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DR. A. K. GHOSH
Director
Zoological Survey of India

RECORDS OF THE ZOOLOGICAL SURVEY OF INDIA

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ON A COLLECTION OF REPTILES FROM THE ANNA AND MADURAI
DISTRICTS, TAMILNADU

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INTRODUCTION

This account is based on a lot of collections made in the Anna and Madurai Districts during 1986-1987 as part of the ongoing project on the mopping survey of the State of Tamilnadu taken up by the Southern Regional Station (SRS) of the Zoological Survey of India (ZSI).

The paper deals with 9 species of lizards and 5 species of snakes collected both from the plains and the forested tracts of the districts mentioned.

The entire material worked out has been incorporated in the reptile collections of the SRS, ZSI.

Key to the abbreviations : VRL/VRS : V—Vertebrate, R—Reptilia, L—Lizard, S—Snake, ; coll.—Collection ; Ex./Exs.—Example/Examples. The number following the abbreviation indicates the entry number pertaining to the taxon in the Register of National Collections.

Key to the identification of reptiles of the Anna and Madurai districts

Special Notes : A workable key, based upon characters that can be easily determined in the field, is given below. It, however, covers only the species that are discussed in the paper.

* H/20E Tiruvaniyar,
Madras 600 041,

LIZARDS

1.	Top of head with symmetrical shields...	...	...	2
	Top of head without symmetrical shields...		...	6
2.	Body covered with osteodermal plates ; femoral pores absent		...	3
	Body covered with osteodermal plates ; femoral pores present	...	<i>Ophisops jerdoni</i>	
3.	Limbs well developed	...	...	4
	Limbs short, vestigial	...	...	5
4.	Dark bronze above, with an yellowish lateral band on each flank...		<i>Mabuya carinata</i>	
	Greyish-brown above, with 3 broad, black-edged, white (yellow in life) longitudinal stripes	...	<i>Mabuya trivittata</i>	
5.	No supranasals : lower eyelid with a transparent disc	...	<i>Sciacella travancoricum</i>	
	Supranasals present ; lower eyelid scaly or with disc...	...	<i>Lygosoma punctata</i>	
6.	Eyes without movable eyelids ; digits clawed	...	<i>Hemidactylus reticulatus</i>	
	Eyes with movable eyelids : digits free	...	...	7
7.	Hind foot with of four toes only	...	<i>Sitana ponticeriana</i>	
	Hind foot with five toes	...	...	8
8.	Body depressed ; back without a dorsal crest	...	<i>Psammophilus blanfordanus</i>	
	Body not depressed ; back with a dorsal crest	...	<i>Calotes versicolor</i>	

SNAKES

1.	Eyes vestigial	...	...	...	<i>Ramphotyphlops braminus</i>	
	Eyes exposed	...	...	...		2
2.	Tail short, truncated and the truncated portion covered with thickened scales	...	...	...	<i>Uropeltis pulneyensis</i>	
	Tail not so	...	...	...	...	3
3.	Head triangular; covered with small scales	...	...	...	<i>Echis carinatus</i>	
	Head not triangular, covered with distinct shields	...	...	...	...	4

4. Vertebral scales distinctly enlarged ; fangs in front of the month ... *Bungarus caeruleus*
 Vertebral scales not as above ; no fangs in front of the mouth ... 5
5. Head and nape black, with distinctive dark chevrons ; scales round the body in
 17 rows *Oligodon arnensis*
 Head and naps neither black nor with chevrons ; scales round the body in 25 to
 27 rows. *Elaphe helena*

ACCOUNT OF SPECIES

The taxonomic arrangement adopted here follows broadly the lines laid down by Malcolm Smith (1935, 1943) but with nomenclatural modifications as suggested by Mittlemen (1952) and Stimson et al. (1977).

LIZARDS

Family : GEKKONIDAE

1. *Hemidactylus reticulatus* Beddome

Material : 3 exs., VRL 283, Vaigai dam, 17. III. 1917. K. V. Lakshminarayana coll.

Size : Snout to vent 32 mm-42 mm ; tail 27 mm-37 mm.

Distribution : Records from Madurai and Shevaroy, Tamilnadu, Karnataka and Palakonda Hills, Andhra.

Elsewhere : Also recorded from Palnis, Tamilnadu. Endemic to India.

Family : AGAMIDAE

2. *Sitana ponticeriana* Cuvier Fan-throated Lizard

Material : 1 ex., VRL 256, Vaigai Dam, 8. II. 1986, Koshy Mathew coll ; 1 ex., VRL 257, Vaigai Dam—Vaigai River Road, 12. XI. 1986, Koshy Mathew coll. ; 1 ex. VRL 277, Kueyamgalon, 6. III. 1987, K. V. Lakshminarayana coll. ; 1 ex. VRL 281, Vaigai Dam—Vaigai River Road, 10. III. 1987, K. V. Lakshminarayana coll.

Size : Snout to vent 30 mm-45 mm ; tail length : 100 mm-126 mm.

Distribution : The whole of India and Sri Lanka.

3. Calotes versicolor (Daudin)
Indian Garden Lizard

Material : 1 ex., VRL 278, Madhavakulam, 7. III. 1987, K. V. Lakshminarayana coll.

Size : Snout to vent 75 mm ; tail 192 mm.

Distribution : The commonest lizard of India, Pakistan and Sri Lanka. Also found in Sumatra, Hainan, Hong Kong, Afganistan, Indo-Ehine, South China, northern Malay Peninsula.

4. Psammophilus blanfordanus (Stoliczka)
Dwarf Rock Lizard

Material : 1 ex., VRL 279, Palani-Kodai Road, 25. III. 1987, K. V. Lakshminarayana coll.

Size : Snout to vent 62 mm ; tail 121 mm.

Distribution : Bihar, Orissa, Madhya Pradesh, Eastern Ghats and Kerala. Not so common in the plains of South India but is often met with in the hills.

Family : SCINCIDAE

5, Mabuya carinata (Schneider)
Common Skink

Material : 1 ex., VRL 286, Alagar Hills, 6. XI. 1986, Koshy Mathew coll.

Size : Snout to vent 42 mm ; tail damaged.

Distribution : The whole of India excepting the north-west and Sri Lanka.

6. Mabuya trivittata Hardwicke & Gray

Material : 1 ex., VRL 280, Vaigai Dam—Vaigai River Road, 18. III. 1987, K. V. Lakshminarayana coll.

Size : Snout to vent 57 mm ; tail 60 mm.

Distribution : Maharashtra, Karnataka, Tamiladu and Bihar.

7. *Lygosoma punctata* (Gmelin)
Dotted Garden Skink

Material : 1 ex., VRL 259, Chatrapatti, 21.XI.1986, Koshy Mathew coll.

Size : Snout to vent 68 mm ; tail 715 mm.

Distribution : India and Sri Lanka.

8. *Scincella travancoricum* (Beddome)
Travancore Ground Skink

Material : 3 exs., VRL 285, Berijam Lake, Kodaikanal, 15.XI. 1986, Koshy Mathew coll.

Distribution : Anaimalais, Palnis and Hills of South Kerala Western Ghats.

Family : LACERTIDAE

10. *Ophisops jerdoni* Blyth
Snake-eyed Lacerta

Material : 1 ex., VRL 258, Vaigai Dam, 8. XI. 1986. Koshy Mathew coll. ;
1 ex., VRL 282, Rajagopalanpatti, 12. XI. 1986, Koshy Mathew coll.

Size : Snout to vent 30 mm-45 mm ; tail 66 mm-95 mm.

Distribution : Recorded with certainty from Gujarat, Punjab, Rajasthan, Madhya Pradesh, Maharashtra, Karnataka in India and Pakistan. The specimen under study is an additional and interesting record for Tamilnadu.

SNAKES

Family : TYPHLOPIDAE

11. *Ramphotyphlops braminus* (Daudin)
Common Blind Snake

Material : 1 ex., VRS 155, Sathija Annai, 8. III. 1987, K. V. Lakshmi-narayana coll.

Size : 145 mm.

Distribution : Widely distributed in Asia, Indo-Malaysia and New Guinea.

Family : UROPELTIDAE

11. *Uropeltis puleyensis* (Beddome)
Palnis Uropelt

Material : 1 ex., VRS 150, Silver Cascade, Kodaikanal, 8. III. 1987, Koshy Mathew coll.

Size : 380 mm.

Distribution : Palnis and Alagar Hills, Tamilnadu ; Munnar Hills, Kerala.

Family : COLUBRIDAE

12. *Elaphe helena* (Daudin)
Trinket Snake

Material : 2 exs., VRS 222, 245, Ayyalur Forest RH. 24 XI. 1986, Koshy Mathew coll.

Size : 1200 mm-1225 mm.

Distribution : All over India. Sri Lanka and Pakistan.

13. *Oligodon arnensis* (Shaw)
Banded Kukri Snake

Material : 1 ex., VRS 149, Ayyalur Forest RH., 24. XI. 1986, Koshy Mathew coll.

Size : 555 mm.

Distribution : The whole of Asia including the Malay States and in Egypt.

Family : ELAPIDAE

14. *Bungarus caeruleus* (Daudin)
Common Krait

Material : 1 ex., VRS 148, Ayyalur Forest RH., 24. XI. 1986, Koshy Mathew coll.

Size : 1 m.

Distribution : Fairly common in most of India but seems to be rare in Bengal and Assam.

Family : VIPERIDAE

15. *Echis carinatus* (Schneider)
Saw-scaled Viper

Material : 2 exs., VRS 149, 176, Vaigai Dam, 8. XI. 1986 and 17. III. 1987, Koshy Mathew coll.

Size : 70 cm-72.5 cm.

Distribution : Common throughout India but plentiful in parts of Maharashtra, Punjab, Rajasthan and Tamilnadu.

ACKNOWLEDGEMENTS

The authors are grateful to the Director, Zoological Survey of India and the Officer-in-charge, Southern Regional Station, ZSI, Madras and thank especially the scientists and other staff of the moping survey team of the Anna and Madurai Districts, Tamilnadu for their efforts in collecting the material on which the paper is based.

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-

STUDIES ON THE MORPHOLOGY OF MALE GENITALIA OF SOME SPECIES OF SCARABAEIDAE (COLEOPTERA).

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INTRODUCTION

Scarabaeidae is one of the largest families of Coleoptera and contains about 25,000 described species under 2000 genera from all over the world. In India about 1,590 species under 203 genera are known (Annonymus, 1991 ; Arrow, 1937 ; Balthaser, 1963, 1964 ; Schenkling, 1921 ; Young, 1989). The species of this family can easily be recognised by the presence of characteristic form of antennae. However, the genitalia of male (aedeagus) plays an important role in identification of closely related species of scarabaeid beetles. Hence, scanning electron microscope (SEM) was used to study the morphological differences of male genitalia of 10 species of scarabaeid beetles collected from Andaman and Nicobar Islands (Figs. 1-13).

MATERIAL AND METHODS

Fresh samples containing males of 10 different species of Scarabaeidae were separated and cleaned under laboratory using an ultrasonic cleaner. The male genitalia (aedeagus) of each species were dissected out using a fine needle and dehydrated in different concentrations (50, 60, 70 and 100%) of acetone. The air dried samples were coated with carbon and gold in a vacuum coater JEOL JEE-4X. The coated samples were scanned under JEOL JSM-840A electron microscope.

RESULTS AND DISCUSSION

The size of the external male genitalia (aedeagus) of scarabaeid beetles normally varies from 1 mm to 10 mm in length and in most cases their length does not exceed

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5 mm, which makes some times very difficult to study the details of aedeagus with the light microscope. The male genitalia has been one of the characters employed in scarabaeid taxonomy especially for identification of species and subspecies. Further it also helps in grouping the taxa at all levels. Hence, the present study has been made on the morphology of male genitalia of fresh samples using scanning electron micrographs. The result obtained is shown in Figs. 1-13, which will help in the identification of species subspecies of scarabaeidae.

Observations on the scanning electron micrographs of aedeagus of 10 species of scarabaeid beetles are as follows :

***Aphodius (Calaphodius) moestus* Fabricius**

(Figs. 1-2)

Size of aedeagus 1.65 mm ; phallobase longer than parameres ; parameres broad at base and narrowing apically, overlapping each other upto middle and apex with a characteristic longitudinal carina with dentations and small grooves laterally ; carinae with asymmetrical spines studded medially on lateral constrictions.

***Aphodius (Nialus) lividus* (Oliver)**

(Fig. 3)

Size of aedeagus 1.75 mm ; phallobase twice the length of parameres ; parameres rather flat and separated with a median long groove, tapered distally and obliquely narrowing apically, with the characteristic long setae on lateral margin subapically ; apices very pointed.

***Aphodius (Pharaphodius) crenatus* Harold**

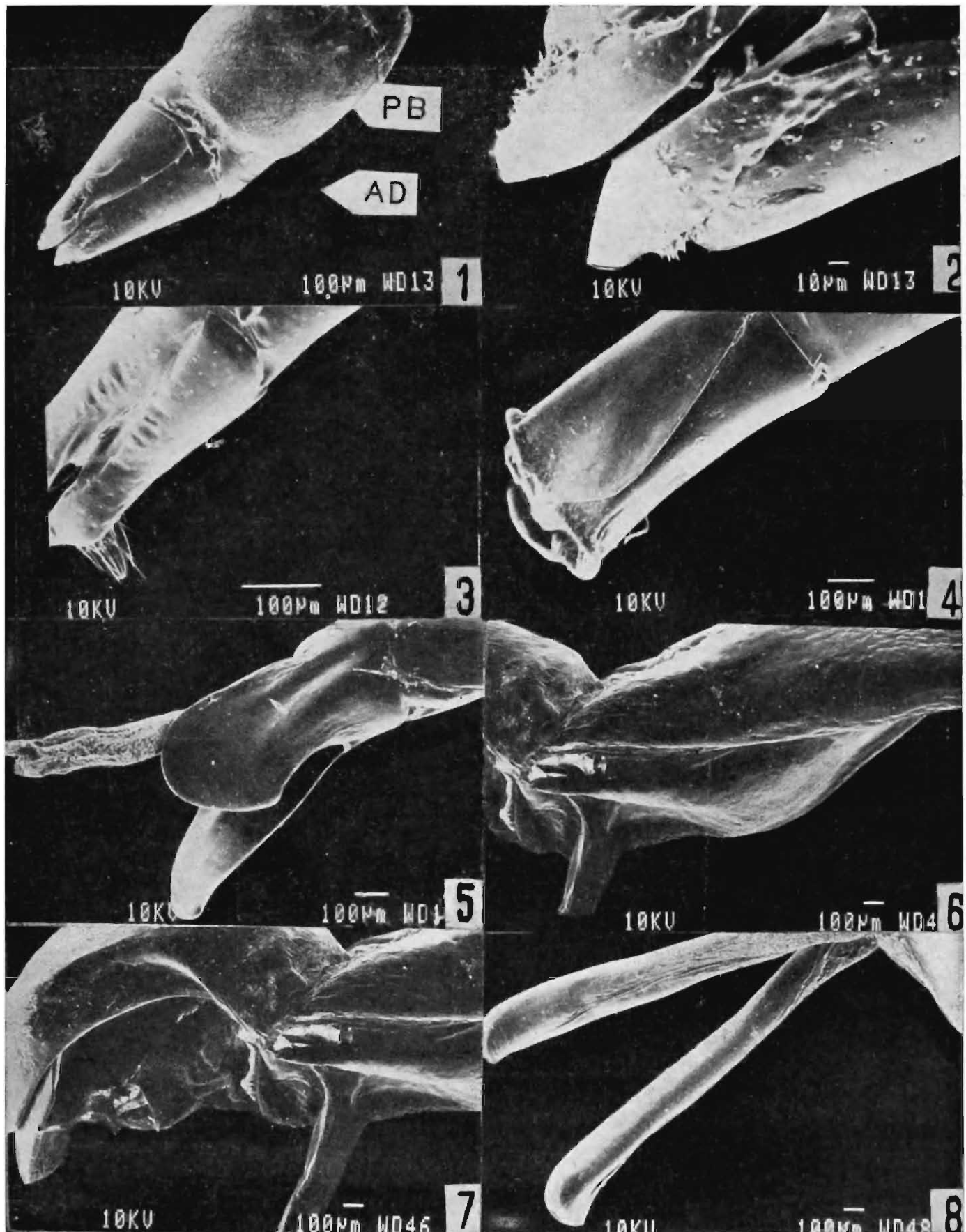
(Fig. 4)

Size of aedeagus 1.8 mm ; phallobase longer than parameres and tubular ; parameres forming a tubular structure, dilating towards apex and overlapping each other subapically, with the characteristic apices.

***Phaeochrous intermedius intermedius* Pic**

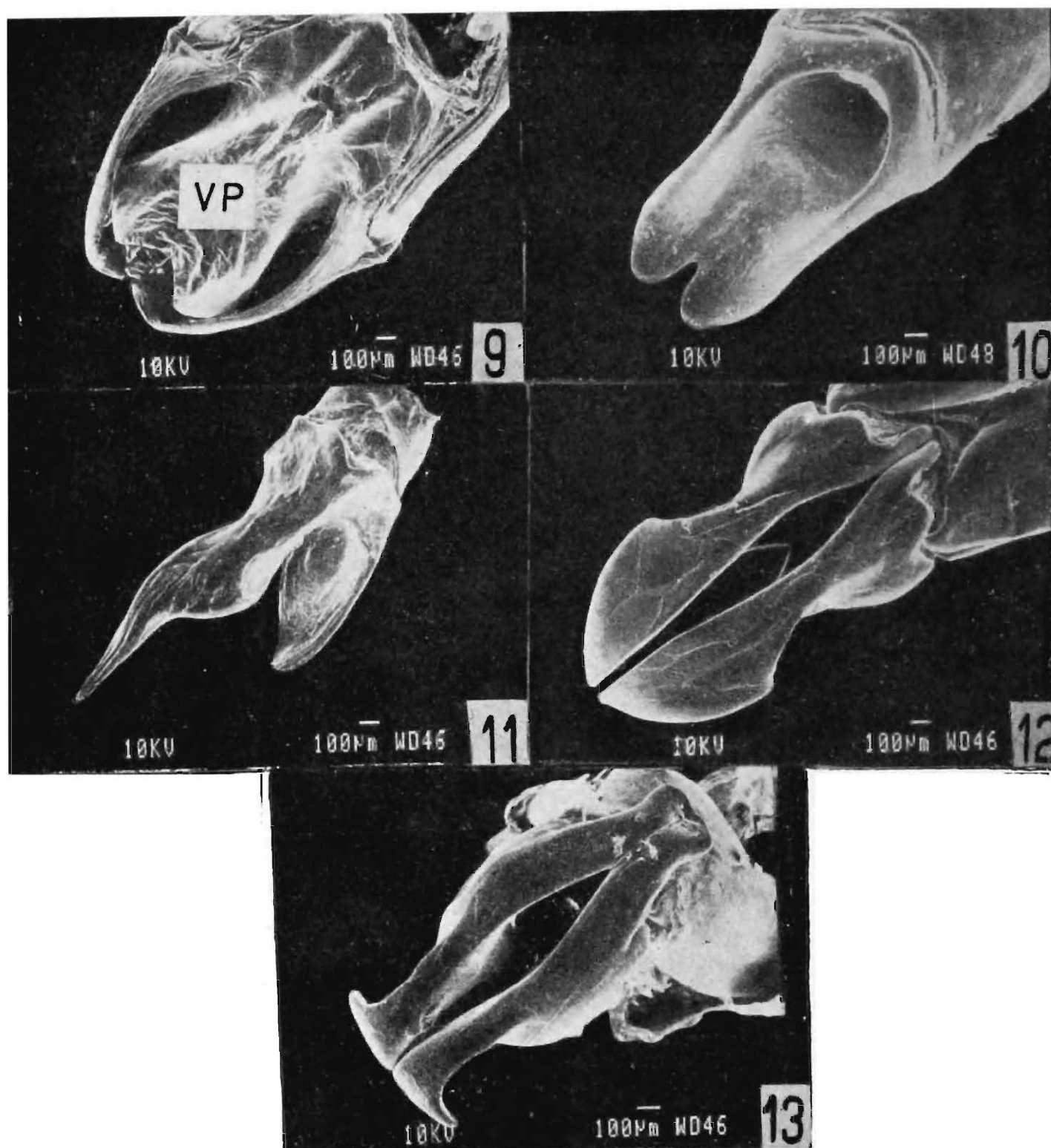
(Fig. 5)

Size of aedeagus 4.75 mm ; phallobase four times longer than parameres ;



Scanning electron micrographs of external male genitalia (aedeagus) of scarabaeid beetles :

Aphodius (*Calaphodius*) *moestus* Fabricius (1-2), 1—aedeagus (dorsal view); 2—apical tip of parameres (dorsal view). *Aphodius* (*Nialus*) *lividus* (Olivier), 3—parameres (dorsal view). *Aphodius* (*Pharaphodius*) *crenatus* Harold, 4—parameres (dorsal view). *Phaeochrous intermedius intermedius* Pic, 5—parameres (lateral view). *Holotrichia nicobarica* Chandra (6-8), 6—phallobase



Scanning electron micrographs of external male genitalia (aedeagus) of scarabaeid beetles :

Anomala desiccata Arrow, 9—parameres (ventral view). *Adoretus costopilosus* Ohaus, 10—paramere (dorsal view). *Adoretus versutus* Harold, 11—parameres (dorsal view). *Heteronychus lioderes* Redtenbacher, 12—parameres (dorsal view). *Alissonotum piceum* (Fabricius), 13—parameres (dorsal view).

VP—paramere.

parameres assymetrical ; characteristic longer paramere far extended towards base and narrowing apically ; short paramere slightly widening in apical half, an angular protrusion laterally and bluntly rounded at apex.

Holotrichia nicobarica Chandra

(Figs. 6-8)

Size of aedeagus 6.55 mm ; phallobase twice longer than parameres ; parameres symmetrical, blunt at apex with a hollow contour laterally ; ventral plate continuing into two characteristic long ventral rods across the Phallobase ; ventral rods slightly pointed laterally at apex.

Anomala desiceata Arrow

(Fig. 9)

Size of aedeagus 6.75 mm ; phallobase large ; parameres short and overlapping each other at base, narrowing towards apex, apices blunt ; ventral plate with apical margin strongly bilobed and laterally sinuated at middle.

Adoretus costopilosus Ohaus

(Fig. 10)

Size of aedeagus 3.85 mm ; phallobase longer than parameres ; parameres consolidated ventrally with lateral margins almost straight except at base, very slightly converging posteriorly ; apices blunt with a deep notch in between the parameres at apex.

Adoretus versutus Harold

(Fig. 11)

Size of aedeagus 4.05 mm ; phallobase twice longer than parameres ; parameres assymetrical ; longer paramere sinuated laterally at base, dilated at middle and sharply narrowing towards apex ; short paramere broad at base and gradually narrowing towards apex internally.

Heteronychus lioderes Redtenbacher

(Fig. 12)

Size of aedeagus 6.85 mm ; parameres short, dorsoventrally flattened, slightly curved ventrally, two sinuations at base obliquely, strongly constricted at middle laterally and abruptly dilated distally and narrowing apically.

Alissonotum piceum (Fabricius)

(Fig. 13)

Size of aedeagus 3.65 mm ; phallobase elongate and longer than parameres ; parameres slender; oval and apices truncate and much prolonged outwards.

From the present study it is apparent that the application of SEM to the systematic studies of Scarabaeidae will be a valuable tool to the investigator particularly if micrographs of genitalia could be gathered into a reference atlas.

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SUMMARY

Genitalia of male scarbaeid beetles play an important role in the identification of species and subspecies and also in grouping the taxa at all levels. Morphology of 10 species of scarbaeid beetles occurring in Andaman and Nicobar Islands have been studied using scanning electron microscope. Descriptions have been made using the micrographs and it has been suggested that the application of scanning electron microscopy to systematic studies of the species of scarbaeidae will be a valuable tool to the investigator, particularly if micrographs of diagnostic features could be gathered into a reference atlas.

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OCCURRENCE OF THE SZECHUAN BURROWING SHREW, *ANOUROSOSEX*
SQUAMIPES SQUAMIPES MILNE-EDWARDS, 1872 (MAMMALIA :
INSECTIVORA : SORICIDAE) IN MIZORAM, INDIA

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INTRODUCTION

A faunistic survey was conducted in Mizoram, specially for mammals, by the Zoological Survey of India during December 1993 and January 1994. The collection thus obtained contains several species of small mammals. Among the insectivores, *Anourosorex squamipes squamipes* Milne-Edwards was found to be unreported from this state (Blanford 1891, Roonwal 1950, Ellerman and Morrison-Scott 1966, Lekagul and McNeely 1977, Agrawal *et al.* 1992, Mandal *et al.* 1994). Hence, it is being reported in the present communication.

External measurements have been taken in the field and the skull measurements in the laboratory. All measurements are in millimetre and have been taken after Mandal and Das (1970).

Material Examined : Mizoram : Aizawl district : 1 ♂, 1 ♀ ; North Khawbung (c 1,500 m) ; coll. Ajoy Kumar Mandal ; 17 & 19 Dec., 1993 (rolled skins and skulls).

Measurements : External : 1 ♂, 1 ♀ : length of head and body 83.0, 91.0 ; length of tail 15.0, 12.0 ; length of hind foot 16.5, 14.0 ; length of ear 7.5, 9.0. Cranial : 1 ♂, 1 ♀ : greatest length 26.4, 26.3 ; basal length 25.5, 25.6 ; palatal length 12.0, 12.2 ; breadth of brain case 14.1, 14.1 ; breadth across molars 8.0, 7.9 ; upper tooth-row 11.7, 12.2 ; lower tooth-row 10.5, 10.9.

Distribution : *Anourosorex s. squamipes* is known from China, Taiwan, Vietnam, Thailand, Myanmar, Bhutan and India (Assam, Meghalaya, Arunachal Pradesh and

Manipur) (Blanford 1891, Roonwal 1950, Ellerman and Morrison-Scott 1966, Lekagul and McNeely 1977, Agrawal *et al.* 1992, Mandal *et al.* 1994). The present specimens, therefore, constitute the first record of the species from Mizoram, and extends its distributional range southwards, in India.

The authors are thankful to the Director, Zoological Survey of India, Calcutta, for providing necessary facilities for this work. They are thankful to Shri P. K. Das, Scientist 'SF' (In-charge, Higher Chordate Division) and to Dr. S. Chakraborty, Scientist 'SE' (Officer-in-charge, Mammal and Osteology Section) for going through the manuscript.

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ECOBIOLOGY OF THE AK GRASSHOPPER
(*POEKILOCERUS PICTUS* FAB.) IN INDIAN DESERT

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INTRODUCTION

Poekilocerus pictus is widely distributed in the drier parts of Indo-Pakistan sub-continent (Popov and Kevan 1979). This grasshopper has been recorded as a pest of some crops (Pruthi and Nigam, 1939, Ghouri, 1975 and Khurana, 1975). Except in the quiescent period whilst in the egg state, the Ak hopper do damage throughout their periods of growth and development and also during their adult condition. But very little is known on ecobiology of this grasshopper, and hence to fill up the lacuna of information on life stages and population trend, the study was undertaken at Jodhpur and is presented in this paper.

MATERIAL and METHODS

For life history study adults of both sexes were collected during May around Jodhpur and bred in wooden rearing cages (*cr.* 45×45×45 cm.) with wire gauze sides and wood bottom in which tubes about 15 cm. long and 2.5 cm. in diameter were sparsely fitted. The tubes were filled with sterilized moist sand for egg laying. With a view to observe their development the newly emerged hoppers were transferred single to 10 cm. long wide mouthed bottles and fed with *Calotropis* leaves.

POPULATION MOVEMENT

Poekilocerus pictus is a mobile insect and there was a continuous flux of the insects in and out from any aggregations, so that the number present in an area at any one time is the result of a balance between the numbers arriving and those leaving. The insects were commonly roosting on Aak (*Calotropis procera*) plants. They tended

to remain on those plants as long as they were available. The movement out of these sites was little and it happened with the disappearance of the shrubs (due to cutting of plants for fuel by local people). Changes in the number of insects in different plots indicated that a progressive movement of the population within the site was occurring. The migration occurred within the site due to to and fro flight of adults. These insects are weak fliers and only take off in the hot and calm conditions during a limited period of the adult life. Hoppers of first and second instars moved 10-300 meters away from the hatching site in quest of suitable weeds or grasses to feed upon. Young hoppers (first and second instar nymphs) preferred weeds (*Taphrosia* sp., *Aerva persica*, *Boerhavia diffusa* and the like) over Aak (*Calotropis procera*).

RESULTS and DISCUSSION

Biological Stages : The following post embryonic stages were studied in detail (Table 1 & 2).

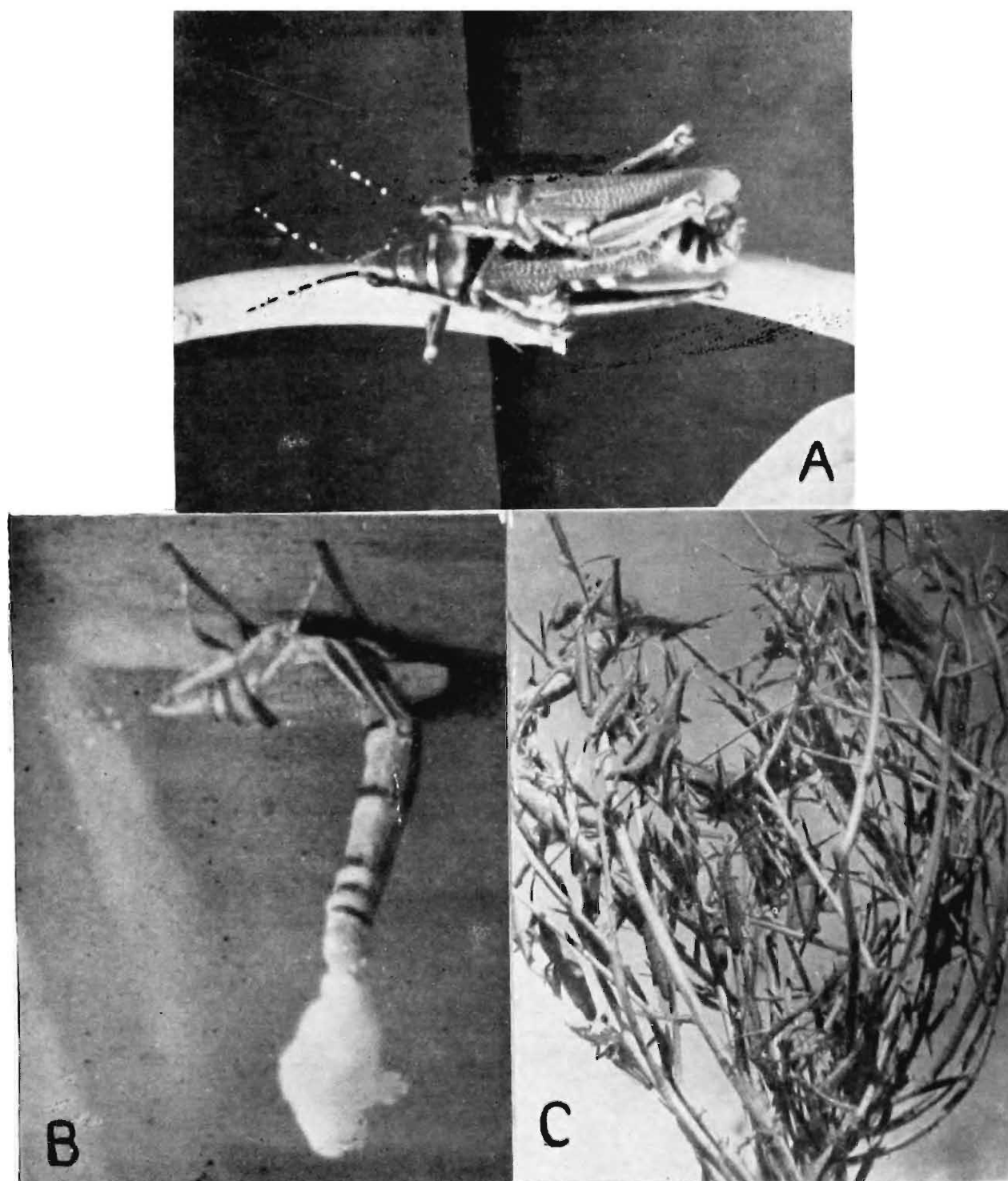
I. Egg pods and eggs :

Egg pods are elongated, soft and fragile, dark brown in colour, slightly bent at the lower end. Egg pod measured 6.0 cm to 6.5 cm and 1 cm in diameter. Eggs are cylindrical and elongated and both ends are bluntly rounded.

TABLE 1

Poecilocus pictus F. : Periods taken by isolated hoppers for development, reared at $34 \pm 5^{\circ}\text{C}$.

Average duration (days $\pm$ SE)							
Sex	1st Instar	2nd Instar	3rd Instar	4th Instar	5th Instar	6th Instar	Average total nymphal duration
Male	8-13	8-13	10-15	12-18	13-24	—	67.79
	11.3 ± 1.2	$12.1 \pm .62$	13.9 ± 1.0	$14.4 \pm .20$	17.6 ± 1.1		73.3 ± 1.2
Female	10-16	12-18	14-20	10-17	8-22	8-12	10.96
	14.3 ± 1.2	14.6 ± 0.5	17.5 ± 1.0	$11.7 \pm .70$	10.8 ± 1.5	10.1 ± 0.5	84.9 ± 2.3



Poekilocerus pictus Fab.

- A. Riding type mode of copulation.
- B. Ovipositing female with stretched abdomen exuding froth in the breeding cage.
- C. Nymphs of different instars perching on the bush in captive breeding.

II. *Hatching* :

The average incubation period varies from 51-55 (mean 53 ± 1.3) days. At the time of hatching, the chorion splits longitudinally leaving the vermiform larvae which becomes the first instar hopper by passing through the intermediate moult. The time taken in hatching of eggs from an egg pod ranges from 4-12 hours.

TABLE 2

Poeciloceris pictus F. : Summary of life stages in laboratory at $30 \pm 5^\circ\text{C}$. Eggs were kept at 8% moist sandy soil. Average is given in parenthesis. Data based upon 20 replicates.

Egg hatching (days)	Sex	hatching to eclosion	Pre-copulation	Pre-oviposition	Oviposition	Post ovi-position	Eclosion to death	Total life span
51-55 53 ± 1.3	Female	69-88 (80 ± 1.7)	6-18 (12.9 ± 1.0)	10-18 14.6 ± 1.2	3-11 78 ± 1.7	2-18 9.7 ± 1.7	32-56 44.2 ± 3.2	127-159 145.0 ± 5.6
	Male	55-87 74.8 ± 2.4	2-12 6.9 ± 1.8	—	—	—	12-45 32.1 ± 2.3	108-139 122.6 ± 1.63

Hopper and adult stages :

There are five to six hopper stages. The total nymphal duration of hoppers were 67-79 (73.3 ± 1.2) for males and 70-96 (84.7 ± 2.3) for female (Table 1).

III. *Copulation*

Male does not copulate immediately after becoming adult but only after 12-20 (mean 16.6) days. Females however are ready for copulation soon after eclosion. The mode of copulation is riding type (Plate 1). The time taken in copulation varied from 2.5-18 hours.

IV. *Oviposition* :

A female oviposits once or twice in its life time. The time taken in egg

laying varied from 1.5 to 6 hours. An egg pod consists 60-117 eggs. Before laying eggs the females with the help of their ovipositors dig in the sand. While the eggs are laid, a frothy secretion is ejected which is absorbed by the sand particles. After oviposition, the females appeared exhausted and start feeding very quickly. The average preoviposition, oviposition and post oviposition period are 10-18 (14.5), 3-11 (7.8 ± 1.3) and 2-18 (9.7 ± 1.7). Total period taken in life span by female was about 145 days and male 122 days.

SUMMARY

Poeciloceris pictus has only one generation a year in its natural habitat. The number of nymphal instars is variable from 5 to 6 under laboratory conditions. The average incubation period of eggs is 53 ± 1.3 . The mode of copulation is riding type. Average 122 days for males and 145 days for females. The population remained at peak during June and lowest in September. The first and second instar hoppers moved around 10-300 meters away for feeding on weeds and grasses.

ACKNOWLEDGEMENT

I offer my grateful thanks to Dr. A. K. Ghosh, Director, Zoological Survey of India, for his encouragement, and to Dr. D. R. Parihar, Senior Scientist, Central Arid Zone Research Institute for his suggestions in the preparation of this paper and Dr. Q. H. Baqri, Officer-in-Charge, Desert Regional Station, Zoological Survey of India, Jodhpur for his keen interest in this work.

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THREE NEW SPECIES OF *CLEPHYDRONEURA* (DIPTERA : ASILIDAE)
FROM SOUTH INDIA

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INTRODUCTION

In 1938 Oldroyd studied the genus *Clephydroneura* Becker in detail and gave a key to the then known 17 species, of which 13 species were from India. From 1979 onwards Joseph and Parui added 21 species. The present paper describes 3 new species *Clephydroneura dasi*, *C. ghoshi* and *C. karikalensis* from South India.

Genus : *Clephydroneura* Becker

1925. *Clephydroneura* Becker, *Ent. Mitt.* 14 : 68.

1. *Clephydroneura dasi* n. sp.

A slender brown and pale-yellow species with infuscated wing and yellow leg.
Male : length 20 mm, wing 14 mm.

Male : *Head* broader than thorax, black with white tomentum ; mystax white ; fronto-orbital bristles white ; ocellarium with black bristles ; postcranium pale pilose ; postocciput with white and black bristles ; postgena pale pilose. Antenna with the scape and pedicel pale yellow, first flagellomere pale yellow at base, rest black, scape twice the length of pedicel, style longer than first flagellomere. Palpus and proboscis shining black with pale yellow pile.

Thorax : Black, greyish-white tomentose ; pronotum greyish-white tomentose with pale pile ; scutum with mediolongitudinal dark brown stripe and three lateral spots ; humerus with pale pile ; chaetotaxy : notopleurals 2, supra-alars 2, post-alars 2 ; anepisternum with a few posterior pale pile ; katepisternum and meron with sparse pale yellow pile. Scutellum black, greyish-yellow pollinose, posterior margin yellow, disc with sparse black bristles, border with a pair of black bristles.

Leg : Yellow ; fore coxa yellow, mid and hind coxae black, all with yellow pile ; hind femur with a black patch dorsally at apex ; fore femur with long yellow pile ventrally,

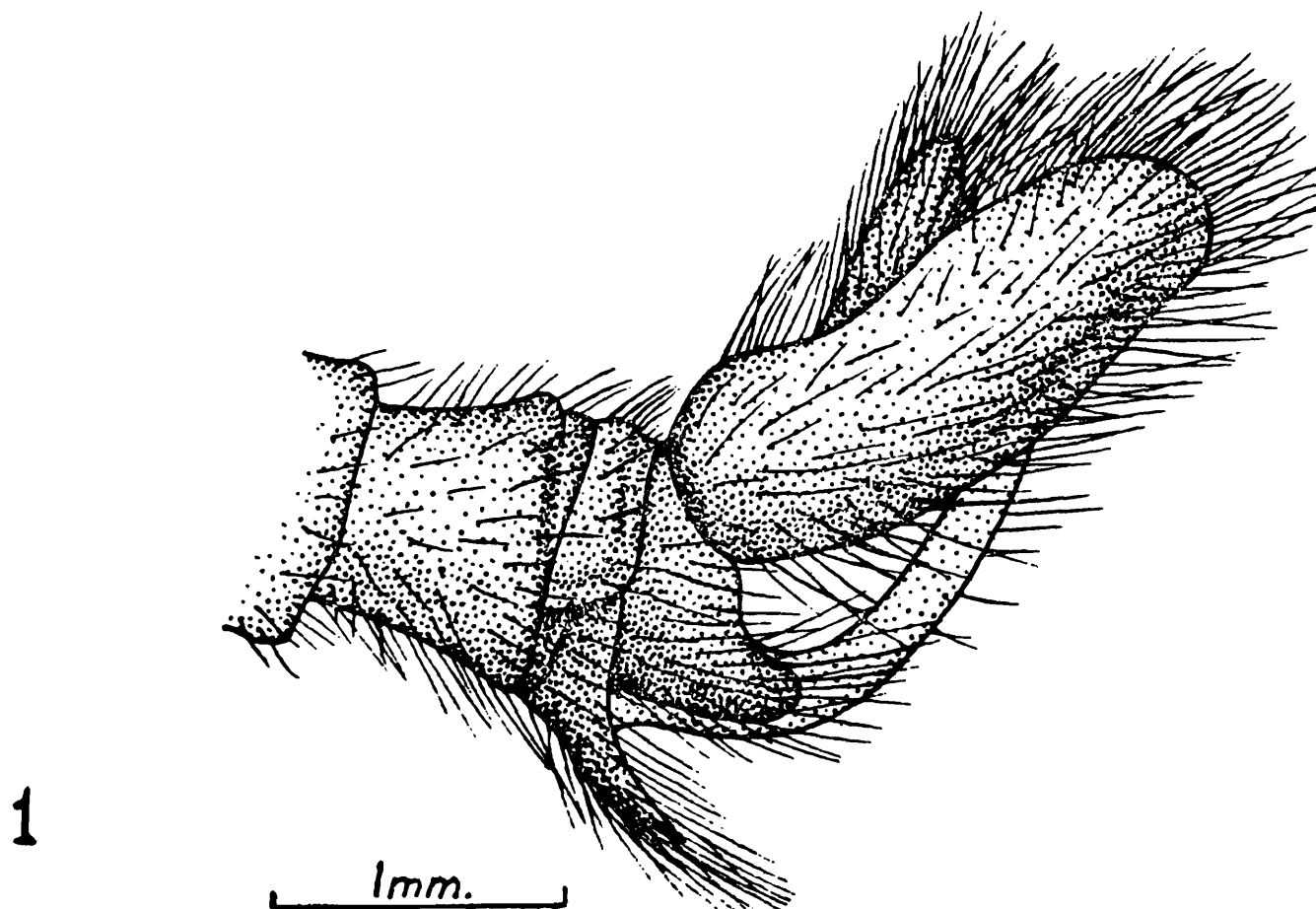


Fig. 1 : *Clephydroneura dasi* n. sp., lateral view of male genitalia.

mid femur with an anteroventral row of bristles and hind femur with an anterodorsal and an anteroventral rows of black bristles ; mid tibia with a row of ventral bristles ; hind tibia with two rows of black bristles on apical half.

Wing : Infuscated at apex which extends up to fifth posterior cell.

Abdomen : Black, hind border of each tergum yellowish-brown, each tergum with a row of bristly pile above posterior border ; sternum black with pale yellow pile. Male genitalia (Fig. 1) black with black and pale yellow pile.

Holotype ♂, Tamil Nadu : Kodaikanal : Pulney hills, 1675 m., v. 1953, coll. P. S. Nathan. Holotype in Smithsonian Institution.

Remarks : The species resembles to *Clephyroneura martini* Joseph and Parui (1979) but differs in the presence of black bristles on the disc of scutellum and in the details of male genitalia. It is named after our colleague, Dr. B. C. Das, who collected many interesting robber flies,

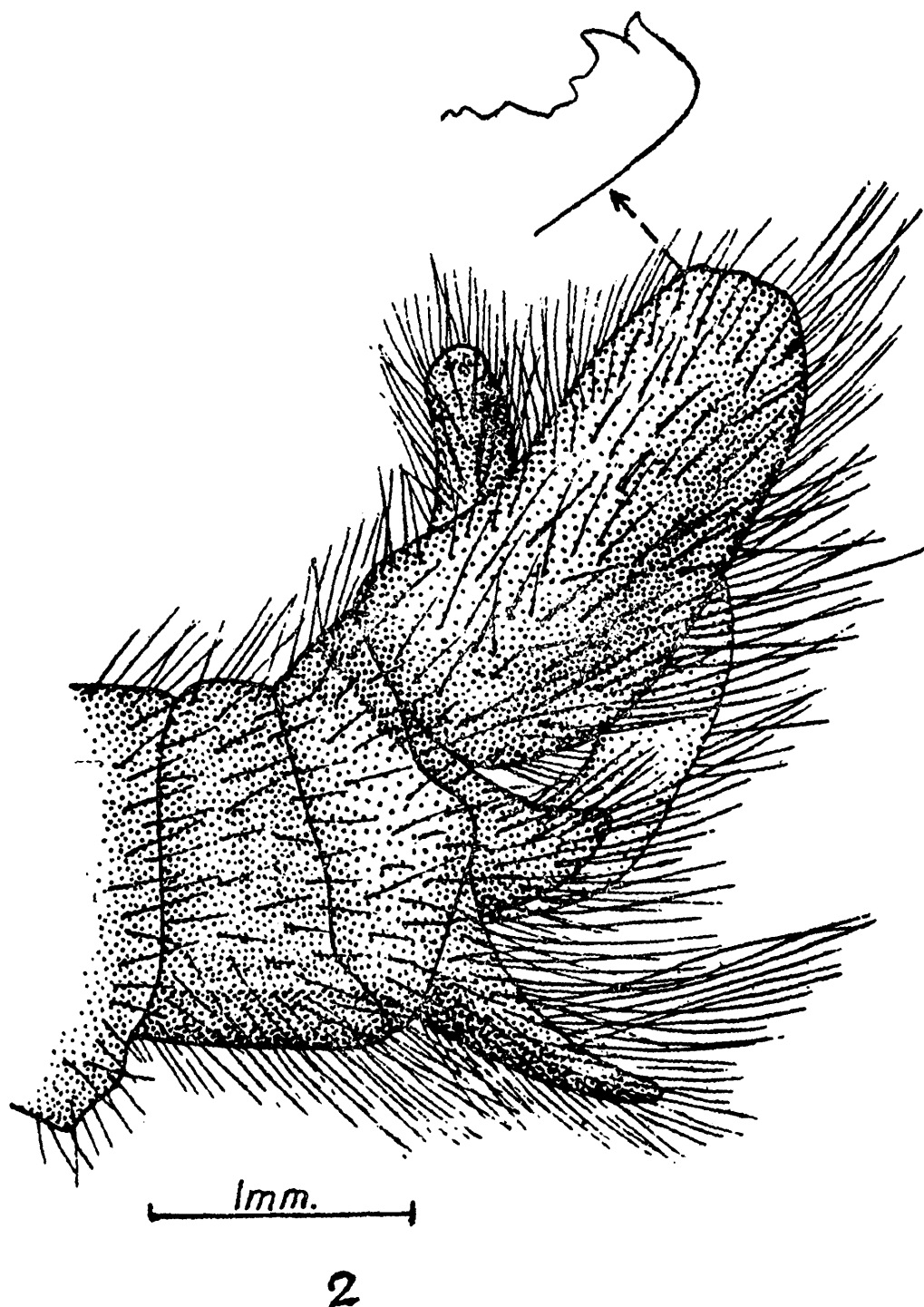


Fig. 2 : *Clephyroneura ghosi* n. sp., lateral view of male genitalia.

2. *Clephydroneura ghoshi* n. sp.

A slender black species with white and black mystax, yellow and black legs and infuscated wings. Male : length 16-18 mm ; wing 10-11 mm.

Males : *Head* broader than thorax with greyish-yellow tomentum ; mystax white with a few black bristles above ; frons and ocellarium with black bristles ; post cranium pale pilose ; post occiput with black bristles ; postgena pale yellow pilose. Antenna black, pedicel and first flagellomere dark brown but in some specimens brown, the latter equal to the combined length of scape and pedicel. Palpus and proboscis black with pale yellow pile.

Thorax : Black with greyish-white pollen ; pronotum with lateral pale yellow pile ; scutum with the mediolongitudinal stripe and two lateral dark brown spots ; chaetotaxy : notopleurals 3, supra-alars 4, post-alars 2, dorsocentrals a series ; katepisternum, anepisternum and meron with sparse pale yellow pile. Scutellum with sparse pale yellow pile on disc and a pair of black bristles on border. Haltere yellowish-brown, knob darker.

Leg : Yellow and black ; femur yellow with black stripe anteriorly and dorsally ; fore femur devoid of bristles, ventrally with long, pale yellow pile, a few of them black, mid femur with a row of anteroventral black bristles, ventral pile few ; hind femur similar to middle pair ; tibiae all yellow, with scattered black bristles.

Wing : Infuscated at apex and the infuscation extends up to fifth posterior cell.

Abdomen : Black with posterior border of each tergum pale yellow, all terga laterally with long, pale yellow pile and bristles ; sterna with pale yellow pile. Male genitalia (Fig. 2) shining black except yellowish gonostylus, pile pale yellow and black, eighth sternum produced with pale yellow bristles on border.

Holotype : ♂, India : Tamilnadu : Nilgiri Hills : Naduvatum, 1835 m., v. 1958. Coll. P. S. Nathan. Paratype 2♂, details as in holotype ; 1♂, Naduvatum 1835 m., 5.v.1950, Coll. P. S. Nathan ; 1♂, Naduvatum, 1835m., 3.v. 1957, Coll. P. S. Nathan. (S. W. Bromley Coll). Holotype and two paratypes in Smithsonian Institution, rest in Z.S.I. collection.

Remarks : The species is closely similar to *Clephydroneura semirufa* Oldroyd (1983) but differs from the latter by the white and black mystax ; uniformly yellow tibia and details of male genitalia. The species is named in honour of Dr. A. K. Ghosh, Director, Zoological Survey of India.

3. *Clephydroneura karikalensis* n.sp.

A black and yellowish-brown species with yellow legs, anteriorly dilated and apically infuscated wings. Male : length 20 mm, wing 14 mm.

Male : Head as broad as thorax, white tomentose ; mystax white ; frontoorbital bristles white ; ocellarium with pale yellow and black pile ; post cranium pale yellow pilose ; post occiput with black and pale yellow bristles ; postgena pale yellow pilose.

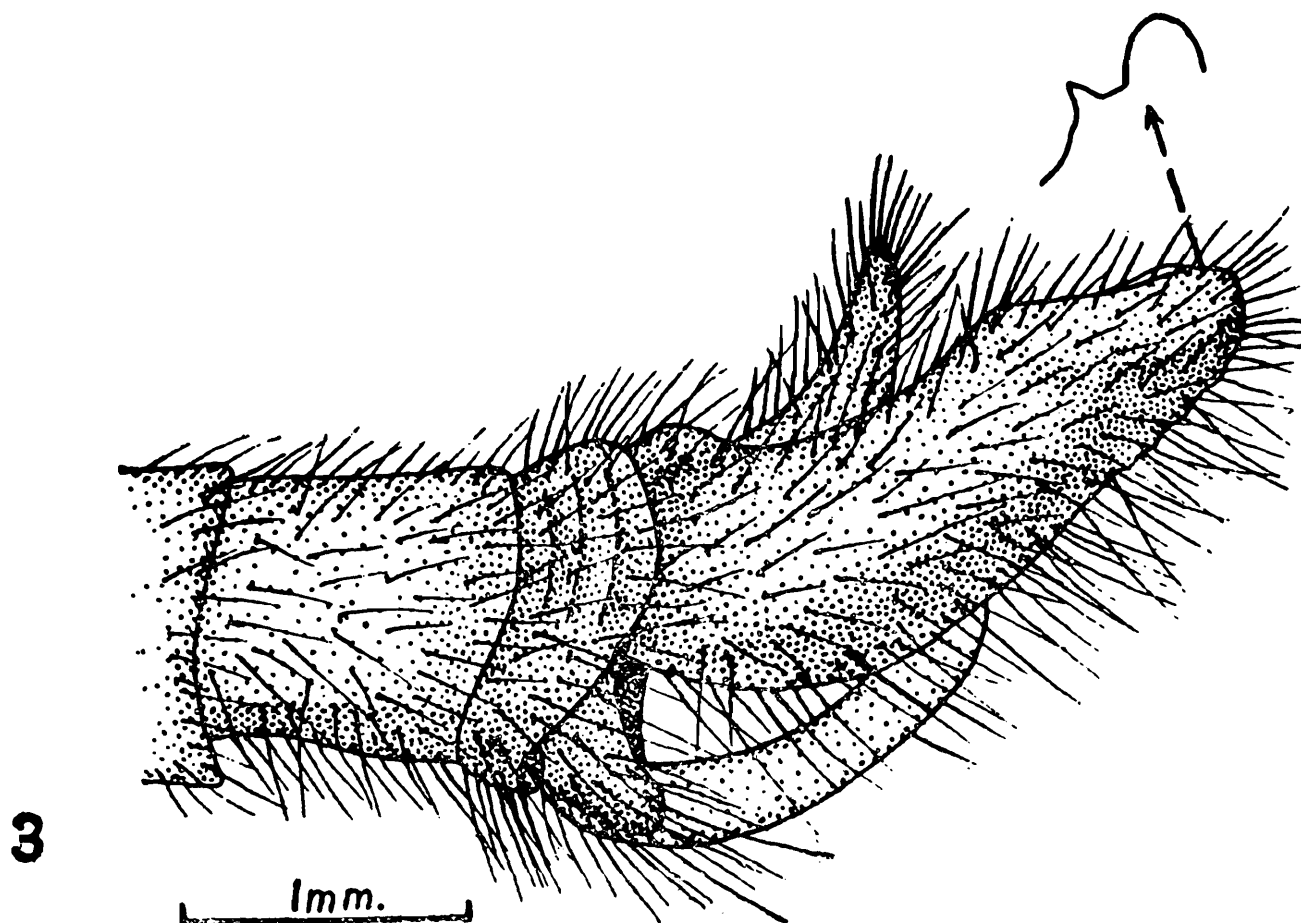


Fig. 3 : *Clephydroneura karikalensis* n. sp., lateral view of male genitalia.

Antenna yellow with dark arista, scape two and a half times the length of pedicel, first flagellomere twice the length of pedicel. Palpus and proboscis black with pale yellow pile.

Thorax : Black, greyish-white tomentose ; pronotum laterally with pale yellow pile ; scutum with dark brown madiolongitudinal stripe and three lateral spots, humeri pale yellow pilose ; chaetotaxy : notopleurals 2, supra-alars 2, post-alars 2, anepisternum

and katepisternum bare, meron with sparse pale yellow pile. Scutellum short with black bristles on disc and border with three black bristles. Haltere yellowish-brown.

Leg : Yellow ; coxa and trochanter black except yellowish fore pair ; femur yellow but mid and hind femora with a subapical black infuscation, fore femur bare of bristles, ventrally with long, yellow bristly pile ; mid and hind femora with an anteroventral row of bristles, the latter with also an anterior row of bristles ; tibiae yellow ; tarsus darker.

Wing : Anteriorly dilated, apical infuscation not so distinct.

Abdomen : Black dorsally and brownish-yellow laterally ; terga with pale yellow pile dorsally, lateral ones longer, posterolaterally with 3-4 long, pale yellow bristles ; sterna with pale yellow pile. Male genitalia (Fig. 3) black with pale yellow and black pile ; eighth sternum produced and with a fringe of bristly pile on border.

Holotype : ♂, Tamil Nadu : Karikal : Bagaram Kurum, 10. x .1949, coll. P. S. Nathan (S. W. Bromley coll. 1955). Holotype in Smithsonian Institution.

Remarks : As regards male genitalia the species is closely similar to *Clephydroneura mudigorensis* Joseph and Parui (1984) but differs from the latter in the structural details, in the wholly white mystax and in the leg colouration. It is also similar to *C. apicalls* Oldroyd (1938) but differs in the details of male genitalia.

ACKNOWLEDGEMENTS

We are grateful to Dr. A. K. Ghosh, Director, Zoological Survey of India, Calcutta, for facilities and encouragement.

It is with great pleasure we express our gratitude to Dr. Gary F. Hevel of Smithsonian Institution for loaning the material.

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THE BIOLOGY OF CEPHALOPODS (DECAPODA) AT DIGHA
COAST (WEST BENGAL)

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INTRODUCTION

This is a preliminary study of the biology of squids and cuttle fish at Digha, West Bengal, undertaken during January 1993 to September 1994 and is expected to continue.

Cephalopods are a fascinating branch of invertebrates ; their highly developed brain and eyes, the most advanced in the invertebrate world, multiple heart, various pulsatile systems, the wide range of forms in 700 odd species from tiny *Idiosepius* to the giant Atlantic squid *Architeuthes* and the giant Pacific Octopus *Octopus dofleini* have gained the attention of physiologists, embryologists as well as of taxonomists. The squid axon is in great demand for certain physiological studies and the isolated cardiac system has been used for testing drugs and chemicals. Furthermore, in many parts of the world cephalopods are an important sector in marine fisheries.

In India too, cephalopods have been studied from the fisheries aspect, for example, Rao (1954) followed by many other reports (Abdul Rahim & Chandran, 1986 ; Seraimeetan, 1940 ; Vidyasagar & Deshmukh, 1992), but ecological, ethological, physiological and embryological studies have been very scanty,—such as on the breeding behaviour of *Octopus dollfusi* (Sarvesan, 1969). Substantial taxonomic work has been carried out at Madras coast (Jyothinayagam, 1987).

Since, to our knowledge, absolutely no investigations have been recorded on the cephalopods of Digha coast, the present study has been executed keeping in mind a long term follow up and the formation of a basic fund of knowledge eventually to be

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utilised by various researchers in or collaborating with the newly established Marine Aquarium cum Research Centre of ZSI at Digha.

We have, therefore, kept in our purview four broad areas—ecology, embryology, physiology and practical aspects of rearing the organisms in the Aquarium. The efforts, limited as they are at this stage by lack of personnel and equipments such as boats for collecting specimen and circulating sea-water in the laboratory, may have still been worthwhile as, hopefully, indicated by the results presented.

MATERIAL and METHODS

Observations and collections of samples from rejected material of commercial catches by dragnets near the beach have been attempted at least twice a month commencing from January, 1993 up to September 1994. Cast off on sand the cephalopods quickly become disabled and morbid, especially in the hot season. Nevertheless, on occasions particularly during winter and spring it has been possible to rescue certain specimens which could swim in containers of sea-water for a short while. Some of these have been made use of for studying the isolated pulsatile systems. Others have been measured and dissected.

All the specimens collected and observed were either the small squid *Loliolus investigatoris* or very rarely, *Loligo duvauceli* and the cuttle fish *Sepiella inermis*.

The lines of investigation were to determine :

1. *Seasonal availability*
2. *Breeding phase and Embryology*
3. *Stomach contents*
4. *Pulsatile systems, especially the gill*
5. *Practical data pertaining to rearing.*

1. Seasonal availability

RESULTS

As evident from Fig 1. there is a single lacuna in our knowledge namely the month May, 1993 when, due to adverse weather conditions, no nettings took place. *Loliolus investigatoris* and *Sepiella inermis* were always found except in the months of July and October-November. *Loligo duvauceli* were available only in June, 1993 and not at all in

1994 (up to September). In May 1994, very small immature *L. investigatoris* were obtained from catches in fine-meshed nets very close to the beach operated by collectors of

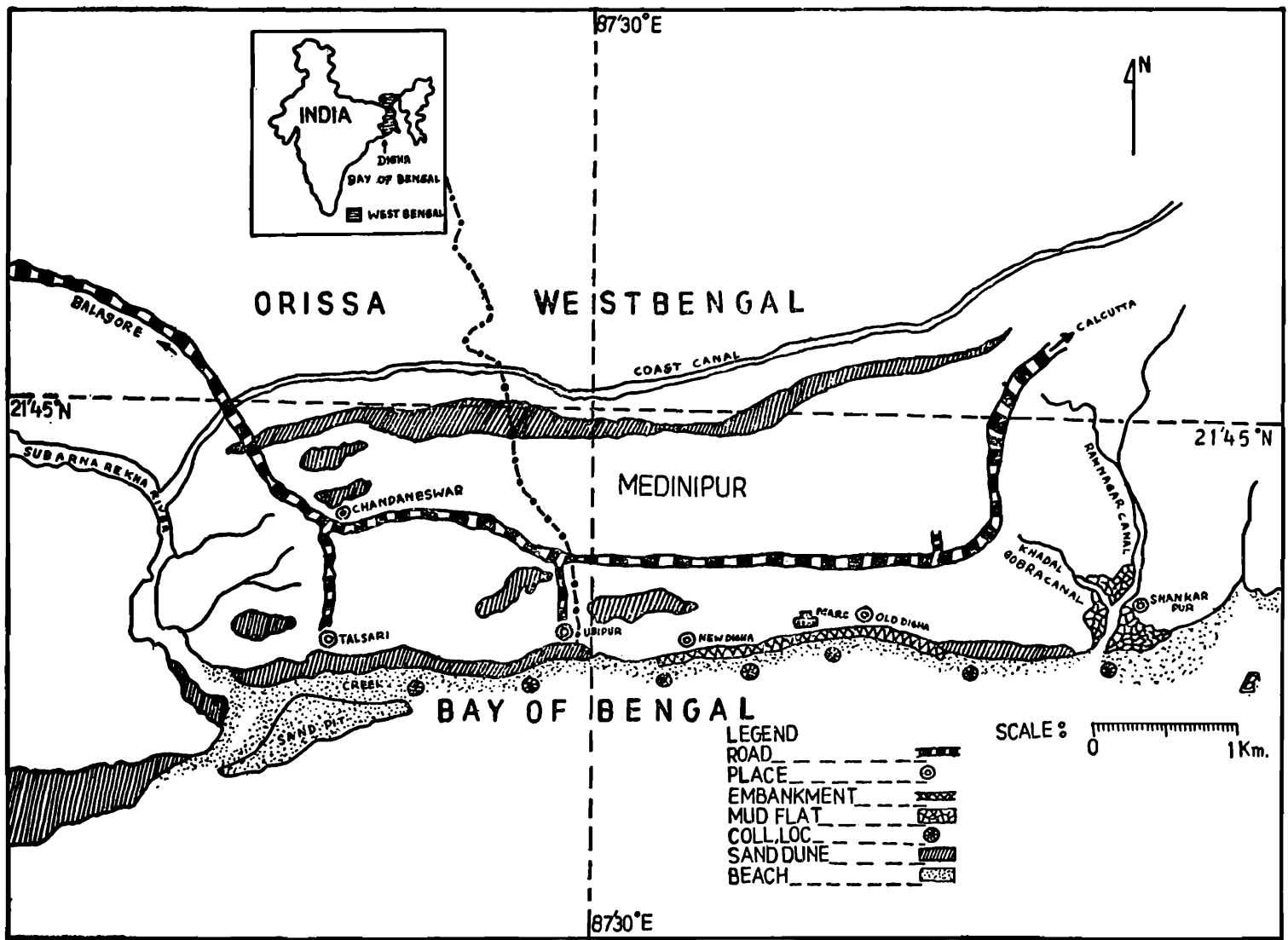


Fig.1: MAP OF THE COLLECTION AREA

'Bagda shrimp' which procedure was adopted this year for the first time. This year in June, July and August no squids were caught in the usual drag nets, young *S. inermis* were collected in June & July, however. Juvenile *L. investigatoris* were caught in 'Bagda net' in July-August, 1994.

Tables 1B, 1C & 1D furnish data on the size of the two squid species.

DISCUSSION

It is clear that *L. duvauceli* is a rare visitor in this coast. *L. investigatoris* and *S. inermis* occur during most part of the year. The sudden disappearance in July, 1993 is intriguing. This is further confirmed by the findings of 1994. This might have something to do with

TABLE 1A

Length and width of *L. duvauceli* (in cm.)

	Total Length	Width (maximal)
1.	10.2	4.8
2.	6.8	3.4
3.	6.8	3.3
4.	8.9	3.3
5.	6.6	3.4
6.	4.9	3.3
7.	8.9	3.3
8.	5.1	3.9
9.	4.7	3.1
10.	4.5	2.7
11.	4.9	2.9
12.	4.7	2.9
13.	4.4	2.4
14.	3.8	2.0
15.	3.4	2.1
16.	3.6	1.8
17.	3.0	1.9
18.	3.4	1.7
19.	3.3	2.0
20.	2.3	1.9
21.	2.4	1.6

the lower salinity of coastal water during this period. Another problem arises in the non-availability during October-November 1993. Salinity during this period has to be ascertained.

All the decapods observed at Digha by various collectors are small in size, although in the Western coast, or even in the Eastern coast, at Paradeep to the west of Digha, larger specimen are available. Jothinayagam (1987) does not describe the *absolute sizes* of the animals and so direct comparisons cannot be made with Digha samples. Absolute values have been given in tables 1A, 1B, 1C & 1D which can later be compared with catches at Paradeep area.

TABLE 1B

Several dimensions of *L. duvauceli* (in cm.)

(TL, total length ; ML, mantle length ; MW, mantle width ; AL, Arm length ; HL, Head length ; FL, fin length ; FW, fin width)

* indicates egg-bearing female

TL	ML	MW	AL	HL	FL	FW
6.4	5.1	1.6	2.2	1.1	2.0	0.9
8.9	7.1	2.1	2.9	1.6	3.5	1.2
3.7*	2.8	1.4	1.3	0.8	2.0	0.9
5.2	4.3	1.7	2.5	1.5	2.6	1.1
5.0*	3.7	1.8	1.5	1.1	2.5	0.9
5.4*	4.1	2.0	1.7	1.2	3.7	1.1
5.5*	4.2	2.0	2.7	1.2	3.0	1.1
3.7	2.8	1.5	0.9	0.8	1.9	1.1
3.7	2.7	1.2	1.2	0.8	1.6	0.5
5.7*	4.1	1.7	1.8	1.8	3.0	1.1

All the egg-bearing *S. inermis* are 5.5×3.2 cm or bigger in size (with a single exception) no animal of size range 3.9×2.2 to 5×2.5 had eggs or spermatophores. (Table 2).

L. duvauceli is a very abundant species in the north-west coast. For example, of the 6 species of decapoda caught in the Gulf of Kutch, 83.5% is answered for by squids and of the squids, *L. duvauceli* constitutes 68.2% while *L. investigatoris* forms only 0.3%

(Siraimetan, 1990). The picture is thus the very reverse at Digha. Another statistics of Saurashtra (Kasim, 1993) is that 67.8% of cephalopod catch is comprised of *L. duvauceli*.

In Bombay also *L. duvauceli* alone comprises 43.5% of the total cephalopod catch (Vidyasagar and Deshmukh, 1992).

TABLE 1C
Measurement of some preserved specimens of *L. duvauceli*

Sl. No.	ML	MW	TL
1.*	6.9	1.8	8.1
2.=	7.1	2.0	8.3
3.	6.3	1.9	7.6
4.*	5.8	1.6	7.2
5.=	6.3	1.8	7.3
6.	7.0	1.7	8.3
7.	6.5	1.9	7.9
8.=	6.5	1.6	8.0
9.	7.1	1.8	8.2
10.=	7.2	2.0	8.2

* Spermatophores (very good in 4), = Eggs (immature in 2)

It is worth noting that Rahim and Chandran (1988) recorded dorsal mantle length (absolute values) of *L. duvauceli* of the Madras coast. These values plus the head length indicate sizes that are much larger than those of Digha samples. Since the data of Rahim and Chandran (1988) record mature animals (though males only) and the Digha samples too, had mature eggs, a valid comparison can be made. It is clear that at Digha the same species is surprisingly smaller in size. The mantle length of the samples here ranged from 2.7 to 7.2 cm, while those of Rahim & Chandran (1988) ranged upto 19.5 cm, all individuals within the size range 10.5-19.5 cm, having spermatophores. At Digha, mature eggs were found within the size range 2.8-4.1 cm (Table 1B). So at least the females attain only a small size.

TABLE 1D
Length and width (in cm.) of *L. investigatoris*

	Females with eggs		Males with spermatophore	
	L	W	L	W
1.	5.6	2.2	4.8	1.7
2.	5.0	1.9	4.7	1.6
3.	4.7	1.9	4.6	1.6
4.	4.4	1.8	4.6	1.5
5.	4.5	1.6		
6.	4.5	1.4		
7.	4.4	1.5		
8.	4.3	1.6		
9.	5.0	1.9		
10.	5.2	1.8		
11.	5.3	1.6		
12.	6.3	1.7		
13.	5.3	1.7		

TABLE 2
Length and width (in cm.) of *S. inermis*

	Females with eggs		Samples without egg/spermatophore	
	L	W	L	W
1.	9.5	4.5	5.0	2.5
2.	8.5	4.4	7.0	3.9
3.	7.5	4.4	4.5	3.0
4.	9.1	4.9	3.9	2.8
5.	9.0	4.7	3.9	2.2
6.	7.5	3.9	3.9	2.2
7.	5.5	3.2		

Very few mature males *L. duvauceli* were caught in the dragnets in Digha. Table (1C) shows the size of two spermatophores bearing individuals (No. 1 and No. 4). At least one of these (No. 4) had very well developed and abundant spermatophore tubes. So it seems that mature male *L. duvauceli* at Digha may attain half the size of their counterparts in the Madras coast.

2. Breeding phase and embryology

RESULTS

a) Breeding season : *L. investigatoris* and *S. inermis* had mature and/or immature eggs in every month, whenever they were available.

L. duvauceli in June, 1993 had mature and immature eggs.

b) Eggs :

Mature eggs of *L. investigatoris* and *S. inermis* are glass clear beadlets.

Dimensions :

i) *L. investigatoris*

1.7 mm × 1.2 mm

ii) *S. inermis*

2.4 mm × 1.9 mm

The number of mature and near-mature eggs was determined in a representative sample of each species.

<i>L. investigatoris</i>	—	643
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<i>S. inermis</i>	—	314
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c) Spermatophores :

Considerable size variation exists but representative values are :

i) *L. investigatoris*

1.2 mm × 0.06 mm

ii) *L. duvauceli*

1.4 mm × 0.09 mm

(*smallest division in the microscale was 0.02 mm.)

d) Artificial fertilization

Artificial fertilization can only be feasible after obtaining facilities for filtered circulating sea-water. Attempts were, however, made to ensure necessary conditions as a sort of rehearsal. Mature eggs and spermatophores were simultaneously collected after dissecting large numbers of the organisms. Good spermatophores were more readily found in *S. inermis*. Being larger these could be more easily crushed in order to yield the milky sperm-bearing fluid. (See Addendum)

DISCUSSION

Various organisms breed continuously throughout the year (or the better part of it) in the tropics while the reproductive phase is more restricted in the northern (or southern) clime. *Loligo vulgaris* is known to have a peak breeding season in spring (February-April) in the Mediterranean followed by a second peak in September or so. In contrast, *L. investigatoris* as well as *S. inermis* at Digha are *always* in the breeding phase, i. e., whenever they are collected. We do not of course know the situation during the three months (July, October-November) when they are absent. The findings with the Bagda net, namely very young squids caught in July and August (1994) suggest that even during this period the adults which have migrated further are still in the breeding phase.

The number of spermatophore-bearing males was always significantly less than that of egg-bearing females and this might be due to the fact that the latter are easier to capture in nets.

Mangold (1987) described fecundity of cephalopods. Since the coeleoid cephalopods generally reproduce only once and then die, the number of eggs laid is an indication of fecundity. Mangold (1987) also listed the number of eggs and the size of eggs in various cephalopods. *Idiosepius pygmaeus*, the smallest known cephalopod has the smallest eggs laid in small numbers (25-64 eggs), while *Octopus bimaculoides* and *Bathypolypus sponsalis* may lay eggs as big as 12×5 mm and 15.5×6 mm respectively. *Octopus tetricus* and *O. cyanaea* boast of 7,00,000 eggs. In all sepioids the relative egg size is large, the absolute value ranging from less than 1 mm (*Idiosepius*) to about 10 mm and the number of eggs vary from 50 to 200 in sepioids while the well-known *Sepia officinalis* may lay as many as 600 eggs. The size and number of *S. inermis* eggs at Digha are well within the ranges mentioned above, though the exact number of immature eggs has not been counted. A rough estimate suggested that this number was less than that of the mature eggs (314).

Squids generally lay large numbers of eggs, hundreds of thousands, as listed in several species (Mangold, 1987). Two species, *Loligo pealei* and *Loligo plei* are variable egg-bearers, ranging from thousands to a few hundred or only a couple of hundred eggs (*L. plei*). The egg-size and egg-number in *L. investigatoris* at Digha is towards the upper side of the scale mentioned above. The number of mature eggs was 643 ; the number of immature eggs could not be determined but it could be 3 times the former.

For estimating and comparing the fecundity of the decapods at Digha with those listed by Mangold (1987) it will be necessary to rear adult animals and watch them lay eggs in the Aquarium and to determine whether this is staggered over a period with the immature eggs maturing and being laid later.

The largest spermatophore, 1 m, has been reported in *Octopus dofleini* (Mann *et al.*, 1970) and that of *L. investigatoris* as reported here is on the other end of the scale.

Artificial fertilisation of squids has been attempted with partial success (Marthy, Brahmachary ; see Brahmachary, 1989). The preliminary knowledge gained with *L. investigatoris* and *S. inermis* can now enable us to attempt these experiments in the immediate future.

3. Stomach content

RESULTS

a) *L. investigatoris*

Stomach contents of almost all the samples examined were nil. A very small amount of crustacean remains was found in one or two specimens.

b) *S. inermis*

Large amounts of stomach content were very frequent. The inflated reddish stomachs were striking and one could never fail to notice these organs except in very small samples. All the remains were those of crustacea, probably of a red shrimp frequently netted in the catches. However, shrimps of other colour may also turn red after death. The colour of the stomach is at least partly due to these shrimp remains.

Of 41 sepiella collected on five different dates 33 had stomachs inflated to different degrees ; only 8 had empty stomachs (Table 3).

TABLE 3

Full and empty stomach of *S. inermis*

Date of collection	No.	Full stomach	Empty stomach
3.12.93	6	4	2
4.12.93	4	3	1
6.12.93	17	13	4
8.3.94	9	9	0
9.3.94	5	4	1
Total	41	33	8

The dry weight of the oven dried stomach and contents was also determined in a preliminary initiative (Table 4).

TABLE 4

Dry weight of *S. inermis* stomach and contents

1.	0.57 g*
2.	0.67
3.	0.39
4.	0.28
5.	0.24
6.	0.24
7.	0.17
8.	0.13
9.	0.08
10.	0.13

* (Accuracy of measurement is up to 0.01 g of sartorius digital balance)

DISCUSSION

The usual way of ascertaining cephalopod diet is by examining the stomach content of newly captured animals (Boucaud-Camou and Boucher-Rodoni, 1983). These authors also

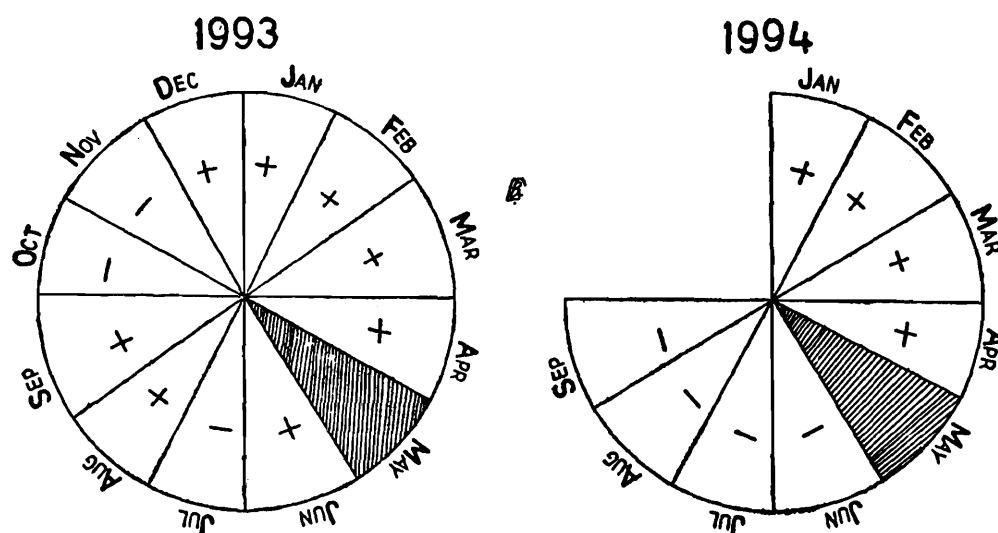
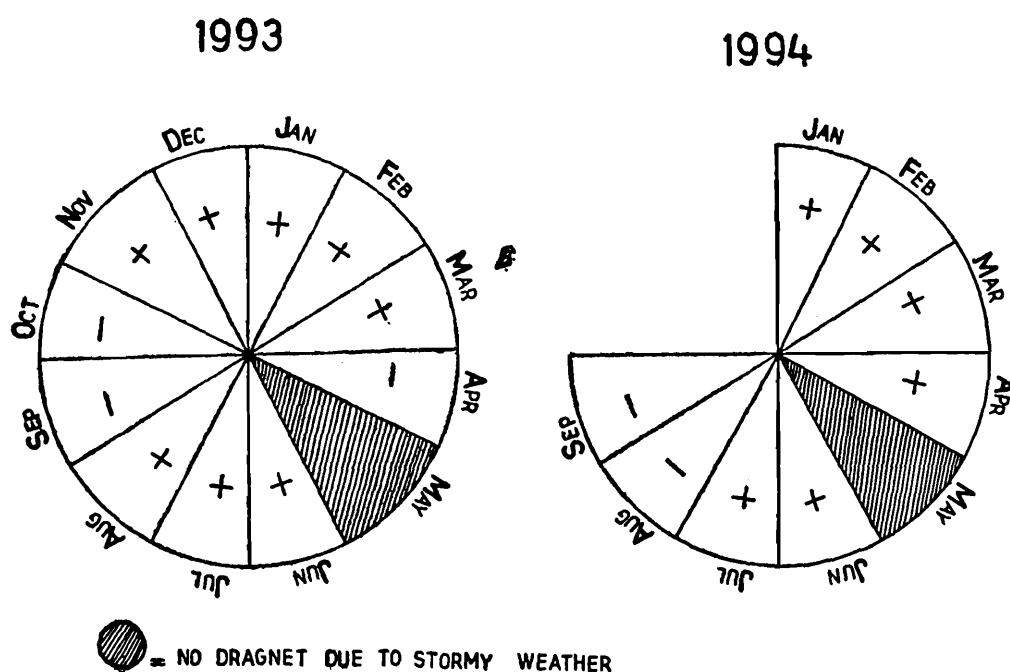
(i) AVAILABILITY OF LOLIOLUS INVESTIGATORIS IN DRAGNET(ii) AVAILABILITY OF SEPIELLA INERMIS IN DRAGNET

FIG-II

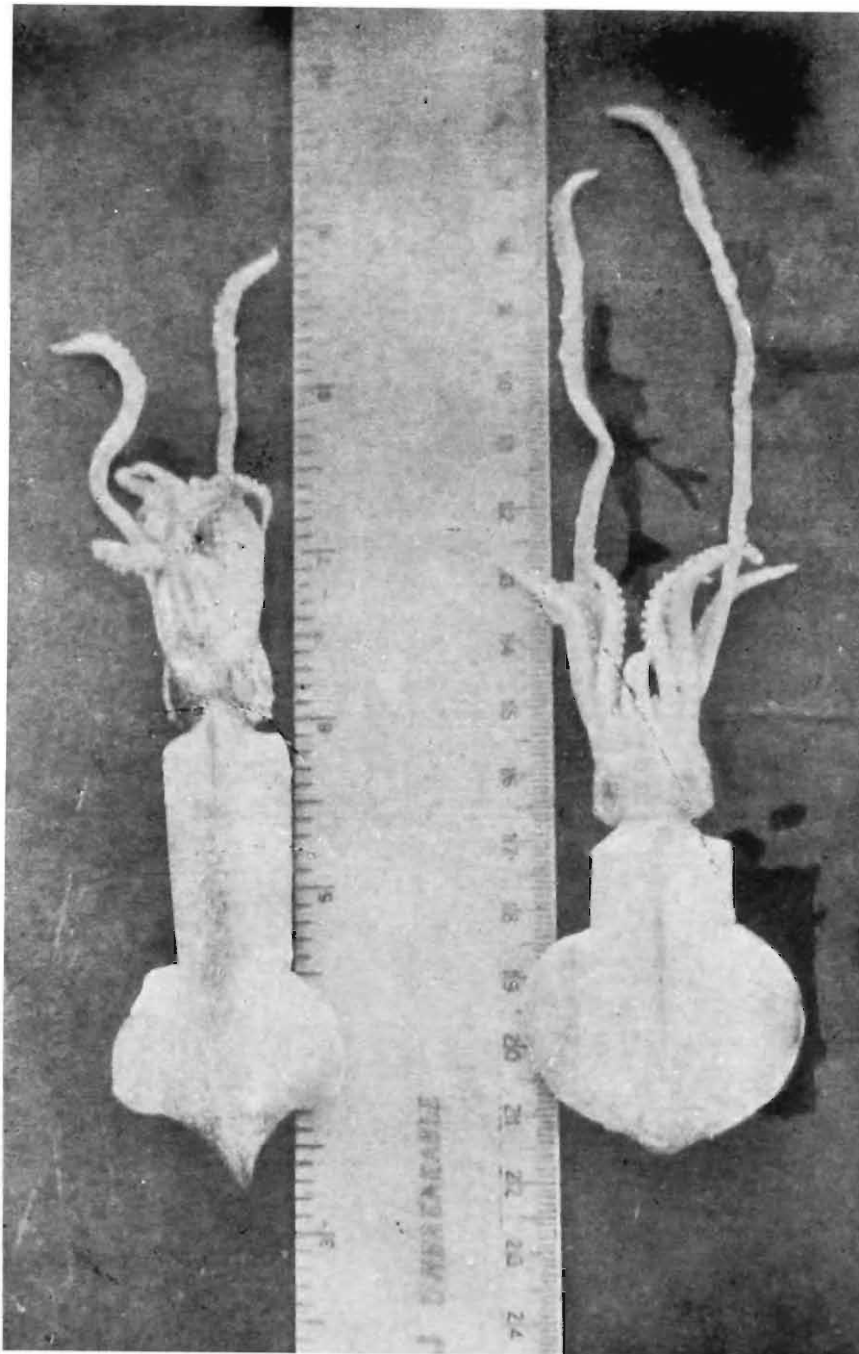


Fig. 1 : *Loligo cluvauceli* (left) and *Loliolus investigatoris* (Right)



Fig. 2 : Guts of *Sepiella inermis* of three different sizes.

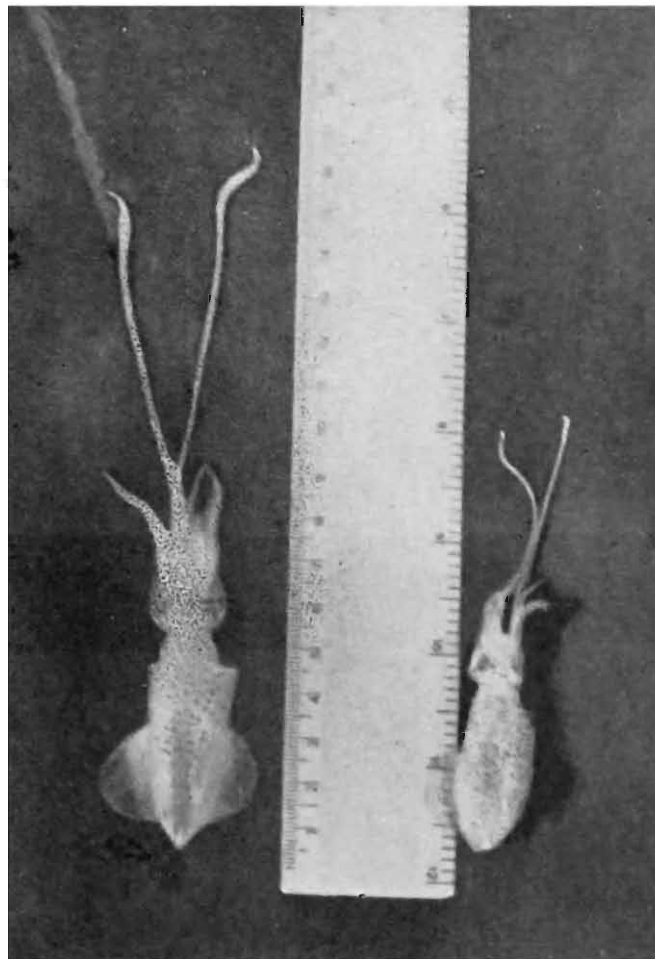
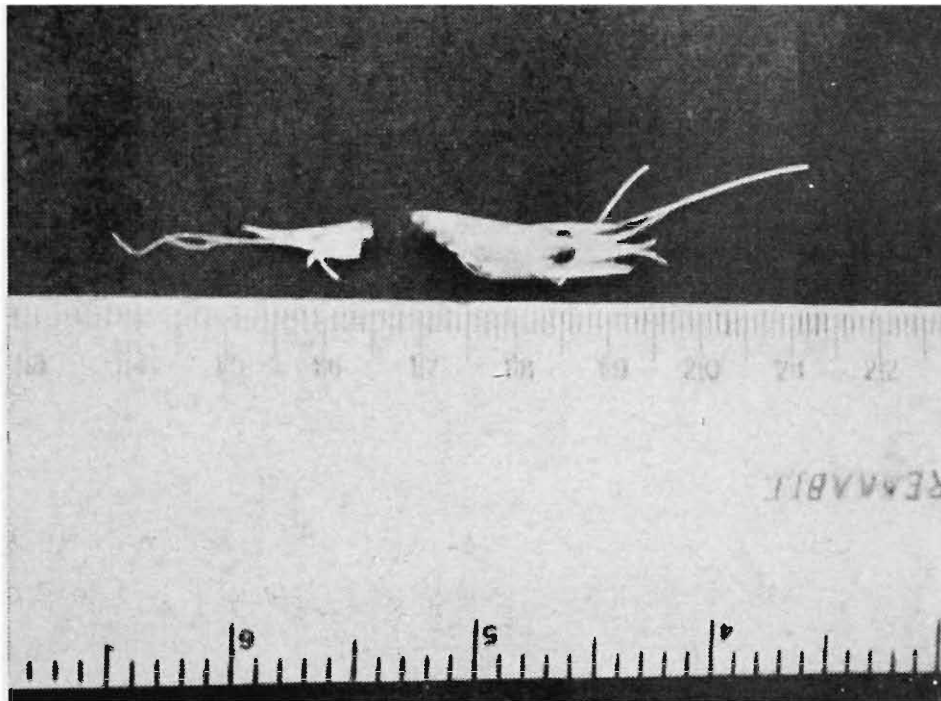


Fig. 3 : Heads of shrimps decapitated by *S. inermis*.

Fig. 4 : *Loliolus investigatoris*.

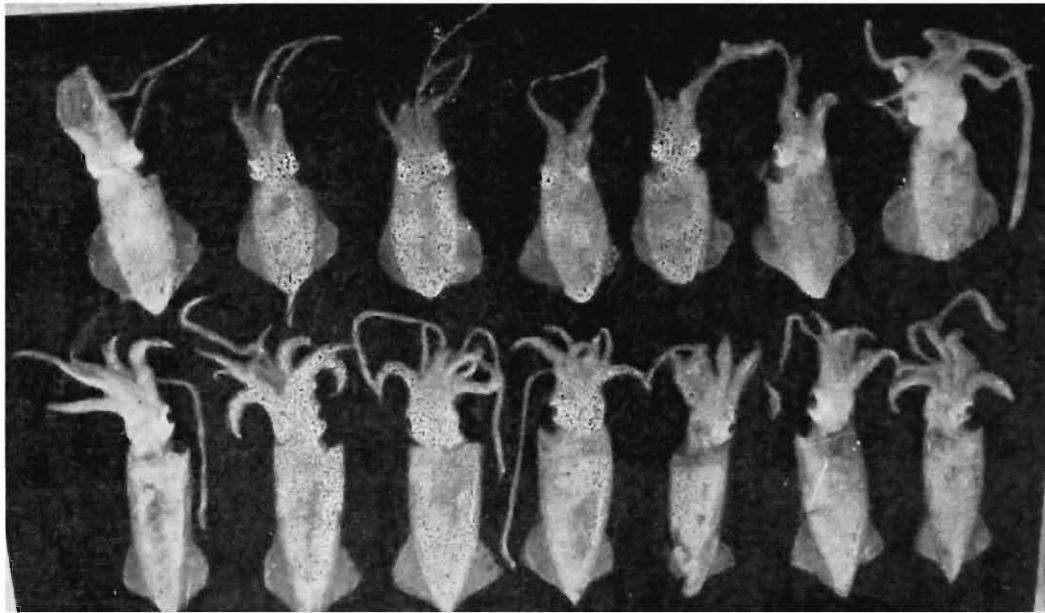


Fig. 5. Upper Row—*Lolislus investigatoris*
Lower Row—*Loligo duvauceli*

sum up the data based on a number of large scale studies on material from commercial catches. Various crustacea form the principal fraction of the stomach content but fish, cephalopods and even sea-weed have been found.

Digestive mechanism is basically the same in all cephalopods; the digestive gland has a dual function, as the provider of the bulk of the digestive enzymes and to act as the site of absorption (Boucher-Rodoni *et al.*, 1987). In *Loligo* "the digestive gland is not involved in absorption" and digestion is a very rapid process. The lack of gut contents in *L. investigatoris* emphasizes on the same physiological process. The very scanty remains of crustacea fit into the general picture of cephalopodan diet.

The frequent gut contents of *S. inermis* at Digha is worth commenting on. The digestion, as expected, is far slower and the size of the stomach is also far larger than those of *L. investigatoris*. Nixon (1987) furnishes the data on sepioid and sepielloid diet. Stomach contents of 500 *Sepia officinalis* in the gulf of Tunis were crustacea, bony fish and molluscs, including cephalopods, polychaete and nemertean worms. 150 *S. officinalis* in the Atlantic coast of Spain revealed crabs as 67.5% of their diet while teleost fish answered for 23.5%. Of 72 *S. elegans* in the same waters, crustacea were again the major prey (80%). *S. inermis* (Tang and Khoo, 1974, See Nixon, 1987) is known to lie half buried in the sand and wait for prey. The food of juveniles was only crustacea while that of the adults was fish, followed by prawn and crab.

S. inermis in Digha seems to feed on only crustacea, perhaps very largely on the local shrimps. (For feeding habit in captivity, see later).

Nixon (1987) also marshalls the data on Loliginid squids. Almost 50% of 622 *L. forbesi* in the Azores sea contained food remains in which fish were the major item, followed by cephalopods including *L. forbesi*. Of 1000 *L. Opalescens* 33% had stomach contents that could be analysed and of these 42% indicated crustacean diet, 19.6% fish and 13.6% polychaetes and miscellanea. About 50% of *L. pealei*, caught in area off Rhode Island, had food remains in the stomach. Crustacea and fish/other squids predominated in the diet of young and adult respectively. Of 629 *Sepioteuthi arctiptinnis* in Palk bay, India, more than 50% had remains of bony fish in their stomachs while only 21 had fed on crustacea (Rao, 1954).

Compared with all these squids, *L. investigatoris* of Digha seems to have a surprisingly rapid digestion and elimination of undigested crustacean remains. Perhaps the enzymes of the digestive gland of this organism warrant a special study.

4. Pulsatile systems

RESULTS

a) Isolated branchial heart of *L. investigatoris*.

This was preserved in pasteurized sea-water (PSW) in the refrigerator (4°C—17°C) after washing in PSW. PSW was changed at least once per day. Autonomous pulsations were easily observed under low magnification after a few minutes at room temperature. A representative sample is shown in Table 5A.

TABLE 5A

Pulsating rhythm of isolated branchial heart of *L. investigatoris*. Numbers indicate the period in seconds.

Pulsation number	Period
1.	15
2.	20
3.	20
4.	17
5.	48

The period is 15-20 seconds for the first four pulsations but the fifth took much longer. A rather similar pattern is evident in the system after two days of preservation (Table 5B).

TABLE 5B

Pulsations of the branchial heart preserved for 48 hrs.

Pulsation number	Period
1.	25
2.	50
3.	14
4.	19
5.	93

Isolated systemic heart of *L. investigatoris*.

Under conditions similar to those described above the pulsations of two systemic hearts were observed (Table 5C).

TABLE 5C

Pulsations (in seconds) of systemic heart.

	No. 1	No. 2
11-30 AM	6	7
	12	9
	8	10
	14	9
	13	12
03-50 PM	11	11
	12	11
	9	13
	18	11
	15	12
	13	14
	11	13
	15	12
	13	12
	25	12
	10	

Another systemic heart was utilized for studying the effect of a drug, adrenalin tartrate.

At 2-30 PM 29 recordings of this heart (No. 3) showed a range of 5-12 seconds. Just before addition of 0.2 mg. adrenalin (in 2ml PSW), the pulsation rates were 17,15,10,8 seconds. Immediately after the addition of the drug pulsations became irregular. After 30 minutes the rate was slowed down significantly ; the heart was then thoroughly washed in PSW and again after 30 minutes the recordings showed a quickening (Table 5D).

b) Isolated branchial system of *L. investigatoris*.

Pulsations and irregular movements were noticed in isolated gills. Merely by frequently changing PSW, gills could be kept in active, though progressively deteriorating, condition up to the fifth day (99 hours of observation). Deterioration was at least partly due to infection.

Three different types of rhythms of pulsations were noticeable.

(i) A rapid "ticking" presumably due to the peristalsis of blood vessels (see discussion) in freshly excised gills.

1st observation : More than 1/second

2nd observation : 1/second

(This continued for 50 seconds)

3rd observation : 10/12 seconds

4th observation : 19/20 seconds

This rhythm is the first to disappear (within hours of preservation).

(ii) Highly irregular movements not amenable to study.

(iii) Bulk movement.

TABLE 5D

Recovery of the systemic heart from the effect of high dose of adrenalin (0.1mg/ml). Numbers indicate interval of pulsations in seconds.

A. (Thirty minutes after addition of drug)	B. (Thirty minutes after washing)
24	17
23	13
26	19
18	16
23	12
24	12
12	12
25	12

TABLE 6A

Periodicity of rhythmic intervals (in seconds) of the movement of gill-tip of *L. investgatoris*

Gill No.	Periodicity	Gill No.	Periodicity	Gill No.	Periodicity
1	35	2	39	3	6
	75		20		14
	35		24		19
	42		17		11
	83		37		12
	42		11		17
	57		17		15
	44		28		37
	54		32		21
	70				

End or tip of the gill can be observed during movement of the gill as a whole. Sometimes the tip is seen to clearly execute an oscillation. Table 6A indicates some representative data.

Table 6B shows the rhythmicity of movements of gill tip.

TABLE 6B

Periodicity (in seconds) of rhythmic movement of two injured tips of *L. investigatoris* gill

Gill No.	Periodicity	Gill No.	Periodicity
1	36	2	10
	35		20
	27		11
	58		26
	101		7
	30		9
			9
			10
			12
			11
			9
			10
			11
			15
			11
			6
			10
			9
			6
			6
			5
			4
			5

Likewise, the isolated gill of *L. duvauceli* executes similar movements. The periodicity of a gill tip is shown in Table 6C.

TABLE 6C

Periodicity (in seconds) of the tip of an isolated gill of *L. duvauceli*

15

14

14

18

23

45

16

25

The gills of *S. inermis* also show similar rhythms (Table 6D).

TABLE 6D

Periodicity in the isolated gill of *S. inermis*

No. of oscillations	Seconds
10	57
10	85
10	66

After about 24 hrs. of preservation, a similar periodicity was noticed (Table 6e).

TABLE 6E

Periodicity in the isolated gill of *S. inermis* after 24 hrs. of presevation.

No. of oscillations	Seconds
10	70
10	80

On isolation, a large gill from a large specimen of *S. inermis* began to swim like an independent organism. Only one such large specimen was found.

c) Other pulsatile systems

Tips of arms of *L. investigatoris* sliced off and preserved in PSW exhibited pulsations.

Also, a very small structure near or with spermatophore, when isolated by accident, showed a rhythm of 10 pulsations/30 seconds to 10/58.

Pulsations at 08.45 AM :

10/30, 10/45, 10/44, 10/40

At 09.15 the rates were :

10/35, 10/35, 10/35, 10/40, 10/48, 10/58, 10/47.

DISCUSSION

It has long been known that there are various pulsatile systems in cephalopods. Some of these might be utilized for studying the biological clock-like rhythms after isolating these from the influence of the whole body. Action of ATP and ATPase on such systems is worth investigating, as well as of such anti-metabolites as Actinomycin D in order to determine the function of newly synthesized RNA, if any.

Again, these systems are also of value for testing drugs. It is known that isolated systemic heart behaves predictably *in vitro* (See Wells, 1983). The (isolated) "Systemic ventricle will continue to beat for many hours if perfused with a pressure head of blood or seawater". If acetylcholine (ACH) is added the beat slows, amplitude decreases and it may altogether stop. ACH is the inhibitory transmitter in these hearts, apparently. Interestingly the effect of ACH is annulled by previous treatment of the well-known drug, curare. The present data on adrenalin are relevant in this context.

Thus, isolated pulsatile systems of cephalopods, particularly the heart, might serve as a test model for various drugs, including the bioactive substances extracted from marine animals. Although mammalian models are the most desirable for medical research, the cephalopod system may also be useful for a preliminary study.

Again, it is interesting *per se* that isolated gills maintain their rhythms for days in merely PSW. Deterioration is largely due to infection and so it might be possible to considerably prolong the activity simply by working under near aseptic conditions.

As early as in 1905 Carlson (See Eno, 1987) noted that most blood vessels of *Loligo* were capable of peristaltic contractions and *isolated* lengths of arm vein were seen to pulsate (Mislin and Kruffmann, 1948; See Eno, 1987). These are probably the cause of the twitchings of isolated arm tips and the "ticking" clock of gill lamellae of *L. investigatoris*

described here. Isolated gills of *Octopus australis* have been reported to contract regularly (Evans and Darling, unpublished ; see Eno, 1987).

The autonomous nature of the movements of isolated gills is particularly evident when the gill is excised from an animal that is no longer lively. Soon after isolation the gill becomes more active as the animal itself dies ; it is as if the gill, now liberated from the dying cephalopod, evinces a brisk rhythm. The independent "Swimming" of the large *S. inermis* gill, caused by its twitchings, is also a similar phenomenon. From the evolutionary point of view such autonomy in invertebrates may have made possible the separate existence of the cormidium that breaks away from *Muggiaea*, a siphonophore (Hyman, 1940 ; see Wilson, 1977).

5. Data pertaining to rearing in Aquarium

RESULTS

a) Longevity of captured animals.

Since there is at present no boat for MARC, live cephalopods collected from nets cannot immediately be transferred to containers of sea-water. Instead, animals cast off on the beach are collected, transported to the laboratory in inadequate vessels within which they spray ink and pollute the ambient. Furthermore, there is no circulating sea-water available at the moment.

Under these circumstances, adult *L. investigatoris* have been in the swimming stage for only one hour or less after being transferred to the laboratory and even this is possible only on cool or overcast days.

A *S. inermis* of relatively large size survived for at least 10.5 hours in a tray of sea-water (from 11 AM to 8.30 PM). Water was changed only twice with mugs. It died some time at night.

Another *S. inermis* survived for more than 20 hrs. under nearly identical conditions (from 11.5 AM to 8.30 AM next day) but was dead soon after.

b) Feeding the captive animal.

A single case of feeding, namely the *S. inermis* that survived for 20 hrs. has been possible but this is worth recording (see discussion).

In the evening the *S. inermis* was left in the tray together with a shrimp about as long as the total length of the former. The tray was partly covered,

Next morning, the head and rostrum of the shrimp was found in the tray, neatly sliced off and turned red by now. There was no trace of the body either in the tray or on the floor.

c) *S. inermis* larva

The larvae were in the process of hatching when the egg mass was brought. Table 7 indicates their dimensions at this stage.

TABLE 7
Dimensions of *S. inermis* hatchlings (in mm)*

Larva No.	Length from base of tentacles to the posterior tip	Width maximal width without the extension of mantle on both sides
1	5.25	5
2	11	5.5
3	12.25	5

* 1 division of the scale was 0.5 mm.

These larvae survived for at least 9 hours (from 1 PM to 10 PM) in small petridish with sea-water. Those in a tray were actively swimming at least up to 34 hours.

d) Juvenile *L. investigatoris* caught in 'Bagda net'.

3 remained active for about 5 hours (5-30 AM to 10-30 AM) in normal temperature. Another was actively swimming under similar conditions for three hours (5-8 AM), but then began to sink to the bottom of the container. with artificial aeration, it immediately responded and became active again and this continued for 2 more hours (See e).

e) Cryobiological data

The effect of low temperature on these animals of hot clime has been studied, at first on the comparatively hardy larvae of *S. inermis*.

After 10 hours of cold shock at 12°C they all looked devoid of the pigment and

immobile, resembling dead bodies. After about 10 minutes at room temperature they all recovered ; they wore a blanched look even after 2 hours though they were mobile.

The 3 Juvenile *L. investigatoris* mentioned in (d) were put at about 12°C at the end of 4 hours of survival in normal temperature. One of these survived for three more hours (total 7 hrs.). The animal that survived for 5 hours at room temperature (aeration during the last 2 hours) was put at ~4°C at 10 AM. It survived up to at least 6.40 PM i.e., for more than 13 hrs. One *S. inermis* remained alive for about 6 days (140 hrs.) in a trough of sea-water with a 14 hour regimen of aeration per day. This was in the cool weather.

DISCUSSION

The very scanty data on survival still indicate the possibility of rearing *S. inermis* of Digha in circulating sea water after quick transport to Aquarium during cold weather. Feeding with crustacea like shrimp in the dark or in dim light should be possible.

About 10% of the known 700 cephalopod species have been maintained, reared or cultured in captivity (Hanlon, 1987). Maintenance connotes only holding wild-caught specimen for a short while and rearing denotes development of wild-caught *juveniles* to near maturity ; only 12 species have been truly cultured in captivity, i. e., hatchlings have been grown to maturity and the birth of second generation has been noticed (Hanlon, 1987). The concept that cephalopods are too delicate to survive or grow in captivity is therefore no longer valid. Casting the catch on hot tropical sands leads, however, to a special difficulty that may be overcome if the research station has a boat at disposal wherein the catch can directly be transferred to containers of sea-water.

ETHOLOGICAL ASPECT

Cephalopods, especially the decapods are known to be dim-light feeders (Boucaud-Camou and Boucher-Rodoni, 1983). The single case of feeding by the captive *S. inermis* recorded here also took place in the hours of darkness but not in the preceding hours of daylight.

Although as yet we have a single case of eating the shrimp, the process that occurred is of interest to behavioural science. The neat decapitation of the shrimp and rejection of the head and rostrum is remarkable. In this organism of a relatively small size,

this rostrum and head would injure the stomach if it could be negotiated at all. To our knowledge such behaviour in the decapoda has not been recorded. Messenger (1977) describes the procedure of prey capture, especially prawn, by sepia. The prey is quickly captured and swallowed, no rejection of the head part has been noticed. Again, the squid *Alloteuthis subulata* dart and capture prawns and shrimps and ingest them within a few seconds (Nixon, 1987) and there is no report of immediate regurgitation of the head part.

Some octopus species neatly remove flesh from exoskeleton and hole-boring in shelled molluscs by octopus has been well studied (Boucher-Rodini *et al.*, 1987) but no example is known of decapitating and rejecting the head and rostrum. This may have been a unique behaviour pattern developed in the small *S. inermis* of Digha in order to prevent injuries to its stomach. Further records of this behaviour pattern would be of interest and this will be looked for in the near future.

GENERAL REMARK

Cryo-conditions may be useful for rearing young cephalopods by cutting down their metabolic rate when, for example, food (like *Artemia*) are not available or circulating sea-water has ceased for some time etc.

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Thanks are due to the staff of Marine Aquarium cum Research Centre, Digha for co-operation at various levels.

ADDENDUM

1. Survival : One *Sepiella inermis* survived up to 16 days in the trough under the regimen of 14 hrs. of aeration per day, with partial replacement of sea water once a day. The experiment had to be discontinued for lack of electricity for a long spell so that the aerator could not be used.

2. Shrimp decapitation by *Sepiella inermis* : A total of three cases has now been recorded suggesting that *Sepiella inermis* cut off the heads of Shrimps which are too big for them to negotiate. Two more *S. inermis* (of two different sizes) decapitated Shrimps in our presence (Photograph). These two heads considerably differ in their sizes. It was also noticed that extremely hungry *S. inermis* might not decapitate the shrimp.

3. Two spermatophore bearing *S. inermis* measured 8.4 cm. and 7.00 cm., respectively (Total length). Spermatophore dimensions : 5.5 mm x 0.3 mm.

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**EFFECT OF SEASONAL TEMPERATURE AND HUMIDITY ON OVULATION,
FECUNDITY AND RETENTION OF EGGS IN SILKMOTH, *BOMBYX MORI* (L.)
[LEPIDOPTERA : BOMBYCIDAE].**

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INTRODUCTION

Studies on reproductive biology in silkmoth, *Bombyx mori* (L.) have shown that temperature and relative humidity, prevailing at the time of rearing, play an important role in egg production and oviposition (Tikkoo *et al.*, 1975 ; Tazima, 1978 ; Rahman *et al.*, 1980). In the tropical plains of West Bengal, there is a high degree of fluctuation in temperature and relative humidity throughout the year. During the period from March to June, temperature is comparatively higher with lower humidity and from June to September, both these parameters are on higher side. Therefore, the silkworm cocoon crops, obtained during the period from April to September, are comparatively poorer, when the season is unfavourable. The other half of the year from October to March, when both the average temperature and relative humidity are comparatively lower, these grow richer, and the season is called favourable (Krishnaswami *et al.*, 1971).

It is observed in *Bombyx mori* that all the eggs produced in the ovary are not oviposited, but some are retained. Therefore, studies have been launched to find out the effect of seasonal temperature and relative humidity on ovulation, fecundity and retention of eggs and their interdependence in multivoltine silkmoth, *Bombyx mori* (race *nistari*). The results of the study are discussed under two broad seasons, viz., unfavourable season (March-September) and favourable season (October-February).

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MATERIALS AND METHODS

The indigenous multivoltine silkworm race nistari of *Bombyx mori* (L.), from West Bengal which is generally reared during the four commercial seasons, viz., Jaistha (May), Bhaduri (August-September), Agrahayani (November) and Chaitra (February), was selected as an experimental material. Larvae were reared in mass under the room conditions. On completion of spinning, cocoons were taken at random on the 5th day of pupation from the mass lot. After cutting the cocoons, 30 each of female and male pupae of approximate weight ($0.9 \text{ g.} \pm 0.05 \text{ g.}$) were selected on the 5th day of pupation for the experiment. The 5th day pupae were selected, because their weight at this stage is less influenced by moisture content than that of the fresh pupae (Drooz, 1965). Pupae and moths were maintained under room conditions. On emergence, mating of male and female moths were allowed to lay eggs for 24 hours on egg cards bearing serial number (1-30). Each female was then dissected to find out the number of retained eggs in the ovarioles; the number of eggs laid were also counted individually. Prevailing data of room temperature and relative humidity were recorded four times a day (6 A.M. 10 A.M., 4 P.M. and 9 P.M.) with the help of a dry and wet bulb wet thermometer from rearing to oviposition. Average data of dry temperature and relative humidity were noted and their mean seasonal readings are presented in Table 1 and 2.

RESULTS AND DISCUSSION

(A) Unfavourable Season (March-September) :

Analysis of the data presented in Table 1 and 3 has revealed that ovulation, fecundity and retention percent of eggs showed significant differences in the seasonal mean readings, as discussed below.

(i) *Ovulation* : The rate of egg production during the seasons of August-September and March-April differed significantly from that during May-July. Number of eggs produced in the ovary was recorded maximum (292) during August-September, when the average temperature was high ($27.65^{\circ}\text{C} \pm 0.157^{\circ}\text{C}$) with high relative humidity ($89.99\% \pm 0.434\%$). It decreased insignificantly during March-April, when temperature was comparatively higher ($29.49^{\circ}\text{C} \pm 0.249^{\circ}\text{C}$) with lower relative humidity ($55.95\% \pm 1.58\%$). Production of eggs in the ovary was found minimum (283-293) during May-July when

TABLE : 1

Mean Ovulation, Fecundity and Retention Percent in *Bombyx mori* (Race-Nistari) with Temperature and Humidity during Unfavourable Season.

Seasons	Ovulation (No.)	Fecundity (No.)	Retention of eggs (%)	Temperature (°C)	Humidity (%)
March-April, 1984	386	376	2.47	29.49±0.429	55.95±1.581
May-June, 1984	283	275	2.81	29.81±0.392	80.26±1.209
June-July, 1984	293	281	3.85	28.33±0.216	90.10±0.320
Aug.-Sept., 1984	392	367	6.51	27.65±0.157	89.99±0.434
C. D. at 5%	23	23	2.71		
C. D. at 1%	30	30	3.59		

C. D. = Critical Difference.

higher temperature (28-30°C) prevailed with higher relative humidity (80-90%). This indicated that higher temperature with higher relative humidity was detrimental to production of eggs in the ovary. Ovulation was found to have positive significant ($P < 0.01$) correlation with both fecundity and retention per cent (Table-3).

(ii) *Fecundity* : The rate of oviposition during the both seasons of March-April and August-September differed significantly from that during May-July. Maximum count of fecundity (376) was recorded during March-April, when temperature was very high (29.49°C ± 0.429°C) with low relative humidity (55.95% ± 1.581%). It decreased insignificantly (367) during August-September when temperature was comparatively low (27.65°C ± 0.157°C) with higher humidity (89.99% ± 0.434%). The fecundity was recorded minimum (275-281) during the period from May to July when high temperature (28-30°C) was marked with higher relative humidity (80-90%). This indicated that high temperature with high relative humidity influenced egg-laying operation adversely. Fecundity was found to have positive significant ($P < 0.01$) Correlation with both ovulation and retention per cent (Table-3).

(iii) *Retention per cent of eggs* : The phenomenon during the season of August-September differed significantly from that of the period during March-July. Retention per cent of eggs was recorded (2.47%) during March-April, when the average temperature was high

($29.49^{\circ}\text{C} \pm 0.429^{\circ}\text{C}$) with low relative humidity ($55.95\% \pm 1.581\%$), while it was recorded maximum (6.51%) during August-September, when the average temperature was high ($27.65^{\circ}\text{C} \pm 0.157^{\circ}\text{C}$) with higher relative humidity ($89.99\% \pm 0.434\%$). This indicated that high temperature with high humidity favoured high retention per cent of eggs in the ovary. Retention per cent also showed positive significance ($P < 0.01$) correlation with ovulation and fecundity (Table-3).

(B) Favourable season (October-February) :

Analysis of data presented in Tables-2 and 3 showed significant difference amongst the seasonal mean-readings for the biological processes under study, as discussed below.

(i) **Ovulation** : The data of ovulation during the seasons of November-December and December-January differed significantly from each other and also individually from that of the seasons of October-November and January-February. However, there was no significant difference between October-November and January-February seasons. Total number of eggs produced in the ovary was recorded maximum (497) during November-December, when the temperature was $25.36^{\circ}\text{C} \pm 0.176^{\circ}\text{C}$ with relative humidity $69.20\% \pm 1.037\%$. It decreased insignificantly (471) during December-January, when the temperature was comparatively low ($24.43^{\circ}\text{C} \pm 0.94^{\circ}\text{C}$) with relative humidity $70.15\% \pm 0.782\%$. However, egg production in the ovary reduced to minimum of 408 (January-February) and 415 (October-November), when the temperature and relative humidity altered from $25.36^{\circ}\text{C} \pm 0.176^{\circ}\text{C}$ and $69.20\% \pm 1.037\%$ (optimum) respectively. Ovulation

TABLE : 2

Mean Ovulation, Fecundity and Retention Percent in *Bombyx Mori* (Race—Nistari) with Temperature and Humidity during Favourable Season

Seasons	Ovulation (No.)	Fecundity (No.)	Retention of eggs (%)	Temperature ($^{\circ}\text{C}$)	Humidity (%)
Oct.-Nov., 1984	415	405	2.22	26.14 ± 0.240	73.93 ± 1.164
Nov.-Dec., 1984	497	495	0.37	25.36 ± 0.176	69.20 ± 1.037
Dec.-Jan., 1984	471	464	1.49	24.43 ± 0.194	70.15 ± 0.782
Jan.-Feb., 1984	408	399	2.20	23.18 ± 0.185	71.53 ± 0.862
C. D. at 5%	23	23	N.S.		
C. D. at 1%	31	36	N.S.		

C. D. = Critical difference.

N. S. = Not Significant,

was found to have high positive significant ($P < 0.01$) correlation with fecundity and high negative significant ($P < 0.01$) correlation with retention percent (Table-3).

(ii) *Fecundity* : The data of this process during the season of November-December differed significantly from that of other three seasons. The same in December-January also differed significantly from that in October-November and January-February seasons. The count of fecundity was recorded maximum (495) during November-December, when the prevailing temperature was $25.36^{\circ}\text{C} \pm 0.176^{\circ}\text{C}$ and relative humidity $69.20\% \pm 1.037\%$. It decreased insignificantly (464) during December-January. When the temperature was $24.43^{\circ}\text{C} \pm 0.194^{\circ}\text{C}$ with relative humidity $70.15\% \pm 0.782\%$, but significantly to 405 (October-November) and to 399 (January-February), when the temperature and relative humidity varied from $25.36^{\circ}\text{C} \pm 0.176^{\circ}\text{C}$ and $69.20\% \pm 1.037\%$ (optimum) respectively. Fecundity exhibited high positive significant ($P < 0.01$) correlation with ovulation and high negative significant ($P < 0.01$) correlation with retention per cent (Table-3).

(iii) *Retention percent of eggs* : There was no significant difference amongst the different seasonal mean readings of this phenomenon. However, it was recorded maximum (2.22%) during October-November, when the temperature was high ($26.14^{\circ}\text{C} \pm 0.240^{\circ}\text{C}$) with comparatively high relative humidity ($73.93\% \pm 1.64\%$). It decreased (2.20%) during January-February, when the temperature was low ($23.18^{\circ}\text{C} \pm 0.185^{\circ}\text{C}$) with comparatively low humidity ($71.53\% \pm 0.862\%$). The retention was recorded minimum (0.37%) during November-December, when the temperature was $25.36^{\circ}\text{C} \pm 0.176^{\circ}\text{C}$ and relative humidity $69.20\% \pm 1.037\%$ (optimum). It increased (1.49%) during December-January, when the temperature was $24.43^{\circ}\text{C} \pm 0.194^{\circ}\text{C}$ and relative humidity $70.15\% \pm 0.782\%$. This indicated that slight variation in temperature and relative humidity from

TABLE : 3

Correlation among Ovulation, Fecundity and Retention Percent in *Bombyx mori* (Race—Nistari) during Unfavourable and Favourable Seasons.

	Seasons	Fecundity	Retention Percent
Ovulation	Unfavourable	0.994**	0.417**
	Favourable	1.000**	-0.951**
Fecundity	Unfavourable		0.314**
	Favourable		-0.960**

** - Significant at 1% level.

optimum level favoured higher retention per cent of eggs in the ovary. Retention percent of eggs exhibited high negative significant ($P < 0.01$) correlation with ovulation and fecundity (Table-3).

Keeping all the seasons in view in the tropical plains of the state, the phenomena of reproductive biology, viz., ovulation, fecundity and retention per cent of eggs of *Bombyx mori* were greatly influenced by both temperature and relative humidity. Wigglesworth (1972) reported that the rate of egg production varies with temperature. It is accelerated up to point and then falls rapidly. The range of temperature, at which reproduction can occur, is often much narrower than that of other normal activities of the same species. Further, if the temperature be of adaptive importance for a particular species, different aspects of life-cycle should be under the strict control of temperature-bound factor (Schnebel and Joseph, 1986). Congdon and Logan (1983) found that at high temperature (up to 31°C), fecundity decreased in Bank Grass Mites (BGM), *Oligonychus paratensis*. Nickel (1960) found that in high humid condition (85-90%) BGM, *Tetranychus desertorum* Banks laid fewer eggs. Boyne and Hain (1983) also noted a similar relationship with *Oligonychus ununguis*. Boudreaux (1958) reported that four *Tetranychus* sps. laid more eggs at a faster rate in dry condition ($< 35\%$ R. H.)

Data presented in Tables 1-3 reveal only one factor alone, i. e., temperature or relative humidity was not responsible for increasing/decreasing ovulation, fecundity and retention of eggs, but indicated that it was a combined effect of temperature and relative humidity.

Considering all the seasons of unfavourable and favourable period in view, it indicated that temperature at $25.36^{\circ}\text{C} \pm 0.176^{\circ}\text{C}$ with relative humidity $69.20\% \pm 1.037\%$ was found optimum (November-December) for maximum production of eggs in the ovary (495), and minimum retention of eggs (0.37%). Any increase or decrease in temperature and relative humidity from the optimum level increased retention of eggs or decreased egg production and fecundity respectively. Fecundity was found to have high positive significant ($P < 0.01$) correlation with ovulation irrespective of seasons. However, with retention per cent of eggs, it exhibited positive significant ($P < 0.01$) correlation during unfavourable season and highly negative significant ($P < 0.01$) correlation during favourable season (Table-3).

Stamenkovic (1985) reported that the effect of temperature plays a significant role on the fecundity of summer fruit tortrix moth, *Andoxophyes orana*. Cunningham (1985) suggested that the most favourable condition for oviposition by grain mite, *Acarus siro* were $20-25^{\circ}\text{C}$ and 80-90% relative humidity. Ouhelli and Pandey (1984) also found that 25°C temperature and 84% relative humidity were suitable for laying viable eggs

in *Hyalomma lusitanicum*. The above studies indicate that an inter-relationship might exist between temperature and relative humidity affecting oviposition. Keeping seasonal conditions in view, above findings corroborate our results that about 25°C temperature and 70% relative humidity is most favourable for maximum egg production and oviposition with minimum retention in multivoltine silkworm, *Bombyx mori* (race-nistari).

The results reported are useful for predicting silkworm seed production as a function of seasonal temperature and relative humidity in the tropical plains. This is an important aspect of efforts to determine their impact on silkworm rearing and silk yield, because it allows one to determine the degrees of seasonal synchrony with potential egg production.

SUMMARY

In the tropical plains of West Bengal, there is a high degree of fluctuation in temperature and humidity throughout the year. With this, ovulation, fecundity and retention of eggs in multivoltine silkworm, *Bombyx mori* (L.) [race nistari] vary in different seasons. Maximum ovulation and fecundity with minimum retention of eggs was recorded in November-December, 1984 when the temperature was $25.36^{\circ}\text{C} \pm 0.17^{\circ}\text{C}$ and relative humidity $69.20\% \pm 1.03$ (optimum). Any fluctuation of temperature and humidity from the optimum level decreased ovulation and fecundity and increased retention of eggs. All these phenomena together with their possible interactions during favourable (October-February) and unfavourable (March-September) season have been discussed.

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STRUCTURE AND PATTERN OF CUTICULAR SCALES ON MID-DORSAL
GUARD HAIRS OF MARBLED CAT, *FELIS MARMORATA CHARLTONI*
GRAY (MAMMALIA : CARNIVORA : FELIDAE)

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INTRODUCTION

Mid-dorsal guard hairs of Marbled cat, *Felis marmorata charltoni* Gray were studied for obtaining the structural details. Opinion differs as regard the structural stability, species-specificity of hair structure and their role in the mammalian taxonomy (Hausman 1920, Cole 1924, Mathiak 1938, Nason 1948, Lyne and McMohan 1951, Mayer 1952, Benedict 1957, Miles 1965, Day 1966, Moore *et al.* 1974, Short 1978). However, importance of hair identification in the study of food habits of carnivores (Day 1966, Koppiker and Sabnis 1976, 77), mammal survey (Adorjan and Kolenosky 1969, Dziurdzik 1973, Joshi 1976) and in forensic use (Anon 1973, Feder and Hebel 1973) cannot be ignored. For the protection of wildlife and to prevent illegal trades with wildlife products, identification of hair is also gradually becoming critical.

Though a considerable research has been carried out on the cuticular structure of hairs of extralimital mammalian species (Brunner and Coman 1974) but so far cuticular scale structure of only few Indian species have been worked out (Koppiker and Sabnis 1976, 77, De 1993).

In the present note an attempt has been made to reveal the structure, pattern of cuticular scale of mid-dorsal guard hair of marbled cat, *Felis marmorata charltoni* Gray.

The marbled cat is one of the most endangered species of lesser cats and included in the Schedule I of the Indian Wildlife (Protection) Act, 1972. Poaching for its pelt is one of the main threats to its survival (Ghose 1994).

MATERIAL AND METHODS

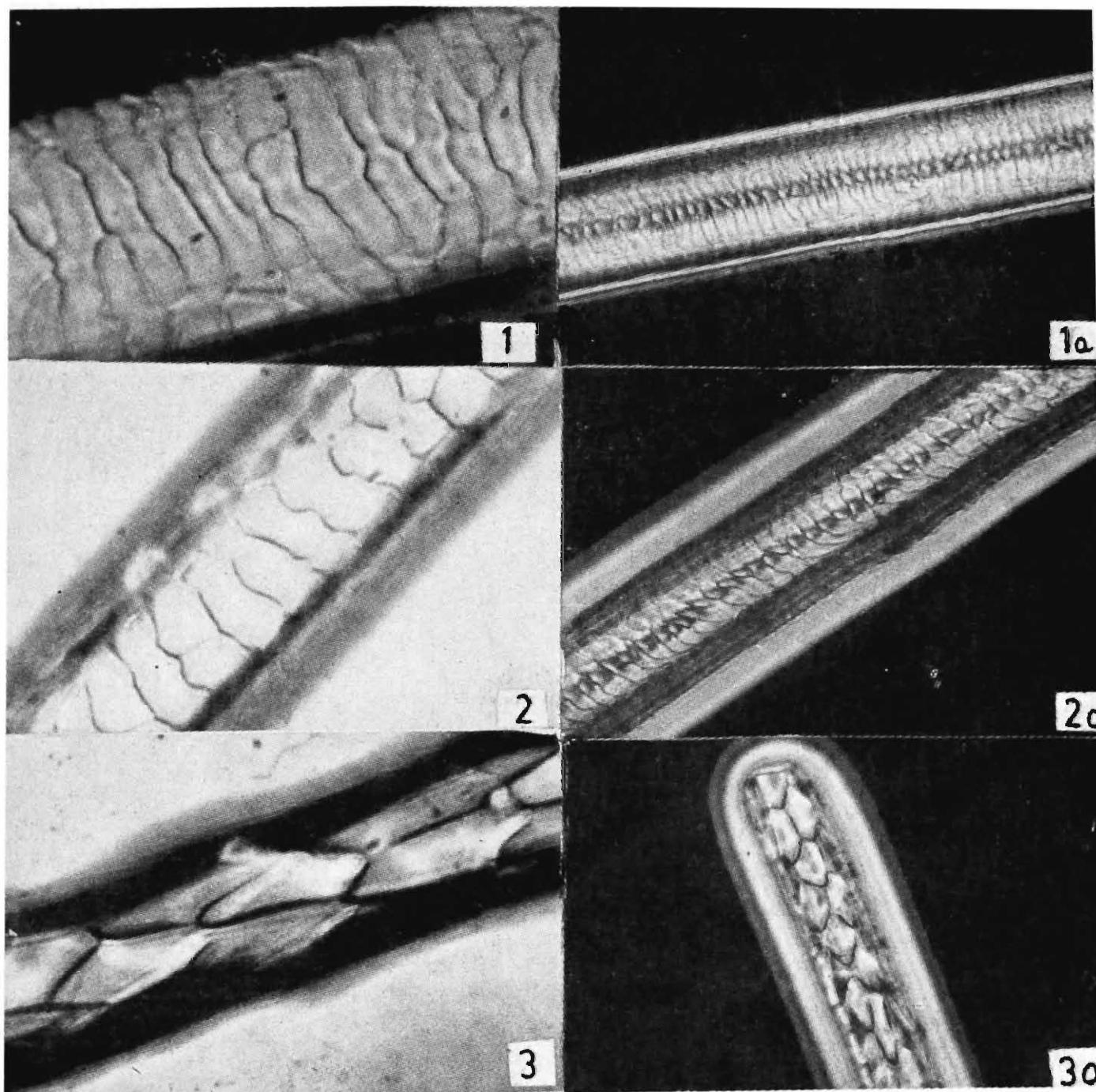
Samples of guard hairs were collected from the dry preserved specimens present in the Zoological Survey of India, Calcutta. The samples have been washed in different grades of aqua-acetone solution, starting with 50 per cent and gradually raised up to pure acetone through the grades of 70, 80, 90 and 95 per cent. Washing time in each grade was 30 minutes and finally kept in pure acetone for overnight. For getting casts of cuticular scales thin film of clear varnish was drawn on the microscopic glass slide and acetone treated dry hair was put on the film with a little pressure by a fine needle. Then the film was dried for 8-10 hours. Before examining under microscope the hair sample was pulled off gently with a fine forcep leaving the casts of scales on the varnish. Slides were kept in air-tight cabinet to prevent dust accumulation.

The casts on the slides were examined under both low and high power of WILD microscope. The measurements were expressed in milimicron. Structural nomenclature was followed after Brunner and Coman (1974) and Moore *et al.* (1974). Particulars of the specimens from which the hairs were collected are given below.

ZSI Reg. No.	Locality	Sex	Date	Collector/Donor
7398	Malacca Is.	—	29 July 1895	W. Rutledge
4216	—	M	1885	W. Rutledge
7339	—	F	24 April 1893	W. Rutledge
7141	—	F	—	Donated by Zoo Garden on 18 Dec., 1889.
3982	—	—	1881	W. Rutledge

OBSERVATION

Most of the dorsal guard hairs of the marbled cat are seal brown throughout, while few with a white or cream buff patch slightly below the tip. Straight in nature with a diameter of $\pm 50\mu$ at the transitional and apical region and $\pm 30\mu$ at the basal region but tip is pointed.



Microphotograph of mid-dorsal guard hair of marbled cat.

Fig. 1 : Basal region 1000 X

Fig. 2 : Transitional region 1000 X

Fig. 3 : Apical region 1000 X

Fig. 1a : Basal region 400 X

Fig. 2a : Transitional region 400 X

Fig. 3a : Apical region 400 X

Scale count varies at the different zones of the individual hair ; average count found to be 555, 164 and 89 per millimeter of hair length at the basal, transitional and apical region respectively. Zonal variations in the proximo-distal length and side to side length of the individual scale are also well marked (Table 1).

TABLE 1

Measurements of cuticular scales of the mid-dorsal guard hairs of marbled cat

	Proximo-distal length	Side to side length
Basal Region	5-10 μ (mean 5.8 μ)	7-17 μ (mean 11.8 μ)
Transitional Region	7-12 μ (mean 9.8 μ)	12.5-17 μ (mean 9.5 μ)
Apical Region	19-25 μ (mean 22 μ)	8-10 μ (mean 9.5 μ)

The pattern of scales at the basal and transitional regions are 'flat', 'regular wave' with 'smooth' margins but apical scales are almost 'diamond petals' or 'broad petals' (Plate 1). Scale margin distance is 'intermediate' at the basal region and 'distant' at the transitional region (Plate 1). In low magnification a distinct black line at the middle of the hair casts is observed in all the five specimens examined which is not found in the higher magnification (Plate 1).

DISCUSSION

Short (1978) opined that the pattern of cuticular scales on the hair surface is insufficient for identification of different mammalian species. However, from the above study it is revealed that variations in the pattern, number and measurements of cuticular scales of the dorsal guard hairs have a similar trend in all the five specimens of marbled cat examined. Thus, it appears that the number, measurements and pattern of cuticular scale revealed in the present study may be species-specific characteristics of the marbled cat. However, further studies with the cuticular scale pattern of the related species of the genus *Felis* along with the consideration of other parameters viz. cross-sectional configurations, medulla type etc. may be significant for providing key to the identification of the species.

An inverse relationship between the width of the hair and proximodistal length of each scale of guard hair obtained by Hausman (1930) and Noback (1951). However,

no such relationship could be obtained in the present study. Authors are unable to explain the black line observed on the hair casts under low magnification.

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SUMMARY

Based on the castings, structure and Pattern of cuticular scales on mid-dorsal guard hairs of marbled cat, *Felis marmorata charltoni* Gray were studied under WILD microscope. Number, shape and pattern of cuticular scales are different in the basal, transitional and apical zones of the individual hair. However, an uniformity could be marked in these respects among all the specimens studied. Cuticular scale structure and pattern may be utilised in the identification of the species.

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ON THE CLASSIFICATION OF SPONGIPHORIDAE (=LABIIDAE)
WITH A LIST OF SPECIES

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INTRODUCTION

The family Spongiphoridae is mainly characterised by the presence of simple 2nd tarsal segment (not lobed) and single proparamere. On the basis of 2nd tarsal segment it could be easily separated from Chelisochidae and Forficulidae.

Burr's (1911) key to the subfamilies was mainly based upon the characters of elytra, antennal segments and the length of eye in relation to post-ocular area. His key was in use with slight modification by Popham and Brindle (1967, 1967a) and Steinmann (1976). Generally various families were divided into two major groups on the basis elytra being carinate or ecarinate. But the subfamily Pericominae did not fit in any of the above groups since the elytra lack a well defined keel on the costal margin and in its place a row of small tubercles is present and from each arises a thick seta.

After a careful study it was found that the shape of hind tarsi especially the 2nd tarsal segment and the relative length of all the three segments in combination with other characters could be utilised for formulating a key for the satisfactory discrimination of various subfamilies.

Hitherto Spongiphorinae and Labiinae were considered as close. But it may be mentioned here that members of the subfamily Spongiphorinae belonging to the genera *Spongevostox* Burr and *Marava* Burr, possess hind 2nd tarsal segment slightly longer than broad, strongly narrowed posteriorly and is about half as long as the third. Besides, first segment is slightly shorter than the combined length of second and third. According to the information available through literature same condition is found amongst the members of the genus *Spongiphora* Serville—the type of Spongiphorinae.

In the light of the above, Spongiphorinae comes close to Homotaginae and can be discriminated from each other by the relative length of hind tarsal segments. In

Homotaginae hind second tarsal segment, in profile, is of uniform width and only scarcely narrowed basally and first segment is slightly longer than the combined length of last two segments.

A new subfamily Rudraxinae is erected for the reception of a new genus and species, viz., *Rudrax brindlei*, from China. It is mainly characterised by the elytra having a sharp keel along the costal margin. It comes close to Ramamurthiinae, but differs by the pilose body and tibiae compressed, at extreme apex slightly grooved.

Srivastava (1985) has described two subfamilies viz., Homotaginae and Irdexinae besides construction of a key for the discrimination of various subfamilies utilising for the first time the shape of the hind tarsi, especially the second tarsal segment and the relative length of all the three segments in combination with other characters.

It may be mentioned here that the genus *Labia* Leach, 1853 as defined by Steinmann (1990) contains now those species which possess parameres with a median incision thus dividing it into two, external and internal lobes. And the remaining species with parameres entire, i. e., not divided vertically were included under *Paralabella* Steinmann, 1990, *Circolabia* Steinmann, 1987, *Spirolabia* Steinmann, 1987 and *Paraspania* Steinmann, 1985. Last three were, however, mainly characterised by the shape and arrangement of virga.

Srivastava (1992) has already pointed out, while discussing the validity of various genera of Pygidicranidae, that genera based upon such characters will not stand. Accordingly, *Paraspania* is placed as synonym of *Chaetospania*. Besides, *Circolabia* is treated as valid with *Paralabella* and *Spirolabia* as its synonym since it has priority. It will now be characterised as "externally similar to *Labia* with parameres entire and virga of various types".

Steinmann (1990) has placed *Chaetospania* under Sparattinae on the grounds of ecological similarity. But this reason does not seem plausible since members of Spongiphorinae, Labiinae and of above subfamily occur in the same habitat, i. e., under loose bark of logs and stems. For this reason it is proposed to transfer *Chaetospania* under Labiinae. Members of this genus although possess depressed head, abdominal tergites are weakly convex unlike those of Sparattinae which are strongly depressed including head.

The size of eye in relation to post-ocular area of head, as a valid character, seems to be doubtful. It is found to be variable intra specifically in several species. At present it is being used to separate various genera pending availability of some other more constant characters. However, in the present arrangement it has been possible to avoid this character in discriminating various subfamilies.

It may be mentioned here that Srivastava (in press) has already transferred Isolaboidinae under Anisolabididae since proparameres are paired. In extreme cases it may apparently look unpaired due to great enlargement of distal lobe of one side covering almost both the halves of proparameres. Generally virga of only one side is well developed and on the other side it may be absent or greatly reduced. Besides, all other external morphological characteristics suggest its inclusion in this family.

Various superspecific taxa included under the family are summarised below :

Subfamily : RAMAMURTHIINAE

Genus : **Ramamurthia** Steinmann

Subfamily : RUDRAXINAE Subfam. n.

Genus : **Rudrax** gen. n. (*R. brindleyi* sp. n.)

Subfamily : PERICOMINAE

Genera : **Pericomus** Burr, **Parapericomus** Ramamurthi

Subfamily : HOMOTAGINAE

Genera : **Homotages** Burr, **Paratages** Srivastava

Subfamily : SPONGIPHORINAE

Genera : **Spongiphora** Serville, **Filolabia** Steinmann, **Formicilabia** Rehn and Hebard, **Marava** Burr, **Pseudomarava** Steinmann, **Purex** Burr, **Spongovostox** Burr, **Vostox** Burr

Subfamily : IRDEXINAE

Genus : **Irdex** Burr

Subfamily : NESOGASTRINAE

Genus : **Nesogaster** Verhoeff

Subfamily : VANDICINAE

Genera : **Strogyloopsis** Burr, **Strongylolabis** Steinmann

Subfamily : SPARATTINAE

Genera : **Sparatta** Serville, **Auchenomus** Karsch, **Mecomera** Serville

Subfamily : GERACINAE

Genera : **Gerax** Hebard, **Barygerax** Hebard, **Eugerax** Hebard, **Nesolabia** Hincks, **Pseudovostox** Borelli, **Yepezia** Brindle

Subfamily : COSMOGERACINAE

Genus : **Cosmogerax** Hebard

Subfamily : CAECOLABIINAE

Genus : **Caecolabia** Brindle

Subfamily : ISOPYGINAE

Genus : **Isopyge** Borelli

Subfamily : LABIINAE

Genera : **Labia** Leach, **Apovostox** Hebard, **Chaetolabia** Brindle, **Chaetospania** Kasch (= **Paraspania** Steinmann—Syn. n.), **Circolabia** Steinmann (= **Spirolabia** Steinmann and **Paralabella** Steinmann—Syn. n.), **Sphingolabis** Bormans

KEY TO THE SUBFAMILIES OF SPONGIPHORIDAE

(Partly modified after Srivastava, 1985)

- 1(10). Second tarsal segment longer than broad
- 2 (5). Elytra with a sharp ridge along the costal margin
- 3 (4). Whole body covered with long and stiff hairs ; femora incrassate, tibiae deplanate and sulcate above in apical half only ... **Ramamurthiinae** Steinmann
(= **Physogastrinae** Ramamurthi)
- 4 (3). Body pilose ; tibia compressed, at extreme apex slightly grooved
... **Rudraxinae** Subfam. n.
- 5 (2). Elytra without a sharp ridge along the costal margin
- 6 (7). Elytra granular, along the costal margin with a row of small tubercles, each bearing a short or long thick setae ; tarsi long and slender ; 1st segment five times or more longer than its width ... **Pericominae** Burr
- 7 (6). Elytra smooth or punctulate, ecarinate along the costal margin and without tubercles or setae ; tarsi shorter, 1st segment three to four times longer than its width
- 8 (9). Hind second tarsal segment, in profile, almost of uniform width, only scarcely narrowed basally and slightly shorter than third, first segment slightly longer than the combined length of last two segments ... **Homotaginae** Srivastava

- 9 (8). Hind second tarsal segment, in profile. narrowed basally, about half as long as the third, first segment slightly shorter than the combined length of second and third segments ... Spongiphorinae Burr
- 10 (1). Second tarsal segment broader than long or about as broad as long
- 11(12). Hind tarsi comparatively longer and slender, first segment five times longer than its width ; elytra smooth, occasionally costal margin with a row of small tubercles, each with a thick setae ... Irdexinae Srivastava
- 12(11). Hind tarsi comparatively shorter and thick, first segment three to four times longer than its width
- 13(18). Elytra with a sharp ridge along the costal margin
- 14(15). Antennal segments conical, each gently expanded apically and narrow basally ... Nesogastrinae Verhoeff
- 15(14). Antennal segments cylindrical
- 16(17). Antennae 16—20 segmented (African species) ... Vandicinae Burr
- 17(16). Antennae 12—15 segmented (American species)... Strongylopsalinae Burr
- 18(13). Elytra without a ridge along the costal margin
- 19(20). Body strongly depressed or flattened, head flat, dorsal surface not convex ... Sparattinae Burr
- 20(19). Body not strongly depressed or flattened, head convex dorsally (except *Chaetospania*)
- 21(22). Tarsal claw with an arolium ... Geracinae Brindle
- 22(21). Tarsal claw without an arolium
- 23(24). Last abdominal tergite semicircular and sloping down to pygidium, tergites 5—9 hidden beneath the preceding tergites ... Cosmogeracinae Brindle
- 24(23). Last tergite rectangular, not sloping down to pygidium and tergites 5—9 not so hidden
- 25(26). Head without eyes (blind species) ... Caecolabiinae Steinmann
- 26(25). Head with eyes

- 27(28). Eyes longer than post-ocular length ; hind margin of ultimate tergite strongly emarginate ; forceps almost as long as the width of ultimate tergite
 ... Isopyginae Hincks
- 28(27). Eyes shorter than the post-ocular length ; hind margin of ultimate tergite sinuate ; forceps distinctly longer than the width of ultimate tergite ... Labiinae Burr

RAMAMURTHIINAE Steinmann

Ramamurthinae Steinmann, 1975. *Acta zool. Hung.*, 21 : 210 (new name for Physogastrinae Ramamurthi, 1967) (Type genus—*Ramamurthia* Steinmann, 1975—new name for *Physogaster* Ramamurthi, 1967—name preoccupied by Lacordaire, 1839, *Ann. Sci. Nat.*, 20 : 276, in Coleoptera).

Physogastrinae Ramamurthi, 1967, *Ent. Meddel.*, 35 : 237.

Diagnostic characters : Build stout, whole body covered with long and stiff hairs. Head sutures, obsolete, eyes about as long as the postocular area or only slightly shorter. Legs with femora incrassate, tibia flattened and sulcate above in apical half, 2nd tarsal segment large, slightly longer than broad.

Disiribution : Australian Region (Bismarck Island).

LIST OF GENERA AND SPECIES

Ramamurthia Steinmann, 1975

(= *Physogaster* Ramamurthi, 1967)

R. scabinata Ramamurthi, 1967 ... Bismarck Island

RUDRAXINAE Subfam. n.

Diagnostic characters : Build normal ; body pilose. Elytra with a sharp ridge along the costal margin. Legs typical for the family, fore-femora swollen, middle and hind ones compressed, at extreme apex above slightly grooved ; hind tarsi with 1st segment a little over 5 times longer than its width ; 2nd segment 3 times longer than broad ; 3rd segment 4 times longer than broad and a little over half the length of 1st segment ; claw without arolium. Pygidium distinct. Forceps long and slender.

Distribution ; Oriental Region.

Type genus : *Rudrax* gen. n.

Remarks : In having elytra keeled along the costal margin and 2nd tarsal segment longer than broad, the described subfamily comes close to Ramamurthiinae but differs by the pilose body and compressed tibiae with a slight depression at extreme apex. In Ramamurthiinae the tibiae are deplanate and grooved in apical half, somewhat similar to some forms of the family Chelisochidae.

***Rudrax* gen. n.**

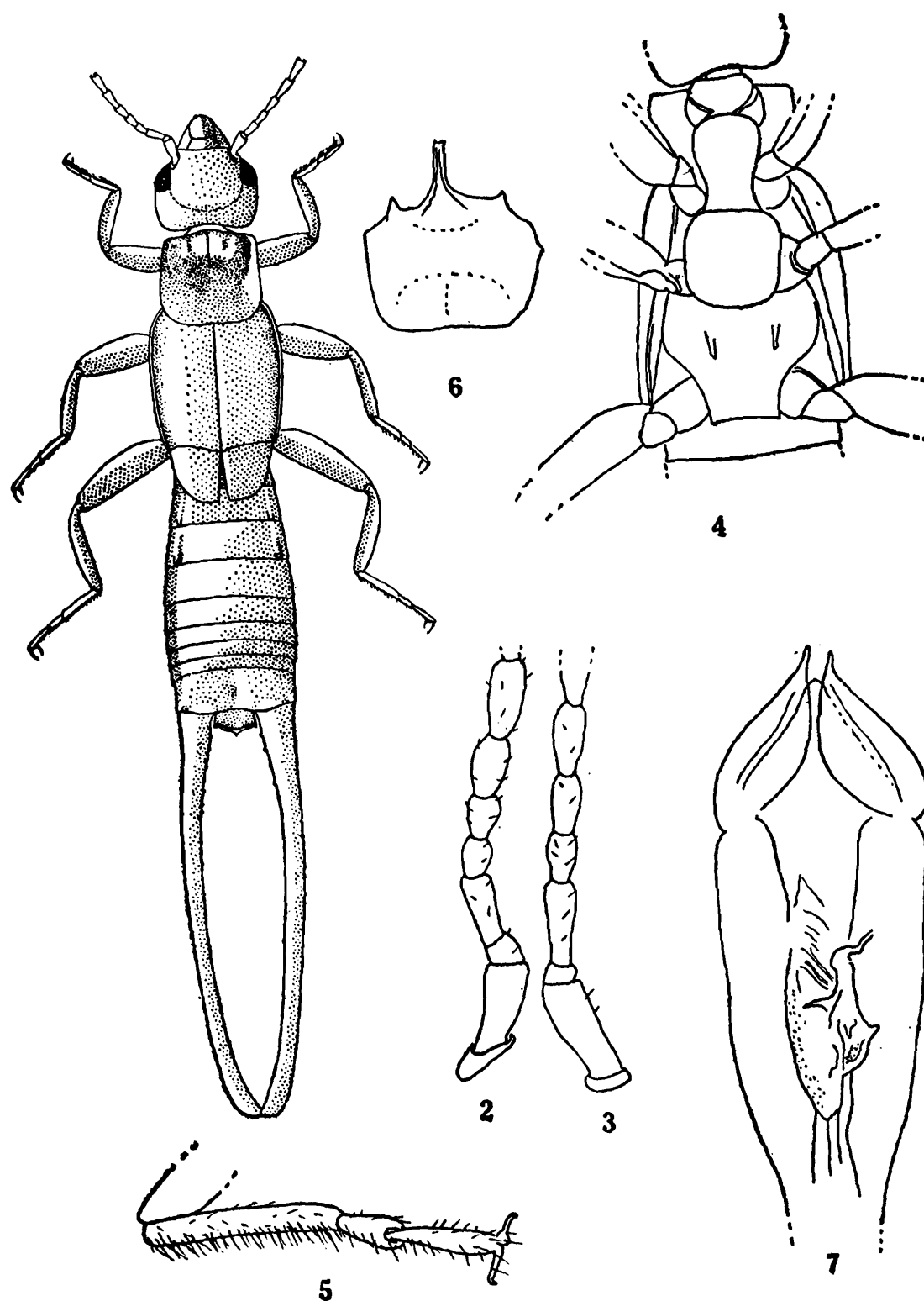
Body pilose ; general colour dull brownish black. Head longer than broad. Eyes shorter than post-ocular area. Antennae 16-segmented or more ; 1st stout, shorter than the distance between antennal bases ; 3rd long and slender, longer than 4th and 5th. Elytra and wings well developed, former with a sharp ridge laterally. Abdomen striolate with punctulations, lateral tubercles on 3rd and 4th tergites distinct, along the hind margin of each tergites a row of compressed tubercles present. Pygidium distinct. Forceps long and slender.

***Rudrax brindlei* sp. n.**

(Figs. 1-6)

♂ : General colour dull brownish black, antennae, legs and forceps lighter in colour.

Head longer than broad, pilose, smooth, moderately convex, postero-lateral angles rounded and hind margin emarginate, sutures fine but clearly distinct. Eyes distinctly shorter than the post-ocular area. Antennae (partly broken) with 16 segments on the left and 8 on the right sides (segments 4 to 6 on the left are comparatively shorter and stouter than those on the right), 1st stout, narrowed at base, shorter than the distance between antennal bases, about as long as the eyes ; 2nd small, transverse ; 3rd long and cylindrical, yellowish brown with apex brownish black, longer than 4th and 5th, remaining segments gradually increasing in length distally and thinning. Pronotum rectangular, with micro-reticulations, about as long as broad or a trifle broader, anteriorly as wide as head with margin slightly convex in middle, sides feebly reflexed, straight, scarcely diverging posteriorly, hind angles rounded and margin straight, median sulcus finely marked but distinct, prozona raised with a faint depression in middle on either side of median line close to anterior margin, metazona weakly depressed. Elytra well developed, surface above obscurely punctulate, humeral angles prominent, costal



Figs. 1-7: *Rudrax brindlei* sp. n. Holotype (male) 1. Dorsal view; 2. Right antennal segments; 3. Left antennal segments; 4. Thoracic sternite; 5. Hind tarsi; 6. Penultimate sternite and 7. Genitalia.

margin with a raised ridge, feeble at shoulder, hind margin obliquely concave. Wings short, about half as long as head, surface above obscurely punctate. Prosternum longer than broad, narrowed posteriorly with hind margin straight. Mesosternum about as long as broad, sides straight and hind margin briefly rounded. Metasternum about as long as broad, posteriorly narrowed between hind coxae with free margin feebly sinuate. Legs with fore-femora thickened, tarsi clad with hairs on underside, hind tarsi with basal segment $1/5$ as broad as long; 2nd elongated, about $1/3$ as long as the basal one and $1/2$ as long as apical segment; claw without an arolium. Abdomen moderately convex, gently dilated in middle, rugosely striolate with punctulations above and on sides, sides of segments broadly convex, tergites 8th and 9th comparatively less rugosely striolate above, hind margin of each tergite with a row of small, distantly placed compressed tubercles. Penultimate sternite rectangular, transverse, finely punctulate, disc broadly depressed in middle, postero-lateral angles rounded with hind margin straight; manubrium slightly shorter than the length of sternite, in basal half triangular, in apical half narrow, parallel sided. Ultimate tergite rectangular, strongly transverse, moderately convex, obscurely punctulate laterally, with numerous small tubercles on lateral and posterior side, hind margin in middle straight or feebly concave, laterally oblique and concave. Pygidium subvertical, pentagonal, gently widened posteriorly with margin slightly raised, postero-lateral angles produced into minute point and in middle with a triangular tubercle. Forceps long, faintly trigonal near base, slender, depressed, slightly curved in middle, tapering apically but gently expanded near apices with tip pointed, internal margin in basal $1/4$ sharp with numerous small tubercles internally and as above. Genitalia with parameres oval, tip sharply pointed; virga short, stout with various chitinous accessory plates. Length : body-11.0 mm; forceps-7.45 mm.

♀ : Unknown.

Material examined : Holotype ♂ (genitalia attached), S. CHINA : Fukien, Changting, Niuling, 9.vi.1940, T.C. Maa; deposited in the B.P. Museum, Honolulu, Hawaii, U.S.A.

Remarks : The second tarsal segment is quite elongated in being three times longer than broad but it is essentially of Labiid type. Although it is narrowed at base and wider apically, it is not lobed. In this respect it approaches, amongst various species of Labiidae, members of genus *Homotages* Burr, which possess ecarinate elytra laterally.

PERICOMINAE

Pericominae Burr, 1911. *Dt. ent. natn. Bibl-thk.*, 2 : 59 (Type genus—*Pericomus* Burr, 1911).

Diagnostic characters : Elytra perfect, rugose, with coarse granulations and punctulations, costal margin with a row of small tubercles, each bearing a thick setate. Wings of the same texture as the elytra. Legs with first segment five times or a little more than its width ; second segment longer than broad.

Distribution : Neotropical and Australian Regions.

Remarks : The inclusion of this subfamily under the division with keeled elytra is not justified since the costal margin is not keeled but it is provided with a row of tubercles and a thick seta arising from each. In this respect this comes close to *Irdexinae* Srivastava, but latter differs by the shape of second tarsal segment and smooth elytra.

LIST OF GENERA AND SPECIES

Pericomus Burr, 1911

- P. ater* Brindle, 1988 ... Panama
P. tenuipes Burr, 1905 ... Peru and Ecuador

Parapericomus Ramamurthi, 1967

(This genus was placed under *Physogastrinae* by Ramamurthi (1967) which is now a synonym of *Ramamurthiinae*. It should be included under *Pericominae* as has been done by Steinmann (1989).

- P. noonadanae*, Ramamurthi, 1876 ... New Britain

HOMOTAGINAE} Srivastava

Homotaginae Srivastava, 1985. *Annali Mus. Civ. Stor. nat. Giacomo Doria*, 85 : 206 (Type genus—*Homotages* Burr, 1909).

Diagnostic characters : Body smooth, glabrous and head longer than broad, convex. Eyes shorter than post-ocular area. Antennae 15-segmented, 1st stout, narrowed basally ;

2nd about as broad as long ; 3rd long and slender ; 4th subconical, shorter than preceding ; 5th longer than 4th but shorter than 3rd, remaining cylindrico-conical, gradually increasing in length distally. Elytra and wings well developed, smooth. Legs long, slender, 1st tarsal segment equal or longer than the combined length of 2nd and 3rd ; 2nd longer than broad, of uniform width throughout, except at base, slightly narrowed. Forceps, in males, strongly undulated and toothed.

Distribution : Oriental Region (India, Myanmar and Nepal-in mountain region only).

Remarks : This subfamily can be easily distinguished by the shape of hind tarsal segments, especially 2nd one which is of uniform width throughout, besides some other minor characters.

LIST OF GENERAL AND SPECIES

Homotages Burr, 1907

<i>H. feae</i> (Bormans, 1888)	—India, Myanmar and Nepal
<i>H. tawangensis</i> Srivastava, 1977	—India (Arunachal Pradesh)
<i>H. principalis</i> Steinmann, 1989	—Vietnam

Paratages Srivastava, 1987

P. sakail Srivastava, 1987

SPONGIPHORINAE Burr

Spongiphorinae Burr, 1911. *Dt. ent. natn. Bibl-thk.*, 2 : 49 (Type-genus : *Spongiphora* Serville, 1831).

Diagnostic characters : Size medium to large. Head with sutures distinct. Eyes generally longer than the post-ocular area. Antennae with 3rd segment longer than 4th or equal and longer than 5th. Wings and elytra glabrous, smooth in most of the species. Legs with hind tarsal segment slightly longer than broad, strongly narrowed posteriorly and half as long as the 3rd ; 1st tarsal segment shorter than the combined length of 2nd and 3rd.

Distribution : Worldwide.

LIST OF GENERA AND SPECIES

Filolabia Steinmann, 1989*F. exigus* Steinmann, 1989

—Brazil

Formicilabia Rehn and Hebard, 1917*F. caribea* Rehn and Hebard, 1917

—Dominian Republic

Marava Burr, 1911(= *Prolabia* Burr, 1911)(= *Larex* Burr, 1911)(= *Laprobia* Hincks, 1960)*M. alluaudi* (Burr, 1904)

—Madagascar

M. arachidis (Yersin, 1860)

—Worldwide

M. bidentata Brindle, 1917

—Ecuador

M. brasiliiana Brindle, 1971

—Brazil and Trinidad

M. calverti Rehn, 1921

—Costa Rica

M. championi (Bormans, 1893)—Panama, Venezuela, Suriname,
French Guiana and Brazil*M. dominica* (Rehn and Hebard, 1917)

—West Indies

M. draco Steinmann, 1985

—Jamaica

M. elegantula Brindle, 1973

—Costa Rica

M. emarginata Brindle, 1977

—Venezuela

M. equatoria (Burr, 1899)—Ecuador, Colombia, Guyanas,
Panama and Suriname*M. feae* (Dubrony, 1879)

—Philippine Isls, New Guinea

M. flaviscuta (Rehn, 1903)

—Mexico and Guatemala

M. flavohumeralis Brindle, 1988

—Panama

M. fulgida Brindle, 1970

—Solomon Isls and Bougainville

M. furia Steinmann, 1989 (New name for

—Venezuela

M. minuscula Brindle, 1977)*M. gracilis* Brindle, 1988

—Panama

M. grata Steinmann, 1985

—Venezuela

M. grenadensis Brindle, 1971

—Grenada and Costa Rica

- M. graeaudi* Brindle, 1966 —Madagascar
M. hildebrandti (Burr, 1912) —Madagascar
M. jamaicana (Rehn and Hebard, 1917) —Jamaica
M. lucida (Brindle, 1968) —Suriname
M. luzonica (Dohrn, 1864) —Oriental and Indo-Australian Regions

M. machupicchuensis Brindle, 1971 —Peru
M. mexicana (Bormans, 1883) —Mexico
M. moreirai (Menozzi, 1933) —Brazil
M. nigrella (Dubrony, 1879) —Oriental Region and Solomon Isls.
M. nigrocincta Brindle, 1988 —Panama
M. nitida (Burr, 1904) —Madagascar
M. pallida Brindle, 1988 —Panama
M. paradoxa (Burr, 1904) —Ecuador
M. paraguayensis (Caudell, 1904) —Paraguay
M. parva (Burr, 1904) —Suriname, French Guiana, Argetina, Venezuela and Costa Rica

M. parvula Brindle, 1988 —Panama
M. pulchella (Serville, 1849) —East and South U. S. A. and West Indies

M. pygidata Brindle, 1988 —Panama
M. pyxis Steinmann, 1985 —Panama
M. quadrata Brindle, 1971 —St. Vincent (West Indies)
M. rogersi (Bormans, 1893) —Costa Rica, Haiti
M. rotundata (Scudder, 1876) —Mexico, Guatemala, West Indies and Peru

M. servini (Burr, 1900) —Colombia
M. silvestrii (Borelli, 1905) —Costa Rica, Panama, Ecuador, Brazil, Paraguay and Argentina

M. splendida Steinmann, 1985 —New Guinea
M. surinamensis (Brindle, 1968) —Suriname
M. towensi Brindle, 1979 —Guatemala
M. tricolor (Kirby, 1891) —Brazil
M. triquetra (Hebard, 1917) —Mexico
M. unidentata (Beauvois, 1805) —Neotropical Region and Canada
M. venezuelica Brindle, 1917 —Venezuela

Pseudomarava Steinmann, 1989*P. prominens* Steinmann, 1989

—Guatemala

Purex Burr, 1911*P. brunneri* (Bormans in Burr, 1903)

—Venezuela, Ecuador and Brazil

P. divergens (Burr, 1899)

—Ecuador and Peru

P. esuivetae Brindle, 1968

—Venezuela

P. eminens Steinmann, 1989

—Ecuador

P. formosanus Hebard, 1920

—French Guiana

P. frontalis (Dohrn, 1864)—Costa Rica, Panama, Venezuela,
Ecuador and Peru*P. parvicollis* (Stal, 1860)

—Brazil and Panama

P. propinquus (Burr, 1911)

—Peru

P. pulchellus Brindle, 1971

—Venezuela

P. remotus Burr, 1899

—Ecuador

P. sinuatus Brindle, 1971

—Venezuela and Mexico

P. staudinger Brindle, 1971

—Peru

P. surinamensis Brindle, 1971

—Suriname

P. versicolor (Bormans, 1883)

—Colombia and Venezuela

Spogiphora Serville, 1831(= **Psolidophora** Serville, 1839)(= **Spogophora** Agassig, 1846)—Invalid emendation(= **Pilex** Burr, 1910)*S. bormansi* Burr, 1897

—Brazil, Paraguay and Argentina

S. buprestoides (Kirby, 1891)

—Brazil, Bolivia and Peru

S. corceipennis Serville, 1839

—Central and South America

S. dissimilis Borelli, 1909

—Costa Rica

S. elongatus (Fabricius, 1793)

—West Indies

S. miracula Steinmann, 1984

—Ecuador

S. moreirai Machado and Castro, 1947

—Brazil

S. paradisea Steinmann, 1984

—Guyana

S. proluxa (Scudder, 1876)—Mexico, Guatemala, Costa Rica
and Ecuador(new name for *Psolidophora parallela*
Dohrn, 1862)*S. salvadorensis* Brindle, 1971

—Salvador

Spongovostox Burr, 1911

(= **Andex** Burr, 1911)

(= **Microvostox** Hebard, 1917)

(= **Afrolabia** Hincks, 1949)

- | | |
|--|---|
| <i>S. alogsiisabaudiae</i> (Borelli, 1906) | —Central and Eastern Africa |
| <i>S. alter</i> Burr, 1912 | —Panama, Suriname, Brazil,
Bolivia and Argentina |
| <i>S. anamalaiensis</i> Srivastava, 1969 | —(South) India |
| <i>S. asper</i> (Menozzi, 1935) | —West and Central Africa |
| <i>S. assiniensis</i> (Bormans, 1893) | —Equatorial Africa |
| <i>S. barberi</i> Hebard, 1917 | —Guatemala |
| <i>S. basilewskyi</i> Hincks 1954 | —Congo Republic |
| <i>S. bilineatus</i> (Scudder, 1869) | —South and Central Africa |
| <i>S. burgeoni</i> Borelli, 1923 | —Congo Republic and Uganda |
| <i>S. carinatus</i> Brindle, 1975 | —Tanzania |
| <i>S. caudex</i> Steinmann, 1985 | —Brazil |
| <i>S. cornutus</i> Brindle, 1973 | —Angola |
| <i>S. cosmos</i> Steinmann, 1985 | —Mexico |
| <i>S. decellei</i> (Brindle, 1968) | —Ivory Coast, Cameron, Gabon
and Nigeria |
| <i>S. doddi</i> (Burr, 1914) | —Australia : Queensland |
| <i>S. excavatus</i> Hincks, 1954 | —French Guinea |
| <i>S. ferrugineus</i> (Borelli, 1907) | —Congo Republic and Cameron |
| <i>S. flavicinctus</i> Brindle, 1982 | —Panama and Venezuela |
| <i>S. flavohumeralis</i> Brindle, 1973 | —Congo Republic |
| <i>S. flavostriatus</i> Brindle, 1982 | —Venezuela |
| <i>S. gestori</i> (Burr, 1909) | —Western and Central Africa
and Ethiopia |
| <i>S. ghilianii</i> (Dohrn, 1864) | —Venezuela, Suriname, French Guiana,
Brazil and Dominican Republic |
| <i>S. globus</i> Steinmann, 1985 | —Afr. ? |
| <i>S. guttulatus</i> (Burr, 1987) | —Malaysia, Indonesia (Sumatra Java,
Lombok) and Celebes |
| <i>S. hackeri</i> (Burr, 1914) | —Australia : Queensland and Victoria |
| <i>S. hakeni</i> Ramamurthi, 1967 | —Philippines : Tawi Tawi |

- S. hinnules* Hincks, 1956
S. kristenseni Burr, 1911
S. marginalis (Thunberger, 1887)
- S. masai* (Hincks, 1949)
S. medleri Brindle, 1976
S. mirabilis Steinmann, 1985
S. mirei Brindle, 1969
S. mucronatus (Stal, 1860)
- S. nigroflavida* (Rehn, 1905)
S. orion Steinmann, 1985
S. orpheus Steinmann, 1985
S. ocellai Steinmann, 1984
S. oweni (Burr, 1911)
S. pygmaeus (Dohrn, 1864)
- S. quadrimaculatus* (Stal, 1855)
S. ruber (Borelli, 1907)
- S. rubescens* Brindle, 1973
S. schlaeferi Burr, 1911
- S. schoutedeni* Borelli, 1923
S. schwarzi (Caudell, 1907)
S. semiflavus (Bormans, 1894)
- S. subaptera* (Kirby, 1891)
S. sumatranus Boesman, 1954
S. suspectus Steinmann, 1989
S. taurus Steinmann, 1985
S. tempus Steinmann, 1981
S. testaceus (Borelli, 1923)
- Cameroon
 —Ethiopia
 —Mainly eastern, central and southern Africa, extending southwards from the Congo Republic and Uganda through most of Africa to Natal
 —Tanzania
 —Nigeria
 —Thailand
 —Cameroon
 —Sri Lanka, India (Sikkim), China, Myanmar, throughout Malay Archipelago to New Guinea
 —Australia : Queensland
 —Tanzania
 —Ghana
 —Thailand
 —West-Central Africa
 —Guatemala, Nicaragua, Panama, Venezuela, Peru and Brazil
 —Eastern and Southern Africa
 —Equatorial Guinea : Bioko and Cameroon
 —Congo Republic
 —Ivory Coast, Ghana, Nigeria, Cameroon and Congo Republic
 —Congo Republic
 —Mexico, Guatemala and French Guiana
 —China : Yunnan, India (throughout India from North through South), Sri Lanka, Myanmar, Vietnam, Indonesia, Java, Sumatra, Sumba and Bismarck Isls.
 —Australia : Queensland and New Guinea
 —Sumatra
 —Java
 —Vietnam
 —Gabon
 —East and Central Africa

- | | |
|---|--|
| <i>S. tripunctatus</i> (Borelli, 1907) | —Ivory Coast, Cameroon, Gabon, Congo
Republic, Zaire, Angola and Uganda |
| <i>S. trituberculatus</i> Brindle, 1973 | —Congo Republic |
| <i>S. tuberculatus</i> (Borelli, 1907) | —Sao Tombi Island |
| <i>S. victriae</i> (Burr, 1904) | —Australia : Victoria |

VOSTOX Burr, 1911

- | | |
|---|---|
| <i>V. americanus</i> Steinmann, 1975 | —Bolivia and Chile |
| <i>V. apicedentatus</i> (Caudell, 1904) | —South U. S. A. and Mexico |
| <i>V. asemus</i> (Hebard, 1920) | —Argentina and Brazil |
| <i>V. basalis</i> (Burr, 1912) | —Mexico and Guatemala |
| <i>V. bertonii</i> (Borelli, 1905) | —Paraguay and Argentina |
| <i>V. binotatus</i> (Kirby, 1891) | —Colombia |
| <i>V. bolivianus</i> Brindle, 1971 | —Bolivia |
| <i>V. brasiliensis</i> Steinmann, 1975 | —Brazil |
| <i>V. brunneipennis</i> (Serville, 1839) | —Canada, U. S. A. and Neotropical
America |
| <i>V. carinatus</i> Brindle, 1971 | —Venezuela |
| <i>V. cabreræ</i> Rehn, 1925 | —Cuba |
| <i>V. comitatus</i> Steinmann, 1989 | —Ecuador |
| <i>V. confusus</i> (Borelli, 1905) | —Colombia and Paraguay |
| <i>V. dubious</i> (Moreira, 1931) | —Argentina |
| <i>V. dugueti</i> Borelli, 1912 | —Mexico |
| <i>V. ecuadorensis</i> Steinmann, 1975 | —Ecuador |
| <i>V. excavatus</i> Nutting and Gurny, 1961 | —U. S. A. : Arizona, New Mexico,
California ; and Mexico |
| <i>V. similis</i> (Bormans, 1883) | —Mexico, Panama and Colombia |
| <i>V. vicinus</i> (Burr, 1912) | —Brazil |

IRDEXINAE Srivastava

Irdexinae Srivastava, 1985. *Annali. Mus. civ. Stor. nat. Giacomo Doria*, 85 : 207 (Type-genus : *Irdex* Burr, 1911).

Diagnostic characters : Eyes small or prominent. Elytra smooth, costal margin with a row of small tubercles, arising from each a thick setae. Wings well developed or consealed. Legs long, slender, 1st tarsal segment 1/5 as wide as long ; 2nd short,

broader than long and 3rd slightly shorter than 1st. Pygidium subvertical, posterior margin provided with tubercles. Forceps, in males, remote at base, gently undulate, internal margin with several minute teeth.

Distribution : Oriental Region.

Remarks : The genus *Irdex* Burr, was redefined by Srivastava (1985) after re-examination of the Type material of *I. nitidipennis* (Bormans).

LIST OF GENERA AND SPECIES

Irdex Burr, 1911

- | | |
|--|---|
| <i>I. singalensis</i> (Dohrn, 1865)
(= <i>S. carli</i> Borelli, 1931) | —Sri Lanka and India (South) |
| <i>I. escheri</i> (Borelli, 1931) | —India (South) |
| <i>I. nitidipennis</i> (Bormans, 1894)
(= <i>Spongophora lutea</i> Bormans, 1894)
(= <i>Spongovostox aborum</i> Burr, 1913)
(= <i>Spongovostox wuermalii</i> Brindle, 1975) | —India, Nepal, Bhutan, Myanmar,
Indonesia : Sumatra and Hainan Isls. |

NESOGASTRINAE Verhoeff

Nesogastrinae Verhoeff, 1902. *zool. Anz.*, 665 : 191 (Type-genus : *Nesogaster* Verhoeff, 1902).

Distribution : Oriental and Australian Region.

LIST OF GENERA AND SPECIES

Nesogaster Verhoeff, 1902

(= *Nesogastrella* Verhoeff, 1902)

- | | |
|---|--|
| <i>N. aculeatus</i> (Bormans, 1900)
(= <i>N. fulgor</i> Steinmann, 1983) | —Widely distributed from Phillippine
Isls to Micronesia |
| <i>N. amoenus</i> (Stal, 1855) | —Malaysia ; Indonesia : Sumatra, Java
and Celebes ; Philippine Isls ; New
Guinea and Australia |
| <i>N. bakeri</i> Hincks, 1947 | —New Hebrides |

<i>N. bidentatus</i> Srivastava, 1978	—Philippine Isls. : Mindanao
<i>N. burri</i> Rehn, 1946	—Philippine Isls. : Mindanao
<i>N. cristatus</i> Brindle, 1976	—New Caledonia
<i>N. dholicus</i> (Burr, 1897)	—Celebes
<i>N. dybasi</i> Srivastava, 1978	—Philippine Isls. : Mindanao
<i>N. grattiosus</i> Steinmann, 1989	—Fiji
<i>N. halli</i> Hincks, 1947	—Borneo
<i>N. lewisi</i> (Bormans in Burr, 1903)	—Japan and Taiwan
<i>N. magnus</i> Steinmann, 1989	—Fiji
<i>N. milleri</i> Steinmann, 1989	—Philippine : Mindanao
<i>N. minusculus</i> Rehn, 1946	—Indonesia : Mentawai Isls
<i>N. mounseyi</i> Burr, 1914	—Philippine Isls. : Mindanao
<i>N. nigritus</i> (Shiraki, 1905)	—Japan : Taiwan
<i>N. papuus</i> (Bormans in Burr, 1903)	—New Guinea
<i>N. rehni</i> Hincks, 1951	—Australia : Queensland
<i>N. ruficeps</i> (Erichson, 1842)	—Australia and Tasmania
<i>N. tristis</i> (Bormans in Burr, 1903)	—New Caledonia
<i>N. wallacei</i> Burr, 1908	—Celebes

VANDICINAE Burr

Vandicinae Burr, 1911. *Dt. ent. natn. Bibl-thk.*, 2: 59 (Type-genus : *Vandex* Burr, 1911).

Diagnostic characters : Antennae with 16 to 20 segments, cylindrical. Eyes small. Elytra short with well defined ridge along the costal margin. Legs slender, first and third tarsal segments equal in length.

Distribution : Confined to the mountains of Africa between 1500m and 3000m in altitude.

LIST OF GENERA AND SPECIES

Vandex Burr, 1911

<i>V. celisi</i> Brindle, 1966	—Uganda
<i>V. fantasticus</i> Steinmann, 1974	—Ghana
<i>V. hincksi</i> Brindle, 1966	—Rwanda : Lake Kivu
<i>V. leleupi</i> Brindle, 1966	—Rwanda : Lake Kivu
<i>V. pophami</i> Brindle 1969	—Tanzania

V. pygidiatus Brindle, 1975

—Tanzania, Burundi and Rwanda

V. schubotzi (Burr, 1909)

—Congo Republic, Zire, Burundi and
Rwanda

STRONGYLOPSALINAE Burr

Strongylopsalinae Burr, 1911. *Dt. ent. natn. Bibl-thk*, 2 : 59 (Type-genus : *Strongylopsalis* Burr, 1900).

Distribution : Neotropical Region.

LIST OF GENERA AND SPECIES

Strongylolabis Steinmann, 1986

S. berlandi (Hebard, 1920)

—Guatemala

S. secunda Steinmann, 1986

—Panama

Strongylopsalis Burr, 1900

S. bidentatus, Brindle, 1971

—Colombia

S. boliviana (Bormans in Burr, 1903)

—Bolivia

S. cheliduroides (Bormans, 1888)

—Peru

S. dlmidlata Brindle, 1977

—Venezuela

S. dubia Moreira, 1932

—Brazil

S. eberhardi Steinmann, 1986

—Costa Rica

S. excavata Brindle, 1971

—Bolivia

S. flava Steinmann, 1987

—Venezuela

S. haitica Steinmann, 1986

—Haiti

S. iheringi Rehn, 1917

—Brazil

S. koepcke Brindle, 1968

—Peru

S. laminata Brindle, 1973

—Bolivia

S. mathurinii Ribeiro, 1931

—Brazil

S. puella Steinmann, 1986

—Main Range (? Central America)

S. tarsata Hebard, 1924

—Ecuador

SPARATTINAE Zacher

Sparattinae Zacher, 1902. *zool. Anz.*, 25 (665) : 198 (Type-genus : *Sparatta* Serville ; 1839).

Diagnostic characters : Build slender, body strongly depressed. Head strongly depressed. Eyes small, much shorter than the post-ocular area. Pronotum anteriorly narrowed to form a sort of neck. Elytra and wings perfect.

Distribution : Neotropical, Ethiopian, Oriental and Australian Regions.

LIST OF GENERA AND SPECIES

Auchenomus Karsch, 1886

- | | |
|--|--|
| <i>A. albaylensis</i> Srivastava, 1976 | —Philippine Isls : Luzon |
| <i>A. angusticollis</i> (Dubrony, 1879) | —Malaysia and Borneo |
| <i>A. arcuatus</i> Brindle, 1968 | —Philippine Isls : Luzon |
| <i>A. bidentatus</i> Borelli, 1924 | —Buru |
| <i>A. bifurcus</i> Steinmann, 1984 | —Australia : Queensland |
| <i>A. blumi</i> Steinmann, 1988 | —New Guinea |
| <i>A. dentatus</i> Srivastava, 1976 | —Philippines Isls : Mindanao |
| <i>A. elongatus</i> Brindle, 1970 | —Solomon Isls |
| <i>A. extractus</i> Steinmann, 1989 | —Fiji |
| <i>A. forcipatus</i> Ramamurthi, 1967 | —New Britain |
| <i>A. fragilis</i> Steinmann, 1988 | —New Guinea |
| <i>A. heros</i> Steinmann, 1984 | —New Guinea |
| <i>A. hincksi</i> Ramamurthi, 1960 | —India (South) |
| <i>A. insularis</i> Brindle, 1976 | —New Hebrides |
| <i>A. intermedius</i> Borelli, 1926 | —Sumatra |
| <i>A. javanus</i> (Bormans, 1883) | —Philippine Isls, Java, Key Island and
New Guinea |
| <i>A. kaszabi</i> Steinmann, 1988 | —New Guinea |
| <i>A. ligua</i> Burr, 1911 | —Sumatra |
| <i>A. longiforceps</i> Karsch, 1886 | —Madagascar |
| (= <i>A. tschitscherini</i> Semenov, 1908) | |
| (= <i>A. pandanicola</i> Chopard, 1951) | |
| <i>A. menozzi</i> Borelli, 1926 | —Philippine Isls : Mindanao |
| <i>A. minutus</i> Boeseman, 1954 | —Sumatra |

- | | |
|--|---|
| <i>A. nathani</i> Ramamurthi, 1968 | —India (South) |
| <i>A. pallidus</i> Brindle, 1968 | —Philippine Isls : Mindanao |
| <i>A. pandani</i> Hincks, 1960 | —New Guinea |
| <i>A. porrectus</i> Steinmann, 1989 | —Malaysia |
| <i>A. proprius</i> Steinmann, 1984 | —New Guinea |
| <i>A. pueritis</i> Steinmann, 1983 | —Philippine Isls : Luzon |
| <i>A. rapidus</i> Steinmann, 1984 | —Solomon Isls |
| <i>A. robustus</i> Borelli, 1921 | —Borneo |
| <i>A. setulosus</i> (Burr, 1900) | —Malaysia, Borneo, Sumatra and
Philippine Isls |
| <i>A. striatus</i> Srivastava, 1976 | —Philippine Isls : Luzon |
| <i>A. variabilis</i> Brindle, 1970 | —Solomon Isls : Bougainville |
| <i>A. variabilis egoloensis</i> Brindle, 1970 | —Solomon Isls : New Georgia Group |
| <i>A. variabilis guadalacanalensis</i> Brindle, 1970 | —Solomon Isls : Guadalcanal |
| <i>A. vicinus</i> Borelli, 1915 | —Philippine Isls : Luzon |

Mecomera Serville, 1839
(=*Metasparatta* Borelli, 1912)

- | | |
|--------------------------------------|--|
| <i>M. brunnea</i> Serville, 1839 | —Nicaragua, Costa Rica, French Guiana,
Brazil, Colombia, Peru, Bolivia and
Argentina |
| <i>M. chacoensis</i> (Borelli, 1912) | —Venezuela, Brazil and Argentina |
| <i>M. reichardti</i> Brindle, 1971 | —Brazil |

Sparatta Serville, 1839
(=*Prosparatta* Burr, 1911)
(=*Parasparatta* Burr, 1911)

- | | |
|---|--|
| <i>S. armata</i> Burr, 1899
(= <i>S. minuta</i> Caudell, 1907) | —Ecuador, Guatemala and Peru |
| <i>S. biolleyi</i> Borelli, 1903 | —Costa Rica, Venezuela and ? Bolivia |
| <i>S. bocainensis</i> (Machado, 1953) | —Brazil |
| <i>S. bolivari</i> Bormans, 1988 | —Costa Rica, Colombia, Suriname,
Venezuela and Peru |
| <i>S. bormansi</i> Kirby, 1896 | —Mexico |
| <i>S. calverti</i> Borelli, 1910 | —Costa Rica |
| <i>S. colombiana</i> Bormans, 1883 | —Costa Rica, Colombia, Brazil, and
Bolivia |

<i>S. dentifera</i> Rehn, 1901 (= <i>S. lobata</i> Borelli, 1909) (= <i>Parasparata guyanensis</i> Habard, 1920) (= <i>Parasparatta panamae</i> Habard, 1923)	—South and Central America
<i>S. diplatyoides</i> (Caudell, 1907)	—Guatemala and Mexico
<i>S. dominicana</i> (Brindle, 1971)	—Dominican Republic
<i>S. dudichi</i> (Steinmann, 1982)	—Brazil
<i>S. ecuadorensis</i> (Borelli, 1932)	—Ecuador
<i>S. flavipennula</i> Rehn, 1903	—Mexico and Guatemala
<i>S. humilis</i> (Hebard, 1917)	—Mexico, Panama, Venezuela and and Nicaragua
<i>S. incerta</i> Borelli, 1905	—Mexico to Argentina
<i>S. luederwaldti</i> (Menozzi, 1932)	—Brazil
<i>S. nigrina</i> Stal, 1855	—Brazil, Nicaragua, Suriname, Guatemala, Argentina and Dominican Republic
<i>S. pelvimetra</i> Serville, 1839	—Brazil
<i>S. picadoi</i> (Borelli, 1911)	—Costa Rica
<i>S. pulchra</i> Borelli, 1906	—Costa Rica and Panama
<i>S. quinquepunctata</i> (Borelli, 1932)	—Brazil
<i>S. rehni</i> (Hebard, 1929)	—Panama, Nicaragua and Guyanas
<i>S. rufina</i> Stal, 1855 (= <i>S. clarkii</i> Kirby, 1896)	—Brazil, Uruguay, Argentina, Paraguay and Guyanas
<i>S. schotti</i> Dohrn, 1865	—Argentina, Brazil and Mexico
<i>S. semirufa</i> Kirby, 1896	—Brazil, Suriname and French Guiana
<i>S. singularis</i> Steinmann, 1978	—Venezuela
<i>S. siunata</i> (Brindle, 1979)	—Brazil
<i>S. spiculifera</i> (Brindle, 1977)	—Venezuela

GERACINAE Brindle

Geracinae Brindle, 1971. *J. nat. Hist.*, 5 : 158 (Type-genus : *Gerax* Hebard, 1917).

Diagnostic characters : Size small. Head convex. Eyes variable in size. Legs with femora stout, smooth, hind tarsi with 1st segment longer than the combined length of 2nd and 3rd ; 2nd short ; claws with arolium. Elytra and wings well developed, generally pubescent, variable in size. Abdomen convex, usually pubescent. Forceps small, elongated or sometimes lamellate.

Distribution : Neotropical, Oriental and Ethiopian Regions.

Barygerax Hebard, 1917

- | | |
|--|----------------------|
| <i>B. auricoma</i> (Rehn, 1903) | —Costa Rica and Peru |
| <i>B. breviforceps</i> (Caudell, 1907) | —Guatemala |
| <i>B. esau</i> Hebard, 1917 | —Panama |
| <i>B. transversalis</i> Brindle, 1974 | —Venezuela |
| <i>B. venezuelicum</i> Brindle, 1974 | —Venezuela |

Eugerax Hebard, 1917

- | | |
|-------------------------------------|------------------------|
| <i>E. clavijoi</i> Brindle, 1974 | —Venezuela |
| <i>E. nigratum</i> Brindle, 1974 | —Venezuela |
| <i>E. poecilum</i> Hebard, 1917 | —Panama and Costa Rica |
| <i>E. salcedoi</i> Brindle, 1974 | —Venezuela |
| <i>E. semiapterum</i> Brindle, 1974 | —Venezuela |

Gerax Hebard, 1917

- | | |
|----------------------------------|------------|
| <i>G. fuscum</i> Brindle, 1974 | —Venezuela |
| <i>G. lucidum</i> Brindle, 1974 | —Venezuela |
| <i>G. phantasma</i> Hebard, 1917 | —Panama |

Nesolabia Hincks, 1957

- | | |
|------------------------------------|----------------------|
| <i>N. longicollis</i> Hincks, 1957 | —Mauritius, Re'union |
|------------------------------------|----------------------|

Pseudovostox Borelli, 1926

- | | |
|--|---------------------------------------|
| <i>P. africanus</i> (Brindle, 1968) | —Central and East Africa |
| <i>P. afrum</i> Menozzi, 1935 | —Ghana, Congo Republic and Mozambique |
| <i>P. bicolor</i> Borelli, 1926 | —Philippine Isls and Borneo |
| <i>P. bispinosus</i> Brindle, 1970 | —Uganda |
| <i>P. fasciatus</i> (Bormans, 1894) | —Myanmar |
| <i>P. flavofascialis</i> Brindle, 1973 | —Sumatra |
| <i>P. hincksi</i> Brindle, 1970 | —Rhodesia |
| <i>P. mameti</i> (Hincks, 1950) | —Mauritius |
| <i>P. myrmecus</i> (Burr, 1908) | —Java |

- | | |
|-----------------------------------|-----------------|
| <i>P. rudebecki</i> Brindle, 1969 | —Angola, Gabon |
| <i>P. truncatus</i> Brindle, 1970 | —Kenya |
| <i>P. unicolor</i> Brindle, 1970 | —Congo Republic |

Yepezia Brindle, 1982

- | | |
|-------------------------------------|------------|
| <i>Y. venezuelica</i> Brindle, 1982 | —Venezuela |
|-------------------------------------|------------|

COSMOGERACINAE Brindle

Cosmogeracinae Brindle, 1982. *Bol. ent. Venez. N. S.*, 2 (4): 35 (Type-genus: *Cosmogerax* Hebard, 1933).

Diagnostic characters: Size small to very small (3.5-4.25 mm), head strongly convex, eyes prominent but smaller than the post-ocular area, pronotum small, elytra and wings well developed. Legs short, tarsal arola absent. Last abdominal tergite semicircular, sloping down to pygidium, almost hidden under the preceding tergites, last tergite together with pygidium and forceps forming a bowl shaped structure. Pygidium generally transverse in males and triangular in females. Genitalia Labiid type with single median lobe.

Distribution: Neotropical Region.

Remarks: Members of this subfamily are, in general, similar to Geracinae but distinct by the absence of tarsal arolia and by the structure of last tergite and forceps.

Generally it is difficult to ascertain the sex without dissecting out male genitalia. However, the species could be identified on the basis of either sex which are similar in morphological details.

LIST OF GENERA AND SPECIES

Cosmogerax Hebard, 1933
(=*Geracides* Brindle, 1973)

- | | |
|--------------------------------------|----------------------|
| <i>C. araguensis</i> (Brindle, 1974) | —Venezuela |
| <i>C. diagonalis</i> Brindle, 1982 | —Venezuela |
| <i>C. doesburgi</i> Brindle, 1982 | —Suriname |
| <i>C. formica</i> (Burr, 1911) | —Guatemala to Brazil |

- C. guatemalensis* (Brindle, 1973) —Guatemala to Panama
C. magicum Steinmann, 1989 —Guatemala

CEACOLABLIINAE Steinmann

Caecolabiinae Steinmann, 1989. *Das Tierreich*, Berlin, 106 : 70 (Type-genus : *Caecolabia* Brindle, 1975).

Diagnostic characters : Size very small (3·5 to 4·5 mm in both sexes), blind and apterus. Body weakly sclerotised. Male genitalia with a tubular virga in median unpaired proparamere.

Distribution : Mascarene Islands : Re'union (near Madagascar and Mauritius).

LIST OF GENERA AND SPECIES

Caecolabia Brindle, 1975

- C. gomyi* Brindle, 1975 —Re'union Isls.

ISOPYGINAE Hincks

Isopyginae Hincks, 1951. *Ann. Mus. Congo belge*. (Ser in 8 vo) *Zool.*, 8 : 12 (Type-genus : *Isopyge* Borelli, 1931).

Diagnostic characters : Head triangular, broader than long ; eyes prominent, longer than the post-ocular area. Antennae 15-segmented ; 2nd, 3rd subquadrate ; 4th and 5th transverse ; 6th onwards segments subquadrate to slightly elongated up to 12th, afterwards heavily built. Legs with tibiae short and broad, sulcate in apical half above ; claw strongly toothed and lacking arolium. Pygidium prominent and forceps similar in both sexes.

Distribution : Madagascar.

Remarks : This subfamily can be easily separated from other Labiid subfamilies by the transverse head ; stout, short segmented antennae and strongly toothed claw.

LIST OF GENERA AND SPECIES

Isopyge Borelli, 1931

I. madagascariensis Borelli, 1931

—Madagascar

LABIINAE Burr

Labiinae Burr, 1909. *Dt. ent. natn. Bibl-thk.*, 2 : 60 (Type-genus *Labial* Leach, 1815).

Diagnostic characters : Size generally small to medium ; form weakly convex or depressed. Eyes generally shorter than post-ocular area (longer in *Apovostox* Hebard). Antennae with 3rd segment shorter than 5th or slightly so. Elytra and wings well developed, usually punctured and pubescent.

Distribution : Worldwide.

Remarks : This subfamily was considered close to Spongiphorinae but on the basis of third antennal segment shorter than 5th and hind 2nd tarsal segment about as long as broad, it can be easily differentiated from the latter.

LIST OF GENERA AND SPECIES

Apovostox Hebard, 1927

(= *Argusina* Hebard, 1927)

<i>A. bicuneatus</i> (Borelli, 1932)	—North Borneo
<i>A. brevis</i> (Brindle, 1970)	—Solomon Isls. : Santa Isabel
<i>A. burri</i> (Srivastava, 1975)	—India
<i>A. ceylonensis</i> (Srivastava, 1983)	—Sri Lanka
<i>A. chapmani</i> (Brindle, 1980)	—Borneo
<i>A. chauhani</i> (Srivastava, 1975)	—India
<i>A. dakshinkaliensis</i> (Kapoor, Malla and Shah, 1978)	—Nepal
<i>A. elongatus</i> Srivastava, 1978	—Philippine Isls : Mindanao
<i>A. ernstmayri</i> (Günther, 1932)	—New Guinea
<i>A. fortunatus</i> (Steinmann, 1985)	—New Guinea
<i>A. gracilis</i> (Borelli, 1932)	—Borneo
<i>A. hilaris</i> (Bormans, 1900)	—New Guinea

- A. jupiter* (Burr, 1900)
 (= *Irdex novaguinea* Boeseman, 1954)
 (= *Irdex philippinensis* Ramamurthi, 1967)
- A. litus* (Hebard, 1927)
A. papuanus (Brindle, 1970)
A. pilosus Bey-Bienko, 1959
A. poggii (Srivastava, 1979)
A. pygidiatus (Dubrony, 1879)
A. rammei (Günther, 1929)
A. serratus (Kapoor, 1967)
A. stella (Bormans, 1900)
- A. s. samsingensis* (Srivastava, 1975)
A. tantalus (Steinmann, 1985)
A. unicolor (Steinmann, 1985)
A. unimitabilis (Steinmann, 1985)
A. wittmeri (Brindle, 1975)
- Borneo and Philippine Isls.
 and New Guinea
- Sumatra
 —Papua New Guinea
 —China (Yunnan) and Bhutan
 —New Guinea
 —Oriental Region and Hawaii
 —Borneo and New Guinea
 —India (South)
 —Philippine Isls., Malaysia and
 Borneo
 —India (Darjeeling dist.)
 —China : Kiangsi
 —Australia : Queensland
 —New Guinea
 —Bhutan and Nepal

Chaetolabia Brindle, 1972

- C. appendicina* (Menozzi, 1941)
C. bihastata (Börg, 1094)
- C. canaca* (Burr, 1903)
C. delicatula (Brindle, 1970)
C. dentata Brindle, 1976
C. esakii (Menozzi, 1941)
C. fryei (Burr, 1910)
C. hilaro Steinmann, 1985
C. montana Brindle, 1973
C. nebulosa Steinmann, 1985
C. parabola Steinmann, 1985
C. quadrilobata (Dohrn, 1867)
C. socculata Steinmann, 1985
C. spiciata Brindle, 1972
C. stoneri (Caudell, 1927)
C. tetragona (Borelli, 1907)
C. venusta Steinmann, 1985
- Carolina Isls. and ? India
 —West and Central Africa, ? New
 Britain and India (Darjeeling dist.)
 —New Caledonia : Noumea
 —Gabon
 —New Hebrides
 —Micronesia : Kusaie
 —Seychelles : Silhouette
 —New Guinea
 —Congo Republic
 —Fiji
 —Congo Republic
 —Principe Island
 —Solomon Isls : Guadalcanal
 —Caroline Isls. : Palau
 —New Hebrides and Fiji
 —São Tombé Island
 —Fiji

Cheatospania Karsch, 1886(= *Sparatta* Verhoeff, 1902)*Paraspania* Steinmann, 1985. *Int. Quart. ent.* (Izmir), 1 (1) : 14 (Type-species : *Sparatta brunneri* Bormans, 1883)—Syn. n.

- | | |
|--|--|
| <i>C. abortiva</i> Rehn, 1949 | —Society Isls |
| <i>C. aculeata</i> (Bormans in Burr, 1903) | —Celebes |
| <i>C. adolescence</i> Steinmann, 1985 | —Fiji |
| <i>C. anamalaiensis</i> Srivastava, 1969 | —India (South) |
| <i>C. andersoni</i> Brindle, 1971 | —Sri Lanka |
| <i>C. arguata</i> Steinmann, 1988 | —India |
| <i>C. attenuata</i> Steinmann, 1988 | —New Guinea |
| <i>C. auchenormoides</i> Hincks, 1954 | —Indonesia : Sumba |
| <i>C. australiana</i> (Mjöberg, 1913) | —Australia |
| <i>C. australica</i> (Bormans, 1883) | —Australia |
| <i>C. bellator</i> Steinmann, 1984 | —Indonesia : Bali Isl |
| <i>C. bilobata</i> Borelli, 1932 | —Borneo and Malaysia |
| <i>C. bispinosa</i> Shiraki, 1928 | —Taiwan |
| <i>C. bormansi</i> Srivastava, 1981 | —Myanmar |
| <i>C. borneensis</i> (Dubrony, 1879) | —Oriental Region and Solomon Isls |
| <i>C. brunneri</i> (Bormans, 1883) | —Philippine to New Zealand |
| <i>C. capella</i> Burr, 1905 | —Madagascar |
| <i>C. castor</i> Steinmann, 1988 | —New Guinea |
| <i>C. celer</i> Steinmann, 1984 | —Thailand |
| <i>C. concitata</i> Steinmann, 1988 | —Zimbabwe-Rhodesia |
| <i>C. dexter</i> Steinmann, 1984 | —Celebes |
| <i>C. distincta</i> Brindle, 1975 | —Tanzania |
| <i>C. discors</i> (Steinmann, 1985) | —Australia : Melbourne |
| <i>C. fallax</i> (Bormans, 1894) | —India, Myanmar, China (Yunnan),
Laos, Philippine Isls (Luzon) |
| <i>C. feae</i> Bormans, 1894 | —India, Sri Lanka, China (Yunnan),
Philippine Isls, Indonesia (Sumatra, Java,
Lombok & Borneo), Myanmar, Laos
and Vietnam |
| <i>C. ferox</i> Steinmann, 1984 | —Bali |
| <i>C. feuerborni</i> Günther, 1934 | —Bali, Lombok and Java |
| <i>C. foliata</i> (Burr, 1911) | —Sri Lanka and Buru Isl. |

- C. fulvescens* Hincks, 1953
C. fulvochracea Borelli, 1923
C. fuscata Brindle, 1972
C. f. clavata Brindle, 1972
C. f. yapensis Brindle, 1972
C. glaciata Steinmann, 1988
C. gardineri (Burr, 1910)
C. gnathonica Brindle 1970
C. hoogstraali Srivastava, 1978
C. huxleyi Brindle, 1970
C. inflecta (Steinmann, 1985)
C. inornata Karsch, 1886
C. javana Borelli, 1926
C. keiseri Brindle 1969
C. kivuensis Brindle, 1973
C. kurseongae Hebard, 1923
C. lakhanmandiensis Kapoor, Bharadwaj and Banerjee, 1971
C. laminata Burr, 1905
C. lanceolata Borelli, 1926
C. luxor Steinmann, 1988
C. malaisi Hincks, 1947
C. mendax Borelli, 1926
C. meridionalis Brindle, 1973
C. mindanaensis Borelli, 1926
C. minuta Borelli, 1921
C. mjöbergi Brindle, 1971

C. nigriceps (Kirby, 1891)

C. nigrītula Brindle, 1972
C. nossibiana Chopard, 1951
C. ochracea Brindle, 1966
C. paederina (Gerstaecker, 1883)

C. parva Brindle, 1970
C. parvula Burr, 1900
- Madagascar
 —Philippine Isls : Mindanao and Palawan
 —Micronesia : Caroline Isls
 —Micronesia : Marina Isl., Guam
 —Micronesia : Caroline Isls., Yap
 —Tanzania
 —Seychelles : Silhouette
 —Solomon Isls
 —Philippine Isls : Mindanao
 —Solomon Isls
 —New Guinea
 —Madagascar
 —Java
 —Madagascar
 —Rwanda : Lake Kivu
 —India (Darjeeling Dist.)

 —India (Himalaya)
 —Java and New Guinea
 —Philippine Isls
 —India
 —Myanmar
 —Myanmar
 —Rhodesia
 —Philippine Isls : Mindanao
 —Malaysia, Borneo and Philippine Isls
 —Australia (Queensland), Solomon Isls and Fiji
 —Papua New Guinea and Solomon Isls :
 Malaita and Choiseul ; Myanmar and Celebes
 —Micronesia : Palau Isls
 —Madagascar
 —Madagascar
 —Mainly West Central Africa from Portugese
 Guinea eastwards to the Zaire and
 extending to Tanzania
 —Solomon Isls
 —Borneo

- | | |
|---|---|
| <i>C. pauliani</i> Hincks, 1954 | —From Ivory Coast to Zaire |
| <i>C. pentagonalis</i> Brindle, 1976 | —New Caledonia |
| <i>C. pittarelli</i> Borelli, 1906 | —Madagascar and Natal |
| <i>C. ponapensis</i> Brindle, 1972 | —Caroline Isls : Ponape |
| <i>C. pygmaea</i> Mjöberg, 1924 | —Australia : Queensland |
| <i>C. quadrata</i> (Burr, 1902) | —Peilippine Isls, Java, Sumatra and
New Guinea |
| <i>C. ridens</i> (Bormans, 1894) | —Myanmar |
| <i>C. rodens</i> Burr, 1907 | —East Africa |
| <i>C. shillongensis</i> Srivastava 1982 | —India (N. E.) |
| <i>C. silvestrii</i> Borelli, 1927 | —Vietnam, Laos, Myanmar and
China : Yunnan |
| <i>C. stella</i> Burr, 1902 | —New Guinea ; Indonesia : Sumatra,
Celebes ; Malaysia and Philippine Isls. |
| <i>C. stilletta</i> Burr, 1911 | —India (South) |
| <i>C. styligera</i> (Burr, 1911) | —Vietnam |
| <i>C. sumatrana</i> Borelli, 1927 | —Sumatra |
| <i>C. thlenemanni</i> Günther | —Java |
| <i>C. thoracica</i> (Dohrn, 1867) | —Oriental Region, New Guinea and
Seychelles |
| <i>C. tibialis</i> Hincks, 1953 | —Madagascar |
| <i>C. torpeo</i> (Steinmann, 1989) | —South Australia |
| <i>C. triangulata</i> (Burr, 1904) | —Madagascar |
| <i>C. ugandana</i> Borelli, 1909 | —Congo Republic and Uganda |
| <i>C. vansomereni</i> Brindle, 1969 | —Tanzania |
| <i>C. villica</i> (Burr, 1911) | —South Africa |
| <i>C. volcana</i> Burr, 1904 | —Madagascar |

Circolabia Steinmann, 1987

- Circolabia* Steinmann, 1987. *Acta zool. hung.*, 33 : 178 (Type-species : *Labia arcuata* Scudder, 1876).
Spirolabia Steinmann, 1987. *Acta zool. hung.*, 33 : 179 (Type-species : *Labia pilicornis* Motschulsky, 1853)—Syn. n.
Paralabella Steinmann, 1990. *Das Tierreich*, 106 : 470 (Type-species : *Forficula annulata* Fabricius, 1793)—Syn. n.

- | | |
|--------------------------------------|----------------------------|
| <i>C. alpha</i> (Steinmann, 1987) | —Celebes |
| <i>C. annulata</i> (Fabricius, 1793) | —Central and South America |
| <i>C. arcuata</i> (Scudder, 1876) | —Central and South America |

- C. biolleyi* (Borelli, 1906)
C. bituberculata (Brindle, 1970)

C. borellii (Burr, 1908)
C. browni (Hincks, 1954)
C. chopardi (Hebard, 1920)
C. cicero Steinmann, 1989
C. conspicua (Borelli, 1906)
C. curvicauda (Motschulsky, 1863)
C. dorsalis (Burmeister, 1838)
C. dubronyi (Hebard, 1922)
C. emarginata (Srivastava, 1978)
C. flavoguttata (Shiraki, 1908)
C. forceps (Burr, 1904)
C. fruehstorferi (Burr, 1897)

C. fulleri (Ramamurthi, 1964)
C. heliconia (Brindle, 1985)
C. kernyi (Borelli, 1926)
C. kermadecensis (Giles, 1973)
C. legoci (Fernando, 1957)
C. maeklini (Dohrn, 1864)
C. malgacha (Brindle, 1966)
C. murrayi (Kirby, 1900)
 (= *Labia indistincta* Kirby, 1900)
 (= *Labia inserta* Kirby, 1900)
C. oraedivitis (Borelli, 1909)
C. pandleburyi (Borelli, 1932)
C. pillicornis (Motschulsky, 1863)
 (= *Labia rogenhoferi* Bormans in Burr, 1903)
 (= *Labia rehni* Hebard, 1917)
C. profana Steinmann, 1990
C. pyropi (Borelli, 1912)
C. reniformes (Srivastava, 1979)
C. rotundiformes (Hincks, 1954)
C. sicaria (Burr, 1902)
C. solitaria (Steinmann, 1987)
C. stigma (Dohrn, 1867)
C. sutteri (Hincks, 1954)
- Costa Rica
—Solomon Isls ; San Cristobal
 and New Hebrides
—Philippine Isls
—Seychelles
—Guyanas and Venezuela
—Costa Rica
—Costa Rica
—Worldwide
—Neotropical Region
—Hawaii and Sumba
—Philippine Isls : Calamine Group
—Taiwan
—Madagascar
—Philippine Isls, Java, Celebes, Lombok
 and New Guinea
—India (Darjeeling dist.)
—Ecuador
—Sumatra and Java
—Kermadec Isls
—Sri Lanka
—Brazil
—Madagascar
—Christmas Isls

—Costa Rica
—Malaysia : Pahang
—Worldwide

—Brazil
—Myanmar
—Borneo
—Sri Lanka
—New Guinea and Solomon Isls
—Fiji
—Colombia and Venezuela
—Sumba

- C. termitophila* (Brindle, 1970) —Solomon Isls. : Guadalcanal
C. testor (Steinmann, 1981) —New Hebrides : Raunon

Labia Leach, 1815

Labia Leach, 1815. *Edinburgh Encycl.*, 9 : 118 (Type-species : *Forficula minor* L., 1758).
Copiscelis Fieber, 1853. *Lotos, Prague*, 3 : 275 (Type-species : *Forficula minor* L., 1758).

- L. fanta* Steinmann, 1990 —Vietnam
L. harpya Steinmann, 1990 —Vietnam
L. minor (L., 1758) —Worldwide
L. phanduwalensis Kapoor, Bharadwaj
and Banerjee, 1971 —India
L. pluto Steinmann, 1990 —Philippine Isls : Luzon

Sphingolabis Bormans, 1883

- S. hawaliensis* (Bormans, 1882) —Philippine Isls to New Guinea ; New
Hebrides, Sandwich Isls and Hawaii
S. latro Steinmann, 1989 —Fiji
S. novaguineae Boeseman, 1954 —New Guinea
S. prolongata Hincks, 1954 —Myanmar
S. semifulva (Bormans, 1884) —Philippine Isls ; Indonesia,
Sumatra and Java
S. tuberosa Brindle, 1970 —Solomon Isls : Guadalcanal

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SUMMARY

An outline of the classification of higher taxa of Spongiphoridae is provided along with a list of species. A key for the discrimination of various subfamilies is presented. A new subfamily, *Rudraxinae* is erected for the reception of a new genus and species, *Rudrax brindlei* from China. It is proposed to synonymise *Paraspania* Steinmann under *Chaetospania* Karsch and *Spirolabia* Steinmann and *Paralabella* Steinmann under *Circolabia* Steinmann. *Chaetospania* is transferred under Labiinae.

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CONSPECTUS OF ODONATA FAUNA OF CALCUTTA, INDIA

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INTRODUCTION

The city of Calcutta was established by Job Charnock of British East India Company on August 24, 1690. The city is known by several names—City of Palaces, City of Joy, City of Museums, City of Nobel laureates of India. It remained the capital of British of India up to 1911. This is one of the highly urbanised area of the country with fourteen hundred kilometer metal roads ; metro rails ; aquatic transport system as well as modern sky scrappers. The municipal area has increased from 4600 acres in 1859 to 44,240 acres in 1989. The population, according to 1981 census was 9,194,018 and now it is estimated not less than ten millions excluding the regular commuters from other districts of West Bengal. The city has more than two hundred parks and tanks ; the Maidan lies on the Western fringe of the city. Pollution in the air and water varies from locality to locality, since there are factories for the manufacture of acids and other chemicals, plastic sheets and other articles, tanneries, Bitumen etc. in different parts of the city including its fringes.

LOCATION

Calcutta lies at latitude 22° 30' N. and longitude 88° 22' E. in the deltaic West Bengal. Its eastern fringe is guarded by the newly established township Bidhan Nagar, erstwhile a marshy swamp known as Salt Lake, the west is bounded by the river Hooghly.

METEOROLOGY

The climate is monsoon type. It receives an average annual rainfall about 1580 mm and the temperature varies from the average 22.1° C. minimum to the maximum 31.8° C.

Seasons :

Winter or cool season : The city has no real winter, though the period from December to February is called the cool season, when the mercury sometimes descends to 7° C. and the R. H. 24%. In January the cool and dry weather at its highest if there is no rain.

Summer : The very hot and dry season usually lasts from March to the first week of June, if there is no early rains. In the hot months the mercury ascends up to 117° F. (=46° C.).

Rains : The hot wet season is spread over the period from June to November. The north-east monsoon blows from the land, hence it brings little rains in the city. The early rains in dry hot season due to norwester or *kalbaisakhi* is also experienced in the city. In the early hot weather too, there is the season of cyclonic storms and tropical cyclones in the Bay of Bengal. These bring considerable amount of rainfall and often cause havoc. The south-west monsoon bursts over Calcutta in June and heavy rainfall is experienced in the season.

HISTORICAL REVIEW

Selys-Longchamps (1891) recorded two species from Calcutta. Later on Ris (1909 & 1910) added two more species and Laidlaw (1915, 1916 a, b, 1917, 1919 & 1922) reported nine species from the city. Fraser (1919 a, b, 1933, 1934 & 1936) recorded some species from the town. After the independence of India Lieftinck (1948), Raychaudhuri & Dasgupta (1949), Bhasin (1953), Dasgupta (1957), Mitra & Mukherjee (1967), Raychaudhuri et al. (1969), Lahiri et al. (1970), Lahiri & Mitra (1972), Mitra & Lahiri (1972), Mitra (1973, 1974 a, b, c, 1975), Mitra & Lahiri (1974 & 1975), Mitra et al. (1975), Lahiri & Mitra (1976), Mitra (1977), Mitra & Lahiri (1980), Peters (1981), Prasad & Ghosh (1982), Ram et al. (1982), Mitra (1983), Prasad et al. (1987), Mitra (1988 a, b) and Mitra (1990) successively contributed on the Odonata fauna of Calcutta.

SPECIES RECORDED

The present paper does not include the data on collections of species, since the present report includes collections deposited in the National Zoological Collections at

Zoological Survey of India, Calcutta, and informations available from the published works. The area under consideration includes Calcutta Municipal Corporation jurisdiction.

The city supports fiftyeight species of Odonata spread over thirty six genera, seven families and two suborders. The taxa have been arranged according to Fraser's (1957). *Reclassification*. Subfamilies have been avoided and other taxa viz. families, genera species have been arranged alphabetically. Names present in the Fauna of British India, Odonata, volumes 1-3 (1933, 1934, 1936) by Fraser have been cited in the synonym.

COENAGRIONIDAE

Agriocnemis lacteola Selys

Agriocnemis lacteola, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 381-383

The species is visible off and on, but not—very common species. It occurs on grass patches and on floating vegetation.

Agriocnemis nana (Laidlaw)

Agriocnemis nana, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 386-387

Mitra & Lahiri (1980) and Mitra (1983) reported it as *A. dabreui* Fraser. The species occurs in the wilder regions of Behala. The specimens show characters of both *Agriocnemis* and *Mortonagrion*.

Agriocnemis pieris Laidlaw

Agriocnemis pieris, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 384-385

Selys-Longchamps (1891) first recorded the species from the city. It is a common species, occurs everywhere, breeds throughout the year. Other dragonflies like *Ischnura senegalensis*. *Ceriagrion coromandelianum* feed on the species.

Cercion malayanum (Selys)

Enallagma malayanum, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 375-376

Lahiri & Mitra (1976) reported it from Calcutta. It occurs near ponds, sometimes rests on floating vegetation. 3 ♂ 4 ♀ were captured in 1966.

Ceriagrion cerinorubellum (Brauer)

Ceriagrion cerinorubellum, Fraser 1933, *Fauna Brit. India, Odon.* 1 : 326-328

The species was collected from the bushes near ponds and drains.

Ceriagrion coromandelianum (Fabricius)

Ceriagrion Coromandelianum, Fraser, 1933, *Fauna of Brit. India, Odon.* 1 : 315-316
Laidlaw (1916 b) recorded the species from the city. It is one of the commonest dragonflies of India. The species is visible on the roads, ponds, drains ; breeds during June to November.

Ceragrion olivaceum Laidlaw

Ceriagrion olivaceum, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 324-325
Locally very common in many parts of India (Fraser 1933). In Calcutta it is not as common as *C. coromandelianum*. It is visible on the grass patches bordering the aquatic regime and floating vegetation.

Enallagma parvum Selys

Enallagma parvum, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 376-378
It was first reported by Lahiri & Mitra (1976). It has similar habitat of *C. malayanum*.

Ischnura aurora aurora (Brauer)

Ischnura delicata, Fraser, 1983, *Fauna Brit. India, Odon.* 1 : 360-362
It is a common species, occurs throughout the year and everywhere ; breeds throughout the year.

Ischnura elegans (Van der Linden)

Ischnura elegans, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 351-354
It was first reported from Calcutta as well as from the Oriental region by Lahiri and Mitra (1976). It is a rare species.

Ischnura forcipata Morton

Ischnura forcipata, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 354-357
Rame et al. (1982) reported it from the city. It is not visible off and on.

Ischnura rufostigma rufostigma Selys

Ischnura rufostigma, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 362-364
This species was first reported by Laidlaw (1916 b). It is usually seen on grass patches bordering the water bodies.

Ischnura senegalensis (Rambur)

Ischnura senegalensis, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 348-351

Laidlaw (1916 b) reported it first from Calcutta. It is a very common species, occurring everywhere. It breeds during the whole year save February to middle of April.

Onychargia atrocyana Selys

Onychargia atrocyana, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 394-395

It occurs everywhere and away from water. Sometimes it enters houses.

Pseudagrion oustralasiae Selys

Pseudagrion bengalense, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 282-284

Laidlaw (1919) reported it from the town. It is visible near edges of the aquatic bodies.

Pseudagrion decorum (Rambur)

Pseudagrion decorum, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 286-289

The species was first recorded from Calcutta by Laidlaw (1916 a). It is visible off and on but not a very common species.

Pseudagrion malabaricum Fraser

Pseudagrion malabaricum, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 284-286

Lahiri & Mitra (1976) reported first from the city as well as from the gangetic alluvium.

Pseudagrion microcephalum (Rambur)

Pseudagrion microcephalum, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 278-280

Laidlaw (1915) recorded the species from Calcutta. It breeds during June to November ; sometimes follows passerby. It is a very common species.

Pseudagrion rubriceps rubriceps Selys

Pseudagrion rubriceps, Fraser, 1933, *Fauna of Brit. India, Odon.* 1 : 296-299

It is a very common species. It breeds during June to November and sometimes form tandem pairs with *F. microcephalum*.

LESTIDAE

Lestes Platystylus Rambur

Platylestes platystyla, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 59-62

A rare species. The only male specimen was collected in 1917 ; after that no specimen could be captured.

PLATYCNEMIDIDAE

Copera cillita (Selys)

Copera annulata, Fraser, 1933, *Fauna Brit. India, Odon.* 1 : 203-206

Laidlaw (1917) recorded the species first from Calcutta. It prefers to remain near bushes bordering the water sources.

Copera marginipes Rambur

Copera marginipes, Fraser, 1933, *Fauna Brit. India, Odon.* 192-197.

A male specimen was captured in a house in 1985. This is the first report of the species from Calcutta.

AESHNIDAE

Anaciaeschna jaspedia (Burmeister)

Anaciaeschna jaspedia, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 152-154

Ram et al. (1982) reported it first from the city.

Anax guttatus (Burmeister)

Anax guttatus, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 140-142

Ram et al. (1982) recorded it first from the city ; it is a rare species.

Anax imperator imperator Leach

Anax imperator, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 136-138

It was first reported by Mitra & Lahiri (1974) ; it is a migratory species.

Gynacantha bayadera Selys

Gynacantha bayadera, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 103-104

The present report is the first record of the species from Calcutta. Only a female specimen was collected in the night near electric lamp.

Gynacantha dravida Lieftinck

Gynacantha hyalina, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 97-100

Lahiri & Mitra (1972) reported the species first from Calcutta. The specimen was collected in the night near electric lamp.

Gynacantha rammohani Mitra and Lahiri

Gynacantha rammohani Mitra & Lahiri, 1975, *Ent. Rec. J. Var.* 87 : 148-149

The species is known by a female specimen only.

Gynacantha bainbriggei Fraser

Gynacantha bainbriggei Fraser, 1922, *Mem. Dept. Agric. India (Ent.)* 8 : 75 ; 1936, *Fauna Brit. India, Odon.* 3

Only one male example was collected on 14. VII. 1978. A new record from West Bengal.

Hemianax ephippiger (Burmeister)

Hemianax ephippiger, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 147-149.

It is the commonest aeshnid dragonfly of the city ; it is a migratory form, visible during the summer months.

CORDULIDAE

Epopthalmia vittata vittata Burmeister

Epopthalmia vittata, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 194-196

The only male specimen was collected from the Indian Museum in 1941 (Ram et al. 1982). After this no collection was available.

GOMPHIDAE

Ictinogomphus angulosus Selys

Ictinus angulosus, Fraser, 1934, *Fauna Brit. India, Odon.* 2 : 378-379

Laidlaw (1922) reported it from suburban area of Calcutta. After this Ram et al. (1982) reported it from Calcutta.

Ictinogomphus rapax (Rambur)

Ictinus rapax, Fraser, 1934, *Fauna Brit. India, Odon.* 2 : 373-376

Laidlaw (1922) recorded the species from Calcutta. It occurs near and away from water. Sometimes it follows running vehicles.

Macrogomphus montanus Selys

Macrogomphus montanus, Fraser, 1934, *Fauna Brit. India, Odon.* 2 : 345-346

Laidlaw (1922) reported for the first time from the city, after that no further record of capture is available.

LIBELLULIDAE

Acisoma panorpoides panorpoides Rambur

Acisoma panorpoides panorpoides, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 330-331

Occurs everywhere near and away from water.

Brachydiplax chalybea chalybea Brauer

Brachydiplax chalybea Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 328-329

A rare species.

Brachydiplax sobrina (Rambur)

Brachydiplax sobrina, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 325-327

First reported by Ris (1910), visible near water.

Brachythemis contaminata (Fabricius)

Brachythemis Contaminata, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 365—366

Very common species ; occurs everywhere, sometimes enter houses in the night. House gecko is one of its common enemy. It breeds during the rainy season.

Bradionpyga geminata (Rambur)

Bradionpyga geminata, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 349-350

It rests on tree trunks and stone walls or metallic roads, the colour of which merges with the cryptic body colour of the species.

Crocothemis erythrae erythrae Brulle

Crocothemis servilia erythrae, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 347
Peters (1981) reported the species from Calcutta. This is the first report from the city.

Crocothemis servilia servilia (Drury)

Crocothemis servilia servilia, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 345-347
A common species, visits everywhere, breeds during June to November. Lahiri et al. (1970) reported the species as *Crocothemis indica* Shani.

Diplacodes nebulosa (Fabricius)

Diplacodes trivialis, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 335-336
Prefers to remain grass patches on the border of ponds.

Diplacodes trivialis (Rambur)

Diplacodes trivialis, Fraser 1936, *Fauna Brit. India, Odon.* 3 : 336-338
A common species, visible everywhere. During summer months it remains in 'obelisk' position to avoid sun rays.

Lathrecista asiatica asiatica (Fabricius)

Lathrecista asiatica asiatica, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 281-284
This is a common species, visible everywhere, sometimes rest on overhead wires.

Neurothemis tullia tullia (Drury)

Neurothemis tullia tullia, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 360-362
Fraser (1919 a) first reported the species from the city. The species is visible off and on and everywhere.

***Orthetrum glaucum* (Brauer)**

Orthetrum glaucum, Fraser, 1936, *Fauna Brit. India*, *Odon.* 3 : 307-309

It is a rare species in the city.

***Orthetrum sabina sabina* (Drury)**

Orthetrum sabina, Fraser, 1936, *Fauna Brit. India*, *Odon.* 3 : 300-302

Ris (1909) first reported from Calcutta, a common species. It breeds during the cool season. Sometimes feed on *Ceriatgrion coromandelianum* (Fabr.).

***Orthetrum triangulare triangulare* Selys**

Orthetrum triangulare triangulare, Fraser, 1936, *Fauna Brit. India*, *Odon.* 3 : 305-307

It is a rare species in the city.

***Pantala flavescens* (Fabricius)**

Pantala flavescens, Fraser, 1936, *Fauna Brit. India*, *Odon.* 3 : 414-416

Migratory species, migration is visible during September-October.

***Potamarcha congener* (Rambur)**

Potamarcha obscura, Fraser, 1936, *Fauna Brit. India*, *Odon.* 3 : 289-291

Ram et al. (1982) recorded it from Calcutta. It occurs near aquatic body and bushes.

***Rhyothemis variegata variegata* (Linne)**

Rhyothemis variegata variegata Fraser, 1936, *Fauna Brit. India*, *Odon.* 3 : 423-424

First reported by Fraser (1919 b) from the city. Fly in swarms over open space, sometimes reaches three to four metres above the ground.

***Sympetrum hypomelas* (Selys)**

Sympetrum hypomelas, Fraser, 1936, *Fauna Brit. India*, *Odon.* 3 : 373-374,

Ram et al. (1982) reported it from the town, it is a rare species.

***Tholymis tillarga* (Fabricius)**

Tholymis tillarga, Fraser, 1936, *Fauna Brit. India*, *Odon.* 3 : 411-413

It is a common species, occurs everywhere. It breeds during the monsoon.

Tramea basilaris burmeisteri Kirby

Tramea basilaris burmeisteri, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 432-434
A rare species in the city.

Trithemis aurora (Burmeister)

Trithemis aurora, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 383-385
Ram et al. (1982) recorded it from the city.

Zyxomma petiolatum Rambur

Zyxomma petiolatum, Fraser, 1936 *Fauna Brit. India, Odon.* 3 : 407
Visible during the rainy season, sometimes enter houses.

MACRODIPLACTIDAE

Aethriamanta brevipennis brevipennis (Rambur)

Aethriamanta brevipennis brevipennis, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 445-447

A rare species occurs in the gardens and open spaces. Selys-Longchamps (1891) reported it first from the city.

Macrodiplax cora (Brauer)

Macrodiplax cora, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 448-450

One example of each sex was captured in 1967. After that no example has yet been captured from the city. It is often visible in the suburban areas. It is a migratory species.

Urothemis signata signata (Rambur)

Urothemis signata signata, Fraser, 1936, *Fauna Brit. India, Odon.* 3 : 442-444

It is the commonest macrodiplactid dragonfly ; it occurs everywhere some times enters houses, breeds during the monsoon and post-monsoon period.

DISCUSSION

The city supports fiftyeight species and subspecies. Among them *Agriocnemis nana* (Laidlaw), *A. pieris* Laidlaw, *Cercion malayanum* Selys, *Enallagma parvum* Selys, *Ischnura elegans* (V. d. Linden), *I. forcipata* Mortan, *Pseudagrion malabaricum* Fraser, *Anaciaeschna jaspedia* (Burmeister) *Anax guttatus* (Burmeister), *A. imperator* Leach, *Orthetrum glaucum* (Brauer) and *Macrodiplax cora*. (Brauer) are rare species in the city. It is presumed that those species reached the town accidentally either being borne by the air currents or due to their migratory habit, since none of them could be collected after the first report of their occurrence in the city.

Three species viz. *Platylestes platystyla* (Rambur), *Epophthalmia vittata* Burmeister and *Macrogomphus montanus* Selys were captured before fifty years and more and no further record is available from the city. Mitra (1990), reported *Agriocnemis pygmaea* (Rambur), *Ceriagrion coromandellianum* (Fabr.), *Ischnura senegalensis* (Ramb.), *Brachythemis contaminata* (Fabr.) *Diplacodes trivialis* (Rambur), *Crocothemis servilia* (Dr.) and *Trithemis pallidinervis* Kerby as common species.

SUMMARY

E. De. Selys-Longchamps reported two species of dragonflies from Calcutta in 1891. The present paper reports fiftyeight species of Odonata spread over thirtysix genera and seven families viz. Coenagrionidae, Lestidae, Platynemididae, Aeshnidae, Gomphidae, Libellulidae and Macrodiplactidae recorded during the last one hundred years from the city of Calcutta.

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