969-1971 in the area, and is the first report on the flora of the area and lists 320 plants belonging to 90 families. Among these, 9 are pteridophytes, 247 are dicotyledons and 64 are monocotyledons. Further, *Canscora perfoliata* Lamk. is reported for the first time from the Eastern Ghats of India. *Habenaria digitata* Lindl., *H. hollandiana* Sant. and *Sporobolus piliferus* Kunth are new records for Rayalaseema in Andhra Pradesh.

INTRODUCTION

Venkatagiri hills, a part of Veligondla hills in the Eastern Ghats, are situated 15 km from Venkatagiri Town in the West 13° 57′N and 79° 37′E. They are 79 km off the sea coast. The altitude of the hills in the area ranges between 500 m and 1033 m. The hills can be approached only on foot, from Venkatagiri and the journey is strenous. Venkatagiri is a small town, 130 km north-west of Madras and is connected both by rail and road. The Kaivalya river traverses the area and is fed by a small water-falls at Malleswara Kona in the hills. Though the area is rich in vegetation, floristic information is lacking except for stray citations as "Veligondla hills" and "Venkatagiri Drug (Cuddapah)" found in FLORA OF THE PRESIDENCY OF MADRAS (Gamble 1957). Therefore botanical excursions were conducted within a 15 km radius of Venkatagiri which include Ammapalem, Jayampu, Malleswara Kona, Mogallagunta, Palemkota and Venkatagiri hills for two years during 1969 to 1971, covering all the seasons of a year. A number of plants were collected in different stages of their life histories and ample field notes were taken. However this paper lists 320 plants spread over 90 families. Of these 9 are pteridophytes, 247 are dicotyledons and 64 are monocotyledons. The identifications of most of the plants were confirmed at the Botanical Survey of India, Southern Circle, Coimbatore by the author. The specimens are deposited in the Herbarium, Visvodaya College, Venkatagiri Town. But the cyperaceous specimens are stored in the herbarium of the Presidency College, Madras.

Climate: On the whole the weather is rather dry and the temperature reaches even 44°C during the hot period, from March to early June.

Monsoon occurs in two phases. The south-west monsoon, the first phase, occurs between June to September bringing down the temperature. The north-east monsoon is the second phase causing heavy showers, during October-December. The cold weather is between January and February. The annual average rain fall is about 105 cm.

[1] Accepted March 1978.

[2] Visvodya College, Venkatagiri, Andhra Pradesh.

General pattern of vegetation

After a few showers of rain by about the middle of June, the land is covered by a number of sprouting grasses. *Borreria articularis* (L.f.) Will., *Bulbostylis barbata* (Rottb.) Cl., *Cleome aspera* Koenig, *Hybanthus enneaspermus* (L.) F. Muell., *Indigofera linnaei* Ali, *Tribulus terestris* Linn., are found among grasses. In the second half of monsoon, grasses grow fairly tall. *Apluda mutica* Linn., *Chloris barbata* Sw., *Cymbopogon martinii* (Roxb.) Wats., *Eragrostis* sp., *Heteropogon contortus* (L.) P. Beauv. ex R. & S., *Perotis indica* (L.) O. Kuntze etc. are often found in mixed or pure stands. Among these tall grasses a number of other plants are noticed namely *Ageratum conyzoides* Linn., *Corchorus aestuans* Linn., *Croton bonplandianum* Baill., *Eclipta alba* (L.) Hassk., *Euphorbia hirta* Linn., *Phyllanthus asperulatus* Hutch., *Sida acuta* Burm. f. etc. By the end of the monsoon or a little later most of the monsoon vegetation disappears and those characteristic of the cold season appear. Some of the common ones are *Andrographis echioides* (L.) Nees, *Anisomelis malabaricus* R.Br., *Barleria prionitis* Linn., *Blumea* sp., *Elytraria acaulis* (L.f.) Lindau, *Heliotropium indicum* Linn., *Lepidagathis mitis* Dalz., *Leucas aspera* (Willd.) Sprang., *Orthosiphon pallidus* Royle ex Bth., etc.

The forests are mainly of two types. 1) dry deciduous on the hills and 2) scrub on the plains.

Vegetation of dry deciduous forests: The thick forests in the area are now subjected to significant disturbance by indiscriminate felling and fire operations for the sake of fuel. Therefore there is every danger of these forests being reduced to scrub jungles in course of time. Trees do not seem to reach a good height and are stunted in growth.

The common trees of the forests are: *Anogeissus latifolia* (Roxb.) Wall. ex Bedd., *Erythroxylon monogynum* Roxb., *Hardwickia binata* Roxb., *Lannea coromandelica* (Houtt.) Merr., *Manilkara hexandra* (Roxb.) Dub., *Strychnos nux-vomica* Linn., *Terminalia chebula* Retz. etc.

The following are occasional trees: *Albizzia amara* Boivin, *Dalbergia paniculata* Roxb., *Madhuca logifolia* (Koenig) Macbride, *Spondias pinnata* (L.f.) Kurz., *Vitex altissima* L.f. *Buchanania angustifolia* Roxb., *Vitex leucoxylon* Linn.f. etc., are rare.

The hedges along footpaths in the forests are commonly represented by *Barleria prionitis* Linn., *Carissa spinarum* Linn., *Diospyros chloroxylon* Roxb., *Maba buxifolia* (Roxb.) Pers., *Memecylon edule* Roxb., *Meytenus emarginata* (Willd.) Ding Hou, *Tarenna asiatica* (L.) Alston, *Xeromphis spinosa* (Thunb.) Keay, *Zizyphus xylopyrus* (Retz.) Willd.

The following are a few of the common climbers on large shrubs: *Ampelocissus tomentosa* (Heyne ex Roth) Planch., *Dioscorea oppositifolia* Linn., *D. pentaphylla* Linn. var. *linnaei* Pr. & Burk, *Hemidesmus indicus* (L.) Schultes, *Pergularia daemia* (Forsk.) Blatt. & McC. and *Rivea hypocrateriformis* (Lam.) Choisy. etc.

Derris scandens (Roxb.) Bth., *Hugonia mystax* Linn., *Pterolobium indicum* A. Rich., and *Ventilago denticulata* Willd. are occasional lianas noticed on tall trees.

Vegetation of scrub jungles: Scrub jungles in the area are commonly represented by *Acacia nilotica* (L.) Del. subsp. *indica* (Bth.) Brenan, *Bauhinia racemosa* Lamk., *Carmona retusa* (Vahl) Masamune, *Dodonaea viscosa* (L.) Jacq., *Euphorbia trigona* Haw., *Maba buxifolia* Pers., *Meytenus emarginata* (Willd.) Ding Hou, *Plectronia parviflora* Bedd., *Tarenna asiatica* (L.) Alston and Zizyphus xylopy-

rus (Retz.) Willd. etc.

Riparian and pond flora: *Alangium salviifolium* (L.f.) Wang., *Allophylus cobbe* (L.) Raeusch., *Flemingia strobilifera* R. Br., *Helicteres isora* Linn., *Homonoia riparia* Lour., *Mallotus philippinensis* (Lamk.) Muell.-Arg., *Pterospermum heyneanum* Wall. etc., form significant components of the vegetation in valleys along the water courses.

In some ponds and water logged areas of the river *Aponogeton natans* (L.) Engler & Krause, *Hydrilla verticillata* Royle, *Ottelia alismoides* (L.) Pers., *Najas minor* All. var. *spinosa* Rendle, *Vallisneria spiralis* Linn., etc., are found in abundance.

On the moist banks of rivers and along the wet margins of temporary ponds *Bacopa monnieri* (L.) Wettstein, *Phyla nodiflora* (L.) Greene form brightly coloured dense mats of vegetation. Along with them several other common and noteworthy plants also are found growing. A few of them are *Alternanthera sessilis* (L.) DC., *Ammannia baccifera* Linn., *A. multiflora* Roxb., *Bulbostylis barbata* (Rottb.) Cl., *Cleome aspera* Koenig, *Commelina diffusa* Burm. f., *Cyperus tenuispica* Steud., *Eriocaulon quinquangulare* Linn., *Ludwigia perennis* Linn., etc. At certain isolated localities *Saccharum spontaneum* Linn., forms a thick hedge along the water course.

In the dry ground of the river-bed and drying temporary ponds *Argemone mexicana* Linn., *Glinus totoides* Linn., *Heliotropium supinum* Linn. and *Solanum surattense* Burm. f. etc., form loose or dense patches. Other common plants are: *Aerva lanata* (L.) Juss., *A. monsoniae* Mart., *Anisomelis malabaricus* R. Br., *Calotropis gigantea* (L.) R. Br., *Cassia auriculata* Linn., *Datura fastuosa* Linn., *Fimbristylis* sp., *Jatropha gossypifolia* Linn., *Leucas aspera* (Willd.) Spreng., *Vitex negundo* Linn., etc.

Vegetation along roadsides: *Aegle marmelos* (L.) Corr., *Albizzia lebbek* (L.f.) Bth., *Azadirachta indica* A. Juss., *Derris indica* (Lam.) Bennett. *Fiscus religiosa* Linn., *Limonia acidissima* Linn., *Sapindus emarginatus* Vahl, *Syzygium cuminii* Skeels., *Thespesia populnea* Cav., etc., are common along roadsides either planted or growing wild.

A number of plants together form thick hedges along roadsides. Among them a few prominent and common ones being, *Carissa carandas* Linn., *Diospyros chloroxylon* Roxb., *Euphorbia trigona* Haw., *Meytenus emarginata* (Willd.) Ding Hou, *Securinega virosa* (Roxb. & Willd.) Pax. & Hoffm., *Tarenna asiatica* (L.) Alston, *Zizyphus oenoplia* Mill. etc., *Anisomelis indica* (L.) O.K., *Barleria prionitis* Linn., and *Cassia auriculata* Linn., are a few other common and attractive plants, by their brightly coloured flowers, among the roadside hedges.

On these hedges many twiners and climbers were noted belonging to the families, Asclepiadaceae, Convolvulaceae, Menispermaceae, Papilionaceae and Vitaceae. Among them the common ones are *Cissus quadrangularis* Linn., *Cocculus hirsutus* (L.) Diels, *Gymnema sylvestre* (Retz.) R. & S., *Pergularia daemia* (Forsk.) Chiov., *Teramnus labialis* Spreng., *Tylophora indica* Merr.

Several herbs are found growing in the undergrowth. e.g., *Aerva lanata* (L.) Juss., *Andrographis echioides* (L.) Nees, *Asystasia gangetica* T. Anders., *Boerhavia diffusa* Linn., *Elytraria acaulis* (L.f.) Lindau, *Hibiscus ovalifolius* (Forsk.) Vahl, *Justicia diffusa* Wild., *Orthosiphon pallidus* Royle ex Bth., *Pavonia zeylanica* Cav.

Vegetation in cultivated fields: From the moist cultivated fields a number of plants were collected. Some of the common and prostrate herbs are *Borreria articularis* (L.f.) F. N.

Will., *Cleome aspera* Koenig, *Hybanthus enneaspermus* (L.) F. Muell., *Indigofera cordifolia*. Heyne ex Roth, *Merremia tridentata* Hallier, *Mollugo nudicaulis* Lam., *Tribulus terrestris* Linn., etc. Several other common but erect plants also were noticed in these fields. To mention a few: cyperaceous plants, *Eclipta alba* (L.) Hassk., *Euphorbia hirta* Linn., *Geniosporum tenuiflorum* (L.) Merr., *Micrococca mercurialis* Bth., *Phyllanthus asperulatus* Hutch., *P. simplex* Retz. etc. After the harvest, from the drying fields several plants were collected. A few of the common ones are: *Achyranthes aspera* Linn., *Cleome viscosa* Linn., *Corchorus aestuans* Linn., *Croton bonplandianum* Baill., *Eclipta alba* (L.) Hassk., *Emilia sonchifolia* (L.) DC., *Heliotropium indicum* Linn., *Leucas aspera* (Willd.) Spreng., *Sida acuta* Burm. f., *Tridax procumbens* Linn. etc.

Plant parasites in the area: *Dendrophthoe falcata* (L.f.) Etting, *Viscum articulatum* Burm. f. are common stem parasites in forests usually found on *Anogeissus latifolius* (Roxb.) Wall. ex Bedd. and *Hardwickia binata* Roxb., *Cassytha filiformis* Linn., is another common twinning stem parasite in scrub jungles noticed on *Carissa spinarum* DC., *Striga angustifolia* (Don) Saldanha, is a frequent root parasite on grasses in the area.

Enumeration of plants

The plants are enumerated in accordance with Bentham and Hooker's system of classification with some delimitations of families according to Hutchinson (1960). The name of the plant is followed by a note on relative abundance, flower colour, flowering and fruiting time (Fls., Frts.) and field numbers. All the field numbers are of Suryanarayana. Where no number is stated, name of the collector is given. The nomenclature adopted here has, as far as possible, been brought upto date in the light of current literature on the subject.

PTERIDOPHYTES

Psilotaceae

Psilotum triquetrum Sw.

Rare on moist rocks covered by humus, under shade. December, 1970. 3982.

Selaginellaceae

Selaginella barbata Spring.

Occasional, but forming dense green carpets in moist humus soil along with *Anthoceros himalayensis* L. Strobili December, 1970. 3537.

Isoetaceae

Isoetes coromandelina Linn.

Rare among grasses. Sori December, 1969. 3839.

Marsileaceae

Marsilea quadrifolia Linn.

Common and abundant in temporary ponds. August, 1969. 3645.

Adiantaceae

Adiantum caudatum Linn.

Common. Sori December, 1969, 1970. 3665, 3950.

Gymnogrammaceae

Hemionites arifolia (Burm. f.) Moore

Common. Sori December, 1969. 3664.

Pteridaceae

Actinopteris radiata (Sw.) Link

Occasional under the shade of rocks. Sori

December, 1970. No number, D. V. Subbaiah.

Pteris geranifolia Raddi

Occasional under the shade of moist rocks. Sori December, 1970. 3660.

DAVALLIACEAE

Nephrolepis cordifolia (L.) Presl.

Occasional in forests. Sori December, 1970. 3945.

DICOTYLEDONS

RANUNCULACEAE

Naravelia zeylanica (L.) DC.

Rare. A gregarious climber in thick forests. Frts. December, 1970. 3892.

MENISPERMACEAE

Cissampelos pareira Linn.

Occasional twiners on hedges. Flowers small green. Fls. December, 1970. 3995.

Cocculus hirsutus (L.) Diels

An occasional twiner. Flowers small, greenish. Fls. June, 1969. 3324.

Pachygone zeylanica (Gaertn.) Sant. & Wagh.

Occasional twiners. Flowers small green. Fls. December, 1970. 3921.

PAPAVERACEAE

Argemone mexicana Linn.

Common in waste dry places. Flowers yellow. Fls. and Frts. February, 1969. 3558.

BRASSICACEAE

Brassica nigra (L.) Koch.

Common in humus covered waste places. Flowers yellow. Fls. and Frts. November, 1969. No number, D. V. Subbaiah.

CAPPARACEAE

Capparis zeylanica Linn.

Occasional on hedges. Frts. May, 1969. 3225.

Crataeva nurvala Buch.-Ham.

Rare. Frts. May, 1969. 3201.

CLEOMACEAE

Cleome aspera Koenig

Common. Flowers yellow. Fls. May, 1969. 3287.

C. gynandra Linn.

Occasional in waste places. Flowers white. Fls. and Frts. November, 1970. 3540.

C. viscosa Linn.

Common. Flowers yellow. Fls. and Frts. October, 1970. 4133.

VIOLACEAE

Hybanthus enneaspermus (L.) F. Muell.

Common. Flowers purple. Fls. and Frts. May, 1969. 3288.

FLACOURTIACEAE

Flacourtia indica (Burm.f.) Merr.

Common. Flowers White. Fls. and Frts. December, 1969, 1970. 3628, 3855.

CARYOPHYLLACEAE

Polycarpaea corymbosa (L.) Lam.

Common in grasslands. Flowers pink. Fls. and Frts. May and November, 1969. 3291, 3495.

PORTULACACEAE

Portulaca cleracea Linn.

A common weed in moist fields. Flowers yellow. Fls. and Frts. October, 1970. 3541.

MALVACEAE

Abutilon indicum (L.) Sweet

Common and abundant in mixed stands. Flowers yellow. Fls. and Frts. December, 1970. 3542.

Decaschitia crotonifolia Wt. & Arn.

Common on hill slopes. Flowers large, yellow. December, 1969, 1970. 3619, 3951, 4170.

Gossypium herbaceum Linn.

Planted. Flowers yellow. Fls. February, 1970. 4015.

Hibiscus ovalifolius (Forsk.) Vahl

Common in the undergrowth of forests. Flowers white. Fls. and Frts. December, 1970. 3934.

Pavonia zeylanica Cav.

Common. Flowers bright rose. Fls. and Frts. December, 1970. 3860, 3955.

Sida acuta Burm. f.

Common. Flowers yellow. Fls. and Frts. December, 1970. 4128.

S. cordifolia Linn.

Common. Flowers. yellow Fls. and Frts. December, 1970. 3899.

Thespesia populnea Cav.

Planted. Flowers yellow with a purple centre. Fls. June, 1969. 3234, 3393.

STERCULIACEAE

Byettneria herbacea Roxb.

Common on hill slopes among tall grasses. Fls. and Frts. December, 1970. 4109, 4151.

Helicteres isora Linn.

Common in forests. Flowers red. Fls. November. Frts. December, 1969, 1970. 3625, 3643, 4144, 4160.

Melhania incana Heyne ex Wt. & Arn.

Rare in the forests of Jayampu. Fls. and Frts. December, 1970. 3871.

Melochia corchorifolia Linn.

Occasional. Flowers purple. Fls. and Frts. December, 1970. 3830.

Pterospermum heyneanum Wall.

Occasional in thick forests. Flowers not seen. Frts. December, 1969. 3614.

Waltheria indica Linn.

Occasional. Flowers yellow. Fls. and Frts. December, 1970. 3858.

TILIACEAE

Corchorus aestuans Linn.

A common weed. Flowers yellow. Fls. and Frts. December, 1970. 3902.

C. olitorius Linn.

Common on earth bunds of the cultivated fields. Flowers yellow. Fls. November, 1969. Frts. December, 1970. 3483, 3998.

Grewia hirsuta Vahl

Occasional. Frts. December, 1970. 3952.

G. rhamnifolia Heyne ex Roth

Occasional. Frts. December, 1969, 1970. 3618, 3881.

Triumfetta pentandra A. Rich.

Common in the undergrowth of forests. Flowers yellow. Fls. and Frts. December, 1969, 1970. 3613, 3944.

LINACEAE

Hugonia mystax Linn.

Occasional in the forests. This specimen matches with the herbarium sheets of Madras Herbarium, BSI, Coimbatore. But in the absence of flowers or fruits the identification is provisional. December, 1970. 3875.

ERYTHROXYLACEAE

Erythroxylon monogynum Roxb.

A common tree in forests. Fls. and Frts. November, December, 1969, 1970. 3469, 3941.

ZYGOPHYLLACEAE

Tribulus terrestris Linn.
Common. Flowers yellow. Fls. and Frts. November, 1969. 3515.

BALSAMINACEAE

Impatiens balsamina Linn.
Rare but abundant in pure stands at Malleswara Kona. Flowers purple. Fls. and Frts. December, 1970. 3904.

RUTACEAE

Aegle marmelos (L.) Corr.
Occasional in forests and near villages. Frts. November, 1969. 3601.

Glycosmis cochinchinensis (Lour.) Pierre ex Engler.
Common in forests. Fls. (buds), December, 1970. 3802.

Limonia acidissima Linn.
Planted. Frts. May, June, 1969. 3267, 3390.

MELIACEAE

Azadirachta indica A. Juss.
Common. Frts. June, 1969. 3391.

CELASTRACEAE

Elaeodendron roxburghii Wt. & Arn.
Common. The plants are very much stunted when growing in scrub jungles. Flowers and fruits not noticed but the specimens match with the herbarium sheets at Madras Herbarium, BSI, Coimbatore. Therefore identification is tentative. 1970. 3979.

Meytenus emarginata (Willd.) Ding Hou
Common in scrub jungles. Flowers white. Fls. November, 1970. 3808, 3864. Frts. June, 1969. 3334

RHAMNACEAE

Scutia circumcissa (L.f.) Druce
An occasional armed shrub in the scrub jungles. Flowers small, greenish-white. Fls. November, 1970. 3385, 3791.

Ventilago denticulata Willd.
Rare, but a gregarious climber. Flowers pale green. Fls. December, 1970. 3924, 4169.

Zizyphus mauritiana Lam.
Occasional. Flowers pale white. Fls. November, 1969. 3543.

Z. oenoplia Mill.
Common in hedges. Frts. December, 1970. 3876.

Z. xylopyrus (Retz.) Willd.
Common in forests. Frts. December, 1970. 3886, 4148.

VITACEAE

Ampelocissus tomentosa (Heyne ex Roth) Planch.
Common. Flowers scarlet. Fls. and Frts. December, 1970. 3938, 3974.

Cissus quadrangularis Linn.
Common in plains, straggling on shrubs. Flowers red. Fls. and Frts. May, 1969. 3209, 3259.

C. vitiginea Linn.
Occasional on hedges. Flowers small, greenish. Fls. and Frts. June, 1969. 3356.

Leea indica (Burm.f.) Merrill.
Rare in ravines. Frts. December, 1970. 3918.

SAPINDACEAE

Allophylus cobbe (L.) Raeusch.
Common. Flowers small, white. Fls. November, Frts. December, 1969, 1970. 3612, 3795, 3853, 3932.

Cardiospermum canescens Wall.
Rare, a gregarious twiner on large shrubs.

Flowers white. Fls. and Frts. December, 1970. 3965.

C. halicacabum Linn.

Rare on hedges near villages. Flowers white. Fls. May, 1969. 3211, 3297.

Dodonaea viscosa (Linn.) Jacq.

Common in scrub jungles. Flowers purplish-yellow. Fls. November, Frts. December, 1969. 3279, 3407, 3467.

Sapindus emarginatus Vahl

Occasional in forests, sometimes planted in villages. Fls. December, Frts. June, 1969, 1970. 3387, 3882.

ANACARDIACEAE

Anacardium occidentale Linn.

Planted. Flowers red. Fls. January, 1969. No number, D. V. Subbaiah.

Buchanania angustifolia Roxb.

Rare. Flowers not seen. Frts. December, 1970. 4141.

Lannea coromandelica (Houtt.) Merr.

Common. Flowers greenish-yellow. Fls. December, 1969, 1970. 3641, 3928.

Mangifera indica Linn.

One tree near the water fall at Malleswara Kona; planted elsewhere. December, 1970. 3991.

Spondias pinnata (L.f.) Kurz.

Occasional in forest. Vegetative. December, 1970. 3915.

PAPILIONACEAE

Abrus precatorius Linn.

Occasional. Frts. December, 1970. 3916.

Aeschynomene indica Linn.

Common. Flowers yellow. Fls. and Frts. December, 1970. 3846, 4119.

Arachis hypogaea Willd.

Probably an escape from cultivation. Flowers yellow. Fls. and Frts. January, 1970. 3999.

Butea monosperma (Lam.) Taub.

Occasional. The trees are very stunted and do not attain more than 3 metres height. Flowering not observed in the area, but reddish-orange flowers were noticed in the forest near Kurnool. Fls. February, 1973. 3207.

Canavalia gladiata (Jacq.) DC.

Occasional. Flowers purple but turning blue with age. Fls. and Frts. December, 1970. 3983.

Crotalaria juncea Linn.

Occasional. Flowers yellow. Fls. and Frts. January, 1970. 4122.

C. madurensis Wt.

Rare. Flowers yellow. Fls. January, 1970. 4166.

C. medicaginea Lamk.

Common. Flowers yellow. Fls. and Frts. December, 1970. 3879, 3947, 4147.

C. retusa Linn.

Occasional. Frts. January, 1970. 4120.

C. verrucosa Linn.

Common. Flowers blue. Fls. and Frts. December, 1970. 3879, 3947, 4147.

Dalbergia paniculata Roxb.

An occasional tree in the forest. Frts. December, 1970. 3545.

Derris indica (Lam.) Bennett

Common, but usually planted for shade. Flowers bright purple. Fls. and Frts. June, 1969. 3319, 3388.

D. scandens Bth.

Rare. Frts. November, 1970. 4111.

Desmodium pulchellum (L.) Bth.

Common and abundant at the foot of hills. Flowers white. Fls. and Frts. December, 1969, 1970. 3622, 3912, 4172.

D. velutinum (Willd.) DC.

Common at the foot of hills. Flowers purple. Fls. and Frts. December, 1970. 3907.

D. triflorum (L.) DC.

Common. Flowers purple. Fls. December,

1970. 3920.

Erythrina variegata Linn. var. **orientalis** (L.) Merr.

A favourite hedge plant in villages. Flowers red and showy. Fls. February, 1969. 3546.

Gliricidia sepium (Jacq.) Walp.

Planted as a hedge plant. Flowers bright rose. Fls. January, 1969. No number, D. V. Subbaiah.

Heylandia latebrosa DC.

Occasional. Flowers yellow. Fls. and Frts. December, 1970. 3851, 4161.

Indigofera astragalina DC.

Rare. Frts. December, 1970. 3993.

I. cordifolia Heyne ex Roth

Common. Flowers red. Fls. November, 1970. 3794.

I. linnaei Ali

Common. Flowers Red. Fls. and Frts. June, 1969. 3312.

Ormocarpum sennoides DC.

Rare. Flowers yellow. Fls. and Frts. November, 1969. 3520, 3600.

Pseudarthria viscida Wt. & Arn.

Occasional. Flowers yellow. Fls. and Frts. December, 1970. 3911.

Rhynchosia sauveolens DC.

Rare. Flowers yellow. Fls. and Frts. December, 1970. 3986.

Tephrosia tinctoria Pers.

Rare. Frts. December; 1970. 3903.

Teramnus labialis Spreng.

A common twiner on bushes. Flowers yellow. Fls. and Frts. December, 1970. 3945.

CAESALPINIACEAE

Bauhinia racemosa Lamk.

Common in scrub jungle. Very much stunted, some times even adpressed to the ground when growing in the plains. Flowers yellow. Fls. October-November, Frts. February-June, 1969. 3200, 3412.

Cassia absus Linn.

Occasional during post monsoon. Flowers vellow. Fls. and Frts. November-December, 1969. 3548.

C. auriculata Linn.

Common and abundant. Flowers yellow. Fls. January-June, 1969. 3222, 3392, 3462.

C. fistula Linn.

Occasional in forests. Frts. December, 1970. 3812.

C. montana Heyne ex Roth

Occasional in ravines. Flowers yellow. Fls. and Frts. December, 1970. 3940, 4149.

C. occidentalis Linn.

Common in waste land. Flowers yellow. Fls. and Frts. January, 1969. 3549.

C. tora Linn.

Common. Flowers yellow. Fls. and Frts. December, 1970. 3368.

Hardwickia binata Roxb.

A common tree in forests. Fls. November, 1969. 3523.

Pterolobium indicum A. Rich.

Common. An armed straggler. Frts. November, 1969. 3529.

Tamarindus indica Linn.

Common near villages. Flowers reddish. Fls. May-June, Frts. November, 1969. No number, D. V. Subbaiah.

MIMOSACEAE

Acasia caesia Willd.

An occasional armed climber. Flowers in white heads. Fls. November, 1969. 3583.

A. ferruginea DC.

Common. Frts. December, 1970. 3883.

A. latronum Willd.

Common in scrub jungles. Fls. December, 1970. 4131.

A. nilotica (L.) Del. subsp. **indica** (Bth.) Brenan

Common in scrub jungles. Flowers yellow. Fls. June, 1969. 3217, 3300.

A. torta (Roxb.) Craib.

Common. Flowers small in heads. Fls. and Frts. December, 1970. 3960.

Albizzia amara Boivin

Occasional in forests. Frts. December, 1969. 3584.

A. lebbek (L.) Bth.

Occasional. It is also planted as avenue tree. Fls. January, Frts. May, 1969. 3257.

Dichrostachys cinerea Wt. & Arn.

Occasional in scrub jungle. Spikes yellow-purple. Fls. November, Frts. December, 1969, 1970. 3229, 3527, 3884.

Leucaena leucocephala (Lam.) de Wit.

Occasional in villages. Frts. May, 1969. 3248, 3383.

Prosopis cineraria (L.) Druce

Common and abundant in waste land around inhabitations. Fls. December, Frts. May, 1969. 3230, 3335, 3399.

COMBRETACEAE

Anogeissus latifolius Bedd.

Common. Flowers small greenish-yellow. Fls. and Frts. December, 1970. 3914, 4165.

Terminalia bellerica (Gaertn.) Roxb.

An occasional lofty tree in forests. Frts. December, 1970. 3880.

T. chebula Retz.

Common on hill slopes at Malleswara Kona. Frts. December, 1969. 3447.

MYRTACEAE

Syzygium cuminii Skeels

Common. Flowers yellowish-white. Fls. March, Frts. June, 1969, 1970. 3395, 3948.

MELASTOMACEAE

Memecylon edule Roxb.

Common. Flowers attractive blue. Fls. sparsely flowered in December in the present area. But elsewhere gregarious flowering is observed in July (1973). Frts. November, 1970. 3528, 3642.

LYTHRACEAE

Ammannia baccifera Linn.

Common in moist places. Flowers red. Fls. and Frts. February, 1970. 4010.

A. multiflora Roxb.

Common in wet fields. Flowers red. Fls. and Frts. December, 1970. 3825.

Rotala densiflora (Roth) Koehne

Occasional but found in pure or mixed stands. Flowers red. Fls. and Frts. December, 1970. 3828.

ONAGRACEAE

Ludwigia perennis Linn.

Common in wet fields. Flowers yellow. Fls. and Frts. December, 1970. 3824.

CUCURBITACEAE

Citrullus lanatus (Thunb.) Monsf.

An occasional creeper in river bed. Frts. May, 1969. 3280.

Solena heterophylla Lour.

Occasional. Male flowers creamy-white, Fls. May, 1969. 3238.

Trichosanthes bracteata (Lam.) Voigt

Occasional. Frts. August, 1969, 1970. 3608, 4132.

CACTACEAE

Opuntia coccinellifera Mill.

Occasional in scrub jungles. Flowers red

and attractive. Fls. November, 1969. 3361.

O. elatior Mill.

Common. Flowers yellow. Fls. October, 1970. No number, D. V. Subbaiah.

MOLLUGINACEAE

Glinus lotoides Linn.

Common. Frts. May-June, 1969. 3242. 3310.

G. oppositifolius (L.) A. DC.

Common, flowers white. Fls. June, Frts. September, 1969, 1970. 3311, 4138.

Mollugo nudicaulis Lam.

Common. Flowers white. Fls. June, Frts. September, 1969, 1970. 3315, 4139.

AIZOACEAE

Trianthema portulacastrum Linn.

Common. Flowers bright purple. Fls. June, 1969. 3363.

ALANGIACEAE

Alangium salvifolium (L.f.) Wang.

Common in the hedges around irrigation tanks. Flowering was not noticed inspite of intense search throughout the year in the present area. Therefore identification is provisional. 1969, 1970. 3368, 3410, 3931.

RUBIACEAE

Borreria articularis (L.f.) F.N. Will.

Common. Flowers purple. Fls. November, 1969. 3587.

Canthium dicoccum (Gaertn.) T. & B.

Occasional, flowers white. Fls. November, 1969. 3477.

Gardenia lucida Roxb.

Occasional, flowers large, white but turning yellow with age. Fls. and Frts. December, 1970. 3956, 4140.

Guetarda speciosa Linn.

One tree is found, probably planted. Flowers white. Fls. January, 1970. 4112.

Knoxia sumatrensis (Retz.) DC.

Occasional in the undergrowth. Flowers white with purplish tinge. December, 1970. 3996.

Morinda tinctoria Roxb.

Planted in private compounds for fragrant white flowers. Fls. January, 1970. 4158.

Oldenlandia corymbosa Linn.

Common. Flowers white. Fls. and Frts. More or less throughout the year, 1969, 1970. 3282, 3317, 3405, 3862.

O. affinis (R. & S.) DC.

Occasional flowers white. Fls. and Frts. December, 1970. 3977.

Plectronia parviflora Bedd.

Common. Flowers white. Fls. May-June, Frts. November-December, 1969, 1970. 3301, 3332, 3379, 3855A.

Tarenna asiatica (L.) Alston

Common in forests and scrub jungles. Flowers white. Fls. December, Frts. May, 1969, 1970. 3210, 3396, 3863, 3877.

Xeromphis spinosa (Thunb.) Keay

Common. Flowers white but turning yellow with age. Fls. June, Frts. December, 1969, 1970. 3334, 3935.

ASTERACEAE

Ageratum conyzoides Linn.

Common. Heads white. Fls. and Frts. December, 1970. 3909.

Bidens biternata (Lour.) Merr. & Sherff.

Common either in mixed or pure stands. Heads yellow, November, 1969. No number, D. V. Subbaiah.

Echinops echinatus Roxb.

Rare. Found a few plants at Jayampu. Flowers white. Heads September, 1970. 3815.

Eclipta alba (L.) Hassk.

A common weed. Heads white, November, 1970. 3552.

Emilia sonchifolia (L.) DC.

Common. Heads purple, December, 1969. 3869.

Glossocardia bosvallea (L.f.) DC.

Common. Heads yellow, November, 1969. 3463.

Tridax procumbens Linn.

Common and abundant. Heads yellow, May-June, 1969. 3320, 3412.

Vernonia albicans DC.

Common. Heads purple, December, 1970. 3961.

V. cinerea (L.) Less.

Common. Heads purple, December, 1970. No number. D. V. Subbaiah.

Vicoa indica (Willd.) DC.

Occasional. Heads yellow, December, 1970. 3816.

PLUMBAGINACEAE

Plumbago zeylanica Linn.

Rare, collected from the roadside bushes on way to Railway Station. Flowers white. Fls. and Frts. January, 1969. 3554.

SAPOTACEAE

Madhuca longifolia (Koenig.) Macbride

Occasional. Flowers light-yellow, succulent. Fls. May, 1969. 3232.

Manilkara hexandra (Roxb.) Dub.

Common. Flowers white, scented. Fls. December, 1969. 3526, 3638.

EBENACEAE

Diospyros chloroxylon Roxb.

Common, often found in hedges. Flowers white. Fls. May-June, 1969, 3220, 3306.

D. melanoxylon Roxb.

Occasional in scrub jungles. Identification is provisional in the absence of flowers and fruits. May, 1969. 3205.

Maba buxifolia Pers.

Common. Frts. May-June, 1969. 3206, 3381.

OLEACEAE

Jasminum auriculatum Vahl

Common in bushes. Flowers white. Fls. and Frts. November-December, 1969, 1970. 3531, 3971.

APOCYNACEAE

Carissa carandas Linn.

Common in hedges. Flowers white. Fls. May, 1969. 3252.

C. spinarum DC.

Common. Flowers white. Fls. June, 1969. 3305.

Catharanthus pusillus (Murr.) G. Don

Rare in cultivated fields as a weed. Flowers white. Fls. and Frts. May, 1969. 3241.

Wrightia tinctoria R. Br.

Occasional in thick forests. Frts. December, 1970. 3814, 3906.

Thevetia peruviana (Pers.) Merr.

Planted. Flowers yellow. Fls. May, 1969. 3221.

ASCLEPIADACEAE

Calotropis gigantea (L.) R. Br.

Common in wasteland. Flowers bluish. Fls. November, 1969. 3536.

Caralluma adscendens (Roxb.) R. Br.

Common in large bushes. Flowers dark purple. Fls. January, Frts. July, 1970. 4107, 4124.

Ceropegia bulbosa Roxb.

Occasional in the bushes along the Railway Station Road. Flowers greenish-yellow. Fls. December, 1969. 3555.

Gymnema sylvestre (Retz.) R. Br. ex Schult.

Common. Flowers yellowish-green. Fls. November, 1969. Frts. December, 1970. 3514, 3811.

Hemidesmus indicus (L.) Schult

Common, very variable plant. Flowers yellowish-green. Fls. and Frts. December, 1970. 3865, 3922, 4264.

Pergularia daemia (Forsk.) Chiov.

Common in hedges. Frts. February, 1970. 4013.

Sarcostemma brevistigma Wt. & Arn.

Common, a leafless straggler. Flowers yellowish. Fls. November-December, 1969, 1970. 3487, 3968.

Secamone emetica R. Br.

Rare, a gregarious climber on large shrubs. Flowers pretty, yellow. Fls. November, 1969. 3461.

Tylophora indica (Burm. f.) Merr.

Common. Flowers yellowish. Fls. May-June, 1969, 1970. 3270, 3322, 4130.

Loganiaceae

Strychnos nux-vomica Linn.

Common in forests. Frts. November, 1969. 3204, 3521.

Gentianaceae

Canscora perfoliata Lam.

Rare in moist, cool and shady places. Flowers white. Fls. and Frts. December, 1970. 3901.

Enicostemma hyssopifolium (Willd.) Verd.

Occasional. Flowers white. Fls. December, 1970. 3831.

Ehretiaceae

Carmona retusa (Vahl) Masamune

Common in scrub jungles. Flowers white. Fls. June, 1969. 3289, 3400.

Cordia obliqua Willd.

Occasional on tank bunds near villages. Flowers white. Fls. June, 1969. 3413.

Boraginaceae

Heliotropium indicum Linn.

Common. Flowers purplish. Fls. and Frts. November, 1969. 3603.

H. supinum Linn.

Abundant in dried tanks. Flowers white. Fls. and Frts. May, 1969. 3246.

Convolvulaceae

Evolvulus alsinoides Linn.

Common in grasslands. Flowers blue. Fls. and Frts. November, 1969. 3485.

Ipomoea muricata (L.) Jacq.

An occasional climber with large purple flowers. Fls. December, 1970. 3793.

I. obscura (L.) Ker.-Gawl.

Occasional on hedges. Flowers white. Fls. December, 1970. 3985.

Merremia tridentata Hallier

Common. Flowers yellow. Fls. and Frts. June, 1969. 3281.

Rivea hypocrateriformis (Lam.) Choisy.

Common. Flowers white. Fls. and Frts. November-December, 1969, 1970. 3502, 3531, 3976.

Solanaceae

Datura fastuosa Linn.

Occasional. Flowers white. Fls. and Frts. November, 1969. 3821.

Solanum nigrum Linn.

Common in waste places. Flowers small and white. Fls. and Frts. December, 1969. 3556.

S. surattense Burm.f.

Occasional in dry places. Flowers violet. Fls. and Frts. June, 1969. 3403.

SCROPHULARIACEAE

Bacopa monnieri (L.) Wettstein

Abundant in pure stands in moist soil. Flowers bluish-purple or almost white. Fls. May, 1969. 3234.

Lindernia hyssopoides (L.) Haines

Common. Flowers purple. Fls. and Frts. December, 1970. 3829.

L. oppositifolia (Don) Mukerjee

Common. Flowers bright purple. Fls. December, 1970. 3827.

Limnophila indica (L.) Druce

Common. Flowers turbid white. Fls. December, 1970. 3857.

Striga angustifolia (Don) Saldanha

Common, but scattered in pasture lands. Flowers white. Fls. November-December, 1969, 1970. 3496, 3798, 3849.

S. lutea Lour. var. **lutea**

Rare, found among grasses on hill slopes. Flowers yellow. Fls. December, 1970. 4152.

MARTINIACEAE

Martynia annua Linn.

Occasional in the forests near Railway Station. Flowers purple. Fls. January, 1970. 3557.

PEDALIACEAE

Sesamum indicum Linn.

Solitary in waste places. Probably an escape from cultivation. Frts. December, 1970. 4134.

ACANTHACEAE

Adhatoda vasica Nees

Occasional in hedges near villages. Flowers white. Fls. and Frts. February, 1971. 4002.

Androagraphis echioides (L.) Nees

Common. Flowers purple. Fls. and Frts. May, 1969. 3266.

A. paniculata (Burm.f.) Wall. ex Nees

Common. Flowers purple. Fls. and Frts. December, 1970. 3870.

Asystasia gangetica T. And.

Common. Flowers white. Fls. and Frts. February, 1971. 4106.

Barleria prionitis Linn.

Common among bushes. Flowers yellow. Fls. November-December, 1969, 1970. 3474, 3873, 3936.

Blepharis boerhaaviaefolia Pers.

Common in the undergrowth. Flowers turbid white. Fls. and Frts. December, 1970. 3962.

Elytraria acaulis (L. f.) Lindau

Common. Flowers white. Fls. May, 1969. 3293.

Justicia diffusa Willd.

Common. Flowers purple. Fls. and Frts. December, 1970. 4159.

J. prostrata (Roxb. ex C.B.Cl.) Gamble

Occasional. Flowers purple. Fls. and Frts. May, 1969. 3296.

J. glauca Rottl.

Common. Flowers purple. Fls. and Frts. December, 1970. 3964, 4105.

Lepidagathis mitis Dalz.

Common in hard soil. Flowers purple. Fls. and Frts. December, 1969. 3856, 3913.

VERBENACEAE

Gmelina asiatica Linn.

Common in scrub jungles. Flowers yellow. Pendulous. Fls. May-June, 1969, 1970. 3226, 4132.

Lantana camara Linn. var. **aculeata** (L.) Moldenke

Common and abundant. Flowers purple and white. Fls. and Frts. May and November, 1969. 3290, 3505.

Phyla nodiflora (L.) Greene

Common in large patches in moist soil. Flowers white with purple streak. Fls. and Frts. November, 1970. 3799.

Tectona grandis Linn. f.

A few trees at Malleswara Kona in lead. December, 1970. 3564.

Vitex altissima Linn.

Occasional in forests. Flowers white. Fls. November, 1970. 4144.

V. leucoxylon Linn. f.

Rare. In the absence of reproductive parts identification is provisional. December. 1970. 3927.

V. negundo Linn.

Common. Flowers bluish-mauve. Fls. May, 1969. 3235, 3273.

LAMIACEAE

Anisochilus carnosus Wall.

Occasional, Flowers light purple. Fls. and Frts. December, 1970. 3905.

Anisomelis indica (L.) O. Kuntze

Common in hedges. Fls. purple. Fls. and Frts. December, 1969, 1970. 3269, 3621, 3847.

A. malabaricus R. Br.

Common. Flowers rosy-purple. Fls. and Frts. December-February, 1969, 1970. 3269, 3852, 3926, 4167.

Geniosporum tenuiflorum (L.) Merr.

Occasional along earth bunds in cultivated fields. Flowers small, purple. Fls. and Frts. February, 1970. 4004.

Leonotis nepetaefolia R. Br.

Occasional. Flowers orange-red. Fls. and Frts. January-March, 1970. 4012, 4104.

Leucas aspera (Willd.) Spreng.

Common. Flowers white. Fls. and Frts. November, 1969. 3504.

L. biflora R. Br.

Occasional. Flowers white. Fls. and Frts. November-December, 1969, 1970. 3506, 3949.

L. lavandulifolia Rees.

Common on hill slopes. Flowers white. Fls. June, 1969. 3342.

Ocimum americanum Linn.

Common. Flowers purplish-white. Fls. and Frts. February and June, 1969, 1970. 3408, 4009.

Orthosiphon pallidus Royle ex Bth.

Common. Flowers purplish white. Fls. and Frts. November, 1969. 3500.

NYCTAGINACEAE

Boerhaavia diffusa Linn.

Common. Flowers purple. Fls. and Frts. June, 1969. 3316.

AMARANTACEAE

Achyranthes aspera Linn.

Common. Flowers small, dry-white. Fls. and Frts. January, 1969. No number. D. V. Subbaiah.

Aerva lanata (L.) Juss.

Common. Flowers white in wooly spikes. Fls. and Frts. December, 1970. 3866.

A. monsoniae Mart.

Common in dry sandy soil. Spikes pale pink. Fls. and Frts. December, 1970. 3910.

Alternanthera sessilis (L.) DC.

Common and abundant in moist margins of temporary ponds and puddles. Flowers white. Fls. and Frts. November, 1969. 3559.

Digera alternifolia (L.) Aschers

A common weed. Flowers purple. Fls. and Frts. February, 1970. 4008.

Pupalia lappacea (L.) Juss.

Occasional. Fruiting. Frts. December, 1970. 3969.

ARISTOLOCHIACEAE

Aristolochia bracteolata Lam.

Common in the dry soil. Flowers deep purple. Fls. February, 1970. Frts. May, 1969. 3224, 3259, 4014.

LAURACEAE

Cassytha filiformis Linn.

Common stem parasite in scrub jungles. Flowers white. January, 1971. 3224, 3259, 4014.

LORANTHACEAE

Dendrophthoe falcata (L. f.) Etting var. **coccinea** (Talb.) Sant.

Common. Flowers red. Fls. December, 1970. 3878, 3897.

Viscum articulatum Burm f.

Occasional. Flowers small, green. Fls. and Frts. December, 1970. 4118, 4155.

EUPHORBIACEAE

Acalypha indica Linn.

Common and abundant in waste places. Fls. small. Fls. and Frts. November-January, 1970. 3561.

Bridelia retusa (L.) Spreng.

Rare in forests. Frts. November, 1970. 4154.

Cleistanthus collinus (Roxb.) Bth. & Hook.

Occasional in forests. Frts. February, 1970. 3868, 4126.

Croton bonplandianum Baill.

Common and abundant in waste places. Male flowers white, females green. Fls. and Frts. November-January, 1969, 1970. 3659.

Euphorbia hirta Linn.

Common. Flowers minute, greenish. Fls. and Frts. May, 1969. 3256.

E. serpens H.B.K.

Common. Flowers minute, green. Fls. and Frts. May, 1969. 3245.

E. tirucalli Linn.

Occasional in hedges. Frts. (dried) June, 1969. 3327.

E. trigona Haw.

Common and abundant in scrub jungles. Flowers red. Fls. January, 1970. 3414, 4114.

Hemicyclia sepiaria Wt. & Arn.

Occasional in scrub jungles. Flowers small white. Fls. and Frts. December, 1970. 3562.

Homonoia riparia Lour.

Common at Malleswara Kona. Flowers red. Fls. and Frts. December, 1969, 3946, 4156.

Jatropha gossypifolia Linn.

Common in scrub jungles. Flowers red. Fls. and Frts. May, 1969. 3216, 4136.

Mallotus philippinensis (Lam.) Muell.-Arg.

Common at Malleswara Kona. Fruits with red tomentum. Frts. December, 1969. 3616.

Micrococca mercurialis Bth.

Common in fields. Flowers minute. Fls. February, 1970. 4113.

Phyllanthus asperulatus Hutch.

Common. Flowers small, greenish. Fls. and Frts. November-February, 1969, 1970. 3568.

P. debelis Ham.

Common. Flowers small, pale green. Fls. and Frts. December-February, 1970, 1971. 3997, 4116.

P. maderaspatensis Linn.

Common. Flowers purplish-white. Fls. and Frts. January, 1971. 4117, 4144.

P. simplex Retz.

Common. Flowers small, greenish-white. Fls. and Frts. November, 1969. 3466.

Ricinus communis Linn.

Occasional in waste land. Flowers, yellowish-white. Fls. February, 1971. 4018.

Sebastiania chamaelea Muell.-Arg.

An occasional weed in cultivated fields. Flowers small, white. Fls. and Frts. January, 1970. 3810.

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

Common. Fruits fleshy and white. Frts. November, 1969. 3331, 3530.

Tragia involucrata Linn.

Occasional among bushes. Flowers minute, greenish. Fls. May, 1969. 3260.

Trewia nudiflora Linn.

Rare in hedges. Flowers small, greenish. Fls. December, 1970. 3834.

MORACEAE

Ficus gibbosa Bl. var. **parasitica** King.

Rare in forests. Fls. and Frts. December, 1969. 3978.

F. hispida Linn. f.

Occasional near villages. Frts. May, 1969. 3208, 3271.

F. racemosa Linn.

Occasional in villages. Vegetative, May, 1969. 3292.

F. religiosa Linn.

Common. Fruits red. March-April, 1969. 3564.

MONOCOTYLEDONS

HYDROCHARITACEAE

Hydrilla verticillata Royle

Abundant in ponds. May, 1969. 3285.

Ottelia alismoides (L.) Pers.

Occasional but gregarious in roadside ponds. Flowers white. Fls. October, 1969. 3447.

Vallisneria spiralis Linn.

Abundant in ponds. Fls. May, 1969. 3276.

ORCHIDACEAE

Eulophia epidendracea (Retz.) Fischer

Rare. Flowers greenish-white with purplish streak. Fls. December, 1970. 3887.

Habenaria hollandiana Sant.

Rare in cool, shady and moist places. Flowers dull white, with greenish tinge. Fls. December, 1969. 3606A.

H. digitata Lindl.

Occasional. Flowers dull white. Fls. December, 1969, 1970. 3606D, 3966.

H. plantaginea Lindl.

Occasional. Flowers pure white. Fls. December, 1969. 3606.

H. platyphylla Spr.

Occasional. Flowers white. Fls. January, 1970. 3806.

Vanda roxburghii R. Br.

Rare. Frts. December, 1970. 4153.

HYPOXIDACEAE

Curculigo orchioides Gaertn.

Common in the undergrowth in forests. Flowers yellow. Fls. November-December, 1969, 1970. 3482, 3577, 3797.

DIOSCOREACEAE

Dioscorea oppositifolia Linn.

Common. Flowers greenish. Fls. December, 1970. 3891, 4173.

D. pentaphylla L. var. **linnaei** Pr. & Burk.

Common. Flowers small green. Fls. November-December, 1969, 1970. 3460, 3609, 3957.

LILIACEAE

Aloe barbadens Mill.

Occasional in scrub jungles. Flowers saffron red. Fls. November, 1970. 3801.

Asparagus racemosus Willd.

Common in forests. Frts. December, 1969, 1970. 3639, 3958.

Gloriosa superba Linn.

Common. Flowers red with yellow streaks. Fls. November-December, 1969, 1970. 3524, 3626, 3937.

Iphiginea indica (L.) A. Gray

Rare among grasses. Flowers deep purple. Fls. and Frts. November, 1969. 3512.

Scilla hyacinthiana (Roth.) Macbr.

Common during monsoon in grass lands. Flowers mauve. Fls. and Frts. October, 1971. 4101, 4125.

HAEMODORACEAE

Sansevieria roxburghiana Schult.

Common in dry places in scrub jungles. Flowers white. Fls. January, 1971. 3954, 4150.

COMMELINACEAE

Amischocephalus axillaris (L.) Rao & Kamathy

Common among grasses. Flowers purple. Fls. and Frts. December, 1970. 3826.

Commelina benghalensis Linn.

Common in moist places. Flowers blue. Fls. and Frts. October-November, 1969, 3565.

C. diffusa Burm. f.

Common trailing on the ground. Flowers purple. Fls. and Frts. October, 1971. 4103.

C. fasciculata (Heyne ex Roth) Schult.

Common among grasses. Flowers blue. Fls. October, 1970. 4102.

C. tuberosa (Roxb.) Schult.

Common in the undergrowth. Flowers blue. Fls. November, 1969. 3501.

Murdania spirata (L.) Bruckn.

Common. Flowers purple. Fls. and Frts. December, 1970. 3861.

PALMACEAE

Borassus flabelliformis Linn.

Common all over the district in the plains. Frts. May-June, 1969. 3565.

Phoenix humilis Royle var. **pedunculata** Becc.

Rare in the forests. In the absence of reproductive organs identification is provisional. December, 1970. 3939.

P. sylvestris (L.) Roxb.

Common in the plains. Frts. May, 1969. 3247, 3800.

ARACEAE

Arisaema leschenaultii Bl.

Rare in the Visvodaya College building construction site. The specimens match with the herbarium sheets at Madras Herbarium. In the absence of flowers and fruits identification is provisional. November, 1970. 3854.

APONOGETONACEAE

Aponogeton natans (L.) Engl. & Krause

Common in temporary ponds. Flowers mauve. Fls. November, 1969. 3509.

NAJADACEAE

Najas minor All. var. **spinosa** Rendle

Abundant in a pond at Kasigardens. Frts. May, 1969. 3286.

ERIOCAULACEAE

Eriocaulon quinquangulare Linn.

Common and abundant on moist margins of roadside puddles. Heads grey-white. Heads. December, 1970. 3844.

CYPERACEAE

Bulbostylis barbata (Rottb.) Cl.

Common. Spikelets November, 1969. 3475.

Cyperus aristatus Rottb.

Common along roadside temporary ponds. Spikelets December, 1970. 3840.

C. clarkei T. Cooke.

Occasional. Spikelets November, 1969. 3494.

C. compressus Linn.

Common. Spikelets February, 1971. 4100.

C. iria Linn.

Common in rice fields. Spikelets November, 1969, 1970. 3533, 4137.

C. polystachyos var. **laxiflorus** Bth.
Common. Spikelets December, 1970. 3990.
C. tenuispica Steud.
Common. Spikelets December, 1970. 3989.
C. triceps (Rottb.) Endl.
Common among grasses. Spikelets in white heads. December, 1970. 3836, 3838.
Eleocharis capitata R. Br.
Common in the crevices of rocks in the river bed. Spikelets, May, 1969. 3253.
Fimbristylis argentea Vahl
Common. Spikelets June, 1969. 3307.
F. falcata (Vahl) Kunth.
Common in moist places in river bed. Spikelets, November, 1970. 3803.
F. littoralis Gaud.
Common. Spikelets December, 1970. 3835.
F. ovata (Burm. f.) Kern
Occasional. Spikelets November, 1969. 3498.
F. shoenoides Vahl
Occasional. Spikelets December, 1970. 3837.
F. tenera R. & S.
Common. Spikelets November, 1969. 3494.

GRAMINEAE

Apluda mutica Linn.
Common. Spikelets December, 1970. 3975.
Aristida adscencionis Linn.
Common. Spikelets December, 1969. 3288, 3338.
A. depressa Retz.
Common. Spikelets June, 1969, December, 1970. 3337, 3843, 3874.
Centotheca lappacea Desv.
Common. Spikelets December, 1970. 3900.
Chloris barbata Sw.
Common. Spikelets June, 1969. 3358.
Cymbopogon martinni (Roxb.) Wats.
Common on hill slopes. Spikelets December, 1970. 3893.
Eleusine coracana Gaertn.
Cultivated. Spikelets February, 1971. 4021.
Eragrostis aspera Nees
Common. Spikelets December, 1970. 3859.
E. gangetica (Roxb.) Steud.
Occasional. Spikelets December, 1970. 3842.
E. tenella R. & S.
Common. Spikelets May, 1969. 3303.
Heteropogon contortus (L.) P. Beauv. ex R. & S.
Common. Spikelets December, 1970. 3841, 3925, 3987.
Melanocenchris jacquemontii Jaub. & Spach.
Occasional. Spikelets November, 1969. 3491.
Oplismenus compositus Beauv.
Common. Spikelets December, 1970. 3611.
Panicum psilopodium Trin.
Common. Spikelets December, 1970. 3994.
Pennisetum hohenackeri Hochst.
Cultivated as a fodder plant. Spikelets February, 1971. 4003.
Perotis indica (L.) O. Kuntze
Common. Spikelets May, 1969. 3262.
Saccharum spontaneum Linn.
Common and gregarious along water courses. Spikelets February, 1971. 4020.
Sporobolus piliferus Kunth.
Rare. Spikelets November, 1969. 3491.

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LARVAL HISTORY OF THE SPIDER CRAB, *SCHIZOPHRYS ASPERA* (H. MILNE-EDWARDS) (BRACHYURA, MAJIDAE) AS OBSERVED IN THE LABORATORY[1]

V. S. KAKATI[2] AND V. N. NAYAK[3]

(With four text-figures)

The present paper deals with the larval history of the spider crab, *Schizophrys aspera* (H. Milne-Edwards) as observed in the laboratory. The metamorphosis comprises 2 zoeal and a megalopa stage at sea water temperature ranging from 26°C to 27.5°C and salinity about 33 ppt. During the experiment the larvae were fed with freshly hatched *Artemia* nauplii. All larval stages have been figured and described in detail.

INTRODUCTION

Though larvae of many species of spider crabs have been known since Rathke's (1840) first description of the zoeae of *Hyas araneus* (Yang 1968), no work has been done in the genus *Schizophrys* but for the description of the larvae of a species given by Kurata (1969) as of *S. aspera*.

Except for the laboratory reared larvae of 3 species of the family Majidae, no other spider crab has been reared from the Indian waters. The 3 laboratory reared spider crabs being, *Dehaanius limbatus*, (Kakati & Sankolli 1975b), *Acheus lacertosus* (Kakati & Sankolli 1975) and *Doclea hybrida* (Sankolli & Shenoy 1975). Therefore, the larvae of *Schizophrys aspera*, one of the 3 species of the genus from Indo-west Pacific region (Serene 1968) were reared in the laboratory. The other two species of the genus represented in the region are *S. dama* (Herbst) and *S. hilensis* Rathbun.

The present account deals with the 2 zoeae and a megalopa of *S. aspera* and compares the larvae with those of Kurata's larvae of *S. aspera*.

MATERIAL AND METHODS

An ovigerous female of *Schizophrys aspera* was collected from Ankola rocky shore, west coast of India, on 12th December 1973 and the crab was kept alive in a plastic container until the larvae hatched on 14th December 1973. The rearing method adapted for the experiment was same as described by Kakati & Sankolli (1975).

During the course of the experiment the temperature of the sea water ranged from 26 to 27.5°C and salinity about 33 ppt. Freshly hatched *Artemia* nauplii were used as food for the crab larvae. The shortest period for complete larval development was 8 days.

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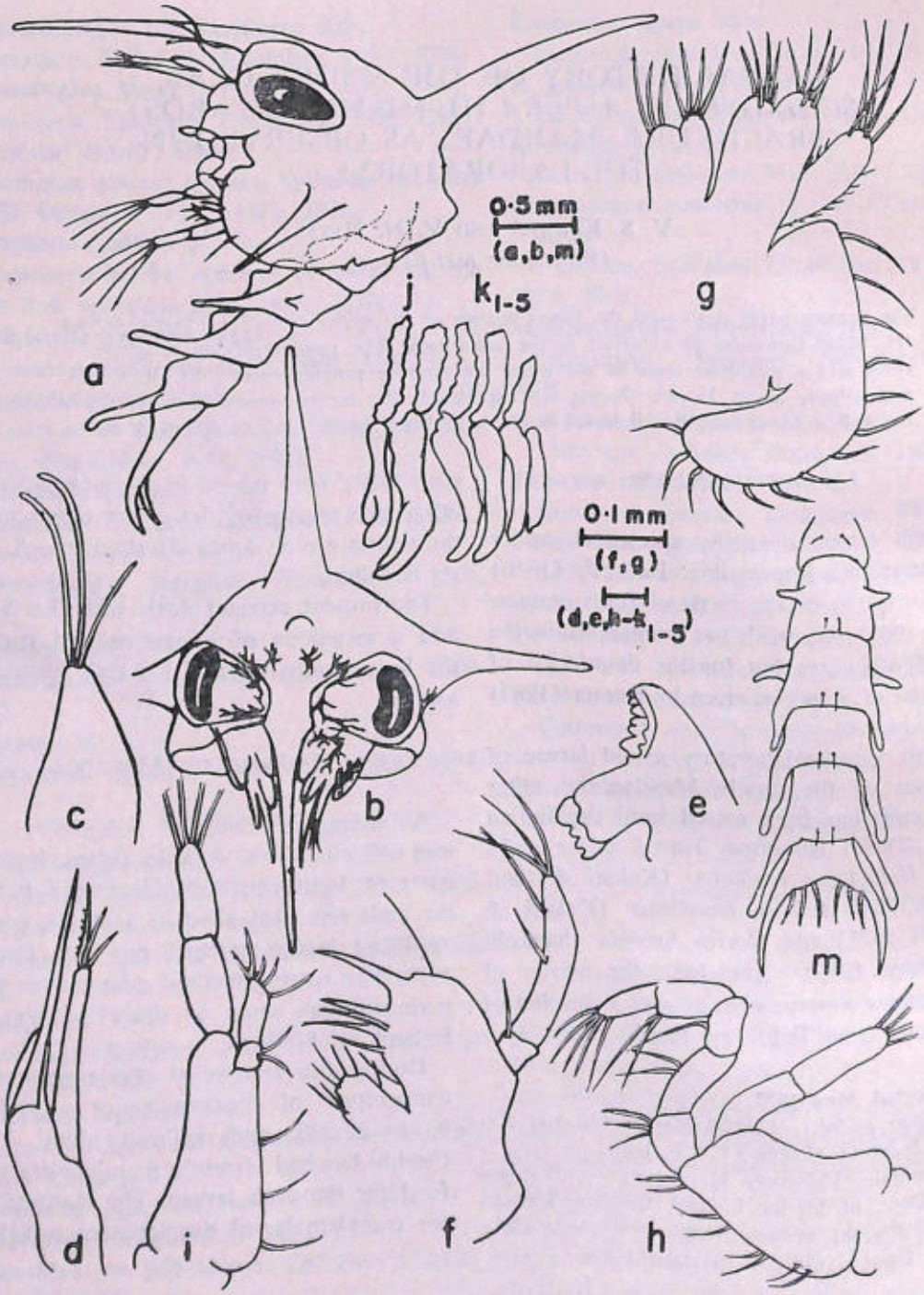

Fig. 1. First zoea of *Schizophrys aspera* (H. Milne-Edwards): a. lateral view of zoea; b. front view of zoea; c. antennule; d. antenna; e. mandible; f. first maxilla; g. second maxilla; h. first maxilliped; i. second maxilliped; j. third maxilliped; k_{1-5}. pereiopods; m. abdomen.

FIRST ZOEA
(Fig. 1)

Rostral spine: 0.90 mm;
Lateral spine: 0.66 mm;
Dorsal spine: 1.03 mm;
Abdomen length: 1.70 mm.
Duration of the stage: 3-4 days.

Carapace smooth, with all three spines; dorsal spine slightly curved backwards; lateral spines more or less straight; the tips of all spines rounded; 3 setae present along the anterolateral border of carapace; prominent mediodorsal and medio-frontal tubercles present.

Antennule (Fig. 1,c): Conical, with 3 unequal aesthetascs. *Antenna* (Fig. 1,d): Spinous process with 2 rows of 10 - 11 spines; exopod with 3 unequal spines which in turn have spinules; endopod bud well developed. *Mandible* (Fig. 1,e): With strongly developed molar and incisor processes and without palp. *First maxilla* (Fig. 1,f): Coxal and basal endites each with 7 setae; palp 2-segmented with a single seta on proximal and 5 setae on distal segments. *Second maxilla* (Fig. 1,g): Both bilobed coxal and basal endites with 3 + 4 and 5 + 5 setae on their lobes; palp unsegmented and with 5 setae terminally, its free margins with minute hairs; scaphognathite with 14 finely plumose setae. *First maxilliped* (Fig. 1,h): Basipod with 8 setae; endopod 5-segmented with 3, 2, 1, 2 and 5 setae arranged distalwards; exopod 2-segmented with 4 natatory setae on its distal segment. *Second maxilliped* (Fig. 1,i): Basipod with 3 setae; endopod 2-segmented with 2 and 5 setae on proximal and distal segments respectively; exopod similar to that of first maxilliped. *Other appendages* (Fig. 1,j & k1-5): Third maxilliped and pereiopods in bud form, the 3rd maxilliped and 1st pereiopod showing biramous and chelate nature respectively; gill buds well developed. *Abdomen* (Fig. 1,m): 5-segmented plus telson, lateral protuberance on 2nd and 3rd segments as illustrated; the postero-lateral sides of segments 3 - 5 produced to form spines with rounded tips, and they increase in length posteriorly; a pair of setae present on all segments. *Telson* (Fig. 1,m): Telson fork wide; cornua smooth; process formula 3 + 3.

Chromatophores: To the naked eye, larvae look reddish brown. Eyestalks reddish-yellow with brownish reticulate chromatophores along their front margins. Carapace spines devoid of chromatophores. All abdominal segments except for telson are crimson red in colour with brownish red branched chromatophores. Basipods of 1st and 2nd maxillipeds reddish in colour with brown reticulate chromatophores. Whole front area is yellowish brown in colour. Other chromatophores are as illustrated and are brownish red in colour. This pattern remains the same for both the zoeal stages.

SECOND ZOEA
(Fig. 2)

Rostral spine: 1.05 mm;
Lateral spine: 0.75 mm;
Dorsal spine: 1.07 mm;
Abdomen length: 2.12 mm.
Duration of the stage: 3 - 4 days.

This stage is characterised by: carapace along its antero-lateral margin carries 5 setae, eyes stalked, mandible with palp bud, maxillipeds with 6 natatory setae, 6th abdominal segment separated from telson.

Antennule (Fig. 2,c): Now with 7 aesthetascs and a seta, with endopod bud near its distal end. *Antenna* (Fig. 2,d): Endopod much elongated extending to about 2/3 of the spinous process. *Mandible* (Fig. 2,e): Now with palp bud. *First maxilla* (Fig. 2,f): Coxal endite with 7 setae and basal with 9; palp 2-

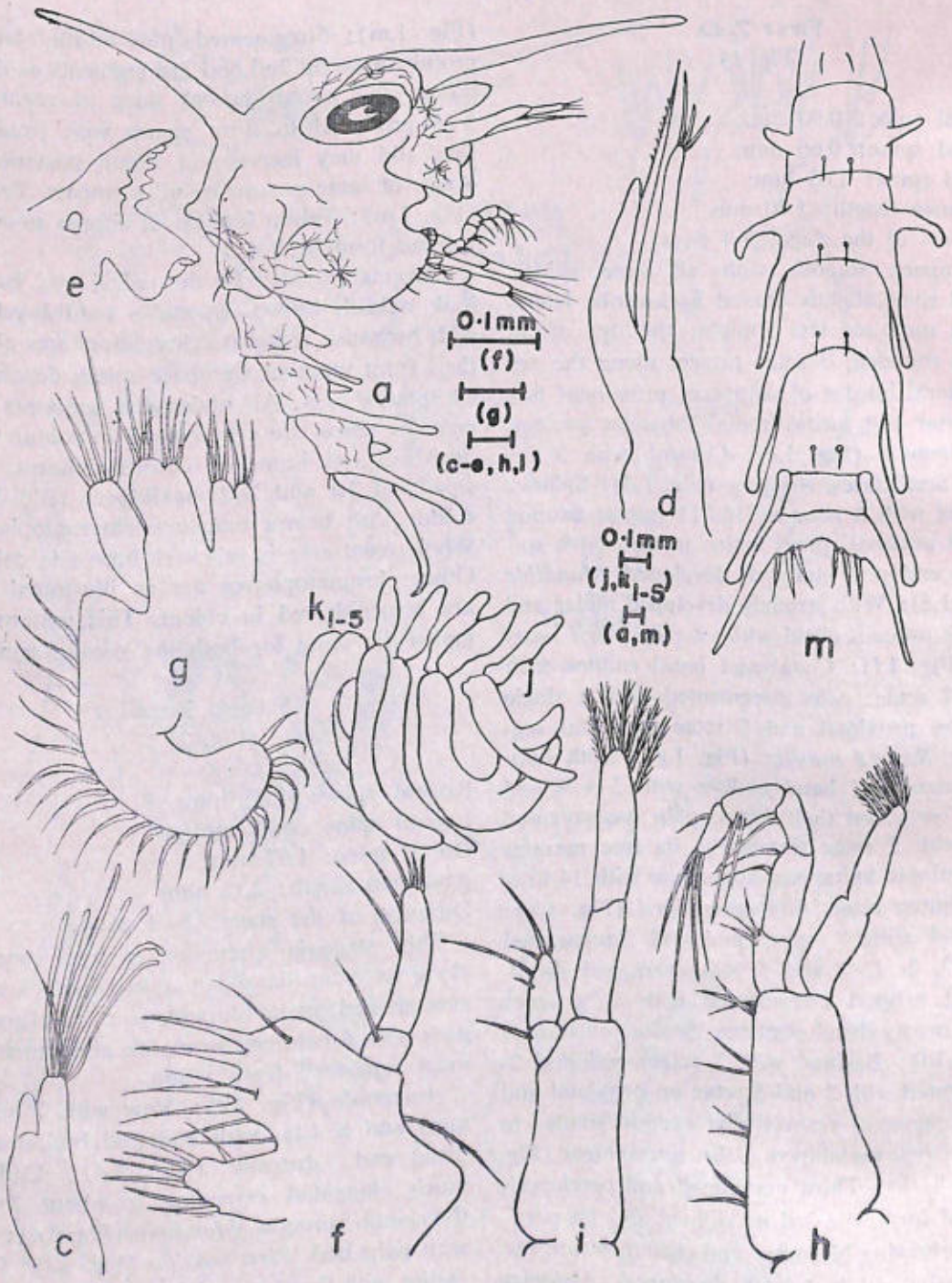

Fig. 2. Second zoea of *Schizophrys aspera* (H. Milne-Edwards): a. lateral view of zoea; c. antennule; d. antenna; e. mandible; f. first maxilla; g. second maxilla; h. first maxilliped; i. second maxilliped; j. third maxilliped; k_{1-5}. pereiopods; m. abdomen.

segmented with 1 and 6 setae on its proximal and distal segments. *Second maxilla* (Fig. 2,g): Both bilobed coxal and basal endites with 3 + 4 and 5 + 5 setae on their lobes; palp with 5 setae; scaphognathite fringed with 25 marginal setae. *First maxilliped* (Fig. 2,h): Except for the increase in number of natatory setae to 6 no other change. *Second maxilliped* (Fig. 2,i): Exopod as in first maxilliped; no other change. *Other appendages* (Fig. 2,j, k1-5): More elongated than in previous stage. *Abdomen* (Fig. 2,m): 6th abdominal segment separated from telson; no other change; *Telson* (Fig. 2,m): No change.

MEGALOPA
(Figs. 3 & 4)

Carapace length: 1.26 mm; Carapace breadth: 1.03 mm. Duration of the stage: 5 days (none moulting to crab instar).

The carapace is quadrangular, length being slightly more than its breadth, covered with spines and setae, 2 pairs of spines on each side of the gastric region, a central spine in the gastric region; 2 spines in cardiac and a spine in intestinal region, hepatic lobes slightly conical, the rostrum bifid though the centre is conical, a single seta springs at subterminal level of rostral horns, eyes with a pair of setae antero-dorsally.

Antennule (Fig. 3,c): Peduncle 3-segmented, each segment with a single seta, inner flagellum unsegmented and with 2 terminal and 2 subterminal setae, dorsal flagellum 3-segmented, proximal with 1 seta, middle with 6 aesthetascs and distal with 4 aesthetascs basally and a seta terminally. *Antenna* (Fig. 3,d): Peduncle 3-segmented, basal segment with its distal tips forming lobes. The following segments with a seta and 3rd segment with 3 setae, flagellum 4-segmented, proximal 2 segments bare, last two segments distally each with 3 setae. *Mandible* (Fig. 3,e): Masticatory process rounded, palp 3-segmented with 4 stiff setae on the distal segment. *First maxilla* (Fig. 3,f): Coxal endite with 9 setae and basal with 17; palp unsegmented, with 2 short terminal setae. Second maxilla (Fig. 3,g): The lobes of coxal endites each with 4 and basal each with 6 setae; endopod simple without any setae; scaphognathite fringed with 35 - 37 setae. *First maxilliped* (Fig. 3,h): Coxal endite with 8 setae and basal with 12; endopod unsegmented and bare; exopod 2-segmented with 1 and 4 setae terminally on proximal and distal segments respectively; epipod with 5 setobranch-like setae. *Second maxilliped* (Fig. 4,i): Endopod 5-segmented and with 0, 0, 1, 3 and 5 setae arranged distalwards; exopod 2-segmented and with 4 apical plumose setae on the distal segment. *Third maxilliped* (Fig. 4,j): Endopod 5-segmented and setation being, 10, 6, 4, 8 and 4 respectively on proximal to distal segments; exopod 2-segmented and with 4 setae at its tip; epipod with 8 basal setae and 8 setobranch-like setae on its ribbon-like structure, with an arthrobranch. *Pereiopods* (Fig. 4,k1-5): Cheliped on its dorsal side near the base of the palm with a tooth-like structure; setose exopodites of segments 2 - 5 with a tooth on inner side and a protuberance with a seta on outer side, and 4 stiff setae on the inner surface of each of the pereiopods 2-5. *Abdomen* (Figs. 3,a & 4,b): 6-segmented; 2nd and 3rd segments each with a pair of posteriorly directed lateral spines; setation being 2 on 1st and 4 on 2nd to 5th segments and 2 on 6th segment. *Telson* (Fig. 4,n): Rounded and its margin smooth, but on ventral side are 2 setae near uropods. *Pleopods* (Fig. 4,l_1-4,n): Expods of pleopods 1 - 4 each with 10 setae while that of 5th (= uropod) with 5 setae; endopods each with

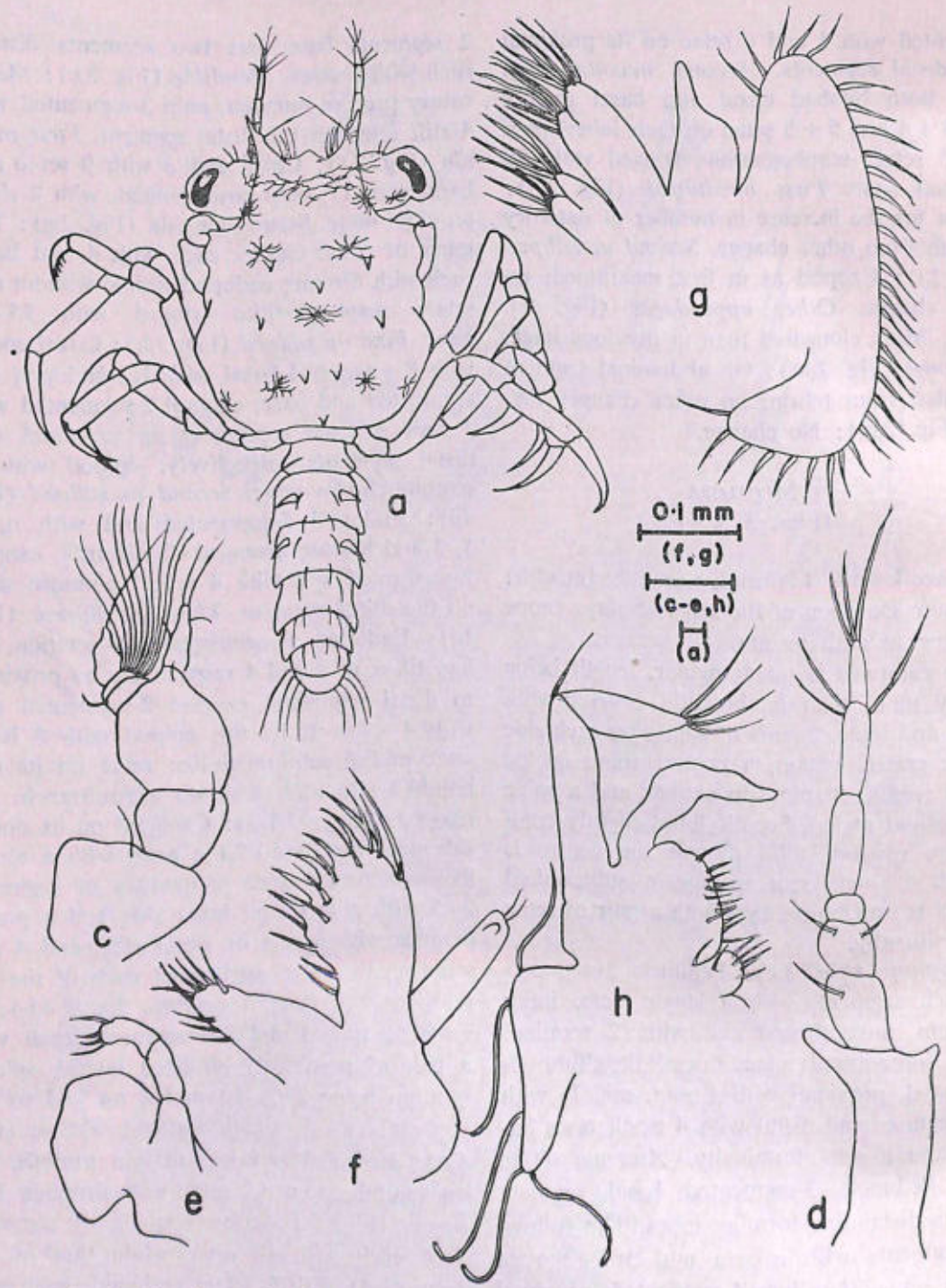

Fig. 3. Megalopa of *Schizophrys aspera* (H. Milne-Edwards): a. dorsal view of megalopa; c. antennule; d. antenna; e. mandible; f. first maxilla; g. second maxilla; h. first maxilliped.

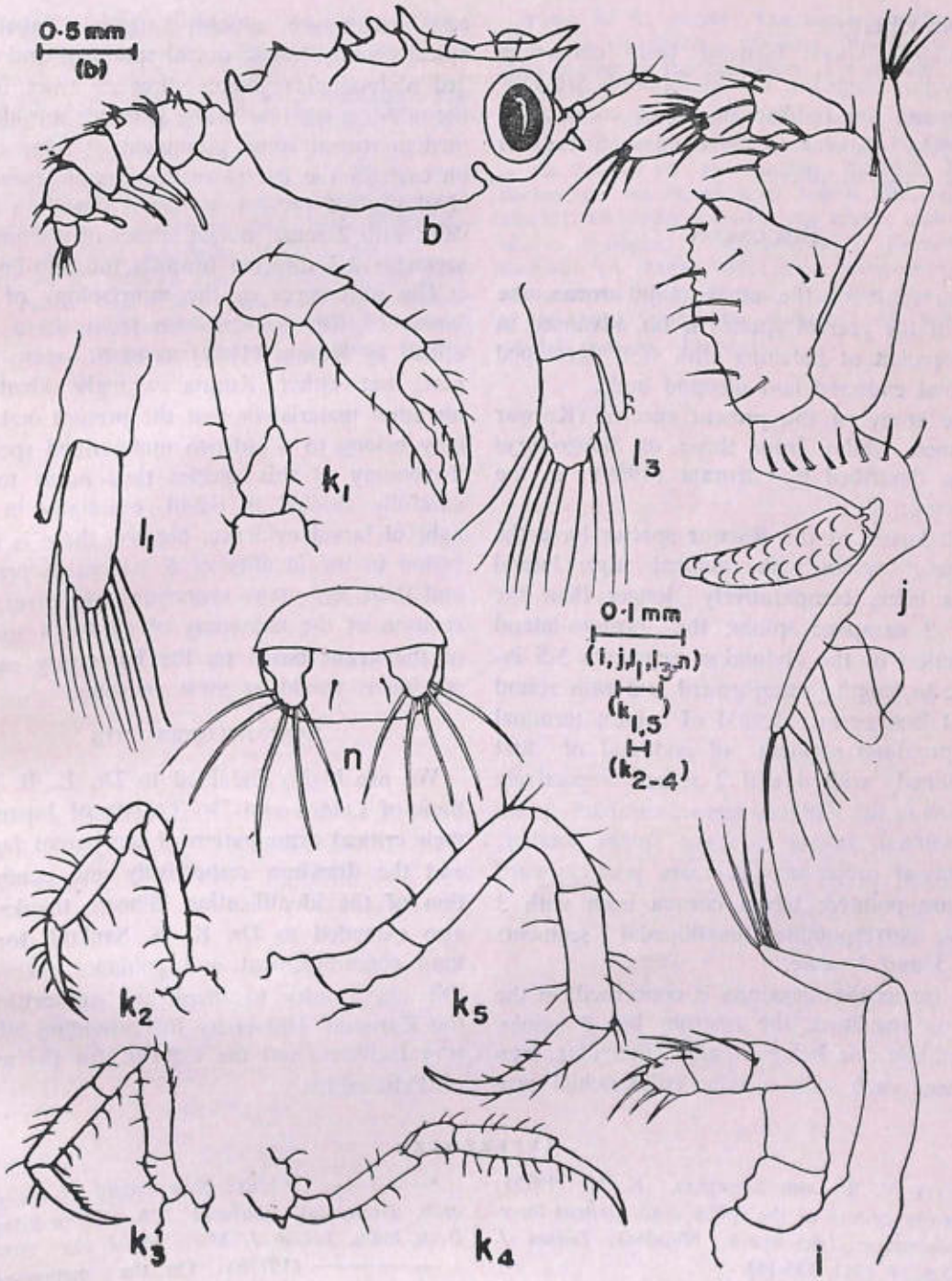

Fig. 4. Megalopa of *Schizophrys aspera* (H. Milne-Ewards): b. lateral view of megalopa; i. second maxilliped; j. third maxilliped; k_1. first pereiopod (cheliped); k_2. second pereiopod; k_3. third pereiopod; k_4. fourth pereiopod; k_5. fifth pereiopod; 1_1. first pleopod; 1_3. third pleopod; n. telson + uropod.

2 hooks distally.

Chromatophores: General body colour is light yellowish-green; chromatophores are reticulate and are reddish brown in colour. All pereiopod segments and pleopods with reddish brown chromatophores.

Discussion

Like most of the other majid zoeae, the zoea of the present species is far advanced in development at hatching with well developed antennal endopod and pleopod buds.

The zoeae of the present species (Karwar specimen)differ from those of *Schizophrys aspera* described by Kurata (1969) in the following:

The larvae of the Karwar species have the carapace spines with rounded tips; lateral spines being comparatively longer than the other 2 carapace spines; the postero-lateral projection of the abdominal segments 3-5 increase in length posteriorward and with round tips; telson cornua devoid of spines; terminal and proximal segment of endopod of first maxilliped with 4 and 2 setae respectively whereas in the Kurata's larvae, carapace spines are pointed; lateral carapace spines smaller; abdominal projections decrease posteriorward and are pointed; telson cornua each with 3 spines; corresponding maxillipedal segments with 5 and 3 setae.

As far as the megalopa is concerned, in the Karwar specimen, the rostrum has 3 spines, the middle one being broadly triangular, lateral ones each with a seta; epibranchial process of carapace absent; antennal flagellum apically with 3 setae; dorsal spines of 2nd and 3rd abdominal segments directed away from the mid-line whereas in the Kurata's megalopa, median rostral spine prominent; 2 setae each on each of the lateral rostral spines; epibranchial process present; antennal flagellum apically with 2 setae; dorsal spines of abdominal segments 2-3 directed towards the mid-line.

The differences in the morphology of the larvae of Karwar specimen from those described by Kurata (1969) as of *S. aspera* suggest that either Kurata wrongly identified his adult material or that the present material may belong to a hitherto undescribed species. Taxonomy of this species thus needs to be carefully studied in detail, especially in the light of larval evidence, because there is confusion in the identity of *S. aspera* at present and there are many synonyms. Moreover, the revision of the taxonomy of all the 3 species of the genus based on the laboratory reared specimens would be most welcome.

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• Kakati and Sankolli 1975a, unfortunately have overlooked the paper published by B. F. Chhapgar in the Journal of the Bombay Natural History Society, volume 58, no. 2, of August 1961, on pages 529-531. Chhapgar recorded the spider, crab *Acanthonyx limbatus* A. Milne-Edwards [—*Dehaanius limbatus* (A. Milne—Edwards)] from Port Okha in the above cited reference. Therefore, the priority of recording, *Dehaanius limbatus* (A Milne-Edwards) goes to Chhapgar.

RECORDS OF NYCTERIBIIDAE AND STREBLIDAE (DIPTERA, PUPIPARA) IN KARNATAKA, INDIA[1]

H. R. Bhat, M. A. Sreenivasan and
M. A. Ilkal[2]

During a survey of bats and their ectoparasites in the western part of Karnataka in connection with Kyasanur Forest disease epidemiological studies, 1921 specimens of Nycteribiid and Streblid flies were collected. These specimens represent 10 genera and 24 species. They are recorded here with notes on geographic range and host relationship.

Introduction

The available information on Indian Nycteribiids and Streblids is scattered and scanty, except for a small monograph on ectoparasites of bats from India by Hiregaudar and Bal (1956), which includes 16 species belonging to these two families, occurring in southern India.

The present communication deals with material collected during a survey of bats and their ectoparasites in connection with the serological studies on Kyasanur Forest disease. In all 1921 specimens (947 males and 974 females) were collected. They represent 10 genera and 24 species and are recorded with additional notes on geographic range and host relationships. Perhaps this is the largest collection of Nycteribiids and Streblids ever made in India.

The classification and nomenclature here are based on the system of Maa (1962, 1965, 1966, 1968 and 1969) and Theodor (1955, 1967, 1968a and 1968b).

The area covered during the survey includes Belgaum, Bijapur, Chitradurga, Coorg, Dharwar, Hassan, Shimoga, South Kanara and North Kanara districts of Karnataka State.

Material and Methods

The bats were collected by trapping them in mist nets or in sweep nets from their daytime roost or foraging areas. Whenever it was necessary they were also collected by shooting. They were killed with chloroform vapour, wrapped in white lint cloth and held for four to six hours to allow any live ectoparasites to detach. All the detached ectoparasites were collected and preserved in 70 per cent alcohol after identification.

Results—Records and Notes on Species

Family Nycteribiidae Westwood, 1840

Sufamily Nycteribiinae Westwood, 1840

Genus *Nycteribia* Latreille, 1796

Subgenus *Nycteribia* Latreille, 1796

1. **Nycteribia (Nycteribia) allotopa** Speiser, 1901

Material examined: 54 ♂♂, 42 ♀♀, all from *Miniopterus schreibersi*.

BELGAUM: 15 ♂♂, 9 ♀♀, removed from bats; 3 ♂♂, 3 ♀♀, from roost; Thigadi, respectively on 18.vi.71 and 5.viii.71. SHIMOGA: 2 ♂♂, 2 ♀♀, Kotipura, 22.viii.71. 14 ♂♂, 15 ♀♀; 20 ♂♂, 13 ♀♀; Kavaledurga, respectively on 18.ii.72 and 3.iv.72.

[1] Accepted July 1977.

[2] Virus Research Centre, Indian Council of Medical Research, Poona, India.

Notes: Originally described from 1 ♂ and 1 ♀, ex *M. schreibersi* collected at Lian Si Pache, W. Sumatra, subsequently recorded from India, Ceylon, Burma, Taiwan, Kiangsu, Moluccas, Philippines, China and Japan from the same host.

The colonies of *M. schreibersi* were also inhabited by other species of bats, but the parasite was not found on them.

2. **Nycteribia (Nycteribia) parvula** Speiser, 1901

Material examined: 73 ♂♂, 64 ♀♀, ex *M. schreibersi*, 1 ♂, ex *Rhinolophus lepidus*.

BELGAUM: 12 ♂♂, 13 ♀♀; 13 ♂♂, 6 ♀♀; Thigadi, respectively on 18.vi.71 and 5.viii.71. SHIMOGA: 29 ♂♂, 25 ♀♀, Kotipura, 22.vii.71. 13 ♂♂, 12 ♀♀; 6 ♂♂, 8 ♀♀; Kavaledurga, respectively on 18.ii.72 and 3.iv.72. 1 ♂, ex *R. lepidus*, Kavaledurga, 3.iv.72.

Notes: Originally described from 2 ♀♀ collected at Lian Si Pache, Sumatra, ex *M. schreibersi*. It has a common distribution range and host specificity with *N. allotopa*. Occurrence on *R. lepidus* is obviously as straggler, as it was cohabiting with *M. schreibersi*.

Genus *Stylidia* Westwood, 1840

3. **Stylidia ceylonica** Theodor, 1967

Material examined: 5 ♂♂, 5 ♀♀, ex *Hipposideros lankadiva*; 1 ♀, ex *Hipposideros speoris*.

NORTH KANARA: 2 ♂♂, ex *H. lankadiva*; 1 ♀, ex *H. speoris*, Gersoppa, 2.xi.71. 1 ♂, 4 ♀♀, ex *H. lankadiva*, Muroor, 31.v.71; 1 ♀, ex *H. lankadiva*, Nislneer, 22.iv.73. SOUTH KANARA: 2 ♂♂, 2 ♀♀, ex *H. lankadiva*, Kamalashile, 10.iv.73.

Notes: So far known only from Sri Lanka ex *H. lankadiva*. Occurrence on *H. speoris* appears to be a straggler as it was cohabiting with *H. lankadiva*.

4. **Stylidia phillipsi** (Scott, 1925)

Material examined: 40 ♂♂, 52 ♀♀, ex *Rhinolophus rouxi*; 1 ♂, ex *Hipposideros bicolor*.

SHIMOGA: 4 ♂♂, 7 ♀♀; 1 ♂, 4 ♀♀; Haravadike, respectively on 20.iii.68 and 18.vi.68. 1 ♂, 4 ♀♀, Nellikoppa, 20.iii.68. 3 ♂♂, 3 ♀♀, Thoragodu, 11.v.68. 3 ♂♂; 6 ♂♂, 4 ♀♀; 1♂, 3 ♀♀; 6 ♂♂, 2 ♀♀; 3 ♂♂, 3 ♀♀; Kasaraguppe, respectively on 23rd and 31.v.68, 13, 22 and 26.vi.68. 3 ♂♂, 7 ♀♀, Hale Ikkeri, 3.v.71. 4 ♂♂, 3 ♀♀, Gilalgundi, 14.vii.71. 1 ♀, Byrekoppa, 25.xi.71.

COORG: 3 ♀♀, Gadduge gate, 31.vii.71. N. KANARA: 1 ♀, Kagaal, 5.xi.71. 5 ♂♂, 7 ♀♀, Muroor, 29.iii.72. 1 ♂, ex *H. bicolor*, Muroor, 31.v.72.

Notes: The species has been recorded earlier from Ceylon and India ex *R. rouxi*. The record ex *H. bicolor* appears to be of a straggler, because the species was associated with *R. rouxi*.

5. **Stylidia** sp. 1

Material examined: 1 ♂, ex *R. lepidus*.

NORTH KANARA: 1 ♂, Muroor, 29.iii.72.

Notes: The species resembles *S. szechuana* (Theodor, 1954) closely.

6. **Stylidia** sp. 2

Material examined: 3 ♂♂, 17 ♀♀, ex *R. lepidus*, Kavaledurga, SHIMOGA, 3.iv.72. 2 ♀♀, ex *R. lepidus*, Kamalashile, SOUTH KANARA, 10.iv.73.

Genus *Basilia* Miranda Ribeiro, 1903

Subgenus *Basilia* Miranda Ribeiro, 1903

7. **Basilia (Basilia) majuscula** (Edwards, 1919)

Material examined: 24 ♂♂, 41 ♀♀, ex *Pipistrellus ceylonicus*.

BELGAUM: 1 ♀, Thigadi, 5.viii.71. BIJAPUR: 1 ♂, 1 ♀, Badami, 15.ix.71. CHITRADURGA: 1 ♂, 7 ♀♀, Chitradurga, 24.vi.71. DHARWAR: 3 ♂♂, 1 ♀, Kaginelli, 16.vii.71; 6 ♂♂, 6 ♀♀, Uppinbetegeri, 4.viii.71; 2 ♀♀, Amminbhavi, 4.viii.71; 1 ♂, 1 ♀, Nargund, 13.ix.71. HASSAN: 1 ♂, 4 ♀♀, Banavara, 28.vii.71. SHIMOGA: 4 ♂♂, 1 ♀, Ikkeri, 9.vii.71; 7 ♂♂, 17 ♀♀, Sagar, 11.v.72.

Notes: Earlier recorded from India, Java, Sumatra and Philippines ex *Pipistrellus* spp. The Indian form was originally described as *B. scotti* Hiregaudar and Bal, 1956 and was later synonimised with *B. majuscula* by Theodor, 1967.

8. **Basilia (Basilia)** sp.

Material examined: 7 ♂♂, 12 ♀♀, ex *Myotis peshwa*, Vakkund, BELGAUM, 19.vi.71.

Notes: The species comes close to *B. nana* Theodor and Moscana, 1954.

Subgenus *Paracyclopodia* Scott, 1917

9. **Basilia (Paracyclopodia) roylii roylii** (Westwood, 1835)

Material examined: 10 ♂♂, 23 ♀♀, ex *Scotophilus temmincki*.

SHIMOGA: 2 ♂♂, 4 ♀♀, Sagar town, 11.v.72. NORTH KANARA: 8 ♂♂, 19 ♀♀, Nagire near Gersoppa, 4.xi.71.

Notes: Recorded from India, Ceylon, Burma and Malaya. Recorded hosts are *Scotophilus* spp., *Hesperotenus tickelli*, *Tylonycteris pachypus*, *Megaderma lyra* and *Pipistrellus coromandra*.

Subgenus *Tripselia* Scott, 1917

10. **Basilia (Tripselia) blainvillii amiculata** (Speiser, 1907)

Material examined: 1 ♂, 1 ♀, ex *Taphozous longimanus*, Ikkeri, SHIMOGA, 30.xii.71.

Notes: Earlier records are from India, Burma, Ceylon, Borneo and Sumatra ex *Taphozous* spp.

Genus *Penicillidia* Kolenati, 1863

Subgenus *Penicillidia* Kolenati, 1863

11. **Penicillidia (Penicillidia) indica** Scott, 1925

Material examined: 29 ♂♂, 23 ♀♀, ex *M. schreibersi*.

BELGAUM: 2 ♂♂, 8 ♀♀, Thigadi, 18.vi.71. SHIMOGA: 2 ♂♂, 2 ♀♀, Kotipura, 22.vii.71. 20 ♂♂, 6 ♀♀; 5 ♂♂, 7 ♀♀; Kavaledurga, respectively on 18.ii.72 and 3.iv.72.

Notes: Earlier records are from India ex *M. schreibersi* and Ceylon ex *M. schreibersi* and *P. ceylonicus*.

12. **Penicillidia** sp.

Material examined: 1 ♂, 1 ♀, ex *R. lepidus*, Muroor, N. KANARA, 29.iii.72.

Subfamily Cyclopodiinae Theodor, 1967

Genus *Eucampsipoda* Kolenati, 1857

13. **Eucampsipoda latisterna** Schuurmans Stekhoven, 1938

Material examined: 169 ♂♂, 126 ♀♀, ex *Rousettus leschenaulti* and 1 ♂, ex *H. lankadiva*.

SHIMOGA: 6 ♂♂, 7 ♀♀; 4 ♂♂, 3 ♀♀; Nadakalasi, respectively on 7.ii.68 and 1.vii.71. 11 ♂♂, 16 ♀♀, Horabail, 17.ii.68. 6 ♂♂, 7 ♀♀, Mungarvalli, 21.ii.68. 1 ♂, 3 ♀♀, Heggodu (Sorab), 9.iii.68. 1 ♂, 2 ♀♀, Patresalu, 22.iii.68. 17 ♂♂, 15 ♀♀, Ikkeri, 16.vi.71. 3 ♂♂, 2 ♀♀, Mundigesara, 10.ix.71. 6 ♂♂, 5 ♀♀; 18 ♂♂, 7 ♀♀; Kangodu, respectively on 10.ix.71 and 15.x.71. 7 ♂♂, 6 ♀♀; 12 ♂♂, 7 ♀♀; Harogoppa, respectively on 27.x.71 and 18.xi.71. 4 ♂♂, 3 ♀♀, Bileyur, 19.xi.71. 9 ♂♂, 5 ♀♀, Bandagadde, 17.xi.71. BELGAUM: 3 ♂♂, 3 ♀♀, Thigadi, 21.vi.71. NORTH KANARA: 34 ♂♂, 23 ♀♀, Kagaal, 8.xi.71, 12 ♂♂, 8 ♀♀; 15 ♂♂, 4 ♀♀; Muroor, respectively on 7.iv.72 and 31.v.72. 1 ♂, ex *H. lankadiva*, Muroor, 31.v.72.

Notes: Originally recorded under *Eucampsipoda hyrtlii* ex *R. leschenaulti* from Orissa, Assam and Bombay in India; ex *R. seminudus* and *Tylonycteris pachypus* from Sri Lanka and from a cave in Thailand. The record from *H. lankadiva* is apparently of a straggler.

14. **Eucampsipoda sundaica** Theodor, 1955

Material examined: 59 ♂♂, 37 ♀♀, ex *Eonycteris spelaea* and 1 ♂, 1 ♀, ex habitat of the same species in association with *R. leschenaulti*; 1 ♀, ex *H. speoris* from the same habitat.

NORTH KANARA: 24 ♂♂, 15 ♀♀; 17 ♂♂, 13 ♀♀; 12 ♂♂, 6 ♀♀; Nislneer respectively on 8.xi. and 10.xii.72 and 10.i.73. 1 ♂, 1 ♀, from habitat on 8.xi.72. 6 ♂♂, 3 ♀♀; Muroor, 1.i.73. 1 ♀, ex *H. speoris*, Nislneer, 30.xi.73.

Notes: The species has been recorded ex *C. sphinx* from Madras, ex *Pteropus* from Burma, in a cave from Thailand, ex *E. spelaea* from Malaya and Sumatra ex *Rousettus amplexicaudatus* and *E. spelaea glandifera* from Philippines, Mindanao and Palwan (Theodor 1955 and 1967; Maa 1962). Recently the species was also recorded ex *E. spelaea* from Kumaon hills in the western Himalayas (Bhat and Kulkarni 1974).

Genus *Cyclopodia* Kolenati, 1863
Subgenus *Cyclopodia* Kolenati, 1863

15. **Cyclopodia (Cyclopodia) sykesii** (Westwood, 1835)

Material examined: 8 ♂♂, 12 ♀♀, ex *Pteropus giganteus*, Kumsi, SHIMOGA, 9.xi.71.

Notes: Recorded from several localities in India, Sri Lanka and Burma ex *Pteropus giganteus*. There is a single record from China. It may be mentioned here that *Cyclopodia kalyania* Chaudhari and Mitra, 1965 is a synonym of *C. sykesii* according to Maa (1968).

Genus *Leptocyclopodia* Theodor, 1959
Subgenus *Leptocyclopodia* Theodor, 1959

16. **Leptocyclopodia (Leptocyclopodia) ferrarii ferrarii** (Rondani, 1878)

Material examined: 16 ♂♂, 7 ♀♀, ex *Cynopterus sphinx*.

SHIMOGA: 2 ♂♂, Nadakalasi, 18.ii.68. 1 ♂, 1 ♀, Lingadahalli (Chipli), 9.ii.68. 2 ♂♂ Horabail, one each on 17.ii.68 and 30.v.68. 1 ♂, 2 ♀♀, Hennegere, 5.iii.68. 1 ♀, Sagar, 1.vii.71. 3 ♂♂, Kangodu, 15.x.71. 3 ♂♂, 2 ♀♀; 4 ♂♂, 1 ♀; Harogoppa, respectively on 27.x.71 and 18.xi.71.

Notes: Earlier records are ex *C. sphinx* from several localities in India and one record ex *Megaderma lyra;* ex *C. brachyotis* and *C. sphinx* from Ceylon; ex *C. sphinx* from Thailand; ex *C. brachyotis* from Malaya, Sumatra and Borneo; ex *C. horsfieldi* from Java; and also recorded in Vietnam, Cambodia ex undet. hosts.

Family STREBLIDAE Kolenati, 1863
Subfamily Brachytarsinae Maa, 1965
Genus *Megastrebla* Maa, 1971
Subgenus *Megastrebla* Maa, 1971

17. **Megastrebla (Megastrebla) parvior parvior** Maa, 1962

Material examined: 17 ♂♂, 17 ♀♀, ex *R. leschenaulti;* 24 ♂♂, 16 ♀♀, ex *E. spelaea;* and 1 ♀, ex *H. speoris*.

NORTH KANARA: 2 ♂♂, 1 ♀; 1 ♂, 7 ♀♀; 12 ♀♀, 8 ♀♀; ex *R. leschenaulti*, Muroor, respectively on 8.xi.71, 31.v.72 and 3.vi.72. 24 ♂♂, 16 ♀♀, ex *E. spelaea*, 1 ♀, ex *H. speoris* from common habitat at Nislneer, 30.xi.73. SHIMOGA: 2 ♂♂, ex *R. leschenaulti* Kangodu, 15.x.71. 1 ♀, Harogoppa, 27.x.71.

Notes: The species was originally recorded under the name *Nycteribosca gigantea* (syn: *Brachytarsina gigantea*) (Jobling, 1934) which is apparently restricted to the bat genus *Dobsonia* (Maa, 1962) in New Guinea, New Britain and Solomon Islands. The species is described under the present name *parvior* by Maa (1962) on the basis of material collected in Sumba ex *R. amplexicaudatus* and in Malaya ex *Hipposideros* sp. and Batu caves, probably inhabited by *Eonycteris spelaea*. Recently the species was transferred under the present genus by Maa (1971).

Genus *Brachytarsina* Macquart, 1851

18. **Brachytarsina amboinensis** (Rondani, 1878)

Material examined: 50 ♂♂, 79 ♀♀, ex *M. schreibersi*.

BELGAUM: 7 ♂♂, 6 ♀♀; 4 ♂♂, 5 ♀♀; Thigadi, respectively on 18.vi.71 and 5.viii.71. SHIMOGA: 9 ♂♂, 20 ♀♀; Kotipura, 22.vii.71. 18 ♂♂, 20 ♀♀; 12 ♂♂, 28 ♀♀; Kavaledurga, respectively on 18.ii.72 and 3.iv.72.

Notes: According to the available records the species has a geographic range from India to Ryukyu Island, New Caledonia and New South Wales. It occurs chiefly on *Miniopterus*. Occassionally it has also been recorded from *Eonycteris, Rousettus, Rhinolophus* and *Hipposideros*. The records on these species are apparently of stragglers due to the cohabitation of different bat species in the same habitat.

19. **Brachytarsina cucullata** (Jobling, 1934)

Material examined: 3 ♂♂, 8 ♀♀, ex *Taphozous melanopogon*.

BIJAPUR: 2 ♂♂, 7 ♀♀, Badami, 14.ix.71. HASSAN: 1 ♂, 1 ♀, Halebid, 1.viii.71.

Notes: Originally described upon a male ex *T. melanopogon* from Sri Lanka. It has

been recorded from Mindanao ex *T. melanopogon* and *C. brachyotis*, and from Malaya ex *T. melanopogon*.

20. **Brachytarsina modesta** (Jobling, 1934)

Material examined: 17 ♂♂, 31 ♀♀, ex *R. lepidus;* and 28 ♂♂, 30 ♀♀, ex *R. rouxi.*

NORTH KANARA: ex *R. lepidus*, 3 ♂♂, 5 ♀♀ Muroor, 29.iii.72. Ex *R. rouxi*: 14 ♂♂, 7 ♀♀, Muroor, 29.iii.72. 10 ♂♂, 5 ♀♀, Gokarn, 30.v.72. SHIMOGA: ex *R. lepidus*: 1 ♀, Jog, 5.i.72. 12 ♂♂, 21 ♀♀, Kavaledurga 3.iv.72. Ex *R. rouxi*: 1 ♀, Haravadike, 18.vi.68. 11 ♀♀, Ikkeri, 3.v.71. 4 ♂♂, 6 ♀♀, Gilalagundi, 14.vii.71. SOUTH KANARA: 2 ♂♂, 4 ♀♀, ex *R. lepidus*, Kamalashile, 10.iv.73.

Notes: First described by Jobling ex *R. rouxi* from Sri Lanka and subsequently the species was recorded in India from the same species of bat (Hiregaudar and Bal 1956).

21. **Brachytarsina pygialis** (Jobling, 1934)

Material examined: 19 ♂♂, 40 ♀♀, ex *H. lankadiva* and 2 ♀♀ ex *H. speoris.*

BELGAUM: 1 ♂, 1 ♀, Thigadi, 18.vi.71. CHITRADURGA: 1 ♀, Chandravalli, 25.vi.71. HASSAN: 7 ♀♀, Banavara, 28.vii.71. NORTH KANARA: ex *H. lankadiva*: 3 ♂♂, 5 ♀♀; 2 ♂♂, 1 ♀; Gersoppa, respectively on 15.iii.71 and 2.xi.71. 10 ♂♂, 15 ♀♀, Muroor, 31.v.72. Ex *H. speoris*: 2 ♀♀, Gersoppa, 15.iii.71. SOUTH KANARA: 3 ♂♂, 10 ♀♀, ex *H. lankadiva*, Kamalashile, 10.iv.73.

Notes: Originally described on specimens collected ex *H. lankadiva* from Sri Lanka. From the present record it appears to be associated with *H. lankadiva*. Record from *H. speoris* is apparently of stragglers due to cohabitation of the bats.

Genus *Raymondia* Frauenfeld, 1856

22. **Raymondia joblingi** Hiregaudar and Bal, 1956

Material examined: 45 ♂♂, 56 ♀♀, ex *R. rouxi* and 2 ♂♂, 2 ♀♀, ex *R. lepidus.*

COORG: 3 ♂♂, 3 ♀♀, Gadduge Gate, 31.vii.71. NORTH KANARA: 3 ♀♀, Kagaal, 5.xi.71. 5 ♂♂, 4 ♀♀, Muroor, 29.iii.72. 18 ♂♂, 21 ♀♀, Gokarn, 30.vi72. SHIMOGA: 1 ♀, Haravadike, 20.iii.68. 1 ♀, Thoragodu, 11.v.68. 1 ♂, 1 ♀; 2 ♂♂, 4 ♀♀; 1 ♂; Kasaraguppe, respectively on 31.v, 13.vi, 26.vi. 68. 1 ♂, 10♀♀, Ikkeri, 3.v.71. 13 ♂♂, 6 ♀♀, Gilalagundi, 14.vii.71. 1 ♂, 2 ♀♀, Byrekoppa, 25.xi.71. Ex *R. lepidus*: 2 ♂♂, 1 ♀, Jog falls, 5.i.72. 1 ♀, Kavaledurga, 3.iv.72.

Notes: First described from India ex *R. rouxi* by Hiregaudar and Bal (1956). Appears to be associated with *R. rouxi*. *R. lepidus* and *R. rouxi* are commonly found in association with each other.

23. **Raymondia molossa** (Giglioli, 1864)

Material examined: 211 ♂♂, 206 ♀♀, ex *Megaderma lyra.*

SHIMOGA: 14 ♂♂, 11 ♀♀, Gilalagundi, 14.vii.71. 6 ♀♀, Bileyur, 19.xi.71. 42 ♂♂, 29 ♀♀, Gavatoor near Ripponpeth, 2.xii.71. 15 ♂♂, 18 ♀♀, Kudroor, 9.xii.71. 35 ♂♂, 35 ♀♀, Kangodu, 1.ii.72. 54 ♂♂, 56 ♀♀, Uddri, 26.v.72. 27 ♂♂, 28 ♀♀, Bandalike, 26.v.72. NORTH KANARA: 24 ♂♂, 23 ♀♀, Banavasi, 17.vi.71.

Notes: The species has been recorded from Sri Lanka and India under the name *R. lobulata* (Speiser, 1900) by Jobling (1930). Consequently the species is designated as *R. molossa* comb. nov. by Maa (1969).

24. **Raymondia pagodarum** Speiser, 1900

Material examined: 26 ♂♂, 19 ♀♀, ex *Hipposideros* spp.

DHARWAR: 4 ♂♂, 4 ♀♀, ex *H. bicolor*, Uppinbetgeri, 4.viii.71. 1 ♂, 2 ♀♀, ex *H. bicolor*, Nargund, 13.ix.71. NORTH KANARA: 1 ♂, 6 ♀♀, ex *H. bicolor*, Gokarn, 30.v.72. 15 ♂♂, 5 ♀♀, ex *H. speoris*, Muroor, 29.iii.72. 5 ♂♂, 2 ♀♀, ex *H. lankadiva*, Muroor, 31.v.72.

Notes: The species has been recorded from *Hipposideros* spp. and *Rhinolophus* spp. from India, Sri Lanka, Burma, Southeast Asia and Pacific Islands.

DISCUSSION

A total number of 24 species of bats have been collected during the survey. Sixteen species of them had one or more species of pupiparan parasites and eight of them did not yield any pupiparan parasite. The details of host

Host-Parasite List

Rousettus leschenaulti	*Eucampsipoda latisterna*
	Megastrebla parvior parvior
Pteropus giganteus	*Cyclopodia sykesii*
Cynopterus sphinx	*Leptocyclopodia ferrarii ferrarii*
Eonycteris spelaea	*Eucampsipoda sundaica*
	Megastrebla parvior parvior
Rhinopoma hardwickei	—
Taphozous longimanus	*Basilia blainvillii amiculata*
Taphozous melanopogon	*Brachytarsina cucullata*
Taphozous theobaldi	—
Taphozous kachhensis	—
Megaderma spasma	—
Megaderma lyra	*Raymondia molossa*
Rhinolophus rouxi	*Stylidia phillipsi*
	Brachytarsina modesta
	Raymondia joblingi
Rhinolophus lepidus	*Nycteribia parvula* (straggler?)
	Stylidia sp. 1 (straggler?)
	Stylidia sp. 2
	Penicillidia sp.
	Brachytarsina modesta
	Raymondia joblingi
Rhinolophus luctus	—
Hipposideros speoris	*Stylidia ceylonica* (straggler?)
	Brachytarsina pygialis
	Raymondia pagodarum
	Eucampsipoda sundaica (straggler?)
	Megastrebla parvior parvior (straggler?)
Hipposideros lankadiva	*Stylidia ceylonica*
	Eucampsipoda latisterna (straggler?)
	Brachytarsina pygialis
	Raymondia pagodarum
Hipposideros bicolor	*Stylidia phillipsi* (straggler?)
	Raymondia pagodarum
	Basilia sp.
Myotis peshwa	—
Pipistrellus coromandra	*Basilia majuscula*
Pipistrellus ceylonicus	—
Tylonycteris pachypus	*Basilia roylii roylii*
Scotophilus temmincki	*Nycteribia allotopa*
Miniopterus schreibersi	*Nycteribia parvula*
	Penicillidia indica
	Brachytarsina amboinensis
Kerivoula picta	—

and parasite associations are presented in the accompanying list. Among the species found negative included a few specimens of *Taphozous theobaldi, Rhinolophus luctus, Pipistrellus coromandra, Tylonycteris pachypus* and *Kerivoula picta;* and more than a dozen specimens of each of the *Rhinopoma hardwickei, Taphozous kachhensis, Megaderma spasma.*

India has a representation of more than a hundred species of bats. Approximately 40 species have been recorded from the present study area. The present sample includes 24 common species. Others are apparently rare or more cryptic in their habit.

A more intensive survey of bat parastites is necessary to have a comprehensive list of Indian bat pupipara.

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A CONTRIBUTION TO THE ORNITHOLOGY OF THE RISHI GANGA VALLEY AND THE NANDA DEVI SANCTUARY

T. M. REED[2]

(With two text-figures)

The Nanda Devi Sanctuary, Garhwal Himalaya, Uttar Pradesh was visited by a party from Cambridge University June-August 1977. Observations were made of the birds around Joshimath, on the trek to and from the Sanctuary & within the Sanctuary. Details are given for the vegetation and birds of the area. 93 species were seen; some are new records for the area, some are extensions beyond documented altitudinal ranges.

The Rishi Ganga is a tributary of the Dhauli Ganga, draining the Nanda Devi sanctuary area of the Garhwal Himalaya (Fig. 1). The river, which has cut a gorge several thousand feet in depth, is rarely visited: the only visitors being international climbing expeditions which pass through the gorge to reach their base camps. So far no details have been published on either the fauna or flora of the area, except Lavkumar's observations around Joshimath (Lavkumar 1956).[3] The present paper is an attempt to partially remedy this state of affairs by detailing the birds seen in the Sanctuary, on the walks in and out, and for the short period spent in the town of Joshimath prior to the visit to the Sanctuary.

The Sanctuary (Fig. 2), a high level, mountain girt, basin at 13,000-14,000 feet is reached by a nine day trek starting from Lata village. The trek crosses several small ranges thereby avoiding the very difficult section of the lower Gorge. The path eastwards into the basin passes through a variety of vegetation types.

Above Lata village oak changes quickly into a mixture of deodar and blue pine, the only open areas being clearings fired for grazing. The path from Belta Karak to Lata Karak involves a rapid ascent through lichen draped deodar and pine. From this stage onward undergrowth is typically sparse or absent, shrubs only found where soils are either too shallow or unstable for tree growth. The forest then changes to a dense rhododendron forest by 12,000 feet, which itself gives way to alpine meadows. The meadows are dominated by the colourful annuals of the Rosacae family.

The meadows pass quickly into montane grassland with tufted grasses, lichens and squat evergreen shrubs. The grasslands are grazed as far as Dibrugheta by summer flocks from Lata village. In this high area, with passes at 15,000 feet, there are few birds to be seen except for an occasional Impeyan pheasant *Lophophorus impejanus*, wren *Troglodytes*

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[3] Some more data on the fauna has been procured by Mr. Lavkumar during his WWF-sponsored reconnaisance of the Nanda Devi Sanctuary in May-June 1977.

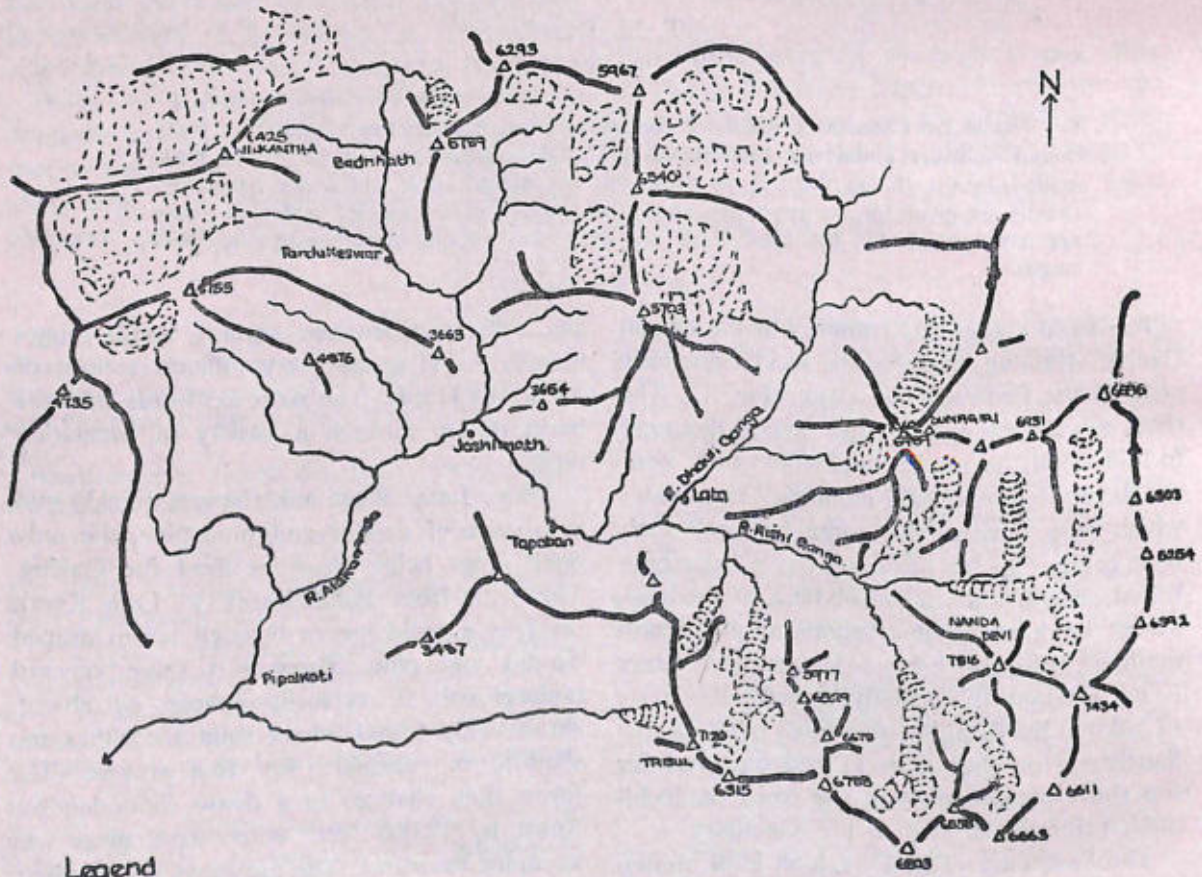

Fig. 1. Nanda Devi sanctuary area of the Garhwal Himalaya.

troglodytes or pipit *Anthus* spp.

A rapid descent from the mountain ridge passes through a zone of alpine flowers, then a belt of scrub and birch *Betula utilis* before returning to the wet forest surrounding the camp of Dibrugheta. The forest here is slightly drier than on the other side of the range, a trend that continues into the Gorge and Sanctuary. This desiccation is progressive, since, as more and more obstacles bar the way that main monsoon winds are quickly drained of much of their load. By the time the monsoon winds reach the Sanctuary the rain is light and in small amount compared to the start of the trek.

From Dibrugheta the path to Deodi climbs back up to the grassland, undulating up and down before finally returning to the coniferous forest. It is noticeable that deciduous trees dominate only the ravines and their immediate surrounds, conifers dominating all other areas below the tree line.

The walk to Ramani is through an admix of rhododendron and birch before returning to pines which dominate beyond the Trisul river, only reverting to birch on the outskirts of the camp area. Beyond Ramani there is little or no tree cover, what there is mainly birch in the base of the gorge, along its tributaries or in inaccessible clefts. The dominant vegetation slowly changes to a sparse cover of montane grasses and squat Ericacae. Only towards the margins of the Sanctuary does scrub juniper *Juniper communis* appear and quickly becomes the dominant cover. By the time the Sanctuary is reached, at the confluence of the Rishi Gangas, the soil is noticeably dry with aromatic herbs present in large numbers for the first time. The two branches of the Rishi Ganga are very similar. In each there is a dominant juniper cover which gives way altitudinally to grasses, prone mosses and lichens, and on riverine soils to annual herbs and dwarf willow *Salix* spp. Both valleys are blocked by glaciers. The woody vegetation extends along the sides beyond the tongue of the glacier before changing slowly to squat alpines and finally to lichens.

The observations listed below were made by members of the Cambridge Garhwal Himalaya expedition in the period early July to late August 1977. Due to pressure of time, and the vagaries of the monsoon, observations on the walks in and out of the Sanctuary were rather brief. By far the largest period of observation was carried out in the Base Camp valley (North Rishi Ganga) and on the slopes of the surrounding peaks.

The valley is surprisingly rich in birds; 43 species being identified, with many of these close to or beyond documented altitudinal limits. The major stronghold is the scrub juniper. In the juniper were warblers *Phylloscopus* spp., Rubythroats *Erithacus pectoralis*, Grosbeaks *Mycerobas* spp., Redstarts *Phoenicurus* spp., and Rose Finches. The other main habitats used by birds were scrub willow and areas of grass and rock debris.

A number of species were observed breeding until the second week of August when there were great numbers of fledglings about. The first movements out of the valley were taking place by the third week of August. During this period several species, previously absent were observed moving down-valley, being first observed high up on the mountain sides and on the glacier margins. Species such as the hoopoe *Upupa epops* and warblers had presumably come over the adjacent divide from Tibet before descending down the Rishi Ganga en route to lowland wintering quarters.

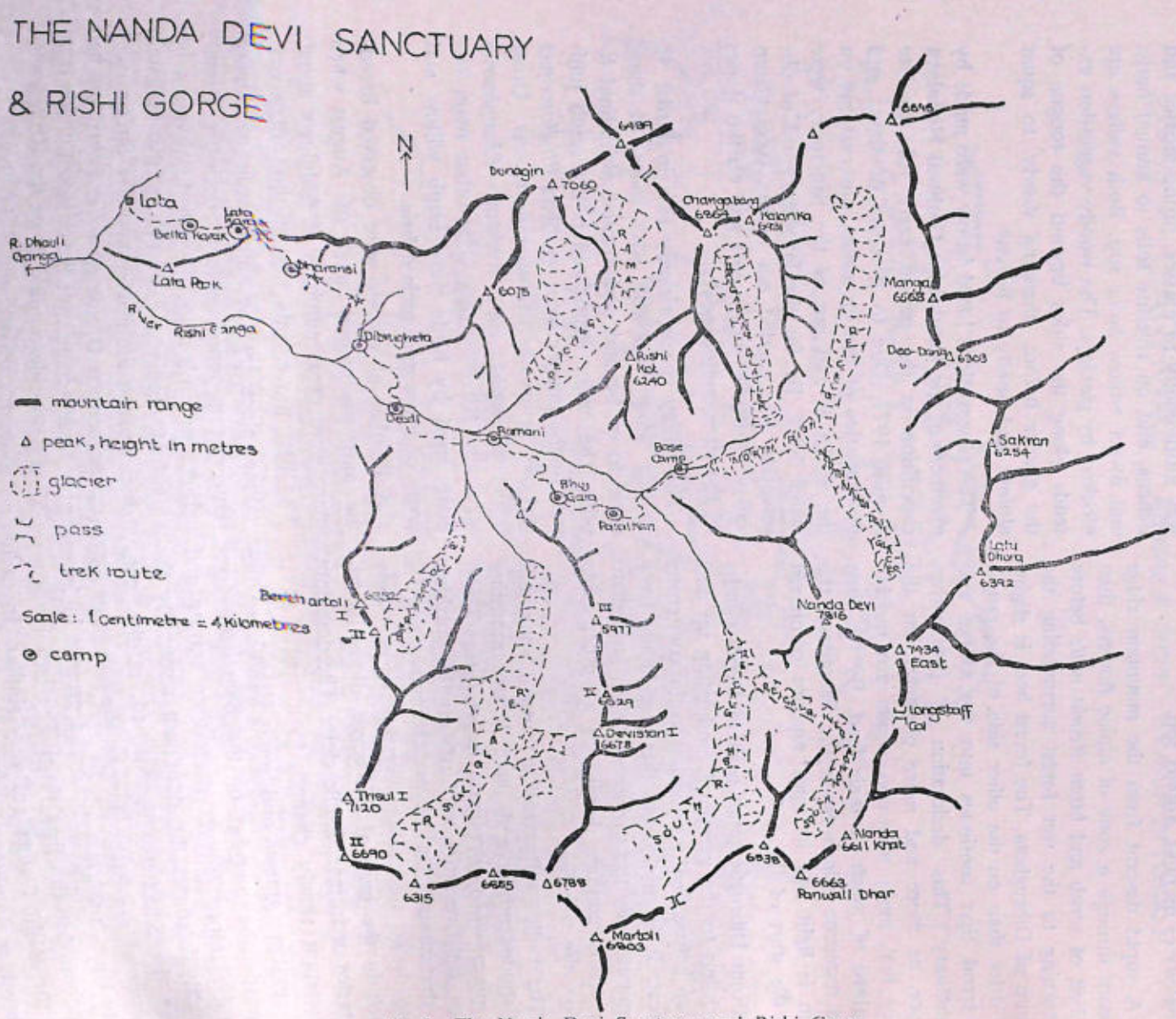

Fig. 2. The Nanda Devi Sanctuary and Rishi Gorge.

List

Anser spp. Geese. A skein seen flying at about 24,000 feet near a col on Nanda Devi.

Milvus migrans Black Kite. Several seen in the vicinity of Joshimath. Very infrequent compared to Lavkumar's notes 1956.

Aquila chrysaetos Golden Eagle. A single adult above Lata village. Two further adults seen in the Sanctuary at Patalkan (15,400 feet). A single bird observed near the Changbang base camp. An adult was mobbed by 150 chough *Pyrrhocorax* spp. on the bluffs above base camp.

Aquila nipalensis Steppe Eagle. A single bird circling just above the forest margins at Joshimath.

Aegypius monachus Black Vulture. A pair circling in the valley between Bhuj Gara and Ramani.

Gyps himalayensis Himalayan Griffon Vulture. Common on thermals above Joshimath. Adults and juveniles seen together below the town. Several on most days above base camp, occasionally mobbed by Redbilled chough *Pyrrhocorax pyrrhocorax*.

Gyps bengalensis Whitebacked Vulture. A single bird above Joshimath.

Neophron percnopterus Egyptian Vulture. Four to five adults and juveniles were commonly seen flying the length of the Joshimath valley.

Gypaetus barbatus Lammergeier or Bearded Vulture. Up to three seen together in the Base camp valley, with one occasion of two adults and a juvenile flying along the bluff-line. An adult bird was observed 'bone dropping' for a period of fifteen minutes. The bird carried a pelvic bone aloft, circled, dropped the bone from a height of 300 feet then swung down to collect the bone before repeating the performance. The process was carried out five times before the bone was sufficiently fractured. Before each drop the bird completed an average of two circles to gain sufficient height.

Falco peregrinus Peregrine Falcon. A single bird stooping on a finch in the valley below Lata village.

Falco tinnunculus Kestrel. Up to two in the Base camp valley. On one occasion a single bird mobbed by ten chough. Also seen at Joshimath.

Lerwa lerwa Snow Partridge. A single bird at 15,500 feet in Base Camp valley giving an alarm call.

Tetraogallus tibetanus Tibetan Snow Cock. An adult and four fledglings at 16,500 feet.

Lophophorus impejanus Impeyan pheasant. Three flew from cliffs near Lata Karak, calling vociferously as they descended.

Lophura leucomelana Kalji Pheasant. A pair in the forest near Belta Karak.

Columba leuconota Snow Pigeon. Several pairs in the Base Camp valley. Birds commonly seen in ones or twos. One individual roosted for most of the day on a river cliff.

Columba rupestris Hill Pigeon. Two seen, one of which was crossing a mountain ridge at 17,000 feet.

Columba livia Blue Rock Pigeon. Single birds seen flying in the lower Rishi Gorge. Not noted beyond Deodi. Absent in the Joshimath region.

Collocalia brevirostris Edible-nest Swiftlet. A single bird above the forest at Joshimath.

Upupa epops Hoopoe. A single carrying food at Joshimath. Not noted in the Sanctuary until the end of August, when numbers were seen descending the valley, being noted first high on the mountains above the glacier line. They had probably crossed the mountain range from Tibet.

Picoides macei Fulvousbreasted Pied Woodpecker. Three on a dead tree in mixed forest above Joshimath.

Delichon urbica House martin. Small flocks of up to 20 around cliffs at 15,000 feet on August 1. Three broods on overhanging cliff face at Bhuj Gara being fed on August 26.

Lanius schach Rufousbacked shrike. A single bird on telegraph lines at Joshimath and one between Lata and Joshimath.

Oriolus oriolus Golden Oriole. A single male on a wall at 7,000 feet.

Oriolus traillii Maroon Oriole. In forests near Belta.

Acridotheres tristis Common Myna. Common in Joshimath but few compared to lower altitudes. A single bird mobbed a kestrel at Joshimath.

Pyrrhocorax pyrrhocorax Redbilled Chough & **P. graculus** Yellowbilled Chough. First seen in the Rishi Gorge at Ramani. Found singly or in flocks in the Sanctuary. Flocks built up from the single numbers of the early morning into flocks of up to 150 by late afternoon. 'Play parties' were usually mixed and led by *P. pyrrhocorax*.

Corvus macrorhynchos Jungle Crow. Many in and around Joshimath wheeling in thermals. Also in the fields around Lata.

Corvus corone Carrion Crow. A pair above the alpine meadow flying towards a cliffline at Dibrugheta.

Corvus corax Raven. Single bird around Joshimath and Lata.

Pericrocotus ethologus Longtailed Minivet. Several in a mixed flock of minivets in the forest above Joshimath. Also seen above Lata and near Deodi.

Pericrocotus solaris Yellowthroated Minivet. Several in a mixed flock above Joshimath.

Pericrocotus roseus Rosy Minivet. Several in a mixed flock above Joshimath.

Pycnonotus leucogenys Whitecheeked Bulbul. In open scrub in a clearing in the forest above Joshimath and in scrub between Lata and Joshimath.

Hypsipetes madagascariensis Gray Bulbul. A single bird on telegraph lines in Joshimath.

Heterophasia capistrata Blackcapped Sibia. A single bird followed by a party of Sibias in the forest above Joshimath.

Muscicapa latirostris Brown Flycatcher. A single bird was caught during ringing work in the Base Camp valley.

Muscicapa westermanni Little Pied Flycatcher. A single male in the forest above Joshimath.

Muscicapa thalassina Verditer Flycatcher. A pair on the forest margins at Joshimath.

Rhipidura hypoxantha Yellowbellied Fantail Flycatcher. A pair in pine trees above Dibrugheta camp.

Rhipidura albicollis Whitethroated Fantail Flycatcher. A single bird near Deodi in pine forest.

Phylloscopus affinis Tickell's Leaf Warbler. Present and nesting in good numbers in the Sanctuary in July and August. Nests predominantly in scrub juniper, dwarf spiked shrubs or occasionally in willow. A single bird was caught and ringed. It raised a brood of four from a nest in a bush two feet above the ground. First movements out of the valley began in the second week of August when there were large numbers of juveniles being fed.

Phylloscopus fuligiventer Smoky Leaf Warbler. Two seen in the Base Camp valley in river side scrub.

Phylloscopus trochiloides Greenish warbler. Seen moving down the Sanctuary in mixed warbler flocks in the third week of August.

Abroscopus superciliaris Yellowbellied warbler. A single bird in the forest above Joshimath.

Regulus regulus Goldcrest. In pine and birch forest between Deodi and Ramani at 12,000 feet.

Erithacus pectoralis Himalayan Rubythroat. Two pairs in the Base Camp valley. Immature birds seen being fed in the third week of August.

Erithacus chrysaeus Golden Bush Robin. Seen in scrub at Dibrugheta.

Phoenicurus caeruleocephalus Bluefronted Redstart. Two pairs in the area of burnt juniper scrub near the expedition base camp, with a further pair towards the glacier margins.

Phoenicurus ochruros Black Redstart. Two pairs seen in the Base Camp valley. One nest found in a tributary ravine. Also a pair observed feeding young on the moraine near the snout of Changabang glacier.

Phoenicurus erythrogaster Güldenstädt's Redstart. A male on scree near Changabang moraine.

Chaimarrornis leucocephalus Whitecapped Redstart. Common on all running water above 8,000 feet. Two to three pairs in the Base Camp valley with distinct territorial battles. A nest found 18 feet above the river overhung by grass, and made of dead grass and sedges. Both parents, attended the nest, the male being the more regular of the two.

Rhyacornis fuliginosus Plumbeous Redstart. A male and female on a moraine by the North Rishi Glacier.

Enicurus scouleri Little Forktail. A single bird on boulders in a ravine near Deodi, standing bobbing its tail.

Enicurus maculatus Spotted Forktail. Single birds at Belta, Deodi and Dibrugheta.

Sexicota torquata Stone Chat. Several in scrubby vegetation on the outskirts of Joshimath.

Monticola rufiventris Chestnutbellied Rock Thrush. A pair in oak forest above Joshimath.

Monticola solitarius Blue Rock Thrush. Single birds in a field outside Joshimath and in the Sanctuary at 16,000 feet.

Myiophoneus caeruleus Whistling thrush. On most streams. Commonly seen from Ramani upwards. Song heard from high above the river.

Turdus boulboul Greywinged Blackbird. A pair feeding young in a nest in a rock cleft in scrub on the forest margins above Joshimath.

Turdus merula Blackbird. A single male sitting on a bush near Lata.

Troglodytes troglodytes Wren. Common in scree areas, on cliffs and crags up to 16,000 feet. Much darker than the European form.

Cinclus pallasii Brown Dipper. Seen on the Trisul and North Rishi Ganga rivers. Also noted on a braided section of the Changabang outwash river.

Prunella collaris Alpine Accentor. On bare rocks above the tree line at Dibrugheta. Also a single bird on scree above the base camp.

Prunella strophiata Rufousbreasted Accentor. Two singles seen hopping amongst rocks and herbs on a damp riverside fan in the Base Camp valley.

Prunella atrogularis Blackthroated Accentor. Two in field near Lata.

Prunella immaculata Maroonbacked Accentor. Single birds in fields near Joshimath.

Parus monticolus Greenbacked Tit. Seen in Single bird in fields near Joshimath.

Parus ater Coal Tit. In forest above Joshimath and in a mixed flock at Lata Karak. Also one in pines at 13,000 ft in the Gorge.

Parus rufonuchalis Simla Black Tit. In conifers at Dibrugheta.

Parus modestus Yellowbrowed Tit. In forest above Joshimath.

Tichodroma muraria Wall Creeper. Several seen in the Base Camp valley either on river cliffs or feeding on high turf and scree fields.

Certhia familiaris Northern Tree Creeper. Single birds seen in the oak and pine forest above Joshimath and at 13,000 feet in the Gorge.

Certhia himalayana Himalayan Tree Creeper. A single bird in the forest at 8250 feet.

Anthus hodgsoni Hodgson's Tree Pipit. In low vegetation in the Base Camp valley.

Anthus sylvanus Upland Pipit. Several seen at 13-14,000 feet working over morainic vegetation.

Anthus roseatus Rosebreasted Pipit. Adult observed feeding a fledgling near base camp.

Motacilla alba Pied Wagtail. One or two occasionally seen in the vicinity of the glacier snout.

Passer domesticus House Sparrow. Common around buildings in Joshimath.

Mycerobas affinis Allied Grosbeak. A single male working through low forest cover in the forest above Joshimath.

Mycerobas carnipes Whitewinged Grosbeak. Occasionally seen in the Base Camp valley. A pair observed feeding in juniper scrub at 14,500 feet was joined by a further bird. Single males and females seen foraging at lower heights.

Carduelis spinoides Himalayan Goldfinch. Common in fields and gardens around Joshimath.

Acanthis flavirostris Tibetan Twite. Single birds seen in and around base camp.

Leucosticte nemoricola Hodgson's Mountain Finch. Single birds seen in a ravine in the Base camp valley on two separate occasions, flitting from rock to rock and ledge to ledge, with a further pair in the vicinity of the Changabang Base Camp.

Carpodacus erythrinus Common Rosefinch. Pairs seen frequently in the valley.

Carpodacus nipalensis Nepal Rosefinch. Pair in junipers at 14,000 feet.

Carpodacus rubicilloides Eastern Great Rosefinch. A male and also a pair seen infrequently in the valley.

Carpodacus puniceus Redbreasted Rosefinch. Male observed in juniper and on rhubarb plants.

Propyrrhula subhimachala Juniper Finch. Two pairs seen near base camp with the males frequently observed disputing territory from juniper or willow song posts.

Emberiza cia Rock Bunting. Several pairs in the valley. Secretive but approached close to the camp. Also noted at Deodi and Dibrugheta.

Emberiza fucata Greyheaded Bunting. A male was seen for a ten minute period in fields outside Joshimath and flushed several times. A male was also observed in a bush on a field boundary at Lata.

Melophus lathami Crested Bunting. Several seen at Deodi.

REFERENCE

LAVKUMAR, K. S. (1956): A contribution to the ornithology of Garhwal. *J. Bombay nat. Hist. Soc.* 53 (3) 315-29.

URBANIZATION IN NEST BUILDING OF INDIAN HOUSE CROWS (*CORVUS SPLENDENS* VIEILLOT)[1]

RUDOLF ALTEVOGT[2] AND T. A. DAVIS[3]

(*With sixteen figures*)

Regarding the normal type of nest (-building) in the Indian house crow, one finds the statement by Sálim Ali (1972), that the "nest (consists of) a platform of twigs frequently intermixed with iron wire, with a cup-like depression lined with tow, coir fibre, etc., 10 feet or more up in a tree, sometimes several nests in the same tree...The koel commonly lays its eggs in crows' nests" (p. 91).

In 1927, E. H. Aitken reported that "in April and May crows make nests of sticks and line them with coir, or horsehair abstracted from a mattress, or even with soda-water wire stolen from the butler's little hoard. In these they bring up three or four callow criminals in their own image" (p. 61).

While this statement by EHA refers to the fancy city of Dustipore, probably a rural site in Northern India, the same author relates the crow situation in Bombay as follows: "In Bombay the crow population has multiplied to such an extent of late years that the competition for nesting materials has become terrible. In Marine Lines, as the season advances, the crows patrol the road or the garden walks, waiting for sticks to fall, or they get up into the trees and tug at twigs which are still green and will not come off. It is not many years since a pair living in the Fort discovered a real El Dorado in an optician's shop. They worked at that mine so stealthily and cleverly that before they were discovered they had succeeded in abstracting about Rs. 400 worth of spectacle frames which they had worked up into a very superior nest, combining durability and lightness like a "helical tube". The Museum of the Bombay Natural History Society contains a ponderous nest made entirely of iron wire, taken apparently from the ruins of railway fences" (p. 122, 2. edition). From a statement by Sálim Ali, the editor of the 3-edition in 1947, it can be gathered that this EHA-statement refers to about 1905 (the 2-edition featuring no year of publication). In 1947, Sálim Ali quotes from "The Birds of Bombay and Salsette" (by S. Ali and H. Abdulali) that "crows nesting on the overhead wire carriers of the newly electrified suburban section of the...railway (in 1922) held up the trains by the iron wire used as building material causing short circuit. A new type of insulated bracket had to be devised specially to overcome this unforeseen nuisance".

There are a few further notes on this peculiar habit of wire nesting in Indian crows (Hume, 1889; Dewar, 1929; Baker, 1932; Lamba, 1963), Indian doves (Walsh, 1924), Indian bulbuls (Lamba, 1968), and the latest report by Lamba (1976) states that "dry, usually thorny sticks are picked up from under the trees, hedges around the fields and farms,

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and from the firewood-piles of poorer people. If fallen sticks are not readily available, twigs are wrenched off the trees. Occasionally metal strips and wires are also brought in for incorporation in the outer framework".

In the non-Indian crows, this wire-nidification seems to be quite an exception: only Walford (1931) and De Vries (1953) report of *Corvus c. corone*, in two nests of which apart from rabbit bones ("a whole set of ribs being fixed in on one side") mainly steel wire had been used. One nest weighed 1845 g (quoted from Melde, 1969). Still, the nest found by Walford "was heavily lined with wool".

Apparently, since these earlier reports the situation in the big cities of India has changed as far as *Corvus splendens* is concerned, and it is for this reason that the following notes, observations and preliminary data are reported here. Moreover, apparently no numerical considerations have been done on the physical properties of crows' wire nests. We plan to extend our studies throughout other regions of India in the near future.

When visiting Calcutta or Bombay, one is struck by the fact that hundreds of nests of *Corvus splendens* are based on electric posts in crowded streets (fig. 1). Most of these nests are built exclusively or partly with metallic wire and pieces of flat sheet. A variety of nesting sites can be noticed, the street lamp probably being the most familiar and most often used. Sign boards on buildings, window sills, between cornices of residential buildings, on the posts supporting power lines of electric trains, on the ceiling of railway station platforms (Howrah!) and waiting halls are some other colonized sites (fig. 2).

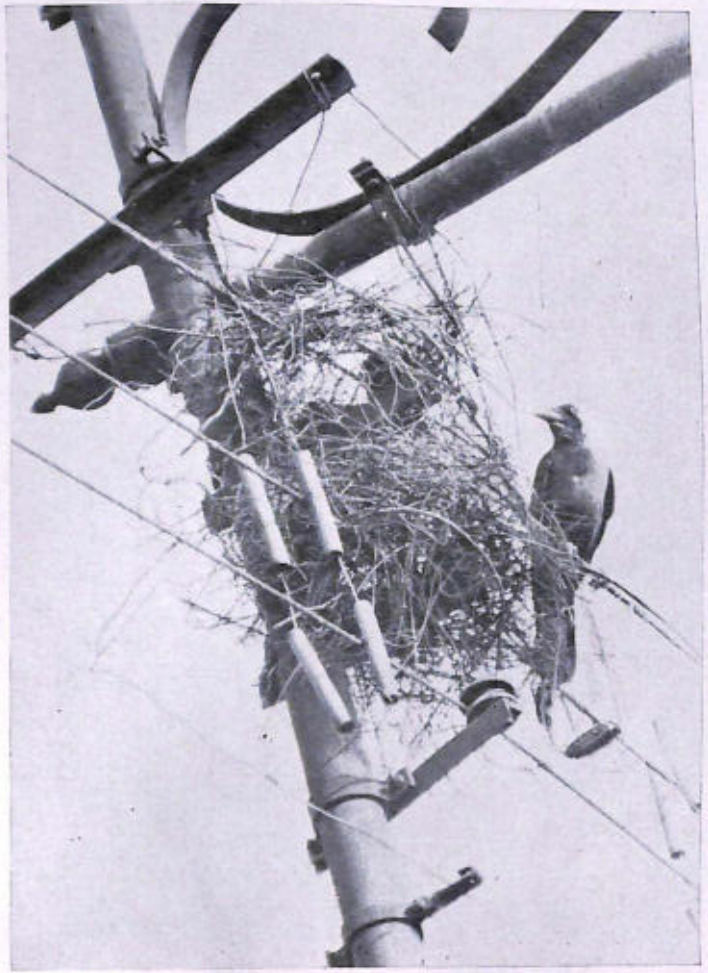
Sometimes many crows compete for one favourable site: on top of a five-storeyed building on the side of a busy road (Barrackpore Trunk Road) an illuminated signboard attracts four to five pairs of crows every year fighting for possession of this site. Ultimately, they compromise, each pair sharing a portion, and they make a sort of a community nest (fig. 3).

In some of the road-crossings in Calcutta, mercury lights on tall posts (fig. 4) have just been introduced. The different hands starting from the terminal of the post slant upwards providing a safe platform for the crow to establish a nest between them. On ordinary lamp posts, nests are built where there are some joints or projections. In such positions, it is not possible to establish twigs, but thin wire, already bent or twisted by the crow itself (fig. 5), is suitable for founding a nest. There is, however, no difficulty to establish a metal nest on trees because of their branching nature: from one large mango tree (*Mangifera indica*) growing in the heart of Calcutta, adjoining the offices of the Reserve Police at Baranagar, twentyfour nests were collected, all built mostly or exclusively with metal (fig. 6).

Normally in rural areas, the house crow builds nests with only dry twigs which may include dry, sharp and branched brambles. The bird also makes a cup inside the nest and lines it with fibre of pliable twigs (fig. 7). Seldom it uses rags and grass blades (see also the above quotations by earlier authors). The nesting season of *Corvus splendens* in the north-eastern parts of India begins in February and extends upto June, after which the heavy monsoon starts.

The use of wire and/or other types of metal depends mostly on the locality and availability of such material. Apparently, however, also a learning process in the sense of handing over the metal habit from crow to crow is concerned. Crows in general do not fetch their

Above: Fig. 1. Wire-nest of *Corvus splendens* in a busy street in Calcutta. *Below*: Fig. 3. Close-up view of the Indian house crow's work: wire and wood in a community nest.



Left: Fig. 2. Detail of wire-nest of *Corvus splendens*.
Right: Fig. 6. Metal nests on a dead tree.

nesting material from long distances (see also Kuhk 1931, Wittenberg 1963, and Melde 1969). While wire seems to be handled effectively though laboriously, other odd-shaped metal objects cannot make a firm and uniform-sized nest. Thicker wires are avoided because they are too heavy to be carried upwards and perhaps because the bird cannot give it the necessary shape. It is surprising, however, that some crows have a fascination for aluminium shirt hangers even though their wires are too thick for the bird to bend. Such hangers were collected by a friend in South Calcutta from a nest founded on the roof of his house (fig. 8).

Some metal nests were pulled down in 1974, but during the 1975 breeding season at most of those sites new nests of approximately the same weight were rebuilt. The following materials were recorded from metal nests:

1) Dry twigs and brambles at varying proportions;

2) Inner cup made of thin shoots and vegetable fibres (fig. 9);

3) Iron wire, often rusted, pliable and of a particular thickness (ranging between 1.5 and 2.0 mm). The preferred wire is usually 25-30 cm long, each weighing not more than 30 grams (fig. 10);

4) Thin strips of metal, perforated flat sheets, grills, expanded metal, springs, coils, discs, cycle pedals, and even aluminium shirt hangers.

Table 1 gives some information on ten nests built entirely with metallic wire. The nests are arranged in descending order of weight. The weight of a nest varied from about 1 kg to more than 6 kg. The number of wires per nest ranged from 91 to 644. There was a proportional range in the total length of wire per nest which was between 43.76 m and 265.32 m. The wires did not vary much in thickness (table 1). These ten nests were collected from a locality covering a distance of one kilometre.

The data on the number, weight and cumulative length of the wire for the ten nests are given in fig. 11. Excepting for a deviation in nests 3 and 4 which had a proportionately greater number of wires than the others, there is a good correlation between the number weight and length of wire in all nests. This again suggests the homogeneity of the nesting

TABLE 1

NESTS OF *Corvus splendens* BUILT COMPLETELY OF WIRE

Nest	Total weight (kg)	Number of wires	Total length of wire (m)	Mean thickness of wire (mm)
1	6.145	644	265.32	1.77
2	4.894	458	218.94	1.81
3	4.466	497	198.14	1.76
4	4.327	569	209.26	1.80
5	2.690	296	116.97	1.75
6	2.689	288	123.69	1.84
7	2.511	275	99.69	1.68
8	1.910	213	85.00	1.83
9	1.618	187	70.29	1.57
10	1.071	91	43.76	1.69

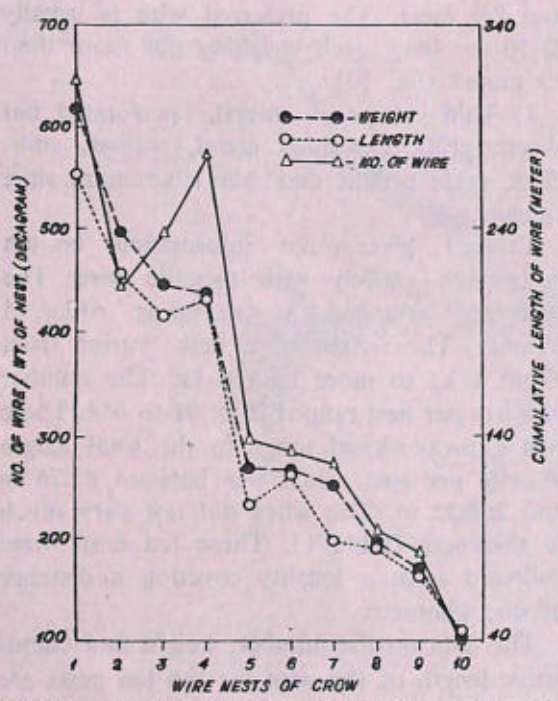


Fig. 11. Number of wires, their weight and cumulative length in 10 pure wire-nests of *Corvus splendens*.

material used. In fig. 12, the frequency distribution of the wire used in nest number 1 from table 1 for their length and weight is shown. While for the majority of the wire the weight is about 10 g, the length ranges from 10 cm to 120 cm with a mode at 30 cm. The longer wires are usually thinner as the bird seems to fix up its limit at 30 g as the weight it can reasonably carry.

Data on four mixed nests gathered from localities about 5 km away from the first one are given in table 2.

These four nests were marked by the presence of twigs and inner fibrous lining. All these nests also had wire. Where more twigs are used, proportionately less metal is supplemented. Flat metals of various size and shape have been used in only two nests. Incidentally, these two nests were pulled down in yet another locality. There are several small workshops in this locality, making small utility articles and toys out of thin metal sheets. Thus, instead of wire, only cut pieces of metallic sheets are available here. Some nests contained a few animal bones, coir rope and clay tea cups.

In another 28 nests of *Corvus splendens* from Calcutta taken in 1975, the following constituents were found (table 3).

In nests 5, 8 and 13, the cup was lined with soft fibre. In nest 7, there was a piece of tyre about 2 cm × 1 cm × 5 cm. Nest 21 had a piece of rope weighing about 10 g.

In some parts of Calcutta and Bombay one

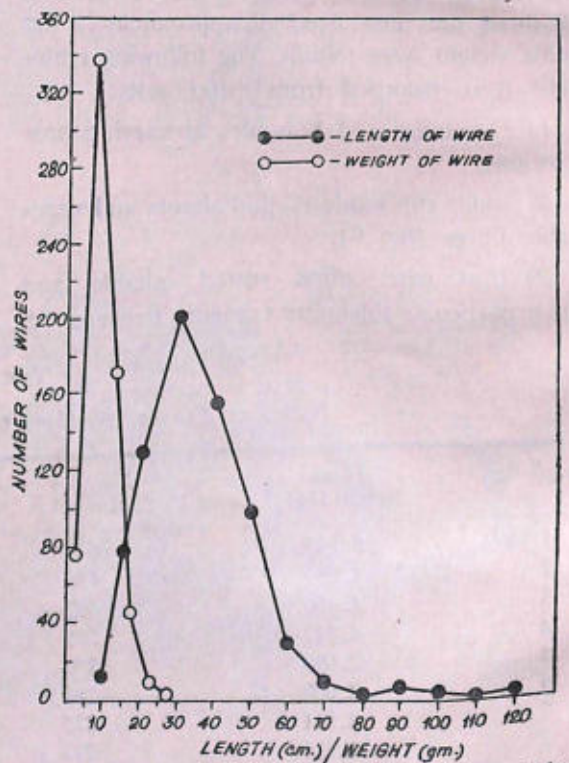
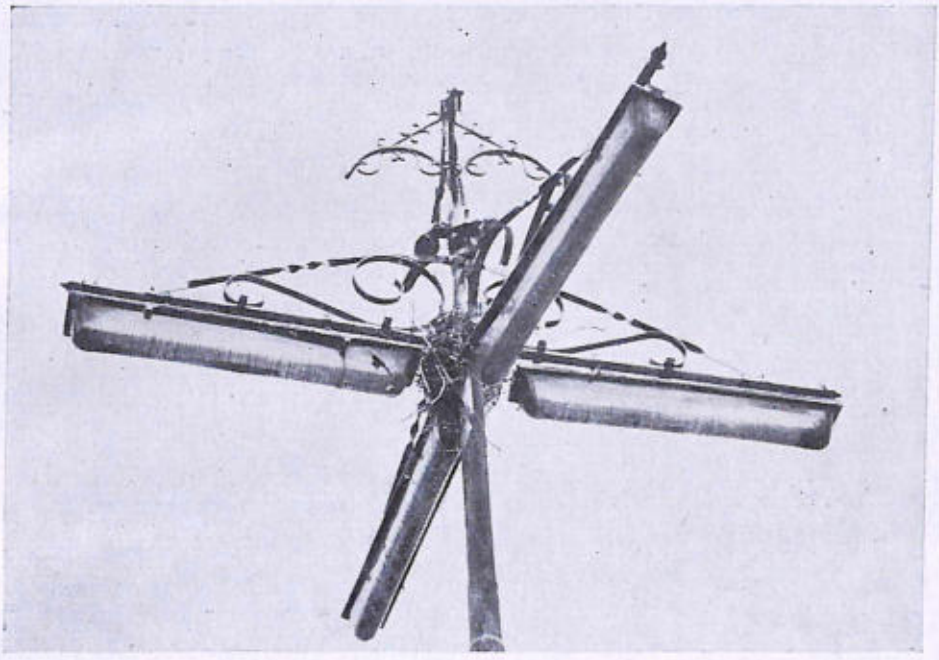
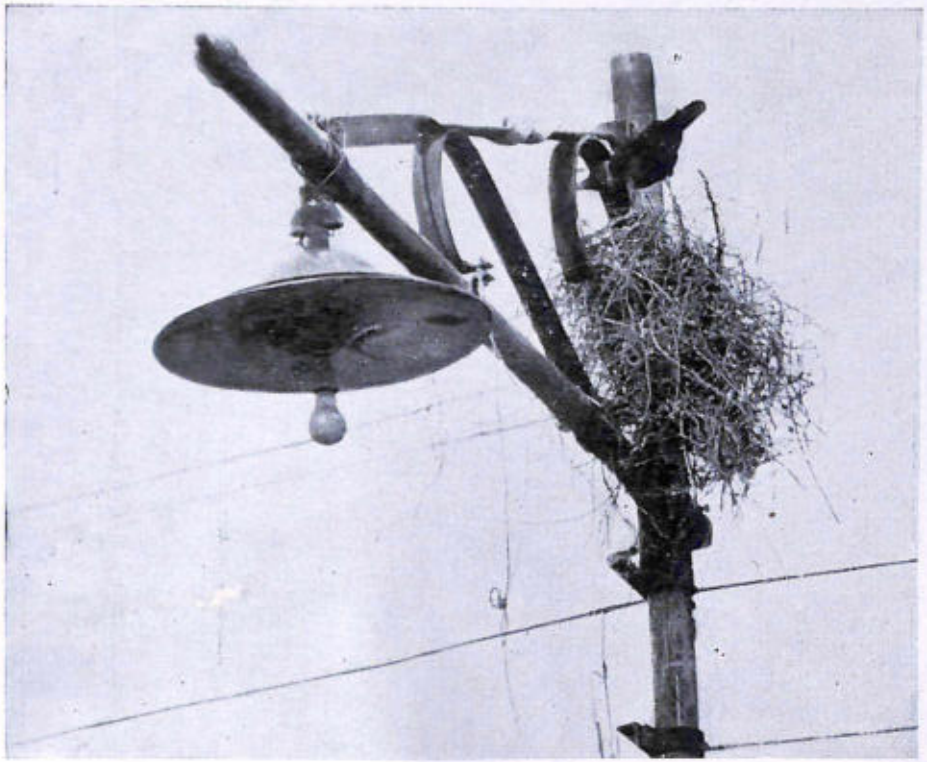


Fig. 12. Frequency distribution of length and weight of wire used by Indian house crows (pure wire-nests).



Above: Fig. 4. Starting a wire-nest on top of a multi-mercury lamp post. *Below*: Fig. 7. "Normal" nest of *Corvus splendens* with egg-cup lined with plant material.



Left: Fig. 5. On ordinary lamp posts, joints and projections initiate wire nidification.
Right: Fig. 16. A well-lit wire-nest means extended and easier scavenging even after dark.

TABLE 2

NESTS OF *Corvus splendens*: WEIGHT OF CONSTITUENTS OF MIXED NESTS (g)

Nest	Twigs	Inner cup of fibre	Rope	Iron wire	Flat metal small	large	Others	Total weight
1	350	185	—	250	—	—	210	995
2	325	190	—	230	—	—	—	745
3	90	—	30	450	385	160	—	1115
4	45	—	65	765	510	675	—	2060

TABLE 3

DETAILS OF NESTING MATERIALS OF *Corvus splendens* FROM CALCUTTA (IN g)

Nest	Total weight	Wire	Flat iron strips	Flat grills	Springs	Wood	Flexible wire
1	8300	8200	80	—	—	20	—
2	7900	7700	150	—	—	50	—
3	5300	4950	200	—	100	50	—
4	5100	4550	350	200	—	—	—
5	4600	3950	—	150	300	200	—
6	4500	4280	—	180	—	20	20
7	4500	3950	—	350	—	150	50
8	3500	3300	—	—	180	20	—
9	3500	3000	500	—	—	—	—
10	3400	3150	—	—	—	250	—
11	3300	3000	250	50	—	—	—
12	3200	2500	500	200	one long umbrella spoke was used		
13	2800	2300	300	—	50	150	—
14	2700	2600	50	—	—	50	—
15	2500	2300	—	200	—	—	—
16	2200	2000	200	—	—	—	—
17	2000	1850	50	100	—	—	10
18	2000	1600	150	—	—	250	—
19	1700	1700	—	one shirt hanger was used in the nest			
20	1600	1350	—	—	—	250	—
21	1500	1430	—	—	50	—	—
22	1300	800	500	—	—	—	—
23	1200	1180	—	—	—	—	20
24	1100	990	10	50	—	—	20
25	1100	930	100	—	—	—	20
26	800	800	—	incomplete nest		—	—
27	800	800	—	incomplete nest		—	—
28	700	700	—	incomplete nest		—	—

finds crows' nests almost completely built of twigs and natural fibres while in others pure metal nests seem to be the rule. This finding suggests population differences in nidification brought about by the gradual spreading of this habit from individual to individual in the sense of a "tradition" (similar to the titmice of London opening the caps of the milk bottles or the habit of food washing in Japanese macaques).

There is also a pseudo-social trait in this expanding habit of metal nidification: due to the super-annual stability and durability of the metal nests, fairly often two nests, quite apart in the first year, tend to be enlarged the following year thus "growing" into the close neighbourhood of each other (fig. 13) until finally they unite, hence forming a community nest. In such nests, sometimes proper brooding is hardly or not all possible (figs. 14, 15), and yet these nests have successful breeding. A striking example of this type of construction is presented by the "sharing nest" from Barrackpore Trunk Road/Calcutta mentioned above. When pulled down in 1974, the entire nest, completely metal, weighed 25 kg. During the 1975 season also, a multi-nest of almost the original size was made, but could not be weighed. It was striking that no lining with organic material for the egg-cup was provided in any part of the community nest. In fact, because of the lack of a regular cup for laying eggs, eggs from two nests were found to lie side by side.

There are some consequences in the context of the metal nidification habit which deserve mentioning:

1) Making a more permanent, super-annual nest of great stability means reduction of labour and saving time (which is obviously used in the urbanized crows for extensive preening and lazying about near the nest). Wooden nests deteriorate within one monsoon season and have to be rebuilt;

2) Protecting the eggs and young from overheating because the wire-nest is more efficiently aerated than the nest made of organic material. No necessity for the parent birds to carry cooling water to the nest (as, for instance in *Vanellus malabaricus* and other birds);

3) Possibly making use of the solar energy for partial incubation of the eggs for which the metal nest is a necessity (and comes in handy due to its preferred site on human constructions like posts, buildings etc., without much shade);

4) Metal nests have the additional advantage of enabling the parents to incubate the eggs during the warm day time, for at such a weather most of the Indian birds avoid brooding over the eggs;

5) Utilizing more advantageous siting niches where the use of wood as nesting material is impracticable;

6) Placing the wire-nests on or near lamp posts (fig. 16) means extension of time for scavenging and collecting food even at night. Crows pouncing on not properly packed food and food material carried by lorries and on bus tops are a common sight in Calcutta, even after dark.

There is one possible disadvantage for the crows in that due to the thermal conductivity of metal, the naked nestlings could be affected by the hot wires. Another disadvantage concerns man: Due to the nidification ingenuity of the Indian house crow in urban areas, now and then a power cut is caused especially in the rainy season by the crows' wire-nests short-circuiting the overhead power lines. There is evidence that crows at the suburbs of Calcutta and Bombay are gradually switching

Above: Fig. 8. Wire-nest of Indian house crow featuring an aluminium shirt hanger (Calcutta). *Below*: Fig. 13. Neighbouring wire-nests tend to unite in next year's nidification period.

Above: Fig. 9. Mixed nest: wire construction with inner cup of plant material.
Below: Fig. 10. Pure wire-nest.

Above: Fig. 14. Eggs of three pairs of crows in a community nest (mixed nest). *Below*: Fig. 15. Even in a mixed nest, proper brooding over the eggs is often hardly possible.

over to the new technique of utilizing metal instead of wood in nest building, thus providing an example of urbanization in birds.

Summary

1. In large cities like Calcutta, Dacca and Bombay the Indian house crow (*Corvus splendens*) is increasingly building its nest fully or partially with metallic wire, strips and odds of flat sheets, grills and expanded metal thus relinquishing the ancient habit of building nests entirely of plant twigs and brambles. Compared to the "normal" nest, the metallic construction is stabler and hardly affected by the monsoon climate, hence being utilized again the next year(s). Such nests tend to be enlarged year upon year and confluate to form community nests for several pairs of crows.

2. The advantages of wire nidification are:

a) Utilization of nesting sites where the use of wood as nesting material is impracticable (lamp posts, sign boards, window sills etc.).

b) Super-annual nests mean reduction of labour and saving time which is used for other activities.

c) Protection of eggs and young from overheating by better aeration of the wire-nest: hence no necessity of cooling by the parents.

d) Enabling the parents to incubate the eggs during the warm day time (in "normal" nests most Indian birds do not brood over the eggs during the noon heat).

e) Possibly making use of the solar energy for partial incubation, the preferred nesting site often being unshaded.

f) Placing wire-nests on or near lamp posts means extended time for scavenging even after dark.

3. From 42 nests ranging from pure metal to mixed constructions numerical data were collected. The heaviest metal nest weighed more than 6 kg, the heaviest mixed construction more than 8 kg, while one community nest (metal) housing 5 pairs of crows weighed 25 kg. The number of wires per nest were between 644 and 91 with a cumulative length of 265-91 m per nest, wires of 120-10 cm were taken with a mode of 30 cm being most frequently used. The average thickness of the wire was between 1.5 and 1.8 mm.

Apart from wire, the most conspicuous nest material were two non-pliable aluminium shirt hangers.

4. There is evidence that the wire nesting is spreading in Calcutta, Dacca, and Bombay which is understood as a process of urbanization.

Acknowledgement

We thank Mr. S. K. De, Artist, at the Indian Statistical Institute for preparing the graphs.

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BREEDING AND DEVELOPMENT OF *RANA CYANOPHLYCTIS* SCHNEIDER

P. MOHANTY-HEJMADI AND SUSHIL K. DUTTA[2]

(With five text-figures)

The breeding habits and development of the Skipper frog *Rana cyanophlyctis* Schneider were observed in the populations under natural conditions as well as laboratory maintained ones. Data collected on the development under natural conditions and the development of artificially inseminated laboratory raised tadpoles, showed that in both cases maximum growth in terms of weight and length, occurred during premetamorphic stage. A dramatic decrease, approximately 32% loss in weight and 67% loss in length, occured during the "metamorphic climax" when the tadpole changed into a froglet.

INTRODUCTION

The commonest of Indian Ranidae, the Skipper frog *Rana cyanophlyctis* Schneider is widely distributed over India. They are found in ponds, water reservoirs, ditches and rain water puddles. An excellent description of their habits has been given by Daniel (1975). This study was undertaken to record the breeding habits and development of the Skipper frog found in plenty in Bhubaneswar, Orissa, (Mohanty-Hejmadi 1977 a).

MATERIALS AND METHODS

Observations on breeding behaviour was done in the Vani Vihar, Utkal University Campus area from January till December, 1976. Tadpoles at various stages were collected from a permanent water reservoir of a depth of approximately 46 cm (1½ feet), as early as 26th April, 1976 before the monsoons arrived. Egg masses, tadpoles and juveniles were collected from temporary and permanent pools of water during the monsoon season from June to August. Tadpoles were also collected in early September. Observations were made at periodic intervals. The larvae were raised in stock tanks (Group-A). Individual variation was seen in length and weight of full siblings at same stage of development. Randomly selected pre-metamorphic tadpoles at same stage of development were separated (Group-B) from stock tanks for study of metamorphosis. These tadpoles were raised in groups of eight in identical finger bowls under conditions standardized in Laboratory (Mohanty-Hejmadi 1977 b). They were fed daily with fish food and vegetable greens. The range of temperature in the laboratory during this period was from 32°C to 41°C. Tadpoles at pre-limb stage were designated as Stage I, with well developed hind limbs as stage-II, upon reaching four-limbed stage as stage-III and after completion of metamorphosis as Stage-IV juveniles. Stage-I, II and III are comparable to the pre-metamorphic, pro-metamorphic and metamorphic climax stages respectively, described by Witschi (1956) for *Rana pipiens*. At stage-III, the tadpoles were transferred into amphibious environment set up as described earlier (Mohanty-Hejmadi 1977 c). The length

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and weight of the tadpoles were taken at periodic intervals. For comparative purpose, tadpoles at Stage-I, II, III and Stage-IV juveniles were also collected from nature. Eggs either from natural spawning in the laboratory or from artificial insemination, were raised through metamorphosis.

Observations

Skipper frogs were seen in both temporary and permanent water pools around Vani Vihar campus throughout the study period. During the winter from November through January, frogs were seen basking in the sun either by sitting on the edges of the pool or by perching on the walls of cemented water tanks. Towards the end of March and in April, a mass migration of frogs occurred during the night from the drying pools to more permanent bodies of water. In a few cases pairs in amplexus were seen.

Since the monsoon did not start until May, tadpoles collected during April, 1976 represented the progeny of frogs who were early breeders taking advantage of the sporadic rains in March, and April. Pre-metamorphic tadpoles were collected even in September indicating that the breeding period lasts from April to September. Since egg masses or embryos were not found in temporary puddles which resulted from sporadic rainfalls during pre-monsoon period, it was concluded that early breeders use permanent water tanks to breed. When the rainfall became more frequent towards the end of May, mature males and females gathered in the evening in rain water puddles, ditches and ponds. They were the leaders of the "amphibian chorus" which was heard both during the day and night. The males and females went into amplexus mostly at night, the amplexus continued throughout the day. Frogs maintained in the laboratory also called, went into amplexus when it rained outside, and even laid eggs spontaneously. Most of the egg masses laid in the laboratory did not grow probably because of the fouling of water resulting from the high concentration of animals in the tanks. However, it was possible to raise tadpoles from one such egg mass.

It is interesting to note that, although pairs in amplexus were seen both during the day and night, in nature as well as laboratory, the ovulation took place only at night. The breeding period lasted from April to September, most of them spawning during the heavy monsoons from middle of June to end of July. The egg masses with 300 to 500 per clutch, were laid in shallow water. The eggs had grayish brown animal pole and pale yellow or white vegetal pole. The diameter of the eggs was approximately 1.0 mm. A week after fertilization, the tadpoles reached a length of 9.25 mm. The characteristic black blotches of the tail (Annandale & Rao 1918; Daniel 1975) appeared when the tadpoles reached a length of about 13.00 mm. Pre-metamorphic tadpoles were occasionally seen eating away dead tadpoles. The Stage-II tadpoles had a mouth disc with one complete row of teeth in the upper lip, and two rows of teeth on the lower lip, and a heavy black serrated beak (Fig. 1).

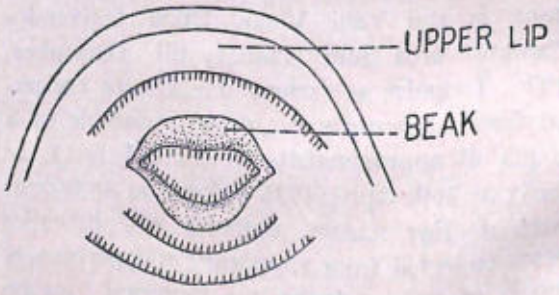

Fig. 1. Teeth structure

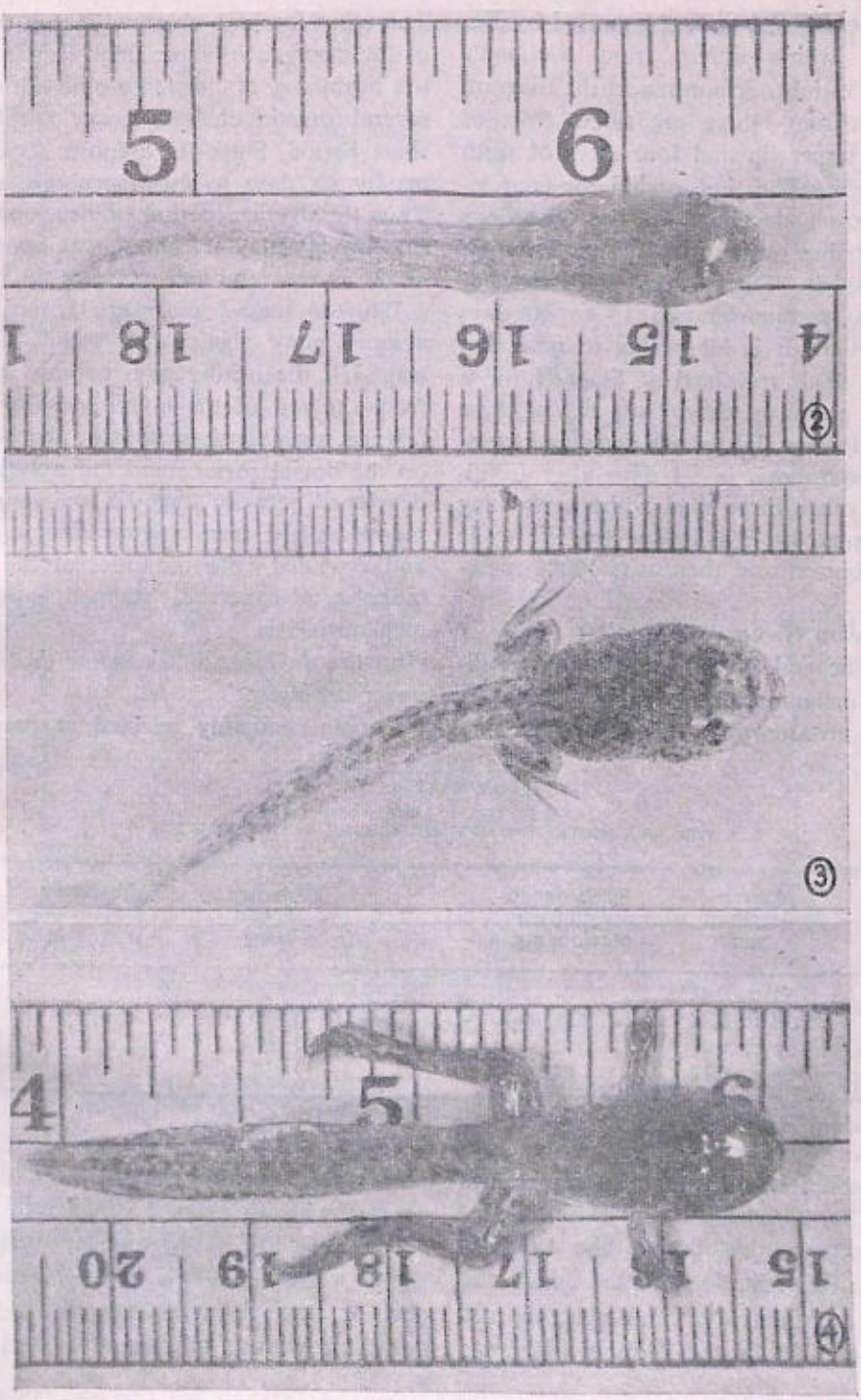

Fig. 2. Pre-metamorphic tadpole. Fig. 3. Pro-metamorphic tadpole.
Fig. 4. Four limbed tadpole at metmorphic climax.

Same teeth structure has been reported by Daniel (1975), which differs from McCann's (1932) observations. According to the diagram given by McCann, there are three rows of teeth in the upper lip and four rows of teeth in the lower lip. The time period for completion of life cycle depended on the conditions under which they were raised. The Group-A tadpoles raised in "Stock tanks" under crowded conditions metamorphosed 15 to 60 days post fertilization. It is interesting to note that four of the stock remained at Stage-II for a considerable period of time. Only one of these four reached stage III in 90 days and completed metamorphosis in 94 days after fertilization. The other three died without reaching Stage-III. In group B tadpoles, the life cycle was much shorter, and there was 100% metamorphosis.

Observations on Group-B Tadpoles:

Towards the end of third week post-fertilization, pre-metamorphic tadpoles (Fig. 2) reached pro-metamorphic (Fig. 3) stage and developed hind limbs. It took fourteen days to complete development of hind limbs. Towards the end of this period the tadpoles reached stage-III (Fig. 4) with the emergence of fore limbs, the right fore limb emerging first in more than 50% of the tadpole observed. The other forelimb emerged within three hours of the emergence of the first. This stage marks the beginning of "metamorphic climax" when several drastic changes occur within a very short period. Stage-III tadpoles took approximately six days to metamorphose completely. Thus the average period of development from egg through metamorphosis was approximately 46 days or six and half weeks in the laboratory.

Between stage-I and stage-II, the larvae developed more pigmented blotches. During the stage-III, the head region became demarcated from the rest of the body. Most of the adult features such as characteristic pigmented spots on the dorsal surface and the webbing of feet developed between stage-III and stage-IV. The mouth shifted from ventral side to the snout and extended upto the sides of the eye. The tadpoles as expected, stopped eating during metamorphosis.

Growth of Group-B Tadpoles during metamorphosis:

Larvae randomly selected at pre-metamorphic stage (Stage-I) ranged from 26 mm to 45 mm with an average of 35 mm in length, and 330 mg to 550 mg with an average of 500 mg in weight (Table-1, Fig. 5). Pro-metamorphic or stage-II larvae ranged from 43 mm to 62 mm with an average of 53 mm in length

TABLE 1 (Fig. 5)

CHANGE IN LENGTH AND WEIGHT DURING METAMORPHOSIS

Stage	Average length in mm	%Change in length from previous stg.	Average weight in mg	%Change in weight from prev. stg
I	35 ± 0.42*		500	
II	53 ± 0.46*	51	1,300	+ 160
III	52 ± 0.25	– 2	1,100	– 15
IV	17 ± 0.18	– 67	750	– 32

(*) Standard error.

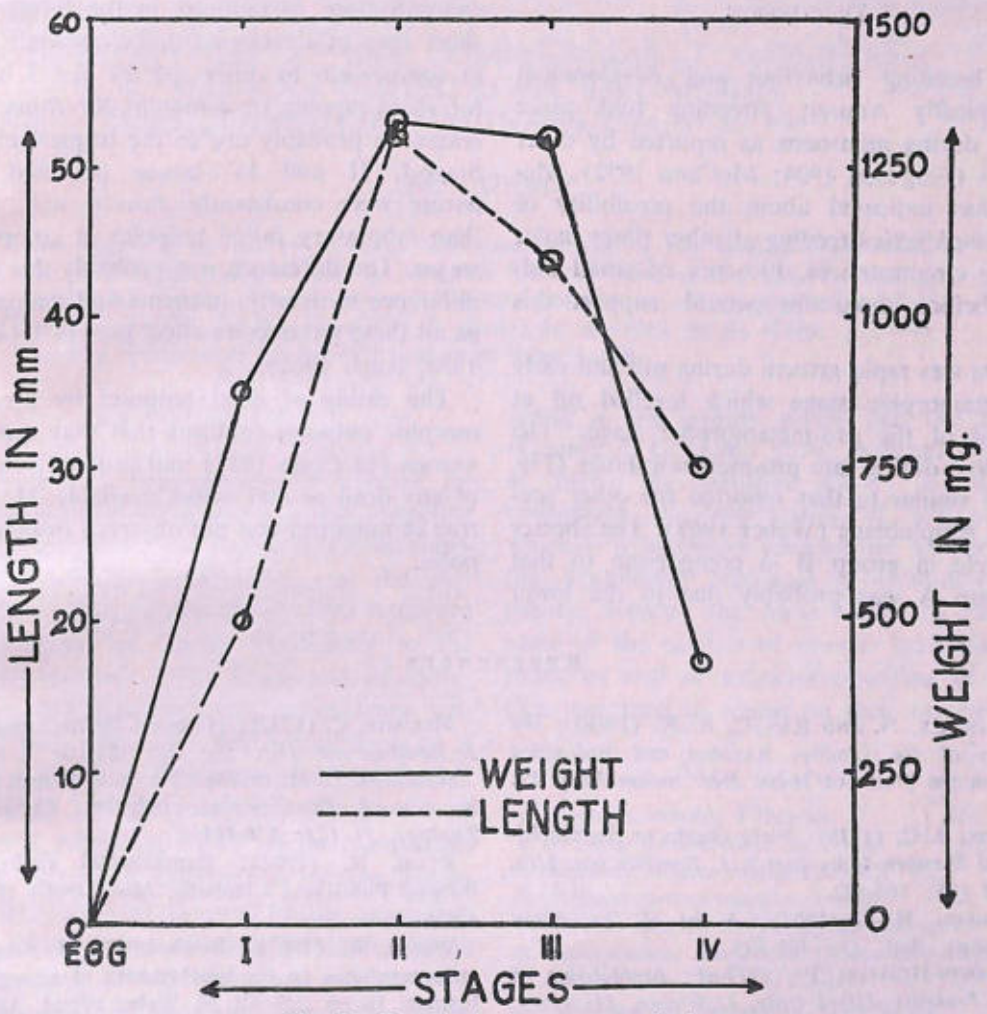

Fig. 5. Growth during metamorphosis.

and from 1333 mg to 1541 mg with an average of 1300 mg in weight. At the beginning of metamorphic climax, stage-III, the larvae ranged from 49 mm to 57 mm with an average of 52 mm in length, and from 1125 mg to 1237 mg with an average of 1100 mg in weight. Newly metamorphosed juveniles ranged from 16 mm to 21 mm with an average of 17 mm in length and from 675 mg to 850 mg with an average of 750 mg in weight. Maximum growth (160%) occurred between stage I and Stage II. Maximum loss in length and weight occurred between stage-III and stage-IV (Table 1). This loss was mainly due to the loss of tail during metamorphosis.

Discussion

The breeding behaviour and development was typically Anuran. Breeding took place mainly during monsoons as reported by other workers (Ferguson 1904: McCann 1932). McCann has indicated about the possibility of *R. cyanophlyctis* breeding at other times under suitable circumstances. Presence of small tadpoles before monsoons would support this view.

There was rapid growth during pre and early pro-metamorphic stage which levelled off at the end of the pro-metamorphic stage. The slight loss during late pro-metamorphosis (Fig. 5) was similar to that reported for other species of Amphibians (Weber 1967). The shorter life cycle in group B in comparison to that of group A was probably due to the lower concentrations of tadpoles in the former. The short time of development, i.e. six half weeks in comparison to other species like 3 months for *Rana pipiens*, or 4 months for *Rana catesbaeana* is probably due to the tropical climate. Stage-I, II and IV larvae collected from nature were consistantly heavier and longer than laboratory raised tadpoles at comparable stages. The difference was probably due to the difference in density, nutrients and temperature as all these parameters affect growth (Richards 1958, Rugh 1962).

The eating of dead tadpoles by pre-metamorphic tadpoles confirms that they are larvivorous (McCann 1932) and probably eat flesh of any dead animal where available. However, true cannibalism was not observed in these tadpoles.

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SYSTEMATICS OF THE COMMERCIALLY IMPORTANT PRAWNS (CRUSTACEA, DECAPODA, SUBFAMILY PENAEINAE) FROM GOA[1]

M. J. GEORGE[2]

The taxonomy of the economically important prawns of the subfamily Penaeinae occurring in the waters of Goa is described. Species belonging to 5 genera, namely, *Penaeus* (4 species), *Metapenaeopsis* (1 species), *Metapenaeus* (6 species), *Trachypenaeus* (1 species) and *Parapenaeopsis* (5 species) are recorded. 10 out of the 17 species included are reported for the first time from these waters.

INTRODUCTION

The demands from an export oriented industry increasing day by day, the estuarine and marine penaeid prawn fishery of the country has improved substantially over the past two decades. As a result, all maritime states are making efforts to exploit the fishery to the maximum possible extent. Along with this development, researches indicate depletionary tendencies as a result of over exploitation of a limited resource in certain areas of the Indian coast like, for instance, the Kerala coast (Menon & Abraham 1971). At the same time, there is increasing exploitation of new prawn resources along certain areas on the east coast. It is necessary that research be continued to find out new prawn resources and to keep existing fisheries at maximum sustainable levels. As in other maritime states, along the Goa coast also, the marine penaeid prawn fishery is developing very fast. However, apart from the recent studies on the fishery biology (Anonymous 1975) and the distribution of their larvae in the inshore waters and the estuary (George & Goswami 1976; Achuthankutty *et al.* 1976), no published account is available concerning the systematics of the prawns, which is a necessary prerequisite to determine the exploitable resources in a multi-species fishery. Hence, the opportunity to examine some of the catches of prawns from both inshore, as well as, brackish estuarine waters of Goa was used to report on their taxonomy.

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LIST OF SPECIES

1. *Penaeus mondon* Fabricius
2. *Penaeus semisulcatus* de Haan
3. *Penaeus indicus* Milne Edwards
4. *Penaeus merguiensis* de Man
5. *Metapenaeopsis mogiensis* (Rathbun)
6. *Metapenaeus brevicornis* (Milne-Edwards)
7. *Metapenaeus dobsoni* (Miers)
8. *Metapenaeus monoceros* (Fabricius)
9. *Metapenaeus alcocki* George and Rao
10. *Metapenaeus affinis* (Milne-Edwards)
11. *Metapenaeus burkenroadi* Kubo
12. *Trachypenaeus curvirostris* (Stimpson)
13. *Parapenaeopsis stylifera* (Milne-Edwards)
14. *Parapenaeopsis cornuta* (Kishinouye)
15. *Parapenaeopsis hardwickii* (Miers)
16. *Parapenaeopsis sculptilis* (Heller)
17. *Parapenaeopsis acclivirostris* (Alcock)

Family PENAEIDAE Aafinesque, 1815

Sub-family PENAEINAE Rafinesque, 1815

Penaeus monodon Fabricius, 1798

Penaeus monodon Mohamed, 1970a : 1258 (with synonymy); 1973 : 551; Muthu 1971 : 154; Racek and Yaldwyn 1971 : 209; Starobogatov 1972 : 387; Ivanov and Hassan 1976a : 246; Kurien and Sebastian 1976 : 100.

Material: Several specimens from the estuary as well as from inshore and off shore catches.

Remarks: The species utilises, to a limited extent, the estuary as a nursery ground only. As a result, the quantity of younger specimens, found in the catches of the estuary is very limited. The large adults are obtained in the mechanised fishery from offshore waters. In the estuary, the species is found mostly in April-May.

Penaeus semisulcatus de Haan, 1850

Penaeus semisulcatus George, 1969 : 23 (with synonymy); Muthu 1971 : 154; Starobogatov 1972 : 368; Mohamed 1973 : 551; Ivanov and Hassan 1976a : 246; Kurien and Sebastian 1976 : 100.

Material: Few specimens from the estuary and the sea.

Remarks: The species is found along with the catches of *P. monodon*, but is rare.

Penaeus indicus H. Milne-Edwards, 1837

Penaeus indicus Mohamed, 1970b : 1274 (with synonymy); 1973 : 551; Muthu 1971 : 154; Starobogatov 1972 : 368; Ivanov and Hassan 1976a : 246; Kurien and Sebastian 1976 : 99.

Material: Specimens from the estuary as well as the sea.

Remarks: All specimens examined show the typical features of the species described in previous literature. The adrostral sulci extend upto the epigastric tooth as described by Alcock (1906), although Racek & Dall (1965) found these sulci slightly exceeding the epigastric tooth. The gastro-orbital carina is well defined. The length of the 3rd pereopod is quite variable as pointed out by Hall (1956). The species occurs in small numbers in both sea and estuary catches.

Penaeus merguiensis deMan, 1888

Penaeus merguiensis George 1969: 24 (with synonymy); Tirmizi 1969 : 757; Muthu 1971 : 154; Racek and Yaldwyn 1971 : 210; Starobogatov 1972 : 368; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 100.

Material: Numerous specimens from the estuarine and marine catches.

Remarks: This is commercially the most important species of the genus present in these waters. It forms an important constituent of the catches from both inside and outside waters. Dall (1957) and Racek & Dall (1965) drew attention to the absence of gastro-orbital carina in the specimens from Australia and New Guinea while the carina is present in specimens from Karachi, Malaysia, Indonesia and the Philippines. The material on hand from Goa waters also shows the presence of this carina occupying middle 1/3 portion between the hepatic spine and area between the hepatic spine and post orbital margin of carapace. Distinction of the species from *P. indicus*, especially in the juvenile stages is very difficult. Muthu & Rao (1973) have described some useful characters for distinguishing the juveniles of these two species.

Genus *Metapenaeopsis* Bouvier, 1905

Metapenaeopsis mogiensis (Rathbun), 1902

Metapenaeopsis mogiensis George, 1969 : 25 (with synonymy); Muthu 1971 : 149; Starobogatov 1972 : 376; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 96.

Material: 3 specimens from the estuary, Ribander area. 42 - 58 mm total length.

Remarks: Considering the differences between Australian and Indian specimens of this species recorded in previous literature, Racek & Dall (1965) remarked that *M. mogiensis* auctorum might consist of more than one species. This has since been proved to be correct and with the material available from Sri Lanka,

De Bruin (1965) separated *P. hilarulus* of de Man (1911) and Barnard (1950) and *M. mogiensis* of Hall (1962) to include them in *Metapenaeopsis hilarulus* (de Man), a view accepted by Muthu (1971) also. Starobogatov (1972) is of the opinion that the specimens of Racek & Dall (1965) are closer to *M. hilarulus*. The present material shows that the specimens belong to *M. mogiensis* auct.

Genus *Metapenaeus* Wood Mason and Alcock, 1891

Metapenaeus brevicornis (H. Milne-Edwards), 1837

Metapenaeus brevicornis George, 1970d : 1564 (with synonymy); Muthu 1971 : 154; Starobogatov 1972 : 389; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 96.

Material: Few specimens from the Zuari estuary and from the sea.

Remarks: This is the first time that the species is recorded south of Bombay on the west coast. The ischial spine is present on the 1st pereopod. Although Kubo (1949) described the telson as devoid of lateral spines, Racek & Dall (1965) observed a pair of clearly perceptible spines near the tip in addition to minute spinules in 24 out of 29 specimens in their collection, a condition described by de Man (1924) and Burkenroad (1934). The specimens in the present collection also show variation in the character, 2 or 3 specimens devoid of the pair of lateral spines on telson while others possessed these spines.

Metapenaeus dobsoni (Miers), 1878

Metapenaeus dobsoni George, 1970a : 1342 (with synonymy); Muthu 1971 : 154; Racek and Yaldwyn 1971 : 212; Starobogatov 1972 : 393; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 97.

Material: Innumerable specimens from the estuary and the sea.

Remarks: This is one of the most important commercial species of the area with reference to quantity of landings. The numerous specimens examined agree with the previous descriptions. The free filament of the petasmal distomedian projection about which attention was drawn by Racek and Dall (1965) is clearly seen in the adult petasma examined. This is one of the species belonging to the group with conjoined white pads on the thelycum in impregnated females.

Metapenaeus monoceros (Fabricius), 1798

Metapenaeus monoceros George, 1970b : 1547 (with synonymy); Muthu 1971 : 154; Racek and Yaldwyn 1971 : 212; Starobogatov 1972 : 389; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 97.

Material: Numerous specimens from the estuary and from the sea.

Remarks: One of the common species in the catches of the estuary, though not very common in the catches from the inshore waters, probably because of the adults occurring in deeper waters than other species as has been reported from the south west coast of India. Trawl nets operated in shallower areas, therefore fail, to trap them.

Metapenaeus alcocki George and Rao, 1966

Metapenaeus alcocki George and Rao, 1966 : 146; George 1969 : 31; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 96.

Material: Few specimens from the estuary.

Remarks: The species is reported for the first time from outside the type locality, the Gulf of Kutch. In the length of the 5th pereopods and mid-dorsal carination of the abdominal somites, slight differences were noticed from the type material. Traces of carination are noticed in the anterior abdominal segments also and the 5th pereopods reach slightly beyond the middle of the scaphocerite.

Metapenaeus affinis (H. Milne-Edwards), 1837

Metapenaeus affinis George, 1970c : 1366 (with synonymy); Muthu 1971 : 154; Racek and Yaldwyn

1971 : 211; Starobogatov 1972 : 368; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 96.

Material: Several specimens from the inshore catches. Only very seldom seen in catches from the mouth of the estuary.

Remarks: The confusion created by Hall's (1962) re-examination of the type material of the species and his comments has since been cleared (Ref: Racek & Dull, 1965, p. 54): Still, there is considerable difference of opinion on the taxonomic status of this species (Mistakidis 1968). Pending a final decision, the two new species of Hall (1962) *Metapenaeus necopinans* and *M. mutatus* are treated as synonyms of *M. affinis*.

Metapenaeus burkenroadi Kubo, 1954

Metapenaeus burkenroadi George, 1969 : 32 (with synonymy); Starobogatov 1972 : 393; Muthu and Manickam 1973 : 214; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 96.

Material: Several specimens from the estuary and rarely from inshore catch.

Remarks: This is the first report of the species from the northern half of the west coast of India, extending its distribution in Indian waters. The species is represented in the fishery of the lower reaches of the estuary and plenty of specimens with mature gonads are seen in the catches in January, February, indicating that the species breeds inside the estuary in these months. Mature specimens of the same species were reported from Pulicat lake by Muthu & Manickam (1973).

De Bruin (1965) recorded some variable features in Sri Lanka specimens. In the present material the dorsal pubescence is less in males than in females as in Sri Lanka specimens. In comparison with De Bruin's specimens the abdominal somites are more pubescent, especially the anterior somites.

Genus *Trachypenaeus* Alcock, 1901

Trachypenaeus curvirostris (Stimpson), 1860

Trachypenaeus curvirostris George, 1969 : 33 (with synonymy); Muthu 1971 : 154; Starobogatov 1972 : 370; Mohamed 1973 : 551; Kurien and Sebastian 1976: 101; Ivanov and Hassan 1976b: 1300.

Material: Few specimens from the sea.

Remarks: In Sri Lanka specimens, De Bruin (1965) found that the rostrum is straight and not curved as illustrated by Dall (1957). Large numbers of specimens examined from the south west coast of India as well as the present material show much variation in this character as noticed by Hall (1961) also. Based on features like straight rostrum and other differences in thelycum and petasma, Ivanov & Hassan (1976b) described 4 specimens from the western Indian Ocean as a new species, *Trachypenaeus starobogotovi*.

Genus *Parapenaeopsis* Alcock, 1901

Parapenaeopsis stylifera (H. Milne-Edwards), 1837

Parapenaeopsis stylifera Rao, 1970: 1580; Starobogatov 1972: 393; Mohamed 1973: 551; George 1973: 421 (with synonymy); Kurien and Sebastian 1976: 98.

Material: Numerous specimens from the sea and a few from the mouth of the estuary.

Remarks: Although the species does not penetrate into the estuary, large numbers are found in the catches from the region of the mouth of the estuary. George (1973) has given the complete synonymy of the species, relegating as synonyms, the two sub-species, namely, *P. stylifera stylifera* and *P. stylifera coromandelica* suggested by Racek & Dall (1965).

Parapenaeopsis cornuta (Kishinouye), 1900

Penaeus cornutus Kishinouye, 1900: 23.

Parapenaeopsis cornuta de Man, 1911: 93; Muthu 1971: 147; Starobogatov 1972: 397; Mohamed 1973: 551.

Parapenaeopsis cornutus Kubo, 1949: 374; Dall 1957: 215; Cheung 1960: 67 (key); Kunju 1967: 1384.

Parapeneopsis cornuta Racek, 1959: 10; De Bruin 1965: 95.

Parapenaeopsis cornuta cornuta Racek and Dall, 1965: 98.

Material: 1 female—48 mm total length from the inshore catch.

Remarks: This is the first record of the species along the west coast of India south of Bombay. Although Hall (1961) suggested that Alcock's *P. maxillipedo* might be considered as geographical variety of *P. cornuta* (Kishinouye), De Bruin (1965) felt that the two are distinct species, based on comparison of the features in Sri Lanka specimens. Racek & Dall (1965) considered them as two subspecies, *P. cornuta cornuta* (Kishinouye) and *P. cornuta maxillipedo* (Alcock). A critical examination of specimens from the south west coast of India and of the present specimen shows that De Bruin's view was correct.

As in De Bruin's (1965) specimens, the 3rd pereopod does not possess basial spine. 2 or 3 pairs of minute spines are present on distolateral margins of the telson. A median tuft of setae is also not present behind the posterior thelycal plate.

Parapenaeopsis hardwickii (Miers), 1878

Parapenaeopsis hardwickii George, 1969: 36 (with synonymy); Muthu 1971: 154; Starobogatov 1972: 370; Mohamed 1973: 551; Kurien and Sebastian 1976: 98.

Material: Several specimens from the estuary and from the sea.

Remarks: The species is recorded for the first time from the west coast south of Bombay. It is also interesting to note that most of the specimens come from the estuary, contributing to the fishery of the estuary to a certain extent in some areas.

The first two abdominal segments are without median carination. The telson is armed with 3 pairs of small lateral spines. The cultrate rostrum of the adult males is a feature shared by both *P. hardwickii* and *P. sculptilis*.

Parapenaeopsis sculptilis (Heller), 1862

Parapenaeopsis sculptilis George, 1969 (with synonymy); Muthu 1971: 154; Starobogatov 1972: 370; Mohamed 1973: 551; Kurien and Sebastian 1976: 98.

Material: A few specimens from the estuary.

Remarks: This species also is reported for the first time from the west coast of India south of Bombay. Occurs in association with *P. hardwickii* which is more common. The specimens of *P. sculptilis* can be separated by the presence of dorso medial carinae on 1st and 2nd abdominal somites, absence of lateral spines on telson and the features of thelycum and petasma as described by earlier authors.

Parapenaeopsis acclivirostris (Alcock), 1905

Parapenaeopsis acclivirostris George, 1969: 37 (with synonymy); Muthu 1971: 154; Starobogatov 1972: 397; Mohamed 1973: 551; Kurien and Sebastian 1976: 97; Ivanov and Hassan 1976b: 1299.

Material: Few specimens from the catches of the sea.

Remarks: Racek & Dall (1965) suggested that the vicinity of Palk Strait on the east coast of India could be considered the zoogeographic boundary separating the eastern species *P. tenella* from its western congener *P. acclivirostris*. Alcock's (1906) record of *P. acclivirostris* from Madras and Visakhapatnam on the east coast of India as well as the recent record of *P. tenella* from East African waters by Ivanov & Hassan (1976b) makes it difficult to accept this suggestion.

KEY FOR THE IDENTIFICATION OF PRAWNS OF THE SUBFAMILY PENAEINAE IN THE WATERS OF GOA

1. Rostrum without ventral teeth 2
   Rostrum with ventral teeth 5
2(1) A distal fixed pair of spines on the telson and 1-3 pairs of mobile spines; petasma asymmetrical; 3rd maxilliped with basial spine ..... *Metapenaeopsis*
   Stridulating organ absent; hepatic sulcus absent or not reaching to ventral edge of branchiostegite; a pair of tooth-like plate-

lets immediately posterior to thelycal plate; distinct groove present on 3rd abdominal carina; anterior edge of anterior sternal plate between 5th pair of legs in female with 4 rounded teeth, 2 median ones being incurved; distomedian lobule of petasma small ..... *Metapenaeopsis mogiensis* (Rathbun)

Distal fixed pair of spines on the telson may or may not be present; petasma symmetrical; 3rd maxilliped without basial spine 3

3(2) No exopod on 5th pereopod; pleurobranch on 7th thoracic somite present..... *Metapenaeus*..... 8

Exopod on 5th pereopod present; pleurobranch on 7th thoracic somite absent..... 4

4(3) 3rd pereopod with epipodite..... *Trachypenaeus*

Epipodites present on 1st and 2nd pereopods; anterior plate of thelycum may have a raised anterior margin but laterally the margins not raised; an excavation present between the anterior plate and the transverse sternal ridge..... *Trachypenaeus curvirostris* (Stimpson)

3rd pereopod without epipodite..... *Parapenaeopsis*....13

5(1) Hepatic carina present 6

Hepatic carina absent 7

6(5) Hepatic carina horizontally straight; 5th pereopod without exopodite ..... *Penaeus monodon* Fabricius

Hepatic carina inclined at an angle of 20° antero ventrally; 5th pereopod with small exopodite ..... *Penaeus semisulcatus* de Haan

7(5) Gastro-orbital carina occupying the posterior 2/3 distance between hepatic spine and orbital angle; rostral crest may be elevated but not triangular in profile..... .....*Penaeus indicus* H. Milne-Edwards

Gastro-orbital carina absent or not reaching hepatic spine and occupying the middle 1/3 distance between hepatic spine and orbital angle; rostral crest triangular in profile.... ..... *Penaeus merguiensis* de Man

8(3) Distomedian petasmal projection with fully developed or vestigial apical filament; thelycum of impregnated females usually with white conjoined pads 9

Distomedian petasmal projection without apical filament; thelycum of impregnated females without conjoined pads.....10

9(8) Posterior part of rostrum with distinctly elevated crest; basial spine on male 3rd pereopod simple; apical petasmal filaments slender, slightly converging; thelycum with a large anterior and small lateral plates.... .....*Metapenaeus brevicornis* (H. Milne-Edwards)

Posterior part of rostrum without distinctly elevated crest; basial spine on male 3rd pereopod long and barbed; apical petasmal filaments not readily visible; anterior thelycal plate tongue-like .... *Metapenaeus dobsoni* (Miers)

10(8) Ischial spine on 1st pereopod distinct 11

Ischial spine on 1st pereopod small or absent 12

11(10) Lateral thelycal plates with salient and parallel ear-shaped lateral ridges; distomedian petasmal projections hood-like..... ..... *Metapenaeus monoceros* (Fabricius)

Lateral thelycal plates without lateral raised ridges; distomedian petasmal projections not hood-like but overlying lateral projections and distally trilobed; posterior extention of the anterior median thelycal plate bound laterally by an oval flat plate on each side ....*Metapenaeus alcocki* George and Rao

12(10) Branchio cardiac carina distinct, extending from posterior margin of carapace almost to hepatic spine; anterior thelycal plate longitudinally grooved, wider posteriorly than anteriorly; distomedian petasmal projections crescent shaped ..... *Metapenaeus affinis* (Milne-Edwards)

Branchio cardiac carina feeble or ill-defined, anterior end not exceeding posterior 1/3 of carapace; distal margin of anterior thelycal plate convex to indistinctly triangular; petasma with laminose and strongly diverging distomedian projections .... *Metapenaeus burkenroadi* Kubo

13(4) Epipodites present on 1st and 2nd pereopods; rostrum inclined upwards at an angle to carapace for whole of its length.....

.....*Parapenaeopsis acclivirostris* (Alcock)
Epipodites absent on 1st and 2nd pereopods 14

14(13) Telson with a pair of fixed sub apical spines; at least distal ½ free portion of rostrum unarmed ..... *Parapenaeopsis stylifera* (Milne-Edwards)
Telson without fixed sub apical spines, with or without lateral movable spines; 1/3 or less free portion of rostrum unarmed....15

15(14) Petasma with a pair of long slender caliper-like distolateral projections directed forwards; 3rd pereopod of female without basial spine ..... *Parapenaeopsis cornuta* (Kishinouye)
Petasma with a pair of distolateral projections directed laterally or distolaterally, short and spout-like 16

16(15) Antennular flagella 0.5-0.6 length of carapace; movable lateral spines absent on telson; thelycum with median tuft of setae on posterior plate ..... *Parapenaeopsis sculptilis* (Heller)
Antennular flagella 0.7 length of carapace or longer; movable lateral spines present on telson; thelycum without median tuft of setae on posterior plate ..... *Parapenaeopsis hardwickii* (Miers)

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OBSERVATIONS ON LIFE-HISTORY OF THE PEDUNCULATE BARNACLE, *IBLA CUMINGI* DARWIN[1]

S. N. GAONKAR AND A. A. KARANDE[2]

(With six text-figures)

Ibla cumingi Darwin, 1851 is an intertidal pedunculate cirripede found at many places in India. The presence of *I. cumingi* Darwin in the intertidal waters of Bombay had been recently noted. It is a well established species in the low intertidal waters of Madh Island and shares the habitat with another recently discovered barnacle, *Tetraclitella karandei* Ross (Ross 1971). Unlike many other cirripedes *I. cumingi* is a bisexual species. The male, not measuring more than 2 mm, resides in the mantle cavity of the female. This species continues to produce fresh masses of ova throughout the year. However, March, April and May are the active breeding phase. Its smallest size at maturity is 5 mm and individuals measuring between 10-14 mm contribute most towards the growth of the population.

INTRODUCTION

Barnacles constitute a major fouling community and hence interest has been generated in these shell dwelling crustaceans. The nauplii and cyprids of barnacles are being used as test organisms in the assessment of potential antifoulants and the adhesive cement material used by these organisms for settlement has been the subject of considerable interest.

In this Laboratory the breeding habits of several barnacle species including observations on their larvae have been made (Karande & Thomas 1976). In this paper, the breeding behaviour, time and duration of the breeding phase of *Ibla cumingi* are reported so as to facilitate laboratory rearing of this pedunculate barnacle which has been observed to be very convenient for raising larval young, under controlled laboratory conditions.

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MATERIAL AND METHODS

Specimens of *I. cumingi* were collected every month from the rocky shores of Madh Island, from January 1976 to January 1977.

The condition of gonads was determined by microscopic examination and on the basis of development of ovaries, the following five stages of ovarian growth were recognised.

Stage — O : Ovarian tissue absent.
Stage — I : Lamellae with undeveloped ova.
Stage — II : Lamellae with well developed ova.
Stage — III : Fertilized eggs.
Stage — IV : Encased embryos.
Stage — V : Free nauplii in mantle space.

The breeding pattern was judged on the basis of frequency occurrence of the above stages in freshly collected specimens every month.

For raising the larvae of this species in the laboratory, a method described by Karande & Thomas (1971) was adopted.

OBSERVATIONS

Taxonomy:
A short taxonomic description of *I. cumingi* is included for facilitating easy identification.

The number of segments in the anterior and posterior rami of the cirri in the specimen examined is as follows:—
I cirrus—13, 17; II cirrus—23, 25; III cirrus—22, 24; IV cirrus—23, 25; V cirrus—23, 24; VI cirrus—24, 25.

The second to the sixth pair of cirri are alike in shape and structure. Each segment has three pairs of spines on the interior margin and a pair of slender bristles at the distal tip. The caudal appendage is sixteen jointed and reaches above the tip of the pedicel of the sixth cirrus. The mandible (Fig. 1) has three teeth with the lower margins of the large upper teeth non-

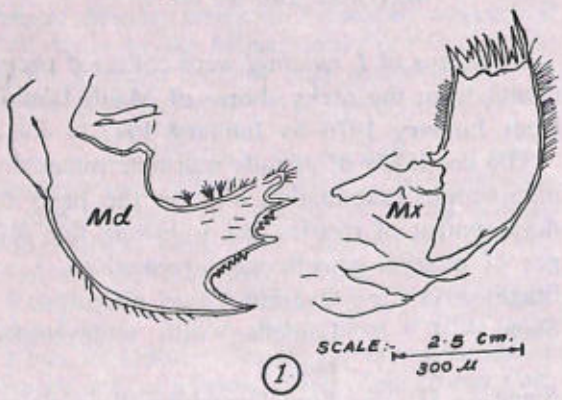


Fig. 1. *Ibla cumingi* Darwin. *Md*, Mandible and *Mx*, Maxilla I.

pectinated and with the upper margins of the second and third teeth pectinated. The upper margin of the second tooth is provided with nine small spines and that of the third with three small spines. Maxilla I (Fig. 1) with the free edge has two depressions. The male is minute with a body length of 1-2 mm. The body is vermiform and whitish in colour. There are two pairs of cirri of which the first pair is four jointed and the shorter three jointed. The maxilla I is with five small spines and a single large spine at the apex (Daniel 1954).

Breeding:

Table 1 shows percentage incidence of *I. cumingi* in relation to different stages of ovarian development over a period of 13 months. The ovarian lamellae are present all through the year in various stages of development.

For a major part of the year, the individuals having mature and maturing ova are of common occurrence. This species continues to produce fresh masses of ova throughout the year. The oogenic activity is continuous throughout the year as is evident by high incidents of ovarian stages I and II.

In December, January and February, when the water temperature is low, a rapid proliferation of the egg lamellae is evident in about 70% of the population. The fertilization of the eggs (Stages III and IV) commences somewhere in the middle of February and in April, a majority of the population, about 68-70%, bears a large number of larvae ready for the release. This period is an active breeding phase in *Ibla cumingi*. During the warmer months of May, June and July, though 70% to 80% of the individuals hold well developed eggs, in the absence of fertilization, the breeding is more or less at a standstill. The fertilization commences again by the end of August and by October a considerable number of individuals bear broods holding developing larvae in the mantle space. The breeding activity is gradually reduced by the middle of November.

I. cumingi individuals measuring between 5 mm and 22 mm were examined every month with a view to determining its smallest size at maturity and for deciding productive phase of life cycle. It will be seen from the data summarised in Table 2, that this species at-

TABLE 1

FREQUENCY INCIDENCE OF VARIOUS OVARIAN GROWTH STAGES IN *Ibla cumingi*

Period of Observation	Stages of ovarian development (Percentages)						Total Fertilized specimens Stages) III to V	
	O	I	II	III	IV	V		
January 1976	16	64	12	4	4	0	8	(360)
February ,,	0	56	20	16	8	0	24	(600)
March ,,	12	20	40	28	0	0	28	(1225)
April ,,	8	4	20	64	4	0	68	(635)
May ,,	8	16	60	8	4	4	16	(270)
June ,,	16	48	36	0	0	0	0	—
July ,,	20	20	48	8	4	0	12	(520)
August ,,	8	12	48	16	12	4	32	(720)
September ,,	12	24	44	20	0	0	20	(630)
October ,,	24	40	0	0	36	0	36	(790)
November ,,	8	8	68	16	0	0	16	(575)
December ,,	8	56	36	0	0	0	0	—
January 1977	28	48	20	4	0	0	4	—

Figures in parenthesis are highest number of larvae counted from a single individual.

tains maturity when it is about 5 mm in length. The individuals measuring between 5 mm and 9 mm (size group I), however, contribute very little towards the growth of the population. This is also true for the individuals coming under size 15-19 mm. Individuals after growing to a body length of 19 mm make no significant contribution towards the production of young larvae.

The individuals coming under size Class II (10 mm to 14 mm) contribute most towards the growth of the population. The continuous development of fresh ovarian lamellae followed by quick embryogenesis and the development of nauplii occur among the individuals of this size group. The highest incidence of developing ova (60%), the highest incidence of fertilized eggs (70%) and also the highest incidence of larvae (68%) are confined to this size group of 10 mm to 14 mm and lend support to this view.

Careful examination of the mantle space of 25 individuals carried out every month revealed that in almost all individuals measuring between 3 mm to 22 mm the male was present. Only in about 4 to 8% individuals the males were not traced. However, this could be due to personal error in locating the males. In about 10% of the individuals examined, two males were simultaneously present in their mantle spaces. A majority of the males pos-

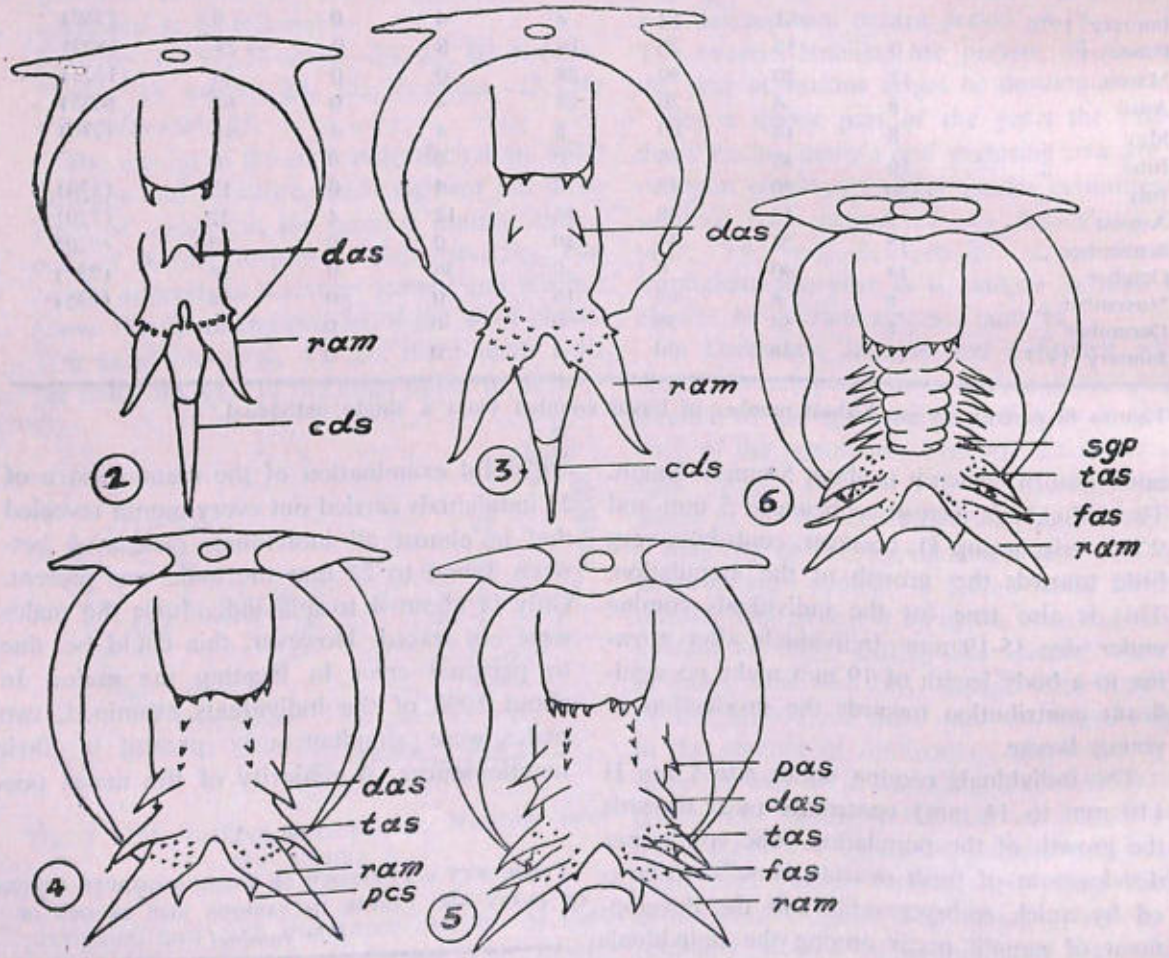
TABLE 2

FREQUENCY OCCURRENCE OF VARIOUS GROWTH STAGES OF OVARY AND LARVAE IN VARIOUS SIZE GROUPS OF *Ibla cumingi*

Size-group	Percentage occurrence		
mm	Early ova	Fertilized eggs	Larvae
I (5-9)	20	23	12
II (10-14)	60	70	68
III (15-19)	19	4	16
IV (19-22)	1	3	4

sess well developed gonadial lobes during most part of the year.

The breeding pattern of the pedunculate barnacle *I. cumingi* compares generally well with most of the other operculate barnacles, in that there is intense activity during months of February, March and April followed by relatively quiescent phase during monsoon months. A recurrence of breeding in this species is not due to lack of ovarian or male gonadial activity, since well developed eggs and sperms are generally present throughout the year. It is the



Figs. 2-6. Semidiagrammatic outline drawings of the larvae of *I. cumingi* (2-6 represent 2nd, 3rd, 4th, 5th, and 6th nauplius stages respectively and the dimensions in μm respectively are 372, 385, 420, 460 and 500.

Abbreviations:

cds, caudal spine; *das*, distal abdominal spines; *fas*, 4th abdominal spines; *pas*, proximal abdominal spines; *pcs*, posterior carapace spine; *ram*, ramus; *tas*, 3rd abdominal spines.

absence of fertilization during certain times of the year that leads to poor breeding activity. This is observed during the monsoon when along the coast, the water quality particularly with reference to salinity is changing.

Larval stages:

The first nauplius is 300 μm long and like those of other species is pear shaped in appearance. It is the largest first nauplius so far examined from the Bombay waters.

The second nauplius is very fast moving and strongly phototropic. Measuring about 375 μm, it is slightly bigger than the 2nd nauplii of *Balanus amphitrite amphitrite*, *Chthamalus withersi* and *Ch. malayensis*. Its ill-defined carapace is 300 μm long (Fig. 2).

The third nauplius is 385 μm long (Fig. 3). The frontal filaments are now 45 μm in length. The upper surface of the carapce shows a characteristic sculpturing of brick-work like pattern.

The fourth nauplius measuring 420 μm in length is in many ways different from the preceeding stages (Fig. 4). The total disappearance of caudal process is the most important change noticed. The true carapace, whose frontal and the lateral sides start sloping towards the mid axis of the body, shows a pair of 40 μm long posterior carapace spines.

The fifth larva measuring 460 μm in total length appears different from the 4th larva in many respects (Fig. 5). The 385 μm long and 335 μm wide carapace shows pronounced inward slope at its free margin. The 160μm long labrum is a massive organ and generally bears 7-8 teeth and numerous hairs on its free margin. The abdominal area grows very bulky and the cirral appendages in the form of ill-defined papillae are seen under the exoskeleton.

The sixth larva or the metanauplius is 500 μm long (Fig. 6). Its carapace is 420 μm long and 360μm wide. The 150 μm long labrum continues to be a massive structure that retains all 7 or 8 teeth and the hair. The abdomen is very broad and bulbous and has 6 pairs of segmental spines. These spine are broad and bulbous at the bases and acutely pointed at their free ends.

The cyprid larva emerges at the end of ten days development. Its boat-shaped carapace is 565 μm long and 250 μm wide. A large number of oil/fat droplets of about 25 μm diameter are seen under the carapace. The antennular adhesive pad is of 30 μm diameter. Each ramus of cirral appendages has four segments and about 120 μm long cirri. The cirri of the first appendages are stouter than those of the appendages which appear subsequently. The subterminal segment of each ramus of 6 appendages bears a short but a distinct hook like spine.

Remarks:

I. cumingi as compared to other operculate species encountered along Bombay coast is a poor breeder. For the whole one year several individuals were examined and the numbers of larvae held in their mantle space were individually counted in this and five other species. The highest numbers of larvae counted in a single brood of *B. a. variegatus*, *B. a. amphitrite*, *T. karandei*, *Chthamalus withersi*, *Ch. malayensis* and *I. cumingi* were 35000, 18700, 5900, 7000, 4300 and 1200 respectively. Despite this limitation of the number of larvae, it is felt that, *I. cumingi* is a handy material to raise the larvae under controlled laboratory conditions.

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PREDATION ON NATURAL NESTS OF THE SALT-WATER CROCODILE (*CROCODYLUS POROSUS* SCHNEIDER) ON NORTH ANDAMAN ISLAND WITH NOTES ON THE CROCODILE POPULATION[1]

B. C. CHOUDHURY[2] & H. R. BUSTARD[3]

(With five plates and two text-figures)

During June/July 1978 a quantitative study of saltwater crocodile nests and nest predation was carried out in North Andaman. Predation was found to be extremely higher, twentyeight of thirty nests (93.4%) were destroyed by predators and a further nest was completely flooded, giving a 3.3% hatching success. Human predation accountd for almost all nest predation (84.6%). Nests occurred predominantly in the creeping cane/evergreen vegetation zones. Data are presented on the ecology of nesting and compared with data from elsewhere in the species' wide geographical range.

Active nest hunting by settlers, together with killing of adult crocodiles—often the nest-guarding female—combined with data on the remaining adult population gives cause for great concern for the future of this population of an endangered species.

INTRODUCTION

Precise scientific data on saltwater crocodile nests has been lacking until recently (Neill 1971) although the natural history has been known in outline for a long time Deraniyagala (1939). The recent paper by Webb *et al.* (1977) is an important contribution. However, it deals with a typically Northern Australian situation which is very different from the Indian situation. In Northern Australia flooding is a major nest hazard, but predation, both human (by aborigines) and by wild life, is invariably extremely low.

During the latter part of the 1978 egg laying season approximately four weeks (22nd June to 16th July) were spent in the crocodile habitat of North Andaman observing nests. Data were collected on a total of thirty nests in which eggs had been laid, as a result of personal observation, or readily checkable information, collected on nests from reliable sources. This paper gives an account of nest predation together with information on the crocodile population of North Andaman.

North Andaman (Fig. 2), with a total area of 1376 sq km is one of the five main islands which form the Andaman group. The Andaman Islands (10° 13′—13° 30′N and 92° 15′—93° 10′E) lie in the Bay of Bengal. The northernmost major island of the Andaman group, North Andaman, lies at a distance of 896 km south-east of the mouth of the Hoogly (Ganges) and at a distance of 192 km south of Cape Negaris in Burma. The main mass of North Andaman is roughly hexagonal in outline with a maximum length of 77 km from North to South and maximum width of 29 km from East to West. North Andaman Island

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is separated from Middle Andaman by a narrow sea water creek known as Austin strait.

The study area, together with the rest of the Andaman-Nicobar Group, comprises one of the three last remaining saltwater crocodile habitats in India—the other two being Sundarbans in West Bengal and Bhitar Kanika at the Brahmini-Baitarni delta in Orissa.

Study area

The coastline of the study area is highly indented and at many places penetrates deeply into the island landmass to form island bays and deep creeks. Most of the rivers and streams empty into these creeks.

In the South of North Andaman, Kalara, Balmi, and Parangara creeks, in the East, Kalpang River and its tributaries, and in the West the streams that empty into the Casurina and Hudson Bay, were the major areas where extensive field work was carried out (Fig. 2). These creeks and streams form the major saltwater habitat in North Andaman.

All these creeks are fringed by belts of mangrove swamps (Plate I) which are regularly inundated during the high tide. Over the years, forests on both banks of the Kalpang River have been cleared and settlements are growing. This river was formerly a good habitat for saltwater crocodiles.

The creeks along the East coast of North Andaman are deep, those along the West coast shallow, about nine and three metres respectively, at mean tide level, the latter creeks (Plate I) with pebble beds. There are two tides every twentyfour hours inundating the banks of the streams. The tide fluctuation in the creeks is above 2 mts.

In the undulating terrain and thick tropical forests of North Andaman communication depends entirely on the open sea and inland creeks. This results in a certain amount of disturbance. Other than transport, fishing, crabbing and cutting of cane, bamboo and mangrove trees along the creeks, also creates some disturbance.

Climate:

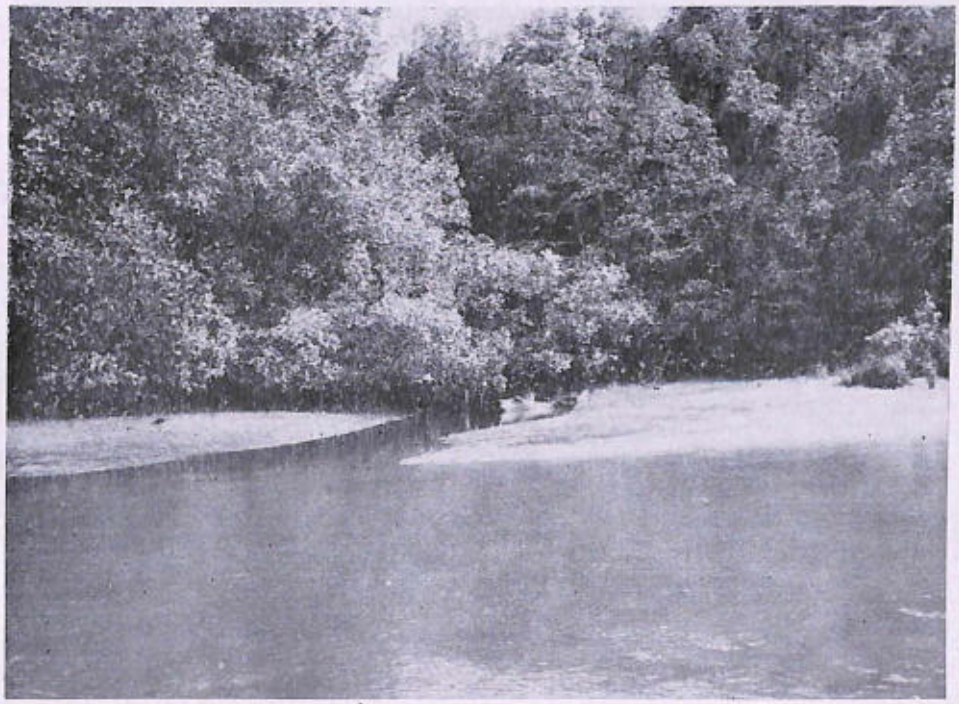
The study area lies south of the Tropic of Cancer between 12°50′ to 13°13′N and experiences a tropical climate, warm and moist throughout the year except for a cool period during December and January. The location subjects it to the South-West monsoon from the beginning of May to the middle of October and the North-East monsoon from the middle of October to mid-December.

North Andaman receives less rainfall than Middle and South Andaman. The average annual rainfall recorded at Mayabundar, the northern most part of Middle Andaman is 216 cm. Because most of the landmass of North Andaman lies on the lee side of Saddle Peak (737 mts) it receives less of the South-West monsoon.

The mean maximum/minimum temperatures for North Andaman are 27.7°C/24.3°C respectively and humidity is relatively high at 80% (Lal 1976).

Vegetation:

The vegetation along the streams and creeks can be classified into three distinct types; zone 1: tidal mangroves (Plate I), zone 2: standing cane, sometimes associated with bamboo brakes, (Plate II), zone 3: low level evergreen, riverine forests along the banks of the streams (Plate II). All these three vegetational types occur within 300 mts of a high water mark. The stratification from coastal mangroves (foreground) to the evergreen forests (background) is clearly illustrated in Plate III. Settlements have been established on the upper reaches of the streams due to availability of fresh water, and forests have been cleared to provide cultivated land.



Above: Typical mangrove vegetation along the Kalpang River, East coast of North Andaman. *Below*: Typical, shallow, West coast, creek with pebble bed providing excellent habitat for *C. porosus*.

Above: Zone III. Creeping cane, in this case associated with bamboo brakes, inland from the main river. Note the firm ground in this vegetational zone not usually liable to flooding. *Below*: Zone III. Creeping cane/evergreen forest complex at the head of a side creek. It is in this zone that most of the nests occur.

Rhizophora mucronata and *Rhizophora apiculata* are the major plant species bordering the creeks with a height of 10 mts or more. Immediately behind this zone follows *Brugviera parviflora* and *B. gymnorrhiza* with an undergrowth of *Ceriops tagal* (Blasco 1977). This zone is called *Khals* (Bengali) by the East Bengal settlers living in North Andaman.

The transitional zone of the tidal mangroves and the riverine forests forms a belt of cane brakes which is most important in the present context as this is the best nesting habitat for saltwater crocodiles in North Andaman. *Calamus andamanicus* and *Calamus palustris* dominate this belt. Creeping cane, is also present in this region. In the next zone of semi-evergreen and evergreen climaxes, dense clumps of bamboo *Oxylenanthera nigso-ciliata* occurs with scattered trees of *Dipterocarpus incanus. Planchoria andamanica, Pinsonia exelsa* etc. Actually the cane brakes and semi-evergreen climax zone is a continuous zone which has been divided here for convenience.

Materials and Methods

Nests were located with the help of boats or by walking along the river and stream banks. Local people also assisted in showing areas where nests had been seen by them in previous years. Wherever the nests were located incidence of egg robbing, flooding and predator damage were noted. Measurements of nest dimension, its position in relation to permanent water, physical surroundings, vegetation in and around the nest, presence of wallows around the nest and presence of nesting female near the nest, were also noted irrespective of the condition of the nest.

Results

The Nest:

The members of the Order Crocodylia lay their eggs in one of two nest types. These are, hole nests and mound nests. In hole nests eggs are laid in a pit dug in dried mud-banks or sand. In mound nesting, rather like Megapode birds, the eggs are laid in the middle of a nest mound prepared with vegetation and mud. Eggs are deposited in a cavity dug in the central area of the elevated nest mound. The saltwater crocodile is a mound nester.

In the study area, the saltwater crocodile nests observed were made of vegetation and mud. The nest mound was circular in appearance with an elevated centre. Since ten, of fifteen nests personally inspected, had already been opened by humans no precise measurements of these nests could be taken. Of the remaining five nests, two opened by wild pigs also had a similar appearance. Only the two Monitor-predated nests, and one flooded nest, from which eggs were collected, were measured. Measurements were also taken of a nest made and abandoned in a wild sugarcane fringe. These three nests averaged about 75 cm in height and 2 mts. in diameter at the base.

The nests were observed to have been made in three types of vegetation zone. These are, tidal cane fringes, creeping cane and evergreen vegetation and cultivated land. In the tidal cane fringes, where four nests were observed (Table III), the nests were made of standing canes; *Calamus* sp. with a higher percentage of mud in the nest construction. The distance of the nearest permanent water varied considerably since the areas were inundated by the high tide. The surface around such nests was

mostly swampy with a certain depth (about 15 cm) of water present all the time. Since the nests were made mostly on the elevated bases of old cane clumps, they were at a higher level to the surrounding ground.

In the next nesting zone, proceeding further inland from creek-bank—the creeping cane and evergreen vegetation zone—ten nests were observed. The ground in this region was solid and dry. The vegetation used in nest making was mostly creeping cane and dry fallen leaves of evergreen trees. These nests had very little mud in them. The nearest permanent water (streambed) was as close as five mts. in some cases. A typical undisturbed nest in this zone is shown in Plate IV. The nest, opened to show the eggs, is shown in Plate IV. The presence of people gives a good idea of the physical size of the nest. In the third nesting zone of cultivated land along the freshwater streams and creeks, only one nest was observed. This nest was made of grass and miscellaneous shrubs without mud.

The nests observed were invariably close to water. Due to the influence of tides, the water mark on the banks also changed, and as such it was not possible to correctly measure the distance of permanent water from the nest. The distance of permanent water from the creeping cane/evergreen vegetation fringes varied at mean tide level from 5-50 mts.

The nests made in tidal can fringes were in shade all the time with the canopy of canes covering the nests. The nests in creeping cane and evergreen vegetation zone were on the forest edge thus exposing the nest to light for some part of the day.

The single nest observed in the cultivated land and the abandoned nest in the wild sugarcane fringes were both totally exposed with no protection from sun, wind and rain.

The presence of wallows near the nests was also recorded. Except for one nest in the cultivated land and one nest in the evergreen forest region, upstream from a creek, wallows were observed in all other nests. From a single wallow to as many as three were seen near the nests. The wallows near the tidal cane fringe nests were not very deep but the wallows in the creeping cane/evergreen forest fringe nests were deep. Wallows in the two habitats measured as follows: (a) tidal cane fringes (four nests observed with nine wallows: mean length, breadth and depth are followed by range in brackets 161.2 (105—185), 74.9 (63—90), 46.8 (35—65), (b) creeping cane/evergreen forests complex (nine nests observed with seventeen wallows) 176.0 (135—223), 81.6 (58—108), 113.2 (65—155). The difference in depth between the two habitats is significantly different.

Before any attempt was made to inspect the nests closely, the wallows were disturbed with long poles to note the presence of nesting females. Of the fifteen nests observed, nesting females were seen at three of them, one of which had the eggs intact, one had been predated by *Varanus* but the nest shape remained intact (Plate V) and the third nest had been destroyed by humans, and at another nest, also destroyed by humans, an adult was observed in the water of the creek close to the nest. Additionally, tracks, believed to be those of the nesting females, were seen at six of the nests. Though many of them seemed to be fresh, the last visit of the nesting female to the nest could not be ascertained with certainty. Thus nest-guarding was taking place, or could be inferred, at ten of the fifteen nests. It is noteworthy that at the nest from which eggs were collected and the female was present in the adjacent wallow the mother crocodile meekly ran into the water after once being poked with a long pole.

Above: A view of the East coast from the open sea. The fringing mangroves are clearly visible, and behind and towering over them, the darker vegetation of the evergreen forests. Between these are the transitional tidal cane fringes. *Below*: Mangroves, completely felled and cleared, on the West coast, for use as fuel and for house construction.

Above: An undisturbed saltwater crocodile nest (the only one encountered during the study) in creeping cane/evergreen forest, Zone III, on the West coast. *Below*: The same nest opened to expose the eggs. This plate gives a good impression of the size of the nest, here mostly constructed of creeping cane and dry, fallen, leaves of evergreen forest trees.

NEST PREDATION

Of the thirty nests studied only one gave rise to hatchlings (Table 1).

TABLE 1

HATCHING OF NATURAL NESTS OF SALTWATER CROCODILE (*Crocodylus porosus*) AT NORTH ANDAMAN ISLAND.

Number of nests	Number hatched	Number destroyed by predators	Number flooded
30	1 (3.3)	28 (93.4)	1 (3.3)

(Figures are followed by percentage in brackets).

This results from an high incidence of nest predation, almost entirely by humans (Table 2).

TABLE 2

INCIDENCE OF NEST PREDATION

Number of nests	Predators			
	Humans	Monitors	Wild Pigs	Undetermined
26	22	2	2	2
	(84.6)	(7.6)	(7.6)	(7.6)

(Figures are followed by percentage in brackets).

Wherever, humans have taken the eggs clear evidence of clearing of bushes, canes etc., using sharp cutting instruments and complete destruction of the nest mound was observed. In case of wild pig predation, the nest mound was spoiled (Plate V) and hoof marks were clearly visible on the cleared vegetational area around the nest. The most clearly ascertained predation was that by Monitor lizards (*Varanus*). Fresh tracks as well as the tail marks with a few scattered egg-shells around a perfect nest with neat holes (Plate V) indicated the presence of *Varanus*. A Monitor Lizard was seen close by one of the two nests which had been predated by *Varanus* (Table 2). This nest also had the nesting female crocodile lying in one of the wallows on one side of the nest. The *Varanus* had made a neat hole in the opposite side and eaten all the eggs (on opening the nest no more eggs remained).

Non-human predators may not eat all the eggs. However, when the egg mass is exposed by a predator, the micro-environment of the nest, essential for incubation, is destroyed. Hatching of any of the remaining eggs is, therefore, unlikely. The nests observed with one exception (Table 3) were restricted to two vegetational complexes. No nests were observed in the mangroves at the mouths of the creeks. In these two types of vegetational complexes, namely tidal cane and creeping cane/evergreen forests, more than two-thirds of the total nests occurred (Table 3).

The break-up of nest predation in the nests personally observed in the various habitats is given in Table 4. Humans frequent both of the main nesting habitats, wild pigs are mostly in the creeping cane/evergreen vegetation and monitors favour the tidal cane fringes since they search for small invertebrate and vertebrate prey in the areas subject to inundation.

Table 5 analyses the human predation on eggs in the nesting habitats.

CROCODILE POPULATION

Data on the naturally occurring crocodile population were recorded during the course of this study. However, no night survey work was carried out for census determination purposes.

A female observed with her brood of young

TABLE 3

NEST LOCATION IN RELATION TO VEGETATION COMPLEX

Number* of nests	Location of nest			
	Mangroves	Tidal Cane Fringes	Creeping Cane and Evergreen Vegetation	Cultivated land along the fresh water streams
15	-	4 (26.6)	10 (66.6)	1 (6.6)

(Figures are followed by percentage in brackets).

* These fifteen nests were all personally inspected.

TABLE 4

PREDATION IN RELATION TO VEGETATION COMPLEX

Vegetation complex	Predator				
	Humans	Monitors	Wild Pigs	Undetermined	Total
Tidal cane fringes	4 (26.6)	2 (13.3)	-	-	6 (40)
Creeping cane and evergreen vegetation	4 (26.6)	-	2 (13.3)	2 (13 3)	8 (53.4)
Cultivation lands along the fresh-water creeks	1 (6.6)	-	-	-	1 (6.6)
Total	9	2	2	2	15

(Figures are followed by percentage in brackets).

TABLE 5

TYPE OF HUMAN HUNTING ACTIVITY

Number of nests taken by humans	Type of human hunting activity	
	Deliberate hunting for eggs	Chance encounters of crocodile nests
22	19 (86.3)	3 (13.7)

(Figures are followed by percentage in brackets).

measured about 2.7 mts. Two nest-guarding females also measured approximately 2 mts. A third nest-guarding female measured approximately 3.5 metres.

Four crocodiles were sighted in the open water. Two measured approximately 3 to 3.75 mts and two were in excess of 4.5 mts, one of which measured about 6 mts. Apart from these eight adults, six juvenile crocodiles measuring not more than 1.2 mts were sighted in the creek emptying into Casurina Bay on

Above: A nest destroyed by wild pig. Note that the nest shape has been completely lost and the debris scattered over a wide area. *Below*: A nest preyed upon by monitor lizard. The nest retains its shape and access to the eggs is gained through a well defined hole. Two wallows can be seen behind the nest on left and right.

the West Coast, and a cluster of approximately twentyfive recent hatchlings was sighted in the company of their mother at a creek on the west coast.

The crocodiles actually sighted are given according to size/age class group in Table 6.

Adult Losses:

During the nest survey information on killing of nesting females was also collected. A total of five nesting females were reported to have been killed during the 1978 nesting season. Of these killings four were reported from the west coast (Casurina and Hudson Bay) where encroachment on forest land along the fresh water streams is very high. Activities such as bamboo and cane cutting, crabbing and fishing are also high. One nesting female was reported to have been killed on the Kalpang river in an area of cultivated land (but outside the cultivation season). All these females were reported to have been of less than three metres in size.

TABLE 6

DIFFERENT SIZE/AGE CLASSES OF SALTWATER CROCODILES SEEN IN NORTH ANDAMAN

Number of crocodiles seen	Adults			Hatchlings	Yearlings/Second years
	Nesting females	Other adults	Total		
39	4	4	8	Approx.25 in one group	6

Further insight into the population structure can also be obtained from an examination of clutch size data, since clutch size in saltwater crocodiles increases with increase in length/age females. Precise data are available for six nests from this study and cross-checked reports of clutch size for further five nests (Table 7 and Figure 1).

TABLE 7

CLUTCH SIZE OF SALTWATER CROCODILE IN NORTH ANDAMAN

Cluth size*		Mean (all nests)
Confirmed	Unconfirmed	
55	39	
60	39	
42		
42	39	46.1
42	69	
67	19	
Mean 51.3	Mean 41.0	

* During 1976 June one nest collected from North Andaman had 51 eggs, and during the latter part of June/July 1976 another nest with 72 eggs was also observed by Whitaker (1978).

DISCUSSION

Whitaker and Whitaker (1978) have stated that North Andaman nests are susceptible to flooding and predation, especially by the water monitor (*Varanus salvator*). These observations are not borne out by the present quantitative study also in North Andaman. While it is true that nests of saltwater crocodiles tend to be susceptible to flooding, the building of two-thirds of the nests in the cane/creeping cane, evergreen forest interphase area reduces this most effectively. Only one nest (3.3%) was lost from this cause (Table 3).

Flooding was the major cause of the nest loss in Webb *et al.*'s (1977) study in which

Above: A nest destroyed by wild pig. Note that the nest shape has been completely lost and the debris scattered over a wide area. *Below*: A nest preyed upon by monitor lizard. The nest retains its shape and access to the eggs is gained through a well defined hole. Two wallows can be seen behind the nest on left and right.

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	Nesting females	Other adults	Total		
39	4	4	8	Approx.25 in one group	6

Further insight into the population structure can also be obtained from an examination of clutch size data, since clutch size in saltwater crocodiles increases with increase in length/age females. Precise data are available for six nests from this study and cross-checked reports of clutch size for further five nests (Table 7 and Figure 1).

TABLE 7

CLUTCH SIZE OF SALTWATER CROCODILE IN NORTH ANDAMAN

Cluth size*		Mean (all nests)
Confirmed	Unconfirmed	
55	39	
60	39	
42		
42	39	46.1
42	69	
67	19	
Mean 51.3	Mean 41.0	

* During 1976 June one nest collected from North Andaman had 51 eggs, and during the latter part of June/July 1976 another nest with 72 eggs was also observed by Whitaker (1978).

Adult Losses:

During the nest survey information on killing of nesting females was also collected. A total of five nesting females were reported to have been killed during the 1978 nesting season. Of these killings four were reported from the west coast (Casurina and Hudson Bay) where encroachment on forest land along the fresh water streams is very high. Activities such as bamboo and cane cutting, crabbing and fishing are also high. One nesting female was reported to have been killed on the Kalpang river in an area of cultivated land (but outside the cultivation season). All these females were reported to have been of less than three metres in size.

DISCUSSION

Whitaker and Whitaker (1978) have stated that North Andaman nests are susceptible to flooding and predation, especially by the water monitor (*Varanus salvator*). These observations are not borne out by the present quantitative study also in North Andaman. While it is true that nests of saltwater crocodiles tend to be susceptible to flooding, the building of two-thirds of the nests in the cane/creeping cane, evergreen forest interphase area reduces this most effectively. Only one nest (3.3%) was lost from this cause (Table 3).

Flooding was the major cause of the nest loss in Webb *et al.*'s (1977) study in which

twentyfour of thirty nests under study were flooded. However, data have to be collected over a number of years. In the Northern Australian environment due to marked variations in the severity of floods Bustard (unpublished data) arrived at an annual, average, nest loss, due to flooding, of about 50% for the West coast of the Cape York peninsula in North Queensland, Australia, in the vicinity of Edward River. In the present Andaman study of the fifteen nests personally inspected only one was flooded. However, the eggs were taken by people from most nests before they had a chance to be flooded. Incidence of flooding might, therefore, have been much higher in the absence of this very high level of human predation. However, even making allowance for this we do not anticipate a level anywhere

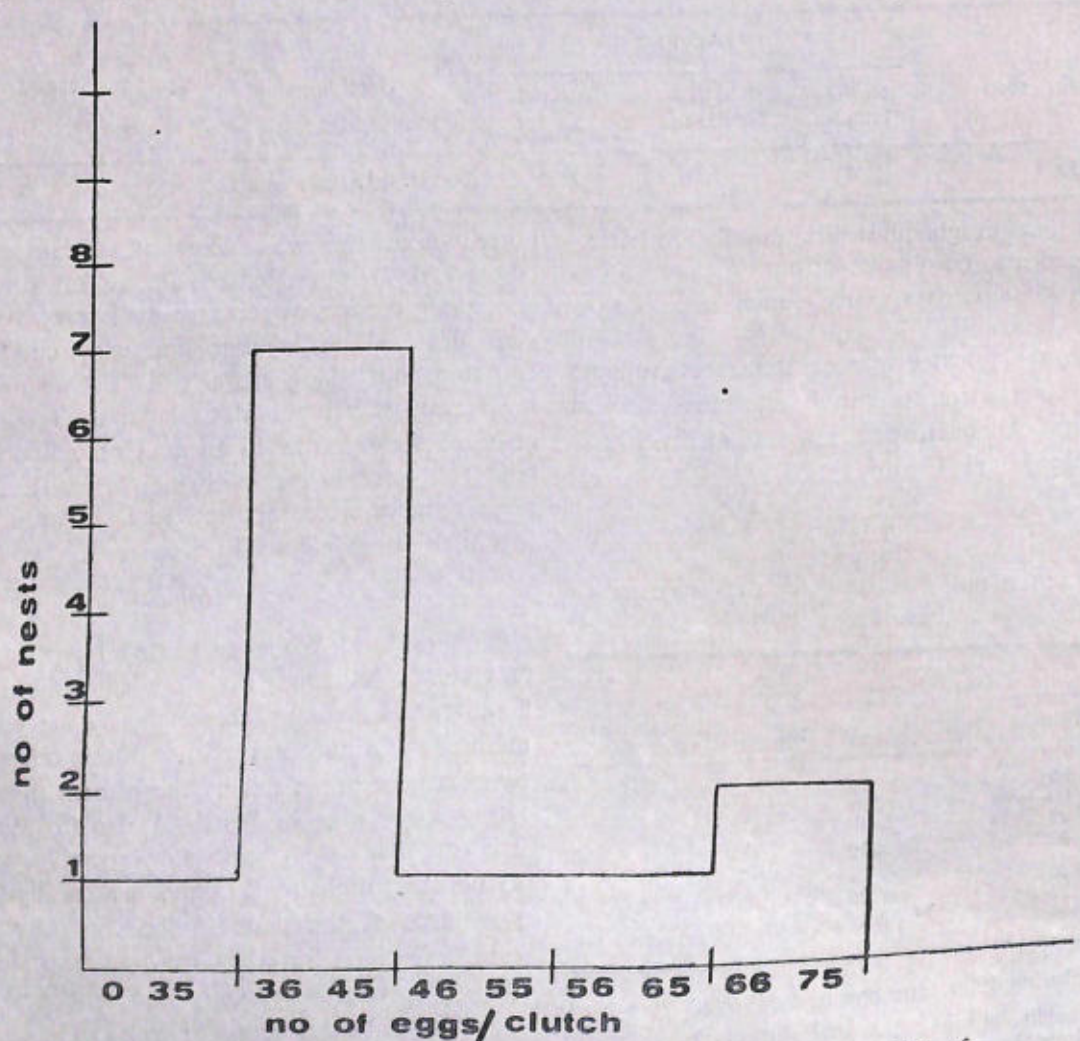

Fig. 1. Clutch size variation. Note 36—45 eggs is the most common range of clutch size.

approaching the Australian figures quoted by Webb *et al.* (80% of nests lost through flooding).

Webb *et al.* also record absence of nests from the tidal mangrove forests. There would appear to be good reason for this due to the high probability that nests laid in this environment would be flooded. Webb *et al.* give the mean distance of fifty nests from the water as 7.8 metres but agree with our observation that this distance is difficult to measure and somewhat arbitrary due to tidal fluctuations.

The mean dimensions of the three nests examined in the present study are considerably larger than those given by Neill (1971) for the Philippines, several parts of Indonesia and Papua (height 25-30 inches, diameter 4-5 feet), and the mean figure given by Webb *et al.* although our figures are well within the range observed by the latter authors.

Surprisingly, Neill (1971) dismisses the presence of nest wallows thus:

> "According to the Ceylonese legend, the female estuarine crocodile scoops out two basins near her nest, waits until these basins are full of water, and then with her tail splashes this water over the nest. It is easy to see how the legend of the two basins could have developed: the female uproots and scrapes up vegetation from a small area in which her nest will be located, and in so doing might easily leave depressions in which rainwater or seepage could accumulate."

With the exception of two nests, one to three wallows were always present in the present study. Bustard has also noted the invariable presence of wallows elsewhere in India and in Australia. Webb *et al.* also noted the presence of one to four wallows and raised the interesting question that these could be of two origins. While some might have been created by sweeping up mud and debris for nest construction as suggested by Neill, some, they state, appeared to have been excavated specifically for the crocodile to lie in. They noted, and this is the important point, that the nest-guarding crocodile occupies both types of wallow, an observation with which we concur. We confirm that the saltwater crocodile regularly lies in wallows close to the nest, both in the wild and in captivity (Bustard and Maharana in preparation).

The function of the wallow deserves discussion. We consider that they may play a role in thermoregulation—particularly where the nest is exposed to direct sunlight for part of the day. We also feel that wallows may have an important psychological effect for this very aquatic crocodilian. In this connection we would stress the role of the larger wallows—clearly constructed specifically for the crocodile to lie in as suggested by Webb *et al.*—since they are frequently many times larger than the total volume of nest material, so that Neill's suggestion that they occur as a by-product of nest construction is untenable (see Figure 2 of Webb *et al.* for a clear illustration of this). In these latter wallows, the crocodile can lie completely unseen, giving it a psychological advantage, and certainly a feeling of security. Further substantiation of this hypothesis comes from the fact that the wallows in the creeping cane/evergreen forest zone are deeper and longer compared to those in the tidal cane fringes. This increased depth is necessary in this drier zone to ensure a good supply of water. Incidentally, Deraniyagala (1939) also refers to the presence of nest wallows in Sri Lanka.

The mean clutch size observed by Webb *et al.* (1977) was fifty eggs (range 40 to 62). Neill (1971) gives a range of twentyfive to seventytwo. Our own observations for North

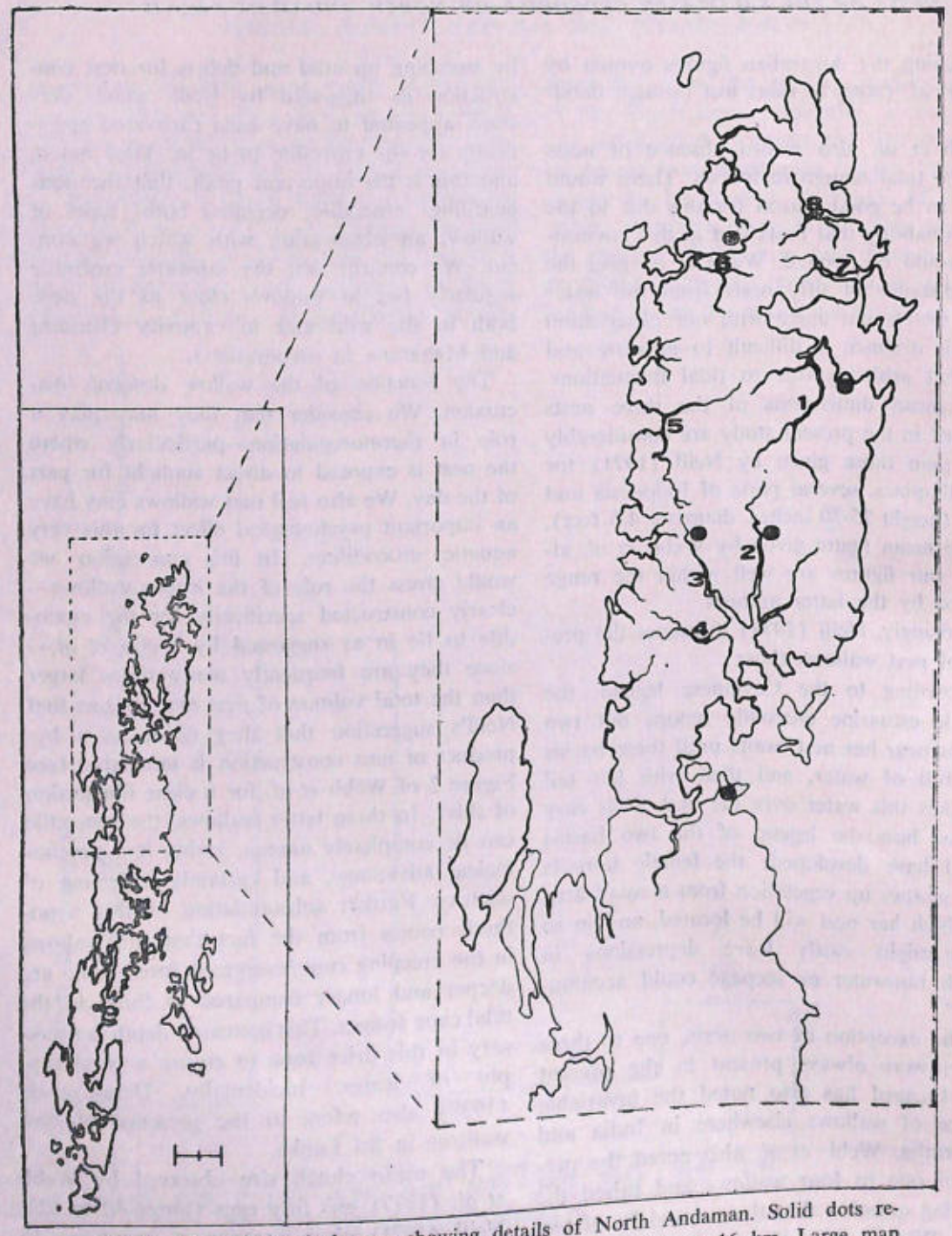

Fig. 2. Map of the Andamans showing details of North Andaman. Solid dots represent centres of field activity. Scale on small map represents 16 km. Large map not to scale. Numbers refer to rivers and creeks as detailed below:
1. Kalpang river, 2. Kalara Creek, 3. Parangara Creek, 4. Balmi Creek, 5. Creeks emptying into Casurina Bay, 6. Creeks South-West of Shyamnagar, 7. Creeks near Gandhinagar, 8. Creek emptying into Caddle Bay.

Andaman give a mean, based on confirmed nest data, of fiftyone eggs (range 42 to 67), remarkably similar to the data of Webb *et al.*

Nest materials in the present study were fresh leaves of standing canes eight to nine feet tall, fresh leaves of the much taller creeping cane, and dead evergreen tree leaves. This agrees with Smith (1931). Neill (1971) found tall green grass or herbaceous aquatic plants most commonly used in the Philippines, Indonesia and Papua. Kopstein (1929) noted that in Java the nests were constructed of man height grass and small branches. It would appear that the saltwater crocodile uses the available material. For instance, in North Andaman there is no herbaceous aquatic vegetation, and the single nest found in cultivated land was made of grass and miscellaneous shrubs.

In the present study no emaciated crocodiles were seen as reported by Deraniyagala. We believe that the nest-guarding female leaves the nest periodically for unknown periods of time. This fits in with frequent observations of tracks leading from the nests to the water and absence of female crocodiles from the wallows near the nest, a view which agrees with the data of Webb *et al.* (1977) but conflicts with the data of Deraniyagala (1939). Incidentally, the latter's observation that two nest-guarding individuals which he shot had empty stomaches is not convincing data that they do not feed during the incubation period as very many stomachs of crocodiles shot during the course of normal activities were found to be completely empty of food (Cott 1961).

Neill (1971) states that the female saltwater crocodile will guard the nest against man. We have no personal experience of this in Andamans, although occasional instances are known to us from elsewhere. We consider the trait unusual, nowadays, since such nest-guarding females are usually killed.

Human predation was found to be eleven times more serious than that of either the water monitor lizard or wild pigs (Table 2). These latter predators could have been expected to take a larger proportion of eggs in the absence of a such a high level of human predation. Human predators, as a result of deliberate hunting for eggs, get to the nest shortly after the eggs have been laid, before other predators chance upon the nest. The intensity of human predation on saltwater crocodile nests is in part a result of the belief in the medicinal properties of the eggs (believed to be a reliable cure for rheumatism and bronchitis) combined with the fact that the nesting season takes place with the onset of the South-West monsoon at a time when the villagers are going to the forest to collect cane and bamboo to fence in their fields against wild pig (*Sus andamanicus*) and cheetal (*Axis axis*). Cultivation has not yet started, and encouraged by the believed medicinal values of the eggs, they have ample time to search out the nests.

The very high level of predation, despite nest-guarding by the female, requires elaboration. Firstly, taking the case of the two main non-human predators, the female crocodile, if present at the nest, will not hesitate to attack. However, during an incubation period extending over about two months, it is not possible for the female to remain alert at all times. Even when the female is present at one of the wallows it may be possible for a predator to approach the nest undetected from the other side. An instance of this was observed when visiting a nest, the eggs of which had been eaten by the water monitor. The female crocodile was present in one of the wallows at the time of the visit and it

could be seen that the nest had been opened from the opposite side through a neat hole (Plate V) and the entire clutch consumed. As mentioned in Results the mother crocodile does not remain at the nest throughout the entire incubation period. Should the predator arrive at the nest during one of the absences of the female predation is, of course, simple. The nest guarding behaviour of the female crocodile is an aspect of the nesting biology which deserves quantitative study in the field.

Turning to human predation, there has been active selection against females which will guard the nest in the face of a human intruder. Since, such females are easily killed they do not survive to pass on this trait to their offspring (it should be noted that crocodile hunters elsewhere in the world, who may not be interested in the eggs, often shoot nest-guarding female due to the ease with which they can (could) be shot. Nowadays it is unusual, therefore, for a female to attack humans at the nest and it would seem that the present predation pattern on adults, as well as eggs, would favour poor mothers who desert the nest at the first sight of a human intruder! To this should be added the fact that hunting pressure has reduced the average age, and, therefore, average size of nest guarding females. Not only are present-day, nest-guarding females, smaller and therefore, less able physically to protect the nest against predators but they are new or relatively new nesters and, therefore, inexperienced.

The small size of most of the observed females reinforces the concern for the future of this population, since it indicates that they have only recently recruited to the breeding population, and that hunting pressure on nesting females is severe.

Exact information about the female breeding population size can be gathered from precise knowledge of the number of nests. In the present study thirty nests in which eggs have been laid were located, and an additional nest was located which had been constructed by a female which did not lay eggs in it. This phenomenon is discussed by Webb *et al.* This female might have laid subsequently elsewhere. The nest survey was carried out exhaustively. It is unlikely that nests were missed except, perhaps, in the most remote areas. If it is assumed that a further five to six nests were laid and missed, this gives a breeding population of thirtysix females for North Andaman, considered to be the best remaining area in the Andamans for the saltwater crocodile. Assuming the expected sex ratio of about 2.5 females per male the breeding male population would be approximately 15. Due to a probably higher incidence of killing nesting females the male population may be somewhat higher.

There is a need to strengthen the Wild Life Wing of the Andamans Forest Department so that it can offer more effective protection in the field to such an endangered—and fully protected—member of the Indian fauna. A Union Territory such as Andaman and Nicobars should set an example to other States. The problem of the conservation of the saltwater crocodile—on an all India basis—is taken up in a later paper.

ACKNOWLEDGEMENTS

The study was carried out as a part of Government of India Project on Crocodile Breeding and Management. We gratefully acknowledge the support of our respective organisations, the Forest Department of Andhra Pradesh and the Food and Agriculture Organisation of the United Nations. We are also indebted to Andaman and Nicobar Forest Department for their co-operation and field assistance.

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NEW DESCRIPTIONS

TAXONOMIC STUDIES ON SOME INDIAN EULOPHID PARASITES (HYMENOPTERA: CHALCIDOIDEA)[1]

M. YOUNUS KHAN AND S. ADAM SHAFFE[2]

(With four text-figures)

Additional generic characters of pronotum, subgenital plate and external female genitalia are proposed for the genera *Euplectrus* Westwood, *Scotolinx* Ashmead and *Syntomosphyrum* Foerster. One known species of *Euplectrus* (*E. gopimohani* Mani), one known species of *Scotolinx* (*S. quadristriata* Subba Rao and Ramamani) and two new species of *Syntomosphyrum* (*S. udaipurensis* sp. nov. and *S. anomalococci* sp. nov.) are described in detail. Key to species of *Syntomosphyrum* is also provided. Holotypes, paratypes and other material examined by the authors are deposited in Zoological Museum, Aligarh Muslim University, Aligarh, India.

Genus **Euplectrus** Westwood

Euplectrus Westwood, 1832, *Phil. Mag.* 3: 128.

Type-species: *Euplectrus maculiventris* Westwood = *Pteromalus bicolor* Swederus (Monobasic).

The genus *Euplectrus* was proposed by Westwood (1832) for the species *Euplectrus maculiventris* Westwood. The genera *Diplectron* Dahlbom and *Pachyscapha* Howard are generally considered as synonyms of *Euplectrus* Westwood by all recent workers. Recently, Kerrich (1974) synonymized the genus *Rekabia* Cameron with *Euplectrus* Westwood. The distinguishing characters of this genus have been given in detail by Nikol'skaya (1952) and Peck *et al.* (1964). Some new generic characters are suggested namely Pronotum with anterior margin deeply concave in middle, antero-lateral arms long and narrow, posterior margin convex (fig. 1 D); first valvifers triangular with basal and apical angles at different levels (fig. 1 K); third valvulae rudimentary, articulated with second valvifers (fig. 1 L); outer plates of ovipositor narrow at base, broadened at apex (fig. 1 M); subgenital plate of uniform width, anterior margin straight, posterior margin with a notch in middle (fig. 1 N).

Euplectrus gopimohani Mani (Fig. 1 A-N)

Euplectrus gopimohani Mani, 1941, *Indian J. Ent.*, 3: 33.

FEMALE (Redescribed in detail).

Head (fig. 1 A).—Dark with metallic reflections except clypeal region which is yellowish brown, triangular in facial view; frontovertex slightly more than twice as wide as long, width slightly more than half the total head width; ocelli white, arranged in obtuse triangle, lateral ocelli twice their own diameters from orbital margin and less than their own diameters from occipital margin; eyes dark brown and smooth; antennae inserted below lower level

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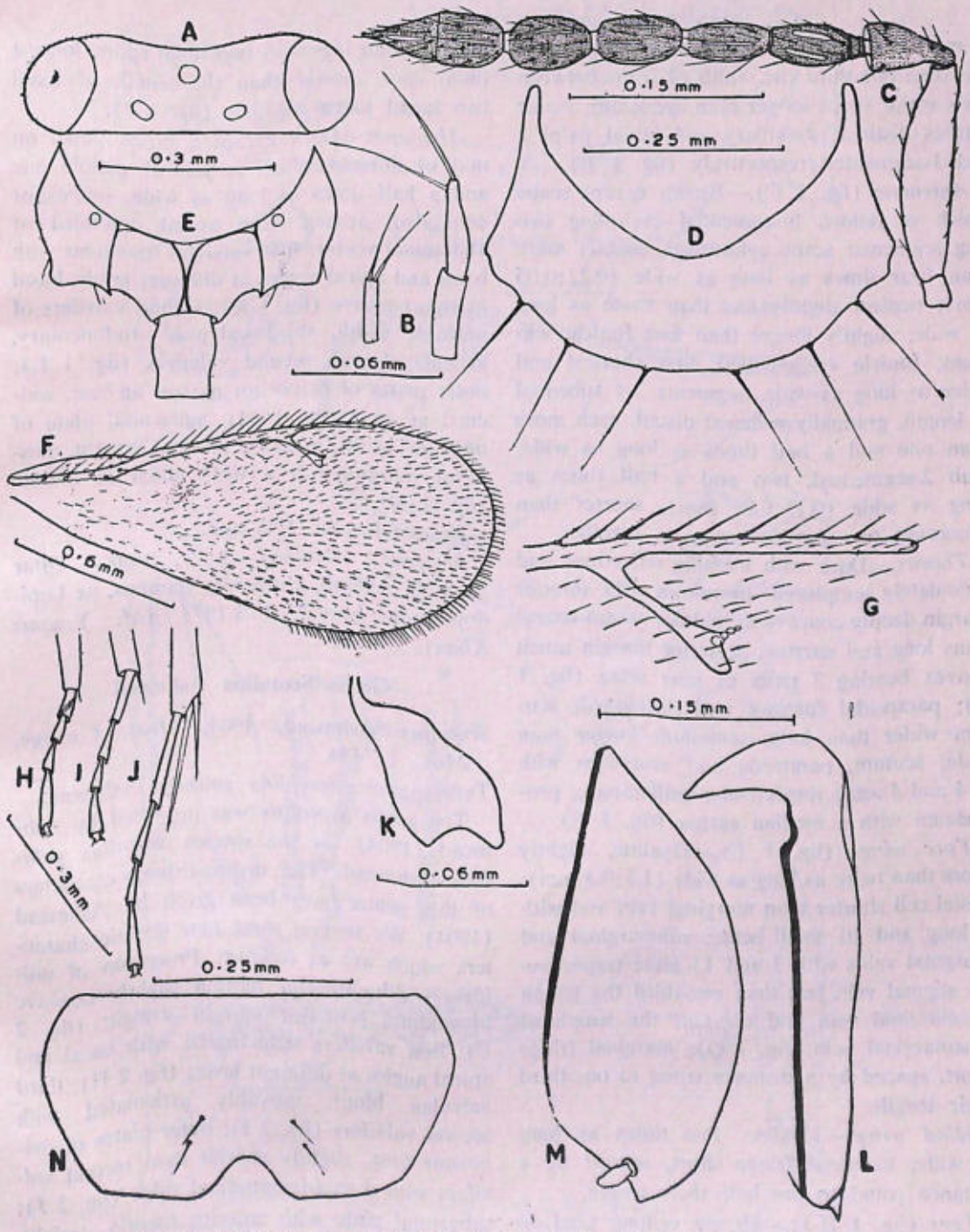

Fig. 1 A-N. *Euplectrus gopimohani* Mani, ♀ : (A) Head in dorsal view; (B) Maxillary and labial palpi; (C) Antenna; (D) Pronotum; (E) Propodeum and petiole in dorsal view; (F) Fore wing; (G) Part of fore wing venation; (H) Part of fore leg; (I) Part of Middle leg; (J) Part of hind leg; (K) First valvifer; (L) Second valvifer and third valvula; (M) Outer plate of ovipositor; (N) Subgenital plate.

of eyes; prominence between antennal sockets less than one-third the width of frons between eyes; malar space longer than eye width; malar sutures distinct; maxillary and labial palpi 2 and 1-segmented respectively (fig. 1 B).

Antennae (fig. 1 C).—Brown except scape which is yellow, 8-segmented excluding two ring segments; scape cylindrical, slightly more than four times as long as wide (0.22:0.05 mm); pedicel slightly less than twice as long as wide, slightly longer than first funicle segment; funicle 4-segmented, first shortest and twice as long as wide; segments 2-4 subequal in length, gradually widened distad, each more than one and a half times as long as wide; club 2-segmented, two and a half times as long as wide (0.15:0.06 mm), shorter than preceding two funicle segments together.

Thorax.—Dark with metallic reflections and reticulately sculptured; pronotum with anterior margin deeply concave in middle, antero-lateral arms long and narrow, posterior margin much convex bearing 3 pairs of long setae (fig. 1 D); parapsidal furrows well developed; scutum wider than long; scutellum longer than wide; scutum, parapside and scutellum with 6, 4 and 4 setae respectively; axillae bare; propodeum with a median carina (fig. 1 E).

Fore wings (fig. 1 F).—Hyaline, slightly more than twice as long as wide (1.5:0.7 mm); costal cell shorter than marginal vein and with 5 long and 10 small setae; submarginal and marginal veins with 3 and 13 setae respectively; stigmal vein less than one-third the length of marginal vein and one-half the length of postmarginal vein (fig. 1 G); marginal fringe short, spaced by a distance equal to one-third their length.

Hind wings.—Hyaline, five times as long as wide; marginal fringe short, spaced by a distance equal to one-half their length.

Legs (fig. 1 H-J).—Honey yellow; tarsi 4-jointed; hind legs with two tibial spurs, longest tibial spur shorter than the length of basal two tarsal joints together (fig. 1 J).

Abdomen.—Dark except a broad patch on mid of dorsum which is yellow; petiole one and a half times as long as wide; ovipositor concealed, arising from apical one-third of abdominal venter; first valvifers triangular with basal and apical angles at different levels, basal margin concave (fig. 1 K); second valvifers of uniform width, third valvulae rudimentary, articulated with second valvifers (fig. 1 L); outer plates of ovipositor narrow at base, widened at apex (fig. 1 M); subgenital plate of uniform width, anterior margin straight, posterior margin with a wide notch in middle (fig. 1 N).

Female length: 1.86 mm.

Material examined.—1 ♀, INDIA: Uttar Pradesh, Aligarh, University Campus, ex Lepidopterous Larva, 10.x.1977 (*M. Younus Khan*).

Genus **Scotolinx** Ashmead

Scotolinx Ashmead, 1904, *Mem. Carnege. Mus.*, 1: 354.

Type-species: *Scotolinx gallicola* Ashmead.

The genus *Scotolinx* was proposed by Ashmead (1904) for the species *Scotolinx gallicola* Ashmead. The distinguishing characters of this genus have been given by Ashmead (1904). We suggest some new generic characters which are as follows: Pronotum of uniform width, anterior margin slightly concave in middle, posterior margin straight (fig. 2 E); first valvifers semicircular with basal and apical angles at different levels (fig. 2 H); third valvulae blunt, movably articulated with second valvifers (fig. 2 I); outer plates of ovipositor long, slightly shorter than second valvifers with a mid-longitudinal ridge (fig. 2 J); subgenital plate with anterior margin straight,

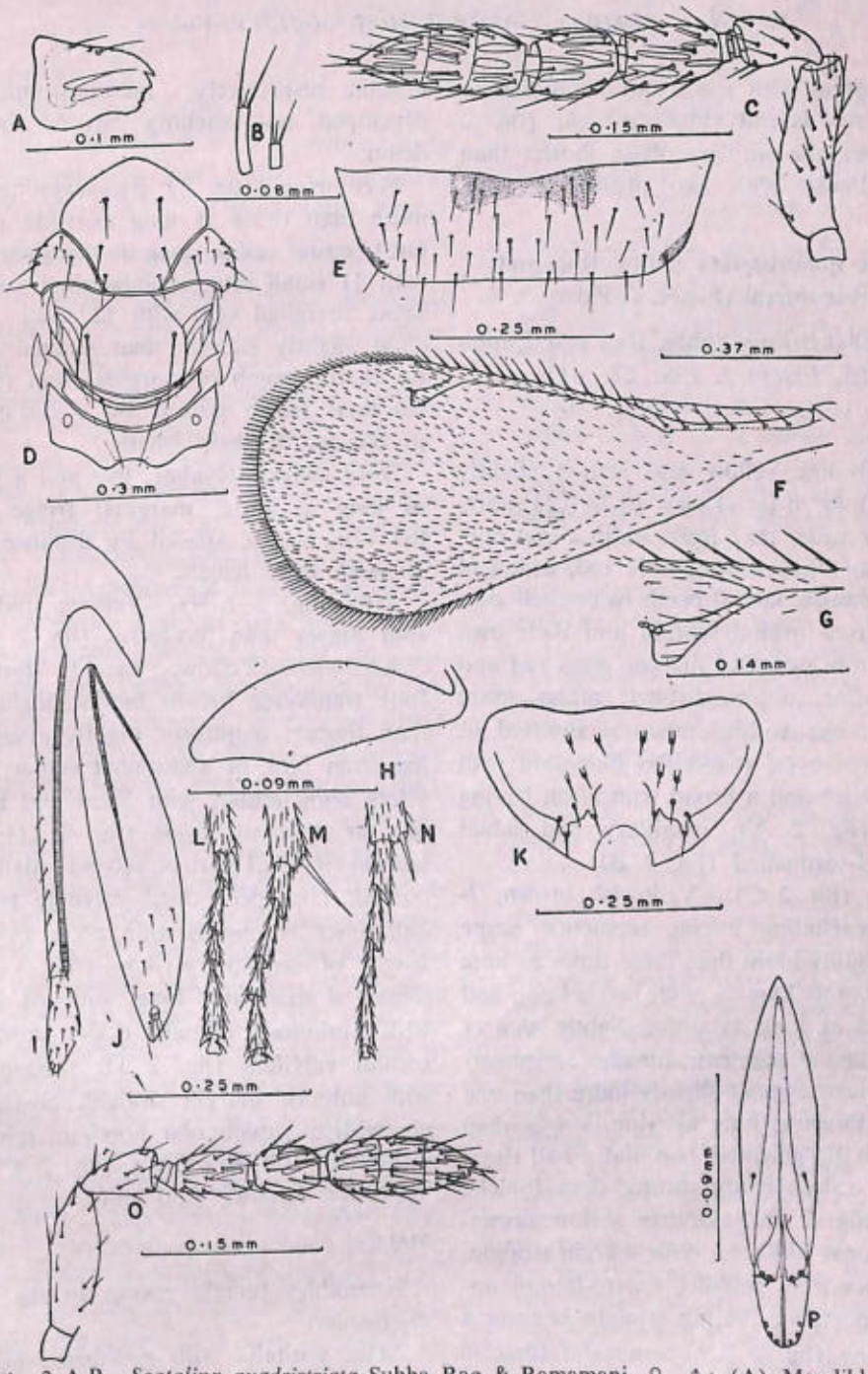

Fig. 2 A-P. *Scotolinx quadristriata* Subba Rao & Ramamani, ♀, ♂: (A) Mandible, ♀; (B) Maxillary and labial palpi, ♀; (C) Antenna, ♀; (D) Propodeum and part of thorax in dorsal view, ♀; (E) Pronotum, ♀; (F) Fore wing, ♀; (G) Part of fore wing venation, ♀; (H) First valvifer, ♀; (I) Second valvifer and third valvula, ♀; (J) Outer plate of ovipositor, ♀; (K) Subgenital plate, ♀; (L) Part of fore leg, ♀; (M) Part of middle leg, ♀; (N) Part of hind leg, ♀; (O) Antenna, ♂; (P) Genitalia, ♂.

posterior margin with a semicircular notch in middle, postero-lateral ridges present (fig. 2 K); male genitalia with gonobase shorter than aedeagus, digitus with two projections (fig. 2 P).

Scotolinx quadristriata Subba Rao and Ramamani (Fig. 2 A-P)

Scotolinx quadristriata Subba Rao and Ramamani, 1965, *Indian J. Ent.* 27: 412.

FEMALE

Head.—Orange yellow and setose, slightly wider than long in facial view (0.28:0.23 mm); frontovertex wider than long, width about one-half the total head width; ocelli red, arranged in obtuse triangle, lateral ocelli twice their own diameters from orbital margin and their own diameters from occipital margin; eyes red and smooth; malar sutures distinct; malar space longer than eye width; antennae inserted at lower level of eyes; mandibles bidentate with one acute tooth and a broad truncation having serrations (fig. 2 A); maxillary and labial palpi each 1-segmented (fig. 2 B).

Antennae (fig. 2 C).—Yellowish brown, 7-segmented excluding 2 ring segments; scape flattened, slightly more than three times as long as wide, about as long as club; pedicel one and a half times as long as wide, slightly shorter than first funicle segment; funicle 2-segmented, first funicle segment slightly more than one and a half times as long as wide, longer than second; club 3-segmented, two and a half times as long as wide, slightly shorter than funicle.

Thorax (fig. 2 D).—Orange yellow pronotum of uniform width, anterior margin straight, slightly concave in middle, antero-lateral angles acute, posterior margin straight bearing 4 pairs of setae (fig. 2 E); parapsidal furrows complete; scutum and scutellum with 6 and 4 setae respectively; mesopostphragma well developed, not reaching beyond the propodeum.

Fore wings (fig. 2 F).—Hyaline slightly more than twice as long as wide (1.26:0.58 mm); costal cell as long as marginal vein and with 11 small setae; submarginal vein with 5 setae; marginal vein with 12 setae; postmarginal slightly shorter than stigmal and one-fourth the length of marginal vein (fig. 2 G); marginal fringe spaced by a distance equal to one-fourth their length.

Hind wings.—Hyaline, five and a half times as long as wide; marginal fringe one-third the wing width, spaced by distance equal to one-fifth their length.

Legs (fig. 2 L-N).—Yellow; middle tibial spur longer than basitarsus (fig. 2 M).

Abdomen.—Yellow, except dorsum with four transverse brown bands, silghtly longer than thorax; ovipositor slightly exserted, arising from base of abdominal venter; first valvifers semicircular, with basal and apical angles at different levels (fig. 2 H); anterior margin of basal part of second valvifers much curved, U-shaped; third valvulae two and a half times as long as wide, about one-fifth the length of second valvifers (fig. 2 I); outer plates of ovipositor long, widened in middle with mid-longitudinal ridge, shorter than second valvifers (fig. 2 J); subgenital plate with anterior margin straight, posterior margin with a semicircular notch in middle, postero-lateral ridges present (fig. 2 K).

Female length: 1.38 mm.

MALE

Resembles female except in the following characters:

Male genitalia with gonobase shorter than aedeagus, digitus short, each with two pro-

jections (fig. 2 P).

Male length: 0.98 mm.

Material examined: 2 ♀, 1 ♂, INDIA: Rajasthan, Udaipur, ex leaf mining Lepidoptera on *Citrus* sp., 1.x.1975 (*M. Younus Khan*).

Genus **Syntomosphyrum** Foerster

Syntomosphyrum Foerster, 1878, *Verhandl. Naturhist. Ver. Preuss. Rheinl. u. Westfalens*, 35: 60.

Type-species: *Syntomosphyrum fulvipes* Foerster (Monobasic).

The genus *Syntomosphyrum* was proposed by Foerster (1878) for the species *S. fulvipes* Foerster. Muesebeck *et. al.* (1951) considered the genus *Tetrastichopsis* Girault to be a synonym of *Syntomosphyrum* Foerster. Recently, *Syntomosphyrum* Foerster was synonymized with *Aprostocetus* Westwood by Graham (1961) and with *Tetrastichus* Haliday by Domenichini (1965). However, Waterston (1915 a & b), Ferrière (1933, 1940), Muesebeck *et al.* (1951), Kurian (1954), Burks (1952, 1967), Risbec (1957), Peck (1963) and Peck *et al.* (1964) recognized *Syntomosphyrum* as a valid genus. They separated it from its closely allied genera by the absence of longitudinal grooves on scutum and scutellum. We have followed earlier workers in treating *Syntomosphyrum* as a valid genus. This view gets support from Kerrich's (1969) separation of *Platocharis* Kerrich and *Schizocharis* Kerrich on the basis of the presence or absence of scutellar grooves. Some new generic characters are suggested namely Pronotum with anterior margin deeply concave, posterior margin straight or slightly curved (fig. 3 F; fig. 4 D); third valvulae movably articulated with second valvifers (fig. 3 I; fig. 4 H); posterior margin of subgenital plate with a notch in middle (fig. 3 K; fig. 4 J); male genitalia with gonobase longer than aedeagus, digitus short, each with single projection (fig. 3 N).

KEY TO SPECIES OF *Syntomosphyrum* FOERSTER, BASED ON FEMALES

1. Funicle segments subquadrate or longer than wide.....2
— Funicle segments transverse; first funicle segment with two sensoria; bristle to spur of club as long as or longer than the last club joint.....*S. indicum* Silvestri
2. Pedicel longer than first funicle segment.....3
— Pedicel as long as or shorter than first funicle segment.....4
3. Abdomen shorter than head and thorax together; antennae with 2 ring segments; vertex smooth; body aeneous black.....*S. javanicum* Ferriere
— Abdomen as long as head and thorax together; antennae with 3 ring segments; vertex finely punctate; body orange yellow.....*S. obscuriceps* Ferriere
4. Pedicel shorter than first funicle segment; first funicle segment more than one and a half times as long as wide; thorax brown or yellow, non-metallic; submarginal vein with 3 or 4 setae.....5
— Pedicel as long as first funicle segment; first funicle segment as long as wide; thorax dark brown; submarginal vein with 2 setae.....*S. taprobanes* Waterston
5. Thorax brown; scutum with 16 longitudinal ridges anteriorly and with a row of 4 setae near each parapsidal furrow (fig. 3 E); first funicle segment less than twice as long as wide, second and third each slightly longer than wide; club much longer than preceding two funicle segments together; submarginal vein with 3 setae; first valvifers with basal and apical angles at different levels (fig. 3 H).....*S. udaipurensis* sp. nov.
— Thorax yellow; scutum with 4 or 5 longitudinal ridges anteriorly and with 8 setae irregularly arranged near each parapsidal furrow (fig. 4 C); first funicle segment more than twice as long as wide, second and third each twice as long as wide; club as long as preceding two funicle segments together; submarginal vein with 4 setae; first valvifers almost semicircular with basal and

apical angles in one plane (fig. 4 G).....
.....*S. anomalococci* sp. nov.

Syntomosphyrum undaipurensis sp. nov.
(Fig. 3 A-N)

FEMALE

Head (fig. 3 A).—Brown, wider than long in facial view; frontovertex width more than one-half the total head width; ocelli yellowish, arranged in obtuse triangle, lateral ocelli slightly more than their own diameters from orbital and less than their own diameters from occipital margins; eyes red and smooth; malar space longer than eye width; malar sutures distinct; antennae inserted above lower level of eyes; prominence between antennal sockets about one-fourth the width of frons between eyes; mandibles tridentate with apical tooth long and acute, mesal small and acute, lower rudimentary (fig. 3 B); maxillary and labial palpi each 1-segmented (fig. 3 D).

Antennae (fig. 3 C).—Brownish, except scape and apical half of pedicel which are yellow; 8-segmented excluding 2 ring segments; scape cylindrical, slightly more than three times as long as wide (0.10:0.03 mm); pedicel one and a half times as long as wide, shorter than first funicle segment; funicle 3-segmented; segments 1-3 gradually decreasing in length distad; first funicle segment longest, more than one and a half times as long as wide, second and third slightly longer than wide; club 3-segmented, much longer than preceding two funicle segments together.

Thorax (fig. 3 E).—Brown; pronotum broad, antero-lateral angles acute, posterior margin straight, lateral margin of each side with a small protuberance, posterior submarginal ridge absent (fig. 3 F); scutum slightly wider than long with 16 longitudinal ridges anteriorly and a row of 4 setae near each parapsidal furrow; each parapside with single seta; scutellum wider than long and with two pairs of setae; scutum and scutellum without longitudinal grooves; propodeum with a median carina diverging backwards.

Fore wings (fig. 3 G).—Hyaline, slightly more than twice as long as wide (0.85:0.4 mm); costal cell long and narrow, slightly shorter than marginal vein and with 8 small setae; submarginal and marginal veins with 3 and 11 setae respectively; postmarginal vein rudimentary; marginal fringe short, spaced by a distance equal to one-fourth their length.

Hind wings.—Hyaline, four times as long as wide; marginal fringe spaced by a distance equal to one-fourth their length.

Legs.—Yellow; tarsi 4-jointed; mid tibial spur shorter than basitarsus.

Abdomen.—Dark brown except base which is yellow, as long as head and thorax together; ovipositor slightly exserted, arising from near base of abdominal venter; first valvifers semicircular with basal and apical angles at different levels (fig. 3 H); third valvulae five times as long as wide, slightly less than one-half the length of second valvifers (fig. 3 I); outer plates of ovipositor long and of uniform width (fig. 3 J); subgenital plate with anterior margin slightly concave, posterior margin semicircular with a notch in middle (fig. 3 K).

Female length: 1.07 mm.

MALE

Resembles female except in the following characters:

Body yellowish brown; antennae (fig. 3 M) 9-segmented; scape slightly flattened, two and a half times as long as wide; pedicel slightly longer than wide, longer than first funicle segment; funicle 4-segmented, each segment with a whorl of long hairs; first funicle segment

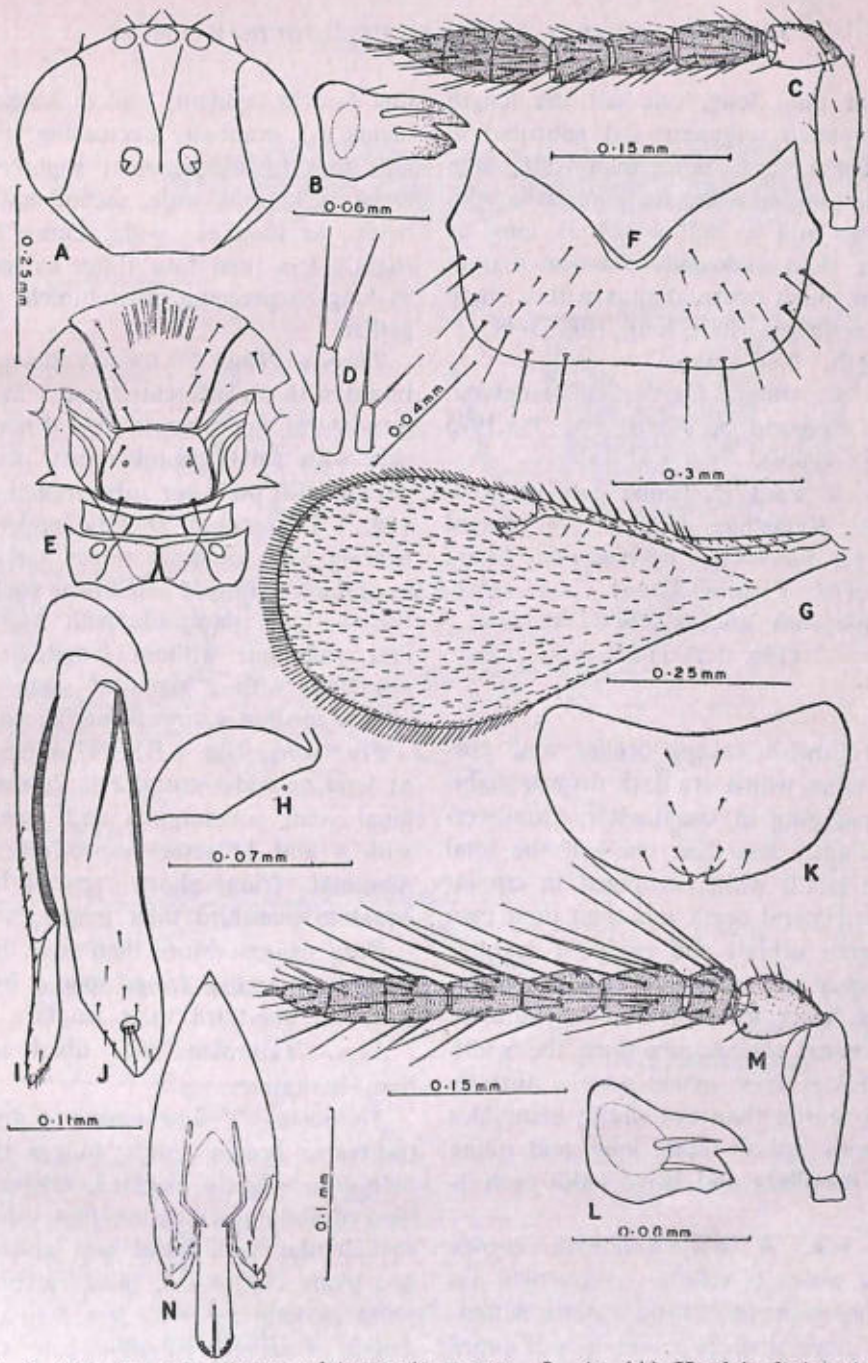

Fig. 3 A-N. *Syntomosphyrum udaipurensis* sp. nov., ♀, ♂: (A) Head in facial view, ♀; (B) Mandible, ♀; (C) Antenna, ♀; (D) Maxillary and labial palpi, ♀; (E) Propodeum and part of thorax in dorsal view, ♀; (F) Pronotum, ♀; (G) Fore wing, ♀; (H) First valvifer, ♀; (I) Second valvifer and third valvula, ♀; (J) Outer plate of ovipositor, ♀; (K) Subgenital plate, ♀; (L) Mandible, ♂; (M) Antenna, ♂; (N) Genitalia, ♂.

slightly wider than long, one-half the length of second segment, segments 2-4 subequal in length, each distinctly longer than wide; club four times as long as wide; male genitalia with gonobase two and a half times as long as wide, longer than aedeagus, anterior margin of basal part much acute, digitus with a small projection, aedeagal shaft long (fig. 3 N).

Male length: 0.96 mm.

Holotype ♀. INDIA: Orissa, Bhubaneswar, ex eggs of Fulgorid on *Ficus* sp., 4.ix.1975 (*M. Younus Khan*).

Paratypes. 4 ♀, 3 ♂ (same data as holotype); 10 ♀, Rajasthan, Udaipur, ex eggs of *Pyrilla* sp. on *Saccharum officinarum* Linn., 10.viii.1977 (*M. Younus Khan*).

Syntomosphyrum anomalococci sp. nov.
(Fig. 4 A-J)

FEMALE

Head.—Yellowish except ocellar and postoccipital regions which are dark drown, slightly wider than long in facial view; frontovertex width slightly less than one-half the total head width; ocelli white, arranged in equilateral triangle; lateral ocelli less than their own diameters from orbital and occipital margins separately; eyes red and smooth; antennae inserted above lower level of eyes; prominence between antennal sockets one-third the width of frons between eyes; malar sutures distinct; malar space shorter than eye width; mandibles tridentate with apical tooth long and acute (fig. 4 A); maxillary and labial palpi each 1-segmented.

Antennae (fig. 4 B).—Yellowish brown except scape which is yellow, 8-segmented excluding 2 ring segments; scape slightly flattened, slightly more than two and a half times as long as wide (0.13:0.05 mm); pedicel one and a half times as long as wide, shorter than first funicle segment; funicle 3-segmented, segments 1-3 gradually decreasing in length distad; first funicle segment slightly more than twice as long as wide, second and third each twice as long as wide; club 3-segmented, slightly less than four times as long as wide, as long as preceding two funicle segments together.

Thorax (fig. 4 C).—Yellow; pronotum broad with an infuscated patch in middle, antero-lateral angles acute, lateral margin of each side with small protuberance, posterior margin straight, posterior submarginal ridge absent (fig. 4 D); scutum slightly longer than wide, bearing 5 longitudinal ridges anteriorly and 8 irregularly arranged setae near each parapsidal furrow; each parapside with 7 setae; scutum and scutellum without longitudinal grooves; scutellum with 2 pairs of setae; propodeum with a median carina diverging backwards.

Fore wings (fig. 4 E).—Hyaline, about twice as long as wide; costal cell shorter than marginal vein; submarginal and marginal veins with 4 and 11 setae respectively (fig. 3 F); marginal fringe short, spaced by distance equal to one-third their length.

Hind wings.—More than four times as long as wide; marginal fringe spaced by a distance equal to one-third their length.

Legs.—Yellowish; mid tibial spur shorter than basitarsus.

Abdomen.—Yellow except dorsum with transverse brown bands, longer than thorax; ovipositor slightly exserted, arising from near base of abdominal venter; first valvifers almost semicircular with basal and apical angles in one plane (fig. 4 G); third valvulae long, six times as long as wide, less than one-half the length of second valvifers (fig. 4 H); outer plates of ovipositor long and of uniform width (fig. 4 I); subgenital plate of uniform width,

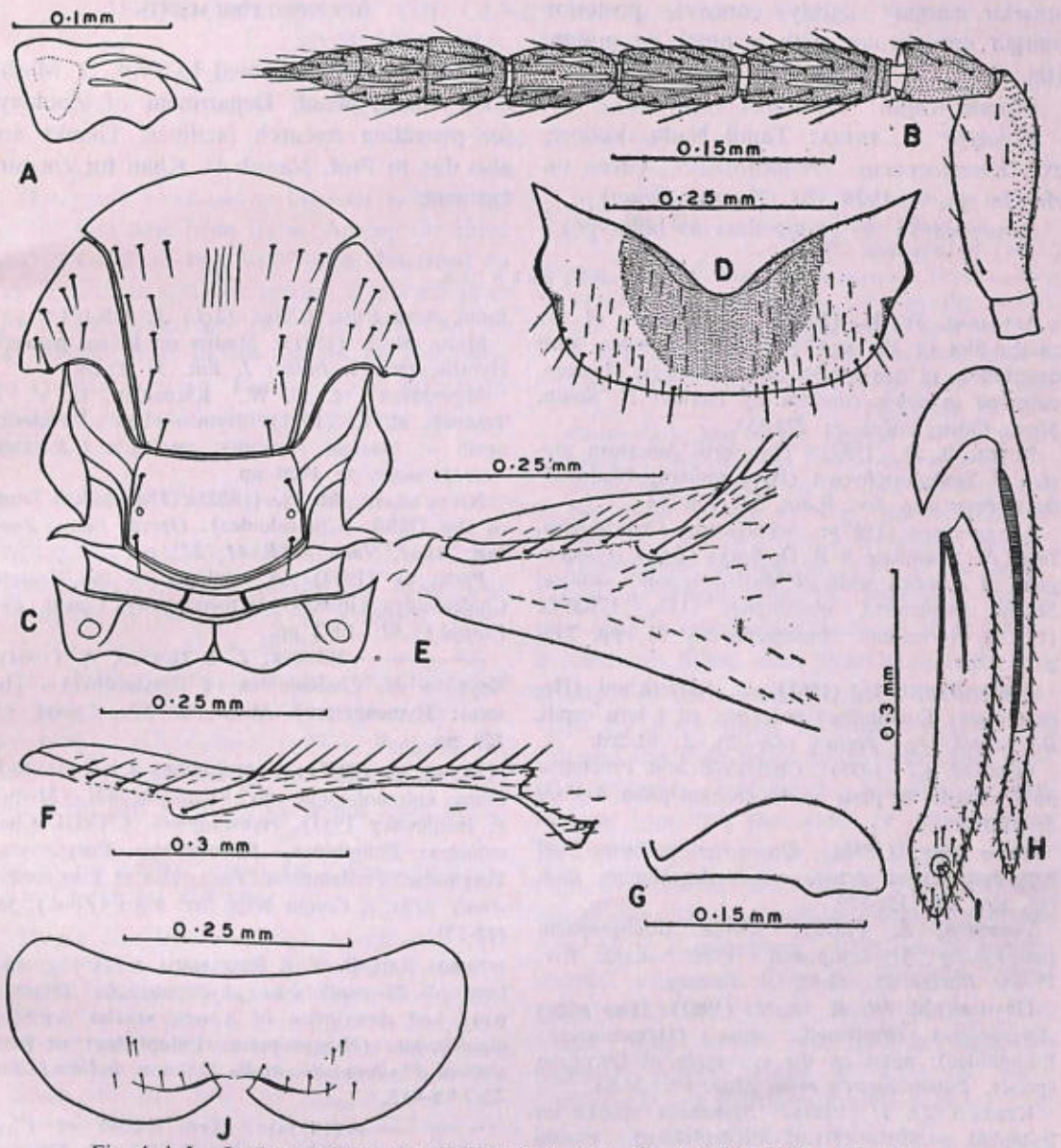

Fig. 4 A-J. *Syntomosphyrum anomalococci* sp. nov., ♀: (A) Mandible; (B) Antenna; (C) Propodeum and part of thorax in dorsal view; (D) Pronotum; (E) Basal part of fore wing; (F) Fore wing venation; (G) First valvifer; (H) Second valvifer and third valvula; (I) Outer plate of ovipositor; (J) Subgenital plate.

anterior margin slightly concave, posterior margin semicircular with a notch in middle (fig. 4 J).

Female length: 1.4 mm.

Holotype ♀. INDIA: Tamil Nadu, Vellore, ex *Anomalococcus cremastogastri* Green on *Acacia* sp., 4.i.1976 (*M. Younus Khan*).

Paratypes 15 ♀ (same data as holotype).

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.

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INDIAN SPECIES OF THE GENUS *TRICHAPORUS* FOERSTER (HYMENOPTERA: APHELINIDAE)[1]

M. NAYYAR AZIM AND S. ADAM SHAFEE[2]

(With eleven text-figures)

The genus *Trichaporus* Foerster is recorded for the first time from India. Among the three species collected two have been described as new to science and one species *T. partenopeus* (Masi) has been reported for the first time. A key to the three Indian species of *Trichaporus* Foerster is given. The specimens have been deposited in the Zoological museum, Aligarh Muslim University, Aligarh, India.

Genus *Trichaporus* Foerster

Trichaporus Foerster, 1856, *Hym. Stud.* 2:84.
Type-species: *Encarsia partenopea* Masi. Designated by Nikol'skaya & Yasnosh, 1966, *Opred. Faune. SSSR.* 91:264.

The distinguishing characters of the genus *Trichaporus* Foerster have been given by Dozier (1933), Nikol'skaya (1952), Peck *et al.* (1964) and Nikol'skaya and Yasnosh (1966). This is the first report of the genus from India.

KEY TO THE INDIAN SPECIES OF *Trichaporus* FOERSTER, BASED ON FEMALES

1. Thorax completely yellowish brown (Fig. 4); scape longer than basal two funicle segments together, first funicle segment shorter than second (Figs. 2, 6) 2
— Thorax yellowish brown except one large patch on scutum and two small patches on scutellum which are dark (Fig. 10; Nikol'skaya & Yasnosh, 1966, Fig. 468); scape as long as basal two funicle segments together, first funicle segment as long as second (Fig. 9; Nikol'skaya & Yasnosh, 1966, Fig. 469); funicle segments 1-4 subequal in length; third valvulae short .... *T. partenopeus* (Masi)
2. Coxae yellow; first funicle segment twice as long as wide; funicle segments 2-4 gradually increasing in length distad, each more than two and a half times as long as wide; club five times as long as wide; scutum with three pairs of setae ..... *T. indicus* sp. nov.
— Coxae dark; first funicle segment one and a half times as long as wide; funicle segments 2-4 subequal, each about twice as long as wide; club four times as long as wide; scutum with four pairs of setae..... *T. gunturensis* sp. nov.

Trichaporus indicus sp. nov. (Figs. 1-5)

FEMALE: Head (Fig. 1) yellowish, wider than long in facial view (0.26:0.2 mm); frontovertex two times wider than long; ocelli red, arranged in obtuse triangle, basal ocellus separated by three times its diameter from eye rim and less than twice its diameter from occipital margin; prominence between antennal sockets one-fifth the width of frontovertex (0.03:0.15 mm); malar space slightly shorter than longitudinal diameter of eye (0.08:0.11 mm); eyes bare; mandibles tridentate; maxillary palpi 2-segmented, labial palpi unisegmented. Antennae (Fig. 2) yellowish; scape cylindrical, five times longer than wide, longer than basal two funicle segments together; pedicel twice as long as wide, distinctly longer than first funicle segment; first funicle segment shortest, about twice as long as wide; funicle segments 2-4 gradually lengthened distad, each more than $2\frac{1}{2}$ times longer than wide; club 2-segmented, five times longer than wide, slightly longer than preceding two funicle segments combined. Thorax yellowish

[1] Accepted May 1978.

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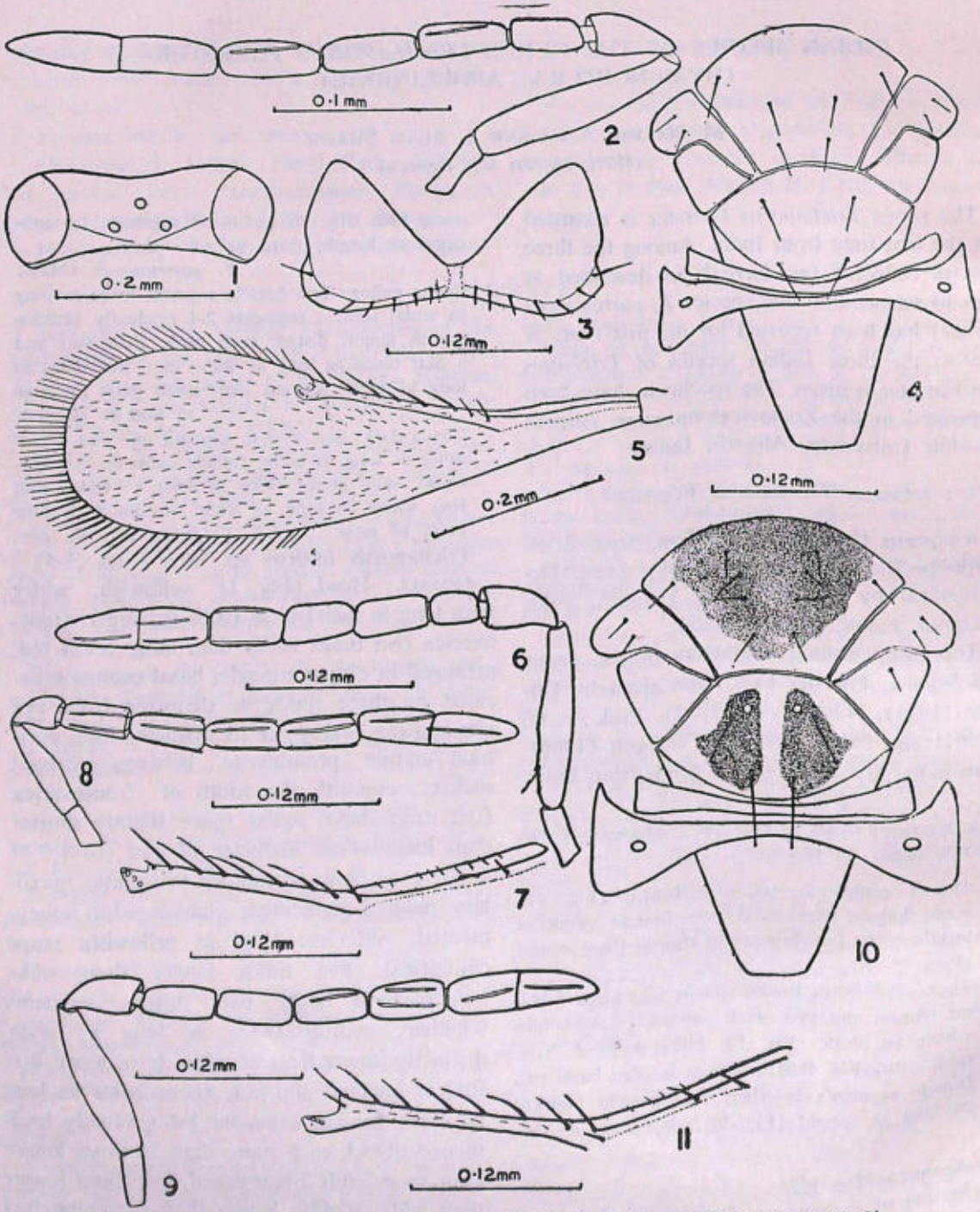

Figs. 1-5. *Trichaporus indicus* sp. nov., ♀, (1) Head, in dorsal view; (2) Antenna; (3) Pronotum; (4) Thorax; (5) Fore wing. Figs. 6-8. *Trichaporus gunturensis* sp. nov., (6) Antenna, ♀; (7) Fore wing venation, ♀; (8) Antenna, ♂. Figs. 9-11. *Trichaporus partenopeus* (Masi), ♀, (9) Antenna; (10) Thorax; (11) Fore wing venation.

brown; pronotum (Fig. 3) very narrow in middle, much expanded on sides, anterior margin deeply and acutely notched in middle; mesoscutum and scutellum with 3 and 2 pairs of setae respectively (Fig. 4); each parapside with 2 setae; axillae bare; scutum and scutellum with reticulate sculpture. Fore wings hyaline, three times longer than wide (0.63:0.21 mm) (Fig. 5); costal cell narrow; marginal vein slightly longer than submarginal vein (0.16:0.14 mm), the former with 8 setae; postmarginal vein rudimentary; stigmal vein short; marginal fringe short and are spaced by a distance equal to one-fourth their length. Hind wings hyaline, eight times longer than wide; marginal fringe longer than wing width. Legs orange yellow. Abdomen orange yellow except basal two segments which are infuscated; about as long as thorax (0.26:0.26 mm); ovipositor concealed.

Female length : 0.69 mm.

Holotype ♀, ex Aleyrodid on *Nerium*, INDIA, Tamil Nadu, Ootacamund, 24.vi.1968. Coll. S. Adam Shafee.

Paratypes. 6 ♀ (Same data as for holotype).

Trichaporus gunturensis sp. nov. (Figs. 6-8)

FEMALE: Head yellowish, wider than long in facial view; frontovertex about twice as long as wide; ocelli red, arranged in obtuse triangle, basal ocellus separated by more than twice its diameter from eye rim and twice its diameter from occipital margin; antennae inserted at lower level of eyes; malar space about as long as eye width; maxillary palpi 2-segmented, labial palpi unisegmented. Antennae (Fig. 6) yellowish; scape cylindrical, five times as long as wide, longer than basal two funicle segments together; pedicel twice as long as wide, distinctly longer than first funicle segment; funicle 4-segmented; first funicle segment shortest, one and a half times as long as wide; funicle segments 2-4 subequal in length, each twice as long as wide; club 2-segmented, four times as long as wide, slightly longer than preceding two funicle segments together. Thorax yellowish brown; mesoscutum and scutellum reticulately sculptured and with 4 and 2 pairs of setae respectively. Fore wings hyaline, three times as long as wide (0.6:0.2 mm); costal cell long and narrow; submarginal vein about as long as marginal vein; postmarginal vein rudimentary; stigmal vein short (Fig. 7); marginal fringe short, spaced by a distance equal to one-fourth their length. Hind-wings hyaline, about five times as long as wide; marginal fringe length more than the greatest wing width. Legs orange yellow except coxae which are dark. Abdomen orange yellow except basal two segments which are slightly infuscated; ovipositor concealed.

Female length: 0.72 mm.

Male antenna as shown in figure 8.

Holotype ♀. ex Aleyrodid on weed plant, INDIA, Andhra Pradesh, Guntur, Budampadu, 3.iii.1967. Coll. S. Adam Shafee.

Paratypes.—4 ♀, 3 ♂ (Same data as for holotype).

Trichaporus partenopeus (Masi) (Figs. 9-11)

Trichaporus partenopeus (Masi); Nikol'skaya & Yasnosh, 1966, *Opred. Faune. SSSR.* 91:267.

FEMALE: Head brownish, wider than long in facial view; frontovertex two and a half times wider than long; ocelli white, arranged in obtuse triangle, basal ocellus separated by twice its diameter from eye rim and by its own diameter from occipital margin; malar space longer than eye width; maxillary palpi 2-segmented, labial palpi unisegmented. Antennae (Fig. 9) yellowish; scape cylindrical, four times longer than wide, as long as basal

two funicle segments together; pedicel twice as long as wide, as long as first funicle segment; funicle segments 1-4 subequal in length, each slightly more than twice as long as wide; club 2-segmented, four times as long as wide, as long as preceding two funicle segments together. Thorax yellowish brown except one large patch on scutum and two small patches on scutellum which are dark; mesoscutum and scutellum reticulately sculptured and with 5 and 2 pairs of setae respectively. Fore wings hyaline, two and a half times as long as wide; costal cell narrow; submarginal vein shorter than marginal vein; postmarginal vein absent. Hind wings hyaline, seven times as long as wide; marginal fringe long, as long as wing width. Legs orange yellow. Abdomen orange yellow except base and lateral margins of dorsum which are infuscated; ovipositor concealed, arising from the base of abdomen.

Female length: 0.64 mm.

Material examined. 3 ♀, 2 ♂, ex Aleyrodid, INDIA, Maharashtra, Nasik, 4.v.1969. Coll. S. Adam Shafee.

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STUDIES ON THE SCARAB BEETLES (COLEOPTERA: SCARABAEIDAE) OF NORTH INDIA PART II. THREE NEW SPECIES AND TWO NEW RECORDS FROM INDIA[1]

S. BISWAS[2]

(With four text-figures)

Three new species, *Copris* (*S. str.*) *siangensis, Onitis assamensis* and *Drepanocerus kazirangensis* are described. Two species, *Drepanocerus runicus* Arrow and *Drepanocerus striatulus* Paulian are recorded for the first time from India.

1. **Copris (S. str.) siangensis** sp. nov. (Figs. 1, 2)

MALE: Body elongated oval, highly convex, upper surface black and shining; mouth organs, antennae, legs and scanty hairs beneath reddish.

Head broad, almost semicircular, with a long, backwardly directed horn with two tubercles, placed posteriorly about one third dist-

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ance from base; clypeus moderately strongly punctured, anterior margin reflexed and excised in the middle. Pronotum highly convex, strongly but unevenly punctured, anterior declivity feebly punctured and sides of mid-dorsal line almost smooth, upper margin of declivity with three sharp projections, middle one bifid at extremity; front angle blunt, truncated, hind angle obsolate, base rounded, lateral margin straight in front, rounded behind. Elytra strongly striate, striae closely punctured, interval a little convex, smooth and shining. Metasternal shield feebly punctured in the middle with a longitudinal groove; sides of metasternum bare, strongly punctured anteriorly. Front tibiae with 4 external teeth, apical spur broad toward apex. Pygidium strongly and uniformly punctured.

Measurement: Length, 12.0-13.5 mm; breadth 6.0-6.5 mm.

Holotype, ♂, collected from cattledung, India: Arunachal Pradesh, Siang: Along, 9.ii.1973 coll. R. S. Pillai, Regd. No. A1/4394. Paratypes 2 ♂♂, same data as for holotype.

Remarks: *Copris* (*S. str.*) *siangensis*, sp. nov. Comes near to *Copris* (*S. str.*) *delicatus* Arrow, but differs from the latter in having closely punctured clypeus and strongly developed prothoracic processes.

2. **Onitis assamensis** sp. nov. (Fig. 3)

FEMALE: Body broadly oval, not very convex; upper surface greenish, ventral surface brown, elytral suture and legs blackish.

Head subtriangular; with a short clypeo-frontal carina, posterior carina long, curved and entire, clypeus transversely rugulose, ocular lobes smooth, vertex deeply excavated, smooth posteriorly, finely tuberculate behind frontal tubercle. Pronotum very thinly and finely punctured anteriorly and laterally, closely and strongly in the middle near base; front angles sharp, hind angles obsolate, base rounded; lateral margin straight in front, feebly sinuate behind, mid-dorsal groove or line absent, basal fovae not large and separated from each other by more than the length of the fovae. Elytra broadly but shallowly striate, striae more broader laterally, intervals flat, not perceptibly punctured. Metasternum smooth, bare, flat, with a shallow longitudinal groove, base with two deep pits, sides of metasternum closely granular and hairy. Pygidium almost smooth without hair.

Measurement: Length; 23.0 mm; breadth, 12.0 mm.

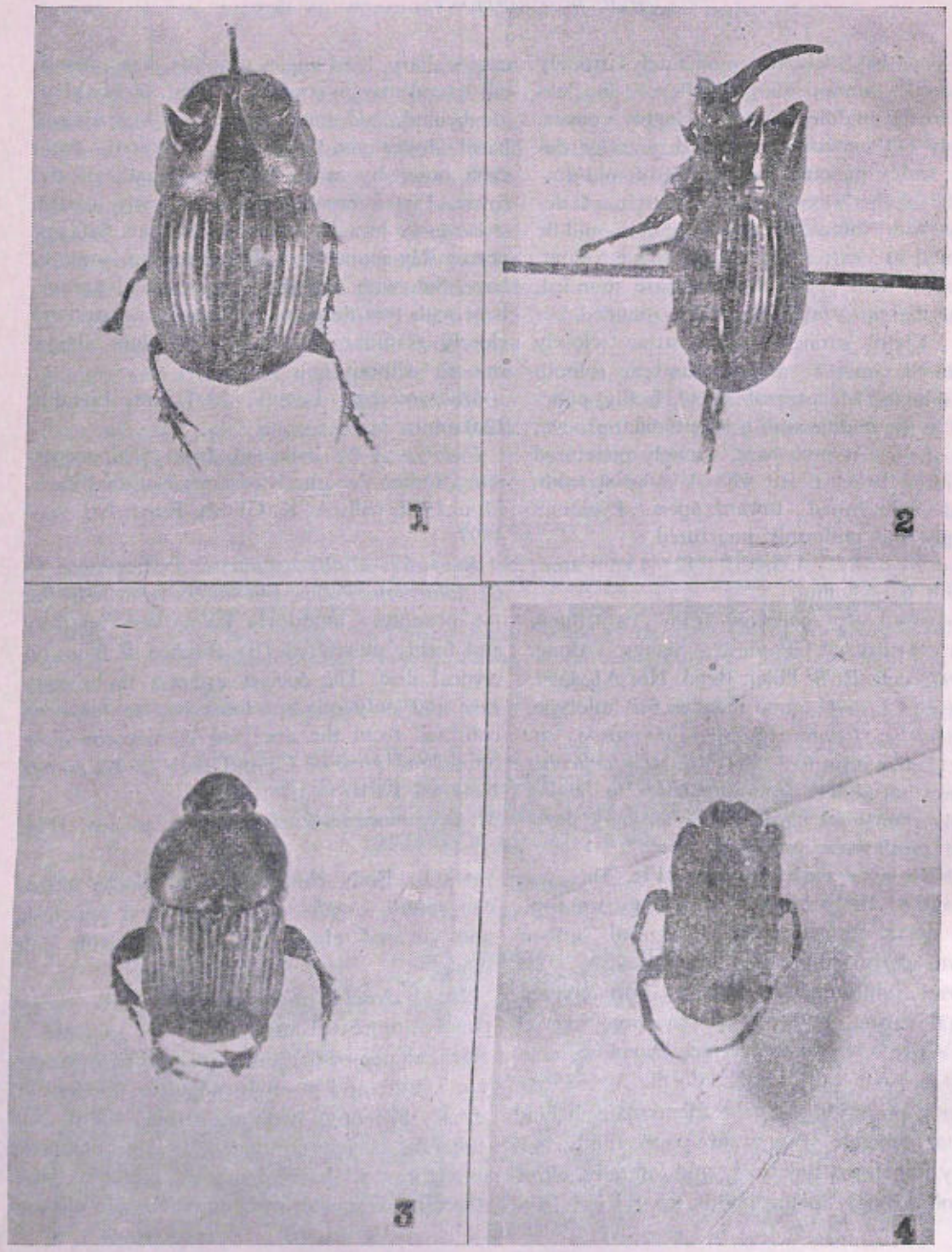
Holotype, ♀, collected from Rhinoceros-dung, India: Assam: Kaziranga National Park, 21.xii.1972, coll. A. K. Ghosh, Regd. No. A1/4397.

Remarks: *Onitis assamensis* comes close to *O. humerosus* Pallas, but differs from it in the (i) pronotum anteriorly being very sparsely and feebly punctured (ii) absence of hairs on clypeal disc. The species appears to be very rare and only one specimen has so far been collected from the decaying Rhinoceros dung on upland area of Central path in Kaziranga National Park.

3. **Drepanocerus kazirangensis** sp. nov. (Fig. 4)

MALE: Body elongated oval, black; antennae, mouth organs, tibiae, and tarsi brownish, and covered above and beneath with pale setae.

Head closely punctured, clypeal margin deeply impressed in the middle, rounded at sides, clypeo-ocular junction marked by carinate suture and strongly angulate in front of eyes. Pronotum without carina, horns and tubercle, closely covered with large umblicate punctures, a basal depressed pit near base, three more smaller ones on either side of basal



Figs. 1-2. *Copris* (*S. Str.*) *siangensis* sp. nov.: 1. Dorsal view; 2. Lateral view. Fig. 3. *Onitis assamensis* sp. nov.: Dorsal view. Fig. 4. *Drepanecerus kazirangensis* sp. nov.: Dorsal view.

depression anteriorly basal depression highly convex and gradually sloping in front, front angle blunt, hind angle obsolate, base rounded, lateral margin straight, feebly sinuate behind. Elytra narrowly striate, striae not very closely punctured, intervals covered with minute granules, 3rd interval convex anteriorly, 5th interval throughout the length with a setose ridge and 7th with an interrupted one behind shoulders. Metasternal shield vertical in front, middorsally convex anteriorly, rugosely punctured, more so behind; sides of metasternum closely covered with large shallow pits. All femora rugosely punctured, front tibiae with four external teeth, apical one directed forewords. Pygidium hollowed at base and apex, with an interrupted transverse ridge a narrow incomplete carina separating the basal depression into two halves. Last ventral sternite emarginate in the middle.

FEMALE: Same as male except with broad last ventral sternite.

Measurement: Length, 4.5-5.5 mm; breadth 2.5-3.0 mm.

Holotype, ♂, collected from dung of wild buffalo. India: Assam: Kaziranga National Park, 18.ii.1972. coll. G. M. Yazdani, Regd. No. A1/4777. Paratypes, 1 ♂, 4 ♀♀ data same as for holotype.

Remarks: *Drepanocerus kazirangensis* sp. nov. differs from *D. setosus* (Wied.), *D. sinicus* Harold, and *D. runicus* Arrow in having pronotum without any horn, carina or tubercle and from *D. striatulus* Paulian in having prosternum not being elevated behind front coxae. The species is peculiar in having single mid-dorsal depression in both sexes.

4. **Drepanocerus runicus** Arrow.

Drepanocerus runicus Arrow, 1931. Fauna Brit. India, Lamell., 3: 384.

Drepanocerus runicus Arrow, Balthasar, 1963. Monogr. Scarab. Aphod. palaearkt. orient; 2:66.

Arrow (1931) described the species from Burma: Karenhills: Asciuii Ghecu, Balthasar (1963) reported this species as being recorded also from Vietnam: Tonkin, Hoa Binh, Luc Nam. This is the first record of the species from India.

Material examined: INDIA: Assam: Goalpara, 4 ♂♂, 3 ♀♀, 17.i.1972. 1 ♂, 12.i.1972. North Cachar, 4 ♂♂, 3 ♀♀, 22.xi.1972. Manipur: Moreh, 3 ♂♂, 3 ♀♀, 21.i.1976. Meghalaya: Garo Hills, 9 ♂♂, 10 ♀♀, 8-15.iv.1973.

Remarks: Balthasar (op. cit.) considered the species to be rare. During the collection of Scarab beetles from different states in Northeast India it has been observed that the species is not rare but restricted to lower elevations upto *c* 1000 m. altitude and generally is not available in fresh dung. It is mostly confined to the dried crust of dung. When disturbed it withdraws its legs and remains motionless.

5. **Drepanocerus striatulus** Paulian

Drepanocerus striatulus Paulian, 1945. Col. Scarab. de L' Indochine: 138, 140.

Drepanocerus striatulus Paulian, Balthasar, 1963. Monogr. Scarab. Aphod. palaearkt. orient., 2: 69.

Paulian described the species from North Vietnam (Personal Communication). Balthasar (1963) reported this species as being recorded also from China (Kouy Tscheu). This is the first record of the species from India.

Material examined: India: Assam: Sibsagar, 2 ♂♂, 2 ♀♀. 22.xii.1972. North Cachar, 7 ♂♂, 8 ♀♀. 22.xi.1972. Lakhimpur, 10 ♂♂, 1 ♀, 8.xi.1972. Manipur: 9 ♂♂, 9 ♀♀, 23-25.iii.1975. Meghalaya: Garo Hills, 8 ♂♂, 7 ♀♀, 8-17.iv.1973.

Remarks: Balthasar (op. cit.) mentioned that the species is very rare. In Northeast India, however, the species may be considered to be common. His remark that the female of this species may be confused with those of *D. sinicus* Harold does not seem to be justified, as the species is peculiar in having much depressed body different types of elytral striae and prosternum elevated beyond the fore coxae, none of these characters is shared by *D. sinicus* Harold.

All types are at present in the collection of Eastern Regional Station, Zoological Survey of India, Shillong.

ACKNOWLEDGEMENTS

I am thankful to Dr. H. Khajuria for facilities, Dr. A. K. Ghosh for encouragement. My thanks are also due to Dr. R. Paulian Rector, Academy de Bordeux, France for kindly identifying *Drepanocerus striatulus* Paulian for me.

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TWO NEW SPECIES OF *BALOCHA* DISTANT (IDIOCERIDAE: HOMOPTERA)[1,2]

P. KAMESWARA RAO[3] AND
USHA RAMAKRISHNAN[4]

(With twenty-three text-figures)

Distant (1908) erected the genus *Balocha* with the type species, *Balocha tricolor* Distant from India. The species, *Idiocerus astutus*, described by Melichar (1903) from Nilgiri Hills was transferred to *Balocha* Distant by Maldanado (1964). Baker (1915) described *B. melichari* and *B. nacreatus* from Philippines. Further, Maldanado (1961) described *B. lucida* from Borneo and *B. pallida* from West Pakistan. Other species, subsequently added to genus *Balocha* are, *bicolor* from Borneo (Maldanado 1968), *maculifrons* and *pseudomaculifrons* from New Guinea and *unilineata* from New Britain (Maldanado 1970) This paper describes two more species of this genus.

KEY TO THE SPECIES OF *Balocha*

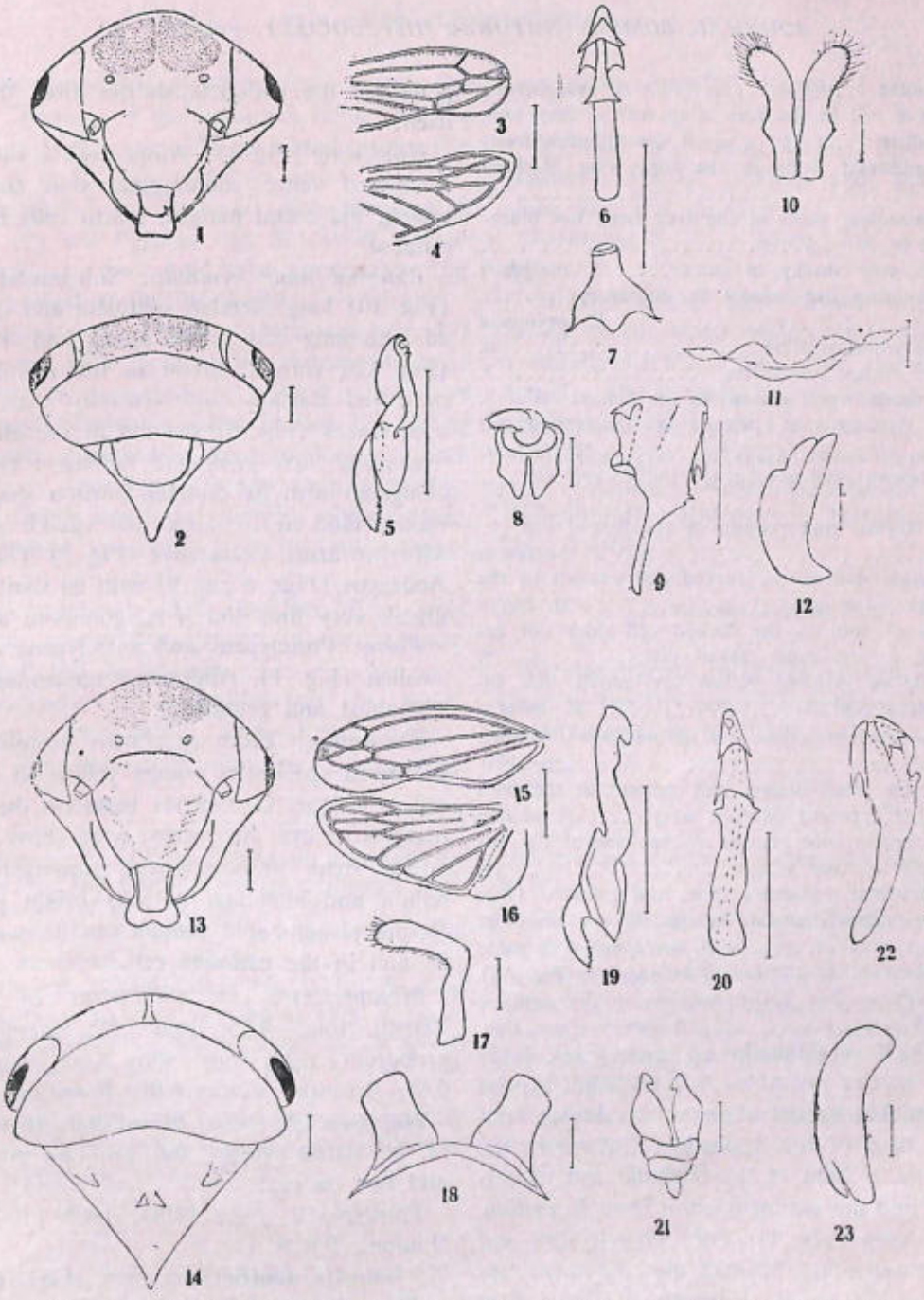
1. Face dark ..... 2.
   Face not dark ..... 3.
2. Forked cell in the fore wing with a very short

[1] Accepted November 1978.

[2] Part of the thesis of the senior author for the award of Ph.D. degree of I.A.R.I., New Delhi during 1976.

[3] Department of Entomology, A.P. Agril. University, Hyderabad-500 030.

[4] Division of Entomology, Indian Agril. Research Institute, New Delhi.



Figs. 1-12. *Balocha maldanadoi* sp. nov.: 1. face; 2. vertex, pronotum and scutellum; 3. forewing; 4. hind wing; 5. paramere; 6. aedeagus (caudal view); 7. connective; 8. anal tube appendages; 9. aedeagus (lateral view); 10. subgenital plates; 11. abdominal apodemes; 12. pygofer lobe. Figs. 13-23. *Balocha anufrievi* sp. nov.: 13. face; 14. vertex, pronotum and scutellum; 15. forewing; 16. hind wing; 17. subgenital plate; 18. abdominal apodemes; 19. paramere; 20. aedeagus (caudal view); 21. anal tube appendages; 22. aedeagus (lateral view); 23. pygofer lobe.

peduncle ..... *B. maculifrons*
Forked cell in the fore wing with a very long peduncle ..... *B. pseudomaculifrons*

3. Longitudinal veins in the fore wing blackened ..... 4.
Longitudinal veins in the fore wing not blackened ..... 5.
4. Fore wing smoky in colour.....*B. melichari*
Fore wing not smoky in colour..... *B. unilineata*
5. Fore wings hyaline ..... 6.
Fore wings subhyaline ..... 7.
6. A piceous spot, present in the forked cell...8.
No piceous spot, present in the forked cell ..... *B. astutus*
7. A brown spot present in the forked cell.... *B. bicolor*
No brown spot present in the forked cell.... *B. nacreatus*
8. Piceous spot in the forked cell extends to the outer apical cell ..... *B. lucida*
Piceous spot in the forked cell does not extend to the outer apical cell.....9.
9. With an invested yellow arc across face including ocelli .....*B. tricolor*
Without the yellow arc across face including ocelli ..... 10.
10. A very small brown spot present at the base of the appendix of fore wing.....*B. pallida*
No brown spot present at the base of the appendix of fore wing ..... 11.
11. Abdominal apodemes short and rounded (Fig. 11); paramere chelate in cephalic portion (Fig. 5) ..... *B. maldanadoi* sp. nov.
Abdominal apodemes subrectangular (Fig. 18) paramere (Fig. 19) nonchelate in the cephalic portion ..... *B. anufrievi* sp. nov.

1. **Balocha maldanadoi** sp. nov. (Figs. 1-12)

This species resembles *B. pallida* but can be differentiated by the absence of a brown spot at the base of the appendix. Internally the paramere is bifid at the cephalic end of this species and this distinguishes it from *B. pallida.*

Fore wing (Fig. 3): Fore wing hyaline and narrow extending beyond the abdomen; appendix very broad, extending to the third apical cell, four apical cells, third apical cell petiolate, the peduncle shorter than the cell itself.

Hind wing (Fig. 4): Wings hyaline with well developed veins; submarginal vein complete joining the costal margin; apical cells four in number.

External male genitalia: Sub-genital plate (Fig. 10) long, slender, spatulate and upcurved with long hair in the apical half. Pygofer (Fig. 12) convex, broad in the middle and narrowed dorsally and ventrally. Anal tube appendages (Fig. 8) pointed at the end.

Internal male genitalia: Paramere (Fig. 5) elongated with its cephalic portion short and broad, bifid at its apex, the caudal portion with two arms. Connective (Fig. 7) Y-shaped. Aedeagus (Figs. 6 and 9) with its shaft cylindrical, very thin and long, gonopore apical.

Form: Postclypeus and anteclypeus slightly swollen (Fig. 1). Abdominal apodemes (Fig. 11) short and rounded.

Coloration: Fresh specimens greenish and preserved specimens orange yellow to orange red in colour. Castaneous band on the inner margins of eye. Interocular area above ocelli, lateral areas on postclypeus stramineus, scutellum and abdomen dorsally bright orange. Round piceous spot present on the eye (Fig. 2) and in the petiolate cell.

Measurements in millimetres of male: Length: total—4.18; head 1.59; vertex—0.28; pronotum 0.38; fore wing 3.50; scutellum 0.67; Breadth: Vertex 0.96; Pronotum 1.25.

Holotype ♂, INDIA, Pusa-Bihar, 16-xi-1933, H. N. Batra (Wings and genitalia on slides and rest on tag).

Paratypes 2 ♂♂, INDIA, Delhi 10-i-1975, 'Jamon', P.K.R.

2. **Balocha anufrievi** sp. nov. (Figs. 13-23)

This species comes nearer to *B. maldanadoi* sp. nov. but can be differentiated by the shape

of the abdominal apodemes and in the cephalic portion of the paramere being fan-like.

Fore wings (fig. 15) and hind wings (fig. 16) as in *B. maldanadoi* sp. nov.

External male genitalia: Sub-genital plate (fig. 17) and Pygofer (fig. 23) as in *B. maldanadoi* sp. nov. Anal tube appendages (fig. 21) hooked at the distal end.

Internal male genitalia: Paramere (fig. 19) elongated with its cephalic portion involuted and ending in a fan-like portion. Connective Y-shaped. Aedeagus (figs. 20 and 22) having its shaft narrowed at apex, gonopore apical.

Form: Anteclypeus longer than wide (fig. 13), convex lengthwise showing slight ridging. Abdominal apodemes (fig. 18) subrectangular.

Coloration: As in *B. maldanadoi* sp. nov. Piceous round spot, present in the pedunculate cell and on the eye.

Measurements in millimetres of male: Length: total—4.70; head—1.54; vertex—0.19; Pronotum—0.58; forewing—3.94; scutellum—0.96. Breadth: vertex—1.10; pronotum —1.40.

Holotype ♂, INDIA: Delhi: 10-i-1975; 'Jamon', P.K.R. (Wings and genitalia on slides and rest on tag).

Paratypes 5 ♂♂ (same data as for holotype).

All the figures were drawn with camera lucida except wings which were drawn with a microprojector. Lines were drawn to 0.2 mm. for all the parts except in case of wings which were drawn to 1.0 mm.

All the type specimens were deposited in the National Pusa Collections, Indian Agricultural Research Institute, New Delhi-110 012.

ACKNOWLEDGEMENTS

We are grateful to Dr. N. C. Pant, formerly Head of the Division of Entomology, I.A.R.I., New Delhi for the facilities and encouragement given.

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A NEW SPECIES OF *MOONIA* (HOMOPTERA: ULOPIDAE)[1,2]

P. KAMESWARA RAO[3] AND
USHA RAMAKRISHNAN[4]
(*With ten text-figures*)

Distant (1908 and 1916) described seven species of *Moonia*, *M. sancita* Distant (type-species) from Mussoorie Hills, U.P., and *albimaculata, capitata, brunnea, variabilis, diversa* and *albivitta* from Chikkaballapura, Nilgiri hills and Kodaikanal in South India. Kameswara Rao and Ramakrishnan (1978) added two more species, *M. immaculata* and *M. ixora* and one subspecies *M. sancita pomegranata* from Delhi. One more new species of *Moonia* is described in this paper from Delhi. The type specimens have been deposited in the National Pusa collections, New Delhi.

Moonia carinata sp. nov. (Figs. 1-10)

This species comes near to *Moonia variabilis* Distant and in the key given by Kameswara Rao and Ramakrishnan (1978) for the species of *Moonia* but can be differentiated from *variabilis* by the presence of a distinct carina on the postclypeus and well expanded gena. Internally the pygofer process of *variabilis* is more serrated at the apex than that of *carinata*.

The head, pronotum and surface of the fore wings of these hoppers show numerous pits.

Form: Face (Fig. 1) shows the postclypeus with a distinct longitudinal ridge; anteclypeus oval and distinctly separate from the postclypeus by a transverse depression; lora oval, distinctly marked off from adjoining sclerites; gena broad. Pronotum (Fig. 2) broader than long, convex and carinate medially.

Fore wing (Fig. 8): Fore wing broad, narrowed at apical portion; coriaceous thickly pitted, pits absent in the apical portion; veins prominently raised.

Hind wing (Fig. 9): Wings with well developed veins and three apical cells.

External male genitalia: Ninth sternum more or less triangular. Subgenital plate (Fig. 4) slender and long. Pygofer (Fig. 5) long and broad, posterior portion membranous bearing a spine like projection, mesially each lobe of the pygofer bears a flattened process (Fig. 7) which is irregularly toothed at the apex.

Internal male genitalia: Paramere (Fig. 6) elongated and arcuate with its cephalic portion short, narrow and rounded at apex, caudal portion long, broad and ending into a clubbed rounded apex. Aedeagus (Fig. 10) articulated to the connective (Fig. 3) by a short preatrium, atrial apodeme well developed, broader at the base than at apex, pointed, aedeagal shaft equal in length to atrial apodeme; gonopore subapical, almost at the mid-length of the shaft.

Coloration: Ochraceous specimens. The depression behind the anterior margin of frons,

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[2] Part of the Ph.D. thesis of the author submitted to Indian Agricultural Research Institute, New Delhi-110012 during 1975.

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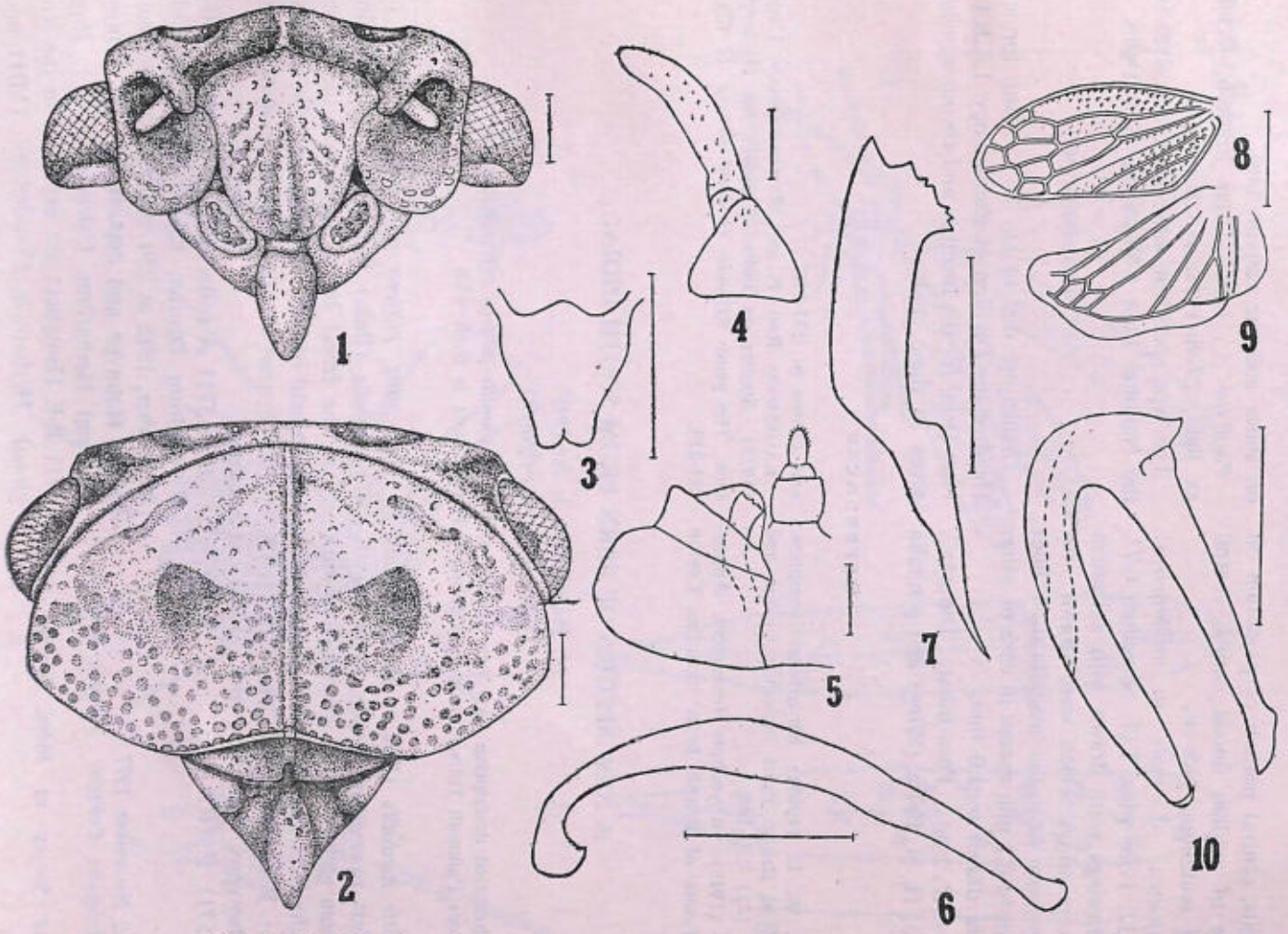

Figs. 1-10. *Moonia carinata* sp. nov.: 1. face; 2. vertex, pronotum and scutellum; 3. connective; 4. subgenital plate; 5. pygofer with anal ring; 6. paramere; 7. pygofer process; 8. forewing; 9. hind wing; 10. aedeagus.

antennal pits, central portion of pronotum on either side of median dorsal carina, central portion of scutellum, piceous.

Measurements of male in millimetres: Length 4.32; Fore wing 3.17; Scutellum 0.72. All the drawings were drawn with a camera lucida except wings which were drawn with a microprojector. All the magnification lines were drawn to 0.2 mm except in case of wings which were drawn to 1.0 mm.

Holotype ♂, INDIA: Pusa-Bihar, "Duranta", 19-vii-1913, H. N. Batra (Wings and genitalia on slides and the rest on tag).

Paratype ♀, INDIA, Uttar Pradesh, Delhi, ex light, 27-vii-1974, P.K.R.

The type specimens have been deposited in the National Pusa Collections, New Delhi.

ACKNOWLEDGEMENT

Thanks are due to Dr. N. C. Pant, former Head of the Division of Entomology. I.A.R.I., New Delhi for the facilities and encouragement given in these studies.

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A NEW SPECIES OF FERN FROM SOUTH INDIA[1]

N. RAVI[2] AND J. JOSEPH[3]

(With five text-figures)

Illustrated description of a new species of fern-*Grammitis pilifera* (Grammitidaceae) from Ponmudi Hills, Trivandrum District, Kerala State is dealt with.

Grammitis medialis (Bak.) Sledge affinis, tamer differt praesertim fronde, facie dorsali, hirsuto quam glabro; paleis rhizomatis peltatis quam basifixis; et sporangiis unisetosis.

Holotypus: Ponmudi Hills *Ravi* 5711 A (CAL); Isotypus *Ravi* 5711 B-E (MH) et Isotypus 5711 F (RH).

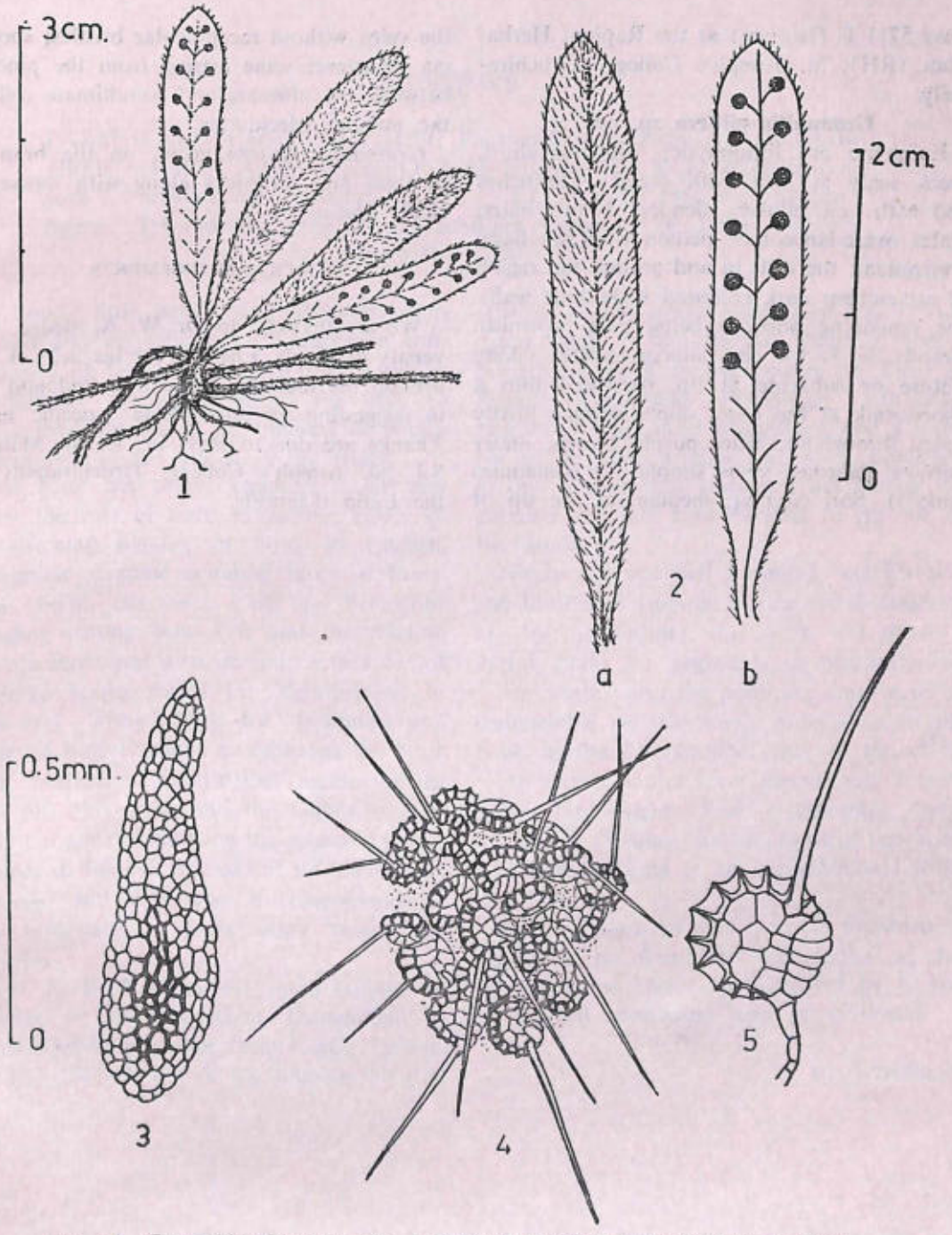
Grammitis pilifera sp. nov. is allied to *G. medialis* (Bak.) Sledge, but differs mainly in the frond being hirsute on the dorsal side instead of glabrous; scales on the rhizome peltate instead of basifixed and sporangia unisetose.

Ravi 5711 A collected from Ponmudi Hills, Trivandrum District, Kerala State, on 13th November, 1975 at 750 m. has been designated as Holotype and deposited in the Central National Herbarium, Calcutta (CAL). *Ravi* 5711 B-E (Isotypes) are deposited in the Regional Herbarium, Coimbatore (MH) and

[1] Accepted November 1977.

[2] Sree Narayana College, Sivagiri, Vaskala, S. India.

[3] Botanical Survey of India, Eastern Circle, Shillong.



Figs. 1-5. *Grammitis pilifera* sp. nov.: 1. Habit; 2. Frond: a. Upper surface; b. Lower surface; 3. Scale; 4. Sorus; 5. A single sporangium. (4 & 5 not to scale).

Ravi 5711 F (Isotype) at the Rapinat Herbarium (RH), St. Joseph's College, Tiruchirapally.

Grammitis pilifera sp. nov.

Epiphytic or lithophytic; rhizome short, erect, scaly at base with creeping branches and with unicellular slender brown hairs; scales ovate-lanceolate, peltate with sub basal attachment; the cells in and around the region of attachment dark coloured with thick walls, the remaining portions being pale brownish. Fronds ± 3×0.4 cm., subcoriaceous, oblong obtuse or subacute at tip, narrowed into a short stalk at the base; upper surface bristly hairy throughout; hairs purple brown; under surface glabrous; veins simple (or sometimes forked). Sori circular, median, at the tip of the veins without receptacular bristles; sporangia unisetose; setae arising from the junction between the ultimate and penultimate cells of the annulus, deciduous.

Grammitis pilifera grows on the branches of trees and on rocks along with mosses in shady places.

ACKNOWLEDGEMENTS

We are thankful to Dr. W. A. Sledge, University of Leeds, England for his help in confirming the identity of the new find and also in suggesting an appropriate specific name. Thanks are due to Rev. Fr. K. M. Matthew S.J., St. Joseph's College, Tiruchirapally for the Latin diagnosis.

REVIEWS

PAKSHIKALUM MANUSHYRUM: Pakshinirikshanathinu Oru Amukham (Birds and Men: An introduction to bird-watching). By K. K. Neelakantan, with a Foreword by Dr. Sálim Ali. pp. v + 80 (24 × 18.5 cm), with 67 text-figures. Trivandrum, 1979. The MacMillan Company of India Limited. Price Rs. 12.50.

A handy little book, comprehensive, summarised and updated in facts, rather a conglomerate of basic information that a young bird-watcher needs, it meets the need to arouse love for nature and interest in nature conservation in the minds of the young.

The book has twelve chapters in all and covers the role of birds in nature, basics of bird-watching, naming of birds in English, description of some common birds of India, flight, moult, migration, song and behaviour including mating behaviour and the relation between birds and men. It ends with a list of reference books useful for identification of birds and bird-watching for beginners and advanced bird-watchers. Eventhough the book is in Malayalam the English names of the birds are also given and the author stresses the importance of studying the scientific names of birds in English because of its universality in usage and usefulness in correspondence with bird-watchers from other states and countries.

Prof. K. K. Neelakantan, more familiar to Keralites by his pseudonym 'Induchudan', a retired English professor from Kerala University, is a life member of the Bombay Natural History Society and President of the Trivandrum wing of the Kerala Natural History Society. A book in Malayalam on Birds of Kerala (Keralathile Pakshikal), numerous articles in Malayalam Magazines, and a number of scientific articles and notes published in this *Journal* and elsewhere are among the author's valuable contributions to the art of Bird-study.

Nicely got up, well arranged, well printed and illustrated (unique in that all illustrations are by the author), this book will prove a useful guide for beginners in bird-watching.

The author and the publisher deserve to be commended on the timely publication of the book in the International year of the child.

An ardent nature lover himself and a competent bird-watcher Prof. Neelakantan meets his aim of showing students through this book that bird-watching is an enjoyable and thrilling hobby.

As Dr. Sálim Ali puts it in the foreword to this book, the non-Malayalee readers are deprived of the knowledge imparted by it and an English translation may prove useful.

S. M. SATHEESAN

A BUNDLE OF FEATHERS: Proferred to Sálim Ali on his 75th Birthday in 1971. Edited by S. Dillon Ripley II. pp. 241 (16×23 cm), with many illustrations and plates. New Delhi, 1978. Oxford University Press. Price Rs. 85/-.

We have in this volume a bundle of essays mainly on feathered bipeds proferred to the greatest Indian friend of them all—Dr. Sálim Ali by an international group of his friends and admirers. It is a most enjoyable book from which you will gleam a variety of fascinating facts. To mention just a few: while the north Indian bayas choose to nest on the babul tree, their south Indian brethren prefer the coconut tree; the half-a-million swiftlets from the great cave at Niah in Borneo consume no less than 20 million individuals of winged ants over the canopy of the rain forest every single day; the hill mynas imitate some of the calls of their neighbours of the same sex, but the call repertoire of the males and females is kept entirely distinct; the habits of the Himalayan honey-guides were accurately recorded by the authors of Chinese Materia Medica no less than a thousand years ago; many birds of high Andes and Tibet regularly use burrows of mammals for their nests; the starlings arrived in the North Americas with only three out of four lice that infect them in their original home in Europe; and, finally that our Indian cattle egret has prospered mightily in the U.S. over the last forty years. But the book is not a mere collection of interesting facts about the natural history of birds, it is a collection of some fifteen serious scientific papers ranging over the whole span of avian biology from biochemical changes in the migratory rosy pastor and the fauna of Narcondam islands to the migration of gannet in the Mediterranean and the role of birds in the natural foci of tick-borne arboviruses. The authors also range over the three continents of North America, Europe and Asia and include many leading ornithologists of the world.

The book is divided into four sections. The first is biographical and includes a most charming portrait of Sálim Ali by Zafar Futehally. The second section on life history and field biology has eight papers; of these I particularly enjoyed two. Tom Harrison's paper on the food of swiftlets at the Niah great cave in Borneo is a model of careful field work half-a-million swiftlets in this cave spread far and wide over the forest canopy and specialize on winged ants and termites. Harrison looks carefully at the composition of the diet of the two species and provides new insights into their role in the ecosystem. Yu A Isakov's paper on the great bustard, *Otistarda* is a fascinating account of the historical changes in the pattern of land use in Central Asia and Europe and the consequent rise and fall of the populations of the great bustard.

The section on zoogeography and systematics has seven papers, beginning with an interesting one on the discontinuous distribution of *Muscicapa latirostris*. The Stressemann's show that the one isolated population on the island of Sumba has diverged from the palaearctic populations, while those nesting in India, coming under the swamping influence of the migratory population do not do so. Theresa Clay in a paper on the distribution of bird lice brings out how these can be used to elucidate phylogenetic and distributional history of their bird hosts.

The last section deals with migration, biomedicine and learning. It contains a scholarly article by Netsky, Malkov and Bogdanov on the role of birds, ticks and mosquitoes in the natural foci of tick-borne arboviruses. Landsborough Thomson traces the migration of the Gannet and shows that the first year birds are much more apt to disperse, and that the birds do not migrate to the Balkan Sea the way they do into the Mediterranean.

All in all very varied and interesting fare. The articles differ widely in the originality of new information presented, the care with which it is analysed, breadth of the subject under review, the rigour of the argument and readability of the language. Some, such as the fauna of Narcondam islands is merely descriptive and of limited technical interest. Horace Alexander's article on what leads to an increase in the range of certain birds is a mere summary of well-known facts with what appear to me to be completely unjustifiable hand-waving arguments on the possible changes in the central part of the range of the birds. It is nevertheless a very readable article. Others such as the one on the biology of the olivaceous leaf warbler of the Tian-shan mountains present a lot of new data, but are somewhat difficult to read. Then there is Thorpe's masterly review of bird vocalization with special emphasis on duetting.

Taken altogether, there is something for everybody, but no substantial contribution of a type which would render the book an indispensable item in an ornithological or a bird-watcher's library. It may have been a much more important book if, for example, a theme had been chosen and a series of authoritative reviews on that theme brought together. The theme could have been conservation of bird species or bird migration; areas to which Sálim Ali has contributed so much. Or else it could have been a book in which professional ornithologists could have recounted major developments in avian biology in simple language for the amateur bird-watcher for whom again Sálim Ali has done a great deal through his bird book. But this caveat apart, I heartily recommend this bundle of feathers to all bird lovers the world over.

MADHAV GADGIL

FLORA MALESIANA—Series I—FLOWERING PLANTS, Vol. 8. General editor Dr. C. G. G. J. van Steenis. pp. i-cxv + 577 (17×24 cm) in three parts. The Netherlands, 1974-1978. Sijthoff & Noordhoff International Publishers.

Part I (1974) contains 2 articles:

A. CYCLOPAEDIA OF COLLECTORS AND COLLECTIONS—Supplement II by M. J. Van Steenis-Kruseman. Pp. i-cxv. This second and final supplement is in continuation of the supplement I (Flora Malesiana I : Pt. 5, 1958, pp. ccxxxvii-cccxlii). It contains an impressive list of 1049 collectors with their brief biographia, main contributions and photographs in many entries. It is a highly creditable work on the part of the compiler. An addenda to the 6 chapters of the main work is also appended. The information given here is relevant to all the students of tropical plants including India, where a large number of

floristic elements commonly occurring in Malesia are extant. The whole work is of interest to students of Indian floristics.

B. Revision of the family HYPERICACEAEA by N. K. B. Robson, pp. 1-29, figs. 20. This small family is expertly treated by the author. It gives distribution, ecology, anatomy, palynology, embryology, cytology and chemotaxonomy. The author feels Hypericaceae does not deserve the family rank and should be treated as a sub-family of Guttiferae. The following genera are treated: *Cratoxylum* (6 spp) and *Hypericum* (15 spp).

Part II: SYSTEMATIC REVISIONS (1977)

(i) ULMACEAE by E. Soepadmo (pp. 31-76, Figs. 27) contains generic description and brief notes on distribution, fossils, ecology, anatomy, palynology, embryology, cytology, chemotaxonomy and phylogeny. It treats 6 genera and 27 species (*Ulmus*-1, *Parasponia*-5, *Trema*-4, *Celtis*-9, *Aphananthe*-2 and *Gironniera*-6).

(ii) IRIDACEAE by D. J. L. Geerinck, pp. 77-84, figs. 6. Contains brief notes on distribution, ecology, morphology and uses. 6 genera are treated: *Patersonia* (1 sp.), *Sisyrinchium* (2 spp), *Belamcanda* (1 sp.), *Eleutherine* (1 sp.), *Gladiolus* (1 sp.) and *Trimezia* (1 sp.)

(iii) CORNACEAE by K. M. Matthew, pp. 85-97. Figs. 6. Treats the genus *Mastixia* with 10 spp. and several subspecies.

(iv) ONAGRACEAE by P. H. Raven, pp. 98-113, figs. 10. Contains brief notes on distribution, dispersal, pollination, morphology and anatomy, chromosomes, hybridization and chemotaxonomy. Two genera—*Ludwigia* (8 spp.) and *Epilobium* (2 spp.) are treated. 2 species of *Fuchsia* and *Oenothera* (1 sp.) which occur in cultivation are also mentioned.

(v) BIGNONIACEAE by C. G. G. J. van Steenis, pp. 114-186, figs. 39, gives notes on distribution, flower biology, pollination, dispersal, germination, taxonomy, genetics, palynology and chemotaxonomy. 30 species under 15 genera are treated. 27 spp. of cultivated plants are added.

(vi) CRYPTERONIACEAE by R. J. van Beusekom-Osinga, (Pp. 187-204, figs. 13) gives notes on distribution, ecology, morphology, anatomy, taxonomy and uses. 3 genera *Crypteronia* (4 spp.), *Dactylocladus* (1 sp.) and *Axinandra* (3 spp.) are treated.

(vii) SYMPLOCACEAE by H. P. Nooteboom, pp. 205-274, figs. 20. *Symplocos* is treated under 2 subgenera *Symplocos* and *Hopea*. 58 species and several subspecies are treated.

(viii) LENTIBULARIACEAE by P. Taylor, pp. 275-300, figs. 26. *Utricularia* with 22 species is well treated under distribution, ecology, pollination, genetics and morphology.

Part III—SYSTEMATIC REVISIONS is dedicated to the memory of F. A. W. Miquel, whose biography and main works are appended. pp. 1-16. List of abbreviations and signs are given on pp. 17-19.

(ix) LABIATAE by H. Keng, pp. 301-394, figs. 32, is treated with notes on distribution, ecology, dispersal, palynology, phytochemistry. Taxonomy and uses have been summarized. An elaborate key to 32 genera is provided. In all 87 species and 10 subspecies are treated. Cultivated plants are also noted.

(x) ANACARDIACEAE by Ding Hou, pp. 395-548, figs. 69 is treated with notes on Distribution, morphology, dispersal, galls, germination, taxonomy, phytochemistry, chromosomes, uses etc. 22 genera and 151 species are given. An addenda, Corrigenda et emendanda is given on pp. 549-552 concerning systematic revisions given in Vols. 4, 5, 6 and 7.

Index to scientific plant names is appended on pp. 553-577.

On the whole this volume containing revisions of 10 interesting families which are common in this part of the world contains very valuable information worked out by well-known scholars in plant taxonomy and will prove very useful to the systematic botanists in India.

P. V. BOLE

THE OXFORD BOOK OF TREES: By A. R. Clapham. Illustrated by B. E. Nicholson. pp. 216 (18×24 cm) with many coloured and Black-and-White illustrations. London, 1975. Oxford University Press. Price £4.95.

One of a series of several publications on plant and animal life in Britain, this fascicle is truly fascinating particularly on account of its illustrations of which more than 500 are in colour.

The introduction tries to explain differences between trees and shrubs with reference to the woody vegetation of Britain. It defines with the help of suitable illustrations the shapes and types of trees and their variations.

The main text gives an enumeration of native British trees with their habit such as woodlands, wet-places and hedges. It differentiates the conifers and has separated the trees introduced to Britain from other parts of the world.

Each of the species described is superbly supported by the fascinating colour portraits by Barbara Nicholson. A key to identify the various genera and species of trees is appended together with a glossary, further reading references and general index. Winter aspects of about 30 species are drawn on the inside covers of the book.

This book excels in production value, is moderately priced and can be considered an essential reference work for any student of temperate tree flora. All public libraries must have such an excellent production for reference.

P. V. BOLE

MISCELLANEOUS NOTES

1. THE SURAT DANGS REVISITED

During the summer of 1976 Mrs. Shull and I revisited India. It was a real thrill, with some disappointments, to return to Ahwa, district headquarters of the Dangs, after an absence of twelve years. We had lived at Ahwa from 1951 to 1964, enjoying the "exotic" flora and fauna.

Some noteworthy changes were evident. The improved forest resthouses (with their electric lights), roads, and buses greatly facilitated travel throughout the area; but, it was still the jeep that made travel over washed-out roads possible. The monsoon had arrived early in June, so our trip to Mahal and other villages from June 18th to 25th was occasionally hazardous.

In Ahwa, there was a substantial decrease in the number of teak trees (*Tectona grandis*) and in the various species of bamboo. As we moved throughout the Dangs, it became clear that the formerly accepted cycle of replanting the teak was not keeping pace with the extensive cutting of timber for roundwood. Also the hill tribes were denuding the trees by cutting off the branches for firewood, a scarce fuel in the Dangs and many other parts of the world. At Mahal, the former tall clumps of bamboo were nowhere to be found. Other bamboo varieties were rapidly disappearing from Mahal and other areas; the hills and valleys looked bare. The bamboo was being transported to the paper pulp mills of Gujarat. As India's population of people increases, the need for lumber and paper likewise increases. Thus two of the finest resources of Gujarat State—teak and bamboo—are not being conserved for future generations to enjoy or to use.

Our travel in the Dangs District did not disclose a leopard, tiger, chital, sambar, wild boar, or any of the large mammals. In America we read about the plight of the tiger. With Project Tiger now being supported on an international level, it is our hope that this magnificent animal will survive. The situation in the Dangs is not encouraging.

Habitat destruction, more than hunting, seems to be destroying, or seriously reducing, the flora and fauna of the Dangs. Until India's population growth subsides, as it has in Singapore, the destruction of natural habitats and natural resources will likely continue.

As I assess the situation in the Dangs, the tiger has become rare, the leopard or panther survives but reduced in numbers; whereas, the Axis deer or chital, sambar and wild boar are fewer than in the 1950's and 1960's.

The destruction of the forested areas in the Dangs has apparently reduced the number and kinds of birds. Normally the early monsoon season is an exciting time to see our feathered friends, but again our observations were minimal. Through the rolling hills and valleys from Gulchond to Saputara we saw only two large Racket-tailed Drongos (*Dicrurus paradiseus*) and a few Black Ibises (*Pseudibis papillosa*), formerly not uncommon birds in this area. Flycatchers, cuckoos, bulbuls, hawks, owls, and the formely ever-present vultures were either absent or greatly

reduced in numbers. Even the once common kingfishers were absent.

In the 1960's the mercury vapour lamp on the compound of the Ahwa ST stand attracted a great variety of moths and other insects, lizards, frogs, bats and other small insect-eating animals. In 1976 this same lamp attracted only a few of these; however, one partial explanation might be the presence of many powerful electric lights now in the town. Still very few species of moths, butterflies, and skippers were observed throughout the Dangs. Also the depletion of flowering plants has no doubt contributed to the decreased number of Lepidoptera.

Nature — even when left undisturbed — maintains a sensitive balance between the flora and fauna. Man is the culprit responsible for upsetting the natural order. The very survival of *Homo sapiens* most likely depends on the balance of nature being preserved. After all, the future of the earth might be with the insects rather than with man. Can man survive? That question will be raised more seriously by the time man enters the twenty-first century.

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2. A NOTE ON THE TIGER CENSUS CONDUCTED IN GUJARAT STATE FROM 15TH TO 21ST APRIL, 1979

A census of tigers in the Gujarat State was carried out from 15th to 21st April, 1979. A brief account of the same is given below.

Initially, the following potential tiger areas of the State were proposed to be covered during the census:

This census area covered a total of 275 beats, the beat being the territorial unit for the census.

Detailed cyclostyled instructions in the vernacular on the census methodology were supplied to each Beat Guard. The period from 3rd to 5th April was earmarked for collecting preliminary census information so as to determine the areas where tigers or their signs were reported during the last 12 months. On the basis of this information, the final census was confined to the following areas:

NAME OF CIRCLE	NAME OF FOREST DIVISION	NAME OF RANGE
Surat	Dangs (North)	All Ranges
	Dangs (South)	—do—
	Valsad	Bansda (including the Bansda National Park areas). Pangarbari and Fatepur
	Vyara	Vajpur Range covering Satkashi forest
	Rajpipla (West)	Mandvi (North) Mandvi (South)
	Rajpipla (East)	Dediapada, Fulsar, Piplod, Rajpipla, Sagbara.
Gandhinagar	Banaskantha	Danta and Ambaji.

Dangs (North) and Dangs (South) Divisions; Bansda Range of Valsad Division; Rajpipla Range of Rajpipla (East) Division and Ambaji Range of Banaskantha Division.

Throughout the census week, each Beat Guard within the census area did intensive patroling within his jurisdiction (with the help of hired trackers where necessary), specifically for the purpose of detecting signs of tiger movement in his area (such as actual sighting, pugmarks, droppings, kills, etc.). Any positive report received from them were immediately verified on the spot by a responsible officer (Range Forest Officer, Asst. Conservator of Forests or Dy. Conservator of Forests). Wherever pugmarks were found, they were recorded on a tiger tracer indicating the location and time. A blueprint showing the actual size samples of tiger pugmarks (male, female and cub) were supplied to each Beat Guard for his guidance in the field and to eliminate the possibility of panther pugmarks being mistaken for a tiger's.

In all, 11 cases of direct or indirect tiger sightings were reported at the end of the census period from Dangs (North), Dangs (South) and Rajpipla (East) Divisions, of which only 7 were finally accepted as enumerated below:

Thus, in the final analysis, it can definitely be recorded that there were 7 tigers in Gujarat State during the census period from 15th to 21st April, consisting of 4 males and 3 females distributed over the following divisions:

Dangs (North) : 3 males and 2 females
Dangs (South) : 1 female
Rajpipla (East) : 1 male

Advantage of this tiger census was also taken to estimate the population of panthers in Dangs District, i.e. Dangs (North) & Dangs (South) Divisions. These observations indicate that there are approximately 70 panthers in this District, which can be considered to be a fairly substantial number.

During the last all India Tiger Census conducted in 1972, 8 tigers had been reported from Gujarat State, all of them from Dangs District. As against this, the present census has indicated the existence of 6 tigers in Dangs District and one in Rajpipla (East). Division (Bharuch District). It appears quite obvious that the tiger in Gujarat is struggling for survival and its population in the State is on the decline. The main adverse factors which the tiger has to face may briefly be enumerated as under:

A steady reduction and constant human disturbance in its habitat. Among the more serious causes of disturbance may be mentioned the industrial exploitation of bamboos, intensive management of the forest (particularly in Dangs), the collection of minor forest produce by the tribals resulting in recurring forest fires, and the heavy depletion of wild ungulate population due to persistent poaching by the tribals, particularly during the critical summer months. With hardly any natural prey left for the tiger, it is compelled to turn to domestic cattle. But here also he has to face severe competition because the moment a kill is detected, the local tribals rush in to drive the tiger away from his kill and to appropriate the meat for their own consumption. It is virtually impossible for the tiger to survive under these conditions, although the panther can always manage to eke out a living even under such unfavourable conditions.

ACKNOWLEDGEMENTS

The following non-officials very kindly assisted in the census as non-official observers, Mr. Digveerendrasinhji I. Solanki, Jamshedji D. Gabba, Dr. Neumann T. Mascati, Mr.

Kasimkhan J. Khan and Madhusudansinhji of Danta. I would like to place on record my deep sense of gratitude to all these gentlemen for having so kindly offered their voluntary services for the census work, particularly Shri Digveerendrasinhji and Shri K. J. Khan who ungrudgingly spared their valuable time and took a lot of trouble at considerable personal discomfort to tour the forest areas extensively for the verification of pugmarks, etc.

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3. OCCURRENCE OF CIVETS IN THE CITY OF RANGOON (BURMA)

During the war period (January 1942—May 1945) as I returned home late one night from the Orient Club on the Royal Lakes (Kandawgyi), I saw in the beam of my car light a large Civet which ran across the road in the Golden Valley area.

Since 1954, I have been residing in the Inya Myaing area which adjoins the Golden Valley area. Inya Myaing is 4½ miles from the General Post Office, Strand Road. Adjoining my compound on one side is The International Meditation Centre. The compound is over an acre in area with a number of large trees. I planted a number of plum and guava trees around my cottage. The branches of these trees drop on the roof of my cottage.

A few years after our arrival, a large Civet took up its abode under the roof of my cottage. It climbed to its abode by a guava tree. It came to its abode early in the morning and left its abode to feed at dusk. I saw the Civet resting on the roof on one or two occasions during the day. It had black stripes on the back, the long tail also being banded with black and could have been the banded palm civet (*Hemigalus derbyanus* Gray).

After the disappearance of this civet and a break of several years a pair of civets took up their abode under the roof of my cottage. They climb to the roof and descend from the roof by a plum tree. They leave their abode to feed between 1900 and 2000 hrs. and return to the abode between 0400 and 0500 hrs. next morning. We know when they leave and when they return by the noise they make when moving about and by the noise caused by the branches of the plum tree striking the roof.

They were not much of a nuisance at first. But in 1977 they bred two young. They are a nuisance now from the cries of the young and from their urine. The urine drips through the ceiling down to the floor all over of my cottage and is not confined to one place only. It has a very strong odour and the floor has to be washed immediately before it dries up.

I have sat up at night fall as well as early in the morning on several occasions but have not been fortunate to observe any of the civets. On one occasion during the day I observed two tails dropping down through an aperture in the ceiling. The tails are not banded. The house maid, however, has been fortunate. She observed through a window in her dormitory the two adults coming down from the abode at night fall and returning to the abode early

next morning on a number of occasions. She observed also the family frolicking on the lawn during clear weather on more than one occasion. I showed her plates of civets. She picked out the plate of the Masked Palm Civet (*Paguma larvata larvata*).

The civets can either be the Tenasserim white whiskered Palm Civet *Paguma larvata janetta* Thomas or the Himalayan Palm Civet *Paguma larvata neglecta* Pocock.

The caretaker of the International Meditation Centre informed me that there are two species of Civets in their Centre. On one occasion, the two fought and one was killed. He identified the dead civet as *Kyaung-na-ga*. Malayan Palm Civet (*Paradoxurus hermaphroditus pallasi* Gray).

As regards the second species he said the civets he saw are similar to the Common Palm Civet or Toddy Cat (*Paradoxurus hermaphroditus*).

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4. AN INSTANCE OF WILD DOGS SCAVENGING ON A TIGER'S KILL

On the morning of 24th July 1978 Keechanna, my tribal boy, came across Jungle crows calling near a forest road two kilometres from Bandipur campus. As he walked along the road looking at the crows he failed to see a tiger lying 3 metres from the road. The tiger was also looking at the crows and so it did not see Keechanna who had gone as close as ten metres to it. When he saw the tiger he silently retreated for 60 metres climbed a small *Butea frondosa* tree and observed. Once the crows 15-20 in number alighted on the kill, a prime adult sambar stag with 48 cm velvet antlers, which was 8-10 metres from the tiger. The tiger with a whoop ran to, chased the crows and returned to its 'bed'. Tigers are intolerant of vultures also and on occasions they may even kill them (Schaller 1967).

I had gone to another part of my study area and when Keechanna informed me of this around 1000 hrs, in his company I hurried to the spot. When we were 50 metres from the spot, at 10.30, I saw the tiger walking to the road from the kill. Hurriedly and silently we moved to the cover of the *Butea* tree trunk and watched. The tiger remained on the road for 3 minutes. Three times it flexed its tail arching over its back and once it lay down for a few seconds. At 1033 the tiger went back to the kill. We were in an active elephant country close to a much used pool. Since there was no suitable tree we left the place.

In the evening my wild dog pack was seen 500 metres from Bandipur but it eluded us and went to the kill. We did not hear any altercation between the tiger and the wild dog but repeated sambar belling was heard. Next morning around 1000 hrs we went to check the kill. This time we were accompanied by S. N. Prasad one of the students of Dr. Madhav Gadgil. The wild dogs had eaten a good amount of meat from the kill but on the wet muddy road there was no sign of either excited running or of struggle. The

tiger, most probably before the arrival of the dogs, while dragging the kill had severed a portion of the carcass with the head, neck and anterior part of thoracic region with 3 ribs and had dragged it nearly 80 metres from the major part of the carcass. While looking for the missing part I saw a pit with some water where the sambar had been killed. After killing, the tiger had eviscerated and removed the rumen contents. Then it had dragged the kill for 20 metres and left it under a stand of *Kydia calycina*.

Meanwhile Keechanna found the drag mark and while we followed and found it the tiger from the cover coughed three times. On the throat of the sambar there were four canine marks. Here it would be pertinent to record that the tiger and the lion while killing large prey prefer to bite on the throat (Schaller 1967, 1972) though Krishnan (1972) has found an adult Gaur cow with two sets of two deep punctured wounds, inflicted by the canines of a tiger on either side of a nape. After removing the jaw we returned to the road, and the tiger remained hidden and growled two times from a distance of 50 metres. Since coughs and growls are the early warning signals of a tiger which wants to discourage people disturbing it (Corbett 1957) we went away.

In the evening Keechanna was taken by the local Forest staff to show the kill and he found that the tiger had eaten most of the meat from the major part of the carcass. He did not take them to the other spot. Next morning we saw the pugmarks on the tracks of the van and the remains close to the road were licked clean. As the crows were calling from trees around the other area we did not venture to check.

I was not able to deduce the exact cause which prevented the wild dogs from following the drag marks of the smaller portion of the kill. May be they had sufficient meat on the major part of the kill or were reluctant to face an irritated tiger in the scrub. When there was sufficient meat left on a kill the wild dogs most often revisited the kill. In this case, however, the wild dogs did not do so. The presence of the tiger did not permit us to weigh the remains so as to calculate the amount of meat eaten by the tiger and the wild dog. From the above incident, with certainty one can infer, that wild dogs can scavenge on tiger's kills and a tiger may amicably withdraw in the presence of 15-16 dogs. This withdrawal may only be temporary and a tiger can operate in an area frequented by wild dogs.

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5. ON THE VALIDITY OF *FRANCOLINUS PICTUS PALLIDUS* (J. E. GRAY)

When cataloguing the Painted Partridges (*Francolinus pictus*) from Indian limits in the Society's collection (1969, *JBNHS* 66: 257-258), I said there was much variation in the patterns both above and below, but with the material available (31 specimens none from near the type locality) it was not possible to separate any as *pallidus* (J. E. Gray, type locality Udaipur) from nominate *pictus* (Jardine & Selby, Bangalore).

With the assistance of Mr. Amrendra Singh of Udaipur, we have now been able to obtain a male from near Udaipur, the type locality, dated 1 September 1977 (BNHS Reg. No. 24381), which is distinctly paler than any of the others. This paleness is most prominent on the wings and is generally emphasized by the pale streaks in the form of paler edges to the dark feathers on the head. The last character is visible in only one other skin from Mt. Abu (o? 13746) and which does show an appreciable tendency towards *pallidus*. In any case, it would appear that this form does exist but covers a very restricted range.

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6. INCUBATION AND INCUBATION PERIOD IN THE INDIAN LITTLE BROWN DOVE *STREPTOPELIA SENEGALENSIS*

A pair of Indian Little Brown Dove *Streptopelia senegalensis* managed to construct a nest in the veranda of my house in Baroda. Soon after the construction work of their nest got over, the eggs were laid, one each on successive days, namely on 29th and 30th of January 1977. Both the sexes participated in incubating the eggs, both of them working in shifts for a few hours during the day time, but only one of them would remain at the nest at night. Since one of them had lost several tail feathers it was possible to tell the otherwise indistinguishable members apart: it was always the one with the tail feathers intact that would take up the night duty. This individual, moreover, was also very aggressive as compared to the other. The feathers on its head were also conspicuous, in that they were always disturbed and slightly raised and would give an appearance of a comb. On two occasions when the bird was disturbed at night (because of my prying), the bird simply left the place leaving the nest unguarded all through the night only to return next day morning (after 11-00 a.m.) to see if the place was safe and undisturbed. Wallace and Mahan (1975) have reported that in Mourning Dove and some other columbids it is the female which takes on the duty of incubating the eggs at night, and is relieved by the male during the daytime. It is possible tha tthe aggressive individual doing the night shift is probably a female, and that the aggressive attitude towards suspected invaders develops during the breeding season rather than only during incubation periods; for, even after the young

ones had hatched out and had left the nest the aggressive attitude was maintained.

After continuous incubation of the eggs by both the parents, both the eggs hatched out on 13th February 1977, and the young ones left the nest together on the 27th. About five days later, a new nest was buit on the top of the existing one apparently by the same pair and an egg was laid on 6th March. However, the adult bird doing the night shift on the nest had an encounter with a prowling cat. The birds, subsequently abandoned the nest, which I ultimately cleared away.

A pair of doves moved in once again on 11th August 1977 and started nest building at the same site. The building activity was slow initially but became vigorous by 15th and continued with the same pace on 16th. The first egg was laid on 16th and the second on 17th. Both the young ones hatched out on 30th August. Soon after the nest-leaving by young ones on 12th September, the doves built one more nest on the top of the existing one and laid two eggs, one on 18th and the other on 19th of September. Two days later these were, however, found punctured—probably by a male House Sparrow which was always seen hovering near by.

Since the incubation period of the eggs is defined as the time interval between the laying of the last egg of the clutch and hatching of that egg (Welty 1964), the incubation period hitherto unreported in this species (Sálim Ali & Ripley 1969) could be said to be of 13-14 days.

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7. THE VOICE OF THE JUVENILE BROWN HAWK-OWL [*NINOX SCUTULATA* (RAFFLES)]

In a note on the calls of the Jungle Owlet (*Glaucidium radiatum*) (*J. Bombay nat. Hist. Soc. 68*: 830-2) I pointed out that the juvenile has a food-call quite unlike any of the numerous notes uttered by the adult. The juvenile Brown Hawk-Owl, too, has a set of call notes strikingly different from the adult's unvarying *oo-uk* or *oo-up* call.

Since the 26th of July, 1973, when, at Parambikulam, I heard the voice of a young Hawk-Owl for the first time, I have been hearing it in Trivandrum fairly regularly in June and July. However, it was only in 1977 that, apparently, our area fell within the territory of Hawk-Owl family. Between 4-vi-1977 and 27-x-1977 a juvenile and one parent used to

haunt our backyard. On 62 nights at least during these 5 months, the birds were in our area for periods varying from half an hour to two hours or more.

The young bird's favourite perch was the tip of a truncated, upward-pointing frond of a 40-foot coconut tree. Generally it used to sit there, calling from time to time, waiting for the parent to come and feed it.

The note most often uttered was a loud, rather querulous, nasal *kweng*. This would be repeated 2-6 times in 60-120 seconds, followed by 5-10 minutes of silence. Occasionally the young bird would be silent for as long as 30 minutes.

Variations such as a sharp *m-yóom, m-yóon, m-yóong, koom kyoom, kweyoong,* and a very brief *méwm* were often uttered, some of them highly suggestive of impatience and annoyance.

When the adult came, the young one used to utter a series of sharp, but low, *kwey-kwey-kweys*, but this was only in the earlier days. Later on, the only clue to feeding was the ghost-like form of the adult flitting to and away from the juvenile's perch. Throughout the period feeding was an absolutely silent and quick process. The adult in attendance never uttered any call-notes except towards the end of the period (September and October), when it appeared as though the juvenile was learning to produce the characteristic adult note. Elsewhere in the city the adult's voice could be heard frequently throughout this 5-month period as during other parts of the year.

After the 27th of October, 1977, the juvenile's peculiar call-note was never heard in our area. But on 1-i-1978 I heard it in another part of the city. My son, who is also very familiar with this call-note, wrote that he had heard it in December (1977) at Rourkela (Orissa). Therefore, it may be presumed that the juveniles of the two races, *N.s. lugubris* and *N.s. hirsuta* utter the same kind of food-calls.

I have made fairly satisfactory recordings of these notes on tape.

K. K. NEELAKANTAN

24/1337, Behind G.P.O.,
Trivandrum 695 001,
April 27, 1978.

8. NORTHWARD EXTENSION OF THE RANGE OF THE SOUTH INDIAN BLACK BULBUL *HYPSIPETES MADAGASCARIENSIS* SYKES

On 15th August 1977, Humayun Abdulali, J. S. Serrao the Society's Librarian, and the author, spent a delightful day motoring through some of the most wonderfully scenic country in north Thana District, not far from Bombay. We travelled along the Agra Road until Ghoti, where we branched off westwards, passed the Vaitarna Reservoir, and then through Khodala to Suriamal at the top of the Ghats turning south to Wada to rejoin the Agra Road at Bhiwandi.

Between Vaitarna and Suriamal, we saw a party of birds flying to a small mango by the road along the cultivated hillside. At first sight they looked like Blackheaded Blackbirds (*Turdus merula*). Through glasses we counted 11 birds moving about a tree—a flock of blackbirds!? Perplexed, we walked nearer and

as the birds flew across the road and settled again, we got excellent views of their slim grey bodies, scraggy blackcrested heads, orange-red bills and legs, and slightly forked tails—a flock of Black Bulbuls (*Hypsipetes madagascariensis ganeesa* Sykes)!

According to the books, the northernmost record is from Matheran. H.A. tells me that one was seen by Sálim Ali at Bhimashankar (on the main axis of the Sahyadri Range) on 8th September 1948, when they had visited the place together. He also noted a small party in a forest beat on the Pen-Khopoli road (east of Karnala) on 26th December 1965. Nesting records from Khandala by McCann and Navarro have been published (1945) (JBNHS 45:241) and it is common at Mahableshwar.

The present record extends the accepted range of the species northwards by approximately 90 km.

LAVKUMAR J. KHACHER[1]

WORLD WILDLIFE FUND—INDIA,
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BOMBAY 400 023,
August 25, 1977.

[1] *Present address*: 14 Jayant Society, Rajkot-4, Gujarat.

9. COURTSHIP SONG AND DISPLAY OF THE WHITETHROATED GROUND THRUSH *ZOOTHERA CITRINA CYANOTUS* (JARDINE & SELBY)

During the non-breeding months the Whitethroated Ground Thrush is quite frequently seen rummaging among the litter of the forest-floor, not much concerned about the presence of the birdwatcher. But a distinct change of mood occurs as the breeding season approaches. A bird may sometimes be seen singing from a bare high perch, but most often they become extremely shy and difficult to spot though the presence of numerous individuals evident from the rich lovely song which is a characteristic sound of a morning in April and May in the evergreen jungles of Mahableshwar, where most of my observations have been made. In high leafy or moss-covered branches of jambul the bird's chestnut and slate-blue coloration camouflages it surprisingly well. The voice has a ventriloquial quality which makes accurate location difficult, and the cautiously approaching birdwatcher usually sees the exasperatingly elusive and audience-shy songster only when it flies from its perch for a more private location to resume its serenade.

Singing from such well-concealed positions the male sometimes assumes its peculiar courtship display—probably the reason why the display is so seldom observed. I have been lucky enough to see it on a few occasions, invariably when the female was somewhere near. I give a composite description from the notes sent by me to Dr. Sálim Ali on these occasions.

The normally spruce upright-perching bird bows forward with wings drooping limply. The neck is stretched far forward horizontally

giving the bird a hunch-backed appearance and the head and beak point vertically down at right-angles to the horizontally stretched out neck. Seen from the rear the rufous on the sides of the bird is visible from behind the drooping wings as two small but conspicuous patches against the slaty grey back, slightly above each axilla. The overall effect in terms of human mime is a ludicrous abjectly humble shame-faced hanging head stance. The bird continues to sing during the display but the drollery is hightened when occasionally its full throated notes change to high-pitched scarcely audible pipings as if the serenader *was being choked by overpowering emotion.*

I first saw the display about 25 years ago one May morning at Matheran on the road between Coronation and Porcupine points. The bird was singing in a high crotch of a large tree—was very much puzzled when the bird suddenly went into the drooping wing pose. But when I saw the female fly in a couple of seconds later and settle near by, I realized that this was a courtship display by the male directed at her.

The next observation was made with Dr. Sálim Ali at Mahableshwar in April 1974. On a high jambul tree in a nallah between Jeejee Lodge and Dhun Villa what appeared to be a discoloured leaf was spotted by Dr. Sálim Ali as the male thrush in drooping pose. On 20.v.1976 I recorded another observation at Mahableshwar about 200 yards away from the foregoing location, again on a high jambul at the head of the path leading down to the nallah. The bird had been singing continuously for 10 minutes, before being spotted. The female about 25 ft up on a large horizontal branch appeared quite indifferent and was swallowing something small. The well-camouflaged displaying male was perched about 7 ft away and slightly higher in a thin leafy branch.

During the last observation (May 1977) at Mahableshwar on Dan to Beersheba path below Mt. Ferohin, I had an unusually clear and prolonged view of a singing and occasionally posing bird fairly low on a jambul branch. The pose varied from a scarcely noticeable droop to full intensity of contortion. The song also changed to the high pitched wheezing described previously, when the display was at its intensest. Possibly the change in pose and song varied according to the proximity of the female which unfortunately I could not spot in thick foliage till it flew away, the male first and the female following, when another thrush started singing about 30 yards away.

DINSHA J. PANDAY

4-A, RASHMI,
CARMICHAEL ROAD,
BOMBAY-400 026,
June 10, 1977.

[Some more details of this bizarre display will be found on p. 88, Vol. 9, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, under the orange-headed (nominate) subspecies. That observation, however, was also made in Mahableshwar and should correctly refer to the Whitethroated Ground Thrush.—EDS.].

10. WAGTAILS AS PREDATORS OF FIELD BEAN APHIDS

Wagtails are essentially insectivorous birds preying on insects and other small arthropods. Toor and Ramzan (1975)[1] reported Wagtails as good predators of mustard aphid, *Lephaphis erysini* Kalt from Ludhiana.

We observed flocks of Wagtails feeding on the field bean aphid (*Aphis craccivora* Koch.) when we were screening the field bean germplasm to aphid resistance. The flock consisted mainly of the yellow Wagtail (*Motacilla flava* L.) and the Grey Wagtail (*Motacilla caspica* Gmelin). The field bean varieties (*Lablab niger* L.) were trained on to a pandal in about 20×15 sq. metre area, and the birds frequently visited the periphery of the plot. On detailed examination with 8×30 field glasses of the lowermost branches of the plant infested with aphids, it was ascertained that the birds fed on aphids. The birds also fed on aphide placed on a white paper kept on the ground near the plant, thus confirming the observation. Further, on close examination of the fed area, it was found that it had only the immature stages as compared to unfed areas where the aphid colony consisted of mature and immature forms, suggesting that the Wagtails fed mostly on adult and grown-up nymphs. Thus, it is inferred that the Wagtails play an important role in checking aphid build-up on field bean.

[1] Toor, H. S. and Ramzan, M., (1975): The Grey Wagtail, *Motacilla caspica* Gmelin—a good predator of Mustard aphid, *Liphaphis erysini* Kalt. *Sci. & Cult., 41* (6): 288.

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11. REACTION TO NIGHT SPOTTING IN THE GHARIAL, *GAVIALIS GANGETICUS* (GMELIN)

Light from a two-celled torch, held at the level of the eye, were thrown on captive hatchling and yearling gharials on various occasions. The eyes of all juveniles reflected a bright red glow when the yearlings were in water, they moved towards the light.

In line with gharial's body axis, the minimum distance from which the glow was perceived between 1.00 and 1.50 m for hatchlings about 50 cm long, and 1.75 and 2.00 m for yearlings over a metre. The glow could not be observed when the height of the light source was not lowered while nearing the animal. Because of obstructions the glow could not be seen beyond 6 m in experiments with both hatchlings and yearlings. However, reflections from juveniles, released in the wild in the Satkeshia Gorge of the River Mahanadi, have been percieved from a distance of about 15 m.

Observations made on captive muggers (*Crocodylus palustris*) also showed exactly similar results.

Abdulali (1951) reported that gharials do not reflect torch light, which was contradicted by Ross (1975). Ross (1975) further contradicted Oliver's (Abdulali 1957) statement that in gharial the colour of the glow is "much fainter".

Ross (1975) reported that "the eyes would not reflect light from a distance of less than 4 m" and that "this has also been observed for other species of crocodilians." However, the present observations on the captive gharials and muggers at the Gharial Research and Conservation Unit showed that the minimum distance for reflection of light by the eyes is 1.00 m for hatchlings about 50 cm long and 1.75 m for a metre long yearlings.

ACKNOWLEDGEMENTS

I am in receipt of a Research Fellowship from the Government of Orissa (Forest Department) through the State Crocodile Project. Thanks are due to Sri D. K. Sahoo and Sri I. C. Sahoo, Research Assistants for help.

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12. STRANGE PRACTICE OF A CATERPILLAR

Among the potted plants in the backyard of our house in Alipore area of Calcutta, I discovered one day by the middle of August, a caterpillar hidden within a broad leaf of a *Curcuma zedoaria rosa* (Zingiberaceae). The damaged leaf blade from which extensive areas had been eaten away drew my attention to it. I found a part of the broad leaf folded upon itself. When I pulled apart the leaf blade which was stuck with whitish silk webbings, a greenish grey, flat-looking caterpillar, about two inches long, came into view. The caterpillar had folded the leaf blade to make a chamber and remained snugly within it. It almost immediately started to fold the leaf back by secreting a sticky fluid from its mouth. It touched the leaf blade with its mouth alternately on its left and right side and stretched up a fine thread over its head. The thread soon grew thicker and that part of the leaf blade slowly but surely started to be folded upon itself. At this stage it suddenly started raining and the Curcuma leaf as well as the caterpillar got thoroughly drenched. But rain water did not seem to have any effect on the stickiness of the fluid or upon the determination of the caterpillar to continue its work.

While I was watching, I suddenly noticed slight contortions at the posterior end of the caterpillar where soon a blackish pellet came out. As I was closely watching, the caterpillar suddenly shot the pellet straight at me and hit me fully and squarely on the face. Perhaps it is normal for these caterpillars to eject their pellets of faeces in that way, but for a moment I had the feeling that the shooting had been done deliberately. As it was raining hard, and also as I had no desire to furnish the caterpillar with further targets, I withdrew from the scene rather in a huff.

Later in a cool moment, when I thought of the incident, it seemed to me that this remarkable habit of shooting of pellets of faeces by these caterpillars must have some useful purpose. These caterpillars can easily keep their chambers of folded leaves clean and unsoiled by shooting their faeces outside. And this shooting can also be used with telling effect upon their enemies which may try to sneak into the chamber from the rear.

After about twelve or fifteen days one morning at about 9 o'clock I found a medium big butterfly with white spotted black wings resting on the wall near that Curcuma plant. It was resting with its forewings upright and slightly apart and the hindwings resting flat, the white spots in the wings thus showing to advantage. It flew away when I tried to approach it. From the little that I could glimpse of the spotted wings and the sitting posture, I take it to be a Hesperiid. I wonder if this dapper and brisk butterfly could be the same dull and wormlike creature that behaved so disreputably with me a couple of weeks ago.

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September 4, 1978.

13. THE RED PIERROT *TALICADA NYSEUS* GUERIN (LEPIDOPTERA: LYCAENIDAE) IN BOMBAY AND THE SALSETTE ISLAND

Though 'Bombay', presumably the erstwhile Bombay Presidency or Bombay State prior to bifurcation into Gujarat and Maharashtra in May 1960, is listed under the range of the Red Pierrot, *Talicada nyseus* Guerin (Lycaenidae), there is neither a specific record of its occurrence in Bombay City and the Salsette Island in any of the lists published on the area in the *Journal* of the Bombay Natural History Society (Vols. 50 : 331-9; 53: 282-4; 54: 215-6; 56: 358-9; 57: 233-4; 74: 190-1), nor any specimen collected in the area is in the Society's collection. In these circumstances two specimens of the butterfly collected in the Bombay area in May 1979: one by Mr. P. W. Soman from Dadar, and the other by Miss Renée Borges from a garden in Colaba are of interest. These two specimens add to the Lepidopteran fauna of Bombay and Salsette Islands, and are now registered in the Society's collection.

Mr. J. S. Serrao of the Society informs me that this butterfly is rather common mostly during the dry season in gardens in Bandra, Bombay, and that it invariably keeps to patches of miscellaneous assortments of garden plants, with *Bryophyllum* interspersed here and there. He has also come across this butterfly in Mahableshwar in April/May 1978.

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June 30, 1979.

14. ANTS (*CAMPONOTUS* SP.) HUNTING FLIES

On 20th June 1975, we observed an uncommon event. We were staying overnight at a tourist bungalow at the Borivli National Park, Bombay and while sitting on the verandah steps in the evening, we saw some black ants carrying flies. Every few seconds a new ant would appear with a lifeless fly. On tracking the line of ants, we discovered that the flies carried by the ants were not dead ones found by chance, but that the ants were systematically hunting flies. As the ground was moist and dirty, plenty of flies were hovering around, often landing and remaining on the ground for some time. The ants wandering about were pouncing on any fly within striking distance. Although the percentage of successful strikes was low, the frequency of strikes and the large number of ants ensured that every 30 seconds or so, at least one ant would get its prey. After striking and capturing the fly, the ant would bend into a 'U' so as to make its abdomen touch the fly. This was probably to inject some venom from its sting. After this the fly would stop struggling and would be carried off. Sometimes a fly was seen to escape the clutches of the ant, even after capture. The ants had their nest in a hole in the ground beside the wall of the house. There were two sizes of ants indulging in this hunting. One ant was observed to hunt in a different way. It would remain motionless in one place, (it was seen on a banana peel) and let the flies come near. Whenever a fly came too close, it would jump on it and try to catch it. This behaviour was observed on two separate days at the same place. Ants are known to hunt and kill other insects and even bigger animals are taken by army ants. But for an individual ant to hunt so agile a creature as a fly seemed unusual and uncommon. The flies were certainly in good health and perfectly capable of flying.

13/A, AVANTI APARTMENTS,
SION (EAST),
BOMBAY-400 022,
February 2, 1979.

SHAILESH J. ZAVERI
JYOTINDRA J. ZAVERI
AMEET K. ZAVERI

15. COLOUR DURING LIFE OF THE CRAB *ATERGATIS ROSEUS* (RUPPELL)

The Xanthid walking crab *Atergatis roseus* (Ruppell) had been recorded by me, from collections made at Port Okha by my colleagues in the Department of Fisheries in the erstwhile Bombay State (Chhapgar, 1957, *JBNHS* 54, pages 426, 427). The crabs in that collection had been received by me preserved in formalin, and were seen to be of the colour of rose flowers; the trivial name *roseus* thus aptly describes the body coloration.

Subsequently I have had the opportunity to observe freshly collected crabs of this species; these had a brick-red body coloration quite similar to that of *Atergatis integerrimus* (Lamarck). However, while the latter has white pits on the carapace—sparsely distributed all over the outer hepatic, and the epi-, meso- and meta-branchial regions, the carapace in *A.*

roseus is uniformly brick-red except for an ivory-white border.

Incidentally, Alcock (1898, *Journ. Asiat. Soc. Bengal* 67, page 97), describing the coloration of *A. roseus* recorded from Madras and Karachi, gives it as "Colours in spirit brownish yellow." On the contrary, he has described the colours in spirit of *A. integerrimus* as "pinkish ochre."

B. F. CHHAPGAR

E-31, CUSROW BAUG,
COLABA CAUSEWAY,
BOMBAY-400 039,
March 15, 1979.

16. NEW RECORDS OF EUPHORBIACEAE FROM MADHYA PRADESH

Among trees and shrubs enumerated by Biscoe (1910), 8 genera and 12 species of Euphorbiaceae were recorded from the erstwhile Indore State; while among weeds, Kenoyer (1924), reported 4 genera and 9 species of this family from the former princely state of Gwalior and adjacent parts. After reorganisation of states the floristic composition of Madhya Pradesh has been assessed and evaluated by Heweston (1951), Sagreiya and Singh (1958), Tiwari (1968) and Khan (1973).

Panigrahi and Prasad (1967) reported 23 genera and 47 species of Euphorbiaceae from Madhya Pradesh, while 14 genera and 27 species have been described by Kaushik (1969, 1974) from Shivpuri (M.P.). Recently a few more have been added by Oommachan (1973) and Javed (1975) from Bhopal, but none of these authors have included the following plants in their respective works.

(1) *Euphorbia microphylla* Heyne, (2) *E. trigona* How., (3) *Jatropha podagrica* Hook., (4) *Pedilanthus japonica* Hook., (5) *Phyllanthus nivosus* Bull and (6) *Synadenium grantii* Hook.

Thus these 6 species belonging to 5 different genera collected from Bhopal are new records from Madhya Pradesh as a whole.

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17. *ACALYPHA INDICA* LINN.—A NEW RECORD FOR GARHWAL

Many European botanists explored Garhwal from the end of eighteenth century to the beginning of twentieth century and their results were published by J. F. Duthie in 1906 in the revised Strachey and Winterbottom's "Catalogue of the Plants of Kumaon and of the adjacent portions of Garhwal and Tibet". In recent years Indian Workers who collected plants in this region make no mention of its occurrence.

Acalypha indica Linn. in Sp. Pl. 1003, 1753; Hook. f. in Fl. Brit, Ind. 5:416, 1887; Duthie in Fl. Upp. Gang. Pl. 3:108, 1920; Maheshwari in Fl. Delhi 316, 1963 & in Illustr. Fl. Delhi t. 197, 1966.

An erect annual herb, 30-80 cm. high with many spreading and ascending branches. Leaves membranous, 5×3.5 cm. Flowers minute, green in lax, erect, axillary spikes. Capsule glabrous.

G. S. Rajwar: 120 (30-9-1977) Kotdwara (Distt. Pauri). Common in waste places in dry situations. Flowering Aug.-May.

G. S. RAJWAR

DEPARTMENT OF BOTANY,
GOVT. POST GRADUATE COLLEGE,
KOTDWARA-246 149 (GARHWAL), U.P.,
May 20, 1978.

18. OCCURRENCE OF *MYRIOPHYLLUM SPICATUM* LINN. IN RAJASTHAN

Myriophyllum spicatum Linn. (Haloragaceae), a Himalayan plant, has so far been reported from Kashmir, northern boundary of Punjab and Uttar Pradesh between 500-2,000 m. above m.s.l. (Subramanyam, K.: Aquatic Angios. 17. 1962). During botanical exploration of Bikaner district, the senior author collected *M. spicatum* L. from stagnant water in the Rajasthan Canal near Lunkarnsar (240 m. above m.s.l.), where it grows in association with *Vallisneria spiralis* Linn. and *Potamogeton nodosus* Poir. or forms pure stands. It is interesting to note that this taxon has become fully adopted to adverse conditions. This species can be easily distinguished from other related taxa by its leaves being finely pinnated

into filiform segments. Spikes terminal; each flower in the axil of a large pinnatisect—serrate bract and two small, lateral, serrate bracts not exceeding 5 mm in length. Petals in male flowers only. Stamens 8. Fruits of 3, 1-seeded cocci which are tubercled on the dorso-lateral margins and muricated on its flat back. Furrows between the fruiting carpels are very narrow, hardly noticeable. *Flowering and Fruiting*: August-November.

The specimens (*Roy* 2160, 2424) are deposited in the herbarium of the Botanical Survey of India, Jodhpur (BSJO) and CNH., Howrah (CAL.).

G. P. ROY
V. SINGH

BOTANICAL SURVEY OF INDIA,
D-7, SHASTRI NAGAR, JODHPUR,
RAJASTHAN.
November 1, 1977.

19. RARE OR LITTLE KNOWN PLANTS FROM SOUTH INDIA

Five species of Angiosperms, known to be endemic to Kanyakumari and Tirunelveli Districts of Tamil Nadu and adjoining regions of Kerala, South India, are reported in this paper. They were rediscovered recently after a lapse of 70 to 100 years. All the specimens examined are present in MH.

Byrsophyllum tetrandrum (Bedd.) Hook. f. ex Bedd. Fl. Sylv. t. 326. 1873; Hook. f. Fl. Brit. India 3: 107. 1880; Bourd. For. Trees Travancore 217. 1908; Rao, Fl. Pl. Travancore 208. 1914; Gamble, Fl. Pres. Madras 2: 433. 1957 (repr. ed.). *Gardenia tetrandra* Bedd. Icon. t. 20. 1868-74. [RUBIACEAE].

Glabrous shrubs or small trees, 3-4.5 m tall; branches stout. Leaves 4.5-8 x 1.8-3.4 cm., elliptic-oblong to elliptic-obovate, entire coriaceous, shining, obtuse at apex, narrowed at base; petioles up to 2.5 cm long. Flowers up to 4 cm long, white reddish tinge without, fragrant; male in few—flowered terminal corymbs, female solitary or in pairs, terminal. Berries *c.* 2 cm across, ovoid or subglobose.

This species was described by Beddome dur ing 1868-74, based on Captain Davidson's collection from "Travancore mountains (Athraymallay)". It was subsequently collected by Bourdillon from Muthukuzhivayal, Kanyakumari Dt. (previously S. Travancore, Kerala) in 1894. Recently we could relocate the plants in exposed areas at the top of the hill in Muthukuzhivayal area, and also in Agastyarmalai, Tirunelveli Dt., after a lapse of about 70 years.

Specimens examined: TAMIL NADU. Kanyakumari Dt.: M. K. Vayal, 4200 ft., 2-10-1894, *Bourdillon 371;* way to Muthukuzhivayal, 1000 m, 1-9-1976, *Henry 48190.* Tirunelveli Dt.: "S. Travencore & Tinnevelly", 5000 ft., *Beddome? s.n.* (acc. no. 25142); way to Agastyarmalai Peak, 1700 m, 1-7-1964, *Henry & Chandrabose 19219.*

Distribution: South India (Kanyakumari and Tirunelveli Dts. of Tamil Nadu, and adjoining regions of Kerala).

Didymocarpus missionis Wall. [Cat. no. 6396. 1832, *nomen*] ex R. Br. in Benn. & R. Br. Pl. Jav. Rar. 119. 1840; DC. Prodr. 9: 266. 1845; Clarke in DC. Mon. Phan. 5:104. 1883 & in Hook. f. Fl. Brit. India 4:354. 1884; Rao, Fl. Pl. Travancore 295. 1914; Gamble, Fl. Press. Madras 2: 694. 1957 (repr. ed.). *D. membranacea* Bedd. Icon. t. 176. 1868-74. [GESNERIACEAE].

Scapigerous, somewhat succulent herbs. Leaves up to 16×9 cm, ovate to ovate-lanceolate, succulent (appearing membranous in dried specimens), entire, pellucid white-hairy, acute at apex, cordate and unequal at base; petioles up to 13 cm long, white-hairy. Flowers 1.2-1.4 cm long, blue, funnel-shaped, in racemes on scapes up to 24 cm long. Capsules 3-4 cm long, slender, finely apiculate, glabrous.

Beddome (loc. cit.) who collected this species in 1874 remarks: "A most delicate species apparently very rare, I have only met with it in one place on the South Travancore ghats, moist rocks, Pachemallay (2000 feet elevation)". Gamble who could study both the Wallichian and Beddomean collections of this species at Kew Herbarium in 1922 writes on Beddome's sheet (acc. no. 36686, the only sheet present in MH): "Specimens badly wanted at Kew. The only one at Kew is in the Wallich collection....". After a lapse of over 100 years we could locate the plants on wet rocks in the ghats of Kanyakumari Dt., Tamil Nadu (old South Travancore).

Specimens examined: TAMIL NADU. Kanyakumari Dt.: Asamboo hills, Pachymallay, 2000 ft., *Beddome s.n.* (acc. no. 36686); Kalikesam riverside—Balamore, 700 m, 30-8-1976, *Henry 48151;* Kilaviarumalai—Balamore, 480 m, 28-7-1977, *Henry 49421.*

Distribution: South India (Kanyakumari Dt. of Tamil Nadu).

Didymocarpus ovalifolia Wight, Icon. t. 1351. 1848: Clarke in DC. Mon. Phan. 5: 104. 1883 & in Hook. f. Fl. Brit. India 4: 354. 1884; Rao, Fl. Pl. Travancore 295. 1914; Gamble, Fl. Pres. Madras 2: 694. 1957 (repr. ed.). [GESNERIACEAE].

Scapigerous, white—strigose herbs., Leaves up to 13×7.5 cm, elliptic—ovate, crenate—serrate, obtuse at apex, rounded at base; petioles up to 11.5 cm long. Flowers 1.5—2 cm long, bluish-violet, tubular-ventricose, 3-6, in umbels on scapes up to 19 cm long. Capsules 3-3.5 cm long, slender, cuspidate, pubescent.

Wight, who discovered this endemic species in 1848 (loc. cit.) writes under Explanation of plates: '!'Courtallam, flowering August and September. A very beautiful species conspicuous on account of the large size of its flowers." This species was subsequently collected by Beddome from Tirunelveli Hills in 1867. After a lapse of about 100 years, we could relocate this species along exposed rocky slopes at the top of Agastyarmalai Hills in Tirunelveli Dt. and in Muthukuzhivayal area, Kanyakumari Dt.

Specimens examined: TAMIL NADU. Kanyakumari Dt.: Muthukuzhivayal, 1300 m, 6-8-1977, *Henry 49610.* Tirunelveli Dt.: "Tinnevelly", 1867, *Beddome s.n.* (acc. no. 36737); "Tinnevelly hills", "Courtallam hills" *Beddome? s.n.* (acc. nos. 36687 & 36690); Exposed slopes-way to Agastyarmalai Peak, 1200 m, 24-8-1963, *Henry 17317;* Agastyarmalai Peak, 1600 m, 1-7-1964, *Henry & Chandrabose 19215.*

Distribution: South India (Kanyakumari and Tirunelveli Dts. of Tamil Nadu).

Elaeocarpus venustus Bedd. Fl. Sylv. t. 174. 1872; Bourd. For. Trees Travancore 60. 1908; Rao, Fl. Pl. Travancore 55. 1914; Gamble, Fl. Pres. Madras 1: 89. 1957 (repr. ed.). *E. monocera* sensu Masters in Hook. f. Fl. Brit. India 1: 405. 1874. *p.p.* (non Cav.). [ELAEOCARPACEAE].

Trees. 12-15 m tall; branches glabrous. Leaves 6-12×3-5 cm elliptic or obovate, inconspicuously serrate-apiculate, glabrous, acute at apex, attenuate at base; the axils of primary nerves beneath with large glands promi-

nently impressed above; petioles 1-3 cm long. Flowers 2.5-3 cm across, white, in axillary, 4-8—flowered racemes: pedicels 2-2.5 cm long. Sepals glabrous without, pubescent within. Petals fimbriate, silky without and at base within. Anthers minutely puberulous, mucronate. "Drupe ovoid, about 2 in. by 1 in., hanging on 2-3 in. peduncles from the old wood" (Bourdillon).

Beddome (loc. cit.) who described this species states: "A fine large tree only observed in the Muti-kuli vayal...it is truly beautiful when covered with its snow white large flowers, which it produces in great abundance ..." This endemic species was subsequently reported by Bourdillon (loc. cit.) from "Muthu kuli vayal and Chimunji in South Travancore at an elevation of 3500—4500 ft." After a lapse of over seventy years, we have succeeded in locating this rare plant again at the type locality, and making its first representation in MH.

Specimens examined: TAMIL NADU. Kanyakumari Dt.: Muthukuzhivayal, 1400 m, 10-9-1976, *Henry 48327;* Oothu to Upper Kodayar, 1300 m, 8-8-1977, *Henry 49662.*

Distribution: South India (Kanyakumari Dt. of Tamil Nadu and adjoining regions of Kerala).

Eugenia floccosa Bedd. Fl. Sylv. t. 200. 1872; Duthie in Hook. f. Fl. Brit. India 2: 501. 1879; Rao, Fl. Pl. Travancore 170. 1914; Gamble, Fl. Pres. Madras 1: 342. 1957 (repr. ed.). [MYRTACEAE].

Trees, 8-12 m tall, young parts densely floccose. Leaves 4-14×2-7.5 cm, broadly elliptic or obovate, entire, densely floccose on both sides when young, glabrescent when old, rounded or obtuse at apex, obtuse at base, nerves not prominent, arched, midrib impressed below, petioles 1-2 cm long. Flowers 2.3-2.6 cm across, showy, few in cymes, or solitary; corolla 2 cm long, white, floccose without, glabrous within, larger than calyx. Berries 3.5-4 cm across, globose, densely floccose, crowned with large persistent calyx-lobes.

"This is a most beautiful tree" (Beddome), scattered along outskirts of shola forests. Beddome, who described the size of the fruit as that of a Pigeon's egg, apparently observed only young fruits. Later workers accepted Beddome's description, as they evidently could not study additional materials. After a lapse of a century, we have located this plant in the vicinity of the type locality—"above calcad", in both flowers and fruits. The fruit at maturity is quite large, about 4 cm across.

Merril & Perry (Jorun. Arn. Arb. 18 : 322-343. 1937 & seq.) opine that majority of the Old World species of *Eugenia* should be placed under *Syzygium* Gaertn. Their arguments for separating *Syzygium* from *Eugenia* are based mainly on the structure of seed: *Syzygium* has the cotyledons separate and distinct while in *Eugenia* (sensu stricto) they are fused together and are mechanically inseparable; further the testa in *Syzygium* is adherent to the pericarp while in true *Eugenia* it is free from it and adherent to the cotyledons. Henderson (Garden. Bull. Singapore 12: 1-293. 1949), while revising the genus *Eugenia* in Malaya has shown that the seed coat and its degree of adherence to the cotyledons, and the pseudomonocotyledonous nature of the seed, could hardly be used as a basis for generic distinctions. For the present we treat this species under *Eugenia* Linn. (sensu lato) since a complete monograph on the subject is not available.

Specimens examined: TAMIL NADU. Kanyakumari Dt.: Muthukuzhivayal, 1400 m, 10-9-1976, *Henry 48320* & 6-8-1977, *Henry*

49618. Tirunelveli Dt.: Calcad hills, *Beddome? s.n.* (acc. no. 20811); Tinnevelly, *Beddome s.n.* (sec. nos. 20812-14 & 85664); Oothu, 1-9-1963, *Henry 17410*.

Distribution: South India (Kanyakumari & Tirunelveli Dts. of Tamil Nadu).

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A. N. HENRY
M. S. SWAMINATHAN

20. NOTES ON THE DISTRIBUTION OF A FEW INDIAN GRASSES

Hitherto *Indochloa clarkii* (Hack.) Bor, (Panicoideae-Andropogoneae) was considered to be endemic in the Pareshnath hills, Bihar. The present paper reports its occurrence on the plateau of Madhya Pradesh for the first time. This shows that it is a rare grass but not with a restricted distribution.

Indochloa clarkii (Hack.) Bor in Kew Bull. 1954: 76, 1954.

(Panicoideae—Andropogoneae, Poaceae)

Hooker (Flora of British India 7: 197. 1897) recorded this taxon under *Andropogon clarkii* Hack. and Haines (Bot. Bihar & Orissa 1040. 1924) placed it under *Dicanthium clarkii* (Hack.) Haines. Both the authors reported the species from the top of Pareshnath hill. This report from Sonmuda, Bilaspur, Madhya Pradesh, 5-11-1970, *G. Panigrahi* 13333 (BSA), is an extension of the range of the species northwards.

As such it appears to extend its range under favourable environments into the adjoining hilly regions. The Collector records: "rooting in black mud along Son River stream. A large number of branches from lower internodes. Inflorescence with chocolate coloured awns. Seen only here. Very light grass. Rare." However, examinations of the available materials in (CAL) reveal: that the glabrous stems, leaves glabrous, except the margin, young leaves, matured pedicels and neuter spikelets, reddish brown, and fertile ones villose, help to identify the taxon in the field.

Polypogon monspeliensis (Linn.) Desf. (Poaideae-Agrostideae)—This grass has been known for a long time from North Western Himalayas, the Upper Gangetic Plains, Bihar and Madras as a winter annual. The winter in the Upper Gangetic Plains is very severe. Grows as a bushy grass in low lying marshy lands at different localities of Howrah district in West Bengal. It appears that this grass has successfully invaded the Lower Gangetic Plains of India at its eastern most extension.

Polypogon monspeliensis (Linn.) Desf. Fl. Allant. 1: 64. 1789.—*Alopecurus monospeliensis* Linn. Sp. Pl. ed. 1, 61. 1753. Tufted annuals. Panicles spiciform oblong or cylindric; glumes oblong, scaberulous ciliolate, tip deeply notched; awn from the sinus or beneath it, 5-9.8 mm long, 2-3 times the length of the glumes.

INDIA: West Bengal, Howrah district. Thanamakua, *A. K. Naskar* s.n., collected on 12-8-72 (*CAL*): Andul Road, West Bengal, Near Damodar Valley Corp., Feb. '72,

Growing on moist situations, *R. B. Mazumdar* 1; 2, 3 (*CAL*)

Rhynchelytrum villosum (Parl.) Chiov. in Ann. 1st Bot. Roma 8: 310, 1908, (Panicoideae—Paniceae, Poaceae). This grass is reported here from West Bengal for the first time. During the identification of earlier collection, we located specimens collected from the slope facing the river Hooghly, IBG Head Office Ghat, (Opp. to old herbarium building), Indian Botanic Graden, Howrah (*H. P. Naskar* 1 on 15-3-1949,: *CAL*). It is an erect herb with scabrid leaf sheaths; pedicels of the spikelets not hairy. Glume I, linear-oblong, obtuse, minute. Glume IV thin, 0.8 mm, below the upper, bearded at the base, glabrescent upwards. It occurs on sandy loam soil. A scrutiny of available literature as well as herbarium specimens in the Central National Herbarium, Howrah, (CAL), revealed that this species has been collected from Badami also (*A. Meebold* 11215, Sept. 1910, *CAL*) The range of the species extends to Tropical Africa. Bor (Grasses of India, Burma & Ceylon: 355, 1960) reports it from Punjab and Rajputana. Thus the present report establishes the continuity of the distribution from Northwestern and Peninsular India.

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BARIN GHOSH
R. N. BANERJEE

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