

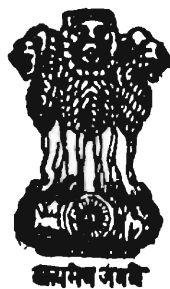
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ADDITIONS TO THE COPEPODS PARASITIC ON THE MARINE
FISHES OF INDIA

2. *KABATAELLA INDICA* GEN. ET SP. NOV. (CALIGOIDA)

By

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(With 12 Text-figures)

INTRODUCTION

During a faunistic survey of the caligid copepods parasitic on fishes inhabiting the coastal waters of Kerala, the first author collected from the nasal fossae of *Pomadasys maculatus* (Bloch) three females of a remarkable caligid. The morphology of this copepod is such that it cannot be placed in any of the known genera. We, therefore, create a new genus under the sub-family Lepeophtherinae. The genus is named after Dr. Z. Kabata as a tribute to his magnificent work on parasitic copepods.

TAXONOMIC ACCOUNT

Kabataella indica gen. et sp. nov.

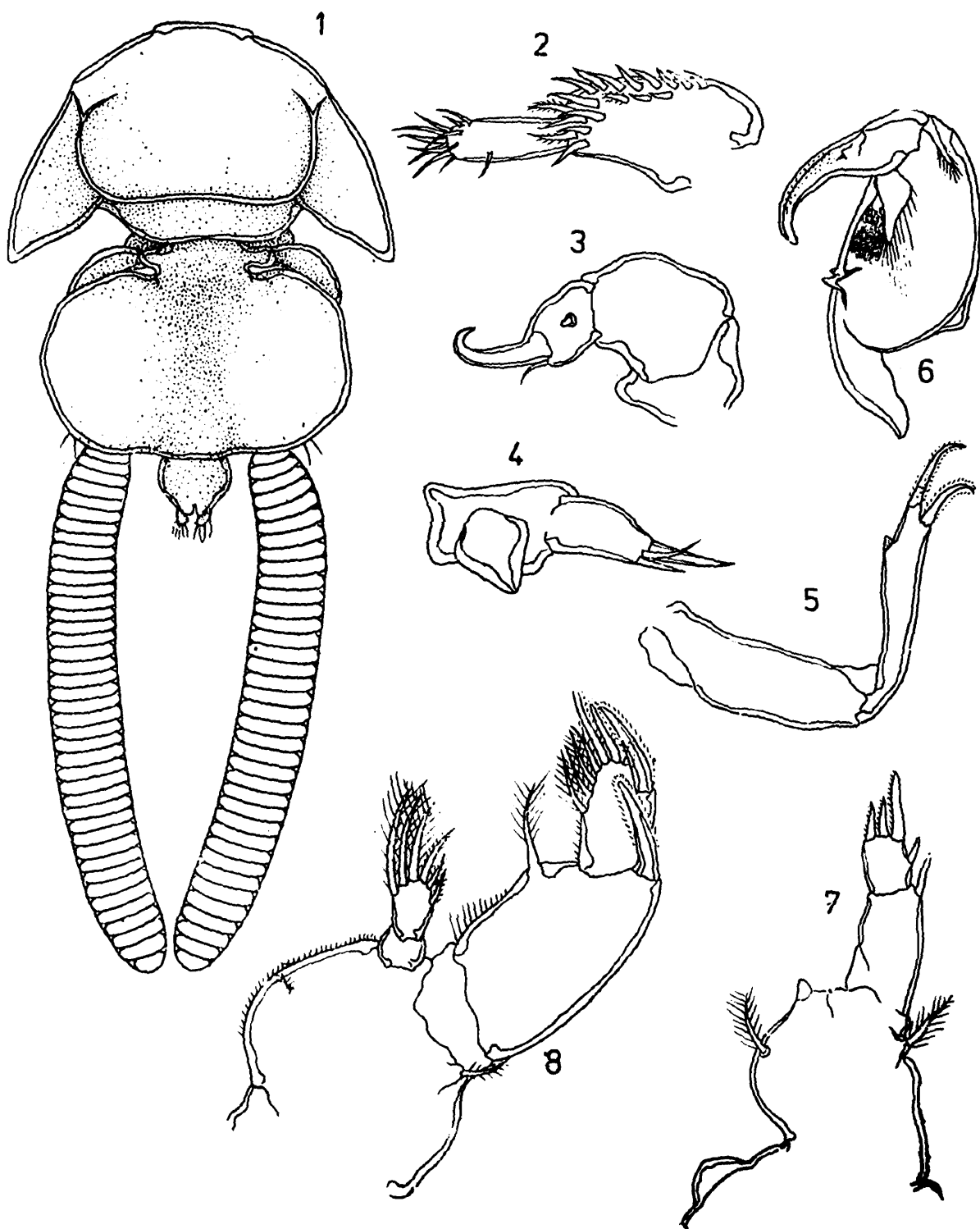
(Text-figs. 1-12)

Holotype.—Female, Reg. No. C 2902/2 Zoological Survey of India, Calcutta ; Loc. : Trivandrum, Kerala ; host : *Pomadasys maculatus* ; nasal fossae ; coll. C. Prabha.

Paratype.—Female kept in the Department of Aquatic Biology and Fisheries. Other details same as for holotype.

Female. —Body demarcated into a large, roughly semicircular cephalothorax and an equally large, transversely oblong genital segment, the two connected by a fairly large fourth thoracic segment. The dorsal chitinous covering of the body comparatively hard. Cephalothorax semicircular, with irregular outline, anteriorly convex and posteriorly concave. Frontal plates absent, their position indicated by a slight expansion. Dorsal longitudinal and transverse ribs together forming a semicircular ridge shifted backwards and almost contacting the posterior sinuses. Hind border of cephalothorax trilobed, lateral lobes forming

large triangular wings directed outwards making the posterior sinuses shallow and wide open. Median lobe about twice as broad as lateral lobes and not reaching beyond them, slightly overlapping the fourth thoracic segment. Membranous flange absent from any part of the cephalothorax and its appendages. Fourth thoracic segment well developed, much broader than long and partially fused to the genital segment, produced as rounded lobes overlapping the bases of the fourth

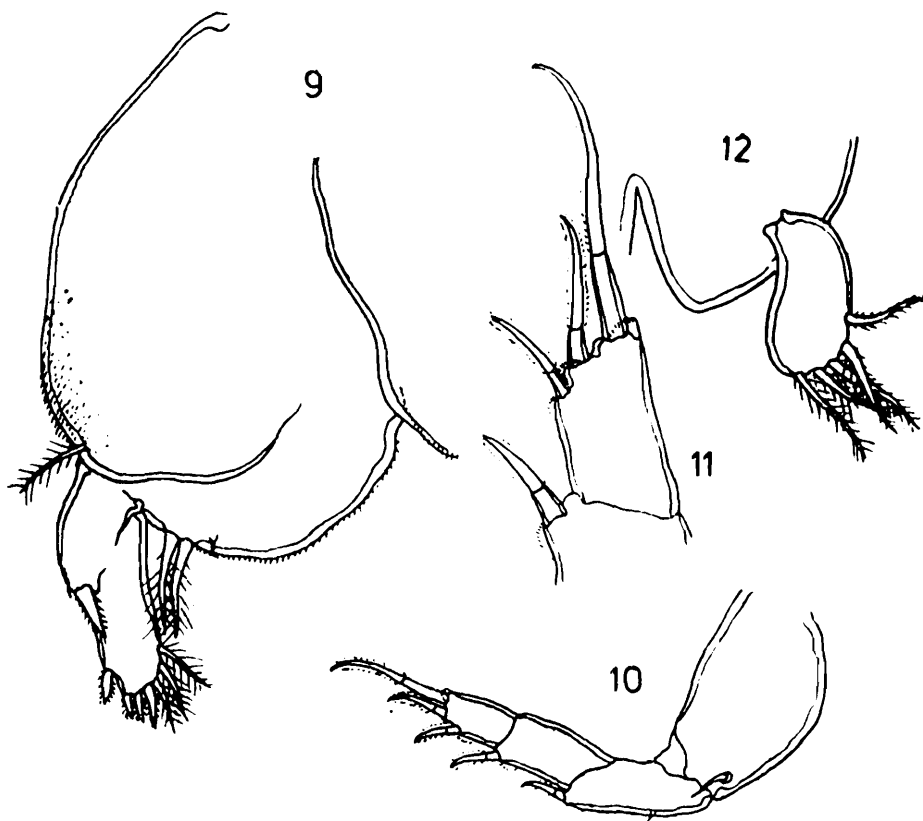


Text-figs. 1-8. *Kabataella indica* gen. et sp. nov.

1. female, dorsal view ; 2. antennule ; 3. antenna ;
4. post-oral process and maxillule ; 5. maxilla ;
6. maxilliped ; 7. leg. 1 ; 8. leg 2.

legs. Genital segment transversely oblong and only slightly narrower than cephalothorax, postero-medially slightly protruding and overlapping the abdomen. Abdomen one-jointed, narrowing distally and cleft behind. Caudal rami submarginal, ventral, well developed and curving inwards, each with one small and four large setae. Egg tubes stout and longer than the body.

Antennule attached to ventral side of cephalothorax, short but stout, basal segment with short stout setae, distal segment stout and cylindrical. Basal segment of antenna without the customary proximal process, second segment as long as broad, third segment proximally stout and with a blunt process and a seta, beyond the insertion of the seta the segment suddenly narrowed and curved apically. Post-antennal process absent. Post-oral process a small triangular chitinised projection.



Text-figs. 9-12. *Kabataella indica* gen. et sp. nov.

9. leg 3 ; 10. leg 4 ; 11. same, tip enlarged ;
12. caudal ramus.

Maxillule with large base, one of the setae very stout. Maxilla small, segments subequal in length, outer flange on distal segment very small, apical claws subsimilar. Maxillipeds very stout, basal segment with proximal inner bifid process, distal segment stout and strongly falcate, with a small sharp spine. Sternal fork absent.

First leg very poorly chitinised. Basipod fairly broad, with dorsal and ventral plumose setae and a small conical vestigial endopod. Exo-

pod indistinctly two-jointed, basal segment with a large upper distal spine, second segment with a dorsal spine (absent from opposite member) and three distal spines pectinate on the lower margin, spine-like seta and ventral setae absent.

Second leg stout and well chitinised, much different from the basic pattern found in caligids. Basipod with upper and lower small setae and ventral marginal row of spinules. Endopod small and two-jointed, distal segment with six plumose setae. Exopod two-jointed, basal segment stout, with large winged upper distal process, ventral border proximally spinulose and with a distal plumose seta (both absent from opposite leg), distal exopod segment with a large winged claw, a small naked spine, two modified setae and four small plumose setae.

Apron of third leg reduced in size, a trilobed lamina without membranous flange. Exopod indistinctly two-jointed, without the usual basal claw, first segment with outer distal spine, second with four small pectinate spines and three plumose setae. Endopod represented by a plumose seta on one side and two similar setae on the other. Apron armed with marginal spinules and a plumose seta above the place of insertion of the exopod.

Fourth leg normal, four-jointed, basal segment short but broad, second and third segments with one each and fourth with three claws, all the claws jointed and with pectinate flange, last claw twice as long as the penultimate. Fifth and sixth legs represented by one seta each.

Length. —5.2 mm.

Genus **Kabataella** gen. nov.

Diagnosis. —Cephalothorax semilunar, with large wing-like postero-lateral lobes; frontal plates and membranous flange absent. Fourth thoracic segment normally developed. Genital segment enlarged. Abdomen small, one-jointed. Caudal rami normally developed. Antennules attached to ventral side of cephalothorax. Antennae without basal process. Post-antennal process absent. Post-oral process much reduced. Maxillule with stout base, one of the three setae very stout. Maxilla small. Maxilliped stout. Sternal fork absent. Exopod of first leg reduced in size, distal segment without ventral setae. Second leg with two-jointed rami, endopod very small. Apron of third leg reduced in size, without membranous flange, exopod two-jointed, without basal claw, endopod reduced to one or two setae. Fourth leg normal, four-jointed.

Male unknown.

Type species. —*Kabataella indica* gen. et. sp. nov.

Discussion. —*Kabataella* is very distinctly different from all the other caligid genera. There is, however, no doubt that it is closest to *Lepeophtheirus* and must be included in subfamily Lepeophtherinae.

The nasal fossae of fishes have been known to be infested by cyclopoid copepods but the present appears to be the first record of a caligid doing so. The interesting morphological peculiarities appear to have evolved as a direct result of the natural protection the animal obtained inside the nasal fossae. In caligids the cephalothorax is the main attachment organ. For firm attachment the frontal plates and lateral borders of the cephalothorax and the apron of the third legs are provided with membranous flange. In *Kabataella* the cephalothorax is virtually open and cannot act as a sucker. Hence the frontal plates have disappeared and the membranous flange on the cephalothorax and the apron also got suppressed. The third legs themselves have got reduced in size.

Among caligids the second pair of legs is the most conservative. But in *Kabataella* this leg also underwent considerable reduction making it resemble the typical first leg of a caligid. *Kabataella* shows how a change in the site of infestation can alter the morphology of a parasite.

ADDITIONS TO THE COPEPODS PARASITIC ON THE
MARINE FISHES OF INDIA

3. THREE SPECIES OF *SHIINOA* (CYCLOPOIDA)

By

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(With 63 Text-figures)

INTRODUCTION

Kabata (1968) created the genus *Shiinoa* to describe a copepod collected from the gill filaments of *Scomberomorus commersoni* (Lacépède) in the Queensland waters. Subsequently Cressey (1975) described *S. inauris* from the nasal lamellae of *Scomberomorus regalis* (Bloch) and *S. maculatus* (Mitchill) in the Atlantic. Cressey also collected both sexes of the type species, *S. oclusa*, from the nasal lamellae of *Grammatocycnus bicarinatus* (Quoy and Gaimard) in the Arabian sea. The third species, *S. elagata* Cressey (1976) was collected from the nasal lamellae of *Elagatus bipinnulatus* (Quoy and Gaimard) from the Indo-Pacific.

During a survey of the copepods parasitic on the fishes of the coastal waters of Kerala the second author collected *S. oclusa* Kabata, *S. elagata* Cressey and a new species to which we give the name *S. rostrata*. Our collection includes both sexes of all the three species. We give below detailed descriptions of all the species, a revised definition of the genus and an artificial key for the identification of the four known species.

TAXONOMIC ACCOUNT

Genus *Shiinoa* Kabata

1968. *Shiinoa* Kabata, *J. Nat. Hist.*, 2 : 497.

1975. *Shiinoa* : Cressey, *Crustaceana*, 28 : 211.

Diagnosis : Body narrow and subcylindrical or broad and dorso-ventrally flattened, with indistinct segmentation. A cephalothoracic, three thoracic and three abdominal segments indicated by constrictions or septa. Cephalothorax drawn out into a rostrum carrying the antennules and antennae and a posterior enlarged portion carrying

the oral appendages and the first one or two pairs of legs, the two portions connected by a narrow neck. First thoracic segment carrying the third pair of legs, second without appendages but often produced into a pair of postero-lateral lobes. Genital segment small. Abdomen long or short, three-jointed. Caudal rami well developed, often with spine-like setae. Egg tubes cylindrical, eggs multiseriate.

Antennules and antennae far removed from the oral appendages. Antennules fully segmented and setose. Antennae parallel to each other, curved beneath the rostrum providing an attachment organ, two- to three-jointed. Labrum prominent and projecting. Mandible with long bilaterally dentate blade and accessory blade. Maxillule with three spines. Maxilla with bilaterally dentate distal segment carrying two spine-like setae. Legs three pairs, placed just behind the oral appendages or the third pair shifted backwards. First and second pairs biramous, rami two- or three-segmented. Third leg uniramous, with two-jointed protopod and one-jointed ramus.

Male much smaller than female, free or attached to female. Body varying in shape, clearly segmented. Cephalothoracic segment with indistinct partition, thoracic segments, excluding the genital segment five, genital segment not enlarged, abdomen two- to five-jointed.

Antennae modified into strong prehensile organs, third segment with two to four strong claws. Legs generally as in female but exopod of second usually large, terminating in long stout claws.

Type species : *S. occlusa* Kabata.

Parasitic on the nasal lamellae of teleosts.

Discussion : *Shiinoa* now contains four species falling into two distinct groups. The first group which includes *S. occlusa* and *S. inauris* has long slender body with a pair of conical postero-lateral trunk processes. In the second group which includes *S. elagata* and *S. rostrata* the body is broad and dorso-ventrally flattened and the trunk has only rounded posterolateral lobes. Judging from the available information species belonging to the first group are parasites of scomberid fishes and those of the second of other teleosts. All except the type specimen of *S. occlusa* have been collected from the nasal fossae to teleosts. As observed by Cressey (1975) the occurrence of Kabata's specimen on the gill filaments is accidental.

There have been some comments on the affinity of the family Shiinoidae. Kabata observed that *Shiinoa* should be placed in the family Chondracanthidae. This suggestion was prompted by the close similarity of the oral appendages. The mode of attachment of the

male, at least in *S. rostrata*, reminds one of the chondracanthids. Ho (1971) suggested that *Shiinoa* should be placed in a new family. Acting on this suggestion Cressey (1975) created the family Shiinoidae and observed that shiinoids are closely related to ergasilids. Cressey also suggested a possible affinity between Shiinoidae and Philichthyidae. Copepods inhabiting unusual locations like the eye ball or nasal fossae generally show such peculiar morphology that their true affinity is often difficult to detect. We are describing elsewhere a caligid copepod collected from the nasal fossae of *Pomadasys maculatus* (Bloch). This copepod though a true caligid is totally different from all the other caligids in external morphology illustrating how the site and mode of attachment can bring about profound adaptive modifications.

Key to Species of Shiinoa

FEMALE

1.	Body narrow and cylindrical. ...	...	2
	Body broad and dorso-ventrally flattened. ...	...	3
2.	Abdomen longer than pregenital segment, exopod of legs one and two two-jointed. ...	<i>inauris</i> Cressey	
	Abdomen shorter than pregenital segment, exopod of legs one and two three-jointed. ...	<i>occlusa</i> Kabata	
3.	Rostral process narrowing forwards, rami of legs one and two three-jointed. ...	<i>elagata</i> Cressey	
	Rostral process broadening forwards, rami of legs one and two two-jointed. ...	<i>rostrata</i> sp. nov.	

MALE

1.	Post-cephalothoracic part of body regularly narrowing backwards, antennule with first two segments produced into stout processes, antenna with four apical claws. ...	<i>elagata</i> Cressey	
	Post-cephalothoracic part of body not regularly narrowing backwards, first two segments of antennule not produced into processes, antenna with less than four apical claws. ...	...	2
2.	Basal segment of antenna with blunt processes, distal with two claws, legs with two-jointed rami. ...	<i>rostrata</i> sp. nov.	
	Basal segment of antenna without blunt processes, distal with three claws, legs with three-jointed rami. ...	...	3
3.	Antenna with a bifid apical claw, legs with two-jointed rami. ...	<i>inauris</i> Cressey	
	Antenna with three apical claws, legs with three-jointed rami. ...	<i>occlusa</i> Kabata	

Shiinoa occlusa Kabata

(Text-figs. 1-21)

1968. *Shiinoa occlusa* Kabata, *J. Nat. Hist.*, **2** : 497, Figs. 1-2.1975. *Shiinoa occlusa* : Cressey, *Crustaceana*, **28** : 216. Figs. 16-20.

Material : One female and one male from the nasal fossa of *Acanthocybium solandri* (Cuvier) examined at Trivandrum.

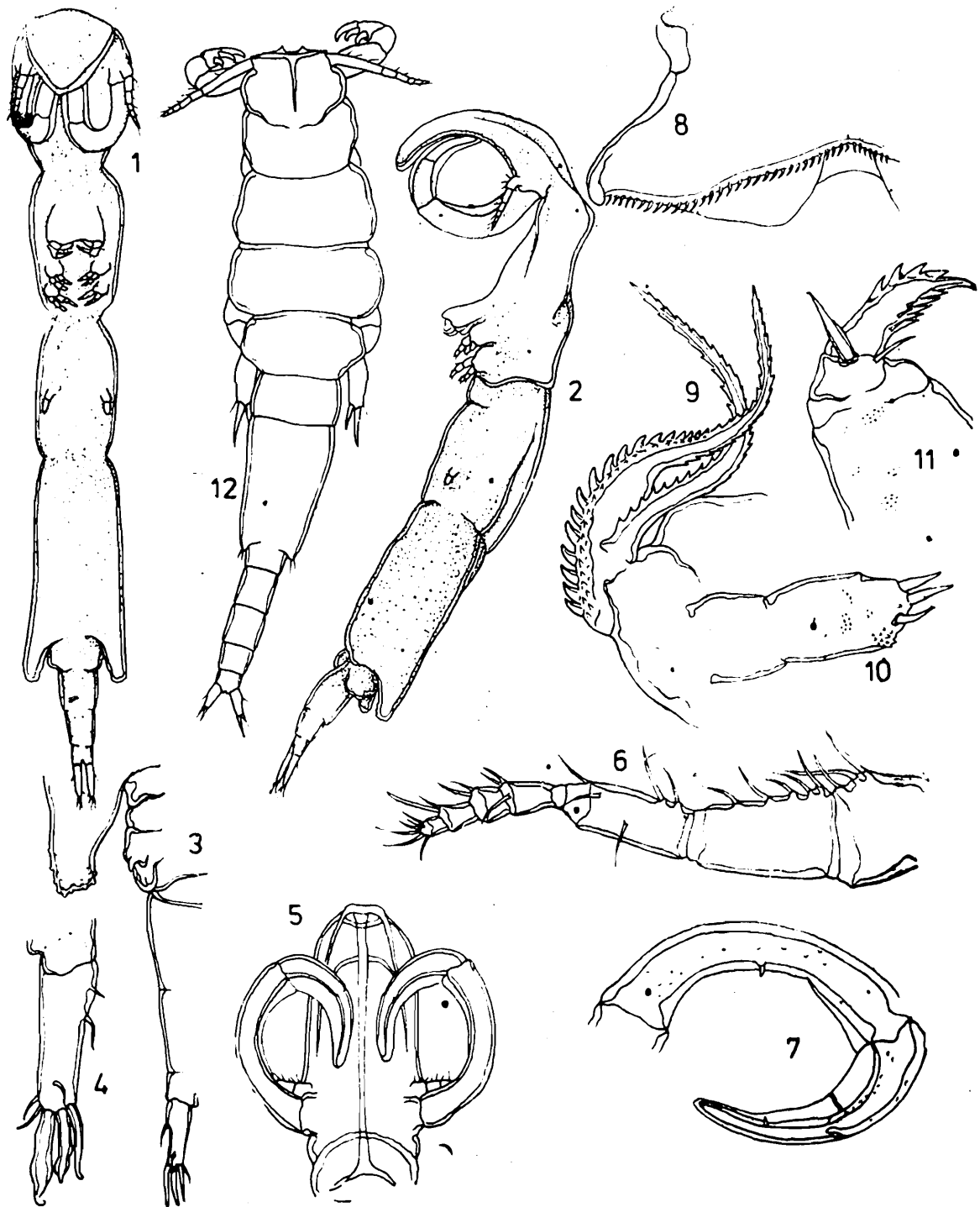
Female : Body long and slender, with indistinct segmentation ; segments indicated by lateral constrictions. Cephalothoracic segment demarcated by a deep constriction into an anterior broad and posterior narrow part, former produced forwards into a rostrum carrying the antennules and antennae on its base and the latter carrying the oral appendages and the first two pairs of legs. Rostrum antero-medially slightly produced and strengthened by chitinous ridges as shown in the figure. First thoracic segment shorter and narrower than the adjacent segments, carrying the third pair of legs. Second segment long and gradually widening backwards and postero-laterally produced into conical lobes, their tips roughened by small pustules. Third or genital segment rounded and immersed in the previous segment. Abdomen comparatively short and three-segmented, narrowing backwards. Caudal rami as long as the first abdominal segment, with two outer, two inner and one ventral setae and three stout distal processes.

Antennule seven-jointed and fairly well setose, first three segments stout, sixth segment with an aesthete. Antenna apparently two-jointed but the distal segment with indication of a division, basal segment with median inner process, distal segment with broad hyaline covering. Labrum as described by Kabata but the hyaline lobes larger. Mandible, maxillule and maxilla as described by Kabata but the maxillule with a prominent constriction.

First two segments of endopod of first leg externally expanded, second segment with one outer distal spine and third with three inner setae and two distal spines. Exopod narrower than endopod, first two segments with one spine each, third with three inner setae and three distal spines. Second leg slightly larger than first, third segment of endopod comparatively broader and with four distal spines. Basal segment of exopod with three inner spinules and outer distal spine, third segment with two inner spinules and three distal spine. Basipod of third leg indistinctly two-jointed and with a long seta, ramus with two pectinate spines and a long seta.

Length : 4.6 mm

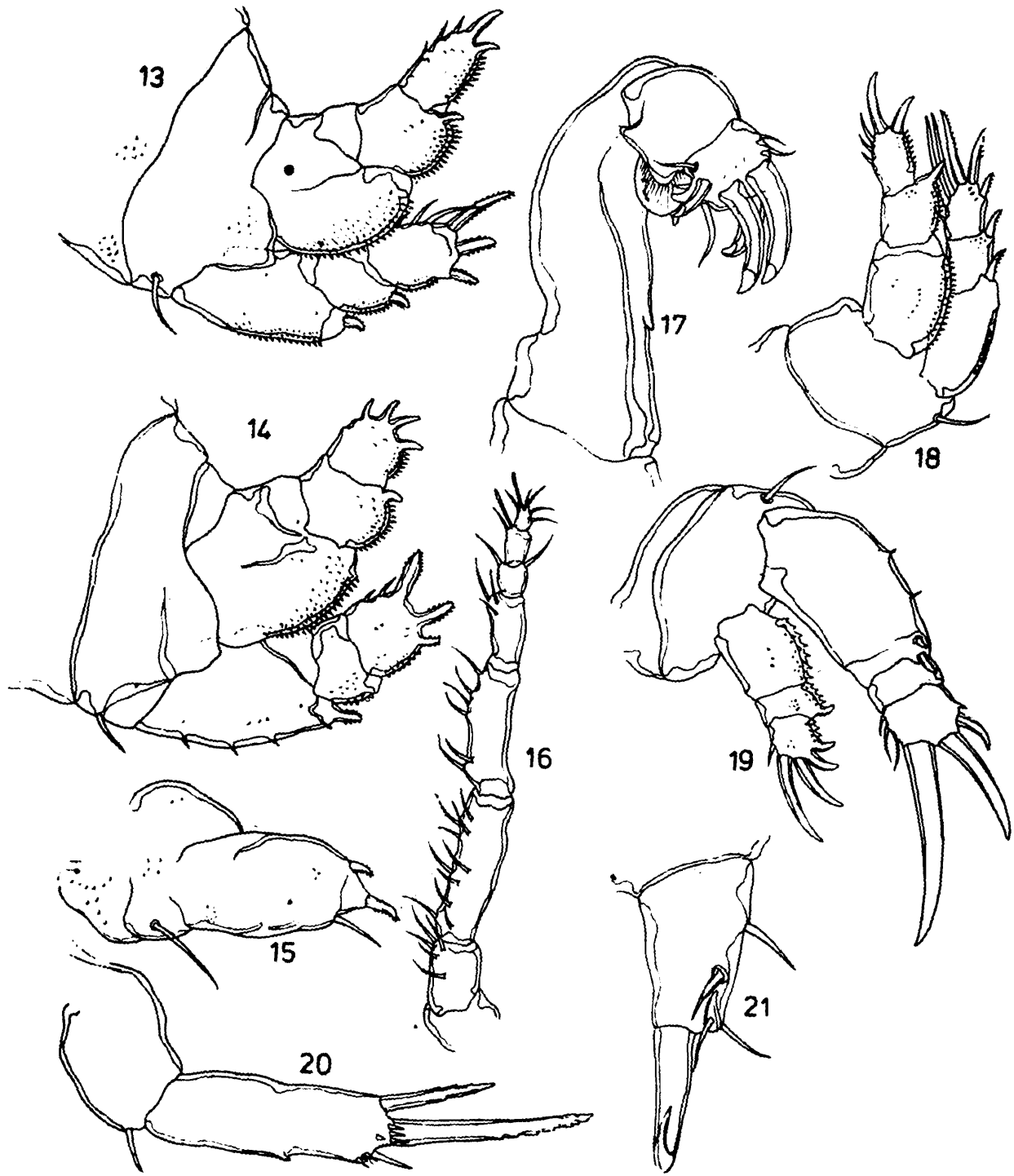
Male: The pregenital part of the body clearly broader than the post-genital, subequal in length. Cephalic segment longer than broad, its anterior border subtruncate, with a pair of conical processes, lateral borders with a constriction and transverse grooves dividing the segment into two parts. Trunk segments one and two subequal in size, third segment smaller. Fourth segment as broad as genital segment and demarcated from the latter by a partition. Genital segment one and a half



Text-figs. 1-12. *Shiinoa occlusa* Kabata.

1. Female, ventral view ; 2. same, lateral view ; 3. hind end of body, dorsal view ; 4. caudal ramus ; 5. rostral prolongation, ventral view ; 6. antennule ; 7. antenna ; 8. labrum ; 9. mandible ; 10. maxillule ; 11. maxilla ; 12. male, dorsal view.

times as long as broad, narrowing backwards. Abdomen five-jointed, first segment telescoped into the genital segment, fifth small. Caudal rami stout, with four elements, two setiform, one spine-like and the fourth a claw carrying a seta.



Text-figs. 13-21. *Shiinoa occlusa* Kabata.

13-15. female; 16-21. male; 13. leg 1; 14. leg 2; 15. leg 3;
16. antennule; 17. antenna; 18. leg 1; 19. leg 2; 20. leg 3;
21. caudal ramus.

Antennule seven-jointed and fairly well setose, segments two and three long, last two segments with aesthetes. Antenna stout and prehensile, basal segment with median inner projection, second segment

internally produced into a large semicircular lobe and a short blunt claw, third segment with two inner claws and two setae, its outer border with two setae and the distal with three stout claws. Oral appendages generally as in the female.

First leg with three-jointed subsimilar rami, much different from the corresponding leg of the female. Second leg with dissimilar rami, very much different from that of female, exopod much longer than endopod and the inner and middle claws on the third segment very stout. Third leg with long parallel sided ramus carrying on its distal border a short spine and two long sparsely dentate processes very much different from that of the female.

Length : 3.0 mm.

Remarks : The original description of this species by Kabata was based on a single female. Cressey who collected both sexes described the male but not the female observing that the female has been well described by Kabata. Kabata had to study the appendages *in situ* and hence his description differs from ours in some details. The antennule is seven and not six-jointed. The antenna is three and not two-jointed. The postero-lateral processes on the last thoracic segment are tubercular and the abdomen shows segmentation though indistinctly.

The male described here shows difference from those of Cressey. On the basal segment of the antenna Cressey has illustrated a small spine and a moderately large lobe carrying a spine. Instead of the median-spine our specimen has a low lobe and the distal lobe is a large semicircular flattened expansion originating on the second segment and not the first.

Shiinoa elagata Cressey

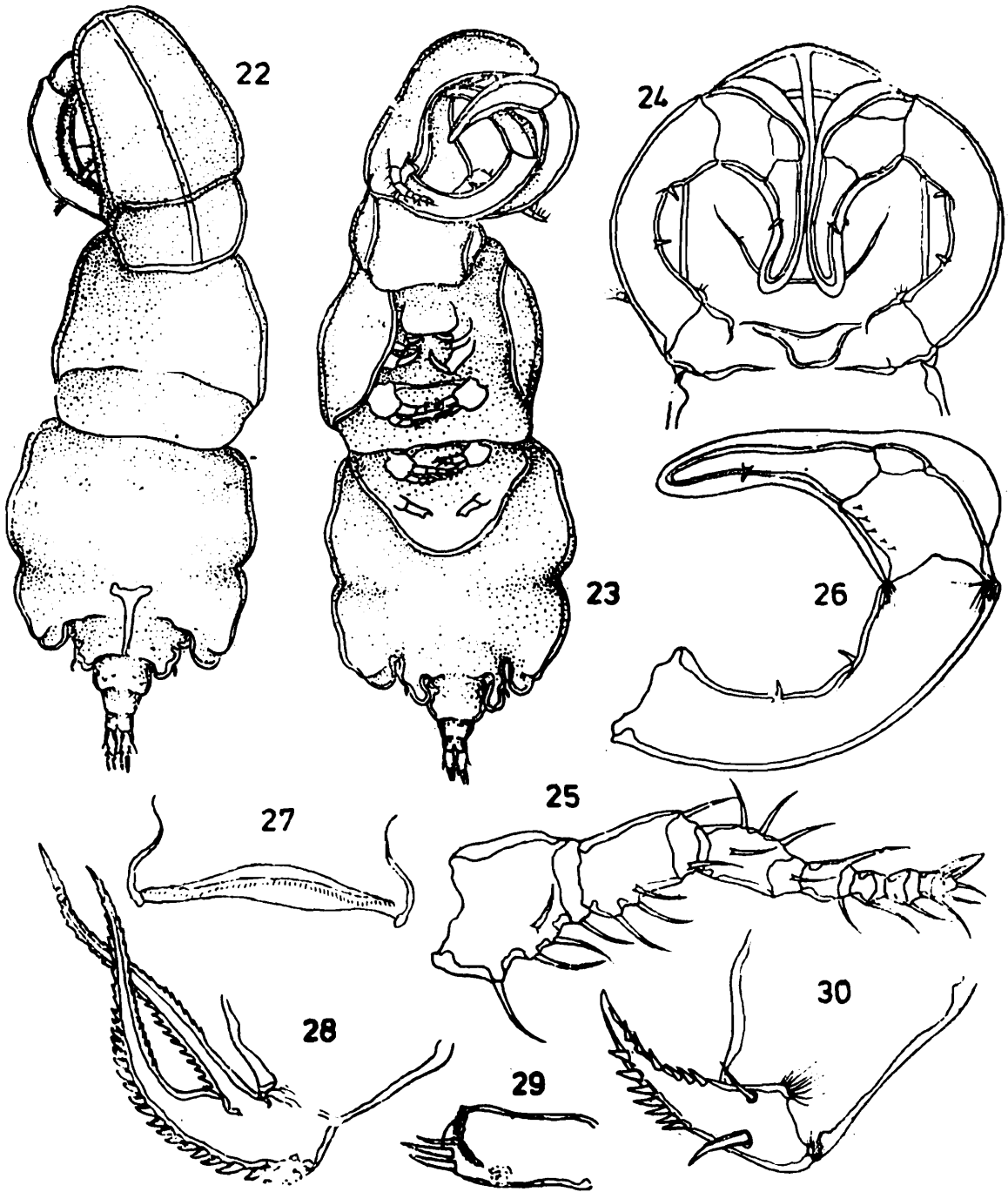
(Text-figs. 22-43)

1976. *Shiinoa elagata* Cressey, *Proc. biol. Soc. Wash.*, 88 : 438, Figs. 1-12.

Material : Seven females from the nasal fossae of *Parastromateus niger* (Bloch), four females and one male from the nasal fossae of *Seriolichthys bipinnulatus* Bleeker and one female and two males from the nasal fossae of *Platax orbicularis* (Forsk.) all collected at Trivandrum.

Female : Body comparatively broad and dorso-ventrally flattened, distinctly segmented. Lateral parts of thoracic segments folded downwards. Cephalothorax composed of three distinct parts, rostral prolongation, segment proper and a short neck segment connecting these two. Rostrum nearly parallel sided or slightly narrowing forwards,

its anterior border evenly rounded ; dorso-median part with a strong chitinated rib. First thoracic segment interpolated between the cephalothorax and the second trunk segment, dorsally visible as a small constriction and an incomplete groove and ventrally as an arcuate groove.



Text-figs. 22-30. *Shiinoa elagata* Cressey.

22. female. dorsal view ; 23. same, ventral view ; 24. rostral process, ventral view ; 25. antennule ; 26. antenna ; 27. labrum ; 28. mandible ; 29. maxillule ; 30. maxilla.

Second thoracic segment large, nearly equal in length and width, postero-laterally expanded into rounded lobes. Genital segment immersed in the previous segment, twice as broad as long, with a pair of chitinated processes carrying a small seta ; dorsal side with a median rib. Abdomen three-jointed and short, first segment comparatively

large, with two pairs of dorsal tubercles, second and third segments small. Caudal rami large, each with three slender and two stout setae.

Antennule seven-segmented, segmentation somewhat obscured, first three segments comparatively long, others short. Antenna clearly three-segmented, first segment with two sharp inner processes, second short, with a row of tubercles carrying a spinule, third segment with an inner process, second and third segments with hyaline covering. Lateral parts of the free border of labrum produced, distal border concave and fringed with a row of spinules, with hyaline flap projecting beyond the border. Mandible very much like that of *S. occlusa* but the submarginal row of teeth very few, both blades comparatively stouter and shorter. Maxillule with a seta and two spines and a transverse arc of small teeth ending in a patch of spinules. Maxilla with the two customary spines, ventral border of the claw with seven and dorsal with six sharp teeth.

First and second legs with three-jointed rami. Basal segment of endopod with inner distal seta, second segment, with a strong outer distal claw, third segment with three inner setae and two distal claws. Basal segment of exopod with outer claw, second segment with an outer claw (that of second leg with an inner seta), third segment with three inner setae and three distal claws. Rami of both legs sparsely tuberculated. Third leg with clearly two-jointed protopod, the ramus carries two inner claws and a spine fringed outer distal hemispherical bulge.

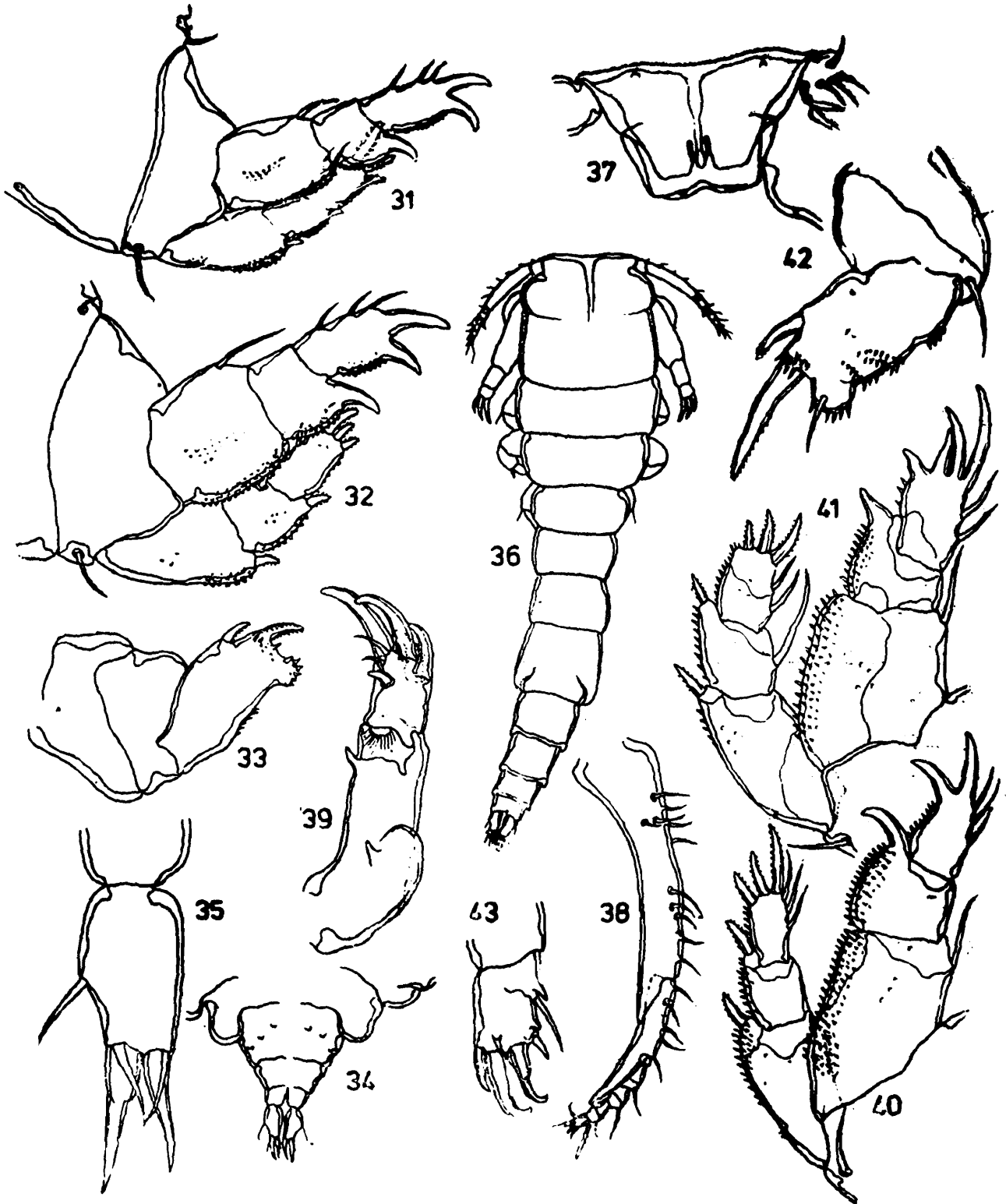
Length : 2.7 mm.

Male : Cephalic segment squarish, with an indistinct partition as in *S. occlusa*, anteriorly produced into a large remotely triangular distally truncate rostrum remaining bent downwards. Trunk segments, in addition to genital segment, five in number, successively decreasing in width. Genital segment longer and broader than the previous segment, broader behind. Abdomen four-jointed, gradually narrowing backwards. Caudal rami slightly longer than last abdominal segment, with outer short spine and long seta, distal border with four strong claw-like processes and a submarginal seta.

Antennule seven-segmented and highly chitinated, first segment forming half of the appendage and distally produced into a conical process, second segment moderately long and produced into a process as long as the segment, succeeding four segments short. Antenna cylindrical and nearly straight, basal segment with proximal outer bulge and inner distal process, second segment produced distally into a lobe carrying three setae below which is a small claw, third segment short,

with four claws successively increasing in length, fourth claw very long. Oral appendages as in female.

Legs one and two subsimilar except that the endopod of the second is stouter. First endopod segment with inner seta, second with outer claw, third segment of the first leg with three setae and two claws, of



Text-figs. 31-43. *Shiinoa elegata* Cressey.

31-35. female ; 36-43. male 31. leg 1 ; 32. leg 2 ; 33. leg 3 ; 34. genital segment and abdomen ; 35. caudal ramus ; 36. male, dorsal view ; 37. rostral lobe, ventral view ; 38. antennule ; 39. antenna ; 40. leg 1 ; 41. leg 2 ; 42. leg 3 ; 43. caudal ramus.

second leg with two setae and four claws. Exopods differing in the presence of a stout seta on the inner border of the second segment of the second leg. Rami of both legs strongly spiny. Basipod of third leg with a long seta, ramus as in female but with longer distal spines and a large ventral patch of denticles.

Length : 2.0 mm.

Remarks : In spite of certain differences there is no doubt that the present specimens belong to *S. elagata*. In the description of the female Cressey observes, "cephalon posterior to second antennae constricted, followed by laterally expanded area bearing mouth parts and first legs." This description is applicable to our specimens but in the dorsal view of the animal the rostral segment, neck segment and the cephalothoracic segment are delimited by septa. Following the cephalothorax (cephalon of Cressey) is a large segment which Cressey describes as the genital segment. This does not appear to be correct, since the genital segment is a small clearly visible segment partially fused with the trunk segment and also immersed in it, more or less as in *S. occlusa*. At the hind end of the cephalothorax is a constriction with two transverse grooves and on the ventral side of the pregenital segment an arcuate ridge just behind the third pair of legs. These structures indicate the presence of a vestigial trunk segment which is well developed in the type species and also in the new species described below.

The male which has not so far been described is remarkable in the shape of the body, nature of the antennule, armature of the antenna, presence of a large downwardly bent rostrum and in the armature of the caudal rami. The similarity of legs one and two is also significant.

***Shiinoa rostrata* sp. nov.**

(Text-figs. 44-63)

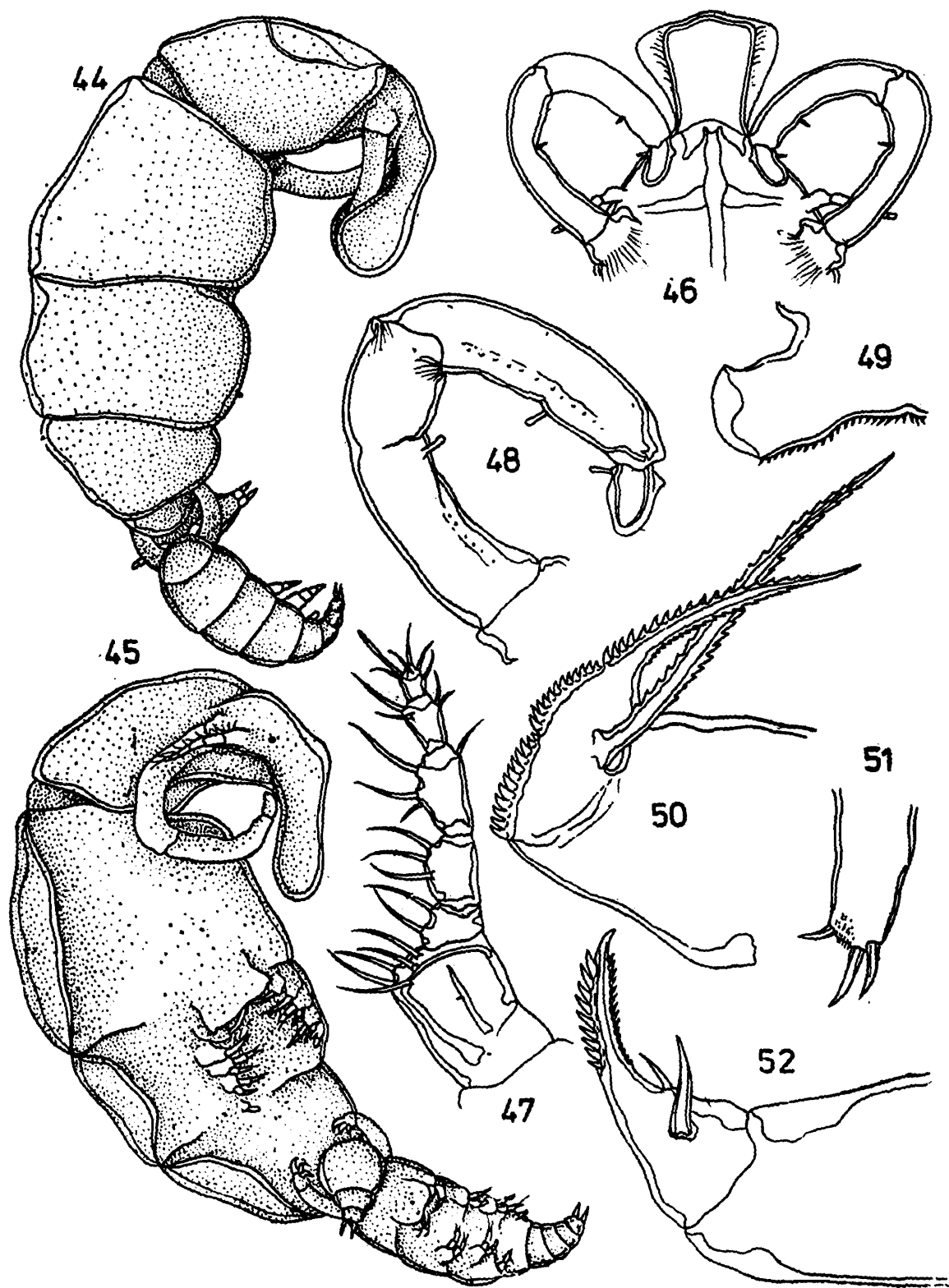
Holotype.—Female, Reg. No. C. 2903/2 Zoological Survey of India, Calcutta ; loc. ; Trivandrum, Kerala ; host : *Priacanthus hamrur* (Forsk.), nasal fossae ; Coll. C. Prabha.

Paratype.—3 ♀ ♀ and 1 ♂, loc. Trivandrum, Kerala ; host. *Epinepheles* sp. *Lutianus* sp., *Priacanthus hamrur* ; other details same as for holotype.

Female ; Body closely resembling that of *S. elagata*. Cephalothorax clearly demarcated into rostral segment, a fairly large neck segment carrying the antennules and antennae and a large dorso-ventrally flattened hind segment carrying the oral appendages. First and second trunk segments distinct, the former, unlike as in other species, carrying the three pairs of legs. Second segment without postero-lateral lobes. Geni-

tal segment and abdomen fused into a swollen part terminating in a pair of rectangular caudal rami, each armed with a lateral and distal small seta and three distal stout spines.

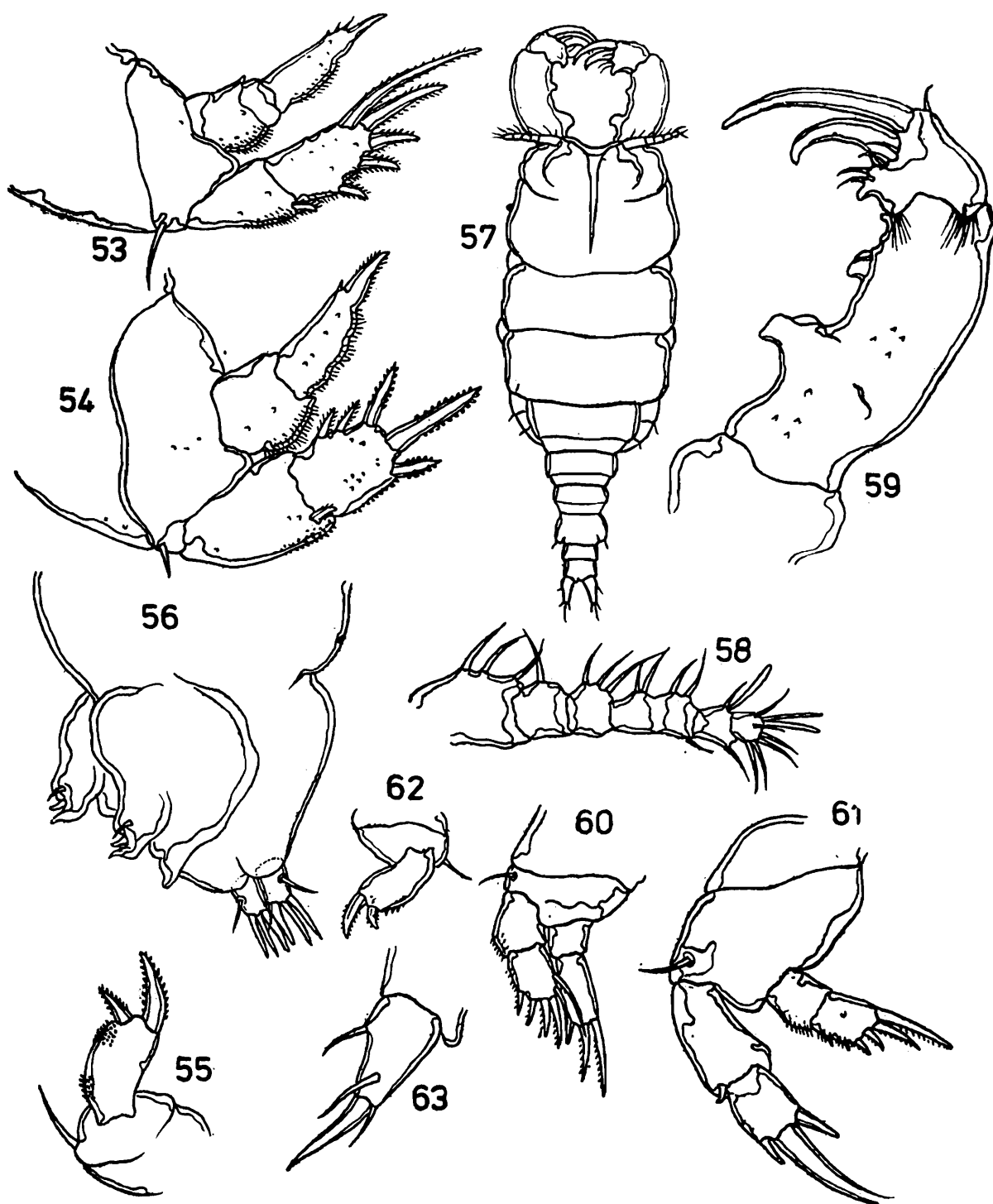
Antennule six-jointed, basal segment stout, each of the last two segments with an aesthetasc. Antenna clearly three-jointed, first seg-



Text-figs. 44-52. *Shiinoa rostrata* sp. nov.

44. female and male, lateral view ; 45. same, ventral view ; 46. rostral prolongation, ventral view ; 47. antennule ; 48. antenna ; 49. labrum .
50. mandible ; 51. maxillule ; 52. maxilla.

ment with an indistinct partition and an inner process, second segment nearly as long as first, with one inner process, third segment very short, ovate and with a hyaline covering, an inner process and a conical outer



Text-figs. 53-63. *Shiinoa rostrata* sp. nov.

53-56. female. 57-63. male. 53. leg 1 ; 54. leg 2 ; 55. leg 3 ; 56. genital segment and abdomen ; 57. male, dorsal view ; 58. antennule ; 59. antenna ; 60. leg 1 ; 61. leg 2 ; 62. leg 3 ; 63. caudal ramus.

projection. Labrum with large lateral wing-like expansions, free border armed with sharp spines. Mandible with large basal segment, main blade basally broad and with bilobed margin, each lobe with a row of

teeth, narrow part slightly longer than the basal and bilaterally dentate, accessory blade bilaterally dentate and reaching far beyond the main blade. Maxillule with three strong processes and a patch of denticles. Basal segment of maxilla stout, distal with two spines, one of them very stout, blade with about ten large ventral and fourteen to fifteen small dorsal teeth.

Legs placed close together behind the oral appendages, first two pairs biramous, with two-jointed rami, third pair uniramous. Endopod of first leg smaller than exopod, its distal segment with three small inner distal spinules and a stout apical process. Basal segment of exopod with an outer process, distal segment with five processes regularly increasing in length so that the last is longer than the segment. Second leg generally like the first, distal endopod segment with one inner spinule and a stout distal process. Exopod compared to that of first leg stout, distal segment with two inner and three distal strong processes. Both legs with poorly spiny rami. Third leg with indistinctly two-jointed basipod with a seta, ramus with two patches of spinules and two processes, one of the processes large.

Length. —3.0 mm.

Male. —Closely attached to the abdomen of female. Body clearly demarcated into a broad anterior division comprising the cephalic and the first two thoracic segments and a comparatively narrow posterior division composed of three thoracic segments, genital segment and the abdomen. Cephalic segment squarish, with an incomplete partition. First two thoracic segments rectangular, as broad as the cephalic segment, third segment abruptly narrowed, narrowing backwards to meet the narrow fourth segment. Genital segment not enlarged, slightly broader than long. Abdomen very short and two-jointed, as long as genital segment. Caudal rami strongly narrowing, with one stout apical process and three slender setae.

Antennule seven-jointed, first segment only moderately stout, penultimate segment with one and ultimate with two aesthetes. Antenna stout, with massive basal segment internally produced into a pair of blunt median processes and three smaller distal processes, second segment internally produced into a lobe carrying one spine and two setae. Third segment almost non-existent, with three setae and two very long curved slender processes. Oral appendages generally as in female.

Legs one and two biramous, with two-jointed rami, endopods normally developed, exopod of second showing the usual dimorphism. Distal segment of endopod of first leg with three apical spines, first very

small, third very long, distal segment of exopod with two inner setae and four distal spines. Endopod of second leg comparatively small, distal segment with four distal processes, last process very long. Basal segment of exopod with outer distal process, distal segment with three distal processes, middle process very large. Third leg similar to that of female.

Length. —0.67 mm.

Remarks : In practically every important character this species differs from its congeners. The female closely resembles *S. elagata* in the shape of the body. But in the nature of the body segments, shape of the rostrum, absence of postero-lateral trunk lobes and the shape of the post-genital part of the body there is easily recognisable differences. The antenna is very characteristic, with a very short distal segment. The mandible has a characteristic dentition and the maxilla has a larger number of teeth. Unlike as in all the other species, both rami of legs one and two are two-jointed and the endopod has a very peculiar shape.

The shape of the body of the male, especially the presence of a very short two-jointed abdomen, is very characteristic. So is the shape and armature of the antenna.

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A NEW SPECIES OF *GERENIA* STAL, 1878 (ORTHOPTERA :
ACRIDIDAE) FROM THE FOOTHILL OF THE EASTERN
HIMALAYA, WEST BENGAL, INDIA

By

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(With 5 Text-figures)

INTRODUCTION

The genus *Gerenia* Stal, 1878, is represented in oriental region by four species : *G. intermedia* Brunner, 1893, from Burma ; *G. abbreviata* Brunner, 1893 (now with 2 subspecies) from Burma and Indo-Malayan regions ; and last 2 species, *G. dorsalis* Walker, 1870 and *G. pustulipennis* Walker, 1871, from southern and western India respectively. Lately while studying a big lot of grasshoppers collected from the 'Tarai' and the 'Duars' of West Bengal, the authors have come across the present species which turns to be new to science and is described below. This new species thus represents the genus, for the first time, from the northern and eastern India.

***Gerenia bengalensis* sp. nov.**

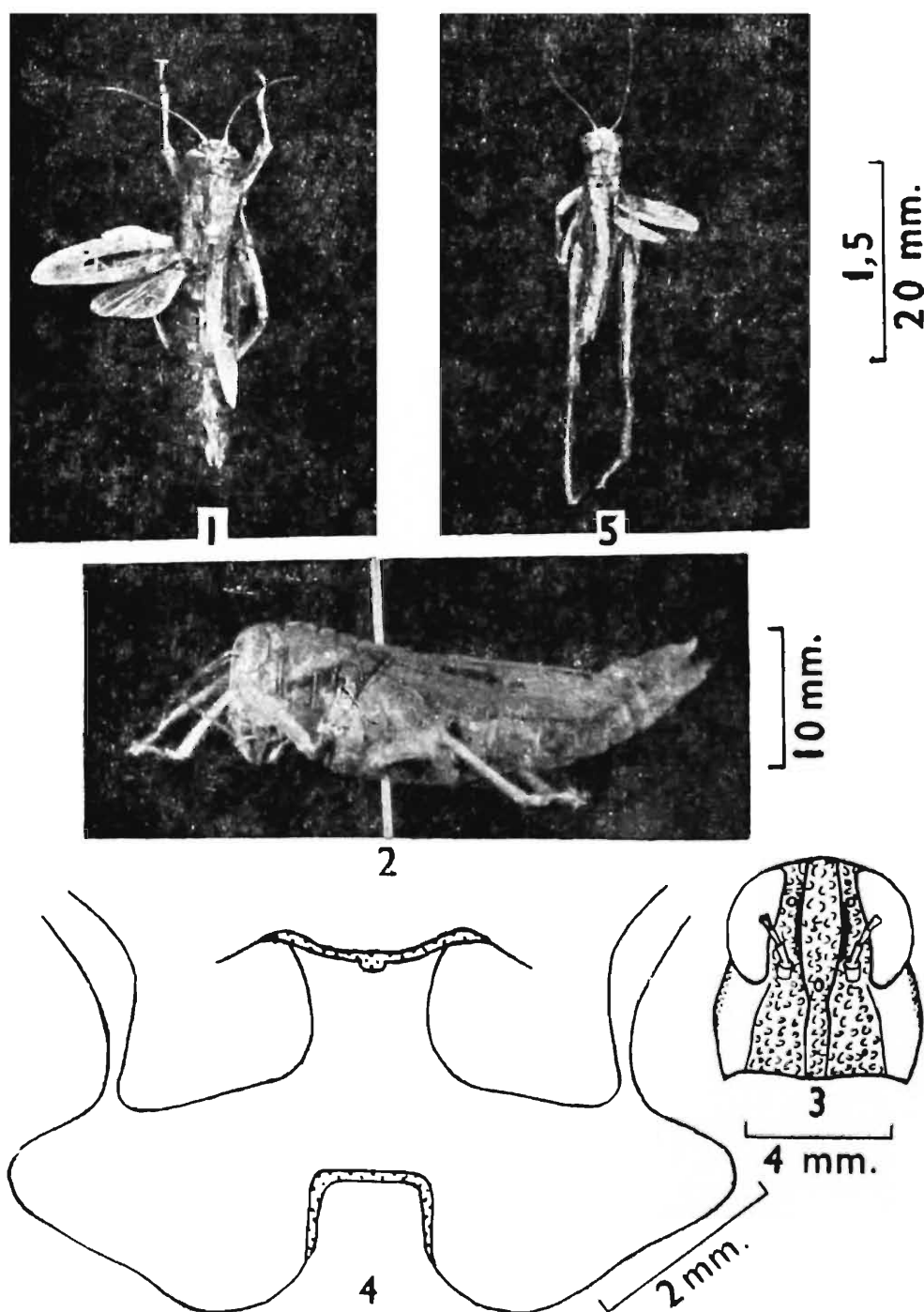
Holotype : 1 ♀ ; Bhutanghat, Jalpaiguri district (Duars), West Bengal ; 7.9.1975 ; H. K. Bhowmik coll.

Paratype : 1 ♂ ; Bamanpookri, Darjeeling district (Tarai), West Bengal, 25.8.1975 ; H. K. Bhowmik coll.

Description

Holotype (♀) : Size medium but robust in appearance (Text-fig. 1, 2). Antennae filiform, longer than head and pronotum taken together, first 8 segments brownish, remaining segments dark. Head short, less than half of pronotum ; fastigium very shallowly concave, semi-lunar, transverse, separated from frontal ridge. Vertex of head with an ill-defined median carina. Face vertical, coarsely punctured. Frontal ridge (Text-fig. 3) widened between antennae, gradually tapers towards behind of middle ocellus where it becomes a little constricted and then the carinae get more or less parallel and runs up to clypeus ; coarsely and densely punctured ; lateral carinae almost straight. Eyes brownish,

lateral projected, pointed at apex and approximating; interocular distance wider than width of frontal ridge. Pronotum longer (8.9mm) than wider (6.5 mm); heavily and coarsely punctured all over; moderately tectiform; median carina distinct, linear but crossed by three usual



Text-figs. 1-5. *Gerania bengalensis* sp. nov.

1. Profile of holotype (♀), dorsal view.
2. Lateral view.
3. Front view of face (up to clypeus) showing frontal ridge.
4. Meso- and metasternal plate and their interspace.
5. Profile of male paratype, dorsal view.

transverse sulci; prozona distinctly longer than metazona; the latter with its posterior margin obtusely angulated; lateral pronotal lobe somewhat depressed, its lower margin straight, a little oblique at anterior

angle. Prosternal tubercle straight, conical. Mesosternal interspace (Text-fig. 4) shorter than width of one of its plates, inner margin of which rounded; metasternal plates clearly separated by a distinct interspace inbetween. Elytra coriaceous-like, shorter than abdomen and less than half of total body length; medial area adorned with an irregular longitudinal black band. Wings hyaline, shorter than elytra. Tympanum closed. Abdomen with a distinct median, dorsal carina. Supra-anal plate almost tongue-shaped, with a median longitudinal sulcation. Valves of ovipositor curved, margins of upper ones somewhat margined. Cerci small, conical. Posterior leg (broken); posterior tibia with 10 internal and 8 external spines.

Paratype (♂) : Fairly identical (Text-fig. 5) with the holotype except that it is much smaller in size and differs in genital parts. Cerci longer than supra-anal plate, the latter similarly with a median longitudinal sulcation. Sub-genital-plate hairy, navicular. Both upper and lower basal lobes of posterior femora equal, their upper carinae denticulated. Upper lobe of posterior knee longer than lower one; both of them more or less rounded. Posterior femora with 2 ill-defined dark bands on external face, first one at base, small and incomplete, second one almost fills whole length and extends to inner face; posterior

Measurements (in mm) :

Body Parts	Holotype ♀	Paratype ♂
Length of body	33.0	22.5
Length of head	3.5	2.8
Maximum width of head	5.0	4.5
Interocular distance	2.25	1.5
Length of antennae	14.0	13.5
Length of pronotum	8.9	6.0
Maximum width of pronotum	6.5	4.0
Length of prozona	5.25	4.0
Length of metazona	3.75	2.5
Length of elytron	16.0	9.5
Length of wing	11.0	6.0
Length of posterior femur	23.0	15.0
Length of posterior tibia	21.0	13.5

tibiae smaller than femora and possess equal numbers of spines to that the holotype.

Colouration : General colouration of the types olivegreen. The most remarkable colouration is the black, shiny mark on the posterior, superior margin of pronotal lateral lobe, the mark gradually tapers

and extends up to anterior border. The medial dark band of elytra also unique.

Remarks : The species comes close to the other Indian species, *G. pustulipennis* Walker, 1871, described from Bombay, in having black spots on elytra but differs strongly from all known species of the genus for having the frontal ridge extended up to clypeus, dark band on the lateral lobe and the unique longitudinal colour band on medial area of elytra and posterior femora.

SUMMARY

The genus *Gerenia* Stal, 1878, was represented in oriental fauna by four species. Now a fifth one is described, *G. bengalensis* sp. nov., from the foothill of the eastern Himalaya, West Bengal, India.

ACKNOWLEDGMENTS

The authors owe their indebtedness to Dr. B. K. Tikader, Ph. D., D. Sc., Director, for facilities provided, to Dr. N. D. Jago, PSO, 1/C, Acridid Taxonomy, of the Centre for Overseas Pest Research, London, for confirming the identification of the species and to the staff members of the Field Survey Division, for assistance in the different capacities.

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STUDIES ON THE AQUATIC CRUSTACEA OF REWA

By

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INTRODUCTION

(With 1 Map)

Rewa district lies on the eastern boundary of Madhya Pradesh State in India. Ponds and rivers are much abundant in this region. A systematic study of aquatic fauna of this region was started in July 1976, but the identification of collections and re-examination of specimens collected during periodic collections led to considerable delay. Still several interesting specimens could not be determined due to paucity of the material.

SITUATION AND PHYSIO-GEOGRAPHY

Rewa district is bounded on North by Banda and Allahabad districts and on North-East by Mirzapur district of Uttar Pradesh. On its south lies Sidhi and in South-West Satna district of Madhya Pradesh. It covers about an area of 6287 square kilometers of mountainous country and includes Huzur, Sirmour, Mauganj and Teonthar tahsils. Geographical limits of Rewa are 24°-28' and 25°-12' North and 81°-2' and 88°-18' East. It is situated 318.7 meter above the sea level.

CLIMATE

The climate of Rewa is moderate and this is attributed to the greater elevation and to the Western winds. Average temperature during 1976-77 was 24.9°C. May was the hottest month with the maximum temperature of 33.9°C. and January was the coldest with the minimum temperature of 15.2°C. The highest humidity of 93% was recorded in the month of August and the lowest 74% in the month of June. Monsoon usually spreads over this area during June and July and the annual rainfall is 84.9 centimeter.

MATERIAL AND METHOD

Zoologically Rewa district has been an unexplored area. During these explorations fresh water system has been studied. It consists of

flowing water and standing water provinces and both ponds and rivers were considered. During these studies trips were made to various tahsils for collections, at Teonthar tahsil specimens were collected from river Tamas near Chakghat, at Sirmour from Semaria pond, at Mauganj from Mauganj pond, at Huzoor tahsil from river Behar near Rewa Bus stand and Lalpa, Lakhoribag, Bahurian ponds.

The exploration of various ponds and rivers under the plan of study was begun in July 1976 and continued upto December 1977, systematics and quantitative investigations of crustaceans was made, material collected during these years was brought to laboratory for examination.

Both macroscopic and microscopic fauna were collected from lotic and the lentic habitats. These collections were made by using a 20 liter trap. The details of the survey work have been summarised and are presented below.

SYSTEMATICS

This paper deals with the crustacean fauna. Further details will be communicated in a series of papers.

Order : CLADOCERA

Family : DAPHNIDAE

(1) *Scapholeberis mucronata* (O. F. Müller)

Body and feet covered by bivalve shell, five pair of feet, intestine with two hepatic caeca. Valves arched dorsally, posterior and ventral margins straight ; at their junction a spine. Antennules very small. Post-abdomen short and broad rounded at the posterior end ; five anal teeth.

Measurements : Length of female 0.8 mm ; male 0.5 mm.

Locality : These specimens were collected from river Behar, Tamas and Lakhauribag, Semaria, Mauganj ponds.

(2) *Simocephalus vetulus* (O. F. Müller)

Body and feet covered by bivalve shell, five pair of feet, intestine with two hepatic caeca. Vertex rounded ocellus elongated, valves with a blunt posterior angle, post abdomen very large. Anal spines about ten, decreasing from the claws. Claws long, slender, little curved denticulate.

Measurements : Length of female 3.0 mm ; male 1.0 mm.

Locality : These specimens were collected from Mauganj, Semaria, Lakhauribag and Bahurian ponds.

Family : SIDIDAE

(3) **Diaphanosoma sarsi** (Richard)

With six pairs of foliaceous legs. Antennae of female biramous and flattened without lateral expansion, dorsal ramus two segmented. Without spines on post abdomen. Ocellus absent.

Measurements : Length of female 0.6 mm ; male 0.5 mm.

Locality : These specimens were collected from Lakhauribag, Bahurian and Lalpa ponds of Hazur Tahsil.

Family : BOSMINIDAE

(4) **Bosmina longirostris** (O. F. Mullar)

Body and feet covered by bivalve shell, antennules of female lynig backwards, six pair of feet, intestine simple no caeca. Two series of spinules on claws. Antennules not united at base, parallel, bear small sensory hair near the centre of the space between the eye and the base of the antennule.

Measurements : Length of female 0.3 mm ; male 0.25 mm.

Locality : These specimens were collected from Lakhauribag, Lalpa, Semaria and Mauganj ponds.

Order : COPEPODA

Family : DIAPTOMIDAE

(5) **Heliodiaptomus viduus** (Gurney)

Cephalothorax and abdomen separate, antennules uniramous, longer than body, antepenultimate segment bears no comb. Endopodite of the first leg two segmented. Fifth feet of male terminate in a hook. Right and left feet of male nearly equal in length, terminal hook of right foot symmetrical.

Measurements : Length of female 1.5 mm ; Male 1.4 mm.

Locality : These specimens were collected from Lakhauribag and Lalpa ponds.

Family : CYCLOPIDAE

(6) **Cyclopes serrulatus** (Fischer)

Cephalothorax and abdomen separate fifth feet rudimentary with three setae, swimming feet three segmented. Furcae armed externally with a row of fine spines. Antennae twelve segmented, furcal rami serrate.

Measurements : Length of Female 0.8 to 1.25 mm.

Locality : These specimens were collected from river Behar, Tamas and Lakhauribag, Bahurian ponds.

Family : MESOCYCLOPS

(7) **Mesocyclops leuckarti** (Claus)

Second antennae small without a large apical claw. Rami of fourth leg three segmented. Fifth leg composed of two segments, last segment with two setae of equal length and a spine, with a hyaline membrane on each of the last two segments of first antennae. Caudal rami without hairs on inner margins.

Measurements : Length of female 0.2 to 0.3 mm.

Locality : These specimens were collected from river Behar, Tamas and Lakhauribag, Bahurian, Semaria, Mauganj ponds.

Order : OSTRACODA

Family : CYPRINIDAE

(8) **Spirocypris tuberculata** (Sharpe)

Shell purplish brown, with four purple patches and reticulate patterns, tuberculate, Eyes fused.

Testis originate in the anterior part of the shell, in form of concentric circles.

Second antenna subpediform, clawed, notatory seta equal to the length of the terminal claws. Terminal segment bears a large and a small claw. The larger claw bears a seta at its base and is five times the length of the terminal segment.

Two dissimilar pair of legs. Second leg backwardly bent. Terminal segment with a beak like end segment.

Furca Band like, slightly broadened at the base, about thirty two times long as wide and faintly striated throughout its length. Subterminal claw and the terminal seta are equal in length.

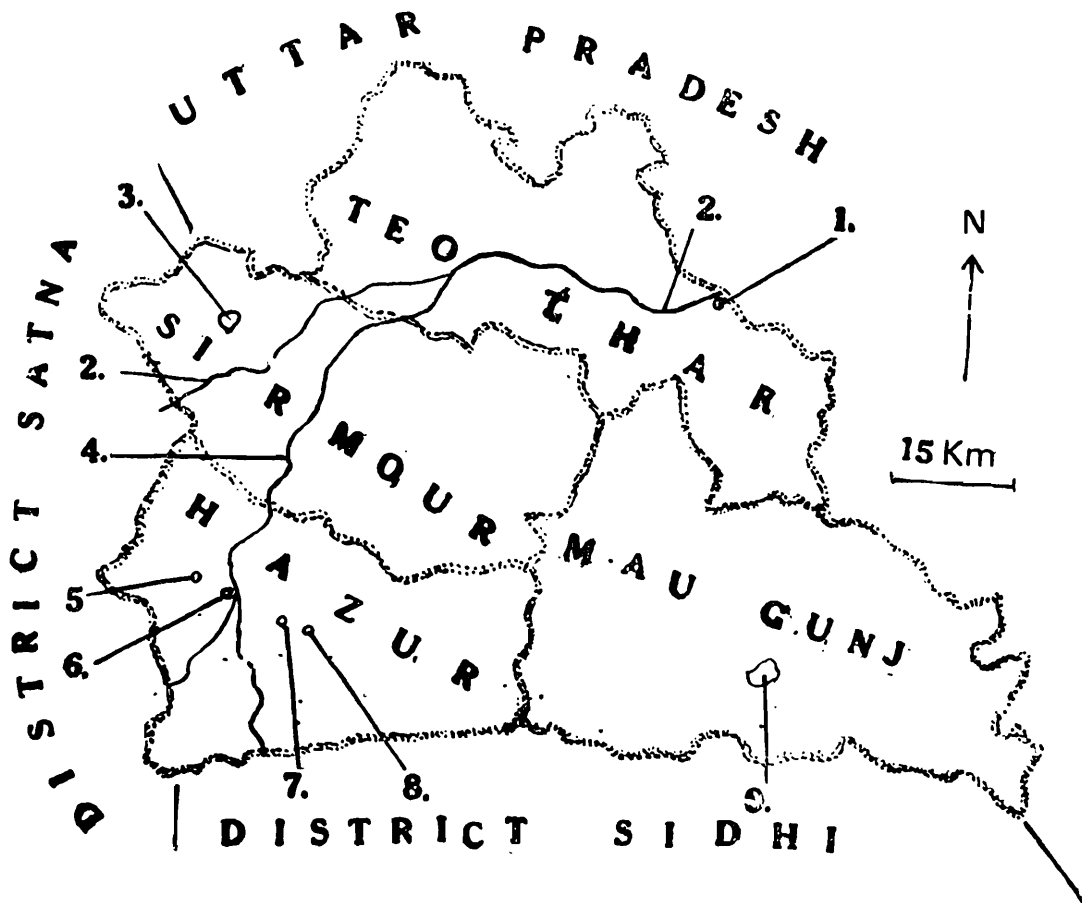
Measurements : Length 0.8 mm ; height 0.53 mm ; width 0.7 mm.

Locality : These were collected from Lakhauribag, Bahurian and Lalpa ponds.

(9) **Spirocypris passaica** (Sharpe)

Shell greenish with reticulate patterns. Eyes fused. Testis originate in anterior part of the shell in form of concentric rings.

Second antenna subpediform clawed at the apex. Notatory seta reach slightly beyond the tips of the terminal claws. Terminal segment bears a large and a small claw. The larger claw bears a seta at its base and is three times the length of terminal segment.



Map of Rewa District

1. Chakghat, 2. River Tamas, 3. Semaria pond, 4. River Behar,
5. Lakhauribag pond, 6. River Behar near Bus stand Rewa,
7. Lalpa pond, 8. Bahurian pond, 9. Mauganj pond.

Second leg backwardly bent. Terminal segment with a beak like end segment and a coma shaped claw.

Furca band like slightly broadened at the base, about thirty three times long as wide and toothed on about one half of its dorsal margin. The terminal claw is larger than the subterminal claw. Terminal seta and terminal claw are equal in length. Dorsal seta equal to the half of the length of the subterminal claw.

Measurements : Length 2.8. mm ; height 0.8 mm ; width 0.8 mm.

Locality : These were collected from Bahurian, Lalpa, Semaria and Mauganj ponds.

AVERAGE MONTHLY POPULATION NO./LITRE, PERIOD : JULY 1976-DEC. 1977

TWO YEARS MONTHLY AVERAGE VALUES

Species	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
<i>Scapholeberis mucronata</i> .	8	9	10	13	16	9	8	8	19	21	..	3	8	9	9	13	15	9
<i>Simocephalus vetulus</i> .	6	7	7	10	10	9	8	6	11	11	4	4	7	8	8	10	10	8
<i>Bosmina longirostris</i> .	2	2	3	4	5	4	3	3	5	6	—	—	2	3	3	5	5	4
<i>Diaphanosoma sarsi</i> .	3	4	4	5	5	4	4	3	6	7	1	1	2	3	3	5	6	3
<i>Heliodiaptomus viduus</i> .	6	7	7	9	9	8	7	6	11	13	4	3	7	8	7	9	10	7
<i>Cyclops serrulatus</i> .	10	11	12	14	14	9	9	10	21	22	4	4	9	10	10	15	16	9
<i>Mesocyclops luckarti</i> .	6	7	7	9	9	7	6	5	11	14	6	6	6	7	7	10	9	7
<i>Spirocypis tuberculata</i>	3	4	4	5	5	4	4	3	6	8	4	4	3	4	4	6	6	4
<i>Spirocypis assaica</i> .	2	2	3	4	4	3	3	4	5	5	—	—	2	2	3	4	5	2
<i>Macrobrachium lamarrei</i> .	—	2	2	5	5	3	2	3	7	7	2	2	—	3	3	6	5	2

Order : DECAPODA

Family : PALAEMONIDAE

(10) *Macrobrachium malcomsoni* (H. M. Edwards)

Rostrum with teeth. Mandibular palp and hepatic spine present. Branchio-Stegal spine absent. Second legs much longer than first, chelae without terminal hair tufts.

Measurements : Length 50 to 80 cm.

Locality : Specimens were collected from river Behar, Tamas and Mauganj, Semaria, Bahurian ponds.

QUANTITATIVE RESULTS

Results of collections made during different months of the year have been tabulated and are as shown below :

GENERAL OBSERVATIONS

The interesting feature that emerges from this study is an uneven picture of the aquatic fauna of this part of the country. Considering the continental weather conditions prevailing in this region it was expected that most of the Cladocera, Copepoda and Ostracoda will be well represented. However the Daphnidae predominate and neither Decapoda nor for that matter the Copepoda and Ostracoda are present in large numbers of genera or species.

Rawson and Moore (1944) in saline water, Sewel (1947) in marine water and Ward, Whipple (1945) in fresh water, reported presence of large number of species. It is therefore surprising that Rewa district having enough aquatic habitat to support a rich fauna do not in reality contain an appreciable number of species, when compared with marine and saline water forms. Perhaps further explorations may yeild additional information or more number of species.

It also appears from this study that *Scapholeberis mucronata* and *Cyclops serrulatus* species are present in much abundance, where as *Bosmina longirostris* and *Spirocypis passia* are scare. *Scapholeberis mucronata*, *Cyclops serrulatus* and *Macrobrachium lamarrei* are lotic and lentic, rest of the species being lentic in habitat. Population densities reduce during the period of high turbidity (July-Sept.) caused by silt load due to rains. In less turbid conditions (Oct.-Nov.) there is a rise in population density. Byars (1960) holds that the temperature exercises the greatest influence on the periodicity of rotifers. In the present

study, the occurrence and density of different groups seems to be influenced by the temperature. The temperature variance causes presence of less population, during hottest (May and June) and coldest (Jan. and Feb.) months. Population abundance is at its maximum in the months (March and April) of moderate temperature.

SUMMARY

The paper describes ten species of aquatic crustacea found in a variety of habitats of Rewa district. Short description of different species has been supplemented with a view to enable one to identify them. The general composition of the aquatic crustacea is predominated by the members of Daphnidae and the Cyclopidae. Palaemonidae is represented only by a single species.

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REDESCRIPTION OF *ALONA TARAPOREVALAE* SHIRGUR
& NAIK, 1977

(CLADOCERA : CHYDORIDAE : ALONINAE)

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(With 1 Text-figure)

INTRODUCTION

Shirgur & Naik (1977) described a new species, *Alona taraporevalae* based on the study of the material collected from shore waters off Back bay opposite Taraporevala aquarium, Bombay, India. However, this taxon was inadequately described and the illustrations provided were much reduced to show distinct taxonomic details. The present authors had the opportunity to examine the "Type material" deposited in Zoological Survey of India, Calcutta, which indicated a number of distinct and notable differences from the original description. Hence, this species is being redescribed in this account.

SYSTEMATIC ACCOUNT

- Class : CRUSTACEA
Subclass : BRANCHIOPODA
Order : CLADOCERA
Family : CHYDORIDAE Stebbing, 1902
Subfamily : ALONINAE Frey, 1966
Genus : *Alona* Baird, 1843 emend. Smirnov, 1971

Alona taraporevalae Shirgur & Naik, 1977

(Text-fig. 1, a-f)

Alona taraporevalae Shirgur & Naik, 1977, p. 48-59, fig. 1. 1-8, fig. 2. 9-13 and fig. 3. 14-18.

Type Material :

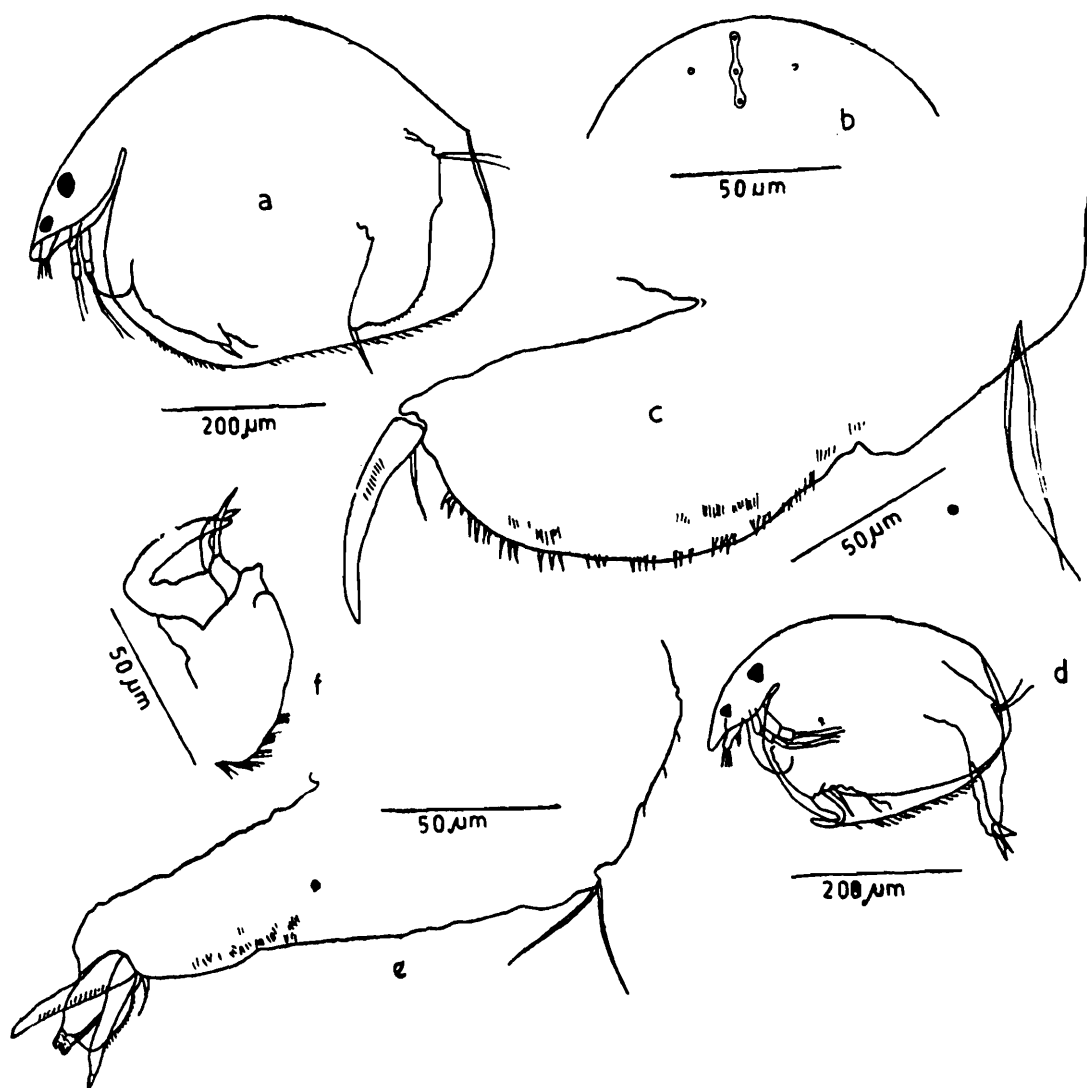
Holotype : Parthenogenetic female, ZSI Regd. No. C 1696/2.

Paratypes : 6 Parthenogenetic females, ZSI Regd. No. C 1697/2 ;
4 Males, ZSI Regd. No. C 1698/2 ; 3 Ehippial females,
ZSI Regd. No. C 1699/2.

Type Locality : Back bay opposite Taraporevala aquarium, Bombay, India.

Description :

Female : Body almost oval in outline, with maximum height just before the middle (Text-fig. 1, a). Dorsal margin strongly arched ; ventral margin with a bulge in the middle and a slight concavity following it. Posterodorsal corner of valves distinct ; posteroventral corner



Text-fig. 1, a-f : *Alona taraporevalae* Shirgur & Naik a. female ;
b. posterior margin of head shield (magnified) showing head pores
c. postabdomen ; d. male ; e. postabdomen (male) ;
f. Leg I (male).

broadly rounded, without denticles. Ventral margin of valves with short setae which continue on the posteroventral corner into a row of fine hairs that extends to the posterior margin of valves. Valves without any markings. Rostrum blunt and directed anteriorly. Head shield with broadly rounded posterior margin ; with three main connected head pores, located in the median line near its posterior margin and two small pores lateral to the median main pore (Text-fig. 1, b). Eyes moderately large ; ocellus slightly smaller than eye, located almost halfway between the eye and the tip of rostrum. Antennules reaching apex of rostrum ; olfactory seta situated in the middle, esthatascs unequal. Antennal setae : 0-0-3/1-1-3. Plate of labrum with broadly convex anterior margin and pointed apex. Postabdomen broad (Text-fig. 1, c), slightly tapering distally ; with maximum width in its middle. Dorsal margin of postabdomen convex ; distal dorsal end rounded, not projecting. Preanal corner not so distinct. Nine groups of anal denticles present, each group with 3-4 denticles ; proximal five groups located laterally and distal four groups situated marginally. Few irregular groups of lateral fascicles present ; not projecting beyond the dorsal margin of postabdomen. Claw long, stout and curved ; with setae on the proximal part of its concave margin. Basal spine single, long and about one third the length of claw.

Length : 0.53 mm.

Male : Smaller than female ; with maximum height slightly before the middle (Text-fig. 1, d). Dorsal margin evenly arched. Posterodorsal corner of valves not as distinct as in female ; posteroventral corner rounded, without denticles. Rostrum blunt and directed anteriorly. Plate of labrum with convex anterior margin and rounded apex. First leg modified ; with a strong, thick and curved hook (Text-fig. 1, f). Postabdomen long, narrow and slender, with maximum width at preanal corner (Text-fig. 1, e) ; preanal corner slightly distinct. Dorsal margin of postabdomen almost evenly tapering distally. Ventral margin longer than the dorsal margin and produced distally above the base of claws. Claw long and stout, with setae on its concave margin and with one slender basal spine. Only a few groups of lateral fascicles present. Vas deferens opening near the base of claw, ventral to it. A remarkably distinct and robust penis present between the claws.

Length : 0.32mm.

REMARKS

The described taxon closely resembles *Alona davidi* Richard but differs from the same in the following details :

- i. in having distinct posterodorsal corner of valves ;

- ii. in the shape of the female postabdomen ; number and arrangement of anal spines and lateral fascicles ;
- iii. basal spine being longer than in *A. davidi* ;
- iv. in the distinct and unique shape of the male postabdomen and arrangement of lateral fascicles thereon ; and
- v. in the presence of a distinct and robust penis in male.

When the description of the present specimens was compared with that given earlier by Shirgur & Naik (1977), a number of differences could be noticed :

- i. the shape of the plate of labrum as figured earlier (Shirgur & Naik, 1977, fig. 1.1) is different from the observed shape ;
- ii. no distinct reticulations in the posterior margin of females were evident as described in the original (Text-fig. 1.3) ;
- iii. lateral fascicles in the female postabdomen do not project beyond the dorsal margin of postabdomen as shown earlier (Text-fig. 1.8) and the number and arrangement of lateral fascicles also showed differences in the presently examined forms ;
- iv. number and arrangement of lateral fascicles in the male postabdomen is also different. In the present study of the material, only a few lateral fascicles were visible ;
- v. the protuberance marked at the distal end of postabdomen of male (Text-fig. 3.18) is infact the distinct and robust penis.

Habitat : The marine habitat reported for *A. taraporevalae* is of special interest since till now amongst the Cladocera only three genera (*Penilia*, *Podon* and *Evadne*) are known to be strictly marine. There is so far no report of any species of *Alona* known to occur in such a habitat. It is likely that the ephippia might have been carried there by wind since this agency is known to play an important role in the dispersal of the cladocerans. However, it is yet to be ascertained whether Back bay was indeed the original habitat of this species.

SUMMARY

This paper deals with redescription of *Alona taraporevalae* Shirgur & Naik, 1977. The present study has indicated a number of distinct and notable differences from the original description. The examined material has also been compared with a closely allied species, *Alona davidi* Richard.

ACKNOWLEDGEMENTS

Thanks are due to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for allowing us to examine the deposited specimens of this species. We are also thankful to the Head, Department of Zoology, North-Eastern Hill University, Shillong for providing the necessary facilities for this work.

REFERENCE

- SHIRGUR, G. A. AND NAIK, A. A. 1977. Observations on morphology, taxonomy, ehippial hatching and laboratory culture of a new species *Alona taraporevalae* Shirgur & Naik, a chydorid Cladocera from Back Bay, Bombay. *Proc. Symp. Warm Water Zooplankton, Goa*, Special publication : 48-59.

ON SOME POLYCHAETES FROM GANGETIC DELTA,
WEST BENGAL, INDIA

By

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(With 1 Text-figure)

The estuarine regions of Gangetic delta, seem to harbour a rich and varied polychaete fauna, though much attention has not been given to the same. Hence, with a view to initiate a systematic study of these worms, the first author during 1974-80 undertook some faunistic surveys of Sagar Island and its environs along the Sunderbans where some polychaetes were collected together with other intertidal organisms. For obtaining the material, the soil had to be dug and rotten wooden logs and posts cut open when they were exposed at low tide.

The present paper deals with 27 species of these worms spread over 18 genera and 10 families. In spite of the paucity of the collected material, the specimens are interesting taxonomically as they present hitherto unrecorded morphological variations and besides, some form new locality records (marked with an asterisk). Under each species, only the original synonymy and the name as reported by Fauvel (1953), have been given, but the complete distribution of the same in Indian waters has been included along with important key characters as well as unrecorded variations.

SYSTEMATIC ACCOUNT

Family APHRODITIDAE

Subfamily POLYNOINAE

***Gattyana deludens* Fauvel, 1932**

Gattyana deludens Fauvel, 1932 : 18, figs. 1, 2 ; Fauvel, 1953 : 39, figs. 15 & 16.

Material : 14 exs., Z. S. I. Reg. No. An 1459/1, Gangasagar, Sagar Is., 24-Parganas, A. Misra, 12.2.78.

Habitat : An associating partner of Hermit-barnacle-sea anemone associating form on the sandy mid-littoral zone.

Description : Prostomium bilobed with four small eyes ; elytra 15 pairs, each with fringed outer border and smooth upper surface divided into polygonal areas ; notosetae long, slender and spinulose excluding the tip, neurosetae long and spinulose with unidentate smooth tip.

Distribution : Ganghipur, Gangetic delta ; Balassore, Orissa ; Pondichery ; Madras and Maharashtra coast.

Family PHYLLODOCIDAE

* *Phyllodoce (Anaitides) madeirensis* Langerhans, 1880

Phyllodoce (Anaitides) madeirensis Langerhans, 1880 : 307, pl. XVII, fig. 44 ; Fauvel, 1953 : 120, fig. 59.

Material : 1 ex., Z. S. I. Reg. No. An 1460/1, Dhamakhali, 24-Parganas, A. Misra and T. K. Samanta, 11.3.75.

Habitat : Low-littoral mud.

Description : Body long ; prostomium heart-shaped ; proboscis with six lateral rows of papillae at base ; dorsal cirri lanceolate, uniramous parapodia ; setae with oval shaft-heads marked by distal striation and with long tapering blades.

Distribution : Andamans and Lakshadweep.

Remarks : This is the first record of the species from the mainland.

Family PILARGIDAE

* *Talehsapia annandalei* Fauvel, 1932

Talehsapia annandalei Fauvel, 1932 : 251, pl. IX, figs. 13-20 ; Fauvel, 1953 : 113, fig. 55.

Material : 2 exs., Z. S. I. Reg. No. An 1461/1, Kachuberia, Sagar Is., 24-Parganas, A. Misra and P. Roy, 5.7.75.

Habitat : Low-littoral patches of hard soil.

Description : Body cylindrical with more than 180 segments ; first 4-5 setigerous segments slightly swollen ; prostomium bluntly conical ; parapodium uniramous with capillary setae only.

Distribution : Baitarani river, Chandbali and Talchua, Orissa.

Remarks : This species was originally described from two incomplete specimens collected from Taleh-sap, Thailand (then Siam). Later Soota and Rao (1977) furnished descriptions of complete specimens from estuarine waters of Orissa.

Family NEREIDAE

***Dendronereis aestuarina* Southern, 1921**

Dendronereis aestuarina Southern, 1921 : 598, pl. XX, fig. 4 ; Fauvel, 1953 : 173, fig. 86.

Material : 6 exs., Z. S. I. Reg. No. An 1462/1, Muriganga creek, Sagar Island, 24-Parganas, A. Chowdhury, 13.6.76.

Habitat : Swimming in swarms.

Description : Oral ring of proboscis with soft papillae, maxillary ring without papillae ; gills lateral, bipinnate on dorsal cirri from 14th/15th to 24th/25th segment ; setae all homogomph spinigers with fine serrations.

Distribution : Gangetic delta ; Madras & Travancore.

*** *Dendronereis arborifera* Peters, 1854**

Dendronereis arborifera Peters, 1854 : 612 ; Fauvel, 1953 : 172, fig. 86.

Material : 2 exs., Z. S. I. Reg. No. An 1346/1, Gangasagar, Sagar Is., A. Misra, 21.9.79.

Habitat : Soft mud in low-littoral zone.

Description : Proboscis without chitinous paragnaths ; lateral pinnate gills on dorsal cirri from 10th/12th to 22nd/24th segment ; setae all homogomph spinigers.

Distribution : Visakhapatnam back waters ; Baitarani river, Chandbali, Orissa.

***Namalycastis indica* (Southern, 1921)**

Lycastis indica Southern, 1921 : 578, pl. 19, fig. 2 ; Fauvel, 1953 : 167, fig. 84.

Material : 4 exs., Z. S. I. Reg. No. An 1274/1, Mandirtala, Sagar Is., A. Misra, 12.6.76.

Habitat : Soft mid-littoral mud.

Description : Proboscis without paragnaths and papillae ; parapodia uniramous ; neuropodial falcigers with blunt and serrated blades.

Distribution : Gangetic delta ; Chilka lake, Orissa ; coasts of Madras & Gujarat ; Andamans.

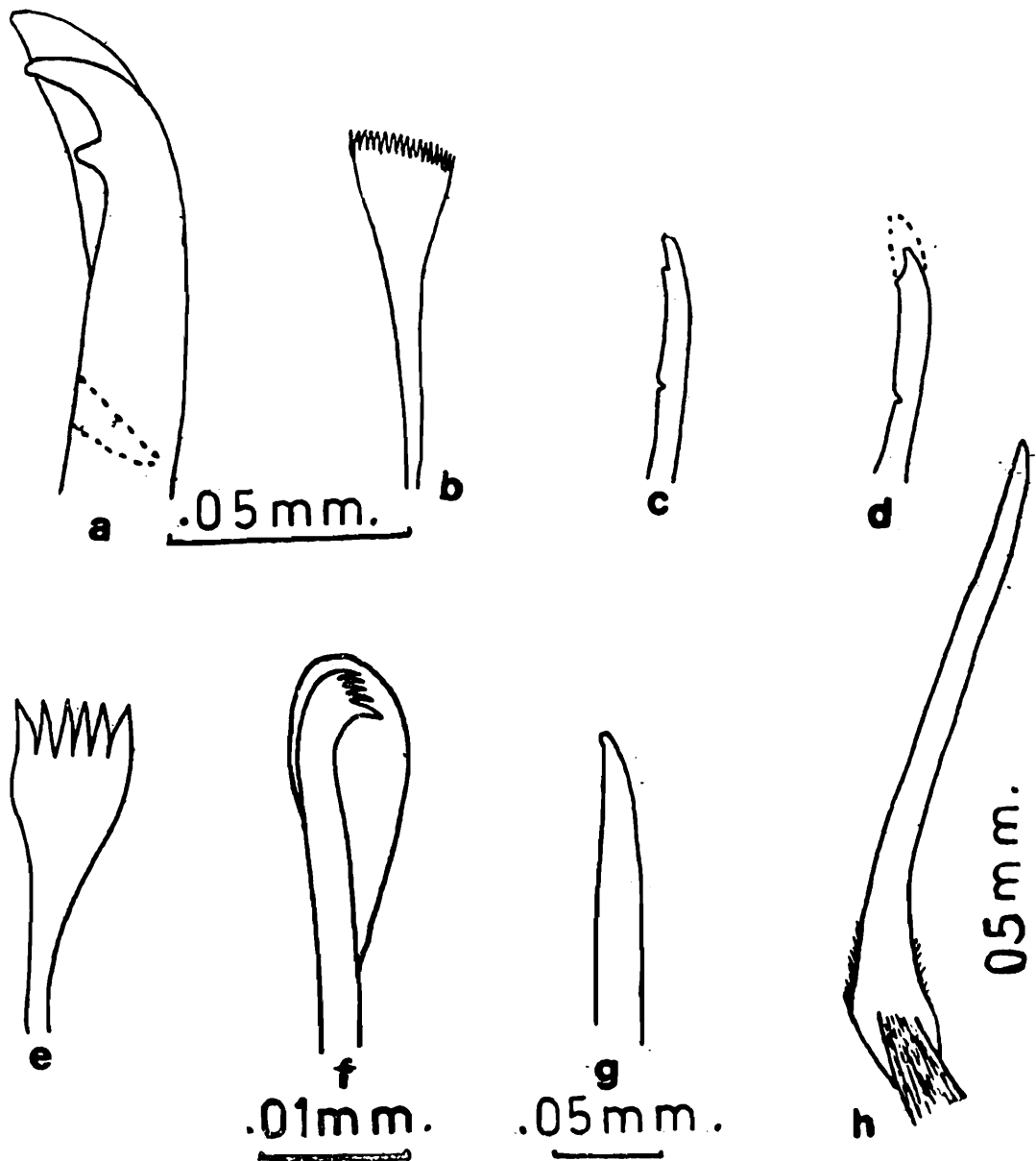
Remarks : This species, originally described as *Lycastis indica* Southern from Chilka lake, Orissa, was placed under the genus *Namalycastis* by Day (1967).

Nereis (Neanthes) chingrighattensis Fauvel, 1932

Nereis chingrighattensis Fauvel, 1932 : 90, fig. 14 ; Fauvel, 1953 : 179, fig. 90.

Material : 3 exs., Z. S. I. Reg. No. An 1463/1, Kachuberia, Sagar Island, 24-Parganas, A. Misra and P. Roy, 5.7.75.

Habitat : Rotten wooden logs in the intertidal zone.



Text-fig. 1. (a) Hook (strongly bidentate) and
 (b) Comb seta of *D. cuprea cuprea*.
 (c) & (d) Hooks (weakly bidentate) and
 (e) Comb setae of *D. neapolitana*.
 (f) Hook of *P. cirrifera*.
 (g) & (h) Blunt and spinigerous setae of *Polydora* sp.

Description : Arrangement of paragnaths on the proboscis is as : Gr 1, two conicals in a vertical line ; Gr. II, several conicals in a crescentic patch ; Gr. III, several conicals in a transverse group of 3-4 rows ; Gr. IV, each with several conicals in an oblique wedge-shaped group ; Gr. V, VI, VII and VIII, forming a continuous belt of which V & VI

forming a single row and VII & VIII forming a band of 2 to 4 lines ; spinigerous bristle through-out the body only.

Distribution : Salt water lake, Chingrighatta, Gangetic delta ; Chandipur, Orissa.

***Nereis (Neanthes) cricognatha* Ehlers, 1904**

Nereis cricognatha Ehlers, 1904 : 29, pl. 4, figs. 3-7 ; Fauvel, 1953 : 180, fig. 91 (a-c).

Material : 3 exs., Z. S. I. Reg. No. An 1464/1, Mandirtala, Sagar Is., A. Misra, 30.7.74.

Habitat : Soft low-littoral mud.

Description : Arrangement of paragnaths on the proboscis is as : Gr. I, 3 to 4 conicals ; Gr. II, III and IV, conicals, arranged in patches but fused together ; Gr. V, VI, VII and VIII, forming a continuous belt, broad ventrally ; larger dorsal ligule with dorsal cirrus at the base ; no dorsal falcigerous bristles on the posterior feet, ventral homogomph falcigers with knife-like terminal piece.

Distribution : Gangetic delta, ; Gulf of Mannar and Andamans.

*** *Perinereis cultrifera* var. *helleri* (Grube, 1878)**

Perinereis camiguina Grube, 1878 : 87.

Perinereis cultrifera var. *helleri* Fauvel, 1953 : 208.

Material : 4 exs., Z. S. I. Reg. No. An 1275/1, Mandirtala, Sagar Island ; 24-Parganas, A. Misra, 10.5.78.

Habitat : Soft mud in the intertidal zone.

Description : Arrangement of paragnaths on the proboscis is as : Gr. I, 2 conicals in a vertical line ; Gr. II. a few conicals forming a triangle ; Gr. III, several conicals forming a rectangle ; Gr. IV, several conicals forming a wedge on each side ; Gr. V, three conicals forming a triangle ; Gr. VI, a transverse bar ; Gr. VII & VIII, several conicals in 2-3 rows of continuous belt ; tentacular cirri long reaching upto 8-9th segment ; notopodial falcigers with short sickle-shaped blades and neuropodial falcigers with moderately straight blades.

Distribution : Gulf of Mannar ; Bombay harbour ; Aberdeen Bay, Port Blair, Andamans.

*** *Perinereis nigropunctata* (Horst, 1889)**

Nereis nigro-punctata Horst, 1889 : 171 ; Fauvel, 1953 : 210, fig. 107 (b-f).

Material : 1 ex., Z. S. I. Reg. No. An 1465/1, Kachuberia, Sagar Island, 24-Parganas, A. Misra, 5.7.75.

Habitat : Inhabiting the rotton log in the intertidal zone.

Description : Arrangement of paragnaths on the proboscis is as : Gr. I, a cluster of about 10-12 conicals ; Gr. II, 2-3 rows forming a triangle ; Gr. III, a crescentic patch of several conicals ; Gr. IV, several conicals forming a wedge ; Gr. V, three conicals in a triangle ; Gr. VI, a transverse bar on each side ; Gr. VII & VIII, a double row of conicals forming a continuous belt ; falcigerous bristles with short sickle-shaped blades.

Distribution : Andamans ; Chilka Lake, Orissa ; Gujarat coast ; Cape comorin, Tamil Nadu.

Family NEPHTYIDAE

Nephtys oligobranchia Southern, 1921

Nephtys oligobranchia Southern, 1921 : 610, pl. XXIV, fig. 12 ; Fauvel, 1953 : 228, fig. 115 (d-f).

Material : 6 exs., Z. S. I. Reg. No. An 1466/1, Port canning, N. Sarangi, 20.1.80.

Habitat : Soft fine muds in the low-littoral zone.

Description : Branchiae small and foliaceous, extending only upto middle of body ; posterior bristles long capillary without serrations.

Distribution : Pulta, Salt Lakes, Gangetic delta ; Chilka Lake, Baitarani river, Chandbali, Orissa ; Visakhapatnam ; Cochin backwaters.

Family GLYCERIDAE

***Glycera alba** (Muller, 1776)

Nereis alba Muller, 1776 : 217, pl. 2 figs. 6-7.

Glycera alba, Fauvel, 1958 : 292, fig. 149 (i-m.)

Material : 1 ex., Z. S. I. Reg. No. An 1467/1, Gangasagar, Sagar Is., A. Misra, 21.9.79.

Habitat : Fine sandy mud in the mid-littoral zone.

Description : Proboscis with four horny jaws, papillae with a nail-like appendage ; parapodia with two equal presetal lobes and two unequal postsetal ones ; branchiae simple arising from dorsal edge of parapodium of 35th to 40th foot.

Distribution : Ganjam coast, Orissa ; Cochin backwater ; Ghogha, Gujarat coast.

****Glycera lancadivae* Schmarda, 1861**

Glycera lancadivae Schmarda, 1861 : 95, with text-figs. ; Fauvel, 1953 : 291, fig. 147 (g-h).

Material : 1 ex., Z. S. I. Reg. No. An 1272/1, Mandirtala, Sagar Island, 24-Parganas, A. Misra, 30.7.74.

Habitat : Soft mud in the mid-littoral region.

Description : Papillae on proboscis with 15-20 rows, parapodium with two subequal presetal and one rounded postsetal lobes with dorsal projection, branchiae absent.

Distribution : Madras coast and Lakshadweep.

****Glycera rouxi* Audouin & Milne-Edwards, 1833**

Glycera rouxi Audouin and Milne-Edwards, 1833 : 264 ; Fauvel, 1953 : 297, fig. 149 (a-d)

Material : 2 exs., Z. S. I. Reg. No. An 1468/1, Gangasagar, Sagar Is., A. Misra, 4.8.1979.

Habitat : Fine sandy mud in the mid-littoral zone.

Description : Papillae on proboscis, some smooth conical, a few globular ; parapodia with two equal and pointed presetal lobes and two posterior subequal shorter ones ; branchiae simple, retractile, often indiscernible in preserved specimen.

Distribution : Chandipore, Orissa ; Visakhapatnam ; Gulf of Mannar ; Pamban backwater ; Andamans ; Lakshadweep.

****Goniada emerita* Audouin & Milne Edwards, 1833**

Goniada emerita Audouin & Milne Edwards, 1833 : 268 : 268 ; 1833 Fauvel, 1953 : 282, fig. 144 (h-q).

Material : 2 exs., Z. S. I. Reg. No. An 1345/1, Gangasagar, Sagar Island, 24-Parganas, A. Chowdhury & party, 30.7.78.

Habitat : Moderately soft mud in the mid-littoral zone.

Description : Proboscis with small rounded papillae, 10-15 V-shaped paragnaths (chevrons) at base on each side ; anterior 65 segments uniramous, rest biramous ; notosetae robust, acicular, neurosetae all spinigerous.

Distribution : Visakhapatnam ; Vandruthi, Cochin ; Gujarat Coast.

Family EUNICIDAE

Subfamily EUNICINAE

Eunice aphroditois (Pallas, 1788)

Nereis aphroditois Pallas, 1788 : 229.

Eunice aphroditois, Fauvel, 1953 : 233, fig. 117 (a-g.)

Material : 2 exs., Z. S. I. Reg. No. An 1469/1, Gangasagar, Sagar Is., A. Misra, 4.8.79.

Habitat : Fine sand in the low-littoral zone.

Description : Anterior end with white bar across setiger 4 ; branchiae from 10th foot as simple filaments, these at first branching to show maximum of 15-16 filaments and then gradually diminishing posteriorly ; acicular setae bidentate, compound setae bidentate falcigers with guards.

Distribution : Gangetic delta ; Andamans.

Remarks : The members of this species although large, are very difficult to collect due to their cryptic nature as well as their rapid locomotion within sandy substrata. The method employed for obtaining these worms was to sprinkle the area in which they occur, with water in which rotten fish had been washed when the heads of the worms emerged out and then they were easily removed by hand. They are generally collected to serve as fish bait.

* **Lysidice collaris** Grube, 1870

Lysidice collaris Grube, 1870 : 495 ; Fauvel, 1953 : 248, fig. 124 (a-g).

Material : 1 ex., Z. S. I. Reg. No. An 1276/1, Mandirtala, Sagar Island, A. Misra, 10.5.78.

Habitat : Solid mud in mid-littoral zone.

Description : Eyes reniform ; second dental plate with three heavy teeth ; notosetae capillaries and comb-setae, neurosetae bidentate falcigers.

Distribution : Andamans ; Kilakarai, Pamban, Tamil Nadu ; Gujarat coast.

* **Marphysa macintoshi** Crossland, 1903

Marphysa macintoshi Crossland, 1903 : 137, pl. 14 figs. 3-6, text-fig. 12 ; Fauvel, 1953 : 246.

Material : 1 ex., Z. S. I. Reg. No. An 1470/1, Mandirtala, Sagar Is., 24-Parganas, A. Misra, 30.7.74.

Habitat : Low-littoral soft mud.

Description : Prostomium undivided and horse-shoe shaped ; gills from 20th foot, increasing to a maximum with six filaments and then gradually decreasing ; notosetae capillaries and comb setae, neurosetae compound with knife-shaped terminal piece, acicular setae unidentate.

Distribution : Krusadai Island, Pulicat lake, Tamil Nadu ; Gopalpur, Orissa.

*** *Marphysa mossambica* (Peters, 1854)**

Eunice mossambica Peters, 1854 : 612.

Marphysa mossambica, Fauvel, 1953 : 246.

Material : 1 ex., Z. S. I. Reg. No. An 1273/1, Mandirtala, Sagar Is., A. Misra, 10.5.78.

Description : Prostomium deeply bilobed ; gills on 25th foot, gradually increasing to a maximum of six filaments, continuing upto end of body ; all simple capillaries with fine striations, no comb setae, bidentate acicular setae.

Distribution : Andamans ; Pondichery ; Kilakarai, Gulf of Mannar, Tuticorin, Tamil Nadu.

*** *Marphysa sanguinea* (Montagu, 1815)**

Nereis sanguinea Montagu, 1815 : 20

Marphysa sanguinea, Fauvel, 1953 : 245

Material : 1 ex., Z. S. I. Reg. No. An 1471/1, Gangasagar, Sagar Island, A. Misra, 4.8.79.

Description : Prostomium bilobed ; long dorsal cirri ; Gills appearing on 16th foot, gradually increasing to seven filaments and then decreasing onwards ; notosetae capillaries and comb setae, neurosetae compound and spinigerous only, acicular setae bidentate with small guards.

Distribution : Andamans ; Visakhapatnam ; Pondichery ; Gulf of Mannar, Pamban, Tuticorin, Tamil Nadu ; Travancore, Kerala ; Umbargaon (Damam), Mormagao Bay (Goa) ; Gujarat.

Subfamily ONUPHINAE

*** *Diopatra cuprea cuprea* (Bosc, 1802)**

(Text-fig. 1, a-e)

Nereis cuprea Bosc, 1802 : 142.

Diopatra neapolitana (in part) Fauvel, 1953 : 252, fig. 126 (a-h)

Material : 5 exs., Z. S. I. Reg. No. An 1472/1, Bhangatushkhali, 24-Parganas, A. Misra & T. K. Samanta, 13.3.75.

Habitat : In tough tubes embedded in soft or sandy mud of mid-littoral zone.

Description : Exposed part of tube with shell fragments ; anterior part diffusely brown without any colour pattern ; eyes absent ; frontal antennae subulate ; gills large with spirally inserted filaments, on 5th foot, increasing in size and then gradually decreasing to completely disappear at about 60th to 70th foot ; pseudo-compound setae hooded and strongly bidentate present on first 4 or 5 setigerous segments, comb setae appearing on and from 10th foot and having numerous fine teeth (20-30), bidentate acicular setae beginning from 9th or 10 foot.

Distribution : Part of the material widely recorded from almost all places of Indian coast as *D. neapolitana*, may be *D. cuprea*.

Remarks : Only one species of *Diopatra*, viz., *D. neapolitana* Delle Chiaje has been recorded from the Indian coast by Fauvel (1953) and others. According to Day (1960), however, "It is very probable that many of the records of *D. neapolitana* from the Indian Ocean which refer to specimens with bidentate pseudo-compound setae and comb setae with numerous teeth really refer to *D. cuprea*". Hence, members with unidentate or weakly bidentate pseudo-compound setae and 5 to 10 coarse teeth in the comb setae are referred to *D. neapolitana*. Detailed results of the members of this genus from Indian waters, will appear in our next publication.

Subfamily LUMBRINERINAE

* *Lumbrineris heteropoda heteropoda* (Marenzeller, 1879)

Lumbriconereis heteropoda Marenzeller, 1879 : 138

Lumbriconereis heteropoda, Fauvel, 1953 : 268, fig. 135 (g-h)

Lumbrineris heteropoda heteropoda, Day, 1967 : 440, fig. 17. 17 (1-o).

Material : 10 exs., Z. S. I. Reg. No. An 14/3/1, Bhangatushkhali, 24-Parganas, A. Misra & T. K. Samanta, 14.3.75.

Habitat : Soft mud in the mid-littoral zone.

Description : Prostomium conical ; dorsal cirrus, rudimentary in anterior feet and absent from the rest, in the posterior feet the postsetal lobe long and erect ; anterior feet all with winged capillaries, posterior ones additionally with unjointed hooks.

Distribution : Holiday camp, Chorwad, Gujarat coast ; Marmugao Bay, Goa ; Bombay coast,

***Lumbrineris notocirrata (Fauvel, 1932)**

Lumbriconereis notocirrata Fauvel, 1932 : 156, pl. VII, figs. 1-8.

Lumbriconereis notocirrata Fauvel, 1953 : 271, figs., 138 (a-h) 139 (a-b).

Material : 1 ex., Z. S. I. Reg. No. An 1475/1, Mandirtala, Sagar Island, A. Misra, 6.7.75 ; 2 exs., Z. S. I. Reg. No. An 1474/1, Bhanga-tushkhali, 24-Parganas, A. Misra & T. K. Samanta, 14.3.75.

Habitat : Low-littoral soft mud.

Description : Prostomium blunt, conical ; dorsal cirrus reduced to small knob in anterior feet and long in middle and posterior ones, setigerous process of the feet with two ligules, anterior short, rounded, posterior long, conical, gradually increasing rearward and becoming erect in middle and posterior segments ; setae of two kinds, capillaries in anterior feet and capillaries and simple hooks in middle and posterior ones.

Distribution : Back waters of Visakhapatnam ; Orissa coast.

***Lumbrineris polydesma (Southern, 1921)**

Lumbriconereis polydesma Southern, 1921 : 622, pl., XXVI, fig., 15.

Lumbriconereis polydesma, Fauvel, 1953 : 264, figs., 133 (a-f).

Material : 2 exs., Z. S. I. Reg. No. An 1477/1, Gangasagar, Sagar Is., A. Misra, 21.9.79., 1 ex., Z. S. I. Reg. No. An 1476/1, Mandirtala, Sagar Is., 24-Parganas, A. Misra, 12.7.76.

Habitat : Soft mud in the low-littoral zone.

Description : Body long ; prostomium round ; feet with anterior small, round lobe with capillary setae and posterior ones longer and conical with simple hooks.

Distribution : Chilka lake, Chandipur, Orissa ; Nani and Devka, Gujarat.

Family SPIONIDAE

Polydora sp.

(Text-fig. 1, g-h)

Material : 2 exs., Z. S. I. Reg. No. An 1478/1, Harwood point, Kakdwip, 24-Parganas, A. Misra, 11.9.77.

Habitat : Within U-shaped tubes in medium hard soil in the mid-littoral zone.

Description : Posterior part missing ; 5th setigerous segment modified, with blunt hooks and hastate bristles ; posterior notopodial setae capillaries and neuropodial bidentate hooks without hood.

Remarks : As the specimens are incomplete, specific identification is not possible. The two types of setae in the 5th setigerous segment resemble with that of *P. caeca* (Oersted).

***Prionospio cirrifera** Wiren, 1883

(Text-fig. 1, f)

Prionospio cirrifera Wiren, 1883 ; 409

Prionospio cirrifera, Fauvel, 1953 : 324, fig. 164 (K-M).

Material : 10 exs., Z. S. I. Reg. No. An 1479/1, Taldi, Canning, 24-Parganas, N. Sarangi, 28.4.79.

Habitat : Fine mud in brackish water pond.

Description : Prostomium almost rounded with four subdermal eyes ; gills simple, 10 to 12 pairs starting on setiger 2, simple capillaries in anterior feet, hooded hooks appearing in neuropodium of the middle part also in notopodium of the posterior one, hooks with two series of three long teeth above main fang.

Description : Visakhapatnam, Andhra Pradesh.

Family SABELLARIDAE

Sabellaria pectinata var. **intermedia** Fauvel, 1932

Sabellaria pectinata var. *intermedia* Fauvel, 1932 : 210 fig. 35 ; Fauvel, 1953 : 397 fig. 207 (a-h).

Material : 4 exs., Z. S. I. Reg. No. An 1480/1, Harwood point, Kakdwip, A. Misra, 11.9.77.

Habitat : Living in small, calcareous and fragile tubes.

Description : Outer paleae denticulate, gradually tapering and ending in long and smooth spine, middle ones short and cup-shaped with short smooth tip, inner ones long, spoon-shaped, with serrated margins.

Distribution : Matlah river, Gangetic delta.

Family Terebellidae

Loimia medusa (Savigny, 1820)

Terebella medusa Savigny, 1820 ; 95, fig. 8.

Loimia medusa, Fauvel, 1953 : 416, fig. 218 (a-f).

Material : 3 exs., Z. S. I. Reg. No. An 1481/1, Gangasagar, Sagar Island, West Bengal, A. Misra & P. Roy, 10.7.75.

Habitat : Within membranous, sand coated tubes in hard sandy soil in the mid-littoral zone.

Description : Body long and slender ; short and collar-like lobe with numerous long tentacles ; gills three pairs with numerous slender branches ; thoracic segment seventeen with dorsal winged and smooth capillaries and ventral pectiniform uncini, latter set in double rows back to back on posterior thorax.

Distribution : Andamans ; Gujarat coast ; Gulf of Mannar, Tamil Nadu.

SUMMARY

The paper deals with 27 species of polychaets from the material collected during 1974-80 from Gangetic delta. Nineteen species form new locality records including one from the mainland.

ACKNOWLEDGEMENTS

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BLOOD PARASITES OF INDIAN BULLFROG,
RANA TIGRINA DAUD.

By

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(With 2 Plates and 2 Text-figures)

INTRODUCTION

In India, little attention has been paid to study the blood parasites of anuran amphibians. Berestneff (1903) reported a haemoflagellate, *Trypanosoma* from *Rana tigrina* for the first time from India. After that Patton (1908), Wenyon (1926), Scott (1926, 1927) and Pujati (1953) reported the occurrence of *Trypanosoma* and *Haemogregarina* in the blood of the same frog.

Recently during the survey on the blood parasites of Indian amphibians a total of 21 spp. of toads and frogs were examined (Ray and Mandal 1976, 1978 ; Ray 1977, 1979a b and Ray and Choudhury, 1980) of which *Rana tigrina*, a Bullfrog was found to be the most resourceful environment for a number of blood parasites and hence the present communication.

MATERIALS AND METHODS

The common Indian Bullfrog, *Rana tigrina* were collected from different districts of West Bengal and some were kept alive in the laboratory for study. Peripheral blood was obtained from the finger tips on alternate days and at autopsy. "Impression" and "Spread" preparations were made from liver, lungs, kidney and bone-marrow. Air-dried blood films and organ imprints were fixed in 100% methanol and stained with Romanowsky type of stains. For microtome section the tissue of lung, liver, kidney and spleen were fixed in Bouin's fixative, followed by general histological technique by Pearse (1960), and stained with iron-haematoxylin and eosin.

Measurements were obtained from the camera-lucida drawings drawn on a graph paper (mm division) by counting the squares covered. The photomicrographs were taken with the help of "Ergavel" C. Z. microscope using PM6 attachment camera.

OBSERVATION

In course of investigation on the anuran haematozoa the author has examined 164 *Rana tigrina* of which 84 (51.21%) were found to be infected with various intracellular viz., *Haemogregarina magna* (17.6%), *H. perinucleophilum* sp. nov. (8.5%), *Lankesterella minima* (3%), *Pirhemocytion ranarum* (5.2%), *Cytamoeba bacterifera* (6.8%) and extracellular parasites viz., *Trypanosoma rotatorium* (31%), Microfilaria (0.6%). The brief descriptions of these parasites are as follows :

Trypanosoma rotatorium (Mayer, 1843)

(Pl. I, fig. 1)

1843. *Trypanosoma rotatorium* Mayer, 'Spicilegium observationum anatomicarum de organo electrico in *Ralis anelectricis* et de Haematozois ; Bonnae.

Description : *Trypanosoma rotatorium*, a pleomorphic haemoflagellate, is represented by 4 distinct forms viz., juvenile, slender, flat leaf-like and large compact form (Ray, 1979a, b). Amongst which the flat leaf-like forms are most predominant. They measure 29.0 μm in length and 4.5 μm in width. The free flagellum is very prominent and measures 24.0 μm in length. The cytoplasm, densely granular in the posterior two-third of the body, stains deep blue and has striated myonemes (3-5 in number) along its longitudinal axis.

Oval or rounded nucleus measuring $2.4 \times 1.6 \mu\text{m}$, is situated on the posterior part of the body (NI=0.3).

Kinetoplast staining deep blue-black with Leishman, very small ($0.8 \times 0.8 \mu\text{m}$) spherical or rod-like and surrounded by a halo, is situated at the extreme posterior end of the body (KI=2.5).

A few amastigote and epimastigote forms were detected in the blood and bone-marrow smears.

Remarks : The trypomastigote stage of *T. rotatorium* exhibited conspicuous pleomorphism with four distinct forms as reported by Wenyon, 1926, Mohammed and Mansour, 1959b. All these four forms of *T. rotatorium* have been found in the blood of *Rana tigrina* collected from a particular locale (Balitha, Bankura, West Bengal).

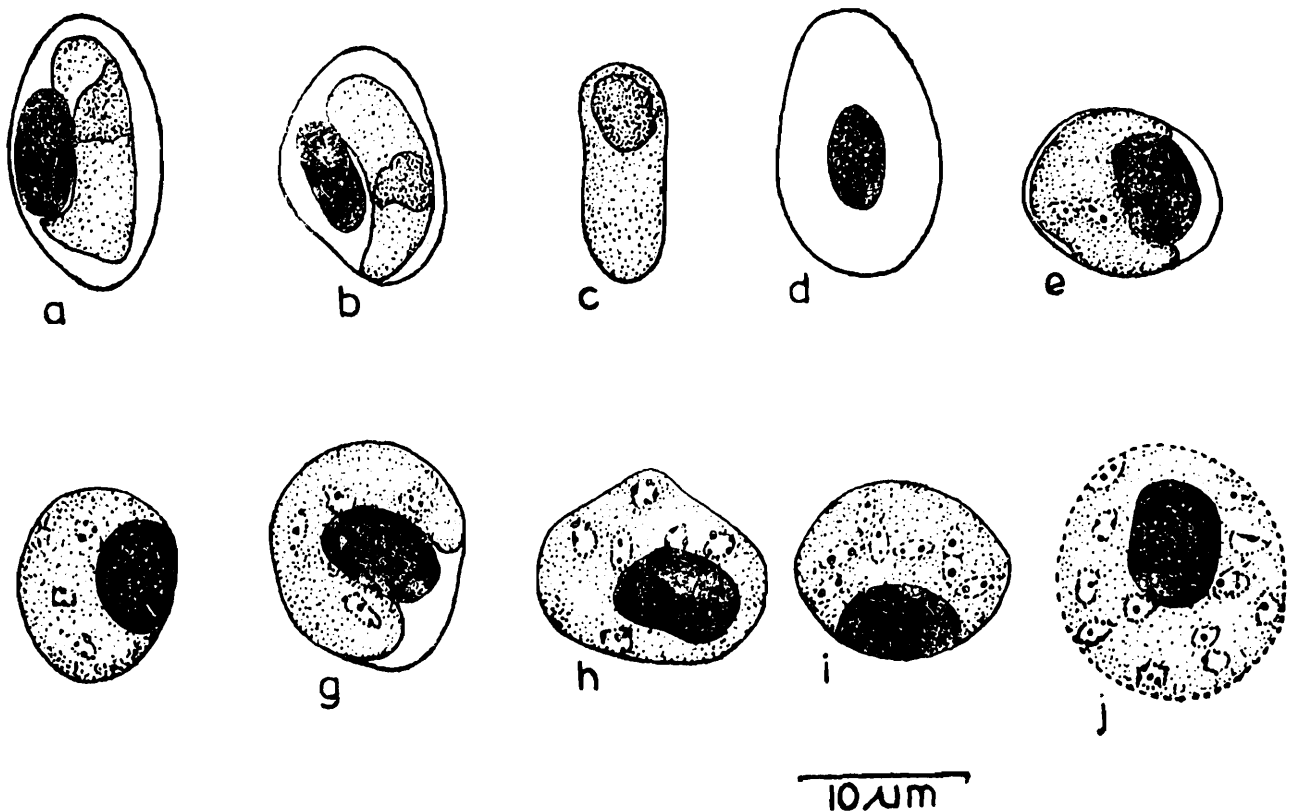
Haemogregarina magna (Grassi and Feletti, 1891)

(Pl. I, figs. 2-8 & Text-figs. 1 a-j)

1891. *Haemogregarina magna* Grassi and Feletti, *Cert. f. Bakt. u. Parasit.* 10 : 449.

Description : Intra-cellular gametocytes (Pl. I, fig. 2 & Text-fig. 1 a, b) : Gamonts are elongated with broadly rounded anterior end and a little

narrower posterior end. The mature form is $12.4 \times 4.06 \mu\text{m}$ and $44.5 \mu\text{m}^2$ in area, occupying about 42.7% of the total host cell-parasite complex. Cytoplasm homogeneous, hyaline, a little granular and stained pinkish blue with Giemsa stains. The nucleus is broad to oval, sometimes rounded or band-shaped. It measures $4.4 \times 3.3 \mu\text{m}$ and $12.1 \mu\text{m}^2$ in area. The parasite was never found to be enclosed in a capsule.



Text-fig. 1 a-j. Camera-lucida drawings of the erythrocytic stages of *Haemogregarina magna* from *Rana tigrina*. a & b, the mature macrogametocytes; c, the extracorporeal free gametocytes; d, the uninfected erythrocytes.; e, the bi-nucleated schizont; f, the tri-nucleated schizont; g, the quadri-nucleated schizont; i, the mature schizont with developing merozoites; j, the mature erythrocytic schizont with 12 nuclei.

Free gametocyte (Pl. I, fig. 3 & Text-fig. 1 c): In some cases free forms were seen in the blood plasma. They are similar in appearance like that of intracellular gametocytes. They measure $11.4 \times 4.16 \mu\text{m}$ and $47.7 \mu\text{m}^2$ in area. The nucleus is compact, rounded measuring $4.36 \times 3.25 \mu\text{m}$ and $12.21 \mu\text{m}^2$ in area, and always situated towards the anterior side.

Schizogony: Two types of schizogony both in the R. B. C. and in the endothelial cells of the lung tissue were observed. (Pl. I, figs. 4-8 & Text-fig. 1 e-j).

Erythrocytic schizont measures $12.5 \times 10.70 \mu\text{m}$ and $103.9 \mu\text{m}^2$ in area. Mostly bi-, tri- and tetranucleated schizonts were found. The mature schizont possesses 12 fully developed spindle shaped merozoites.

They measure $1.9 \times 1.05 \mu\text{m}$ and $1.3 \mu\text{m}^2$ in area (Pl. I, fig. 4 & Text-fig. 1 j).

Schizonts were also found in the endothelial cells or free in the capillaries of the lung tissue. The immature uninucleate schizonts are spherical lay in a parasitophorous vacuole, measuring $5.00\text{-}10.00 \mu\text{m} \times 4.00\text{-}9.5 \mu\text{m}$. The mature schizonts are spherical to subspherical, measuring $19.5\text{-}42.0 \times 19.0\text{-}43.0 \mu\text{m}$ with an average of $31.57 \mu\text{m}$ and contain 30 or more merozoites. (Pl. I, fig. 8). They are elongated lanceolate, straight or curved bodies measuring $5 \times 1.3 \mu\text{m}$.

Locality : Bishnupur, Bankura district, West Bengal.

Remarks : Berestneff (1903), Patton (1908), and Wenyon (1926) recorded this parasite from Indian frog, *Rana tigrina*. Recently Levine and Nye (1977) observed this parasite from the frogs of Illinois, New York, Tennessee and Wisconsin and substantiate the species description with quantitative measurements : Morphometric measurements of the parasite obtained from *Rana tigrina* from West Bengal, India, are included herein and the erythrocytic schizogony of the parasite is described for the first time.

***Haemogregarina perinucleophilum* sp. nov.**

(Pl. II, figs. 1 & 2 and Text-figs. 2 a-j)

Type host : *Rana tigrina* Daudin.

Type locality : Balitha, Bankura District, West Bengal.

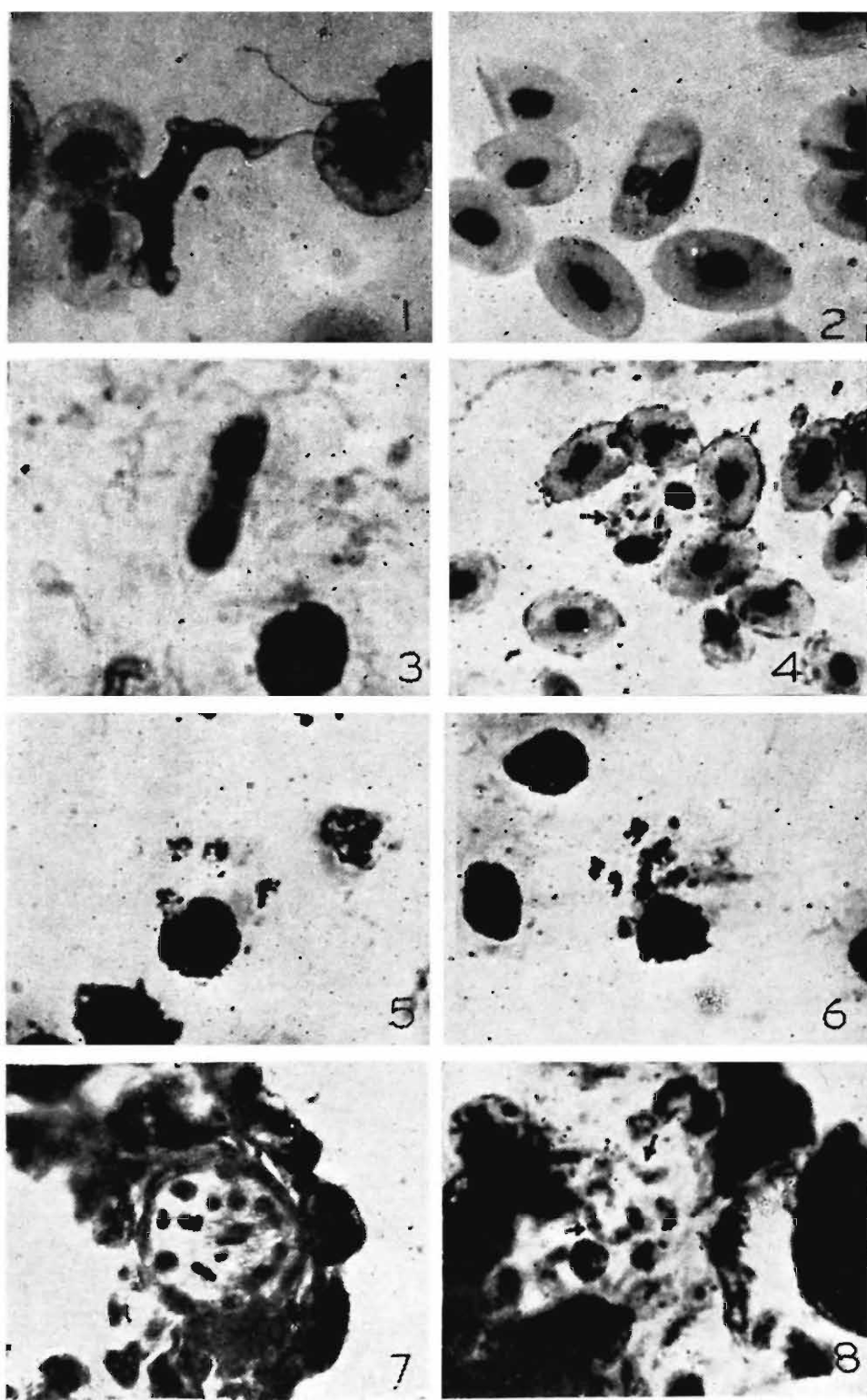
Registration No. *Holotype* Pt. 1953.

Paratype Pt. 1954.

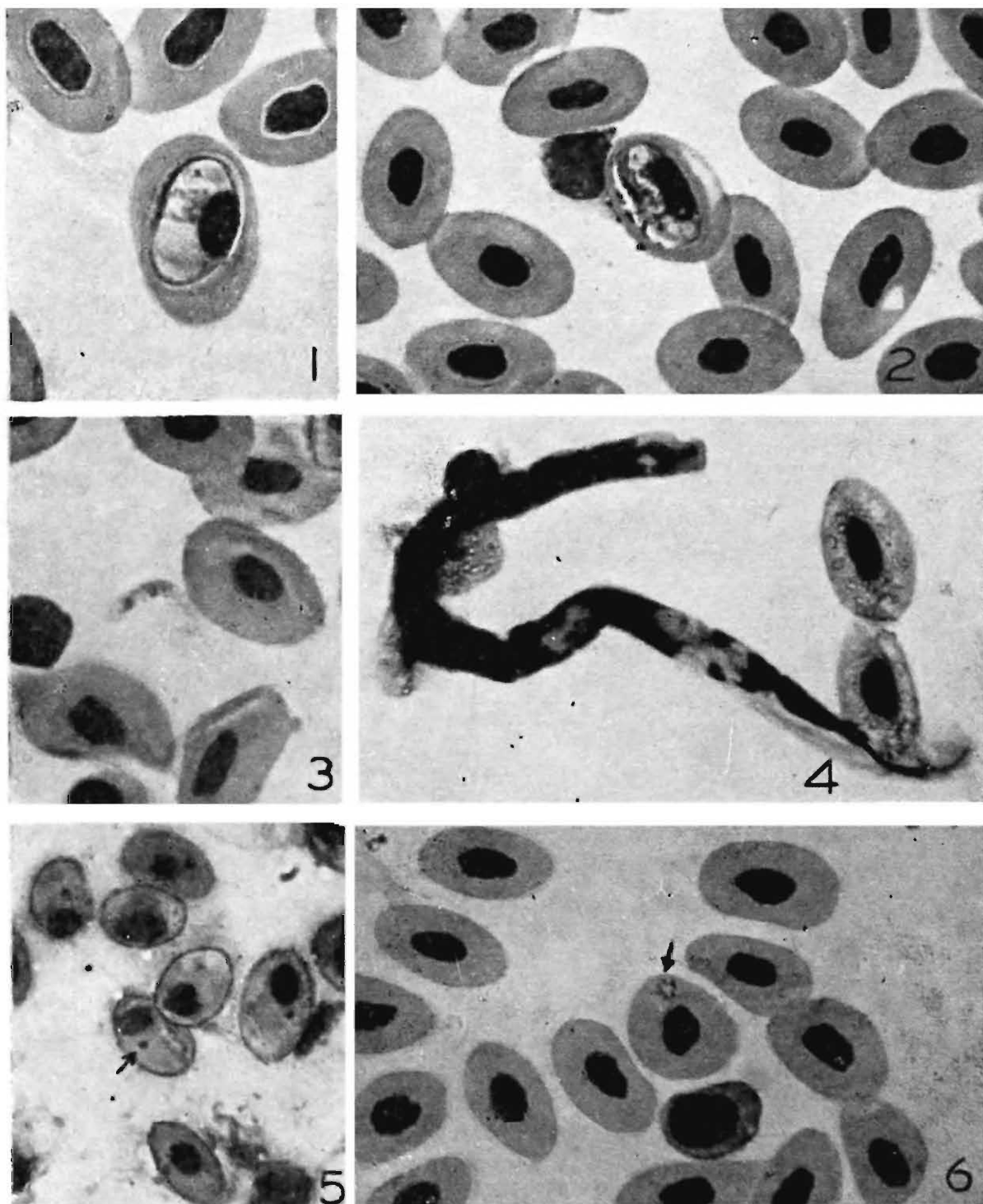
Description : *Young and Growing forms* (Text-fig. 2 e-h) : There are two forms—broad and thin form. The broad forms are elongated with both the ends rounded, occur mostly within the immature erythrocytes. They measure $9.0 \times 3.2 \mu\text{m}$ and $22.8 \mu\text{m}^2$ in area. Cytoplasm is densely granular. Nucleus is composed of chromatin rods at the centre of the parasite crossing the entire width of the body. It measures $3.5 \times 2.0 \mu\text{m}$ and $6.5 \mu\text{m}^2$ in area.

The thin forms are also elongated, measuring $8.0 \times 1.5 \mu\text{m}$ and $13.25 \mu\text{m}^2$ in area. The cytoplasm is densely granular, stained dark blue. Nucleus measures $4 \times 2 \mu\text{m}$ and $4.5 \mu\text{m}^2$ in area, stained purple red with Wright and Giemsa stains.

Elongate mature form : Mature parasites are elongated gregariniform having a broader head, attenuated thin body and a hook-like pointed tail. The parasite always encircles the host cell nucleus by its twisted



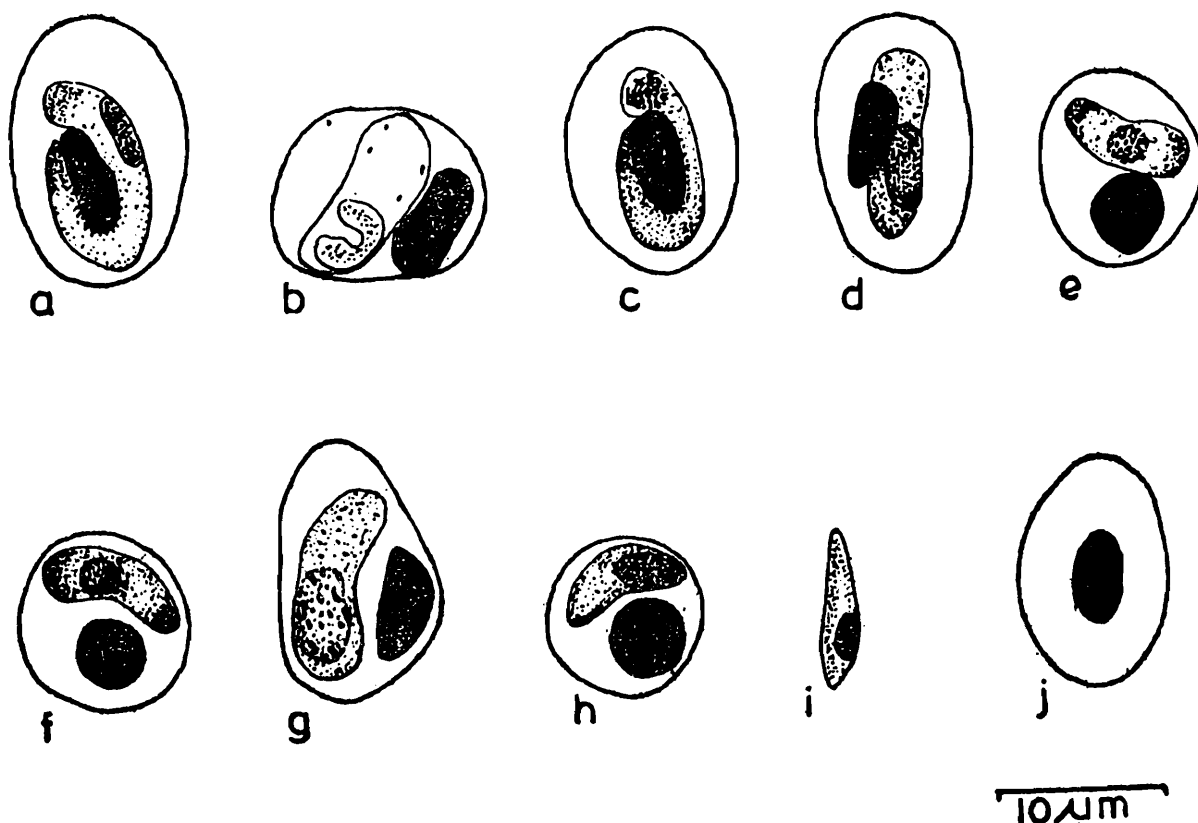
- Figs. 1-8. 1. Typical leaf-like form of *Trypanosoma rotatorium* $\times 1100$
 2. Intra-cellular gametocyte of *Haemogregarina magna* $\times 1250$
 3. Free gametocyte of *H. magna* $\times 1335$
 4-6. Erythrocytic schizonts (arrow) of *H. magna* $\times 1000$, $\times 1250$, $\times 1250$
 7. A mature schizont in the endothelial cells of lung capillaries $\times 1760$
 8. The merozoites (arrow) in the lung tissue $\times 1000$



Figs. 1-6. 1. Microgametocyte of *Haemogregarina perinucleophilum* sp. nov. $\times 3550$
 2. Macrogametocyte of *H. perinucleophilum* sp. nov. $\times 2165$
 3. Free sporozoite of *Lankesterella minima* $\times 1750$
 4. Microfilaria in the blood of *Rana tigrina* $\times 1000$
 5. *Pirhemocyon ranarum* (arrow) in the blood of same frog $\times 1250$
 6. *Cytamoeba bacterifera* (arrow) in the same host $\times 1250$

body. In some cases they may push the host cell nucleus at one corner. They measure $11.1 \times 3.1 \mu\text{m}$ and $25.7 \mu\text{m}^2$ in area. One parasite measures $18.5 \times 4.0 \mu\text{m}$ with an area of $37.5 \mu\text{m}^2$, occupying about 29.3% of the total host cell-parasite complex.

Cytoplasm densely granular, thicker at the ends ; stained deep blue with Leishman's stain. Nucleus is oval or kidney shaped, situated at the anterior half of the body. It measures $3.4 \times 2.2 \mu\text{m}$ with an area of $6.0 \mu\text{m}^2$ and contains less compact chromatin granules. The capsule is not present in this parasite. The microgametocyte possesses a very clear cytoplasm and less compact, band-like nucleus. Macrogametocyte has dense cytoplasm and a compact nucleus (Pl. II, fig. 2).



Text-fig. 2 a-j. Camera-lucida drawings of the erythrocytic stages of *Haemogregarina perinucleophilum* sp. nov. in *Rana tigrina*. a, the macrogametocyte ; b, the microgametocyte ; c & d, the mature macrogametocytes ; e-g, the young broad forms of gametocytes ; h, the young thin forms ; i, the extracorporeal free form ; j, the uninfected erythrocyte.

Extra-corporeal free form (Text-fig. 2 i) : Small, elongated, gregariniform, comparatively fewer in number. Anterior end broader than the posterior which is more or less pointed. They measure $9.6 \times 2.6 \mu\text{m}$ and $13.9 \mu\text{m}^2$ in area. Cytoplasm homogeneous, granular ; stained deep blue with Leishman. The nucleus is rounded or ovoid, sometimes elongated, situated at the anterior half of the body, towards the broader end. It measures $2.7 \times 1.5 \mu\text{m}$ and $2.0 \mu\text{m}^2$ in area.

Effect of parasite on the host cell : The infected erythrocytes became hypertrophied with the displacement of host cell nucleus even in early infection. The host cell nucleus became rounded and sometimes pushed to one corner of the host cell. Host cell hypertrophied only in width (12.79%). Host cell nucleus hypertrophied in area (26.22%).

Occurrence : Out of 164 examples of *Rana tigrina* examined 14 were found to be infected with this parasite.

Remarks : A perusal of the literature revealed that only two species of haemogregarine viz., *Haemogregarina berestneffi* Castellani and Willey and *H. magna* (Grassi and Feletti) were recorded so far in the host *Rana tigrina* from India. Patton (1908) had the opportunity of studying a good number of *Haemogregarina* from amphibian hosts and suggested the presence of some different haemogregarines within the same host.

Haemogregarina perinucleophilum sp. nov. is distinguished from the other haemogregarines by the fact that the mature gametocytes characteristically encircles the host cell-nucleus with its twisted body after which the specific name of the parasite has been coined. The present parasite differs from *H. berestneffi* in not having the capsule and also on the basis of morphometric measurements (Table 1). It can also be differentiated from *H. magna* by its characteristic encircling nature of the parasite to its host cell nucleus and by the position and structure of the parasite nucleus.

Lankesterella minima (Chaussat, 1850)

(Pl. II, fig. 3)

1850. *Lankesterella minima* Chaussat, 'Des hematozoaires (Thesis for the Doctorate degree in Medicine, Paris).

Description : *Sporozoite* : The vermiform elongated sporozoite measure 10.0-11.5 μm in length with a mean of 10.5 μm and 1.0-2.0 μm in width with a mean of 1.5 μm . The nucleus is median to subterminal with a clear refractile area towards the periphery. The cytoplasm is homogeneous, hyaline with more darker margins and stained faint blue. The delicate nucleus is of vesicular type with a central irregular karyosome and peripheral coarser chromatin granules of pinkish colour with Wright stains. Two vacuoles are very clear, located anterior and posterior to the nucleus. An extranuclear granule is also visible at the anterior end of the sporozoite.

After invading the erythrocytes the sporozoites form a crescent-shaped area within the erythrocytes. The intracorpuseular sporozoites became shorter and wider, sometimes attain a greater width.

TABLE 1 : Comparative morphological measurements of the gametocytes of *H. berestneffi*, *H. magna* and *H. perinucleophilum* sp. nov. recorded from *Rana limnocharis* and *R. tigrina* in the present study. Linear measurements in micrometers and area measurements in micrometer². Standard deviation in parenthesis.

	<i>H. berestneffi</i>	<i>H. magna</i>	<i>H. perinucleo- philum.</i>
Uninfected RBC			
Length	12.9(0.37)	15.6(1.26)	13.0(1.5)
Width	9.1(0.53)	8.5(0.52)	8.6(0.82)
Area	86.97(9.41)	94.4(12.95)	87.0(11.25)
Nuclear area	13.04(2.13)	12.2(1.92)	11.10(2.25)
NDR*	0.95(0.05)	0.92(0.06)	0.90(0.07)
Infected RBC			
Length	14.05(0.43)	15.1(0.83)	12.8(2.18)
Width	10.50(0.83)	9.3(0.41)	9.7(1.05)
Area	101.45(12.04)	104.2(8.02)	87.7(16.42)
Nuclear area	13.97(2.12)	18.3(2.81)	13.2(2.84)
NDR*	0.23(0.08)	0.22(0.15)	0.26(0.21)
Intracorpuseular parasite (Gametocyte)			
Length	16.50(0.76)	12.4(1.11)	11.1(3.3)
Width	2.57(0.32)	4.06(0.23)	3.1(0.76)
Area	29.56(3.18)	44.50(7.09)	25.7(7.06)
Nuclear area	5.13(0.76)	12.10(1.93)	6.0(1.90)
Extracorpuseular parasite (Free gametocyte)			
Length	17.60(0.74)	11.40(1.68)	9.6(0.37)
Width	2.30(0.22)	4.16(0.23)	2.6(0.37)
Area	27.70(1.28)	47.70(6.81)	13.9(0.95)
Nuclear area	4.77(1.34)	12.21(2.05)	2.0(0.26)

* NDR = Nuclear Displacement Ratio.

Developmental stages : The sporozoites make their way into the blood capillaries of various organs and enter the endothelial cells where the entire development takes place. The uninucleate schizonts are spherical measuring 7.5-8.5 μm in diameter. Tri-or pentanucleated schizonts are also being encountered in the tissue preperation of lungs and liver. The schizonts fully packed with merozoites numbering 16-25 are also found in the section of lungs.

The merozoites are elongated with one end tapering than the other. They measure 6.0 μm in length and 1.5 μm in width. The spherical macro and microgametocytes measure 6-8 μm . The oocysts are spherical containing 10-20 sporozoites and a compact oocystic residual mass.

Locality : Bankura and 24-Parganas districts, West Bengal.

Remarks : Ray and Mandal (1978) described the life-cycle of *Lankesterella minima* in detail. Previously Bhatia (1938) in his monumental work on the Fauna of British India, mentioned the occurrence of *Lankesterella minima* from *Rana tigrina* and presented the life-cycle based on Nöller (1912, 1920). The findings of the present author well corroborated with Nöller's findings.

Dactylosoma Labbe'

1894. *Dactylosoma Labbe'*, *Arch. Zool. exp. gen.*, 2 : 54.

Generic diagnosis : The genus *Dactylosoma*, Labbé, 1894, parasitising the erythrocytes of amphibia, is characterized by the presence of schizogony ; nucleus with an endosome, a less granular and more vacuolated cytoplasm at all stages. It lacks pigment granules. The schizonts of *Dactylosoma* produce 4-16 merozoites, often with the predivision nuclei arranged somewhat quadrilateral mass (Manwell, 1964).

Remarks : Manwell (1964) has made an up-to-date survey of the literature of this parasite. A large number of species of *Dactylosoma* have been described from fishes, frogs and toads as well as from reptiles.

This parasite though wide spread in its occurrence both in frogs and some other vertebrates, it could not be observed in any of the hosts examined during the present study and till now species of *Dactylosoma* from Amphibians has not been reported from India.

Larval Nematode (Microfilaria)

(Pl. II, fig. 4)

Description : The microfilariae are long, slender, serpent-like measuring 92.2-100.5 μm in length and 4.5-5.0 μm in width. Cephalic space is more or less rounded measuring 2.5 μm in diameter. The nuclear column consists of many nuclei haphazardly arranged and stained deep red with Leishman. There are four oval shaped 'G' cells. The first 'G' cell is situated a little behind the second. The tail is 13.0 μm in length which terminates gradually into a pointed end. A spoon shaped prolongation of the sheath is well marked beyond the tail which measures 24.5 μm in length and stained reddish in colour. Position of land marks : nerve ring 22.5-24.4% ; excretory pore 39.5-42.8% ; central viscous 67.7-68.0% ; anus 68.5-74.2%.

Locality : Balitha, Bankura District, West Bengal.

Remarks : Walton (1964) listed some larval nematodes (microfilariae) from frogs. Mathis and Léger (1911) (cf Walton A. C., 1950) reported

Microfilaria sp. from Indo-China region. Nandi and Mandal (1977) reported the occurrence of microfilariae from *Bufo melanostictus* in India. Present author observed sheathed microfilaria from the peripheral blood of *Rana tigrina* which constitutes the second host record of its kind and first report from India in this host.

Doubtful Protozoans

***Pirhemocyton ranarum* Ray and Mandal**

(Pl. II, fig. 5)

1976. *Pirhemocyton ranarum* Ray and Mandal, *Proc. zool. Soc. Calcutta*, **31** : 85.

Description : The parasites are small 1-2 μm in diameter with a central chromatin dot surrounded by clear cytoplasm which stained pink with Wright stain. Sometimes the chromatin dots are located at the periphery. In some cases the chromatin dots appeared to be dividing into 2 or 3. The parasites are usually in contact with an unstained globular body.

Locality : Tarakeshwar, Hooghly District, West Bengal.

Remarks : Chatton and Blanc (1914) observed this organism in the red blood cells of North African Gecko and established the genus *Pirhemocyton*. Dasgupta (1959, 1961) did some cytochemical observations on *Pirhemocyton* of *Rana occipitalis*. Recently Ray and Mandal (1976) described this species of *Pirhemocyton* from an Indian Bullfrog *Rana tigrina*. The taxonomic position of this organism is doubtful even today.

***Cytamoeba bacterifera* Labbé**

(Pl. II, fig. 6)

1894. *Cytamoeba bacterifera* Labbe', *Arch. Zool. exp. gen.*, **2** : 58.

Description : The parasites are of two morphological types. Smaller types are circular measuring 3-4 μm in diameter, intra-cellular, contained in a clear space within the R. B. C. The parasites stained light blue with Leishman's stain and having small dot-like dark granules scattered throughout the cytoplasm.

The larger types are also circular, measuring 5.0-6.5 μm in diameter, situated at the periphery of the erythrocytes. Other characters are similar like the small forms.

Locality : Sagar Islands, 24-Parganas, West Bengal.

Remarks : *Cytamoeba bacterifera* has been observed by a number of workers in the blood of anuran amphibians. Kruse (1890), probably

the first to figure this parasite, speaks of it not as an organism but as a space in the blood. Labbé (1894), Ziemann (1898), Laveran (1899) Dutton *et al.* (1907), Lehmann (1961) reported this organism from anuran amphibians. Ray (1979 b), observe this organism from anuran amphibians of India. The taxonomic status of this parasite is also doubtful to-day even though they may be listed in the protozoology textbooks.

DISCUSSION

In course of investigation on Amphibian haematozoa a number of blood parasites were found to infect the common Indian bullfrog *Rana tigrina*. The blood parasites which are recorded from this frog include the genera *Trypanosoma*, *Haemogregarina* and *Lankesterella* belonging to phylum protozoa and larval nematodes like microfilaria of the phylum Aschelminthes. Besides these some intracellular organisms viz. *Cytamoeba* and *Pirhemocytos* were also recorded whose taxonomic position is a matter of dispute even today.

Trypanosoma rotatorium is pleomorphic and shows 4 distinct trypomastigote forms. A considerable number of haemogregarine species have been recorded from amphibians, but observation on schizogonic development has been so seldom made. Mohammed and Mansour (1959a) opined that the shape, cytoplasmic and nuclear structure, staining reactions, the effect of the gametocytes on the host cells and nuclei may be accounted as reliable criteria.

However, current diagnosis of the genus *Haemogregarina* (*sensu strictu*) may specify the occurrence of schizogony in the cells of the circulating blood. The generic name *Haemogregarina* may be used in its broad sense (*sensu latu*) for those species in which schizogony in the circulating blood is unknown. The author proposes the generic term *Haemogregarina* (*sensu strictu*) for *Haemogregarina magna* which exhibits typical schizogony in the circulating blood of *Rana tigrina* and *Haemogregarina* (*sensu latu*) for *H. perinucleophilum* sp. nov. in which case schizogony could not be observed. Nöller (1912, 1920) is credited for his pioneer contribution to the study of the life-cycle of *Lankesterella minima* and his experiments with leech as mechanical vector. Nöller's work on the life-cycle of *L. minima* is endorsed with morphometric measurements.

A perusal of the literature revealed that there is only one report of microfilaria from *Rana tigrina* (Walton, 1950) where Mathis and Léger (1911) reported the same from Indo-China region. The microfilaria reported herein constitutes the second host record of its kind and first report from India in this host. Ray and Mandal (1976) described

Pirhemocyon ranarum from *Rana tigrina* for the first time in India. *Cytamoeba* is also reported from this frog for the first time from India.

SUMMARY

1. The paper deals with the description of some intracellular and extracellular parasites of common Indian edible frogs, *Rana tigrina* Daud.
2. The extracellular protozoan parasite *Trypanosoma rotatorium* shows pleomorphism in the host *Rana tigrina* collected from a particular locality.
3. *Haemogregarina magna*, an intracellular blood parasite has been reported herein along with its erythrocytic schizogony and tissue schizogony for the first time in India.
4. *Haemogregarina perinucleophilum* sp. nov. has been described as new to science ; *Lankesterlla minima*, a haemococcidia has reported alongwith morphometric measurements.
5. A Microfilaria and some doubtful organism like *Pirhemocyon* and *Cytamoeba* have also been described in the present paper.
6. The current diagnosis of the genus *Haemogregarina* has been discussed.

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FURTHER RECORDS OF POLYCHAETES FROM GUJARAT COAST

By

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(With 10 Text-figures)

Our knowledge of the polychaete fauna of Gujarat coast is limited with about 65 species now recorded (Dalal and Dubale, 1975 & 1976 ; Rao and Soota, 1981 ; Soota, Misra and Chakraborty, 1981). While studying the unnamed polychaete material collected from different coral-inhabited regions of Gujarat coast, we came across several specimens hitherto not recorded from the area (marked with an asterisk) and few others with some unrecorded structural variations.

Although the polychaetes are not the dominant fauna of a particular habitat, they have certain important place in the complex food chain prevailed in that area. Moreover, the variety and abundance of species present can be used as an indication of the cleanliness of the environment in which they live (Moore, 1972).

SYSTEMATIC ACCOUNT

Family : AMPHINOMIDAE

* *Euphrosyne myrtosa* Savigny, 1818

Euphrosyne myrtosa Savigny, 1818, *Histoire naturelle des animaux sans vertebres* : 332 ; Fauvel, 1953, *The Fauna of India, Annelida, Polychaeta* : 101.

Material : 1 ex., ZSI Reg. No. An 1387/1 ; Veraval, Port area ; B. P. Halder ; 24.1.1978.

Remarks : Earlier recorded from Tamil Nadu coast.

Family : NEREIDAE

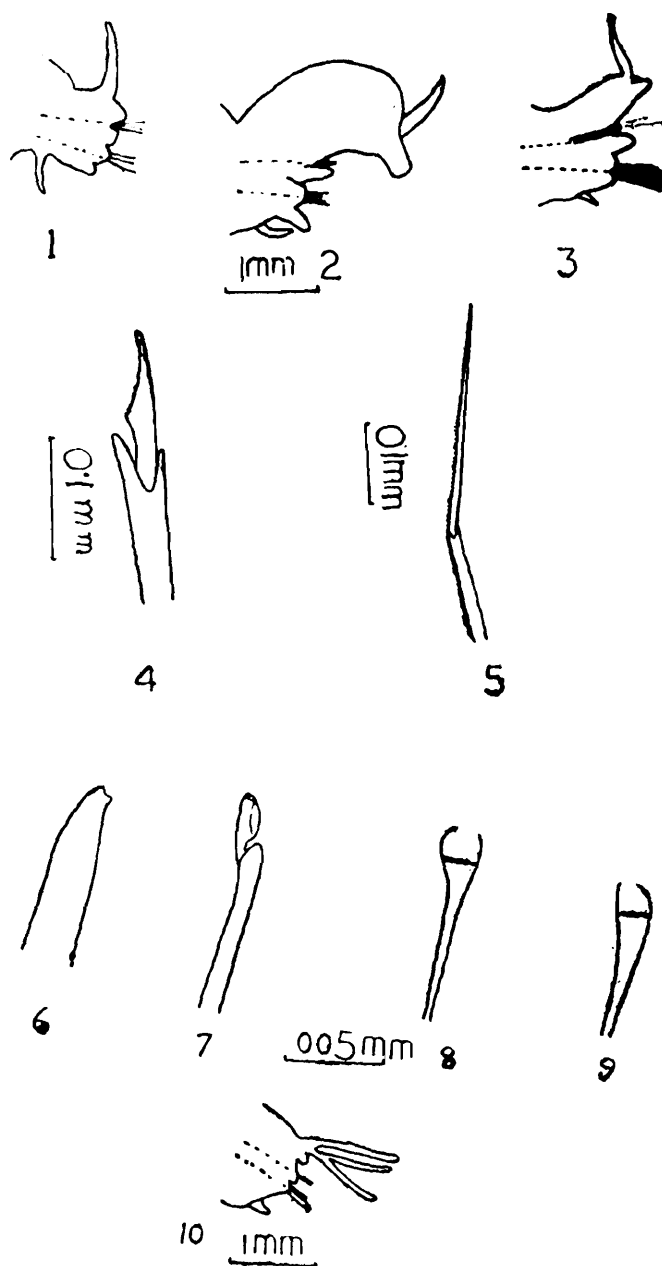
Nereis (*Neanthes*) sp.

(Text-figs. 1-5)

Material : 1 ex. ; ZSI. Reg. No. An 1445/1, Jalandar, Fort Diu ; B. P. Halder ; 27.1.1978.

Description : Length 90 mm ; body colour pale brown ; arrangement of the paragnaths on the proboscis is as : Gr I=2 points, Gr. II=4 oblique rows of conicals, Gr. III=3 transverse rows of conicals, Gr. IV=3 rows and few irregularly arranged conicals, Gr. V=nil, Gr. VI=3

points in one side and very faint in another side, Gr. VII & Gr. VIII = a single row of 7 conicals; anterior feet with two lobes and a large dorsal cirrus, the superior lobes gradually expanding with longer dorsal cirrus towards the posterior end where it lamellate, in mid-posterior region it is globular in about 8 to 10 segments; notosetae homogomph spinigers throughout, neurosetae include both spinigers and falcigers.



Text-figs. 1. Anterior feet of *Nereis* (*Neanthes*) sp. 2. Mid-posterior feet of *Nereis* (*Neanthes*) sp. 3. Posterior feet of *Nereis* (*Neanthes*) sp. 4. Falciger of *Nereis* (*Neanthes*) sp. 5. Spiniger of *Nereis* (*Neanthes*) sp. 6, 7, 8. Simple, compound and comb setae of *Eunice* sp. 9, 10. Feet with gills and comb setae of *Marphysa sanguinea*.

Remarks : This species is closely related to *N. (Nereis) coutierei* Gravier particularly with respect to the arrangement of paragnaths. But the absence of notopodial falcigers from the posterior feet, the structure of anterior, mid-posterior and posterior parapodia and large size of the species under study distinctly differentiate them.

*** *Nereis (Neanthes) willeyi* Day, 1934**

Nereis willeyi Day, 1934, *J. Linn. Soc. zool.*, **39** : 39.

Material : 1 ex., (heteronereis) ; Z. S. I. Reg. No. An 1388/1 ; Veraval ; *B. P. Haldar* ; 24.1.1978.

Description : Arrangement of the paragnaths on the proboscis is as : Gr. I=0, Gr. II=3-4 conicals forming an oblique double row, Gr. III=an oval patch ; Gr. IV=a wedge-shaped cluster ; Gr. V=O, Gr. VI=rosette of six, Gr. VII & VIII=3 to 4 irregular rows of numerous dots.

Remarks : First record of the heteronereis stage of this species from the Indian waters (Puri), is by Soota & Rao (1977).

*** *Nereis (Nereis) coutierei* Gravier, 1899**

Nereis coutierei Gravier, 1899, *Bull. Mus. Hist. nat.*, **5** : 237 ; Fauvel, 1953, *The Fauna of India, Annelida, Polychaeta* : 187.

Nereis (Nereis) coutierei, Day, 1967, *Brit. Mus. (Nat. Hist.) Lond.*, Publ. No. 656 : 311.

Material : 2 exs, ZSI. Reg. No. An 1381/1 ; Veraval ; *B. P. Haldar* ; 24.1.1978.

Remarks : Earlier recorded from Andamans and Gulf of Mannar.

*** *Perinereis cultrifera* (Grube, 1840)**

Nereis cultrifera Grube, 1840, *Actinien Echinodermen...Mittelmeeres* : 74 ; *Perinereis cultrifera*, Fauvel, 1953, *The Fauna of India, Annelida, Polychaeta* : 206.

Material : *P. cultrifera* var. *typica* (Grube, 1840)—1 ex ; ZSI. Reg. No. An 1228/1 ; Wanakbara beach, Diu ; *B. P. Haldar* ; 26.1.1978. 1 ex. ; ZSI Reg. No. An 1385/1 ; Jalandar beach, Fort Diu ; *B. P. Haldar* ; 27.1.1978.

P. cultrifera var. *floridana* Ehlers, 1887—1 ex ; ZSI Reg. No. An 1221/1 Jalandar beach, Fort Diu ; *B. P. Haldar* ; 27.1.1978.

P. cultrifera var. *helleri* Grube, 1878—1 ex ; ZSI Reg. No. An 1235/1 ; Jalandar beach, Fort Diu ; *B. P. Haldar* ; 27.1.1978.

Remarks : All the three varieties are recorded for the first time from the area. Earlier records of *typica* from Andamans and Cape comorin ; of *floridana* from Cape comorin and of *helleri* from Andamans, Gulf of Mannar and Bombay Harbour.

***Perinereis nuntia* (Savigny, 1820)**

Lycoris nuntia Savigny, 1820. *Système des annelides...Syrie, etc.* 33 ; *Perinereis nuntia*, Fauvel, 1953, *The Fauna of India, Annelida, Polychaeta* : 212.

Material : *P. nuntia* var. *typica* Savigny, 1820—2 exs, Z. S. I. Reg. No. An 1446/1, Adatara, Okha ; *Daniel & Party* ; 11.11.1968.

P. nuntia var. *brevicirris* (Grube, 1867)—3 exs. ZSI Reg. No. An 1447/1 ; Pirotan Is. ; Daniel & Party ; 17.11.1968.

P. nuntia var. *heterodonta* Gravier, 1901—1 ex. ZSI Reg. No. An 1448/1 ; Veraval ; Daniel & Party ; 26.11.1968.

P. nuntia var. *vallata* (Grube, 1857)—1 ex ; ZSI Reg. No. An 1449/1 ; Gopnath ; Daniel & Party ; 30.11.1968.

Remarks : *Perinereis nuntia* (Savigny) is reported to occur in Gujarat coast. But there is no record of any variety from the area. Earlier records of *typica* from Andamans, Orissa coast, Gulf of Mannar, Pamban, Tuticorin and Bombay coast ; of *brevicirris* from Andamans, Gulf of Mannar, Cape comorin, Tuticorin and Bombay coast ; of *vallata* from Bombay coast. *P. nuntia* var. *heterodonta* is recorded for the first time from the Indian waters.

***Pseudonereis rotnestiana Augener, 1913**

Pseudonereis rotnestiana Augener, 1913. *Die Fauna Sudwest-Australiens*, 4 : 184 ; Fauvel, 1953, *The Fauna of India, Annelida, Polychaeta* : 217.

Material : 1 ex. ; ZSI Reg. No. An 1389/1 ; Jolandar, Fort Diu ; B. P. Haldar ; 27.1.1978. 3 exs. ZSI Reg. No. An 1382/1 ; Okha beach ; K. N. Reddy ; 12.4.1977. 5 exs ; ZSI. Reg. No. An 1390/1 ; Veraval ; B. P. Haldar ; 24.1. 1978.

Description : Arrangement of paragnaths on the proboscis is as Gr. I=2-5 conicals, Gr. II=an oval patch of pectinate and conicals, Gr. III=4 distinct rows of pectinates, Gr. IV=several rows of small pectinates and a few conicals in front, Gr. V=nil, Gr. VI=5-6 conicals in a row, Group VII & VIII=Two alternating rows of large conicals ; anterior feet with two rounded unequal notopodial lobes and long dorsal cirrus, the superior lobe is gradually becoming large and flattened and then lamellated with the dorsal cirrus in a terminal notch ; notosetae homogomph spinigers throughout and neurosetae stout falcigers with short blades and homogomph spinigers.

Remarks : This is the first record of the species from the peninsular region of India. Earlier record is from the Andamans.

Family NEPHTYIDAE

***Nephtys (Nephtys) polybranchia Southern, 1921**

Nephtys polybranchia Southern, 1921, *Mem. Indian Mus.* 5 : 607 ; Fauvel, 1953, *The Fauna of India, Annelida, Polychaeta* : 227.

Material : 1 ex. ; ZSI Reg. No.—An 1383/1 ; Umbargaon ; B. P. Haldar ; 12.2.1978.

Remarks : The camerated setae are not restricted to the anterior feet, as is recorded in original description. Here, these are gradually diminished in number towards the posterior end. Earlier recorded from Gangetic delta, Chilka lake, Vizagapatnam and Cochin back waters.

Family EUNICIDAE

Eunice sp.

(Text-figs. 6-8)

Material : 1 ex (incomplete) ; ZSI Reg. No. An 1444/1 ; Okha beach ; 13.8.1972.

Description : Body with 65 segments, gills begin about 16th foot, all simple, very long and persist to the last segment, dorsal cirri long but gradually decrease towards the posterior end ; acicular setae faintly bidentate, simple setae, compound falcigers and comb setae present.

Remarks : Setae characters resembling the species *E. marenzelleri* Gravier. But the origin of gill on the 28th foot differentiate this species from the species under study.

Marphysa sanguinea (Montagu, 1815)

(Text-figs. 9 & 10)

Nereis sanguinea Montagu, 1815, *Trans. Linn. Soc. Lond.* II : 20.

Marphysa sanguinea, Fauvel, 1953, *The Fauna of India, Annelida, Polychaeta* ; 245.

Material : 1 ex. ; ZSI Reg. No. An 1384/1 ; Mithapur beach, Okha ; K. N Reddy ; 11.4.1977.

Description : Numerous comb setae with fine teeth ; gills starting from 24th feet, gradually increasing only upto with 3-4 filaments and gradually decreasing towards the hind part of body.

Remarks : The fine teeth in the comb setae and gills with comparatively less number of filaments may be considered as variations due to different eco-niches. So far recorded from Andamans, Andhra and Gujarat coast.

Family CIRRATULIDAE

* **Cirriformia filigera** (Delle Chiaje, 1825)

Cirriformia filigera Delle Chiaje, 1825, *Memorie Salla...Napoli*, 3 : 178.

Audouinia filigera, Fauvel, 1953. *The Fauna of India, Annelida, Polychaeta* : 331.

Cirriformia filigera Day, 1967, *Brit. Mus. (nat. Hist.) London Publ.* No. 656 : 518.

Material : 5 exs., ZSI. Reg. No. An 1450/1 ; Dwaraka ; Daniel & party ; 14.11.1968.

Remarks : Earlier recorded from Andamans, Rameswaram Island, Cape camorin.

***Cirriformia punctata** (Grube, 1859)

Cirratulus punctatus Grube, 1859, *Annulata oerstediana* : 107.

Audouinia semicincta, Fauvel, 1953, *The Fauna of India, Annelida, Polychaeta* : 330 ;
Cirriformia punctata, Day, 1967. *Brit. Mus. (nat. Hist.) London Publ. No. 656* : 517.

Material : 1 ex., ZSI. Reg. No. An 1451/1, Dwaraka ; *Daniel* and party ; 14.11.1968.

Remarks : This is the first record of the species from the peninsular region of India. Earlier recorded from the Andamans.

Family SABELLIDAE

***Hypsicomus phaeotaenia** (Schmarda, 1861)

Sabella phaeotaenia Schmarda, 1861 *Neve, Wirbellare um die Erde* : 35.

Hypsicomus, phaeotaenia, Fauvel, 1953, *The Fauna of India, Annelida, Polychaeta*, : 447.

Material : 1 ex., ZSI Reg. No. 1386/1 ; Veraval ; *B. P. Haldar* ; 24.1.1978.

Remarks : Earlier recorded from the Andamans, Gulf of Mannar, Pamban, Kilakarai.

SUMMARY

The present paper deals with 11 species belonging to 8 genera and 6 families, of which 9 recorded for the first time from Gujarat and the rest showed interesting variations. Among the 7 varieties under 2 species reported here, 6 form new locality records including 1 from the Indian waters. Structural variations and distribution within India, are also included.

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NEUROPTERA FROM WESTERN PENINSULAR INDIA
WITH NEW RECORDS

By

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INTRODUCTION

While sorting out the material of Neuroptera in the National Collections at Zoological Survey of India from certain areas of interest, the author has come across certain lots of them at his disposal. The specimens, which have been authentically studied, are distributed over 20 species including two indetermined ones in 5 families under the suborder Planipennia from Gujarat, Maharashtra and Goa along the Western Ghat of the Indian Peninsula. Majority of the elements are not hitherto known either from Gujarat or Goa, though quite a many were earlier reported on several explorations from Maharashtra by different taxonomists, as cited in the paper.

At present, an attempt has been made just to incorporate in the paper a list of 20 species actually examined along with their current references, detailed localities of distribution particularly in India and also several new locality records including 5 for Maharashtra and one for Goa. In view of rendering the list in its up-to-date form as much consolidated as possible, 37 other species, which are so far known from any of the areas concerned but not presently seen therefrom, have further been appended from literature. A summary has also been incorporated at the end.

Family OSMYLIDAE

Subfamily SPILOSMYLINAE

1. *Spilosmylus tuberculatus* (Walker)

Spilosmylus tuberculatus (Walker), Nakahara, 1911, *Annotnes Zool. jap.*, **8** : 502.

Material examined : 1 ex., India, : Maharashtra, Satara, Ambenali near Pratapgad, 30. v. 1980 (B. K. Tikader coll.).

Distribution : INDIA (Assam, Maharashtra and Andaman Island).
JAPAN. MALAYA. TAIWAN.

Remarks : Ghosh (1978) recorded the species from Maharashtra.

Family HEMEROBIIDAE

Subfamily HEMEROBIINAE

2. *Mixomicromus lampus* Ghosh

Mixomicromus lampus Ghosh, 1977, *Proc. Indian Acad. Sci.*, **86** (B) : 235, 10 figs.

Material examined : 5 exs., India : Maharashtra, Pune, Model colony, Sreeram lodge, 29. ix. 1976 (*R. H. Kamble* coll.).

Distribution : INDIA : Maharashtra.

Family CHRYSOPIDAE

Subfamily CHRYSOPINAE

3. *Chrysopa* (*Chrysoperla*) *gujaratensis* Ghosh

Chrysopa (*Chrysoperla*) *gujaratensis* Ghosh, 1976, *Ent. Scand.*, **7** : 74, 2 figs.

Material examined : 1 ex., India : Gujarat, Dwarka, east of Rly. stn., 2. xi. 1979 (*S. K. Gupta* coll.).

Distribution : INDIA : Gujarat.

4. *Chrysopa* (*Chrysoperla*) *sanandensis* Ghosh

Chrysopa (*Chrysoperla*) *sanandensis* Ghosh, 1977, *Entomon.*, **2** (no. 1) : 103, 7 figs.

Material examined : 1 ex., India : Gujarat, Sanand, Dadagram, 8. xii. 1973 ; 3 exs., Sanand, 3-8. xii. 1973 ; Ahmedabad, Sabarmati, 7. xii. 1973 (*S. K. Gupta* coll.).

Distribution : INDIA : Gujarat.

5. *Chrysopa* (*Chrysoperla*) *punensis* Ghosh

Chrysopa (*Chrysoperla*) *punensis* Ghosh, 1976, *Entomon.*, **1** (no. 2) : 189, 8 figs.

Material examined : 10 exs., India : Maharashtra, Poona, Khed, 3. vii. 1976 (*S. K. Ghosh* coll.).

Distribution : INDIA : Maharashtra.

6. *Chrysopa* sp.

Material examined : 1 ex., India : Maharashtra, Poona, Vishrant-wadi, 31. i. 1977 (*S. K. Ghosh* coll.).

Family MYRMELEONTIDAE

Subfamily PALPARINAE

7. *Stenares improbus* (Walker)

Stenares improbus (Walker), MacLachlan, *J. Linn. Soc.*, **9** : 276.

Material examined : 1 ex., India : Maharashtra, Satara, Yenna valley, Medha, 23. iv. 1912 (*F. H. Gravely* coll.).

Distribution : INDIA (North India, Maharashtra and Karnataka).
SRI LANKA.

Remark : The species is a new record for Maharashtra.

8. *Palpares contrarius* (Walker)

Palpares contrarius (Walker), MacLachlan, 1868, *J. Linn. Soc.*, 9 : 274.

Material examined : 2 exs., India : Maharashtra, Satara, Koyna valley, Helvok, 20-30. iv. 1912 (*F. H. Gravely* coll.).

Distribution : INDIA (Orissa, Maharashtra and Karnataka). SRI LANKA.

9. *Palpares pardus* (Rambur)

Palpares pardus (Rambur), MacLachlan, 1868, *J. Linn. Soc.*, 9 : 275.

Material examined : 1 ex., India : Goa, 5 Km. South of Molem, 25. xi. 1966 (*K. S. Pradhan* coll.) ; 4 exs., Maharashtra (Western Ghat Survey, 1965), 31.x.-5.xi. 1965 (*T. G. Vazirani* coll.).

Distribution : INDIA : Sikkim ; North India ; West Bengal ; Orissa ; South India ; Maharashtra ; Goa and Rajasthan.

Subfamily ECHTHROMYRMICINAE

10. *Echthromyrmex orientalis* MacLachlan

Echthromyrmex orientalis MacLachlan, 1873, *Annls Soc. ent. Belg.*, 16 : 143.

Material examined : 1 ex., India : Goa, Margao, Fatorda, 2. iv. 1966 (*K. S. Pradhan* coll.).

Distribution : INDIA : Orissa and Goa.

Subfamily MYRMELEONTINAE

11. *Nesoleon perpunctatus* Banks

Nesoleon perpunctatus Banks, 1931, *Psyche*, 38 : 60.

Material examined : 3 exs., India : Maharashtra, Khandala, 11.xi. 1963 ; 1 ex., Kanta village, 5.xi.1963 (*B. K. Tikader* coll.).

Distribution : INDIA : Maharashtra and Andhra Pradesh.

Remark : The species is a new record for Maharashtra.

12. *Myrmeleon tenuipennis* Rambur

Myrmeleon tenuipennis Rambur, 1842, *Hist. nat. Ins. Neur.*, 405.

Material examined : 2 exs., India : Maharashtra, Pune, Mukundnagar, 12.i.1977, 22.x.1977 (*B. K. Tikader* coll.).

Distribution : INDIA : North India and Maharashtra.

13. Neuroleon guernii Navas

Neuroleon guernii Navas, 1914, *Russk. ent. Obozr.*, **14** : 319.

Material examined : 1 ex., India : Goa, Fatorda, 11.iv.1966 (K. S. Pradhan coll.).

Distribution : INDIA (Rajasthan ; Maharashtra and Goa). SRI LANKA.

Remark : The species is a new record for Goa.

14. Distoleon audax (Walker)

Distoleon audax (Walker), Ghosh, 1980, *Rec. zool. Surv. India*, **77** : 253.

Material examined : 1 ex., India : Maharashtra, Ambenali, 24.iv.1977 (S. K. Ghosh coll.) ; 1 ex., Pune, Nekhanalla, 21.ii.1973 (M. B. Rao coll.).

Distribution : INDIA (Maharashtra, Andaman & Nicobar Islands). SRI LANKA. CHINA. JAPAN. INSULINDE (Malayan and Papuan Archipelago). AUSTRALIA.

Remark : The species is a new record for Maharashtra.

15. Formicaleon verendus (Walker)

Formicaleon verendus (Walker), Ghosh & Sen 1977, *Rec. zool. Surv. India*, **73** : 306.

Material examined : 2 exs., India : Maharashtra, Pune, behind Law College, 26. iii. 1976 (B. K. Tikader coll.).

Distribution : INDIA : Orissa, North India, Maharashtra and Himachal Pradesh.

Remark : The species is a new record for Maharashtra. Holzel (1972) synonymised the genus *Formicaleon* Banks under the genus *Distoleon* Banks. So, the species should be considered under the latter genus.

16. Creoleon griseus (Klug)

Creoleon griseus (Klug), Holzel, 1972, *Beitr. naturk. Forsch. SudwDtl.*, **1** : 61.

Material examined : 1 ex., India : Maharashtra, Pune, Wanvadi, 27. v. 1977 (G. M. Yazdani coll.).

Distribution : INDIA (West Bengal, Bihar, Orissa, Tamil Nadu, Maharashtra and Rajasthan). SUDAN. EGYPT. ISRAEL. IRAN.

Family ASCALAPHIDAE

Subfamily SCHIZOPHTHALMINAE

17. *Pseudoptynx furcifer* Weele

Pseudoptynx furcifer Weele, 1908, *Cat. Coll. Selys*, 8 : 209.

Material examined : 1 ex., India : Maharashtra, Mahabaleswar, Ambenali rest house, 27. iv. 1977 (*S. K. Ghosh* coll.).

Distribution : INDIA : Maharashtra.

18. *Pseudoptynx* sp.

Material examined : 1 ex., India : Maharashtra, Igatpuri, 23.iii. 1910 (coll. nil).

19. *Glyptobasis dentifera* (Westwood)

Glyptobasis dentifera (Westwood), MacLachlan, 1871, *J. Linn. Soc.*, 11 : 278.

Material examined : 3 exs., India : Goa, Marmugao, 1.x.1916 (*S. W. Kemp* coll.).

Distribution : INDIA : West Bengal, Orissa, South India, Maharashtra, Goa and Uttar Pradesh.

20. *Suphalomitus verbosus* (Walker)

Suphalomitus verbosus (Walker), Weele, 1908, *Cat. coll. Selys*, 8 : 183.

Material examined : 1 ex., India : Maharashtra, Goa, Punjim, Mangeshi, 27.iii.1966 (*K. S. Pradhan* coll.).

Distribution : INDIA (West Bengal, Assam, Maharashtra and Karnataka). SRI LANKA.

Remark : The species is a new record for Maharashtra.

APPENDIX TO THE LIST OF SPECIES

Family CONIOPTERYGIDAE

Subfamily ALEUROPTERYGINAE

1. *Heteroconis terminalis* (Banks)

Heteroconis terminalis (Banks), Meinander, 1972, *Acta zool. fenn.*, 136 : 90.

Distribution : INDIA : Maharashtra (Bombay).

2. *Spiloconis cerata* (Hagen)

Spiloconis cerata (Hagen), Meinander, 1972, *Acta zool. fenn.*, 136 : 139.

Distribution : INDIA (Maharashtra). SRI LANKA.

Family BEROETHIDAE

3. **Lekrugeria lineata** Navas

Lekrugeria lineata Navas, 1929, *Mems. Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, 2 : 41, fig. 49.

Distribution : INDIA : Maharashtra and South India.

Family MANTISPIDAE

Subfamily MANTISPINAE

4. **Mantispilla salana** Navas

Mantispilla salana Navas, 1930, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, 13 : 89.

Distribution : INDIA : Maharashtra.

Family SISYRIDAE

Subfamily SISYRINAE

5. **Sisyra aguavivai** Navas

Sisyra aguavivai Navas, 1929, *Memorie Accad. pont. Nuovi Lincei*, (2) 12 : 52.

Distribution : INDIA : Maharashtra.

Family HEMEROBIIDAE

Subfamily HEMEROBIINAE

6. **Micromus benardi** Navas

Micromus benardi Navas, 1912, *Insectes Neuropteros nuevos Verh. intern. Zool. Kongr.*, 8 : 750.

Distribution : INDIA : Maharashtra.

7. **Micromus umbrosus** Navas

Micromus umbrosus Navas, 1931, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, 14 : 87.

Distribution : INDIA : Maharashtra (Bandra).

Family CHRYSOPIDAE

Subfamily CHRYSOPINAE

8. **Chrysopa bertrani** Navas

Chrysopa bertrani Navas, 1931, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, 14 : 83.

Distribution : INDIA : Maharashtra.

9. *Cintameva glorisa* Navas

Cintameva glorisa Navas, 1930, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, **13** : 85.

Distribution : INDIA : Maharashtra (Bandra).

Remarks : Tjeder (1966) synonymised the genus *Cintameva* Navas with *Chrysopa* Leach. Hence, *glorisa* Navas should be treated under the latter genus.

10. *Chrysopa herasina* Navas

Chrysopa herasina Navas, 1928, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, **12** : 192.

Distribution : INDIA : Maharashtra.

11. *Chrysopa ignita* Navas

Chrysopa ignita Navas, 1910, *Russk. ent. Obozr.*, **10** : 192.

Distribution : INDIA : Maharashtra (Matheran).

12. *Chrysopa khandalensis* Navas

Chrysopa khandalensis Navas, 1932, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, **15** : 16.

Distribution : INDIA : Maharashtra (Khandala).

13. *Chrysopa khandalina* Navas

Chrysopa khandalina Navas, 1931, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, **14** : 84.

Distribution : INDIA : Maharashtra (Khandala).

14. *Chrysopa rocasolanai* Navas

Chrysopa rocasolanai Navas, 1928, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, **12** : 193.

Distribution : INDIA : Maharashtra.

15. *Chrysopa smitzi* Navas

Chrysopa smitzi Navas, 1913, *Russk. ent. Obozr.*, **13** : 426.

Distribution : INDIA : Maharashtra (Bombay) and Karnataka.

16. *Chrysopa villalongae* Navas

Chrysopa villalongae Navas, 1935, *Mems. R. Acad. Cienc. Artes Barcelona*, (3) **25** : 56.

Distribution : INDIA : Maharashtra (Bombay).

17. *Ankylopteryx octopunctata* var. *salai* Navas

Ankylopteryx octopunctata var. *salai* Navas, 1929, *Memorie Accad. pont. Nuovi Lincei*, (2) **14** : 424.

Distribution : INDIA : Maharashtra.

Family MYRMELEONTIDAE

Subfamily PALPARINAE

18. *Palpares pardus asanai* Kuwayama

Palpares pardus asanai Kuwayama, 1933, *Proc. imp. Acad. Japan*, **9** : 446.

Distribution : INDIA : Maharashtra (Bombay).

19. *Palpares pardus partitus* Banks

Palpares pardus partitus Banks, 1911, *Proc. ent. Soc. Wash.*, **13** : 100.

Distribution : INDIA : Maharashtra (Bombay).

Subfamily MYRMELEONTINAE

20. *Centroclisis lutea* Navas

Centroclisis lutea Navas, 1912, *Broteria (Zool.)*, **10** : 42.

Distribution : INDIA : Maharashtra (Bombay).

21. *Cueta levis* Navas

Cueta levis Navas, 1931, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, **14** : 79.

Distribution : INDIA : Maharashtra and Andhra Pradesh (Hyderabad).

22. *Cueta salai* Navas

Cueta salai Navas, 1928, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, **12** : 185.

Distribution : INDIA : Maharashtra (Khandala).

23. *Myrmeleon angusticollis* Rambur

Myrmeleon angusticollis Rambur, 1842, *Hist. nat. ins. Neur.*, p. 399.

Distribution : INDIA : Maharashtra.

***24. *Grocus* (nec *Crocus*) *frontalis*, Castellarnau**

Grocus frontalis, Castellarnau, 1946, *Broteria*, (Ciencias naturais), **15** : 122.

Distribution : INDIA : Maharashtra.

*Original reference not traceable.

25. Myrmeleon (Morter) fulvescens Navas

Myrmeleon (Morter) fulvescens Navas, 1934, *Memorie Accad. pont. Nuovi Lincei*, (3) 1 : 220.

Distribution : INDIA : Maharashtra.

26. Myrmeleon (Morter) hyalinus Olivier

Myrmeleon hyalinus Olivier, *Encycl. Meth.*, 8 : 126.

Myrmeleon (Morter) hyalinus, Holzel, 1972, *Beitr. naturk. Forsch. SüdwDtl.*, 1 : 37.

Distribution : INDIA : (Gujarat). NORTH AFRICA. IRAN. AFGHANISTAN. SOUTH-EAST EUROPE.

27. Balaga pupillatus Navas

Balaga pupillatus Navas, 1930, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, 13 : 36.

Distribution : INDIA : Maharashtra (Khandala).

Remarks : Markl (1954) synonymised the genus *Balaga* Navas with *Hagenomyia* Banks. So, the species *pupillatus* Navas should be considered as *Hagenomyia pupillatus* (Navas).

28. Nelees reticulatus Navas

Nelees reticulatus Navas, 1930, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, 13 : 40.

Distribution : INDIA : Maharashtra (Khandala).

Remarks : Holzel (1972) synonymised the genus *Nelees* Navas with *Neuroleon* Navas. So, all the species including the present one should be considered under the latter genus.

29. Nelees roscidus Navas

Nelees roscidus Navas, 1937, *C. R. Congr. int. zool.*, 12 : 1476.

Distribution : INDIA : Maharashtra (Khandala).

Remarks : *Vide Supra.*

30. Distoleon substigmalis Navas

Distoleon substigmalis Navas, 1921, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, 12 : 191.

Distribution : INDIA : West Bengal and Maharashtra.

31. Banyutus indicus Navas

Banyutus indicus Navas, 1929, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, 12 : 189.

Distribution : INDIA : Maharashtra (Khandala).

32. Hyloleon rhodocerus Navas

Hyloleon rhodocerus Navas, 1929, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, 12 : 189.

Distribution : INDIA : Maharashtra (Khandala).

33. Creagris fulvinarvis Navas

Creagris fulvinarvis Navas, 1932, *Revta Acad. Cienc. exact. fis.-quim. nat. Zaragoza*, 15 : 14.

Distribution . INDIA : Maharashtra (Bombay).

Remarks : Markl (1954) synonymised the genus *Creagris* Hagen with *Creoleon* Tillyard. So, the species *fulvinarvis* Navas should now be considered as *Creoleon fulvinarvis* Navas.

34. Creoleon lugdunensis (Villers)

Creoleon lugdunensis (Villers), Holzel, 1972, *Beitr. naturk. Forsch. SüdwDtl.*, 1 : 60.

Distribution : INDIA : Maharashtra (Bandra). NORTH AFRICA. ANATOLIA. IRAN. AFGHANISTAN. KAZASTHAN. SOUTH-EAST EUROPE.

Family ASCALAPHIDAE

Subfamily SCHIZOPHTHALMINAE

35. Ogcogaster segmentator (Westwood)

Ogcogaster segmentator (Westwood), MacLachlan, 1871, *J. Linn. Soc.*, 11 : 265.

Distribution : INDIA : Western Himalayas including Himachal Pradesh and Kashmir, Maharashtra and Karnataka.

Remark : Ghosh (1977) recorded the species from Himachal Pradesh.

36. Ogcogaster tessellata (Westwood)

Ogcogaster tessellata (Westwood), MacLachlan, 1871, *J. Linn. Soc.*, 11 : 265.

Distribution : INDIA (Bihar, Western Himalayas including Himachal Pradesh and Gujarat). PAKISTAN.

37. Helicomitus sinister (Walker)

Helicomitus sinister (Walker), Kimmins, 1949, *Ann. Mag. nat. Hist.*, (12) 2 : 3.

Distribution : INDIA (West Bengal, North India and Maharashtra). SRI LANKA.

Remarks : Tjeder (1972) synonymised the genus *Helicomitus* MacLachlan with *Ascalaphus* Fabricius. Therefore, all the species including the present one should be considered under the latter genus.

SUMMARY

The paper contains a comprehensive list of 57 species of Neuroptera from Gujarat, Maharashtra and Goa in India along with their corresponding references and also the available ranges of distribution in other areas. Of these, 37 elements, which are not presently examined but compiled from the scattered literature, have been, provided under appendix. Amongst the total number of species, 5 from Maharashtra, and one from Goa constitute new locality records.

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THE CROW-PHEASANT, *CENTROPUS SINENSIS* (STEPHENS)
(AVES : CULCULIDAE) OF CENTRAL AND EASTERN
MADHYA PRADESH.

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(With 1 Plate and 1 Text-figure)

INTRODUCTION

Whistler and Kinnear (1934) noted the presence of some sooty wash on wings in some specimens of the Crow-pheasant, *Centropus sinensis* (Stephens), and considered it to be an 'individual variation'. They, however, remarked "it appears to be to some extent sub-specific in character in that it is more frequently found in *parroti* than in *sinensis*". After a study of the collection of the Bombay Natural History Society, Humayun Abdulali (1956) noted that except for slight traces of sootiness in two juvenile females from Nepal (*C. S. sinensis*) and Prome, Burma (*C. s. intermedius* Hume), the other two subspecies recognized by Ripley (1961), only winter females of *C. s. parroti* (Stresemann) collected from Ambala, Punjab (1), Delhi (1), Bombay (2), Orissa and Bastar, M. P. (4) show the character. In a recent study (Abdulali, 1972, p. 770) based on a much larger collection, he remarked "of 18 dusky birds examined including specimens borrowed from Zoological Survey of India only 4 are males. The birds are from Ambala (1), Delhi (1), Kutch (1), Surat (1), Nasik (1), Thana (1), Bombay (2), Madhya Pradesh (6), Baster (1), and Orissa (3), the character being found throughout the year and most pronounced in Bastar and Orissa. Except that the duskiness appears to be more frequent in the females, it is not possible to indicate what it signifies". Since the majority of specimens from Eastern Madhya Pradesh and adjoining areas are Sooty, Mr. Abdulali had earlier suggested that I might collect a series of specimens from that area. Accordingly a series of 23 specimens was collected in different seasons during 1963-70 from central and eastern Madhya Pradesh but mostly from Jabalpur District.

A study of this interesting variation is presented here particularly with regard to its geographical significance. The population inhabiting

the area under study appears to represent an undescribed subspecies but has not been named pending collection of more data for some characters.

My sincere thanks are due to Dr. B. Biswas, Mr. Humayun Abdulali and statistical section, Jawaharlal Agricultural University, Jabalpur, for their criticism.

OBSERVATIONS

Materials studied : Madhya Pradesh, Sehore Distt : Bagwara : 1 ♂, 1 unsexed (28 Dec. 1964) ; Hoshangabad Distt : Joga Forest 1 ♂, 1 ♀ (12, 19 Dec. 1965) ; Narsinghpur Distt : Barmanghat 1 ♀ (13 Dec. (1964) ; Jabalpur Distt : Richhai, Panagar, Maharajpur, Amkhas, Pachpedi Road, Jabalpur : 4 ♂, 6 ♀, 2 unsexed (14 Feb. 1964, 19 Mar. 1963, 29 Apr. 1964, 7, 17 May 1963, 6 Jun. 1963, 7 Jun. 1967, 16 Aug. 1963, 18 Nov. 1963, 29 Nov. 1967, 24 Dec. 1963) ; Mandla Distt : Deogaon, Manot Patpura, 2 ♂, 1 ♀ (12, 17, 18 Nov. 1963) ; Balaghat Distt : Supkhar : 1 ♂ 31 Mar. 1965). All these specimens were collected by Zoological Survey of India field parties. Four adults in the collection of the Zoological Survey of India, Calcutta, from Rewa and Balaghat District (Jan., March, Sept., Nov.) were also examined.

MEASUREMENTS

9 ♂ : Wing 177-198 (186.7) ; tail 270-306 (283.3) ; tarsus 47-53.5 (51.5) ; bill 37-43 (39.2) mm. ; wt. 205-260 (236.4) g.

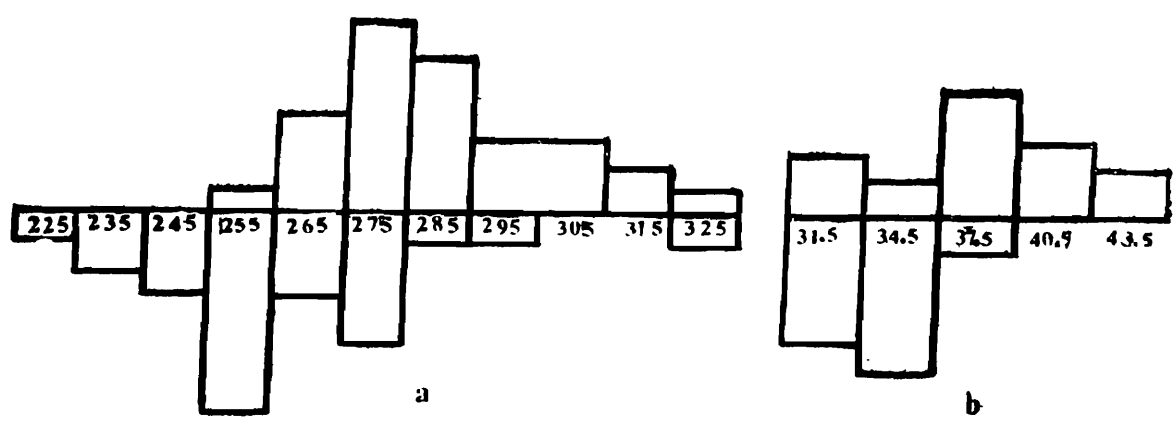
11 ♀ : Wing 176-206 (195.9) ; tail 278-324 (298.3) ; Tarsus 49-56 (53.5) ; bill 38-44.5 (41) mm. ; wt. 252-305 (168.1) g.

3 unsexed : Wing 187, 179, 189 ; tail, 290, 283 ; tarsus, 53.5, 54, 55 ; bill, 35, 38.5, 39.5 ; wt. 225, 240.9, 230.

Colour variations : One of the darkest specimens is a ♀ taken on 19th March from Amkhas villagar, Jabalpur District. It has the whole of the dorsal parts of the wings (including wing coverts and inner secondaries) conspicuously dusky sharply contrasting with the lateral parts of the wing which are chestnut. On the outer secondaries, the duskiness is restricted to the outer fringes and/or to tips. Underwing coverts are predominantly sooty. Other parts are varying shades of black. The crown, the sides of the head and particularly the throat are paler. There is a slight gloss of bluish green here and there especially more marked on the ventro-lateral rectrices. Among the female specimens, the most brightly coloured and has been taken on 19th December. In this specimen the duskiness is confined practically

to tips of the secondaries and to a very few wing coverts with bluish green gloss much more pronounced on other parts of the body particularly on the shoulders.

The darkest male taken on 17th May in Jabalpur District differs from the darkest female described above in being slightly brighter on the posterior lateral parts of the wings, more darker on the shoulders and in having the crown and the throat paler. The brightest male collected on 16th August, has duskiness confined to the tips of primaries and secondaries particularly the outer feathers and extending slightly to wing coverts and in having more blue on the shoulders. Other specimens intergrade between these extremes. It, thus, appears that duskiness, traces of which may very rarely appear in some other subspecies of the species, has become more or less an established character in this population. The duskiness in dorsal aspects appears more pronounced in made-up skins. The character does not appear to be seasonal or age-dependent. Out of 29 specimens examined including 4 adult ♀ from Bastar and Orissa mentioned by Abdulali (1956), 15 approach the condition of the darkest specimens, 5 to that described for the brightest speci-



Text-fig. 1. a. Twin histograms comparing the tail length of 28 adults of *Centropus sinensis* of central and eastern Madhya Pradesh with 24 specimens of *C. sinensis parroti*.
b. The same comparing the bill length of 27 and 25 adults of the above two populations. Upper histograms are for studied population and lower ones for *C. sinensis parroti*. Number in histograms indicate millimetres. There is no sexual dimorphism in size.

mens and other intergrade between these extremes. Out of 29 specimens 24 are dusky. Out of 28 specimens of *C. s. parroti* examined 3 are dusky. Applying Chi-square test, recommended by Mayr *et al* (1953) for such cases, a highly significant value of 29.65 is obtained. The tail and the bill appear to be comparatively longer in these specimens than those of *C. s. parroti* and these differences are shown in twin histograms (Text-fig. 1).

In some freshly killed specimens there was a neatly defined transverse chestnut band on the underwing coverts. The band was separated from the distal portion of the underwing coverts by a broad black band of varying width. The frequency of the occurrence of this character could not be studied in detail. The character is not clearly seen in made-up skins.

An effort was made to collect immature specimens but without success, field observations were also made on the colouration of a number of specimens. The population probably represent an undescribed subspecies but is not being named till all necessary data is available.

Habits : Nothing has so far been recorded about the habits of this crow pheasant (*vide* Baker, 1926 ; Ali and Ripley, 1969) which is common around Jabalpur city. The following observation will, therefore, be of interest.

The author observed two specimens fighting during rains with their plumage much smeared with mud. Specimens were also seen moving up and down the branches of trees very playfully in the season. Two adult females, taken on 23.11.63 and 29.11.67, had the gonads in breeding condition.

However, a grown-up young was observed following its mother on 9.11.74. The young had more or less attained the size and the colouration of mother but its behaviour was very different. It frequently gave out sounds resembling *kren-kren* with drooping and quivering wings possibly begging for food. The mother appeared busy searching for food and replied to the sounds of the young with a sound resembling *kuff-kuff*, from a distance of about 10 m. the neck feathers of the young appeared shorter and brighter than those of the mother. Other subspecies are reported to breed from spring to autumn but mainly during rains. The usual sound of several birds were heard during the later half of November, 67 in Jabalpur city. While giving but its usual sound, a bird was observed, at close range, to bend its head downward with bill pointed downward and inward. The throat was inflated and there is quivering of plumage.

Some peculiar low sounds were heard in a thick bush in the beginning of September. On approach, four birds came out of it and each gave out a different sound. These sounds do not appear to be recorded for the genus *Centropus*. These are low melodius *shren-shren*, harsh, *kren-kren*, resembling that of the Blue Jay, *kuff-kuff* and *kuff kuff-kren-kren*. After coming out of the bush, all the birds perched on a nearby tree. One of them chased the others. Similar sounds were also heard later on a couple of occasions. In one case, they were given out by a pair

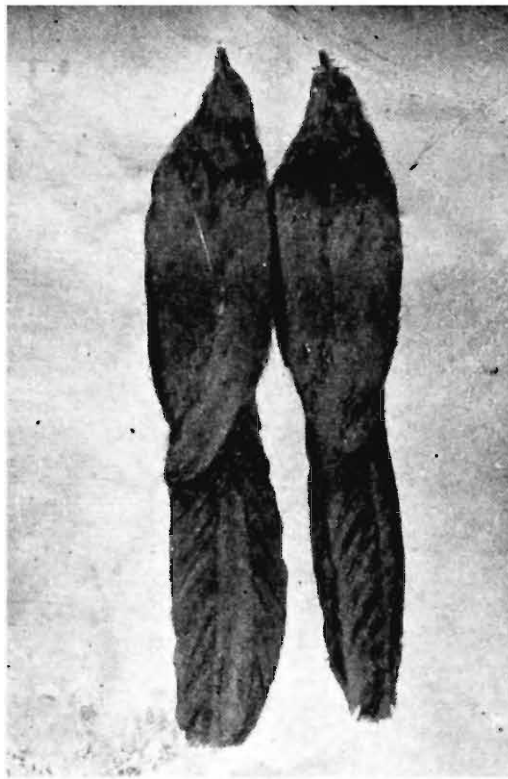


Fig. 1. A sooty and a normal coloured specimen of *Centropus sinensis* from central and eastern Madhya Pradesh.

when another pair appeared nearby. The real cause of such abnormal sounds is not known but it is probable that they have something to do with defence of territory or breeding behaviour.

SUMMARY

The significance of sootiness in the plumage of some specimens of the Crow pheasant, *Centropus sinensis* (Stephens) has been the subject of discussion by some authors. Since majority of specimens from eastern Madhya Pradesh and adjoining areas are sooty, the author collected a large series of specimens in different seasons over a period of eight years to understand the geographical significance of the character. A detailed account of author's study in Central and Eastern Madhya Pradesh is given. In addition, the collection from Zoological Survey of India, Calcutta and Bombay Natural History Society were also studied. The study has shown that the majority of specimens inhabiting the area are sooty and are also probably separable on the basis of other minor differences ; but collection of more specimens particularly young ones is necessary to arrive at a definite conclusion. Unfortunately no young one could be collected during the period despite all effort. The paper describes colour and measurement variations of the population in detail. Information based on fresh observations on the habits of the population is also recorded.

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EPIPHRAGM SECRETION POTENTIAL IN THE GIANT
AFRICAN LAND SNAIL, *ACHATINA FULICA* BOWDICH
(GASTROPODA : MOLLUSCA)

By

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(With 3 Text-figures)

INTRODUCTION

Generally land snails secrete a mucocalcareous epiphragm over the shell aperture with the beginning of aestivation or hibernation. The mechanism of epiphragm secretion has been described in *Helix aspersa* (Allman, 1894-95), *Achatina immaculata*, *Thaumastus sangoae*, *T. bitaeniatum* (Smith, 1899, 1904), *Glessula hastula* and *Zootecus insularis* (Hora and Rao, 1927), *Macrochlamys glauca* (Hora, 1928) and *Achatina albopicta* (Williams, 1951).

The number of epiphragms secreted by an individual during the whole period of aestivation varies with the species. The secretion of multiple epiphragms by land snails is generally interpreted as a response to conditions which threaten dormant snails. *Achatina fulica* is a serious agri-horticultural pest, and has spread to a number of countries having different length of hibernation or aestivation period. In the present probe the potentiality of epiphragm secretion has been studied under experimental conditions to evaluate its ability to withstand the different environmental conditions.

MATERIALS AND METHODS

A total of 45 *A. fulica* with near equal shell length (70 mm) were selected for the study. They were divided into 3 groups (Group—I, Group—II and Group—III) with 15 snails in each. Individuals of the 3 groups were weighed and released groupwise in the terrarium measuring 75×30×70 cm in the first week of November, 1975. The terraria were covered with 1.0 mm polythene net. The snails underwent aestivation in a day or two.

The snails of each group were weighed again following aestivation and were left for 7 days undisturbed. On the 8th day, they were again

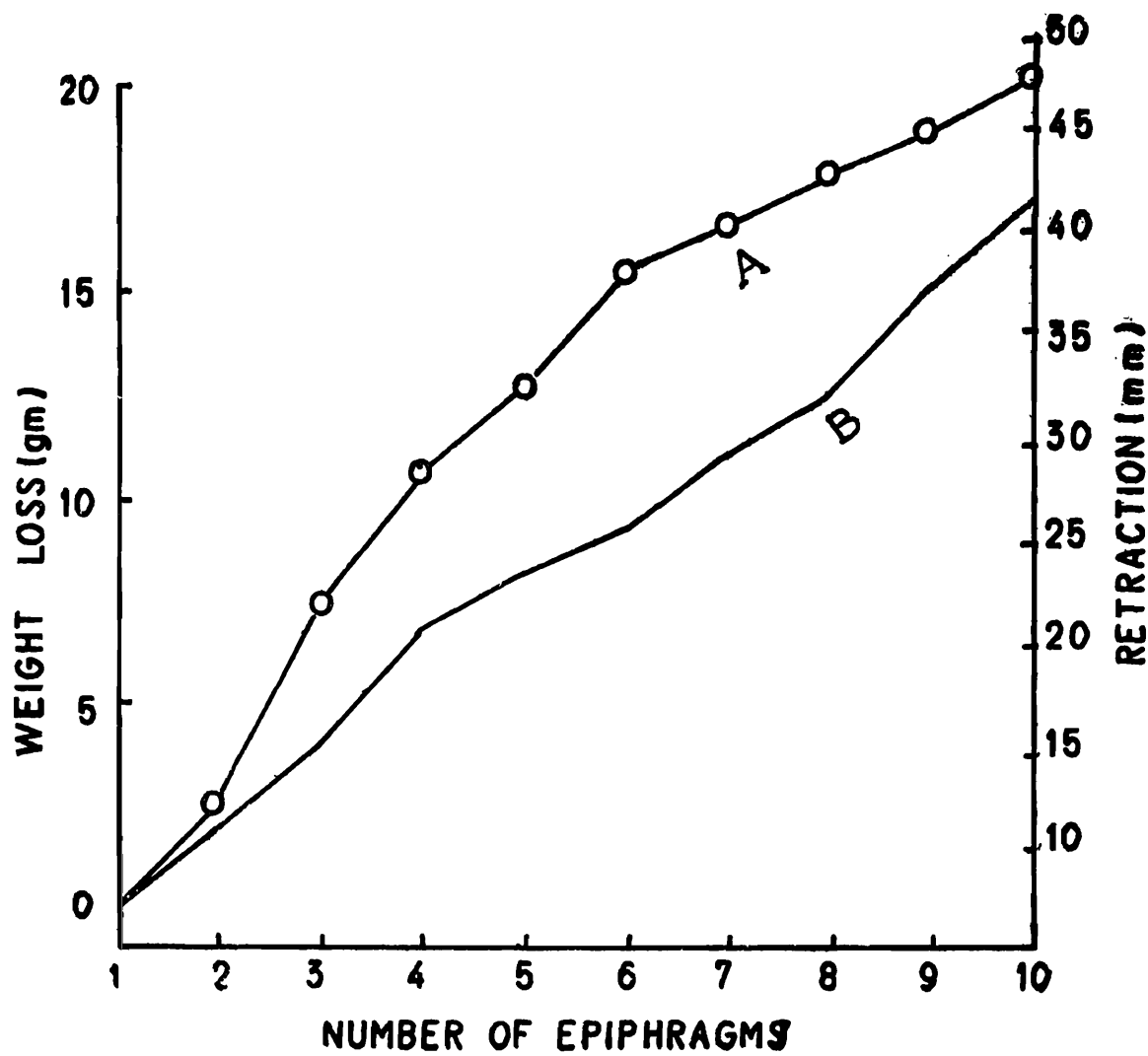
weighed and the epiphragm of all the snails was removed with the help of a pair of fine forceps. Almost all the snails became active during the process. Subsequently the snails of 3 different groups were treated differently. Individuals of Group—I were left to uninterrupted aestivation. The members of Group—II were subjected to water spray at different intervals for a period of 48 hrs. The snails of Group—III received treatment similar to Group—II but they were supplied with choice foods for a period of 48 hrs. which was denied to those of Group—II. The snails of Group—II and III were forced to aestivate and each individual was weighed following aestivation and prior to epiphragm removal. The same process was repeated till the termination of the experiments. In each case the distance between the outer lip of the shell aperture and the point of attachment of the epiphragm was measured.

RESULTS

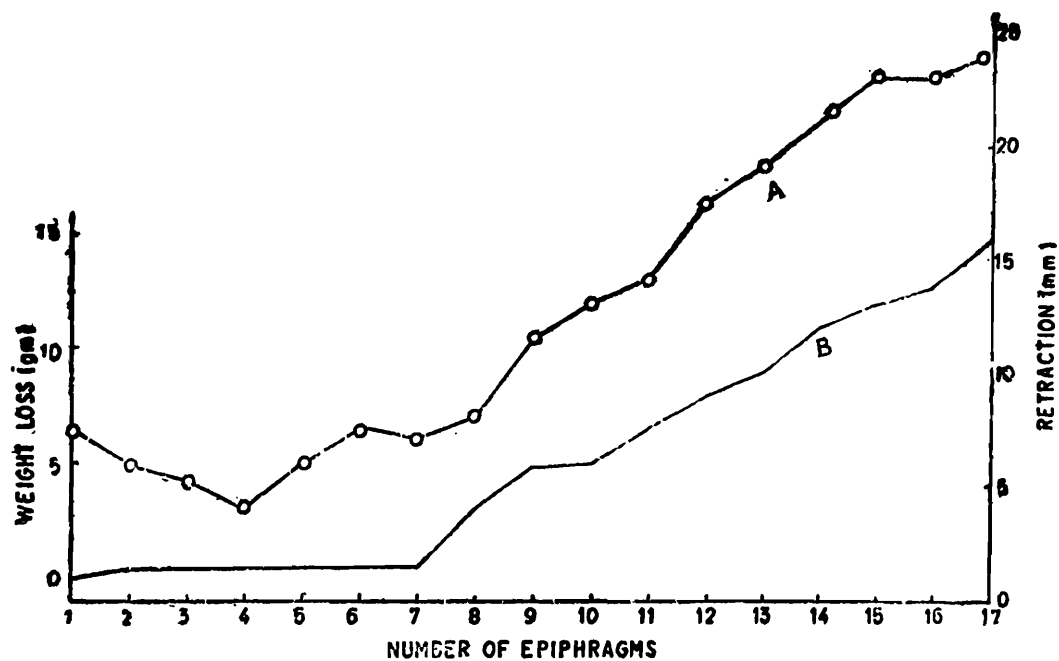
In Group—I, 4 snails died prior to and 11 snails died after the formation of the 10th epiphragm. The initial body weight of a snail was 31.2-34.8g. on an average 33.5g. The distance between the shell lip and the point of first epiphragm attachment was 3.0-5.1, on the average 4.1 mm. The contraction of the visceral mass was gradual and progressive with the formation of succeeding epiphragms and the distance of the 10th epiphragm was 47.8 mm from the shell lip. The maximum and minimum rate of contraction 10 and 2 mm respectively was recorded prior to the 3rd and 7th epiphragm secretion. The average retraction of visceral mass was 4.78 mm per epiphragm secretion.

A gradual loss in body weight of the snails was recorded from first to last epiphragm secretion. The loss in each case was 1.0-2.5, on the average 1.75g. The mean total loss in body weight was 17.5g (53.85%). The loss of body weight and the retraction of the visceral mass in relation to epiphragm secretion have been shown in Text-fig. 1. Of the 10 epiphragms secreted by an individual the first 5 were transparent while the 6th and subsequent epiphragms were thick and heavy perhaps due to the secretion of more calcic substances.

In Group—II, one snail died following the secretion of 15th epiphragm while the remaining specimens died following the formation of 17th epiphragm. Body weight remained unchanged till the formation of the 7th epiphragm. There was a gradual loss of body weight from the secretion of the 8th epiphragm which continued up to the secretion of last epiphragm. The mean total loss of weight was 14.6g (43.9%) (Text-fig. 2).



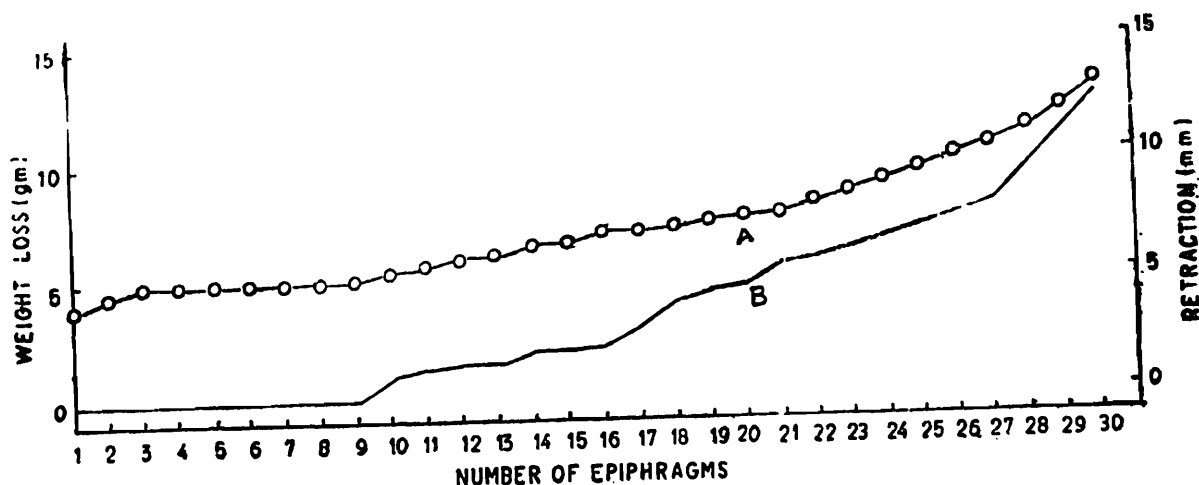
Text-fig. 1. Relation between the number of epiphragm secretion and the loss of body weight (A), and retraction of visceral mass (B) inside the shell cavity in *A. fulica* without food and water supply.



Text-fig. 2. Relation between the number of epiphragm secretion and the retraction of visceral mass (A), and the loss of body weight (B) in *A. fulica* when supplied water but no food.

On the average, the retraction of the visceral mass was 1.46mm after each epiphragm secretion from the 8th to the 17th. The distance between the epiphragm and the shell lip was 7.5, 6.0, 5.2 and 4.0 mm respectively during first, second, third and fourth epiphragm secretion. The retraction was higher with the secretion of 9th epiphragm. However, retraction of visceral mass was a must prior to secretion of each epiphragm. The distance between the lip of the shell and the last i. e. the 17th epiphragm was 24 mm (Text-fig. 2).

The average body weight of the snail in Group—III was 32.83g. Of the 15 selected snails in this group 3 individuals died following secretion of 14th, 23rd and 26th epiphragm respectively. The remaining snails secreted as many as 30 epiphragms in 241 days and the process was continuing. The loss in body weight was recorded between first and



Text-fig. 3. Relation between the number of epiphragm secretion and the loss of body weight (A), and retraction of visceral mass (B) inside the shell cavity in *A. fulica* when supplied both food and water.

third epiphragm secretion and again following the 9th one. A gradual higher loss of body weight has been recorded from the secretion of the 10th epiphragm onwards. The total weight was 20.33g (Text-fig.3) at 30th epiphragm secretion stage. There was no retraction of visceral mass up to the 9th epiphragm secretion stage. A gradual higher rate of retraction of visceral mass was observed following the secretion of 10th epiphragm and onwards. The distance between the shell lip and the point of attachment of the 30th epiphragm was 12.5 mm (Text-fig. 3).

DISCUSSION

Results of the experiments on the potentiality of epiphragm secretion in *A. fulica* suggest that a number of factors influence this process. The prime need for the secretion of mucocalcareous substance is water. Food materials also play significant role but possibly next in order. It

seems that usually a snail is able to produce 10 epiphragms with its reserves. The capacity may be doubled if the loss of body fluid alone is compensated by some means. It appears that the essential components (Mead, 1961) for epiphragm secretion stored in the snail's body are sufficient for the formation of at least 10 epiphragms in *A. fulica*. In nature the snails regain temporary activity due to occasional rains. Such situations offer the scope to compensate loss of body fluid and also certain amount of nutrients and calcic materials through food and from eating the earlier epiphragms. Unlike *A. fulica*, the replacement of transparent epiphragm by calcified epiphragm with the progress of aestivation has also been recorded in *Otala lactea* (Rokitka and Herreid, 1975). It is probable that the snails lose their body water more and more with the progress of aestivation which influences the condensation of the fluid of the secretory organs. The snails while compelled to produce next epiphragm obviously cells will secrete thick mucoid fluid.

The loss of body weight with the successive epiphragm secretion is most probably associated with the rate of evaporation of body water of the snail. However, the materials secreted by the snails as listed by Mead (1961) for the production of epiphragms, though very little in quantity are undoubtedly play a significant role with the weight loss. The gradual loss of water and other materials from the snails in Group—I enforced them to retract more and more inside the shell cavity. The less retraction and no retraction of visceral mass with the progress of epiphragm secretion in the snails of Group—II and III respectively is probably due to the compensatory mechanism of body weight either through the absorption of water or both by water and food. As both water (due to rain) and food are easily available to the snails in their natural habitat, during temporary arousal from their seasonal slumber they regain the necessary requirements for successive epiphragm secretion. This phenomenon put them in advantageous position to overcome a long dry period.

It is already established that epiphragm secretion in land snails is primarily concerned with the conservation of water during drought (Grassé, 1963 ; Machine, 1967). From the present study it is clear that the frequency of epiphragm secretion in aestivating snail depends on the amount of water and reserve materials present in the tissues rather than the environmental factors.

SUMMARY

Epiphragm secretion in *A. fulica* is influenced by water and food. Normally, with the reserves, the snails are able to produce at least 10

epiphragms while with the supply of water the number increased to 17, and with the supply of water and food the snails secreted as much as 30 epiphragms and the process, if continued would be much more.

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OBSERVATIONS ON THE SWARMING, BREEDING HABITS AND
SOME LARVAL STAGES OF THE DEEP SEA PORTUNID CRAB
CHARYBDIS (GONIOHELLENUS) EDWARDSI LEENE AND
BUITENDIJK 1949 IN THE NORTHERN ARABIAN SEA IN
JANUARY-FEBRUARY 1974 AND OFF THE MADRAS
COAST DURING JANUARY TO MARCH
1976 TO 1979.

By

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(With 1 Plate, 10 Text-figures and 1 Map)

INTRODUCTION

Swimming crabs of the family Portunidae as a rule are bottom dwelling animals. The pelagic occurrence of some species of Portunids of the genera *Polybius* and *Charybdis* is attributed as a periodic phenomenon ; the swarms appearing rather suddenly and disappearing equally abruptly, connected with the reproductive cycle, which in turn is associated with the temporary presence of food in the upper layers of the sea.

A perusal of the literature reveals that authentic records of the swarming habit of the swimming crabs of the family Portunidae have been reported only for *Polybius henslowi* Leach and *Charybdis (Goniohellenus) edwardsi* Leene and Buitendijk (Clark, 1909, p. 287 ; Balss, 1955, pp. 1318-1319 ; Della Croce, 1961, pp. 5-13 ; Della Croce & Holthuis, 1964-65, p. 33 for *P. henslowi* and Della Croce & Holthuis, 1964-65, p. 33-37 ; Silas, 1969, pp. 1-86 and Prasad, R. R. & Nair, P. V. R., 1973, p. 1 for *C. (G) edwardsi*).

The abundant occurrence of this species in dense concentrations along the shelf edge in the Arabian Sea between Mangalore and Trivandrum and its possible utilisation for the manufacture of crab meal, if not as food, has been reported by Silas, 1969. This species as a possible resource for further exploitation has also been remarked by Prasad and Nair, 1973.

This ubiquitous crab (Plate IV) was observed to swarm at the sea surface after sun set (16. 05 hrs. to 20. 05 hrs.) i) at two deep sea

oceanic stations 03/03 Lat. 23° 29' N ; Long. 60° 17' E and 09/15 Lat. 20° 30' N ; Long. 61° 55' E established in January and February 1974 during the Oceanographic Expedition on INS Darshak in the Northern Arabian Sea and ii) in the inshore surface waters of the Madras coast, periodically appearing suddenly and disappearing equally abruptly during the cruises of the R. V "Chota Investigator" during January to March 1976 to 1979 either in the early morning before sunrise or after sun set. The distribution and abundance of this species based on previous records and from the present observations are presented in Text-fig. 1. Although this swarming crab has been observed to swim solitarily or float passively at the sea surface of the south-west coast of India and the Laccadive sea (Silas, 1969), its abundant occurrence in swarms in deep sea oceanic regions in the central part of the Northern Arabian Sea, where the total depth was ranging from 1800 to 3240 metres is remarkable. Further, its occurrence in the inshore surface waters of Madras coast during the cruises of the R. V. "Chota Investigator" sporadically, from January to March in 1976, 1977, 1978 and 1979 is first recorded from Bay of Bengal and suggests that the distribution of this species has been extended to the Bay of Bengal, gradually establishing itself in this area also. Furthermore, very little published information is available on the breeding and mating habits of this species. Therefore, details on observations on the swarming, breeding and mating habits, and distribution of this species are presented in this paper. In addition, the first stage zoea, megalopa and first instar stages of a species of *Charybdis*, which is provisionally assigned to this species, since these stages occurred in appreciable numbers in the plankton-neuston collections at the stations where the adults of *Charybdis* (*Goniohellenus*) *edwardsi* were observed in dense swarms, are also briefly described.

DESCRIPTION OF THE SALIENT FEATURES OF THE SPECIES

Family PORTUNIDAE Rafinesque, 1815

Genus *Charybdis* De Hann, 1833

Goniosoma A. Milne-Edwards, 1860-61

Charybdis (*Goniohellenus*) *edwardsi* Leene & Buitendijk, 1949

Goniosoma truncatum A. Milne Edwards, 1860-61, p. 380, pl. 34, fig. 4.

Charybdis (*Goniohellenus*) *edwardsi*, Leene and Buitendijk, 1949, p. 296, figs. 3, 4C ; Della Croce and Holthuis, 1964-65. p. 119, one figure not *Portunus truncatus* Fabricius, 1798, p. 365.

One of the conspicuous and most characteristic features of this species is the smooth and highly polished hexagonal carapace with

transverse granular ridges on it. The small and sharp frontal teeth, large and truncate antero lateral teeth, distinguish this species (Plate IV).

This species which was not represented so far in the collections of the Zoological Survey of India, Calcutta is now being added to the National Zoological Collections.

OBSERVATIONS ON SWARMING AND BREEDING HABITS

During the oceanographic expedition on I.N.S. "Darshak" in Northern Arabian Sea dense swarms of this species were observed over a wide area in the North Western part of Arabian Sea near to Persian Gulf between Lat. 23°29'N ; Long. 61°55'E and Lat. 20°30'N ; Long. 60°55'E after sun-set during January-February 1974. At some regions in this area, they appeared in abundance, two crabs occurring every five feet approximately, as the ship was cruising along its set course, establishing predetermined stations (*vide* Daniel & Jothinayagam, 1977). Similar swarms of this species were observed during the regular cruises of the R. V. "Chota Investigator" either in the early morning before sun-rise or after sun-set, during January to March in 1976, 1977, 1978 and 1979, in the inshore area of Madras coast. These swarms were observed to appear suddenly and disappearing equally abruptly after few days during this period. However, a few female crabs collected from this region were infested by the pedunculate cirripede, *Conchoderma virgatum* (Spengler) bearing large sized eggs suggesting that this pelagic cirripede and its host might have spent at least 80 to 90 days in the pelagic domain of the sea, since *C. virgatum* (Spengler) (*vide* Daniel, 1955, John Roskell, 1969 and Newman, W. A. ; Zullo, V. A. and T. H. Withers, 1969) is a pelagic species which cannot stand the pressure of deep water. Therefore, it is inferred that this crab which occurs in dense swarms in the surface waters for mating, descends to slightly lower depths of 5 to 10 metres only, and does not become a deep sea benthic form, for at least 3 to 4 months. A detailed examination of the adult female crabs obtained in the North Western Arabian sea revealed that while some crabs harboured the same species of Cirripede, i. e. *C. virgatum*, in some other large sized crabs there were only the bases of the peduncles of this cirripede, suggesting that these cirripedes were probably killed during the descent of the adult crab after spending a few months of its life span in the surface waters for breeding purposes.

The occurrence of berried crabs during January and February in the North Western Arabian Sea and the occurrence of the Zoea, megalopa and first instar stages of a species of *Charybdis* (assigned to this species

by the present authors during January to March, 1974 and the occurrence of swarms of berried females in the Madras inshore waters during January to March, forces one to surmise that the breeding season extends most probably from about November to March during each year, since mating in some of these crabs were observed by us, in specimens maintained in the field and laboratory aquaria, during the months of January to March in the Madras coast.

Mating habits :

In the male, the first and second pair of abdominal appendages act as genital organs. The first pair is a tube like organ, while the second is a jointed rod. The two are usually separate, but the second is capable of being inserted into the first. The female is in a soft state during copulation, since it has just moulted. Before copulation, the male hold the female with the second pair of walking legs. The female at this stage is upright, with its back against the abdomen of the male, and is quite passive. It is not attracted towards any food, but the cleaning operation of the gills by moving the third pair of maxillipeds to and fro, takes place. The male, on the contrary, is very active and drives away any intruder with its chelipeds. If, however, the intruder persists in advancing, the male, catching the female in its legs, swims away. The pair may thus lie in the same position for two or three days.

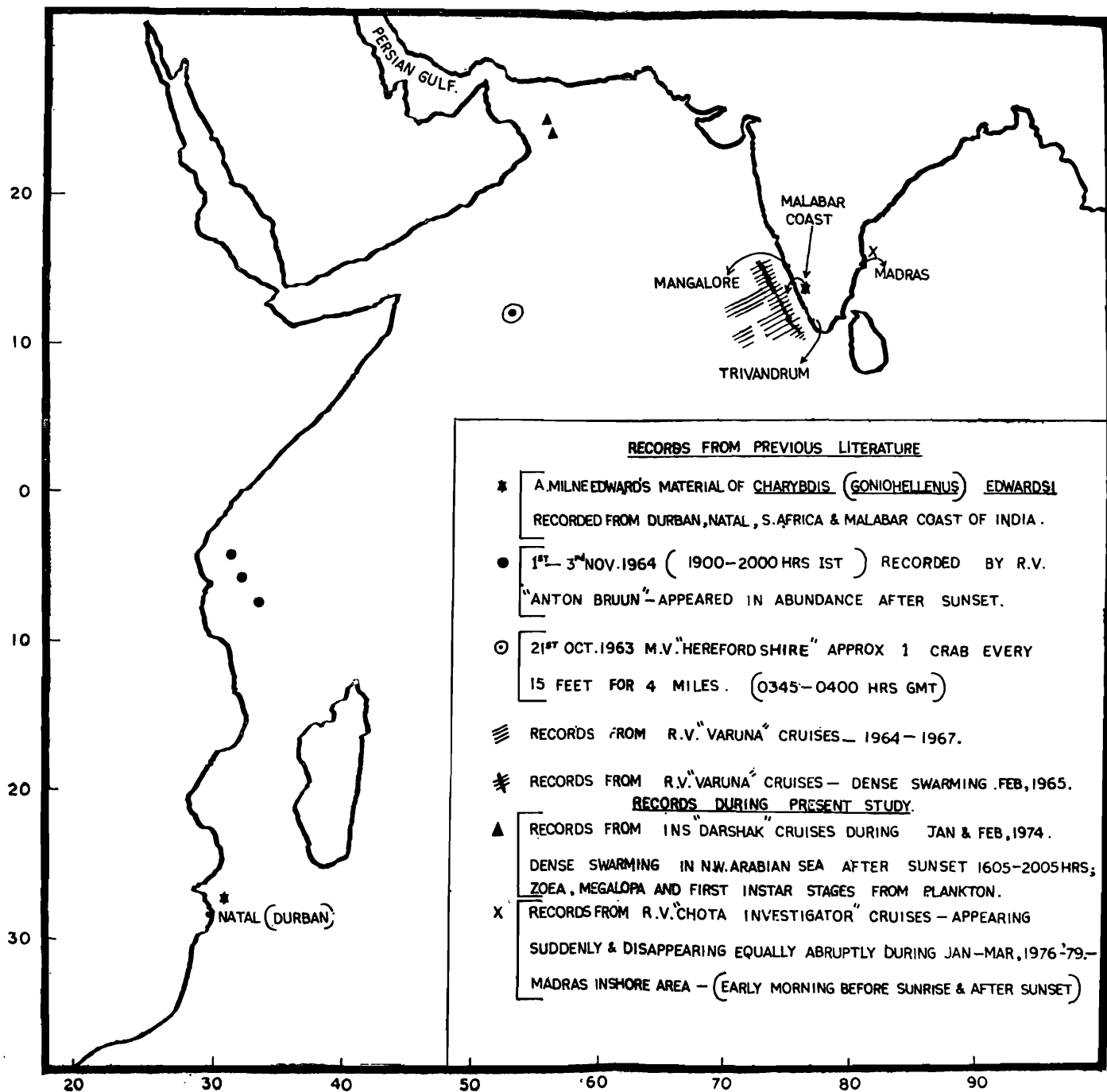
Sometimes it happens that the female is "hard" (i. e. not recently moulted) when the male catches her. In that case, the male still holds the female which struggles hard, not to get away from the male, but to get rid of its moult.

When copulation begins, the male turns the female so that the latter is now inverted, with its abdomen opposed to that of the male. The male then inserts the second pair of appendages inside the first, and both together acting as a penis are thrust into the female openings. The first pair is capable of very little motion in this position, but the second pair of appendages can move freely up and down inside the first, very much like a piston of a pump and forces the sperm into the female. The copulation may last for three or four hours, after which the crabs separate.

The abdomen of the male during copulation is shut against the sternum, only the penis protruding, and the abdomen of the female is opened only just sufficiently for the penis to move freely. If the crabs are disturbed during copulation, the act ceases and the crabs readily separate.



Fig. 1. Showing dorsal view of adult female of *Charybdis* (*Goniohellenus*) *edwardsi* Teene & Buitendijk, 1949.



Records of the swarming crab *Charybdis* (*Goniohellenus*) *edwardsi* in the Arabian sea and Bay of Bengal

Larval stages :

As mentioned in the introduction, the first stage Zoea, Megalopa and first instar stage of a species of *Charybdis* occurred in appreciable numbers in the plankton and neuston collections at the stations where the adults of *Charybdis (Goniohellenus) edwardsi* were observed in dense swarms both in the North West Arabian Sea and inshore waters of Madras coast. These larval stages are, therefore, provisionally assigned to this species. This however, must be confirmed by obtaining berried females of this species and rearing their larval stages in the laboratory aquaria tanks. The following larval forms are briefly described.

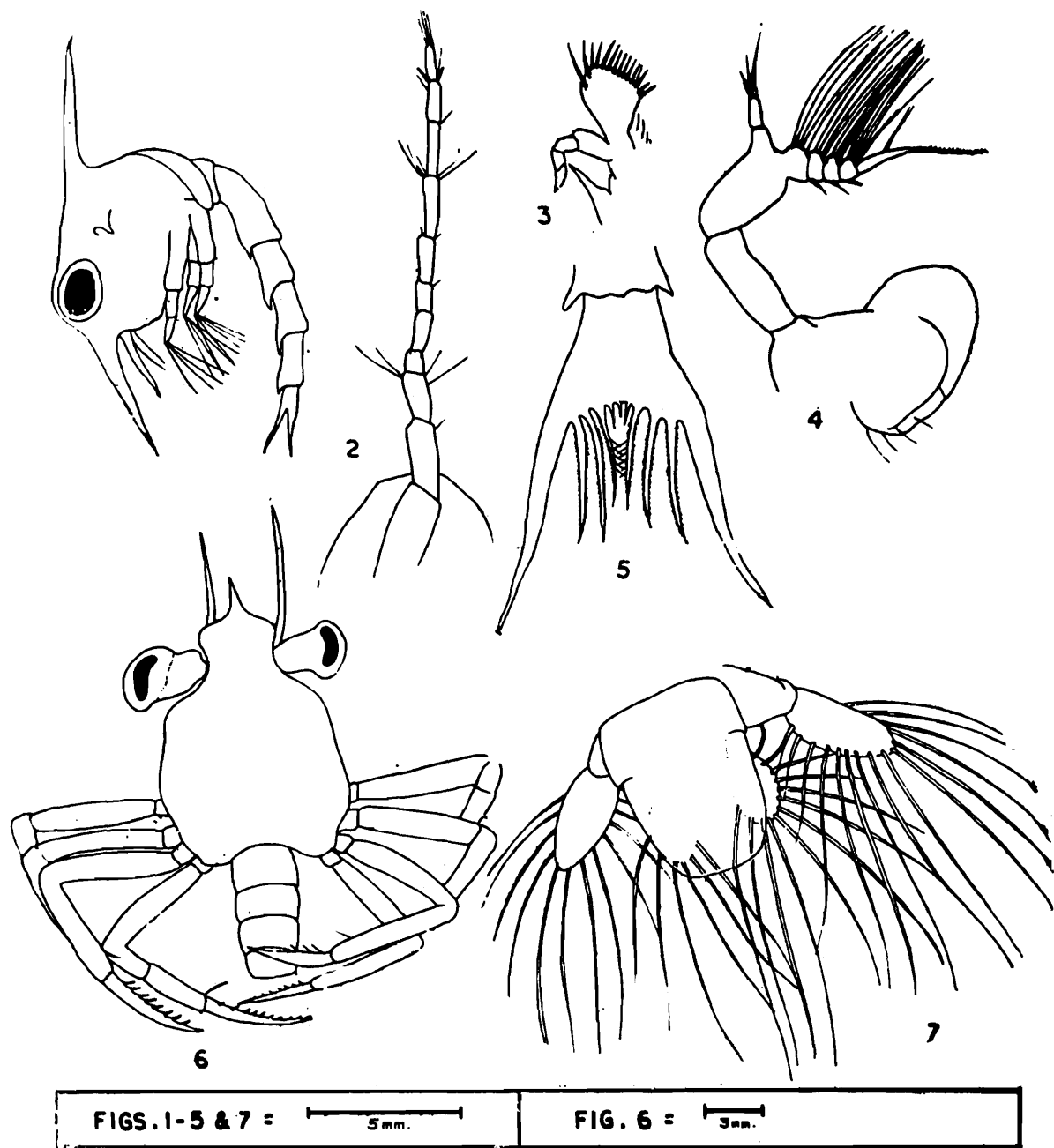
First stage Zoea (Text-figs. 1-5)

The carapace is rounded (Text-fig. 1). The dorsal spine is straight with slightly curved tip and is equal in size with the straight rostrum. The antennule (Text-fig. 3) is a short unjointed pigmented process with a single aestheta. The antenna (Text-fig. 3) consists of a well developed spine from process which is nearly as long as the rostrum and a small exopodite bearing a setae. The first maxillipede (Text-fig. 4) has the usual stout basipodite, an exopodite of two segments with four setae at the tip, and a five-jointed endopodite with four setae at the tip. In the second maxillipede, the endopodite consists of three joints. The thoracic appendages (Text-fig. 2) are ten jointed. The abdomen consists of five segments and a telson. The second and third segments have the usual lateral hooks, while the third, fourth and fifth segments have a pair of long downwardly directed spines from the postero-lateral border. The forks of the telson are curiously inbent posteriorly in a regular curve, and bear two spines. There are seven hairs on the inner border of the innermost pair of setae in the fork of the telson (Text-fig. 5), followed by a few spinules. The outer surface of these setae and both the borders of outer setae are spinulate.

Megalopa stage (Text-fig. 6).

The carapace is elongate a rostrum is present and consists of a single long spine. The sides are angular. A pair of ventral cornua (prolongations of the external plate of the last thoracic segment) is present.

The chelipeds and pleopods are fully developed. The last joint of the last pair of legs is flattened and bears along its inner border five coarse setae with curved tips and three straight setae. The other legs almost resemble those of the crab. The abdomen consists of six segments and a telson. The first segment is comparatively shorter than the rest and bears no pleopods. The postero-lateral borders of the fifth pleon segments are developed into long spines. The pleopods on the last abdominal segment (Text-fig. 7) have 12 setae each.



Text-figs. 1-7. *Charybdis (Goniohellenus) edwardsi*

1. First Zoea — Side view. 2. First Thoracic appendage.
3. Antennule and Antenna of Zoea. 4. First maxillipede of Zoea. 5. Telson of Zoea. 6. Megalopa stage. 7. Last abdominal segment with pleopods.

First instar stage.

The first post larval instar resemble the adult crab. The carapace has widened, and the six serrulate spines on the antero-lateral borders have developed. The last of these is much longer than the rest. The rostral spine of the megalopa has disappeared and the front is a simple transverse curve. The branchio-cardiac groove and the grooves from the last spines on the antero-lateral borders are present. The last pair of leg is adapted into swimming paddles. The abdomen is permanently flexed. Its colour varies from dirty white to a very faint grey, the eyes being yellowish pink and the cornea black.

Records and Distribution.

The previous records and swarming of this species from literature and its present records and swarming based on the present study is represented in Text-fig. 1. It is noteworthy that this species is recorded for the first time from the Bay of Bengal and the Madras coast suggesting that *Charybdis (Goniohellenus) edwardsi* has extended its range of distribution to the Bay of Bengal also.

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HITHERTO UNKNOWN AND SOME NEW RECORDS OF
SEXUALES OF APHIDS (HOMOPTERA : APHIDIDAE)
FROM UTTAR PRADESH, INDIA

By

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(With 2 Text-figures)

INTRODUCTION

The hills of Kumaon range in Uttar Pradesh were further explored for aphids in the cooler months of 1979 and 1980. Examination of the collected samples has resulted in the finding of hitherto unknown apterous oviparous females of *Liosomaphis himalayensis* Basu and *Macrosiphoniella sanborni* (Gillette), first record of apterous oviparous female of *Capitophorus formosartemisiae* (Takahashi) from India and new records of apterous oviparous females and alate males of *Macrosiphum* (*Sitobion*) *rosaeiformis* Das and *Tinocalloides montanus* Basu from the state of Uttar Pradesh. Besides, apterous oviparous female of *Taoia indica* (Ghosh and Raychaudhuri) has also been reported as new to the records of aphid fauna of north-west India.

Material of the reported species are deposited in the collection of Entomology Laboratory, Department of Zoology, University of Calcutta.

***Capitophorus formosartemisiae* (Takahashi, 1921)**

Myzus formosartemisiae Takahashi, 1921. *Aphididae of Formosa*, 1 : 25.

Ghosh, A. K. *et al.* (1971) recorded and described for the first time single apterous oviparous female of this species on *Artemisia* sp. from Bhutan. From India the same morph of this species has been recorded here for the first time. The sexual morph was found along with the viviparous apterae colonised on the undersurface of an old and dry leaf of *Artemisia* host.

¹ Deceased, 1st May 1981.

Material examined : 3 apterous viviparous ♀ ♀ and 1 apterous oviparous ♀ : Nainital, 3.xii.1979 from *Artemisia vulgaris*.

Measurements of the apterous oviparous female in mm

Length	Width	Antenna	Antennal segments				Urs.	ht. 2.	Siph.	Cauda
			III	IV	V	VI				
1.42	0.67	1.44	0.12	0.16	0.21	(0.7+0.61)	0.1	0.09	0.43	0.1

***Liosomaphis himalayensis* Basu, 1964**

(Text-fig. 1)

Liosomaphis himalayensis Basu, 1964. *J. Linn. Soc. (Zool.)*, 45 : 231.

Apterous oviparous female : Body pale, about 1.33-1.53 mm long and 0.55-0.61 mm as maximum width. Head with low lateral and strong median prominence ; hairs on vertex short and blunt. Antennae 6-segmented, about 0.85-0.87 mm long and 0.57-0.85 x body ; paler upto segment IV, rest somewhat darker ; segments I and II scabrous, segment III smooth on outer margin, rest of the flagellum imbricated ; hairs on segment III about 5 μ long and 0.33-0.6 x basal diameter of the segment ; without secondary rhinaria. Rostrum extending upto midcoxae ; ultimate rostral segment as long as second segment of hind tarsus and with 2 accessory hairs. Dorsum of abdomen pale, hairs short and blunt, those on anterior tergites about 15 μ long and about 0.33-0.4 x and on 8th tergite about 0.85-0.92 x basal diameter of antennal segment III. Siphunculi about 0.21 x body, nearly smooth. Cauda constricted near base with 7-8 hairs. Hind tibiae distinctly swollen (Text-fig. 1), bearing numerous pseudosensoria throughout the length. Otherwise as in apterae viviparae.

Material examined : 4 apterous viviparous ♀ ♀ and 2 apterous oviparous ♀ ♀ : Nainital, 4. xii. 1979 from *Spiraea* sp.

Measurements of apterous oviparous females in mm

	Length	Width	Antenna	Antennal segments				Urs.	ht. 2	Siph.	Cauda
				III	IV	V	VI				
1.	1.66	0.82	0.93	0.21	0.16	0.16	(0.1+0.19)	0.09	0.09	0.31	0.13
2.	1.31	0.58	0.86	0.21	0.16	0.15	(0.1+0.15)	0.08	0.08	0.31	0.13

Remark : This endemic species was so far known by its viviparous morphs and the alate male (Raychaudhuri, 1980 ; Basu and Raychaudhuri, 1980). It is the first record of a species of the genus *Liosomaphis* from *Spiraea* sp., usual host being *Berberis* spp. (Miyazaki, 1971 ; Raychaudhuri, 1980).

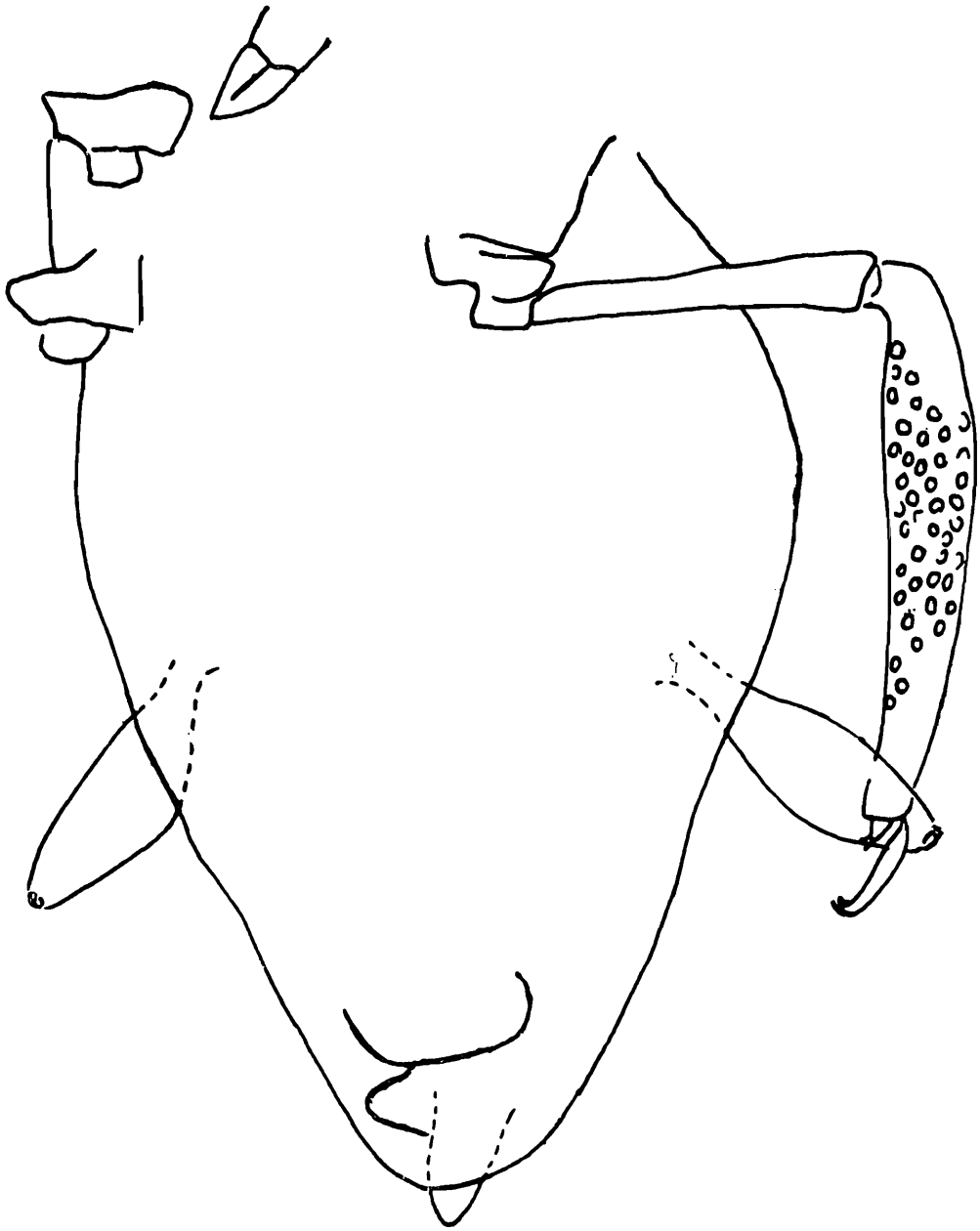


FIG 1

Text-fig. 1. *Liosomaphis himalayensis* Basu :

Apterous oviparous female : Portion of abdomen with hindtibia showing pseudosensoria.

***Macrosiphoniella sanborni* (Gillette, 1908)**

(Text-fig. 2)

Macrosiphum sanborni Gillette, 1908. *Can. Ent.*, **46** : 65.

Apterous oviparous female : Head brown with strong lateral frontal prominences. Antennae 6-segmented, about 0.9 x body ; segment III with 6-8 small, circular secondary rhinaria ; flagellum paler upto basal half of segment IV, rest brown. Rostrum reaching past hind coxae ;

apical segment as long as second segment of hind tarsus and bear 3-4 hairs. Siphunculi stout, tapering towards apex, about $0.13 \times$ body and $0.9 \times$ cauda bearing 12-14 hairs. Femora comparatively darker than in viviparae, hind tibiae not swollen, bearing 4-6 sparsely placed pseudosensoria on innerside of apical half (Text-fig. 2). Otherwise as in apterous viviparae.

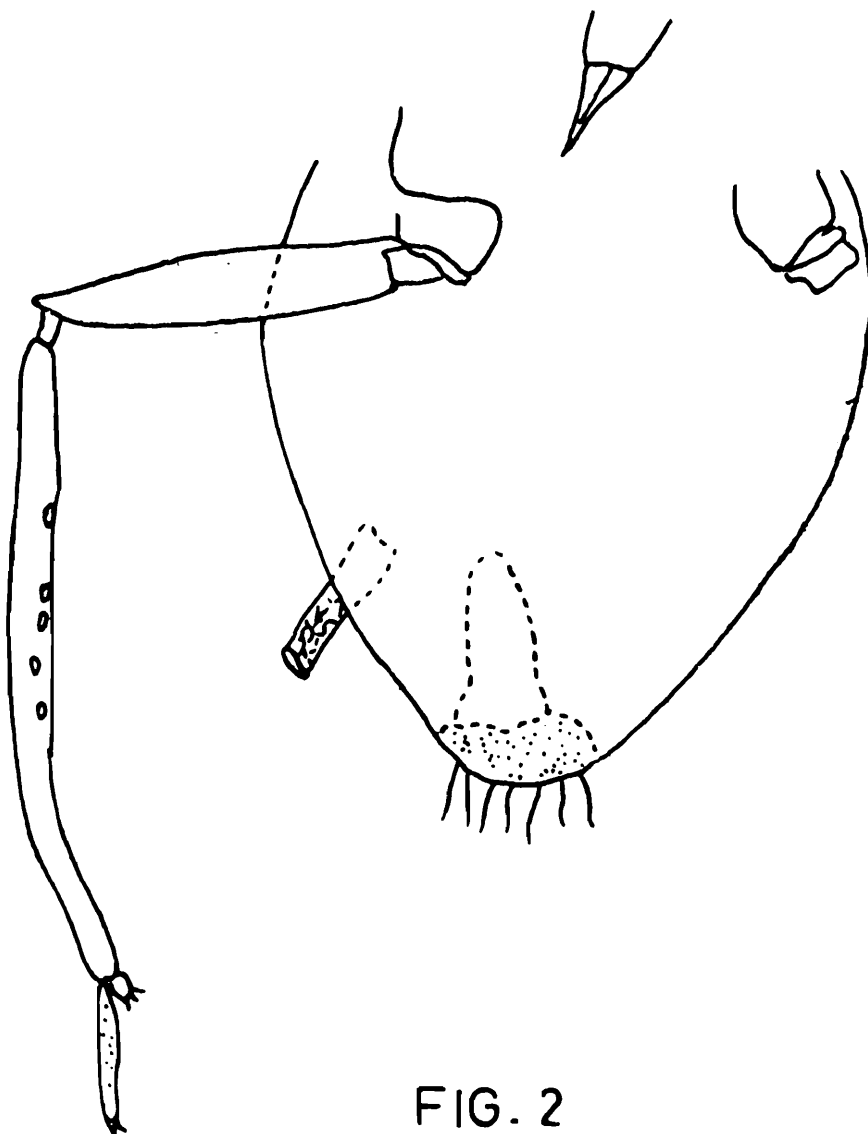


FIG. 2

Text-fig. 2. *Macrosiphoniella sanborni* (Gillette)

Apterous oviparous female: Portion of abdomen with hindtibia showing pseudosensoria.

Material examined : 8 apterous viviparous ♀♀ and 1 apterous oviparous ♀ : Almorah, 9.xii. 1979 from *Artemisia vulgaris*.

Measurement of the apterous oviparous female in mm

Length	Width	Antenna	Antennal segments				Urs.	ht. 2	Siph.	Cauda
			III	IV	V	VI				
2.38	1.24	2.13	0.58	0.19	0.39	(0.19+0.58)	0.15	0.16	0.36	0.36

Remark : This worldwide distributed species is specific on *Chrysanthemum* spp. Hille Ris Lambers (1938) observed that the species lives

on its host without forming sexual forms. In India the species was known by viviparous morphs only. Find of apterous oviparous female along with apterae viviparae on *Chrysanthemum* in the hills of Kumaon Range suggests that the species can possibly lead a holocyclic life cycle in this area.

Macrosiphum (Sitobion) rosaeiformis Das, 1918

Macrosiphum rosaeiformis Das, 1918. *Mem. Indian Mus.*, 6 (4) : 158.

Basu and Raychaudhuri (1980) mentioned the occurrence of both alate male and apterous oviparous females of this species in the hills of north-east India. From Uttar Pradesh it appears to be the first record of the sexuales of this species.

Material examined : 1 alate viviparous ♀ and 1 alate ♂ : Nainital, 4. xii, 1979 from *Rosa* sp. ; 1 apterous viviparous ♀, 2 alate viviparous ♀ ♀ and 5 apterous oviparous ♀ ♀ : Almorah, 9. xii. 1979 from *Rosa* sp.

Measurements in mm

Length	Width	Antenna	Antennal segments				Urs.	ht. 2	Siph.	Cauda
			III	IV	V	VI				
1. 3.27	1.32	3.45	0.79	0.67	0.6	(0.18+0.99)	0.12	0.13	0.67	0.36
2. 2.38	1.24	2.13	0.58	0.19	0.4	(0.19+0.58)	0.15	0.16	0.36	0.36
3. 1.82	1.08	1.62	0.36	0.25	0.26	(0.1+0.51)	0.83	0.11	0.30	0.19
4. 1.75	0.83	1.76	0.35	0.28	0.3	(0.11+0.58)	0.10	0.14	0.35	0.19
5. 1.92	1.03	1.97	0.49	0.33	0.33	(0.12+0.58)	0.10	0.12	0.39	0.15
6. 1.92	0.96	1.69	0.39	0.26	0.23	(0.10+0.58)	0.10	0.11	0.36	0.21

(1, alate male ; 2-6, apterous oviparous females).

Taoia indica (Ghosh and Raychaudhuri, 1972)

Eucерaphis indica Ghosh and Raychaudhuri, 1972. *Oriental Ins.* 6 : 373.

This endemic species was until now known by sexuelle morphs and the viviparous morphs from north-east India only. Present finding of apterous oviparous female along with apterous viviparous morph appears to be new to the aphid record of north-west India and also confirms the earlier finding that the species is confined to the plants of Betulaceae only (Basu and Raychaudhuri, 1980).

Material examined : 4 apterous viviparous ♀ ♀ and 5 apterous oviparous ♀ ♀ : Almorah, 8. xii. 1979 from *Alnus nepalensis*.

Measurements of apterous oviparous females in mm

Length	Width	Antenna	Antennal segments				Urs.	ht. 2	Siph.	Cauda
			III	IV	V	VI				
1. 3.34	1.20	5.26	1.41	1.38	1.10	(0.63+0.45)	0.13	0.21	0.15	0.15
2. 3.31	1.32	5.14	1.32	1.44	1.04	(0.65+0.47)	0.14	0.18	0.12	0.14
3. 3.14	1.22	5.19	1.32	1.32	1.32	(0.59+0.41)	0.14	0.18	0.12	0.11
4. 3.13	1.08	4.88	1.33	1.22	1.05	(0.61+0.47)	0.14	0.18	0.11	0.11
5. 3.17	1.12	5.08	1.32	1.12	1.14	(0.58+0.42)	0.14	0.18	0.11	0.12

Tinocalloides montanus Basu, 1969

Tinocalloides montanus Basu, 1969. *Oriental Ins.*, 3 : 367.

It is another endemic species known also by sexuelle morphs in the hills of north-east India and Himachal Pradesh (Basu and Raychaudhuri, 1980). It is the first report from Uttar Pradesh of alate males and apterous oviparous females along with alate viviparous female of this species which was collected on peach plants infesting the undersurface of leaves along mid-rib.

Material examined : 1 alate viviparous ♀, 2 alate ♂♂ and 24 apterous oviparous ♀♀ : Almorah, 17. iii. 1980 from *Prunus persica*.

Measurements in mm

	Length	Width	Antenna	Antennal segments				Urs.	ht. 2	Siph.	Cauda
				III	IV	V	VI				
1.	1.54	0.75	1.38	0.52	0.25	0.21	(0.12+0.13)	0.07	0.12	0.07	0.03
2.	1.51	0.55	D I S T O R T E D					0.10	0.11	0.06	0.06
3.	1.71	0.66	0.84	0.36	0.15	0.15	(0.10+0.12)	0.09	0.12	0.06	0.03
4.	1.46	0.71	0.87	0.30	0.14	0.14	(0.10+0.10)	0.10	0.11	0.03	0.04
5.	1.46	0.54	0.94	0.35	0.15	0.14	(0.10+0.11)	0.10	0.12	0.03	0.03
6.	1.38	0.58	0.78	0.31	0.13	0.15	(0.09+0.10)	0.09	0.11	0.04	0.03
7.	1.62	0.61	0.82	0.34	0.14	0.14	(0.10+0.11)	0.10	0.11	0.04	0.03

(1-2, alate males ; 2-7, apterous oviparous females)

SUMMARY

This paper includes descriptions of hitherto unknown apterous females of *Liosomaphis himalayensis* Basu and *Macrosiphoniella sanborni* (Gillette) and reports apterous oviparous females of *Capitophorus formosartemisiae* (Takahashi) for the first time from India. Besides, apterous oviparous female of *Taoia indica* (Ghosh and Raychaudhuri) is reported here as new to north-west India and alate males and apterous oviparous females of *Macrosiphum (Sitobion) rosaeiformis* Das and *Tinocalloides montanus* Basu are new to the state of Uttar Pradesh.

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PRELIMINARY OBSERVATIONS ON THE TAXO-ECOLOGY OF
AQUATIC HEMIPTERA AND COLEOPTERA (INSECTA)
OF HIGH ALTITUDE KUMAON LAKES, INDIA
WITH NEW RECORDS.

By

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INTRODUCTION

A great deal of taxonomical, biological and ecological work has been done on aquatic Hemiptera and Coleoptera in various parts of the world. The landmark contributions from abroad are by Hungerford (1948), Balfour Browne (1940, 1950), Clegg (1952), Mellanby (1963), Usinger (1968) and Hart and Fuller (1974).

Available literature on taxo-ecological aspects of aquatic Hemiptera and Coleoptera of the plains of India are mainly by Distant (1903, 1906, 1910), Annandale (1919), d'Orchymont (1928), Ochs (1925, 1933), Hora (1927), Pruthi (1929), Hutchinson (1940), Hafiz and Mathai (1938), Hafiz and Pradhan (1947), Tonapi (1959), Tonapi and Ozarkar (1959), Julka (1977) and Vazirani (1977).

The Kumaon lakes are situated in lesser Himalayas, characterised by lower temperatures of water and air, lower atmospheric pressure and higher degree of rainfall, as compared to the plains of India. This has brought about considerable changes in aquatic entomofauna of this region.

Unfortunately our knowledge of aquatic Hemiptera and Coleopa of high altitude Kumaon lakes (1320-1938 m asl) is restricted only to a few taxonomic fragmentary records/ reports and is confined in the literature of Distant (1910), d'Orchymont (1928), Hafiz and Ribeiro (1939), Singh and Gupta (1956), Vazirani (1968, 1970). Recent literature on some aquatic Hemiptera and Coleoptera of Kumaon are dealt with in the taxo-ecological papers of Bisht (1979), Das and Bisht (1979), Bisht and Das (1979a, 1979b, 1979c, 1979d, 1979e, 1980a, 1980b, 1981).

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LAKE SURVEYED AND METHOD OF COLLECTION

Five Kumaon lakes, Nainital, Bhimtal, Naukuchiatal, Sattal and Khurpatal were surveyed for aquatic Hemiptera and Coleoptera. The collections in the littoral region of the lakes were made with the help of a three metre wooden pole hand net of conventional design (30 cm in diameter), using organdie cloth of about 40 mesh. A container having a capacity of one litre was held in position at the end of the net for collection. Standard net sweeps of about 5 meters (to and fro) were made fortnightly by the net in five fixed stations in each lake. For surface dwelling, macrophytic and substratal insects the pole net was operated separately in respective supporting areas. During the sweeps the speed was kept reasonably constant. In case of saxicoline insect collections, the stones at the substratum were agitated with the help of net. In the laboratory the samples were thoroughly washed for qualitative studies.

For quantitative studies of insects yearly average value (in numbers) for each insect, in each lake was calculated. The general abundance of each insect species was then determined as abundant, common, few, rare and absent.

The collected insects were fixed and preserved in 70% alcohol. Majority of insects have been confirmed by the Commonwealth Institute of Entomology, London ; while a minor portion of the identifications have been confirmed by the authorities of Zoological Survey of India, Calcutta and Z. S. I. Jodhpur.

RESULTS AND DISCUSSION

The list of aquatic Hemiptera and Coleoptera of Kumaon lakes, with their frequency of abundance is given in Table 1. A total of 70 species of aquatic Hemiptera and Coleoptera were collected from Kumaon lakes. 51 species marked with asterisk were new records over the past literature by Distant (1910), S. W. Kemp (1911, collection deposited in Z. S. I., Calcutta), Hafiz and Ribeiro (1939), Singh and Gupta (1956), Vazirani (1968, 1970). Out of these, four species of aquatic Coleoptera viz., *Byrrhinus hirsutulus* Champion (Limnechidae) *Grouvellinus duplariis* Champion (Elmidae), *Cyllodes* sp. (Nitidulidae) and *Apion credulum* Fst. (Apionidae) observed to be the first records from the entire Indian region.

Qualitative studies on aquatic bugs and beetles of Kumaon lakes (Table 1) during the years 1977-1980 has revealed that eutrophication and pollution (as in lake Nainital) adversely affect the distribution of

TABLE 1 : Check-list of aquatic Hemiptera and Coleoptera and their relative abundance

HEMIPTERA		Locality and abundance				
Insect	NT	BT	NAT	ST	KT	
	1	2	3	4	5	
HEMIPTERA						
1. CORIXIDAE						
(1) <i>Micronecta merope</i> Dist*	—	++++	++++	++++	—	
(2) <i>M. wui</i> Lundblad*	+++	+++	++	—	+++	
(3) <i>M. swa</i> Krik*.	+	++	+	+	+	
(4) <i>M. fulva</i> Paiva*	—	+++	+++	+++	—	
(5) <i>Corixa hieroglyphica</i> Duf.*	++	+++	++	++	+	
(6) <i>C. Kempi</i> Hutchinson*	+	++	—	—	+	
(7) <i>Corixa</i> sp.	+	+	+	—	—	
2. NOTONECTIDAE						
(8) <i>Anisops batillifrons</i> Lundblad*	++	+++	+++	+++	—	
(9) <i>A. sardea</i> Herrich-Shaffer*	++	+++	++	++	++	
3. PLEIDAE						
(10) <i>Plea pelopea</i> Dist.	+	+++	+++	+++	+	
(11) <i>Plea</i> sp.	—	+	++	++	—	
4. NEPIDAE						
(12) <i>Laccotrephes griseus</i> (Guer)*	+	+++	+++	++	+	
(13) <i>L. ruber</i> Linn.	—	+++	+++	++	++	
(14) <i>Laccotrephes</i> sp.	—	+	++	+	—	
(15) <i>Ranatra fliformis</i> Fabr.	+	+++	+++	++	+	
(16) <i>R. varipes</i> Stal.*	+	+++	+++	++	—	
(17) <i>R. elongata</i> Fabr.*	—	+	+	+	—	
5. NAUCORIDAE						
(18) <i>Heleocoris vicinus</i> Montand*	—	++++	++++	+++	—	
6. GERRIDAE						
(19) <i>Gerris spinolae</i> Leth & Sever	—	++++	+++	+++	—	
(20) <i>Gerris nepalensis</i> Dist.	+	+	+	+	++	
(21) <i>Metrocoris strangulator</i> Bredd*	—	+++	+++	+++	—	
(22) <i>Chimarrhometra orientalis</i> (Distant)*	+	++	++	++	+++	
7. VELIIDAE						
(23) <i>Microvelia</i> sp.	—	++	+++	++	+	
8. BELOSTOMATIDAE						
(24) <i>Lithocerus indicum</i> (Lep. & Serv.)*	—	+	+	+	—	

HEMIPTERA		Locality and abundance				
Insect		NT	BT	NAT	ST	KT
		1	2	3	4	5
COLEOPTERA						
1. DYTISCIDAE						
(1) <i>Laccophilus inefficiens</i> Walk.	—	++	++	++	++	++
(2) <i>Hyphydrus renardi</i> Severin	—	++	+++	++		—
(3) <i>Hyphoporus aper</i> Sharp.*	++++	+	—	—		+
(4) <i>H. elevatus</i> Sharp*	—	++	+	—		—
(5) <i>Rhantus taprobenicus</i> Sharp*	++	+++	+	+		++
(6) <i>R. punjabensis</i> Vazirani*	++	+++	++	+		—
(7) <i>R. sexualis</i> Reg.*	+	+	—	—		—
(8) <i>Agabus nitidus</i> (Fabr.)*	++	+	—	—		++
(9) <i>A. sinuaticollis</i> Reg.*	+	++++	+++	++		+
(10) <i>Eretes sticticus</i> (Linn.)	+	—	—	—		—
(11) <i>Hydaticus vittatus</i> (Fabr.)	+	++	++	+++		+
(12) <i>Uvarus genitilis</i> (Sharp)*	++	+++	+++	++		+++
(13) <i>Potamonectes balli</i> Vazirani*	+	++	—	—		—
(14) <i>P. manii</i> Vazirani	—	+	+	—		++
(15) <i>Potamonectes</i> sp.	+	—	—	—		—
(16) <i>Platynectes kashmirans</i> Balfour Browne	+	++	+++	+++		+
(17) <i>Cybister limbatus</i> Fabr.*	—	+	+	++		—
(18) <i>C. tripunctatus asiaticus</i> Sharp.	+	++	+	+		+
(19) <i>C. convexus</i> Sharp*	—	+	++	+		—
2. HALIPLIDAE						
(20) <i>Haliplus kupuri</i> Vazirani*	—	++	++	++		+
(21) <i>H. manipurensis</i> Vazirani*	—	++	+	++		—
3. GYRINIDAE						
(22) <i>Orectochilus</i> sp. (Patrus)*	—	+	—	—		+
(23) <i>Dinutes unidentatus</i> Aube*	+	++	++	+++		++
4. HYDROPHILIDAE						
(24) <i>Coelostoma stultum</i> (Walk.)*	—	++	+	++		+
(25) <i>Pachysternum nigrovittatus</i> Motschulsky*	—	+	+	+		—
(26) <i>Sphaeridium quinquema-</i> <i>culatum</i> Fabr.*	—	+	++	—		—
(27) <i>Laccobius simullans</i> d'Orchymont	+	++	+++	+++		++
(28) <i>Helochaeres crenatus</i> Reg.*	++	++++	+++	+++		++
(29) <i>Enochrus vulgatus</i> Regimbart*	+	++	+++	++		—
(30) <i>Paracymus vulgatus</i> Wooldridge*	+	+++	+++	+		++

Insect	Locality and abundance				
	NT	BT	NAT	ST	KT
	1	2	3	4	5
(31) <i>Paracymus</i> sp.	++	++++	+++	+++	++
(32) <i>Hydrocassis regosus</i> Knisch*	+	+	—	—	—
(33) <i>Berosus pulchellus</i> Macleay*	—	+	+	+	—
(34) <i>B. nigriceps</i> F.*	+	+	—	+	—
(35) <i>B. indicus</i> Motschulsky*	+	++	+	—	—
(36) <i>Regimbartia attenuata</i> Fabr.*	+	+	++	++	+
(37) <i>Sternolophus rufipes</i> Fabr.*	—	++++	+++	+++	—
(38) <i>Hydrophilus cashmirensis</i>	—	+	+	+	—
Redtenbacher*					
(39) <i>H. senegalensis</i> Percheron*	—	++	+	+	—
5. HYDRAENIDAE					
(40) <i>Hydraena fontana</i>					
d'Orchymont*	—	+	+	+	—
(41) <i>Ochthebius</i> sp.	—	+	+	—	—
6. LIMNECHIDAE					
(42) <i>Byrrhinus hirsutulus</i>					
Champion*	—	+	—	—	—
7. CURCULIONIDAE					
(43) <i>Bagous</i> sp.*	—	+++	++	++	+
8. ELMIDAE					
(44) <i>Grouvellinus duplariis</i>					
Champ.*	—	++	+	—	+
9. NITIDULIDAE					
(45) <i>Cyllodes</i> sp.*	—	+	—	—	—
10. APIONIDAE					
(46) <i>Apion credulum</i> Fst.*	—	+	—	—	—

NT=Nainital ; BT=Bhimtal ; NAT=Nauouchiatal ; ST=Sattal ; KT=Khurpatal
 +++++=abundant ; +++=common ; ++=few ; +=rare ; —=Absent

entomofauna ; since there are a large number of species which are completely absent in polluted lake Nainital but present in oligotrophic lakes of Kumaon (Table 1). Bisht and Das (1980b) have shown that the quality of water (polluted and unpolluted), quality and quantity of aquatic vegetation, nature of lake bottom, play an important role in determining the qualitative and quantitative distribution of insect communities. Thus there is a marked fall in the number of families, genera and species and their relative abundance as well. On the contrary the oligotrophic waters (Bhimtal, Naukuchiatal, Sattal) show comparatively more diversification of species and thereby more number

of families, genera and species and the abundance of aquatic bugs and beetles (except the biological indicators of pollution (Bisht and Das, 1980b) in these lakes. The present observations support the statement of Tonapi and Khole (1975) that there may be a total disappearance of several beneficial freshwater organisms by pollution contaminants.

One of the most important ecological factors that appears responsible for the differences in habitat and abundance of aquatic bugs and beetles between Kumaon lakes and the Indian plains waters is mainly the altitudinal difference between the two regions, with concomittant differences in climate, temperature of water and air, moisture, food and reproductive seasons. Contrary to the altitudinal difference between extreme high altitude (at or above timber line) and the plains of India, the Kumaon lakes may be considered to be intermediate in altitude. When compared to the alpine zone waters, the Kumaon lakes in general contain incursion of entomofauna from the plains as well as from the alpine zone, which has resulted in an appreciable number of species of aquatic Hemiptera (24 species) and Coleoptera (46 species). But so far as their numerical abundance is concerned most of the genera and species are either common, few or rare ; while only a few occur in abundant numbers. However at extreme high altitudes in North-West Himalaya (about 3,600 m), only a single species of Gerridae (Hemiptera) and eight species of Coleoptera have been recorded (Mani and Singh, 1961). According to these authors aquatic communities inhabiting lakes and ponds and streams etc. of biotic province above timber line, are comparatively smaller in size and in distribution, and are characterised by general absence of surface haunting species of higher orders like Heteroptera and Coleoptera.

Moreover, comparing the species composition of aquatic Hemiptera and Coleoptera of high altitude Kumaon lakes and the plains of India, it appears that there are far more diversified families, genera and species in the plains waters. Tonapi (1959) recorded 11 families, including 41 species of aquatic Hemiptera from Indian plains in Poona when compared to only 8 families and 24 species in the present investigation in Kumaon lakes.

Observations on the qualitative estimations of aquatic bugs and beetles of Kumaon lakes have revealed that many of the families genera and species are completely absent in eutrophic and polluted lake Nainital, but are present in most of the oligotrophic Kumaon lakes. Thus the oligotrophic Bhimtal families are : Naucoridae, Vellidae, Belostomatidae (Hemiptera) ; Haliplidae, Hydraenidae, Limnechidae, Curculionidae,

Elmidae, Nitidulidae and Apionidae (Coleoptera). Their complete absence in lake Nainital appears to be mainly due to pollution and eutrophication of the lake, as evidenced by the physico-chemical characters of its water (Das and Bisht, 1979) followed by higher altitude, as secondary ecological factors.

It may be concluded that the distribution of aquatic bugs and beetles is not only affected by the physico-chemical features of water but also due to the altitudinal differences of a water body.

SUMMARY

1. The present work incorporates the results of investigations on the qualitative and quantitative studies of aquatic Hemiptera and Coleoptera in five high altitude (1220-1938 masl) Kuamon lakes.

2. A list containing 70 species, of which 24 species belonging to Hemiptera and 46 to Coleoptera are given in the paper. 51 species of have been found to be new records from this region ; of these four species of Coleoptera are being recorded for the first time from entire Indian region.

3. A comparison of species of aquatic Hemiptera and Coleoptera collected, has been dealt with reference to the extreme high altitudes (3600 masl) and the plains of India. It has been shown that there is a marked fall in number of these insect families genera and species with the increase of altitude.

4. Certain other ecological factors such as eutrophication and pollution ; tuxture of lake substratum (Bisht and Das, 1980b) ; and the physico-chemical features of water (Das and Bisht, 1979) has been shown to effect the distribution and the relative abundance of aquatic bugs and beetles in coldwater Kumaon lakes.

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ON THREE NEW SPECIES OF SPIDERS OF THE GENUS
CALLILEPIS (WESTRING (FAMILY : GNAPHOSIDAE)
FROM INDIA.

By

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(With 18 Text-figures)

INTRODUCTION

The spiders of the family Gnaphosidae are very little known in the Indian Fauna. Even the classical work of Pocock (1900) on Indian spiders contains on reference to this Family. Recently Tikader (1962, 1966 and 1973) has published a few papers on this group of spiders. Tikader and Gajbe (1977) reported this genus for first time from India and described three new species.

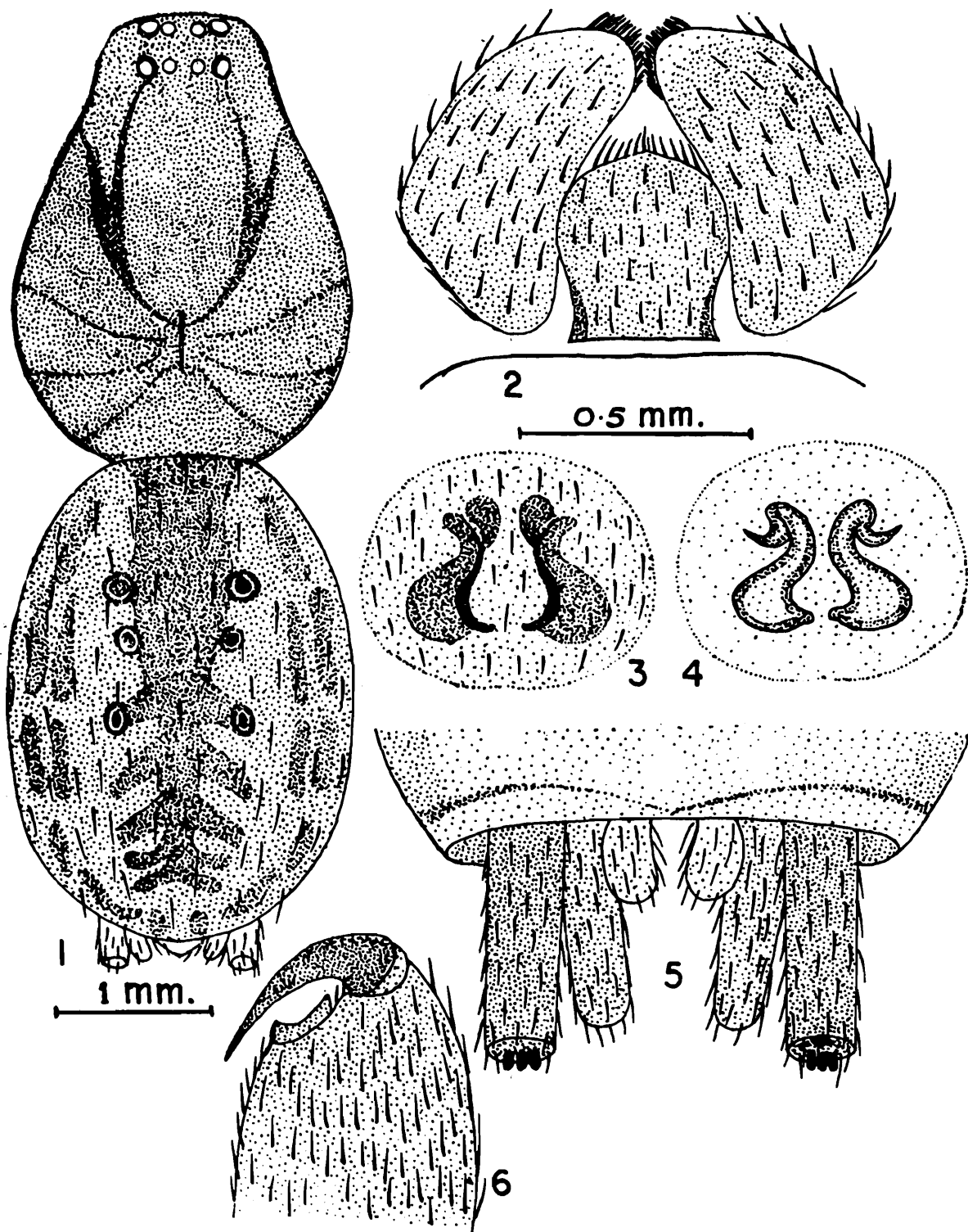
While studying the spider collection, I came across three new species of *Callilepis*, which are described in this paper.

All type specimens will be deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

1. *Callilepis pawani* sp. nov.

General : Cephalothorax and legs reddish brown, abdomen brown. Total length 6.10 mm. Carapace 3.30 mm. long 2.40 mm. wide ; abdomen 3.50 mm. long, 2.50 mm. wide.

Cephalothorax : Longer than wide, narrowing in front, slightly convex, posterior middle provided with a conspicuous fovea and V-shaped brown patch starting from fovea, clothed with pubescence. Eyes pearly white except anterior medians, anterior row nearly equal to posterior row. Anterior row of eyes slightly procurved (as seen from in front) ; medians smaller than the laterals and closer to laterals than to each other. Posterior row of eyes slightly recurved, medians conspicuously silvery white, oval, smaller than the laterals and little closer to laterals than to each other. Sternum heart-shaped, pointed behind and clothed with hairs. Labium and maxillae with conspicuous scopulae, shape as in Text-fig. 2. Chelicerae vertical, inner margin provided with a narrow lamina without serrated ridge as in Text-fig. 6. Legs relatively long, stout, clothed with hairs and spines. Legs Formula 4123.



Text-figs. 1-6. *Callilepis pawani* sp. nov.

1. Dorsal view of female, legs omitted.
2. Labium and maxillae
3. Epigyne
4. Internal genitalia
5. Spinnerets
6. Chelicera

Abdomen : Nearly elliptical, clothed with pubescence and some hairs, dorsally with three pairs of sagitta and a brown longitudinal band up to middle of abdomen and four pairs of cheverons as in Text-fig. 1. Ventral side lighter than the dorsal with a pair of longitudinal brown band starting from epigastric furrow to anal tubercle. Epigyne as in

Text-fig. 3. Internal genitalia as in Text-fig. 4. Spinnerets prominent, anterior spinnerets longer, darker with three spigots, posterior spinnerets smaller than the anterior as in Text-fig. 5.

Male : Unknown.

Holotype : Female in Spirit.

Type-locality : Pakaiya Hills, Bhuri, District Hazaribagh, Bihar, India. Coll. R. Tilak, 10-12-1968.

This species resembles *Callilepis lambai* Tikader and Gajbe but differs from it as follows : (I) Abdomen dorsally provided with three pairs of sagilla and a brown longitudinal band up to the middle of abdomen and four pairs of cheverons but in *Callilepis lambai* abdomen dorsally provided with light cheverons. (II) Abdomen ventrally provided with a pair of longitudinal brown band starting from epigastric furrow to anal tubercle but in *Callilepis lambai* there is no such band. (III) Epigyne and internal genitalia also structurally different.

2. *Callilepis ketani* sp. nov.

General : Cephalothorax and legs reddish-green, abdomen brownish-green. Total length 8 mm. Carapace 3 mm. long, 2.10 mm. wide ; abdomen 4.80 mm. long, 2.50 mm. wide.

Cephalothorax : Longer than wide, narrow in front, slightly convex, clothed with pubescence and hairs, posterior middle provided with a conspicuous short fovea. Eyes pearly white except anterior medians, posterior row slightly longer than the anterior row. Anterior row of eyes slightly procurved (as seen from in front) ; medians smaller than the laterals and closer to laterals than to other. Posterior row of eyes slightly recurved, medians silvery white, oval, smaller than the posterior laterals and closer to each other than to adjacent laterals. Sternum heart-shaped, pointed behind, clothed with fine hairs. Labium and maxillae provided with conspicuous scopulae, shape as in Text-fig 8. Chelicerae vertical, not strong, inner margin provided with a narrow lamina without serrated ridge as in Text-fig. 11. Legs relatively long, stout, clothed with hairs and spines. Legs formula 4123.

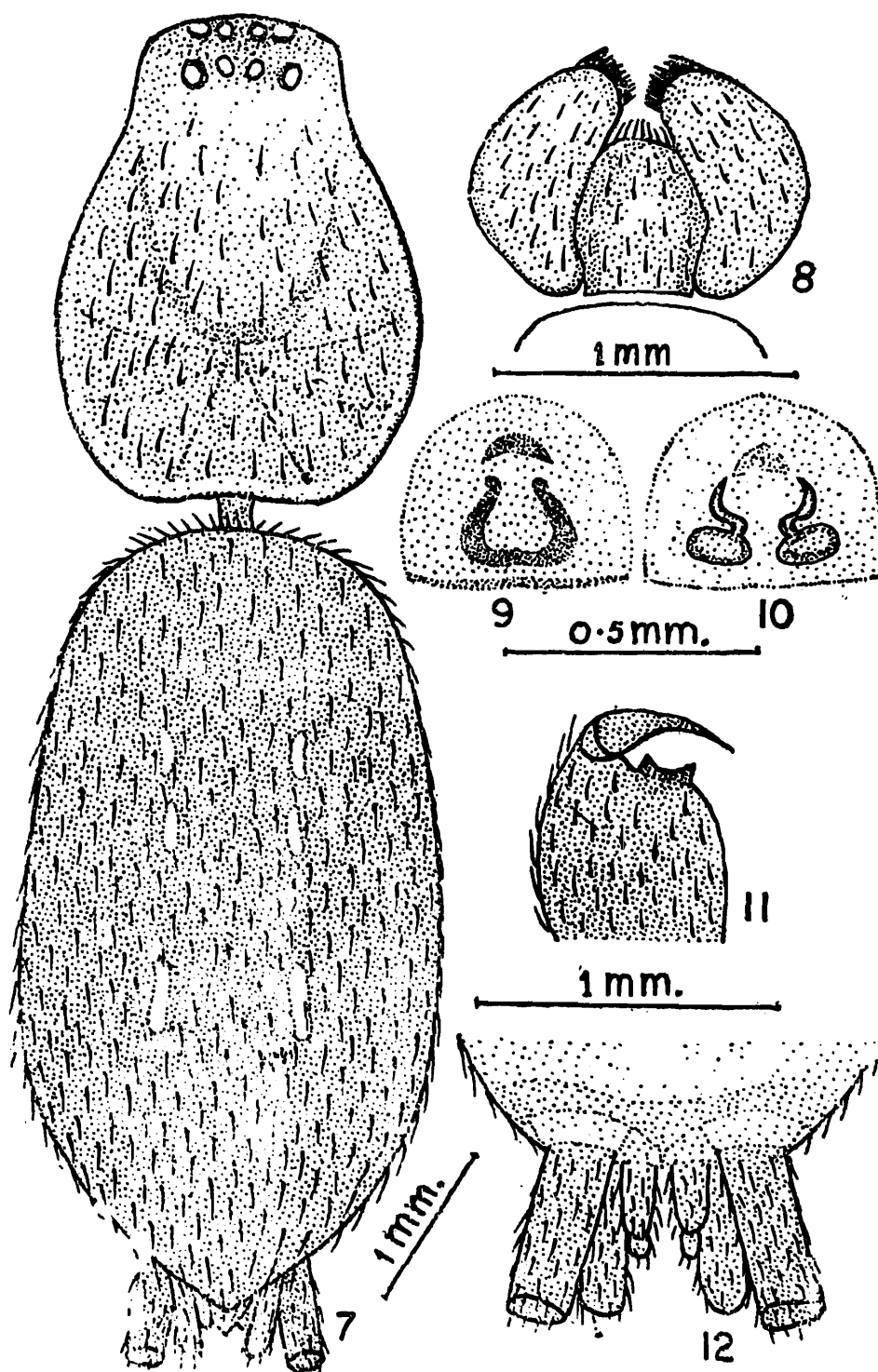
Abdomen : Longer than wide, narrowing posteriorly, clothed with hairs and dorsally provided with three pairs of sagilla as in Text-fig. 7. Ventral side slightly lighter than the dorsal. Epigyne as in Text-fig. 9. Internal genitalia as in Text-fig. 10. Spinnerets prominent, anterior spinnerets longer than others as in Text-fig. 12.

Male : Unknown.

Holotype : Female in Spirit.

Type-locality : Sambhar lake Gudha, District Nagaur, Rajasthan, India. Coll. A. K. Mukherjee, 19-12-1957.

This species closely resembles *Callilepis rajasthanicus* Tikader and Gajbe but differs from it as follows : (I) Posterior middle of cephalothorax provided with conspicuous fovea but in *Callilepis rajasthanicus*



Text-figs. 7-12. *Callilepis ketani* sp. nov.

- 7. Dorsal view of female, legs omitted.
- 8. Labium and maxillae
- 9. Epigyne
- 10. Internal genitalia
- 11. Chelicera
- 12. Spinnerets

posterior middle of cephalothorax provided with inconspicuous fovea. (II) Abdomen provided with three pairs of sagilla but in *Callilepis rajasthanicus* abdomen provided with some deep brownish patches. (III) Epigyne and internal genitalia also structurally different.

3. *Callilepis rajani* sp. nov.

General : Cephalothorax and legs reddish-brown, abdomen deep brown. Total length 6.90 mm. Carapace 3.00 mm. long, 2.20 mm. wide ; abdomen 4.10 mm. long 2.90 mm. wide.

Cephalothorax : Longer than wide, narrowing in front, slightly convex, clothed with pubescence, posterior middle provided with a conspicuous fovea and U-shaped deep brown patch starting from fovea. Eyes pearly white except anterior medians, posterior row as long as the anterior row. Anterior row of eyes slightly procurved (as seen from in front) ; medians smaller than the laterals and closer to laterals than to each other. Posterior row of eyes slightly recurved, medians silvery white, oval, smaller than the laterals and closer to laterals than to each other. Sternum heart-shaped, pointed behind, clothed with hairs. Labium and maxillae provided with conspicuous scopulae, shape as in Text-fig. 14. Chelicerae vertical, not strong, inner margin provided with a narrow lamina without serrated ridge as in Text-fig. 17. Legs relatively long, stout, clothed with hairs and spines. Legs formula 4123.

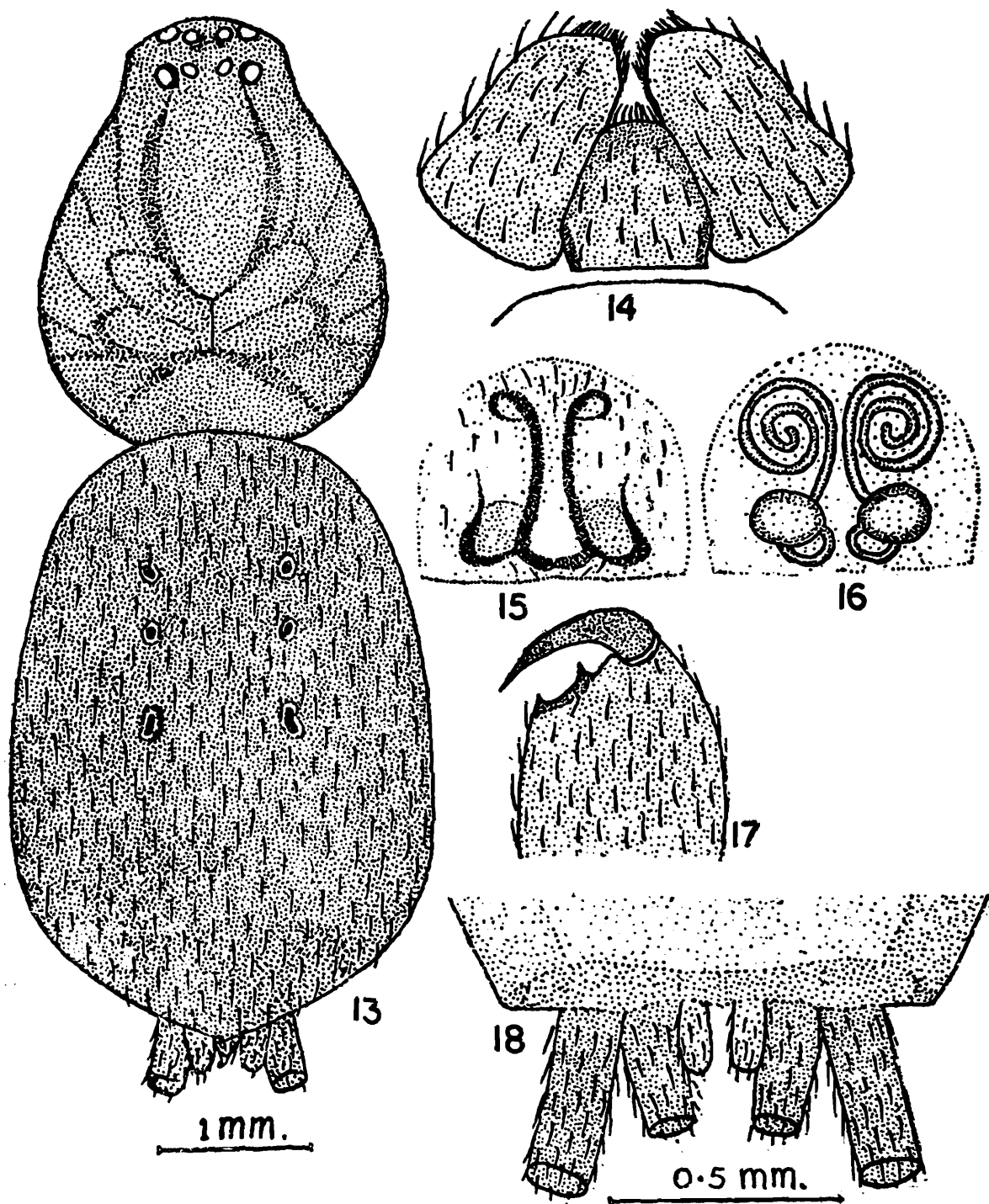
Abdomen : Nearly elliptical, clothed with pubescence, dorsally provided with three pairs of sagilla as in Text-fig. 13. Ventral side lighter than the dorsal. Epigyne as in Text-fig. 15. Internal genitalia as in Text-fig. 16. Spinnerets prominent, anterior spinnerets longer than other as in Text-fig. 18.

Male : Unknown

Holotype : Female in spirit.

Type-locality : Sahastradhara, District Dehra Dun, U. P. India. Coll. G. U. Kurup, 16-2-1961.

This species closely resembles with *Callilepis rukminiae* Tikader and Gajbe but differs from it as follows : (I) Posterior middle of cephalothorax provided with U-shaped deep brown patch starting from fovea but in *C. rukminiae* cephalothorax provided with V-shaped brown patch starting from fovea. (II) Abdomen dorsally provided with three pairs of sagilla but in *C. rukminiae* abdomen without sagilla but provided with some round whitish spots. (III) Epigyne and internal genitalia also structurally different.



Text-figs. 13-18. *Callilepis rajani* sp. nov.

- 13. Dorsal view of female, legs omitted.
- 14. Labium and maxillae
- 15. Epigyne
- 16. Internal genitalia
- 17. Chelicera
- 18. Spinnerets

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BRIEF DESCRIPTIONS OF NEW SPECIES OF OSTRACODA :
CRUSTACEA FROM MAHARASHTRA STATE (INDIA)

By

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(With 19 Text-figures)

INTRODUCTION

A collection of rain water pond crustaceans, made by Dr. K. K. Tiwari, mostly in the Western Ghats region of the Maharashtra State in India, during August—October, 1964, is very rich in diversity as well as numbers of freshwater ostracods. The present paper describes sixteen new, one new record and two possibly new ostracods found in this material.

The large number of new species from a small area in India need not come as a surprise since studies on Indian Ostracods are scattered and non intensive so far. A general report on the entire ostracod collection from Maharashtra State is likely to take some time. In the meantime it is considered desirable to publish the descriptions of new species contained in the material.

Subclass OSTRACODA Latreille, 1806

Order PODOCOPIDA Muller, 1894

Family CYPRIDIDAE Baird, 1845

KEY TO THE GENERA

I. Shell very tumid, broad, width more than half of length	...	Cypris
II. Shell not very tumid and broad.—		
a. Margin of valves entire	...	Eucypris
b. Margin of one valve tuberculate	...	Cyprinotus
III. Shell tumid, elongate, oblong, furca long	...	Cypricercus
IV. Shell compressed, oblong, Furca dissimilar	...	Stenocypris
V. Shell short, very tumid, anterior end of each valve with a row of radiating septa	...	Cypretta
VI. Shell compressed with a dorsal hump	...	Sataracypris
VII. Shell moderately tumid, large, furca normal	...	Sclerocypris

LIST OF SPECIES DESCRIBED

1. *Cypris debi* n. sp.
2. *C. elongata* n. sp.
3. *C. globosa* n. sp.
4. *Eucypris compressa* n. sp.
5. *E. sonia* n. sp.
6. *E. gomti* n. sp.
7. *E. munia* n. sp.
8. *E. indica* n. sp.
9. *E. inequalis* n. sp.
10. *E. ellipticalis* n. sp.
11. *E. himani* n. sp.
12. *Cyprinotus malini* n. sp.
13. *Cypricercus indrani* n. sp.
14. *Stenocypris khopoliensis* n. sp.
15. *S. sohni* n. sp.
16. *S.* sp.
17. *Sataracypris gibbosa* (Baird) 1837, n. Gen.
18. *Sclerocypris* sp.
19. *Cypretta gargi* n. sp.

Generic diagnosis :

Genus 1. *Cypris* O. F. Muller, 1776

Shell very tumid and broad, maximum width more than half of the length. Swimming setae of second antenna as long as the tips of terminal claws. Subterminal segment of first abdominal leg not divided. Furca well developed and normal. Male seldom present. This cosmopolitan genus is most common genus of India also.

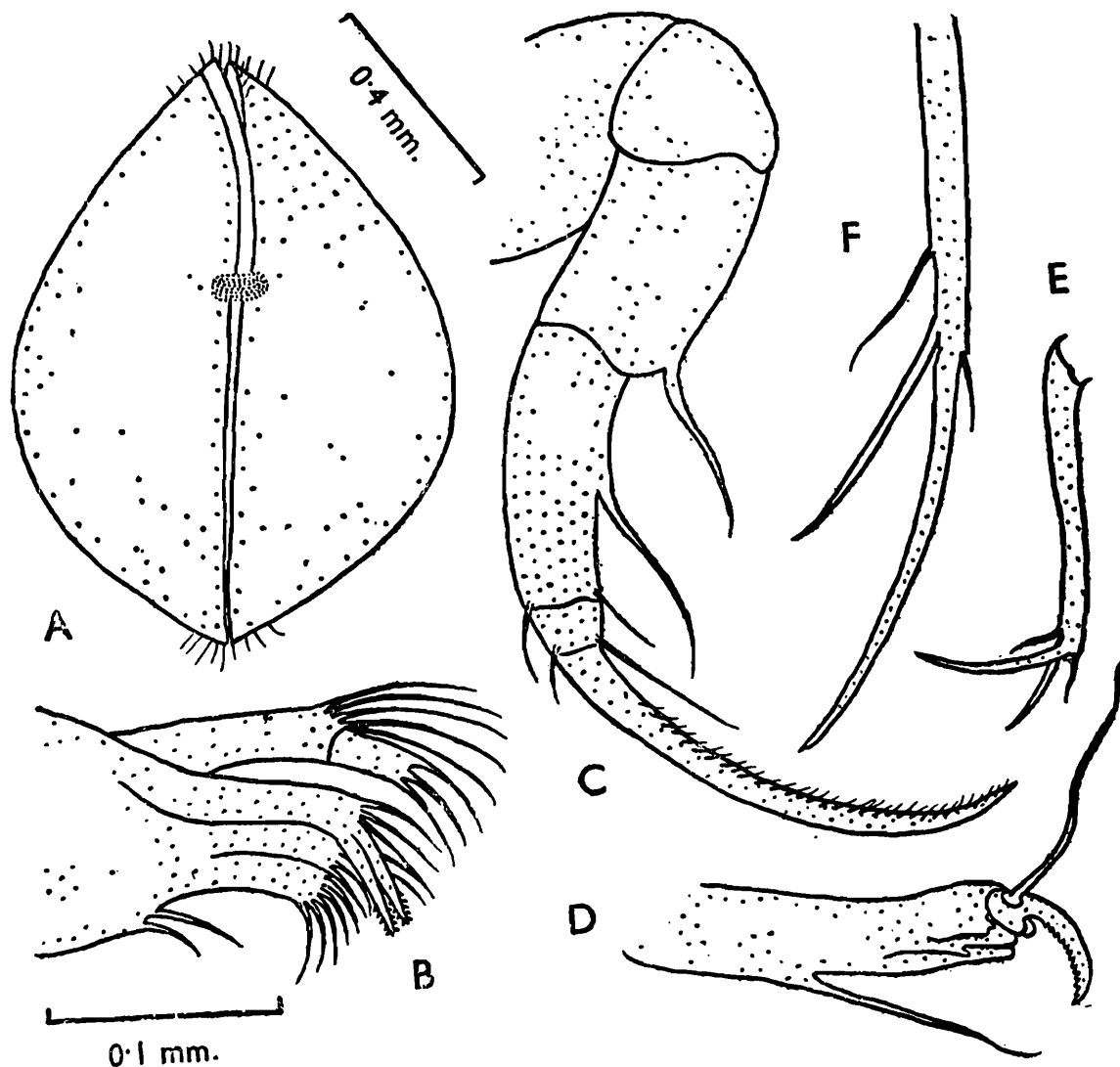
KEY TO THE SPECIES

1.	a. shell shorter than 1.50 mm	...	<i>C. globosa</i>
	b. shell longer than 1.50 mm.	...	... 2
2.	a. In dorsal view, ant. end acutely pointed	...	<i>C. debi</i>
	b. In dorsal view ant. end obtusely rounded	...	<i>C. elongata</i>

1. *Cypris debi* sp. nov.

(Text-figs. 1A-F)

Material : *Holotype* ; One female, Z. S. I. Reg. No. C 1115/2, *Paratype*—Five females, Z. S. I. Regd. No. C 116/2. *Type locality*—Rain water pond, 6 Kms. from Karad, on Karad Satara road (Bangalore Road). Coll. K. K. Tiwari, 5 September, 1964.



Text-fig. 1. *Cypris debi* sp. nov. A. Shell in dorsal view. B. Maxilla C. First abdominal leg D. Second abdominal leg E, F. Furcal rami. A & E same scale.

Maximum dimensions : Length—1.87 mm., Width—1.37 mm. Height—1 mm.

Shell valve with minute, scattered, tubercles ; margins without spines. Shell very tumid ; In dorsal view, spindle shaped ; maximum width slightly behind the middle, both ends pointed ; anterior end more acuminate than the posterior. Left valve slightly bigger than the right, fringed with a narrow lameller flap. In profile, dorsal edge strongly and angularly curved ; ventral edge sinuate in the middle,

maximum height in front of the middle. Anterior end more broader than the posterior. Valve margins entire; surface of the shell with fine, sparse hairs and sculptured with scattered small granular dots.

Swimming setae of second antenna slightly longer than the tips of terminal claws; third maxillary process with two dentate setae; maxilliped with a branchial plate and a palp. Subterminal segment of first abdominal leg not jointed; furcal rami long, narrow and nearly straight, ventral claw slightly more than half of the ramus in length, ventral seta minute. Male not known, greyish white in spirit.

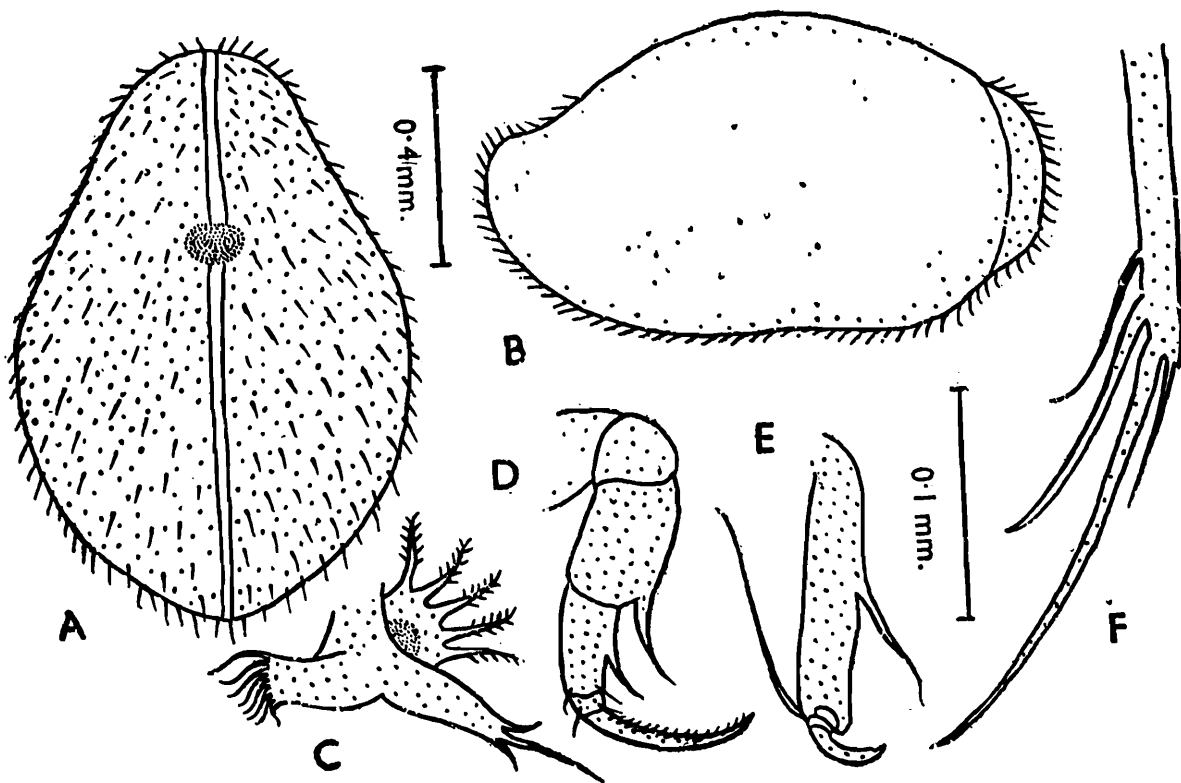
Distribution : Known from type locality only.

Remarks : Though the shell of *C. debi* Deb is similar in shape with *C. subglobosa* Sowerby 1859 and *C. granulata* Daday 1898 from Nagpur and Ceylon yet it lacks the characteristic sculpturing of later. Instead of very close convex areoles of mosaic type, the shell of *C. debi* is adorned with scattered granular dots only. The strong spines of the valve margins of *C. granulata* is also lacking in *C. debi*.

2. *Cypris elongata* sp. nov.

(Text-fig. 2 A-F)

Material : *Holotype*—One female, Z. S. I. Regd. No. C 1119/2 *Paratype*—5 females, Z. S. I. Regd. No. C 1120/2. *Type locality*—Pond inside Satara fort. Coll. K. K. Tiwari. 2nd September, 1964.



Text-fig. 2. *Cypris elongata* sp. nov. A. Shell dorsal view B. Right valve C. Maxilliped D. First abdominal leg E. Second abdominal leg F. Furca A, B same scale, C-F same scale.

Length—1.75 mm. Height—1 mm. Width—1.25 mm.

Shell tumid ; in dorsal view, pear shaped, oblong, elongate, maximum width occurs behind the middle ; anterior half of shell narrower, end broadly rounded ; posterior end obtuse angularly curved. Both the valve almost equal, margin entire. In profile, dorsal edge strongly and evenly curved ; ventral edge sinuate in the middle ; posterior end rounded, slightly upturned and narrower than the anterior end. Anterior marginal border of right valve rather straight. Surface of shell unsculptured, finely hairy.

Swimming setae of second antenna longer than the terminal claws ; third maxillary process with two dentate setae. Subterminal segment of the first abdominal leg not jointed. Furcal rami straight, long, narrow ; terminal claw more than half of ramus.

Distribution : Known from type locality.

Remarks : *Cypris elongata* Deb, differs markedly from the other known species by being much broader and rounded towards the anterior end. Right valve has a broad marginal flange attached towards the anterior end like *C. subglobosa* Sow, 1859, and *C. granulata* Daday 1889, but differs from them in having nearly smooth and unsculptured valves, and in absence of marginal spines.

3. *Cypris globosa* sp. nov.

(Text-figs. 3A-D)

Material : *Holotype*—One female, Z. S. I. Regd. No. C 1139/2 Pond near Inspection Bungalow, Satara. Coll. K. K. Tiwari. 30th August, 1964.

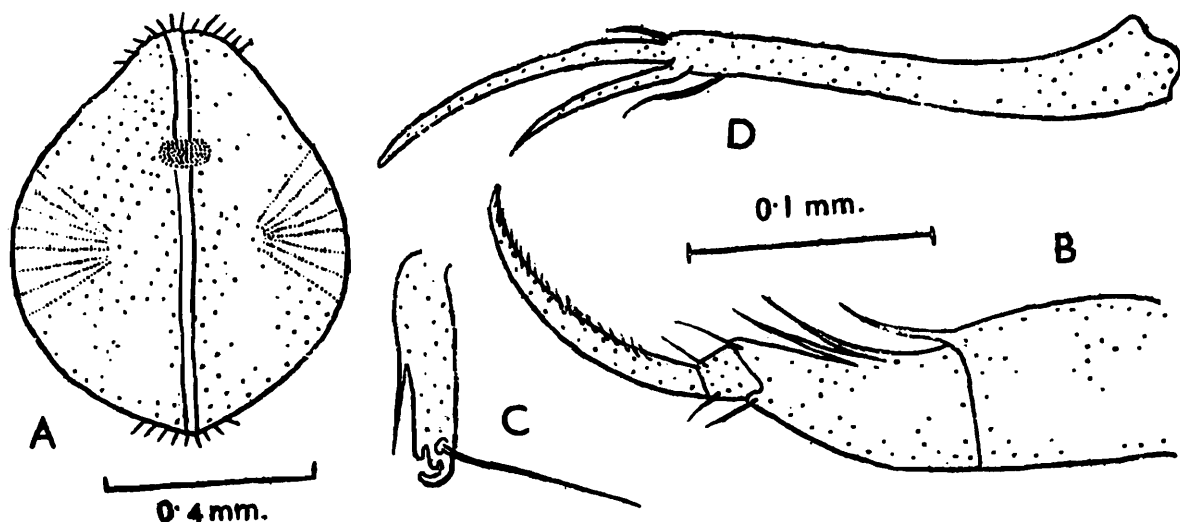
Length—1.25 mm., Width—1 mm.

Shell short, tumid and globular ; In dorsal view, maximum width occurs behind the middle, lateral sides strongly and evenly curved, anterior end broadly rounded, posterior end obtusely pointed. Valves unequal, left valve overlaps the right, margin entire, thin, delicate. Surface of shell unsculptured, finely hairy.

Swimming setae of second antenna slightly longer than the tips of terminal claws. Third maxillary process with two strong setae. Subterminal segment of first abdominal leg not jointed, two setae present on its inner side. Terminal segment of second abdominal leg with a hooked and curved seta. Furcal rami short, stout and curved ; terminal claw more than half of the ramus in length. Ventral seta minute.

Distribution—Type locality.

Remarks—*Cypris globosa* Deb, is easily distinguished from other known species by being more globular and tumid in shape, and in having two setae on the inner side of subterminal segment of the first abdominal leg. *Eurycypris latissima* G. W. Muller 1897-99 has an apparent similarity with *C. globosa* Deb, but differs from the former in following points.



Text-fig. 3. *Cypris globosa* sp. nov. A. Shell dorsal view B. First abdominal leg C. Second abdominal leg D. Furca. B-D same scale.

(1) In *C. globosa* Deb anterior end of shell more broadly rounded in dorsal view.

(2) Swimming setae of second antenna present where it is absent in former.

(3) In *C. globosa* the dorsal edge of third segment of first abdominal leg without five clusters of hairs.

(4) In *E. globosa*, the furcal rami short, stout and curved where as it is reverse in *E. latissima*.

(5) Only one apical claw present on second abdominal leg in *C. globosa*, in *E. latissima*, two apical claws present.

Genus 2. *Eucypris* Vavra 1891

Generic diagnosis :

Shell moderately tumid, valve shape and size variable. Swimming setae of second antenna well developed. Subterminal segment of first abdominal leg divided. Furca well developed, and normal. Not very common genus of India, there is only one previous doubtful record of the genus from Tamilnadu and eight new species described in this paper. Males seldom present.

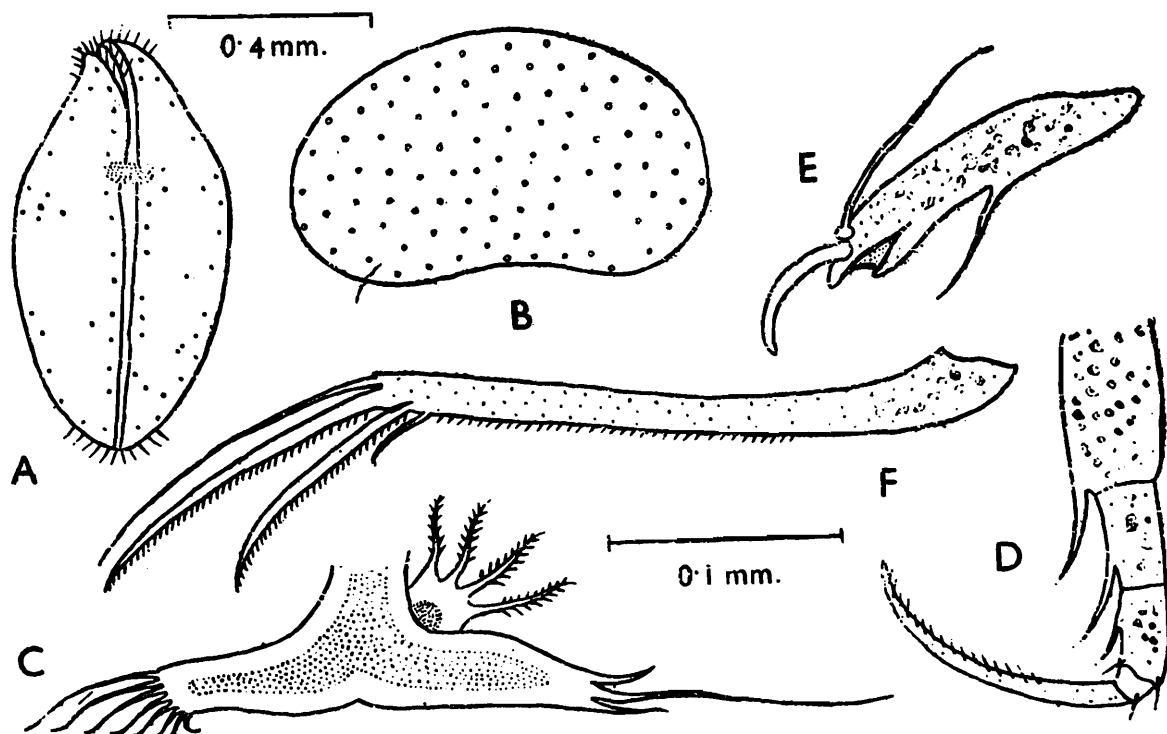
KEY TO THE SPECIES

1. Shell 1.25 mm or less in length,	...	
a. shell compressed	...	<i>E. compressa</i>
b. shell tumid	...	<i>E. himani</i>
2. Shell more than 1.25 in length		
a. shell covered with stiff bristles and finger like projections	...	<i>E. indica</i>
b. Shell covered with fine hairs only	...	... 3
3. Shell longer than 2 mm.	...	<i>E. sonia</i>
4. Shell shorter than 2 mm.	...	... 5
5. Shell narrow, elliptical in dorsal view		
a. Left valve much smaller than right	...	<i>E. munia</i>
b. Right valve slightly smaller than left	...	<i>E. ellipticalis</i>
6. Shell wide and tumid medially		
a. Left valve much smaller	...	<i>E. gombi</i>
b. Right valve much smaller	...	<i>E. inequalis</i>

4. *Eucypris compressa* sp. nov.

(Text-fig. 4A-F)

Material : *Holotype*—One female, Z. S. I. Regd. No. C 1112/2, *Paratype*—3 females. Z.S.I. Regd. No. C 1113/2, Pond at Panchgani. Coll. K. K. Tiwari, 21st August, 1964.



Text-fig. 4. *Eucypris compressa* sp. nov. A. shell dorsal view. B. Right valve C. Maxilliped D. First abdominal leg E. Second abdominal leg F. Furca. C-F. same scale.

Maximum dimensions : Length—0.87 mm ; Height—0.50 mm. Width—0.50 mm.

Shell rather compressed ; in dorsal view, oblong, maximum width occurs in front of the middle, both the ends obtusely rounded, anterior end narrower than the posterior. Right valve bigger than and overlaps the left. In profile bean-like, dorsal edge strongly and evenly curved ; highest in the middle ; both the ends broad and rounded ; ventral edge distinctly sinuate in the middle ; Surface unsculptured, fine hairs and porecanals present on the surface, valve margin entire.

Swimming setae of second antenna longer than the tips of terminal claws ; third maxillary process with two strong, smooth setae. Subterminal segment of first abdominal leg jointed. Furcal rami well developed, long and curved, terminal claws slightly unequal, ventral seta as long as ventral claw ; dorsal seta minute ; dorsal edge of ramus and claws hairy. Male absent.

Distribution : Known from the type locality only.

Remarks : *Eucypris compressa* Deb, is similar in shape to *E. cister-nina* Furtos 1936, but differs in having unequal valves, shell compressed anterolaterally and in having well developed furcal rami, ventral seta and ventral claw equal, and the hairs present on dorsal edge of rami and claws.

5. *Eucypris sonia* sp. nov.

(Text-fig. 5A-F)

Material : *Holotype*—One female, Z.S.I., Regd. No. C 1100/2, *Paratype*—5 females, Z.S.I. Regd. No. C 1101/2, Pond near Inspection Bunglow, Satara. Coll. K. K. Tiwari, 30 August, 1964.

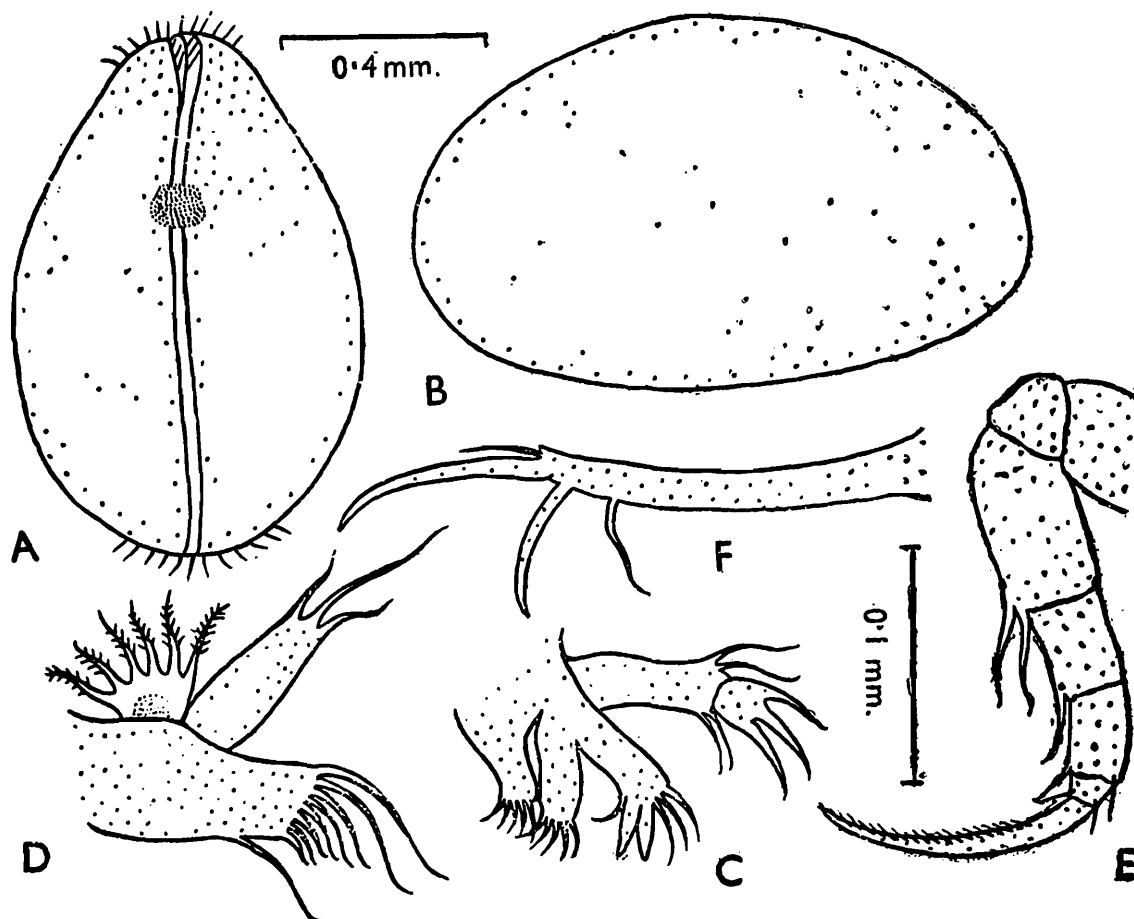
Length—2.12 mm.. Height—1.25 mm., Width—1.12 mm.

Description : Shell tumid ; in dorsal view oblong oval in shape, maximum width occurs behind the middle, both ends broadly rounded, anterior half of shell much narrower than posterior. Right valve slightly bigger than left, margin entire with a narrow fringe. In profile, elongate, dorsal margin strongly and evenly curved, maximum height occurs in the middle ; both ends broadly curved, ventral edge convex. Surface of shell unsculptured with thin scattered hairs and pits.

Swimming setae of second antenna as long as the terminal claws ; third maxillary process with two strong smooth setae, terminal segment of maxillary palp broader than long. Subterminal segment of first abdominal leg jointed ; terminal segment of second abdominal leg ends in a chela. Furcal rami short, stout and curved in middle, dorsal edge

of ramus and claws smooth. Ventral claw more than half of the ramus in length, ventral seta minute. Male absent.

Distribution : Known from type locality.



Text-fig. 5. *Eucypris sonia* sp. nov. A. shell dorsal view B. Right valve C. Maxilla D. Maxilliped E. First abdominal leg F. Furca. C-F. same scale.

Remarks : *Eucypris sonia* Deb, is easily distinguished from the other species of the genus in having unequal shell valves and from other species described in this paper by the combination of characters given above. The furcal rami recalls that of *Cyprinotus kliei* Lindroth 1953, but many details of the appendages are different and they are different genera.

6. *Eucypris gomti* sp. nov.

(Text-fig. 6 A-E)

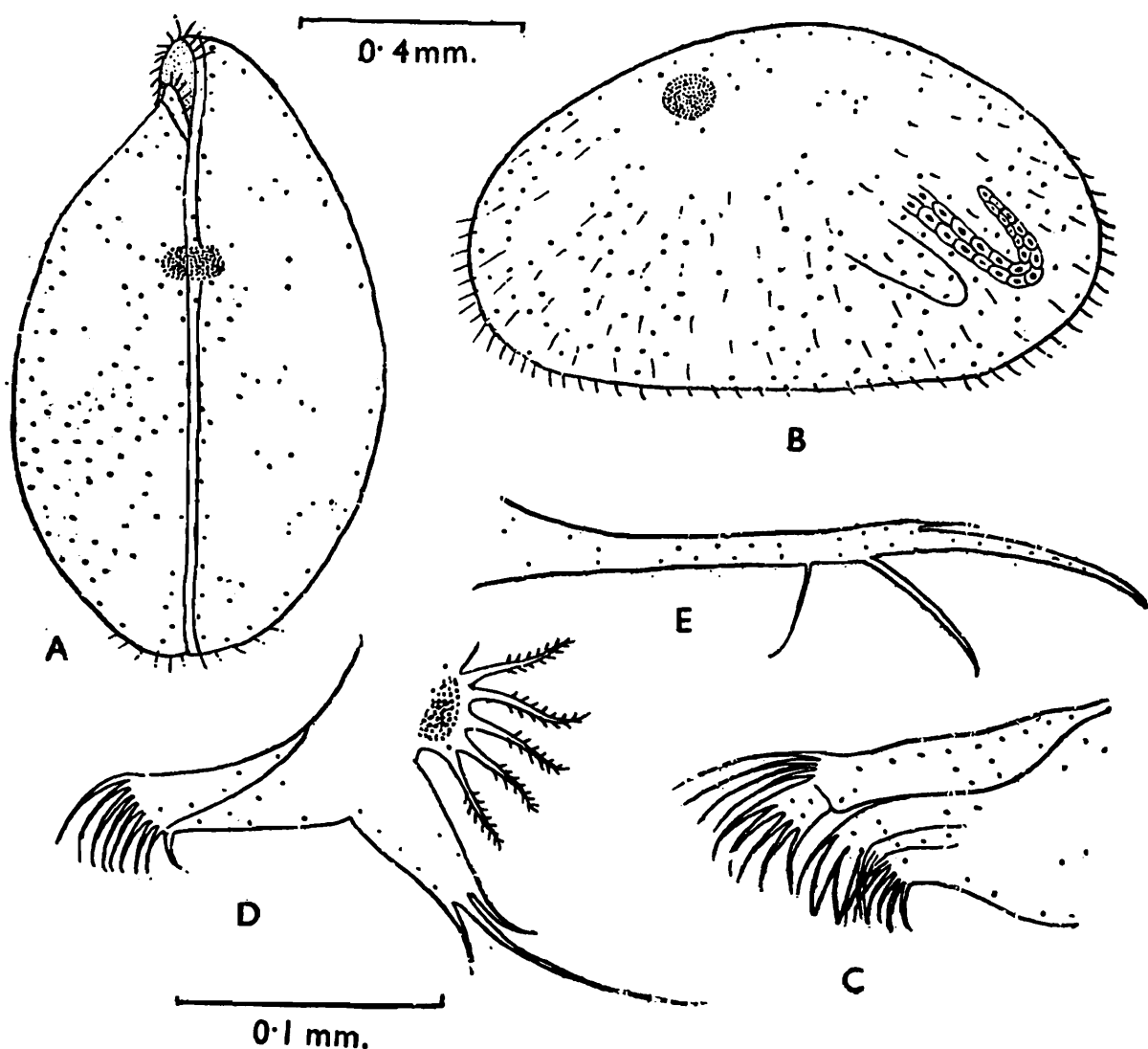
Material : *Holotype*—One female, Z. S. I. Regd. No. C 1094/2 ;

Paratype : 5 females, Z. S. I. Regd. No. C 1095/2. Pond near inspection Bungalow, Satara. Coll. K. K. Tiwari. 30 August 1964.

Length—1.25 mm. width—0.68 mm. ; Height—0.62 mm.

Description : Shell tumid, oblong, in dorsal aspect, eye shaped, widest in the middle and maximum width slightly more than half of length, posterior end broadly rounded ; anterior end narrower than the

posterior ; left valve much smaller than the right and much compressed antero-laterally. In profile, dorsal edge strongly curved, maximum height occurs behind the middle ; ventral edge nearly straight, both ends broadly rounded, posterior end a bit narrower than the anterior. Valves thin, margin entire, surface unsculptured with scattered hairs and porecanals.



Text-fig. 6. *Eucypris gomti* sp. nov. A. shell dorsal view B. shell lateral view C. Maxilla D. Maxilliped E. furca C-E. same scale.

Swimming setae of second antenna slightly longer than the terminal claws. Maxillary palp strong, terminal segment broader than long, third maxillary process with two strong smooth setae. Subterminal segment of first abdominal leg jointed. Furcal rami short, narrow, curved proximally. Distal claw more than half of ramus, distal seta minute. Male absent ; light brown colour in spirit.

Distribution : Known from type locality.

Remarks : A superficial likeness exists between *Eucypris gomti* Deb and *Heterocypris capensis* (Muller) 1908, but it cannot be the later

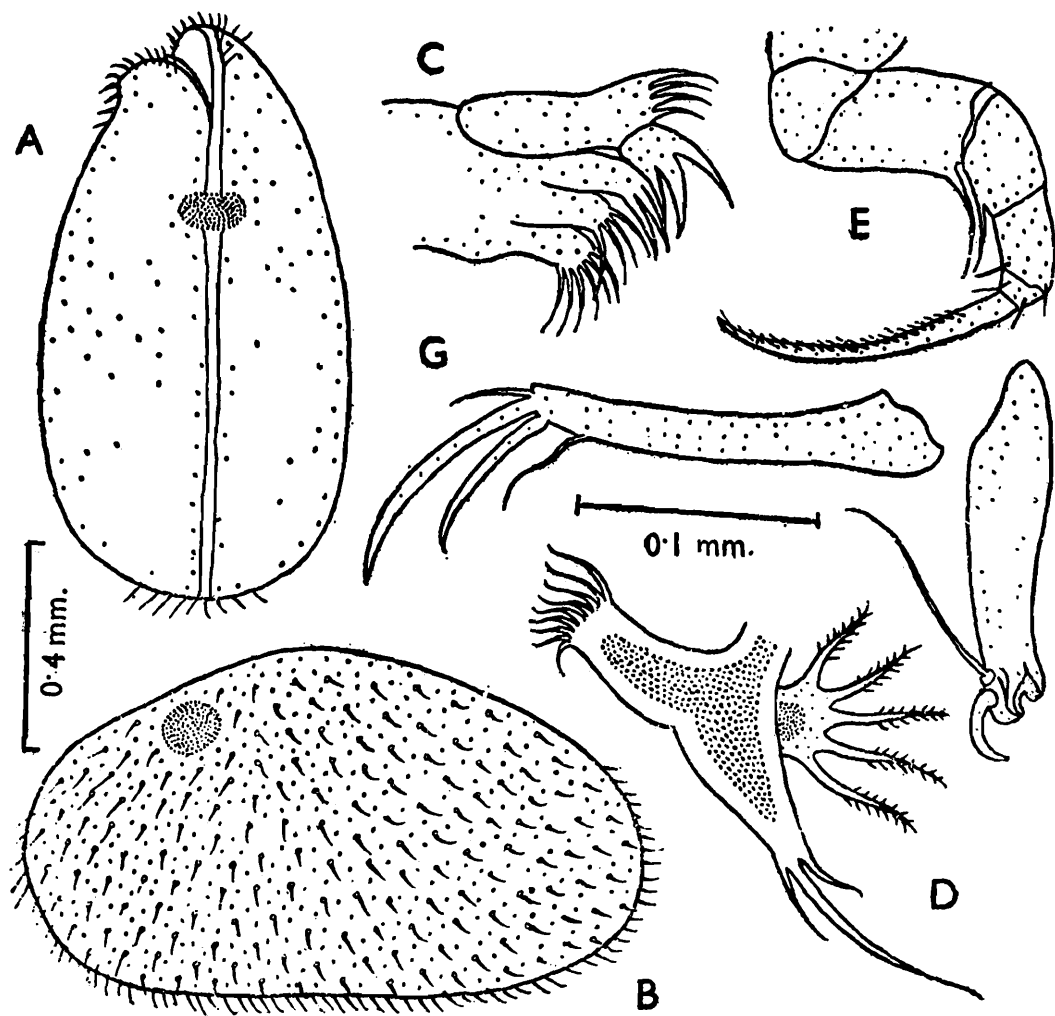
genus as it lacks the valve marginal tubercles. Shell shape and internal anatomy of present species are markedly different from the other species described in this paper.

7. *Eucypris munia* sp. nov.

(Text-fig. 7A—G)

Material : *Holotype*—One female, Z. S. I. Regd. No. C 1103/2 ; *Paratype*—5 females, Regd. No. C 1104/2 ; pond near inspection Bunglow, Satara. K. K. Tiwari Coll. 30 August, 1964.

Length—2.0 mm., Height—1.12 mm. width—1 mm.



Text-fig. 7. *Eucypris munia* sp. nov. A. shell dorsal view B. shell lateral view C. maxilla D. maxilliped E. first abdominal leg F. second abdominal leg G. furca. C-F. same scale.

Shell elongate, rather cylindrical in shape ; in dorsal aspect, anterior end much narrower than posterior, and the latter end more broadly rounded than the former ; maximum width occurs behind the middle ; shell gradually compressed anteriorly. Left valve markedly smaller than right, abruptly compressed and then recurved outwards, margin entire with a narrow flap. In profile, dorsal edge strongly and angularly

curved, maximum height occurs in the middle, both ends broadly and equally rounded ; ventral edge nearly straight. Surface unsculptured, with thin scattered hairs and porecanals.

Swimming setae of second antenna a bit longer than the terminal claws. Maxillary palp and process short and stout ; terminal segment of maxillary palp broader than long, third process with two smooth setae. Penultimate segment of first abdominal leg jointed ; distal end of second leg terminates in a chela having 2 setae, one hooked and one long, attached to it. Furcal rami short, stout and curved in the middle ; distal claw more than half of the ramus in length, ventral seta minute, Male absent ; light brown colour in spirit.

Distribution : Known from type locality only.

Remarks—*Eucypris munia* Deb, is not wholly identical with *E. gomti*, described previously, though both samples are from the same source. The combination of characters viz. shell shape and internal anatomy are clearly different from each other, as the appendages of present species are stouter than those of the previous species. The elongate, tumid and cylindric shape of the present species does not agree with the other species of the genus.

8. *Eucypris indica* sp. nov.

(Text-fig. 8 A-G)

Material : *Holotype*—One female, Z. S. I. Regd. No. C 1109/2 ; *Paratype*—five females, Z. S. I. Regd. No. C 1110/2 ; pond at Panchgani, Coll. K. K. Tiwari, 20 August, 1964.

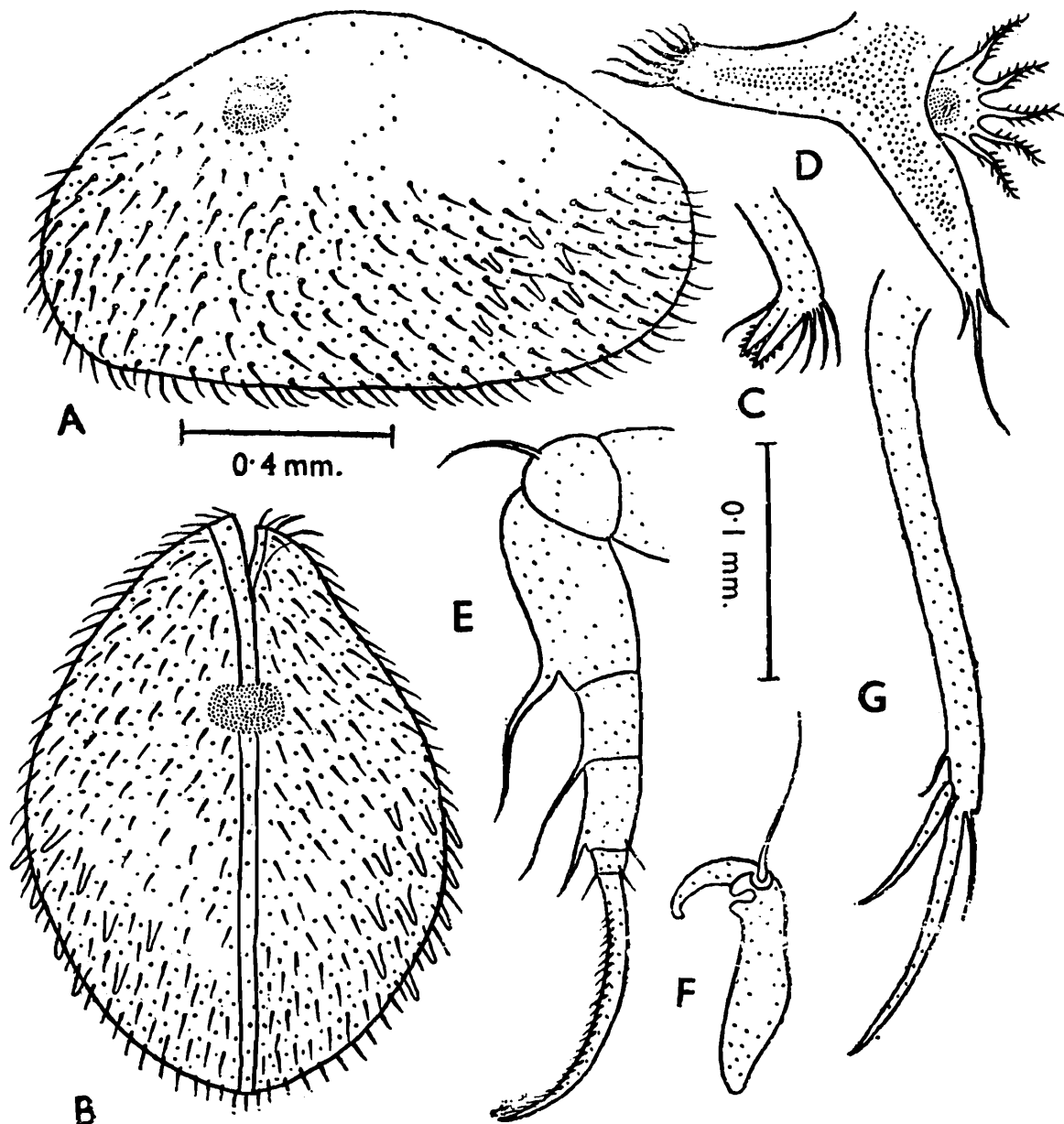
Length—1.37 mm ; Height—0.75 mm ; Width—0.87 mm

Shell tumid, profusely hairy, hairs strong and stiff, valve surface with scattered punctae otherwise smooth. On postero-lateral side of shell, few blunt finger like processes present in between hairs. In dorsal view, both ends obtusely rounded, anterior end narrower than posterior, maximum width occurs in middle ; left valve larger than right which it overlaps ; valve margins entire, a broad marginal fringe and a row of thick hairs present anteriorly. In profile, dorsal edge angularly curved, anterior end more broadly rounded than posterior end ; ventrally sinuate in middle.

Swimming setae of second antenna longer than terminal claws ; third maxillary process with two dentate setae. Subterminal segment of first abdominal leg jointed ; Furcal rami long, narrow, curved proximally, distal claw nearly half of ramus in length, dorsal seta minute. Male absent ; deep brown colour in spirit,

Distribution : Known from type locality and nearby areas.

Remarks : *Eucypris indica* Deb, introduced as a new species because of a thick coat of stiff seta on the shell surface and the presence of few blunt finger-like projections on the posterolateral border of shell.



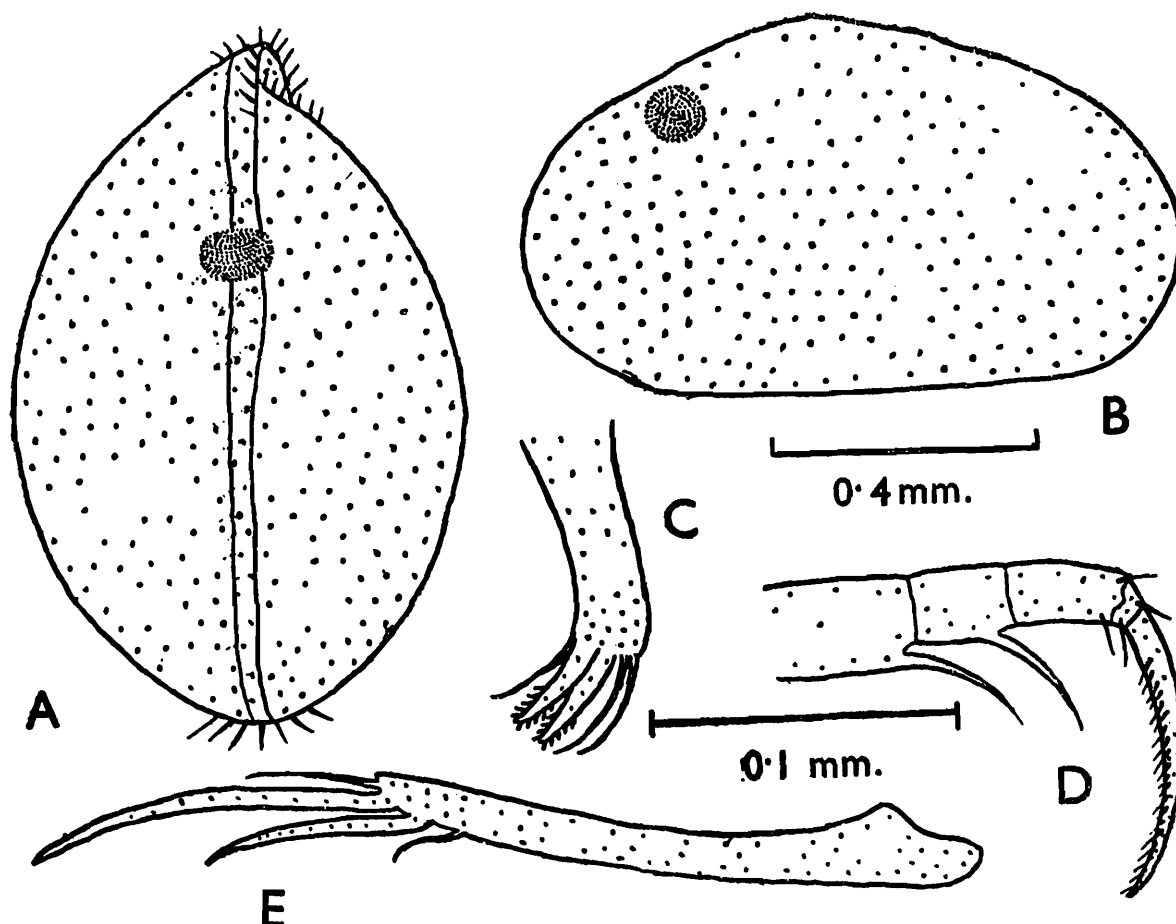
Text-fig. 8. *Eucypris indica* sp. nov. A. shell lateral view B. shell dorsal view C. third maxillary process D. maxilliped E. first abdominal leg F. second abdominal leg G. furca C-G. same scale.

This species is closely allied to *E. hystrix* Furtos 1933, the shell being as in the later but the combination of the other characters *viz.*, by the presence of longer swimming setae of second antenna, curved furcal rami and its finely hairy dorsal edge, and lastly the presence of dentate third maxillary process differs the *E. indica* from *E. hystrix*. The colour of the freshly preserved specimens is dark brown not green as the *E. hystrix*.

9. *Eucypris inequalis* sp. nov.

(Text-fig. 9 A-F)

Material : *Holotype*—One female, Z. S. I. Regd. No. C 1106/2 ;
Paratype—4 females, Z. S. I. Regd. No. C 1107/2 ; From an old unused well at Panchgani, C. 1 km. of Govt. Rest House. Coll. K. K. Tiwari, 23 August, 1964.



Text-fig. 9. *Eucypris inequalis* sp. nov. A. shell dorsal view B. Shell lateral view C. Third maxillary process D. first abdominal leg E. Furca. A & B, C-E. same scale.

Length—1.75 mm ; Height—1 mm ; Width—1.25 mm.

Shell very tumid, in dorsal view, spindle shaped, maximum width occurs in the middle ; anterior end pointed, posterior end obtusely rounded. Left valve much bigger than the right ; valve margin with broad lameller flap. In profile, dorsal edge angularly curved, maximum height occurs in front of middle, ventral edge straight, anterior end more broadly rounded than the posterior end. Surface of shell unsculptured, hairs seem to be absent on surface except for a marginal row.

Swimming setae of second antenna as long as terminal claws. Maxillary process short and stout, third process with two dentate setae ; maxilliped normal ; first abdominal leg with jointed subterminal segment ; Furcal rami short, stout, curved proximally, terminal claw more

than half of ramus in length ; dorsal claw half of terminal claw, dorsal seta minute. Male absent, deep brown colour in spirit.

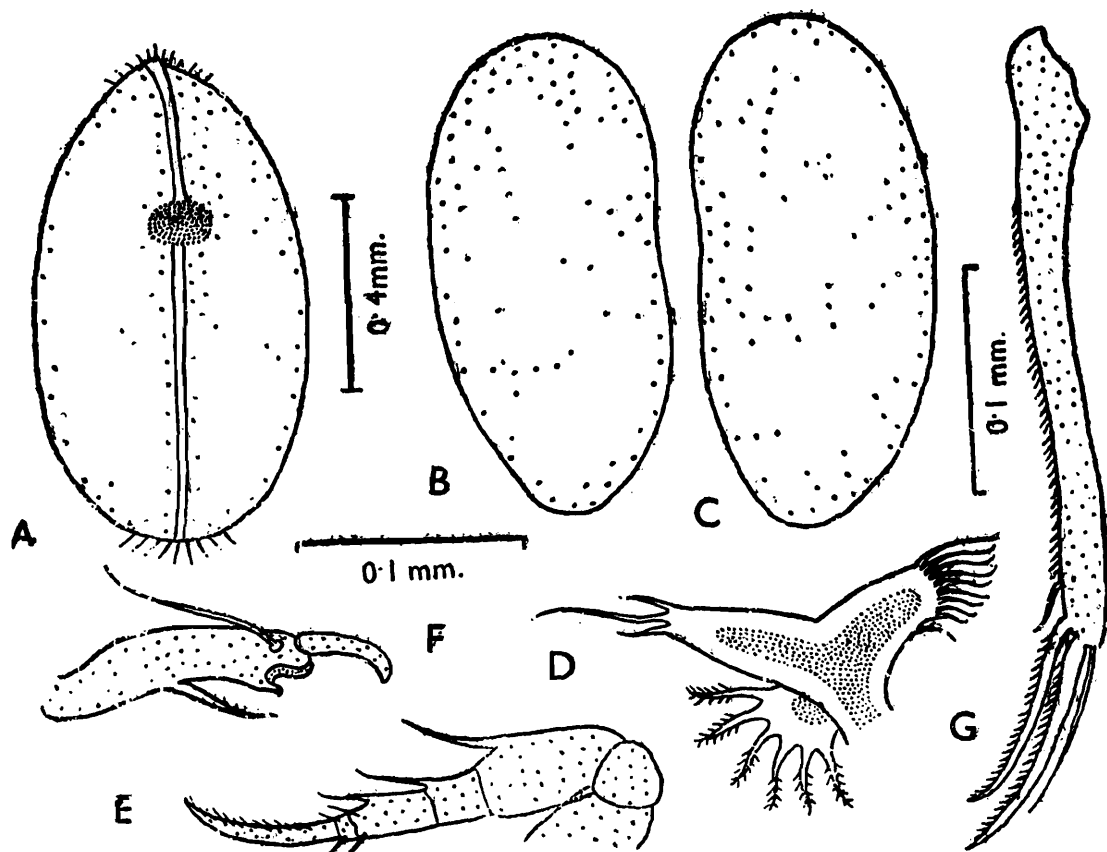
Distribution—Known from type locality only.

Remarks—*Eucypris inequalis* Deb, is allied to the preceeding species and still more perhaps to the *E. hystrix* Furtos 1933, the shell being of same shape. It differs from them mainly in the absence of stiff, setose hairs and in presence of markedly short, stout and curved furcal ramus with very long apical claws.

10. *Eucypris ellipticalis* sp. nov.

(Text-fig. 10 A-G)

Material : *Holotype*—One female, Z. S. I. Regd. No. C 1097/2 ; *Paratype*—4 females, Z. S. I. Regd. No. C 1098/2 ; Rewa, paddyfield near Chaclai, C. 36 km. from Rewa, M. P. Coll. K. K. Tiwari, 18th October, 1964.



Text-fig. 10. *Eucypris ellipticalis* sp. nov. A. Shell dorsal view B. Right valve C. Left valve D. Maxilliped E. First abdominal leg F. Second abdominal leg G. Furca A-C & D-G. same scale.

Length—1.62 mm. ; Width—1 mm. Height—0.75 mm.

Shell elongate, oblong, very tumid ; in dorsal view, barrel shaped, maximum width occurs in the middle ; anterior end obtusely pointed,

posterior end broadly rounded, left valve slightly larger than right which it overlaps. Valves delicate, margin entire, fringed with a narrow flap. In profile, dorsal edge evenly curved, ventral edge sinuate in middle, anterior end more broadly rounded than the posterior. Maximum height occurs in the middle. Surface of shell with scattered hairs and porecanals, otherwise unsculptured.

Swimming setae of second antenna as long as terminal claws. Terminal segment of maxillary palp longer than broad ; third maxillary process with two smooth setae. Maxilliped normal. Subterminal segment of first abdominal leg jointed ; terminal segment of second abdominal leg with a thumb finger like projection present just ahead of tip, terminal hooked claw serrated on its concave edge. Furcal rami short, long, narrow and curved proximally ; one ramus narrower than the other and terminal claws slightly unequal in length, dorsal edge of ramus and claws hairy. Ventral seta three-fourths the length of ventral claw, dorsal seta minute. Male absent ; light brown colour in spirit.

Distribution : From type locality only.

Remarks : *Eucypris ellipticalis* Deb, is a distinct and easily recognisable form, differing conspicuously from *E. crassa* Sars 1928, by being much more tumid in shape, having asymmetrical furcal rami and a differently shaped terminal segment of the second abdominal leg.

11. *Eucypris himani* n. sp.

(Text-fig. 11 A-G).

Material : *Holotype*—One adult female, Z. S. I. Regd. No. C 1161/2 ; *Paratype*—Three females ; Z. S. I. Regd. No. C 1162/2 ; From Duttuwadi, C 7 km. from Poona on way to Singhgarh. Coll. K. K. Tiwari ; 20 September, 1964.

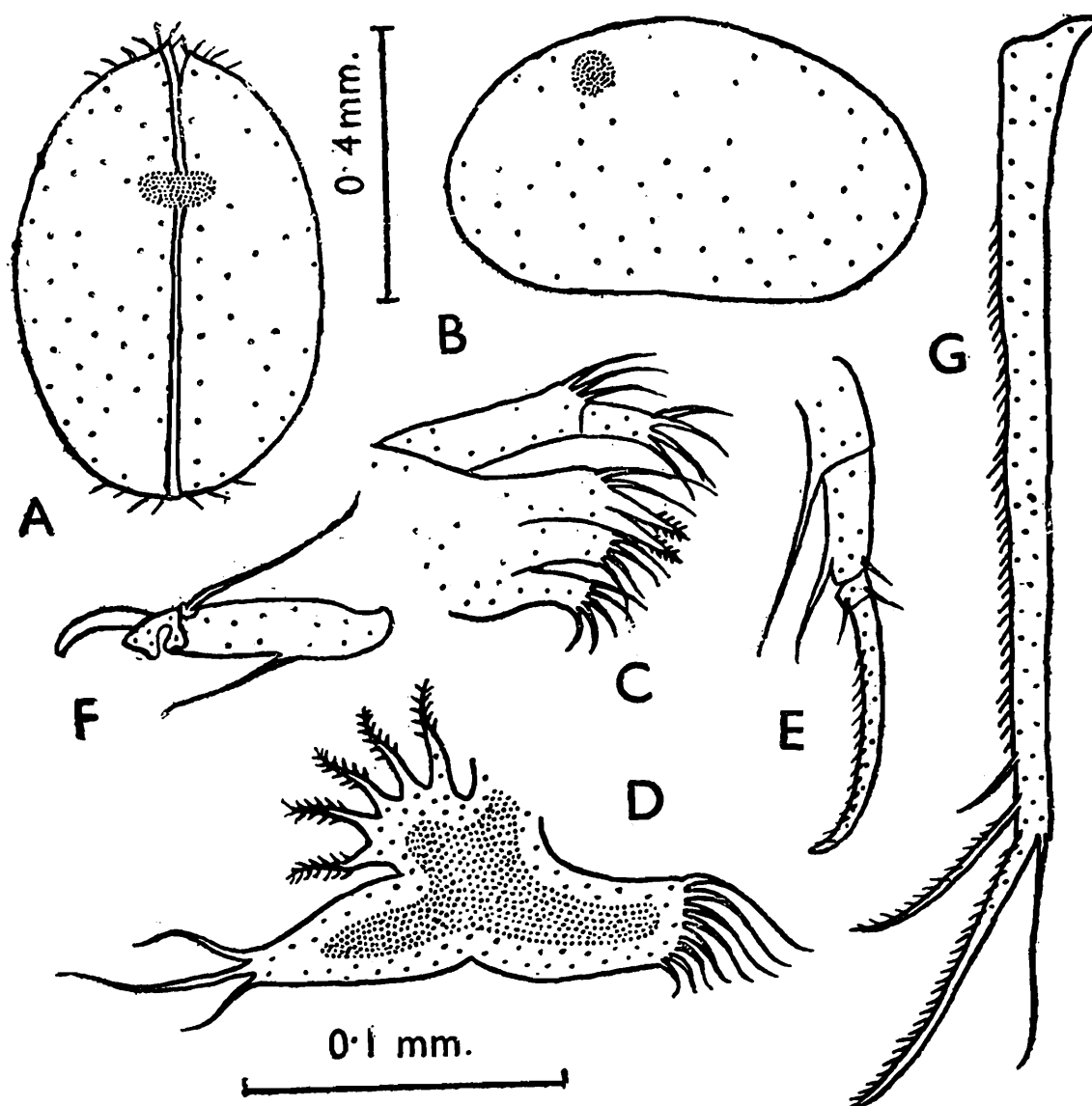
Length—1.25 mm. Height—0.62 mm. Width—0.68 mm.

Shell tumid, in dorsal view elliptical in shape, maximum width occurs in the middle and more than half of the length ; both the ends broadly and similarly curved, but anterior end pointed in the middle ; Left valve slightly larger than the right and overlaps the latter, valve margin entire. In profile, flat, angularly curved dorsally, slightly sinuate ventrally, both the ends broadly curved. Surface of shell thickly pitted, hairs thin and scattered.

Swimming setae of second antenna slightly shorter than the terminal claws ; terminal segment of maxillary palp long and narrow, third maxillary process with two thick, dentate setae. Subterminal segment of first abdominal leg jointed ; terminal segment of second leg triangular

distally and deeply excavate near the base. Furcal rami long, narrow and slightly curved basally. Terminal claw slightly less than one third of rami in length, dorsal claw and ventral seta nearly equal in length; dorsal seta minute. Male not known; Light brown colour in spirit.

Distribution : Known from type locality only.



Text-fig. 11. *Eucypris himani* sp. nov. A. Shell dorsal view B. Shell lateral view C. Maxilla D. Maxilliped E. First abdominal leg F. Second abdominal leg G. Furca.

Remarks : *Eucypris himani* Deb, differs from the closely allied form *E. rava* Furtos 1933, by being more tumid in shape and in having terminal segment of the second abdominal leg, triangular at the tip and markedly constricted near the base. Moreover the ventral seta of the furcal rami in *E. himani* is three fourths of the ventral claw, dorsal seta is minute, whereas in *E. rava*, the ventral seta is less than half of the ventral claw, and the dorsal seta is half of the dorsal claw in length.

Genus 3. *Cyprinotus* Brady, 1886**Generic diagnosis :**

Shell not tumid, valves unequal, subovate to subtriangular in shape ; smaller valve with marginal tubercles. Swimming setae of second antenna well developed. Furca normal, similar. Males common. Very common in stagnant brackish water of Chilka Lake, Sambhar Lake of Rajasthan and other saline water sources of India as well as in fresh water sources.

12. *Cyprinotus malini* sp. nov.

(Text-fig. 12 A-F).

Material : Holotype—One adult female, Z. S. I. Regd. No. C 1164/2 ; From Duttuwadi, c 7 Km. from Poona, on way to Singh garh. Coll. K. K. Tiwari ; 20 September 1964.

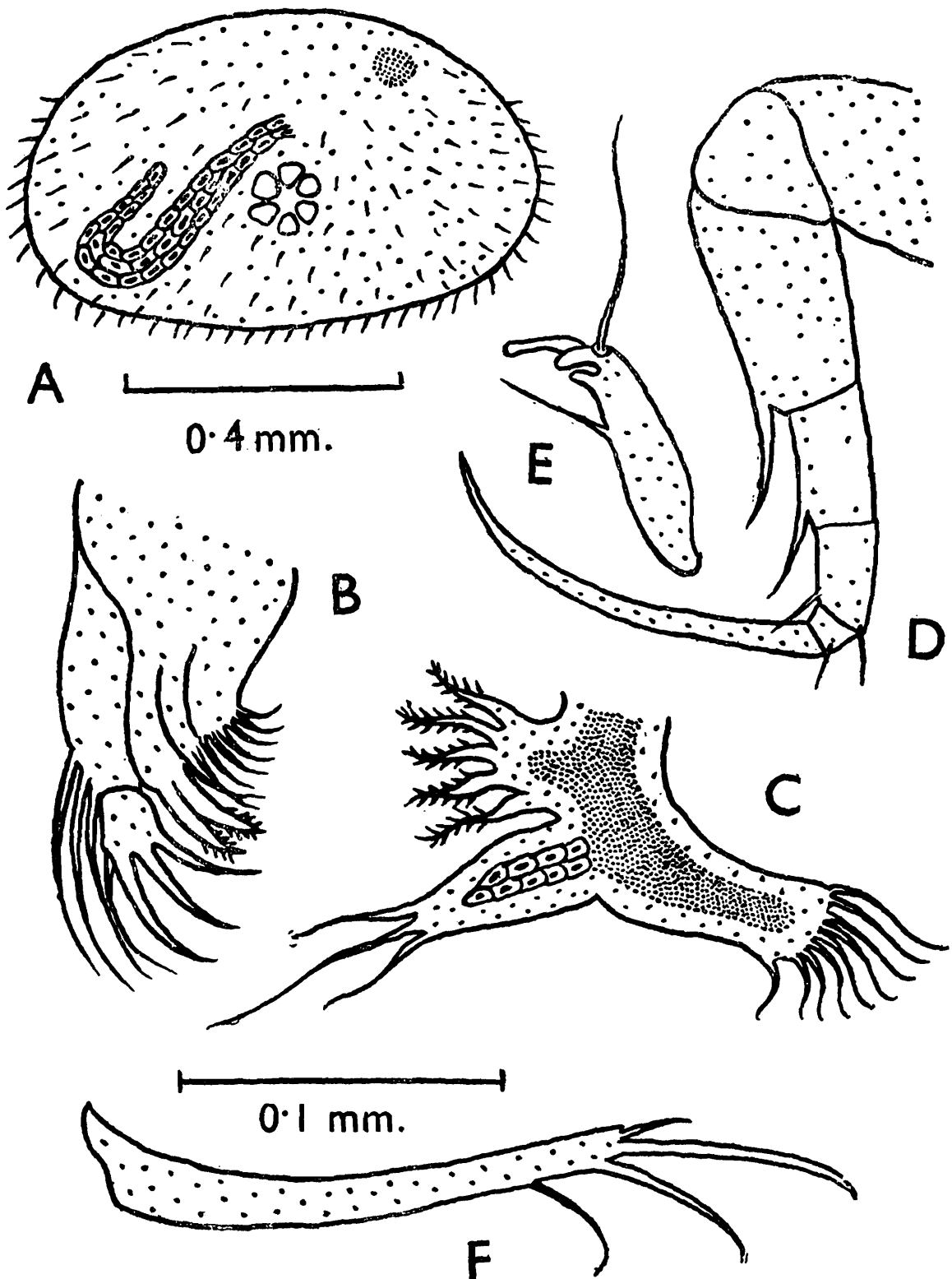
Length—1.15 mm. Height : 0.68 mm.

Shell slightly tumid, when seen dorsally, oblong, maximum width occurs in the middle ; both the ends obtusely pointed ; Left valve slightly smaller than right, left valve margin prominently tuberculate ; right valve entire. In profile, elliptical in shape, dorsal edge evenly, curved, ventral edge markedly convex, both the ends broadly curved. Surface of shell apparently unsculptured although reticulate under high power, and also punctate and with scattered hairs.

Swimming setae of second antenna much longer than terminal claws, third maxillary process with two thick, dentate setae, maxilliped with five rayed branchial plate. Subterminal segment of first abdominal leg jointed, terminal segment of second leg chelate, with a short and a long seta present distally. Furcal rami short, stout, strongly curved in the middle. Two terminal claws slightly unequal, dorsal seta slightly smaller, ventral seta minute. Male not known ; light brown colour in spirit.

Distribution : From type locality only.

Remarks : *Cyprinotus malini* Deb, resembles *C. newmexicoensis* Ferguson 1967, in size, in reticulation of the valves and lastly in combination of the other characters, viz., the second antenna, second abdominal leg and in furcal rami. But the significant difference between them lies in the shape of the shell and in the valve that bears tubercles ; the left valve is tuberculate in *C. malini* whilst it is the right valve of *C. newmexicoensis* that bears the tubercles.



Text-fig. 12. *Cyprinotus malini* sp. nov. A. Shell lateral view B. Maxilla C. Maxilliped D. First abdominal leg E. Second abdominal leg F. Furca.

Genus 4. *Cypricercus* Sars, 1894

Strandesia Hartmann 1964, p. 98 ; Victor, R & Fernando 1979, p. 168.

Generic diagnosis :

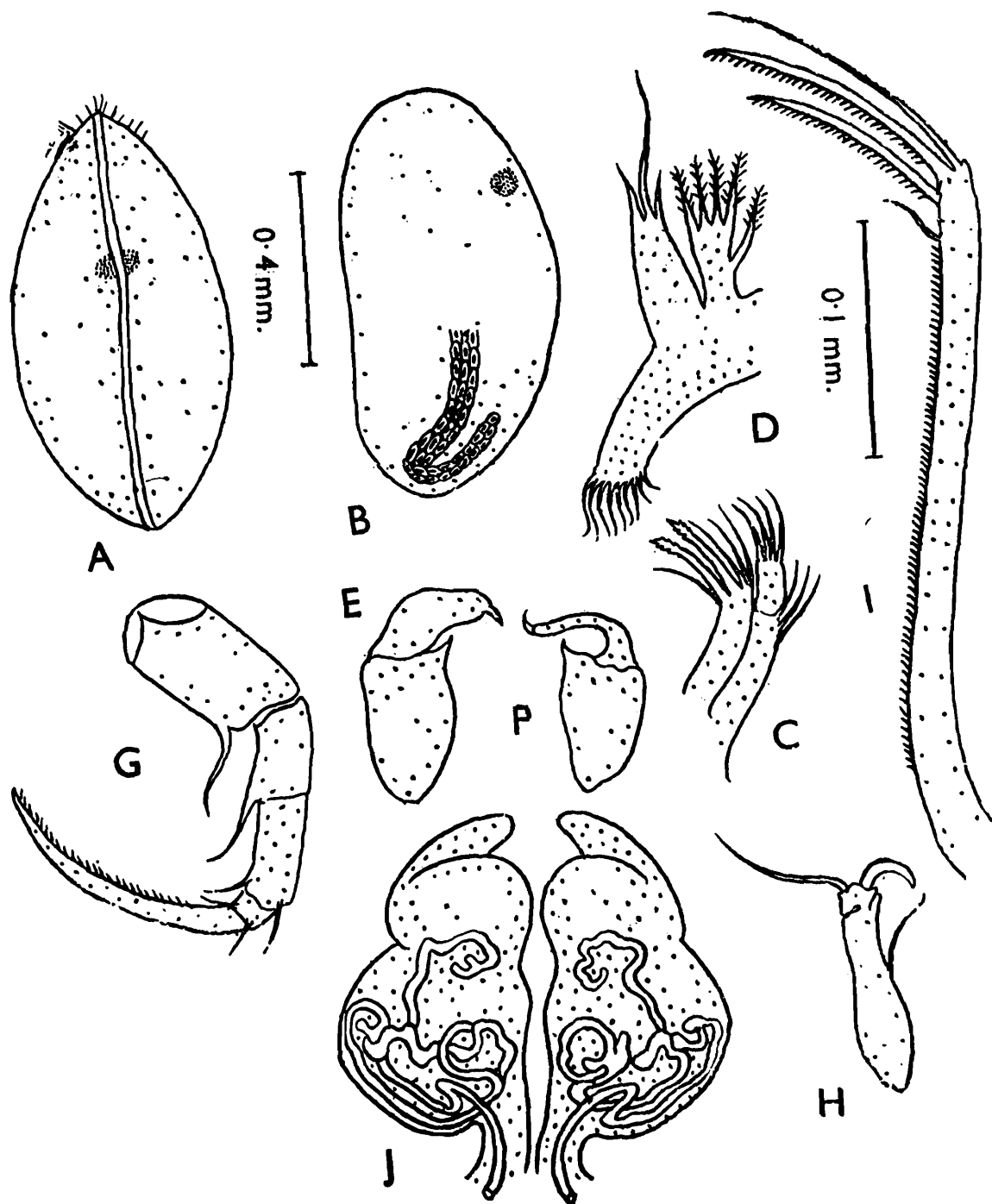
Shell tumid, narrow, elongate, oblong, somewhat cylindric in dorsal view. Swimming setae of second antenna well developed. Furcal rami very long, slender, similar or dissimilar. Males common ; spermatoc

tubes in male forming a dense coil within the anterior and posterior part of shell. Cosmopolitan & common in India.

13. *Cypricercus indrani* sp. nov

(Text-fig. 13 A-J)

Material : *Holotype*—One female, Z. S. I. Regd. No. C 1166/2 ; *Paratype*—One male, two females, Regd. No. C 1167/2 ; From rain water pond on Mahabaleswar Panchgani Road, c 5 km. from Mahabaleswar. Coll. K. K. Tiwari ; 28 August 1964.



Text-fig. 13. *Cypricercus indrani* sp. nov. A. Shell dorsal view B. Shell lateral view C. Third maxillary process with palp D. Maxilliped E & F. Right and left prehensile palp of male G. First abdominal leg H. Second abdominal leg I. Furca J. Male copulatory appendage. A, B same C-J. Same scale,

Length : 1.32 mm. ; Height : 0.62 mm. ; Width : 0.66 mm.

Shell oblong, elongate, oval in dorsal view, maximum width occurs in the middle, both ends obtusely pointed, left valve slightly larger than and overlaps the right. In profile, strongly & evenly curved dorsal edge, ventral margin nearly straight, anterior end more broadly rounded than the posterior end. Maximum height occurs in the middle. Surface without any sculpture, fine hairs and puncta scattered on the valves, valve margin entire. Spermatocystic vessels in the male form dense spiral within the anterior and posterior part of the shell.

Swimming setae of second antenna slightly longer than terminal claws, terminal segment of maxillary palp twice as long as wide, third maxillary process with two strong, dentate setae. In male prehensile palp of maxilliped bears dissimilar claspers and has five-rayed branchial plate. Subterminal segment of first abdominal leg jointed. Furcal rami very long, narrow, curved proximally, dorsal edge of ramus and claws hairy. Ventral seta as long as ventral claw, dorsal seta minute. Ventral claw less than half of ramus in length. Copulatory appendage in male broad plate-like and with upper and lower lappets. Light brown colour in spirit.

Distribution : Known from type locality.

Remarks : *Cypricercus indrani* Deb, differs from the two closely allied species viz. *C. obliquus* (Brady) 1866, in the character of the soft parts viz. of maxilliped, second abdominal leg and furcal rami and from *C. splendida* Furtos 1933, in not having pearly tubercles covering the shell.

Genus 5. *Stenocypris* Sars, 1889

Generic diagnosis :

Shell elongate, length twice or more of height, compressed. Swimming setae of second antenna well developed, reaching upto the tips of terminal claws. Furcal rami dissimilar, asymmetrical, stout. Males common. This is a cosmopolitan and very common genus of Indian ostracods.

KEY TO THE SPECIES OF *Stenocypris*

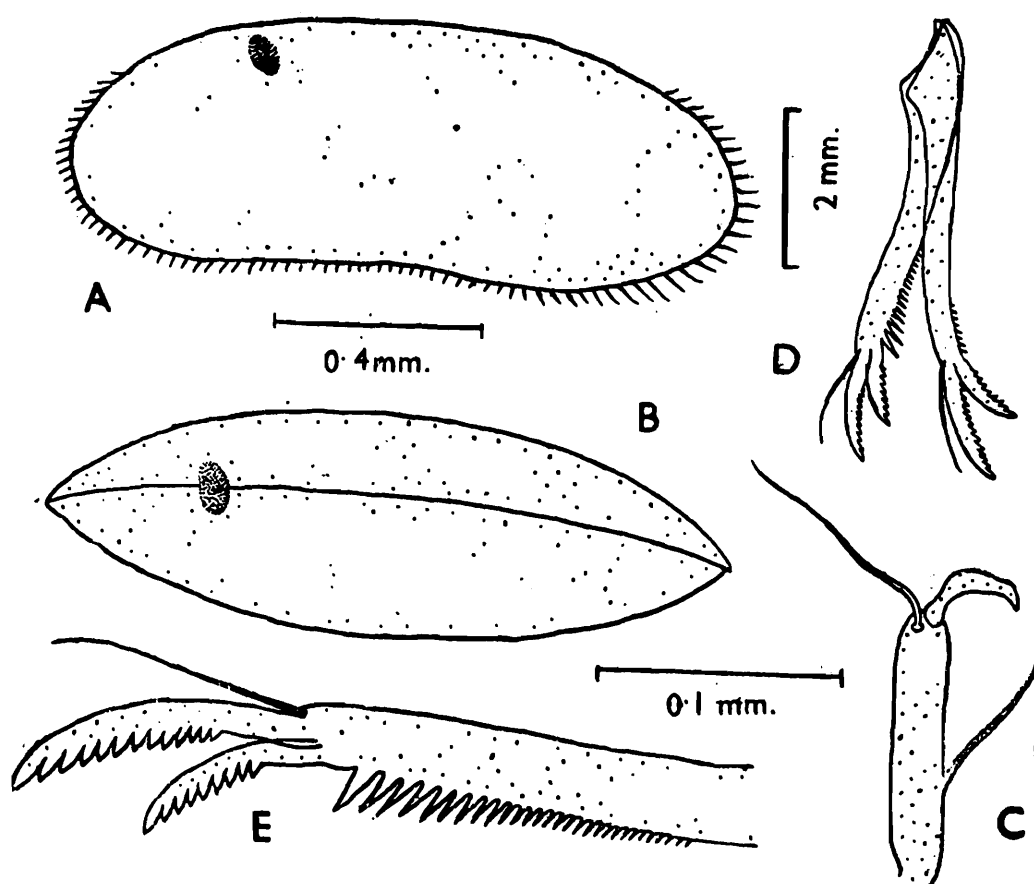
1. Valves without marginal band of radial porecanals	...	<i>S. khopoliensis</i>
2. Valves with marginal band of radial porecanals	...	3.
3. Band of porecanals very broad ; posterior end of valve narrowly rounded	...	<i>S. sohni</i>
4. Band of porecanals narrower, post end of valve broadly rounded	...	<i>S. sp.</i>

14. *Stenocypris khopoliensis* sp.

(Text-fig. 14 A-E)

Material : *Holotype*—One female, Z.S.I. Regd. No. C. 1086/2 ; *Paratype*—Five females, Z.S.I., Regd. No. C 1087/2 ; From Khopoli, rain water pond at Karla, c 13 Km. south of Lonavala on Bombay Poona Road, alt. 616 m ; Coll. *K. K. Tiwari* ; 26 September 1964.

Length : 2.12 mm. ; Height : 0.75 mm. Width : 0.72 mm.



Text-fig. 14. *Stenocypris khopoliensis* sp. nov. A. Shell lateral view B. Shell dorsal view C. Second abdominal leg D, E. Furca C & E. same scale.

Shell elongate, oblong, length more than $2\frac{1}{2}$ of height. In dorsal view, right valve overlaps left ; maximum width occurs in middle, both ends acutely pointed. Seen laterally oblong, dorsal edge forms a flattened arch that slopes towards the end. Anterior and posterior ends broadly rounded ; ventral edge weakly sinuate in the middle. Surface without ornamentation except for hairs and punctae. Marginal porecanals absent.

Swimming setae of second antenna as long as terminal claws ; third maxillary process with two smooth setae. Right furcal ramus broad, curved and with dorsal pectination up to middle of ramus, left ramus narrow, curved, pectination upto distal one fourth of ramus. Ventral

seta slightly smaller than ventral claw. Male unknown. Light brown colour in spirit.

Distribution : Known from type locality only.

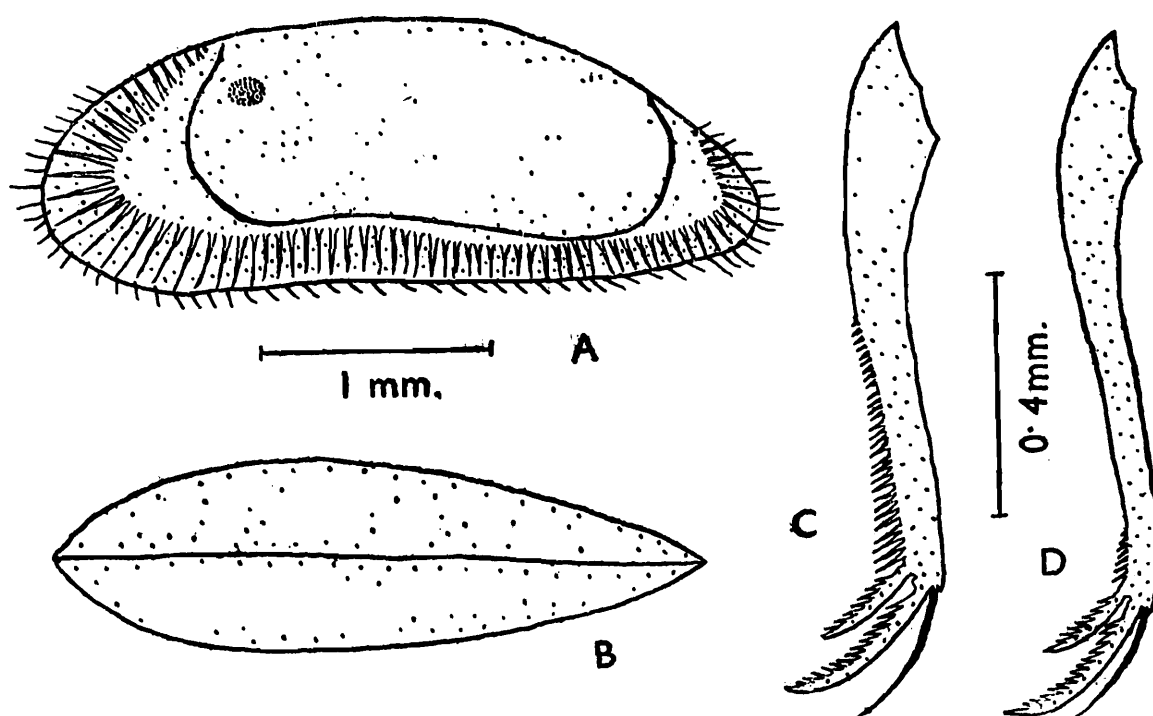
Remarks : *Stenocypris khopoliensis* Deb, shows a remarkable resemblance to *S. hislopi* Ferguson 1969, from Nagpur. Despite a close resemblance between the two species, *S. khopoliensis* is significantly bigger in size than *S. hislopi*, the former differs from the latter and *S. cylindrica major* (Baird 1859), in not having a distinct band of radial porecanals along the margins of valves, and having smooth terminal claw like seta of the second abdominal leg, and both the furcal rami are denticulate and narrower distally. *S. fontinalis* Vavra 1895 resembles the present species in some points, but may be separated by size differences and by the short ventral seta of the furcal rami. *S. fontinalis* measures 1.70 mm. in length, and *S. khopoliensis* measures 2.12 mm.

15. *Stenocypris sohni* n. sp.

(Text-fig. 15 A-D)

Material : *Holotype*—One female, Z. S. I. Regd. No. C 1083/2 ; *Paratype*—five females, Z.S.I. Regd. No. C. 1084/2 ; From rain water pond at Kholapur, c 8 km. North of Inspection Bunglow. Coll. K. K. Tiwari ; 26 September 1964.

Length—3.18. mm. Height : 1.32 mm. ; Width—0.62 mm.



Text-fig. 15. *Stenocypris sohni* sp. nov. A. Shell lateral view B. Shell dorsal view C. Right furca D. Left furca.

Shell seen dorsally, anterior end obtusely and posterior end acutely pointed; maximum width occurs in front of middle, sides gradually compressed posteriorly. In profile, oblong, dorsal edge with a low arch, sloping diagonally downwards posteriorly. Anterior end broadly rounded; posterior end narrow and rounded off below near ventral corner. Ventral edge weakly sinuate in middle. Valves equal, thin and transparent, margins with a very broad band of radial porecanals, the band much broader anteriorly. Surface unsculptured, thinly hairy.

Swimming setae of second antenna extend slightly above the tips of terminal claws. Third maxillary process with two thick feathery setae. Furcal rami stout, right ramus broad, curved, spines on dorsal edge are in groups, 7-8 groups, clearly visible under high power. Left ramus weakly curved, narrow, 2-3 groups of spines on distal end, rest of edge hairy. Terminal claws pectenated, ventral seta three-fourths of ventral claw. Male unknown, light yellowish brown colour, in spirit.

Distribution : Known from type locality only.

Remarks : *Stenocypris sohni* Deb, resembles *S. perarmata* Brady 1904, and *S. derupta* Vavra 1906, but differs from *S. perarmata* by being bigger in size, in having broad marginal band of radial porecanals and not having ten strong spines on the dorsal edge of the furcal ramus. *S. derupta* measures 2.50 mm., its marginal band of porecanals is less broad and dents on the dorsal edge of the furcal ramus are not in successive groups, ventral seta is half the length of the ventral claw, all these characters distinguish *S. derupta* from *S. sohni*.

This species is named in honour of Dr. I. G. Sohn, of U. S. Geological Survey, Washington D. C. in recognition of his significant contributions to our knowledge of ostracod taxonomy.

16. *Stenocypris* sp.

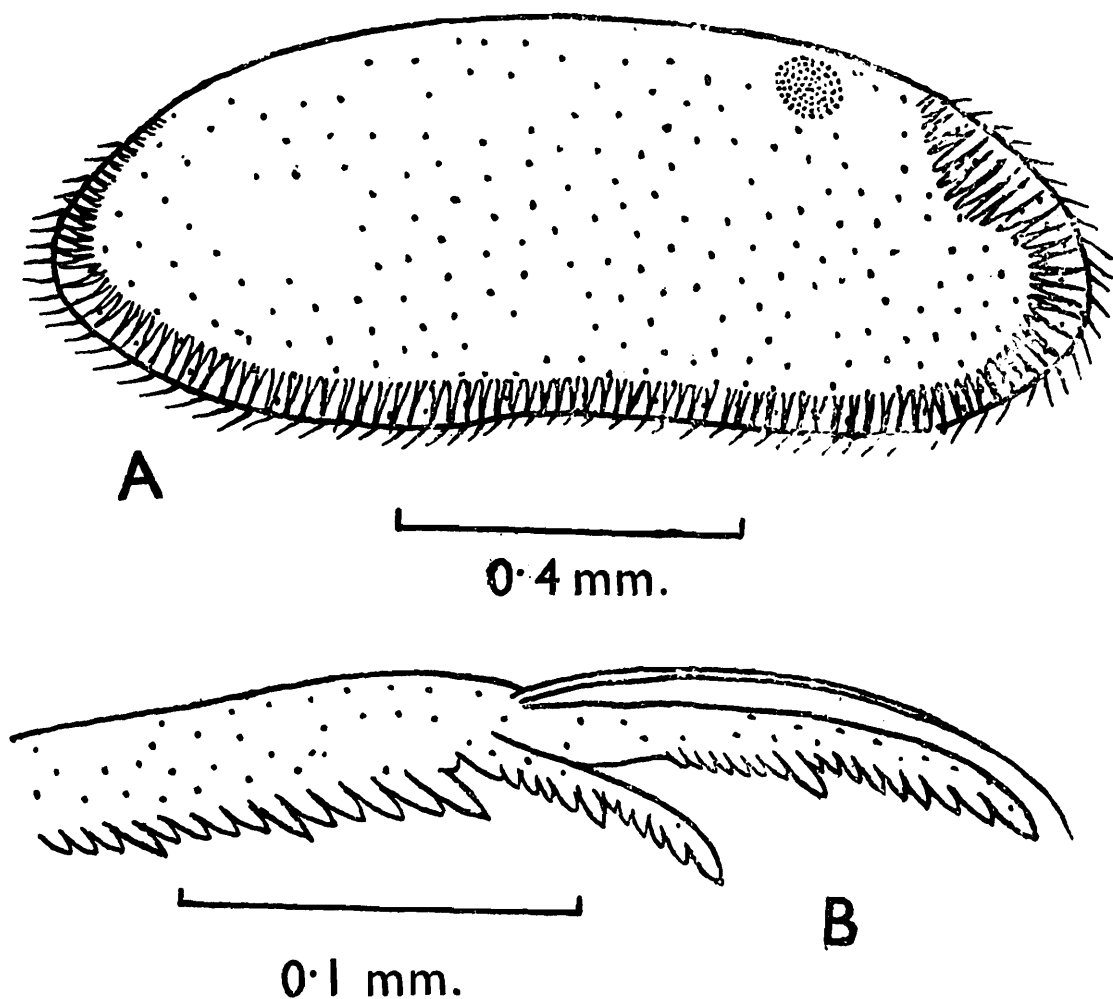
(Text-fig. 16 A-B)

Material : One adult female and two young females. Z. S. I. Regd. No. C 1081/2; from a pond inside Satara Fort, on 2 September 1964, Coll. K. K. Tiwari.

Length : 2 mm. ; Height : 0.80 mm.

Shell oblong, elongate, in dorsal view, maximum width in the middle, ends pointed. Left valve larger than the right. Valve margins with a broad band of radial porecanals. Surface unsculptured, with fine scattered hairs and punctae.

Swimming setae of second antenna slightly longer than terminal claws. Broad furcal ramus denticulate dorsally, dents are arranged in successive groups, six groups quite clear, demarketed by larger dents. Terminal claws denticulate dorsally, one abruptly larger dent present on the middle of claw. Ventral seta slightly longer than the ventral claw, dorsal claw short, not reaching up to the middle of ventral claw. Male absent, greyish colour in spirit.



Text-fig. 16. *Stenocypris* sp. A. Shell lateral view B. Furca.

Distribution : From a pond inside Satara Fort.

Remarks : *Stenocypris* sp., resembles the majority of species belonging to the genus as regards size, shape and other characters. In India, the genus *Stenocypris* is profusely developed as far as I have examined them, though the range of area from where material is being examined is not vast as regards our country.

It is possible that the species is to be regarded as new but the numbers of specimens available and their poor state of preservation makes it impossible to place it properly. Apparently it is very close to *S. malcolmsoni* Brady 1886 though the groups of dents on furcal rami are different.

Sataracypris n. Gen.

Cypris Baird, 1837 ; p. 137 ; 1850 ; p. 156.

Shell moderately tumid, slightly oblong, valves subequal, thin, without any sculpture except fine scattered hairs and punctae. One prominent dorsal protuberance or hump like gibbosity of the shell present. Swimming setae of second antenna well developed, extend much beyond the tips of terminal, thick bristles. These bristles are not like claws as in the other allied genera. Mandibular palp four segmented ; terminal segment of maxillary palp broader than its length. Subterminal segment of first abdominal leg jointed. Terminal segment of second leg chelate apically and adorned with very small claw and a short setae. Furcal rami similar, short, stout, adorned apically with two claws and two setae. Male not known.

Remarks : A new generic name for these hump back *Cypris* have been suggested as they deserve it I feel, because it is not *Cypris* and unlike any other known genera. In olden time all the Ostracods were designated as *Cypris* only. After Baird no record of this *C. gibbosa* has been made.

Sataracypris gibbosa (Baird)

(Text-fig. 17 A-B)

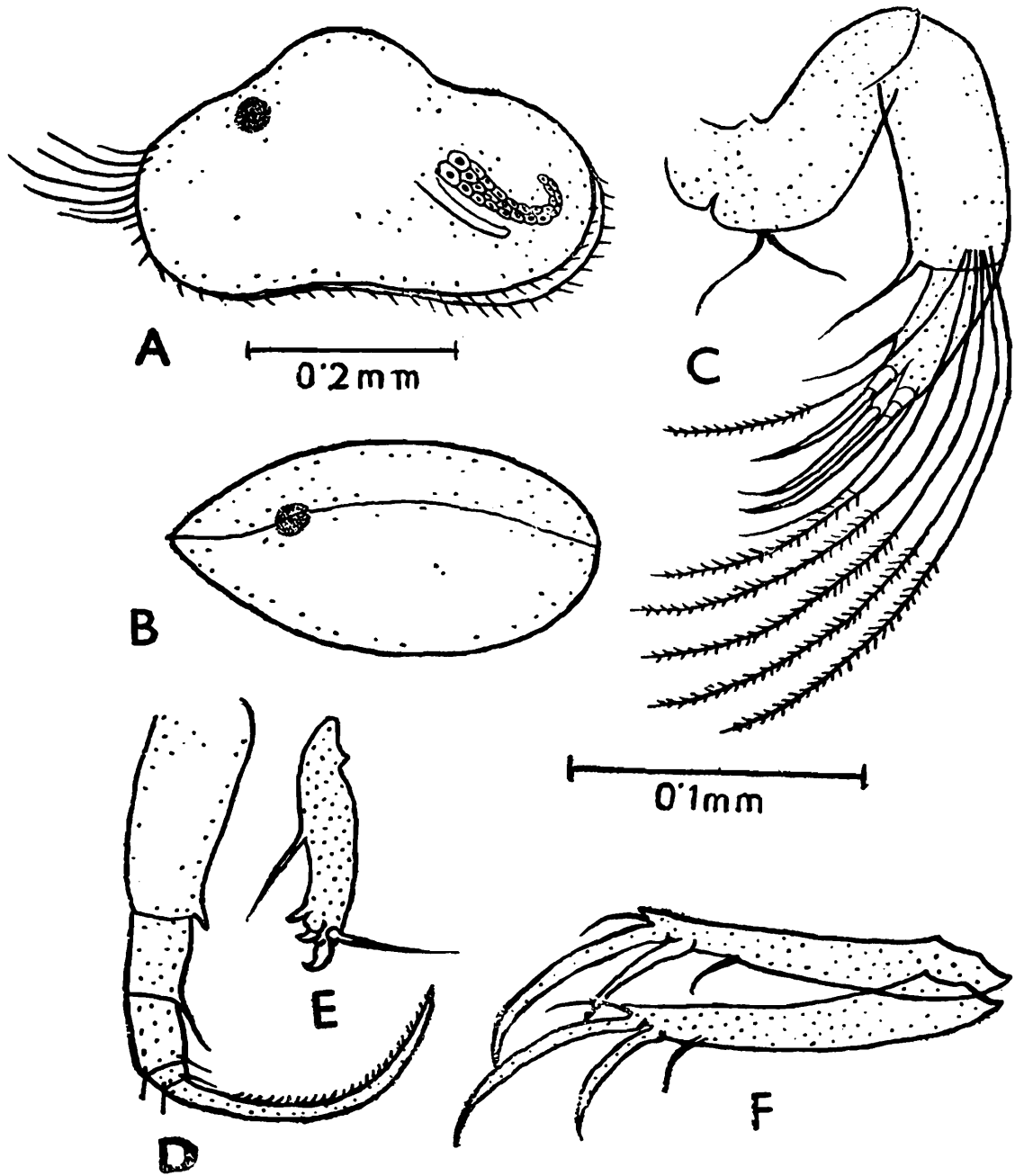
Cypris gibbosa Baird, 1837, p. 137 ; 1850 ; p. 156.

Material : One adult female, Z. S. I. Regd. No. C 1169/2. From pond near Inspection Bungalow, Satara, 30 August, 1964 ; two young females, Z. S. I. Regd. No. C 1170/2, from a pond at Panchgani ; 20 August 1970. *K. K. Tiwari* coll.

Length : 1.50 mm ; Height : 0.6 mm. Width : 0.5 mm.

Shell moderately tumid, when seen dorsally, elongate, oval, maximum width occurs in the middle, anterior end acutely pointed, posterior end broadly rounded. Left valve slightly larger and overlaps the right. In profile, dorsal edge strongly curved with a gibbosity or hump like protuberance. Maximum height occurring in middle. Both the ends broadly rounded ; anterior end broader than posterior. Ventral edge sinuate in middle. Surface of shell without sculpture. Thin scanty hairs present on the surface. Valve thin, delicate, margin entire. Both the antenna with long plumose setae. Swimming setae of second antenna extend much beyond the tips of terminal setae. Third maxillary process with two smooth setae. Subterminal segment of second abdominal leg jointed. Furcal ramus short, stout, similar, ventral claw two third of the ramus in length. Male absent, light brown in colour.'

Distribution : New record from Satara and Panchgani Maharashtra, India ; and from Survey Zoo garden ditch at U. K.



Text-fig. 17. *Sataracypris gibbosa* Baird A. Shell lateral view B. Shell dorsal view C. Second antenna D. First abdominal leg E. Second abdominal leg. F. Furcal ramii.

Remarks : The specimens are very much alike to *C. gibbosa* Baird; in their outward appearance of shell with its dorsal hump, Except the presence of two pairs of plumose antennae and first pair of legs Baird did not mention or show any other appendages in his *C. gibbosa*.

Genus 7. *Sclerocypris* Sars, 1924

Generic diagnosis : Shell large, oblong, moderately tumid, valves subequal. Swimming setae of second antenna not much elongated.

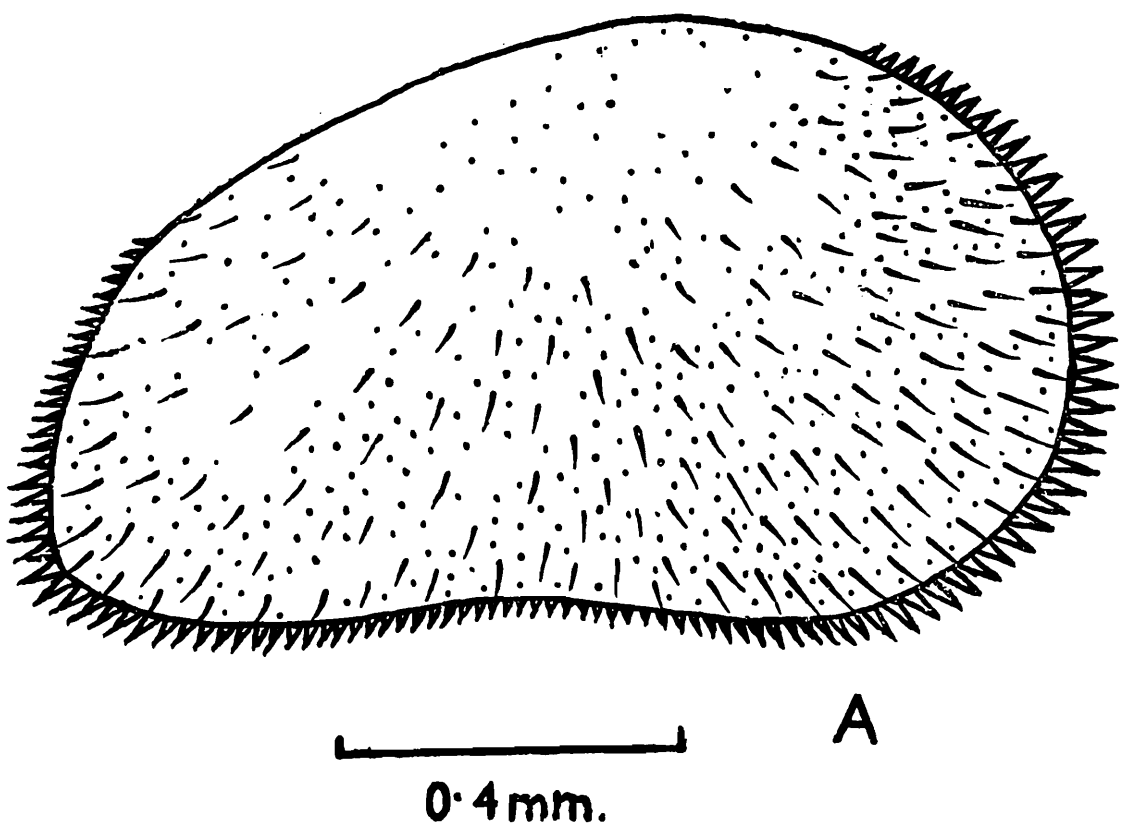
Terminal joint of maxillary palp broader than long. Furca similar, long, slender. Males common. Commonly found in North and South Western parts of India and South Africa.

Sclerocypris sp.

(Text-fig. 18 A)

Material : One ex. Z. S. I. Regd. No. C 1093/2 ; From rain water pond at Panchgani, Coll. *K. K. Tiwari* ; 19 August 1964.

Length : 3.50 mm ; Height : 1.66 mm. Width : 1.62 mm.



Text-fig. 18. *Sclerocypris* sp. A. Shell of young male in lateral view.

Shell large tumid ; profusely hairy towards the anterior end. Hairs long, but shorter towards posterior end. Shell surface unsculptured. In dorsal view, spindle shaped, maximum width occurs in the middle, both the ends evenly compressed and acutely pointed. In profile, anterior end very broad and rounded ; posterior end broadly and angularly curved and much narrower than anterior end. Ventral edge sinuate behind the middle ; Dorsal edge curved and slanting postero-dorsally ; maximum height occurs in front of the middle, where the dorsal edge is slightly angular. Left valve slightly bigger than and overlaps the right. Valve margins with hairs and a row of prominent spines except dorsally.

Furcal rami long, narrow, with two claws and two setae terminally. Ventral seta one haird of ventral claw, dorsal seta less than half of dorsal claw. The specimen seems to be a young male though the coils of vasdeference are not visible outwardly. Dark brown colour in spirit.

Distribution : Panchgani, from where it was collected.

Remarks : *Sclerocypris* sp. is a large, mango like in shape, shell described above, markedly differing from six African species described by Sars 1924-1926, and two Indian records of the present author 1973, from Sambhar Lake, Rajasthan, a salt producing desert area and Punjab.

According to Sars 1924, the present specimen is a young male and as only one specimen present at my disposal, I have not dissected it and have kept it as a doubtful species until more adult specimens could be collected.

Genus 8. *Cypretta* Vavra, 1895

Shell less than 1 mm in length, very broad, tumid and high. Anterior end of valves with well defined radiating septa. Furcal rami similar, normal, short ; terminal claws are very long, slender, whip like setae, sometimes longer than or as long as the ramus itself. Males not uncommon. It is a cosmopolitan genus, common in India also.

Cypretta *gargi* sp. nov.

(Text-fig. 19 A-F)

Material : *Holotype*—One female, Z. S. I. Regd. No. C 1089/2 ; *Paratype* : 10 females, Z.S.I. Regd. No. C. 1090/2. From a temporary pond at Karla, c 13 km. south of Lonavala, on Bombay Poona Road, alt. 616 m ; coll *K. K. Tiwari*, 26 September 1964.

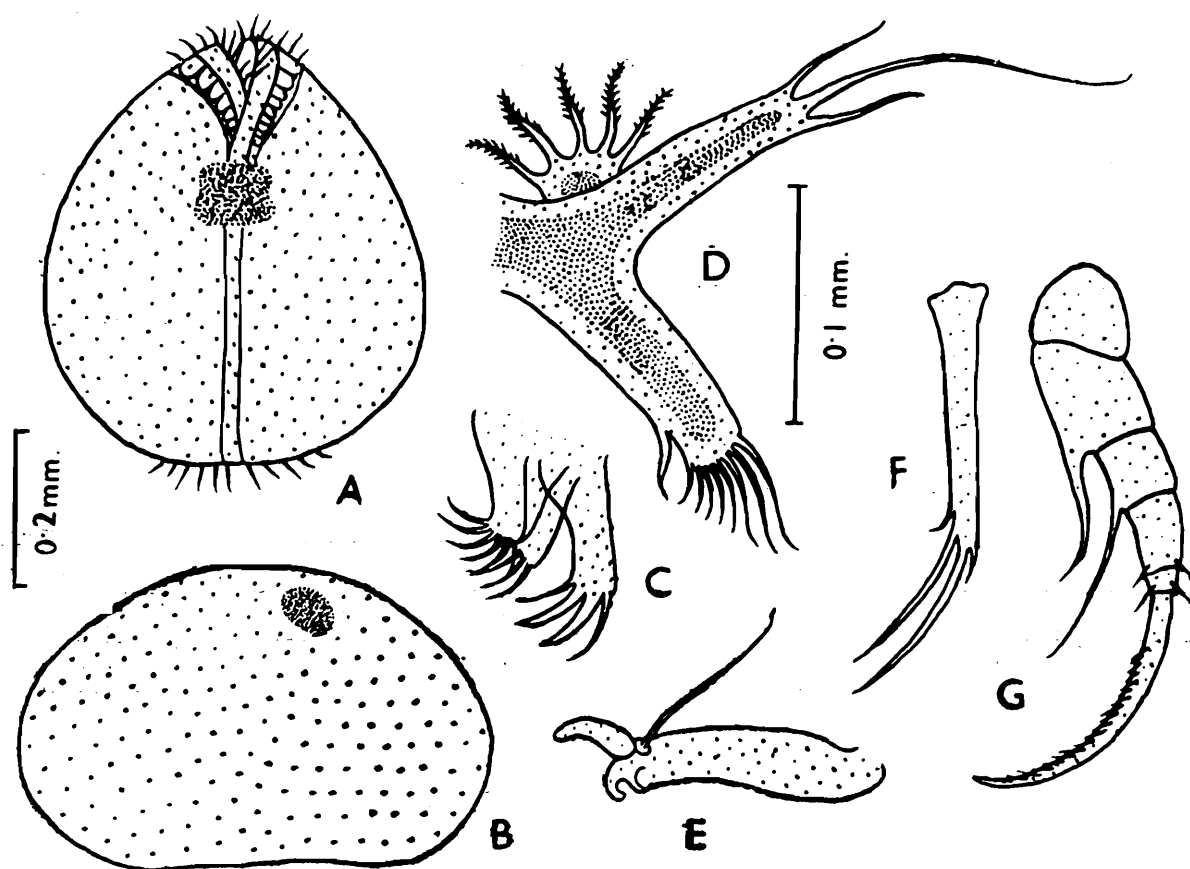
Length : 0.87 mm ; Height : 0.62 mm ; Width : 0.68 mm.

Shell, seen in dorsal view, very tumid with maximum width occurs in the posterior fourth ; anterior end obtusely pointed, posterior end more broadly rounded. In profile, both the ends broadly rounded, dorsal edge highest and somewhat angular about the middle descending on both sides in a smooth curve, ventral edge nearly straight. Valves unequal, right valve slightly larger than the left, overlapping it, margins entire. Anteriorly striated band of radiating septa present on each valve margin bordered by marginal fringe ; Valves thin, punctate, unsculptured and with scattered hairs.

Swimming setae of second antenna slightly longer than terminal claws. Third maxillary process with two thick smooth setae. Subter-

minial segment of first abdominal leg jointed. Furcal rami straight, short, comparatively strong, with two long claws and two small setae. Male not known. Colour in spirit deep brown with darker patches.

Distribution : Known only from the type locality.



Text-fig. 19. *Cypretta gargi* sp. nov. A. Shell dorsal view B. Shell lateral view C. Maxilla D. Maxilliped E. Second abdominal leg F. Furca G. First abdominal leg C-F. same scale.

Remarks : *Cypretta gargi* Deb can be easily distinguished from other known species of the genus by the shape of the shell which is much broader posteriorly. It shares certain similarities of structure with *Cypretta bilicis* Furtos 1936, but can be differentiated from this by its more tumid posterior portion of shell, angular and higher dorsal profile and strong furcal rami armed with two nearly equal claws and two setae.

ACKNOWLEDGEMENTS

I am grateful to the Director, Zoological Survey of India for facilities to examine the material and to Dr. K. K. Tiwari, Carcinologist of the Survey, for guidance and help in identification. The types of the new species described herein are deposited in the National Zoological Collection of the Zoological Survey of India, abbreviated in the text as Z. S. I.

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PRELIMINARY DISTRIBUTIONAL RECORDS WITH REMARKS ON
LITTLE KNOWN SPECIES OF ACRIDIDAE (ORTHOPTERA :
INSECTA) FROM THE WESTERN HIMALAYAS
(HIMACHAL PRADESH)

By

H. K. BHOWMIK AND P. HALDAR

Zoological Survey of India, Calcutta

(With 22 Text-figures)

INTRODUCTION

General

The interesting orthopteran fauna of Himachal Pradesh (Western Himalayas) is little known. Uvarov (1929 : 233, para 2) stated that the acridid faunas of the Western Himalayas and deserts of India are of particular scientific interest. The ecosystems and topography of West Bengal and Himachal Pradesh show marked contrast. The authors are currently comparing the acridid faunas of these two regions as a contribution towards a modern account of the Indian representatives of this economically important group of insects.

The present paper is based mainly on a collection of Acrididae made by us during September, 1980, and some material collected earlier by one of us (H. P.). Although a very small part of the fauna that has been sampled, interesting tentative zoogeographical conclusions can be drawn.

The distribution of species of Himachal Pradesh admits an admixture of species almost from all corners of India. But the palaearctic elements in it are predominant. The presence of an Africa genus (*Orthochtha*) is unique. The results confirm the theory that Palaearctic species originated in the Angara continent and involved a movement from the western Himalayas eastwards. The availability of the southern and northern Indian elements are rather poor ; presence of a few species of southern origin in the area suggest overlapping through the million years of geological ages. There is no endemic or localized species. The study further suggests that more thorough searches are required to find out a clear picture of distribution pattern of these insects along the Himalayas.

An analysis of the species treated here shows that 18 species are both common in the Himachal Pradesh and the Himalayan districts of North Bengal. Of these *Ceracris nigricornis nigricornis* is of South Chinese origin. There are 3 Himalayan species, *Sikkimiana darjeelingensis*, *Chondracris rosea*, and *Sphingonotus longipennis*; the first two being Himalayan origin, and the last representing the eastward extension of a palaearctic species. *Tylotropidia varicornis* is a south Indian element (including Sri Lanka and Burma) and *Pachyacris vinosa* a north Indian species (including Burma and China).

Ten species have been found in the H. P. region but not in the eastern Himalayas. Thus *Heteracris nobilis* is from N. W. India (including Punjab); *Eyprepocnemis rosea* is from Western Himalayas (also from Shillong but not from N. Bengal). *Scintharista blanchardiana*, special to the semi-desert of Southern Asia, is also represented in the region including Bombay. *Orthochtha indica* representing a largely African genus, is also prominent to the area. *Chorthippus* (*Glyptobothrus*) *hammerstroemi*, a truly palaearctic species, is reported here for the first time from India. Of the truly Indian elements, *Choroedocus illustris* and *Pachyacris violascens* are of South Indian origin, *Hieroglyphus banian* from western India (also from Burma) and *Paraconophyma scabra* from northern India (Burdwan; U. P., *Aularches punctatus* (from Tibet, Kashmir, Garhwal (U. P., and Java & Malay) is also abundantly recorded.

The present communication contains only exact records of localities of the relatively well-known species; new data in the form of remarks of systematic value including variability of species and subspecies, additional descriptions with suitable illustrations etc., and measurements are given for little known ones.

All species recorded here for the first time are marked with an asterik.

All material studied will be deposited to the National collections of the Zoological Survey of India, Calcutta.

All measurements are given in millimetres.

Following abbreviations are used in the text :-

- H. P. — Himachal Pradesh
- U. P. — Uttar Pradesh
- J. & K. — Jammu and Kashmir
- W. B. — West Bengal
- T. N. — Tamil Nadu

SYSTEMATIC ACCOUNT

Order INSECTA

Family ACRIDIDAE

Subfamily ACRIDINAE

Genus (1) *Acrida* Stål, 1873

1. *Acrida exaltata* (Walker, 1859)

Truxalis exaltata Walker, 1859. *Ann. Mag. nat., Hist.*, 4 (3) : 222.

Material : H. P. : 1 ♀ ; Solan, 9.9.71. 3 ♂, (and nymph) ; Solan, 28.8.77. 8 ♂, 6 ♀ ; Pandoh, Mandi, 18.9.80. 3 ♂, 2 ♀ ; Near Lake, Bilaspur, 29.9.80. 4 ♂ ; Chakkar, Mandi, 20.9.80. 1 ♂ ; River side, Mandi, 23.9.80. 3 ♂, 1 ♀ ; Sundar Nagar, Bilaspur, 2.10.80.

Remarks : One of the commonest grasshoppers of India. Also known from Saudi Arabia, Iran, Afganistan, Pakistan, S. E. Tibet.

Genus (2) *Sikkimiana* Uvarov, 1940

*2. *Sikkimiana darjeelingensis* (Bolivar, 1914)

Sjoestedtia darjeelingensis Bolivar, 1914. *Trab. Mus. nac. Cienc. nat. Madr. (Zool.)*, 20 : 110.

Material : H. P. : 10 ♂, 1 ♀ ; Drang, Mandi, 21.9.80. 2 ♂ ; Mandi river side, Mandi, 23.9.80. 2 ♂ ; Pandoh, Mandi, 18.9.80. 1 ♂ ; Solan, 18.9.71.

Remarks : Bolivar's (1909) unique genus *Sjoestedtia* is now synonymised with Uvarov's (1940) genus *Sikkimiana* (vide Jago, 1971 : 216).

This species was described from Darjeeling and later was recorded from Sikkim, Assam and Kumaon (U. P.). The availability of present series of specimens from H. P. is not only a new records but also extends its distribution to most western part. The identification of the specimens has been confirmed by Dr. N. D. Jago, C.O.P.R., London.

Following additional morphological characters need special mentioning—From 3rd to 9th segments antennae more or less ensiform, remaining segments elongate, some of middle segment 2.5 to 3 times longer than their width. Metazona distinctly shorter than prozona. Tegmen elongate, about one third of it surpassing tip of posterior femora, opaque except radial sector veins which are subhyaline ; with apices angulated at apex. Wings prominently bluish basally. Male cerci thin, conical. Ovipositor valves short, curved. Posterior tibiae, in both sexes, with 10 to 11 testaceous, brownish tipped spines on each margin, Lower lobe of posterior "Knee" somewhat acute.

Measurements : Length of body ♂ 29-32, ♀ 41-42 ; antennal length ♂ 16-17, ♀ 14-17 ; head length ♂ 4-4.5, ♀ 5.2-5.8 ; maximum width of head ♂ 2.5-3.5, ♀ 4-4.2 ; maximum width of face (at clypeus point) ♂ 4-4.25, ♀ 5-5.5 ; minimum width of inter ocular distance ♂ 1-1.25 ; ♀ 1.5-1.7 ; width of frontal ridge at median ocellus ♂ .8, ♀ 1 ; pronotal length ♂ 5-5.5, ♀ 7.1-7.3 ; length of prozona ♂ 2.5-3, ♀ 3.5-3.6 ; length of metazona ♂ 2.5-2.75, ♀ 3.6-3.7 ; maximum width of pronotum ♂ 3.6-4, ♀ 5-6.5 ; minimum width of pronotum ♂ 2-2.2, ♀ 3-5.5, length of tegmen ♂ 31-33, ♀ 39-41 ; maximum width of tegmen ♂ 4, ♀ 5.2-6 ; length of post. femur ♂ 17-18, ♀ 22-22.5 ; maximum depth of post. femur ♂ 3.5-3.8, ♀ 4-4.5 ; length of post tibia ♂ 15-15.5, ♀ 20-21.

Genus (3) *Phlaeoba* Stål, 1860

*3. *Phlaeoba panteli* Bolivar, 1902

Phlaeoba panteli Bolivar, 1902. *Annls. Soc. ent. Fr.*, **70** : 539.

Material : H. P. : 2 ♂ ; Chakkar, Mandi, 20.9.80. 1 ♀ ; Drang, Mandi, 21.9.80. 1 ♂ ; Pandoh, Mandi, 18.9.80. 2 ♂, 1 ♀ ; Mandi, 23.9.80. 1 ♀ ; P.W. D.R.H., Mandi, 17.9.80. 1 ♂ ; Renuka Lake, Srimour dist., 11.4.74. 1 ♂, 1 ♀ ; Bilaspur. 8.4.72.

Remarks : So far was known from T. N., Bihar, West Bengal and also from Afganistan. This species seems to be common throughout the oriental region. It is also a pest to agricultural crops. It is recorded here for the first time from H. P.

Genus (4) *Ceracris* Walker, 1870

*4. *Ceracris nigricornis nigricornis* (Walker, 1870)

Ceracris nigricornis Walker, 1870. *Cat. Derm. Salt. Br. Mus.*, **4** : 791.

Ceracris nigricornis nigricornis : Uvarov, 1925. *Ent. Mitt.*, **14** : 13-14.

Material : H. P. : 4 ♂, 5 ♀ ; Glen, Simla, 12.9.80. 2 ♂, 5 ♀ ; Kufri, Simla, 15.9.80. 3 ♀ ; Taradevi, Simla, 14.9.80. 1 ♂, 1 ♀ ; Saproon, Solan, 7.9.73. 1 ♂ ; Solan, 8.10.76.

Remarks : This small subspecies occurs in N. E. India, in the middle regions of the Himalayas. In H. P., it is one of the commonest grasshoppers. However, it is a new record for H. P.

The present series tally nicely with Walker's description and Uvarov's (1925) revisional characters.

Genus (5) **Orthochtha** Karsch, 1891

5. **Orthochtha indica** Uvarov, 1942

Orthochtha indica Uvarov, 1942. *Ann. Mag. nat. Hist.*, 9 (11) : 587, fig. 1.

Material : H. P. : 7♂ ; Solan, 15.10.76. 1♂ ; Solan, 19.3.77. 1♀ ; Solan, 24.8.77. 1♂ ; Saproon Office, Solan, 30.7.76.

Remarks ; This unique species was described from Delhi and Nagpur but seems rather abundant throughout the Western Himalayan ranges. The specimens at our disposal nicely agree with the original description except in a few points. Lateral carinae of pronotum not appreciably divergent in metazona in females. "Knees" of posterior femora of females black on sides and brown on upper carina like males.

Measurements : Length of body ♂ 25-26, ♀ 38 ; antennal length ♂ 12-13, ♀ 19 ; head length ♂ 3.5-4, ♀ 5 ; maximum width of head ♂ 3.5, ♀ 4 ; maximum width of face ♂ 2.3-2.5, ♀ 4.5 ; minimum width of interocular distance ♂ 1-1.25, ♀ 2.2 ; width of frontal ridge at median ocellus ♂ .6-.7, ♀ 1 ; pronotal length ♂ 5-5.5, ♀ 7 ; length of prozona ♂ 3-3.5, ♀ 4.5 ; length of metazona ♂ 2-2.2, ♀ 2.5 ; maximum width of pronotum ♂ 2.5-2.7, ♀ 4 ; minimum width of pronotum ♂ 2-2.3, ♀ 3.8 ; length of tegmen ♂ 18-19, ♀ 30 ; maximum width of tegmen ♂ 3.5-3.6, ♀ 5 ; length of post. femur ♂ 16-16.5, ♀ 21.5 ; maximum depth of post. femur ♂ 3-3.2, ♀ 3.5 ; length of post. tibia ♂ 15-15.5, ♀ 20 (measured seven males and one female).

Subfamily GOMPHOCERINAE

Genus (6) **Dnopherula** Karsch, 1896

6. **Dnopherula (Aulacobothrus) luteipes** (Walker, 1871)

Stenobothrus (?) *luteipes* Walker, 1871, *Cal. Derm. Salt. Br. Mus.*, 5 : 82.

Material : H. P. : 1♂, 2♀ ; Pandoh, Mandi, 18.9.80. 2♀ (and 3 nymphs) ; Bilaspur, 2.10.80. 1♂, 4♀ ; Chakkar, Mandi, 20.9.80. 5♂ ; Glen, Simla, 12.9.80. 2♂, 1♀ ; Sundarnagar, 2.10.80. 1♂ ; Rohtang pass, Manali, Kulu, 26.9.80. 2♂ (5 nymphs) ; Vaist, Manali, 25.9.80. 8♂, 7♀ ; Solan, 30.11.76. 12♂, 13♀ ; Solan, 15.11.76. 4♂, 3♀ ; Solan, 9.9.77.

Remarks : Very common species all over India (as well as in H. P.). Also known from Burma, China, Japan, Europe and N. America.

Genus (7) **Chorthippus** Fieber, 1852* 7. **Chorthippus (Glyptobothrus) hammerstroemi** (Miram, 1906)

(Text-fig. 13)

Chorthippus hammerstroemi Miram, 1906-1907. *Ofvers Finska Vetensk—Soc. Forh.*, XLIX. 6 : 5 ; G. Ya Bei-Bienke and Mishchenko, 1951. *Zoo. Inst. USSR. Acad. Sci. No. 2 Part II* : 171.

Material : H. P. : 2 ♂ (9 nymphs) ; Sundarnagar, 2.10.80. 4 ♂, 8 ♀ ; Dhungri, Manali, 27.9.80. 14 ♂, 6 ♀ (& 3 nymphs) ; Vaist, Manali, Kulu, 25.9.80. 5 ♂ ; Rohtang pass, Manali, Kulu, 26.9.80. 1 ♀ ; Mandi, 23.9.80. 3 ♂ ; Solan, 20.4.77. J. M. Julka & P. Haldar.

Remarks : This is a palaearctic species occurring in Siberia and China and is popularly known as Siberian 'Little Horse' grasshopper. In H. P. it is available from rather low-lying areas to alpine, barren locality like Rohtang Jot (ca. alt. 3965 m). The species is thus not only a new record for India but also interesting from the point of its zoogeographical distribution.

The identification of the species has been kindly confirmed by Dr. Jogo.

Subfamily OEDIPODINAE

Genus (8) **Aiolopus** Fieber, 18538. **Aiolopus thalassinus tamulus** (Fabricius, 1798)

Gryllus tamulus Fabricius, 1798. *Ent. Syst. Suppl.* : 195.

Material : H. P. : 5 ♂, 1 ♀ (& 1 nymph) ; Bilaspur Lake, 29.9.80. 2 ♂, 1 ♀ ; Chakkar, Mandi, 20.9.80.

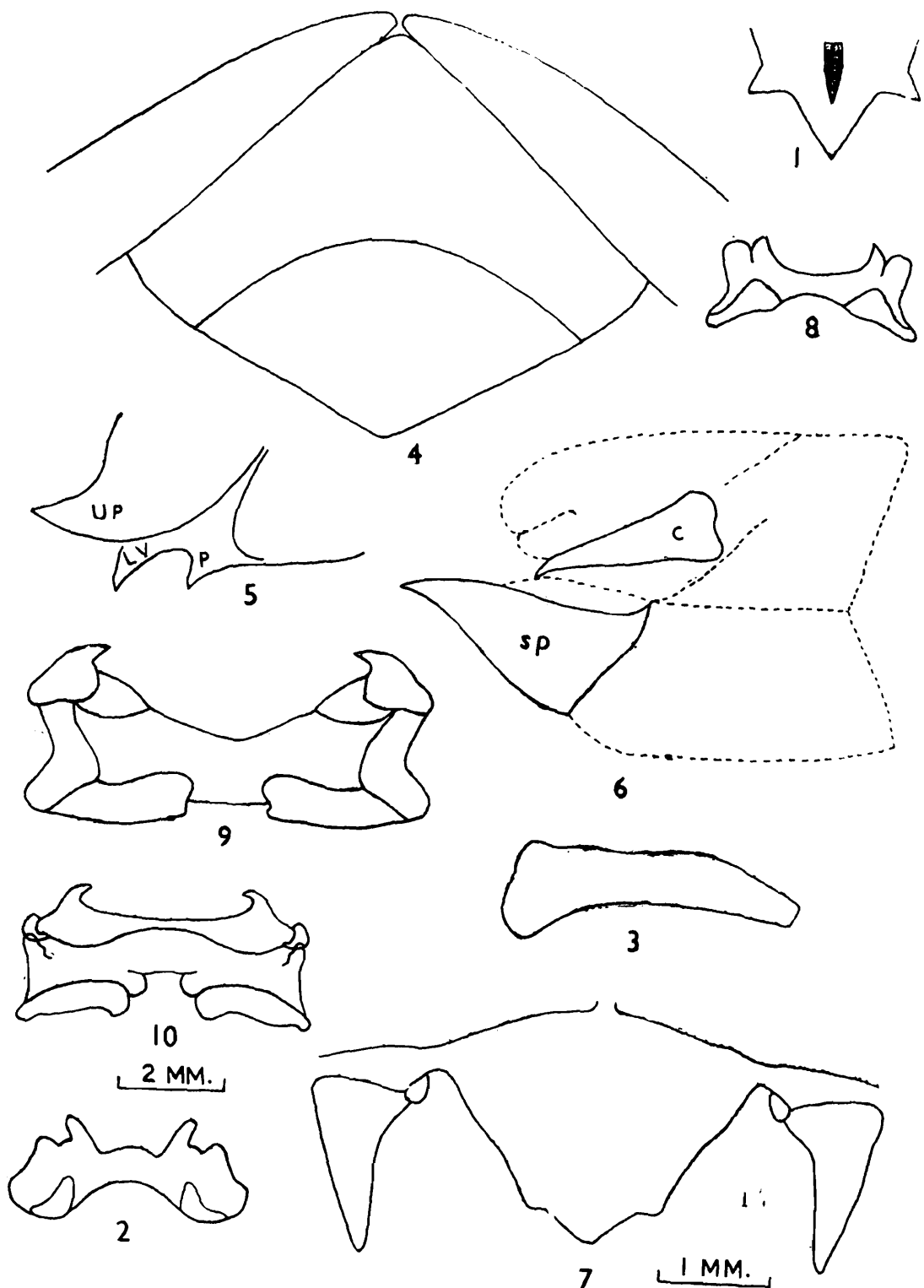
Also from -3 ♂, 1 ♀ (& 1 nymph) ; Bagauri, Belgaum dist., 20.6.80 ; M. Prasad. 2 ♂, 1 ♀ ; Gandhi Nagar, Belgaum dist., 28.9.80 ; M. Prasad. 2 ♂ ; Kittur, Belgaum, 27.6.80 ; M. Prasad. 1 ♀ ; Sukiapokri, Darjeeling, 29.6.80 ; P. Haldar.

Remarks : A very common pest of our agricultural crops found throughout oriental region and extends up to Australia. Recently Hollis (1968) has revised the genus.

Genus (9) **Trilophidia** Stål, 18739. **Trilophidia annulata** (Thunberg, 1815)

Gryllus annulatus Thunberg, 1815. *Mem. Acad. Sci. St. Petersb.*, 5 : 235.

Material : H. P. : 1 ♂ ; Near Lake, Bilaspur, 29.9.80. 3 ♀ ; River side, Mandi, 23.9.80. 3 ♂, 1 ♀ ; Chakkar, Mandi, 20.9.80. 2 ♂, 1 ♀ ; Pandoh, Mandi, 18.9.80. 2 ♂ ; Bilaspur, 29.9.80.



Paraconophyma scabra, male.

Text-fig. 1. Apical portion of supra-anal plate, dorsal view.

Pachyacris violascens, male.

Text-fig. 2. Epiphallus, dorsal view.

Pachyacris vinosa, female.

Text-fig. 3. Anal cercus, lateral view.

Text-fig. 4. Supra-anal plate, dorsal view.

Pachyacris vinosa, male.

Text-fig. 5. Oviposital valves, lateral view. (U. V.—Upper valve ; L. V.—Lower valve ; P.—ventral projection).

Text-fig. 6. Anal cercus (C) and sub-genital plate (S. P.), lateral view.

Text-fig. 7. Supra-anal plate and anal cercus, dorsal view (1, 3, 4, 5, 6 and 7 same scale).

Choroedocus illustris, male.

Text-fig. 8. Epiphallus, dorsal view.

Heteracris nobilis, male.

Text-fig. 9. Epiphallus, dorsal view.

Text-fig. 10. Epiphallus, dorsal view (2, 8, 9 and 10 same scale).

Also from -1 ♂ ; Anmod, Belgaum dist., 24.6.80 ; M. Prasad. 1 ♂ ; Rango, Andhrikhola, Darjeeling, 5.7.79 ; P. Haldar & Party. 1 ♂ ; Naxalbari, Bijohnagar Tea Estate, Darjeeling, 19.6.79 ; P. Haldar.

Remarks : A common grasshopper found throughout oriental region.

Genus (10) *Oedaleus* Fieber, 1853

10. *Oedaleus abruptus* (Thunderg, 1815)

Gryllus abruptus Thunberg, 1815. *Mem. Acad. Sci, St. Petersb.*, 5 : 233.

Material : H. P. : 1 ♂, 1 ♀ ; Kunihar, Solan ; 19.9.70. 6 ♂, 2 ♀ ; Sundar Nagar, Bilaspur ; 2.10.80. 1 ♂, 1 ♀ ; River side, Mandi, 23.9.80, J. & K. : 1 ♂, 1 ♀ ; Jammu Tawi, 12.9.79.

Also from -1 ♂ ; Kittur, Belgaum dist ; 27.6.80. ; M. Prasad.

Remarks : A common Indian species, usually found in rocky areas near river beds. Also known from Sri Lanka, China and Eastern Nepal. Lately Ritchie (1981) has revised the genus.

Measurements : Length of body ♂ 12.5-13.5-17, ♀ 18.5-20.5-21.5 ; antennal length ♂ 8-8.8-9, ♀ 8-9-10 ; head length ♂ 2-2.2-2.6, ♀ 2.7-2.8-3 ; maximum width of head ♂ 1.4-1.5-1.8, ♀ 2-2.2-2.3 ; maximum width of face ♂ 1.8-2.1-2.3, ♀ 2.8-2.9-3 ; minimum width of interocular distance ♂ .6-.8-.9, ♀ 1-1.1-1.2 ; width of frontal ridge at median ocellus ♂ .4, ♀ .4-.6 ; pronotal length ♂ 2.9-3, 3-3.3, ♀ 3.8-4-4.2 ; length of prozona ♂ 1.3-1.4-1.5, ♀ 1.5-1.7-1.8 ; length of metazona ♂ 1.5-1.8-1.9, ♀ 2.2-2.4-2.5 ; maximum width of pronotum ♂ 2.4-3, 3-6, ♀ 3.2-3.4-3.6 ; minimum width of pronotum ♂ 1.4-1.6-1.8, ♀ 2.2-2.4-2.5 ; length of tegmen ♂ 14-15-16.5, ♀ 20-21.22 ; maximum width of tegmen ♂ 2.8-3-3.2, ♀ 3.2-3.8 ; length of hind femur ♂ 9-10-11, ♀ 11.8-12.5-13 ; maximum depth of hind femur ♂ 1.8-2-2.5, ♀ 3-3.2-3.4 ; length of post. tibia ♂ 7.5-8.5-9, ♀ 10-19.5-11.

Genus (11) *Gastrimargus* Saussure, 1884

11. *Gastrimargus africanus africanus* (Saussure, 1888)

Oedaleus (*Gastrimargus*) *marmoratus* var. *africana* Saussure, 1888. *Mem. Soc. Phys. Hist. nat. Geneve*, 30 (1) : 39.

Gastrimargus africanus africanus : Ritchie, 1982, *Bull. Br. Mus. nat. Hist. (Ent.)*, 44 (4) : 248.

Material : H. P. : 5 ♂, 1 ♀ ; Glen, Simla, 12.9.80. 1 ♂ ; River side, Mandi, 23.9.80. 1 ♀ ; Vaist, Manali, 25.9.80.

Remarks : A very common Indian subspecies.

Genus (12) **Scintharista** Saussure, 1884

12. **Scintharista blanchardiana** (Saussure, 1888)

Quiroguesia brullei, var. *blanchardiana* Saussure, 1888. *Mem. Soc. Phys. Hist. nat. Geneve*, 30 (1) : 35.

Quiroguesia blanchardiana : Kirby, 1914. *Fauna British India, Orth.*, 1 : 133, fig. 96.

Material : H. P. : 1 ♀ ; Pandoh, Mandi dist.. H. K. Bhowmik & party. 1 ♀ ; Arki Solan, 17.9.70 ; M. Chandra.

Remarks : The specimens tally nicely with the description and the figure given by Kirby (1914), but it is a rare species which has not been recorded for the region since 1914.

The species was previously known from N. W India and Bombay and also from Somaliland, Arabia and Palestine.

Kirby gives very brief measurements of the species as "Length 23-43 ; expanse of wings 45-78." So we add below detailed measurements of the specimen.

Measurements : Length of body 42 ; antennal length 16 ; head length 5.2 ; maximum width of head 6 ; maximum width of face 6.5 ; minimum width of interocular distance 3.5 ; width of frontal ridge at median ocellus 8 ; pronotal length 10 ; length of prozona 5 ; length of metazona 5 ; maximum width of pronotum 7 ; minimum width of pronotum 6 ; length of tegmen 36 ; maximum width of tegmen 8 ; length of posterior femur 24 ; maximum depth of posterior femur 7 ; length of post. tibia 20.2 (measured one female).

Genus (13) **Sphingonotus** Fieber, 1852

*13. **Sphingonotus longipennis** Saussure, 1884

Sphingonotus longipennis Saussure, 1884. *Mem. Soc. Phys. Hist. nat. Geneve*, 28 (9) : 197, 203.

Material : H. P. : 4 ♂, 5 ♀ ; River side, Mandi, 23.9.80. 3 ♂, 2 ♀ ; Drang, Mandi, 21.9.80. 1 ♂, 1 ♀ ; Pandoh, Mandi, 18.9.80. J. & K. : 1 ♂, 2 ♀ ; Bhadawar, 21.9.76.

Remarks : The specimens at hand are smaller than the measurements given for the type (viz., length 32-35 ; expanse of tegmina 62-79). [The tegminal measurement given in Kirby (1914) (p. 157, fig. 100) is wrong.]

Detailed measurements and additional description of the species are given elsewhere by the authors (Bhowmik & Haldar, yet unpublished). However, it is a new record from H. P.

Subfamily OXYINAE

Genus (14) *Oxya* Serville, 183914. *Oxya hyla hyla* Serville, 1831

Oxya hyla Serville, 1831. *Annls. Sci. nat.*, **22** : 287.

Oxya hyla hyla : Hollis, 1971. *Bull. Br. Mus. nat. Hist. (Ent.)* **26** (7) : 282-284, figs. 1-11, 12-14, 18, 21, 27-32, 41-46, 54.

Material : H. P. : 5♂, 10♀ ; Vaist, Manali, Kulu dist., 25.9.80. 3♂, 1♀ ; Mandi river side, Mandi, 23.9.80. 1♂ ; Drang, Mandi, 21.9.80. 2♀ ; Pandoh, Mandi, 18.9.80.

Remarks : This subspecies is a common grasshopper of India, Sri Lanka and African countries. It is a highly variable subspecies and the specimens at hand show all intermediate grades specially in respect to male cerci. Hollis's (1971) revision of it, however, thoroughly summarises its morphology.

15. *Oxya velox* (Fabricius, 1787)

Gryllus velox Fabricius, 1787. *Mant. Ins.*, **1** : 239.

Material : H. P. : 2♀ ; Drang, Mandi, 21.9.80. 3♀ ; Vaist, Manali, 25.9.80.

Also from—W. B. : 2♀ ; Sankril, Hooghly, 22.7.80 ; P. Haldar.

Remarks : It is a very common Indian grasshopper. Hollis's (1971) revisional work adequately describes its morphology.

Subfamily HEMIACRIDINAE

Genus (15) *Hieroglyphus* Krauss, 1877*16. *Hieroglyphus banian* (Fabricius, 1798)

Gryllus banian Fabricius, 1793. *Ent. Syst., Suppl.* : 194.

Acridium furcifer Serville, 1839. *Ins. Orth.*, : 677, pl. 14, fig. 12.

Hieroglyphus banian : Kirby, 1914. *Fauna British India, Orth.*, **1** : 204.

Material : H. P. : 11♂, 10♀ ; Pandoh, Mandi dist., 18.9.80. 6♂, 11♀ ; Chakkar, Mandi, 20.9.80. 2♂ ; Vaist, Manali, 25.9.80.

Remarks : The species was previously known from Bombay, M. P. (Bilaspur) and Burma. It is a serious pest to paddy and probably to other agricultural crops. Specimens were collected from ripe paddy fields where hundreds of them were seen feeding on the crop.

Mason's (1973) revisional work adequately describes its morphology.

Measurements : Length of body ♂ 30-31, ♀ 44-55 ; antennal length ♂ 14-17, ♀ 13-16 ; head length ♂ 3.4-3.5, ♀ 5.5-6 ; maximum width of head ♂ 3-3.2, ♀ 5-6.5 ; maximum width of face ♂ 3-3.5, ♀ 5-7 ; minimum width of interocular distance ♂ 1-1.2, ♀ 3-4 ; width of frontal ridge at median ocellus ♂ 1-1.5, ♀ 1.5-2 ; pronotal length ♂ 5.5-5.7, ♀ 8-11.5 ; length of prozona ♂ 3.5-3.6, ♀ 5-6.5 ; length of metazona ♂ 2-2.2, ♀ 3-5 ; maximum width of pronotum ♂ 4-4.5, ♀ 5.5-8 ; minimum width of pronotum ♂ 3.5-4, ♀ 5-7 ; length of tegmen ♂ 22-23, ♀ 29-30 ; maximum width of tegmen ♂ 4-4.5, ♀ 5-9 ; length of post. femur ♂ 17-17.7, ♀ 22-24 ; maximum depth of post. femur ♂ 3.5-4.8, ♀ 4-5 ; length of post. tibia ♂ 14-15, ♀ 20-22.

Genus (16) **Spathosternum** Karsch, 1877

17. **Spathosternum prasiniferum prasiniferum** (Walker, 1871)

Heteracris (?) *prasinifera* Walker, 1871. *Cat. Derm. Salt. Br. Mus.*, 5 : 65.

Material : H. P. : 2 ♂, 4 ♀ ; Pandoh, Mandi, 18.9.80. 2 ♀ ; near water supply office, Mandi, 22.9.80. 10 ♂, 4 ♀ ; near Lake, Bilaspur, 29.9.80. 3 ♂, 3 ♀ ; Chakkar, Mandi, 20.9.80. 3 ♀ ; Solan, 24.8.77.

Also numerous examples from Mandi and Bilaspur.

Remarks : A very common subspecies of grasshoppers to be met with everywhere in India.

Subfamily CATANTOPINAE

Genus (17) **Xenocatantops** Dirsh & Uvarov, 1953

*18. **Xenocatantops karnyi** (Kirby, 1910)

Catantops karnyi Kirby, 1910. *Syn. Cat. Orth.*, 3 : 483 ; Kirby 1914. *Fauna British India, Orth.*, 1 : 151-152.

Catantops pulchellus Karny (nec. Walker), 1907. *S. B. Akad. Wiss. Wien.*, 116 : 317, 339.

Xenocatantops karnyi : Jago, 1982. *Trans. Amer. ent. Soc.*, 108 (3) : 454-455, figs. 58, 59, 72, 73, 88-90.

Material : H. P. : 1 ♀ ; Konihar, Solan, 19.9.80. 1 ♀ ; Bilaspur, 2.4.72. 1 ♂, 1 ♀ ; Mandi, 19-22.9.80.

Remarks : Described from Nepal (Termani), the species is now known from northern, western and southern India.

The specimens at hand agree nicely with the known description and is distinctly separable from all other species of the genus by its posterior femora being with a row of black dots on the lower outer carina for the whole length.

18. **Xenocatantops humilis** (Serville, 1839)

Acridium humile Serville, 1839. *Ins. Orth.* : 662.

Material : H. P. : 1 ♂, 6 ♀ ; P. W. D. Rest House, Mandi, 17.9.80. 1 ♀ ; Arki, Solan, 24.10.71.

Remarks : A species of sub-tropical areas ranging into hills, up to about 2000 m. (eg. Kurseong). Jago (1982 : 455) gives its differential diagnosis.

Genus (18) **Catantops** Schaum, 185320. **Catantops pinguis innotabilis** (Walker, 1870)

Acridium innotabile Walker, 1870. *Cat. Derm. Salt. Br. Mus.*, 3 : 629.

Material : H. P. : 4 ♂, 8 ♀ ; Drang, Mandi, 21.9.80. 4 ♂, 17 ♀ ; Pandoh, Mandi, 18.9.80. 3 ♀ ; PWD Rest House, Mandi, 17.9.80. 3 ♂ ; Near water supply office, Mandi, 22.9.80. 1 ♂, 6 ♀ ; Dhungri, Manali, Kulu dist., 27.9.80.

Remarks : The subspecies is very common in the Nengrahar province of Afganistan (Cejchan, 1969 : 250), India, Sri Lanka, China and Korea (?).

Genus (19) **Paraconophyma** Uvarov, 1921*21. **Paraconophyma scabra** (Walker, 1870)

(Text-figs. 1, 2, 14)

Catoptenus scaber Walker, 1870. *Cat. Derm. Salt. Br. Mus.*, 4 : 707.

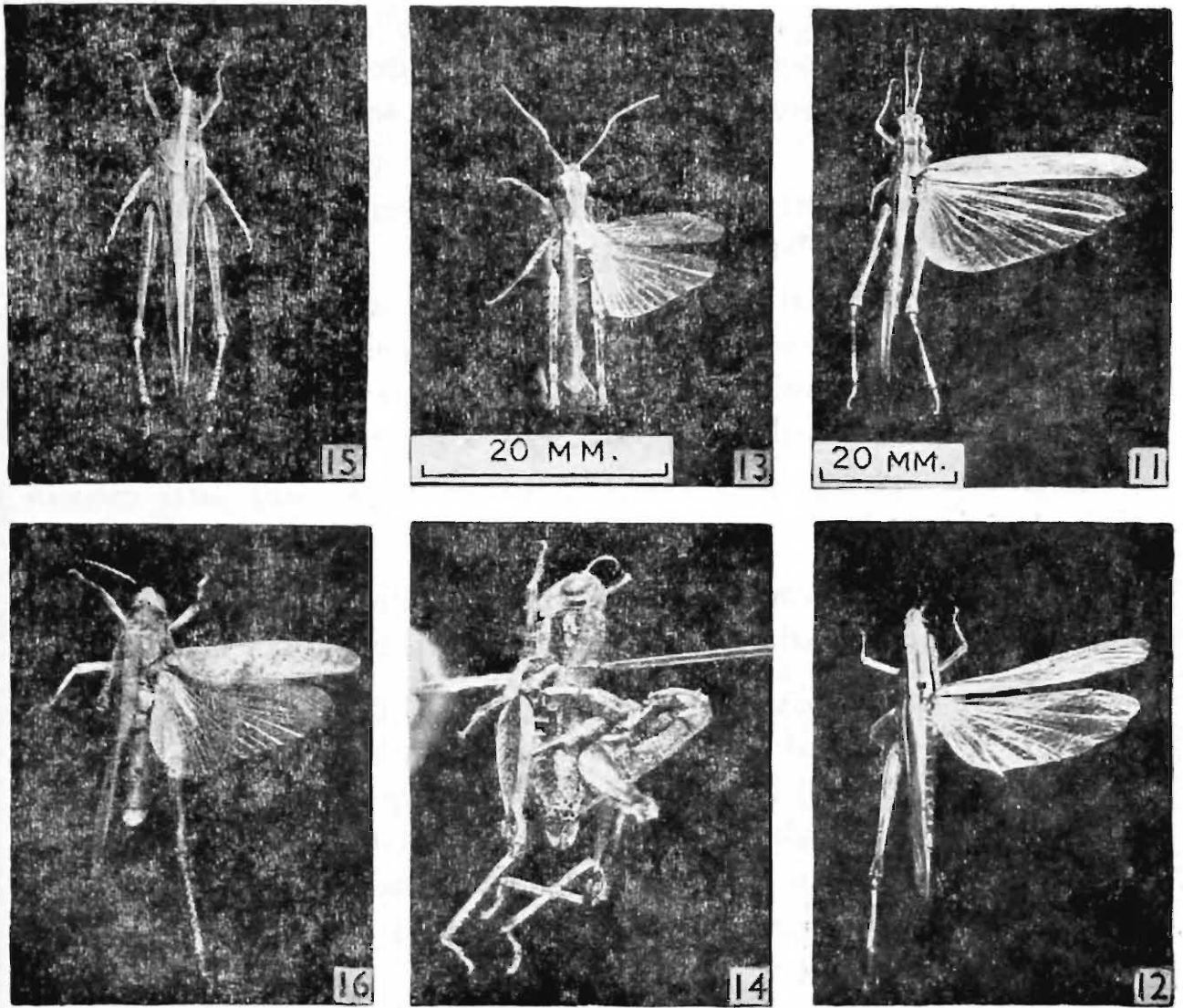
Mesambria scabra : Kirby, 1914. *Fauna British India, Orth.*, 1 : 221.

Paraconophyma scabra : Uvarov, 1921. *Ann. Mag. nat. Hist.*, 7 (9) : 501-502.

Material : H. P. : 20 ♂, 18 ♀ ; Glen, Simla, 12.9.80. 1 ♂ ; Rohtang Jot, Manali, 26.9.80. 2 ♂, 3 ♀ ; Kufri, Simla, 15.9.80. 1 ♂ ; Solan, 13.8.80. 1 ♀ ; Solan, 9.9.86. 1 ♂, 1 ♀ ; Near Water Supply Office, Mandi, 22.9.80.

Remarks : The species (♀) was described from Burdwan (W. B.) and was later recorded from Mussoorie and Kumaon (U. P.). It is now recorded from the H. P. and J. & K. where it is rather very common and abundant.

From the distribution records of the species, it shows that the species exhibits good ecological tolerance. From the subtropical semi evergreen locality of the type, it is now known in the western Himalayas where it is subjected to severe cold, scanty annual rainfall and winter snow in barren, cold and windy places like Rohtang Jot (alt. above 3965 m.).



Profiles of—

Text-fig. 11. *Sikkimiana darjeelingnensis*, female.

Text-fig. 12. *Orthochtha indica*, female. (11, 12 and 19 same scale)

Text-fig. 13. *Chorthippus* (*Glyptothrus*) *hammerstroemi*, male.

Text-fig. 14. *Paraconophyma scabra*, male and female in natural copulating pose. (13, 14, 21 same scale).

Text-fig. 15. *Pachyacris violascens*, female.

Text-fig. 16. *Pachyacris vinosa*, female. (15, 16 same scale).

During September many pairs were observed in copulation.

Though the specimens at hand tally fairly well with the known description, opportunity for additional description is taken here.

Additional description : Males : Antennae filiform, as long as head and pronotum together. A median carinula divides fastigium and continues back over vertex. Metazona less than half of prozona. First and second transverse sulcus of pronotal disc sometimes actually not crossing median carina. Mesosternal interspace longer than broad ; sides lightly divergent in posterior half. Male cercus short, conical ; supra-anal plate longitudinally sulcate in middle, with angulated apex and with

one lateral, spine-like projection on each side (Text-fig. 1), about two-thirds along its length ; subgenital plate rounded and strongly upcurved. Epiphallus (of specimen from Rohtang) as figured (2). Posterior tibiae greenish or slightly very pale yellowish, with 7 to 8 external and 8 to 9 internal spines.

Legs densely pilose, less so on lateral pronotal lobes and ventral parts of body and abdomen.

Females : Identical to males except larger in size and differences in genital parts. Supra-anal plate almost tongue-shaped with a curved transverse sulcus two-thirds along its length and with a median longitudinal groove in basal half. Ovipositor valves short, curved.

In some specimens from Simla, posterior tibiae and tarsi reddish instead of greenish.

Discussion : The two distinctive, brown, transverse, femoral bands indicated in the original description were not visible in our material.

Measurements : Length of body ♂ 14-15, ♀ 19-20 ; antennal length ♂ 7-7.5, ♀ 4-7 ; head length ♂ 3-3.2, ♀ 2.2-3 ; maximum width of head ♂ 3-3.1, ♀ 2.2-3 ; maximum width of face ♂ 3-3.1, ♀ 3 ; minimum width of interocular distance ♂ 1-1.2, ♀ 1-1.1 ; width of frontal ridge at median ocellus ♂ .8-.9, ♀ .8-.9 ; pronotal length ♂ 4-4.2, ♀ 4.5-5 ; length of prozona ♂ 3-3.2, ♀ 3-3.5 ; length of metazona ♂ 1-5, ♀ 1.5-2 ; maximum width of pronotum ♂ 3.5-3.75, ♀ 5-5.5 ; minimum width of pronotum ♂ 2.5-2.8, ♀ 4-4.2 ; length of post. femur ♂ 9-10, ♀ 10-11 ; maximum depth of post. femur ♂ 3-3.5, ♀ 3.8-4, length of post. tibia ♂ 7-7.5, ♀ 8-9.

Subfamily—CYRTACANTHACRIDINAE

Genus (20) *Chondracris* Uvarov, 1923

*22. *Chondracris rosea* (de Geer, 1773)

Acrydium roseum de Geer, 1773. *Mem. Ins.*, 3 : 488, pl. 41, fig. 1.

Cyrtacanthacris rosea : Kirby, 1914. *Fauna British India, Orth.*, 1 : 281.

Chondracris rosea : Uvarov, 1923. *Ann. Mag. nat. Hist.*, 11 (9) : 189 ; Tandon, 1975 : *Dr. B. S. Chauhan Comm. Vol.* : 395-402.

Material : H. P. : 1 ♀ ; Pandoh, Mandi, 18.9.80. 2 ♂, 1 ♀ (and 2 nymphs) ; P. W. D. Rest House, Mandi, 17.9.80.

Remarks : As in Darjeeling, this species was seen hovering over wild herbs bordering on the bank of the river Beas. It is a new record for H. P.

Genus (21) **Pachyacris** Uvarov, 1923

*23. **Pachyacris violascens** (Walker, 1870)

(Text-figs. 3, 15)

Acridium violascens Walker, 1870. *Cat. Derm. Salt. Br. Mus.*, 3 : 387.

Orthacanthacris violascens : Kirby, 1914. *Fauna British India, Orth.*, 1 : 229.

Pachyacris violascens : Uvarov, 1923. *Ann. Mag. nat. Hist.*, 11 (9) : 478 ; Uvarov, 1927. *Spolia zeylan.*, 14 (1) : 112.

Material : H. P. : 1 ♀ ; Chakkar, Mandi, 20.9.80. 1 ♂ ; Vaist, Manali, 25.9.80.

Remarks : The species was previously recorded from Sri Lanka and Karnatak. It is recorded here from North western India for the first time.

In our material pronotal prozona is shorter than metazona, latter having its posterior margin markedly more rounded than in typical series of *P. vinosa*. Lateral pronotal lobes compressed at prozonal area. Pronotal disc almost saddle-shaped ; median carina thin, low, interrupted by punctuation. Tegmina sub-hyaline, brownish spots indistinct ; violet colour of wing not detectable. Posterior tibia pale bluish, with 8 to 9 internal and 11 to 12 external whitish, black tipped spines. Male cercus laterally compressed, widen, gradually and regularly narrowed posteriorly, apex pointed, incurved (Text-fig. 3). Subgenital plate laterally compressed, acute pointed, upcurved, long. Prosternal spine cylindrical.

*24. **Pachyacris vinosa** (Walker, 1870)

(Text-figs. 4-8, 16)

Acridium vinosum Walker, 1870. *Cat. Derm. Salt. Br. Mus.*, 3 : 588.

Cyrtacanthacris wingatei Kirby, 1900. *Ann. Mag. nat. Hist.*, 7 (6) : 381.

Orthacanthacris vinosa : Kirby, 1914. *Fauna British India, Orth.*, 1 : 288.

Pachyacris vinosa : Uvarov, 1923. *Ann. Mag. nat. Hist.*, 11 (9) : 478 ; Uvarov, 1927. *Rec. Indian Mus.*, 29 (4) : 236.

Material : H. P. : 1 ♂, 3 ♀ ; Pandoh, Mandi dist., 18.9.80. 1 ♂ ; P. W. D. Rest House, Mandi, 17.9.80. 1 ♀ ; Mandi 19.9.80.

Remarks : More or less distributed throughout India (W. B. including North Bengal ; Lushi Hills ; Ajhal ; Kumaon ; Chota Nagpur) ; Nepal (Monda) ; and also in China and Burma. It is however, a new record for H. P.

The specimens at hand provide opportunity for addition of some morphological characters.

Eyes elongated, lateral and in male with 8 clear longitudinal stripes. Pronotum somewhat tectiform; metazona distinctly shorter than prozona, its posterior margin broadly angulated. Posterior tibia with 11 internal (in both sexes) and 6 external (in female) and 7 external (in males) spines; spines yellowish in one side but their tips and backsides black; internal spines usually longer. Female supra-anal plate transverse, broadly angulated apically (Text-fig. 4); valves of ovipositor short, curved; lower valves with a pair of ventral projections (Text-fig. 5). Male cerci conical, thin, very acute, spinelike, incurved (Text-fig. 6). Subgenital plate compressed, short, acutely pointed (Text-fig. 6). Supra-anal plate and epiphallus as in Text-figures 7 and 8. Prosternal spine pyramidal.

Posterior margin of head (bordering pronotum) of vermillion colour. Body pilose.

Subfamily EYPREPOCNEMIDINAE

Genus (22) **Choroedocus** Bolivar, 1914

* 25. **Choroedocus illustris** (Walker, 1870)
(Text-figs. 9, 17, 18)

Heteracris illustris Walker, 1870. *Cat. Derm. Salt. Br. Mus.*, 4 : 622, 623.

H (eteracris) illustris : Kirby, 1910. *Syn. Cat. Orth.*, 3 : 555.

Heteracris illustris : Kirby, 1914. *Fauna British India, Orth.*, 1 : 263.

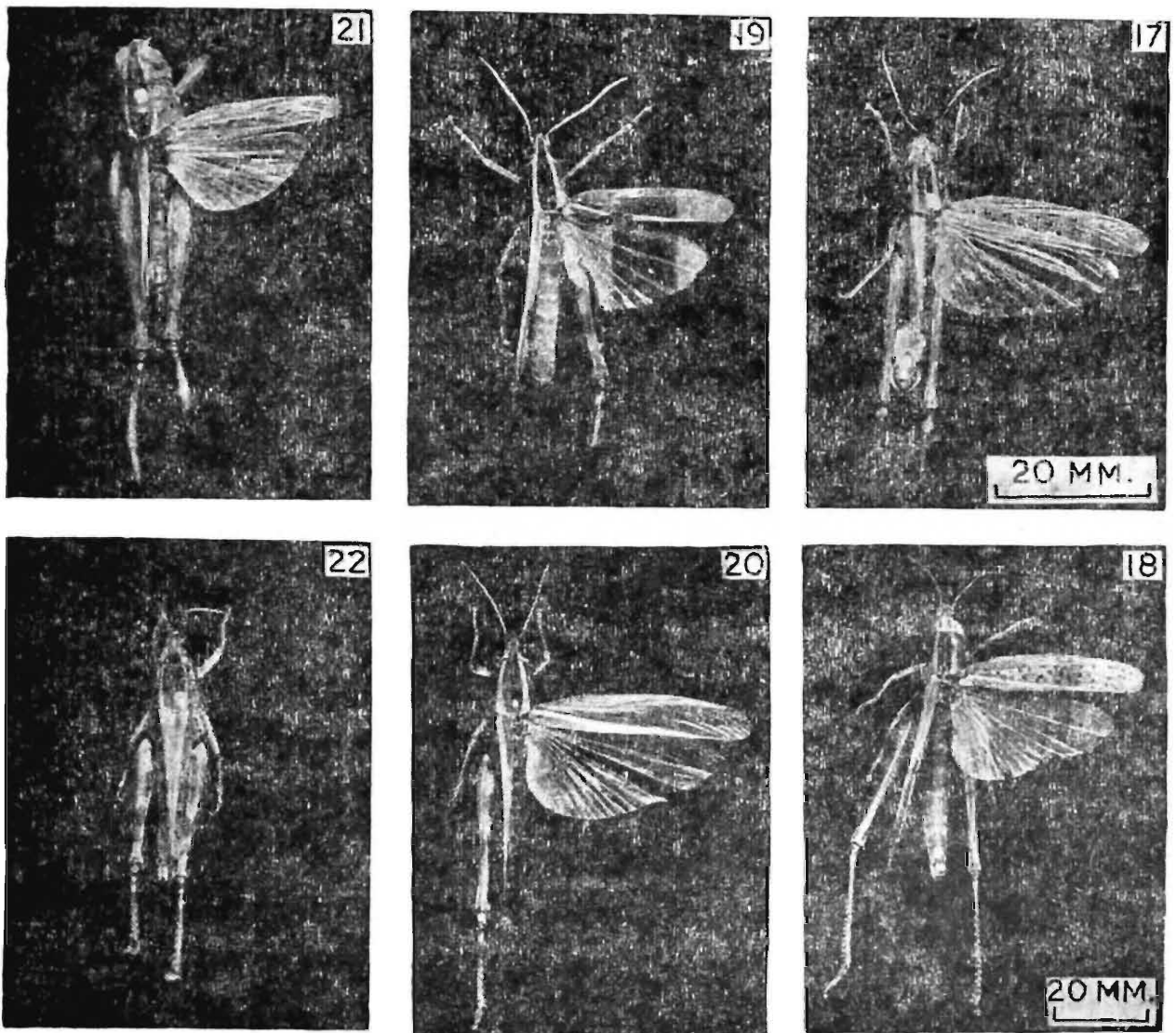
Choroedocus illustris : Uvarov, 1921. *Trans. R. ent. Soc. Lond.*, 69 (1 & 2) : 109.

Material : H. P. : 4 ♂, 4 ♀ ; Mandi, 17-19.9.80. 2 ♂, 1 ♀ ; Pandoh, Mandi, 18.9.80. 4 ♂, 3 ♀ ; P. W. D. Rest House, Mandi, 20-22.9.80. 1 ♂ ; Drang, Mandi, 21.9.80. 1 ♂ ; Solan, 8.12.75.

Remarks : Description of this species was based on a single female from South India. Later Uvarov (1921) referred to 1 ♂, 2 ♀ from India without mentioning exact locality data.

The availability of the present series of specimens from Mandi is, therefore, not only very interesting from zoogeographical point of view but also provides scope to fill up the lacunae of taxonomic features of the species.

Males (previously undescribed) : Size moderate (Text-fig. 17). Antennae filiform, such longer than head and pronotum taken together. Fastigium of vertex distinctly depressed, obtusely and roundedly angulate in front, laterally carinated and curved inwards in between eyes, a median carinula starts from middle of it and continues backwards to vertex. Frontal ridge constricted just below vertex and then gradually widened towards clypeus, punctured but hardly sulcate. Pronotum tri-



Text-fig. 17. *Choroedocus illustris*, male. (17, 22 same scale).

Text-fig. 18. *C. illustris*, female.

Text-fig. 19. *Heteracris nobilis*, male.

Text-fig. 20. *H. nobilis*, female. (18, 20 same scale).

Text-fig. 21. *Eyprepocnemis rosea*, male.

Text-fig. 22. *E. rosea*, female.

carinate, but lateral carinae distinct only up to end of prozona, in metazona it is obsolete or indicated by irregular punctuation only; prozona shorter than metazona; three transverse, equidistant, clear sulci cross pronotal disc. Prosternal tubercle cylindrical, slightly inclined back; mesosternal interspace longer than wide, lobes with their angles at inner margin rounded; metasternal lobes contiguous. Tegmina a little surpassing posterior femora, subhyaline, with rounded apices and elongated cells at radial sector; with small scattered brownish dots throughout disc excluding costal and anal areas. Wings a little shorter than tegmina, bluish basad and hyaline in remaining area. Abdominal tip highly inflated. Supraanal plate and cercus typical for the genus. Subgenital plate conical, upcurved. Epiphallus as in

Text-fig. 9. Posterior femora yellowish except sides of "knees" which are slightly dark at sides ; slender, apical half filiform ; posterior tibiae as long as femora, uniformly light rose in colour, with 11 internal and 12 external yellowish-white spines, tipped with black ; internal spines more longer than external ones. Legs pilose, posterior tibiae more densely.

Females : Identical to males. External spines of posterior tibiae varies from 12 to 14 in number. Description of colour patterns of both sexes agrees broadly with Walker's narration.

Sexual dimorphism in size of this species is very striking.

Measurements : Measurements of type (♀), as given by Kirby (1914), is as follows :- Length of body 70 ; posterior femur 43 ; expanse of tegmen 116.

The present series shorter than the type and measure as follows :—

Length of body ♂ 30-34, ♀ 51-60 ; antennal length ♂ 12-13, ♀ 17-18 ; head length ♂ 4-4.5, ♀ 5-6 ; maximum width of head ♂ 3.8-4, ♀ 4.8-5.8 ; maximum width of face ♂ 4-4.25, ♀ 6-7 ; minimum width of interocular distance ♂ 1.5-2, ♀ 2.8-3 ; width of frontal ridge at median ocellus ♂ 1-1.5, ♀ 1.8-2 ; pronotal length ♂ 6-6.25, ♀ 10-11 ; length of prozona ♂ 3.8-4, ♀ 5.5-6 ; length of metazona ♂ 2.2-2.5, ♀ 4.5-5 ; maximum width of pronotum ♂ 4.5-5, ♀ 7-8 ; minimum width of pronotum ♂ 4-4.2, ♀ 5.5-6 ; length of tegmen ♂ 24-27, ♀ 42-46 ; maximum width of tegmen ♂ 4-4.5, ♀ 7-8.8 ; length of post. femur ♂ 19-21, ♀ 33-34 ; maximum depth of post. femur ♂ 4-4.5, ♀ 6-7 ; length of post. tibia ♂ 17-19, ♀ 29-31.

Genus (23) *Heteracris* Walker, 1870

*26. *Heteracris nobilis* (Uvarov, 1942)

(Text-figs. 10, 19, 20)

Thisiocetrus nobilis Uvarov, 1942. *Ann. Mag. nat. Hist.*, 9 (11) : 596.

Heteracris nobilis : Dirsh, 1958. *Tijdschr. Ent.*, 101 : 54.

Material : H. P. : 4♂, 2♀ ; Pandoh, Mandi, 18.9.80. 4♂, 4♀ ; Drang, Mandi, 21.9.89. 8♂, 3♀ ; P. W. D. Rest House, Mandi, 17.9.80. 1♀ ; Vaisti, Manali, 25.9.80.

Remarks : This species must be very close to *H. pulchra* (Bolivar, 1902) from which it differs chiefly in the absence of brownish spots on the tegmina. The tegmina of *pulchra*—are with fairly defined brownish spots which are more or less confluent. But in the present species it is spotless.

The epiphallaus of male genitalia is added here for the first time (Text-fig. 10). Otherwise the species tally nicely with the original description of Uvarov (1942).

The species is recorded here for the first time from a place other than its type locality Baluchistan and Sind (Pakistan); Lyallpur (Punjab).

Measurements : Length of body ♂ 29-30.5, ♀ 58-60 ; antennal length ♂ 13.5-15, ♀ 17-18 ; head length ♂ 3.8-4, ♀ 5.8-6 ; maximum width of face ♂ 3-3.25, ♀ 5-5.3 ; maximum width of face ♂ 4-4.1, ♀ 6-6.2 ; minimum width of interocular distance ♂ 1.2-1.5, ♀ 2.2-2.5 ; width of frontal ridge at median ocellus ♂ 1.2-1.5, ♀ 2-2.5 ; pronotal length ♂ 5.8-6.5, ♀ 11-11.1 ; length of prozona ♂ 3-3.5, ♀ 5.5-5.6 ; length of metazona ♂ 2.8-3, ♀ 5.5-5.75 ; maximum width of pronotum ♂ 4-4.2, ♀ 7-7.5 ; minimum width of pronotum ♂ 3.5-3.6, ♀ 5-5.2 ; length of tegmen ♂ 24-29, ♀ 41-44 ; maximum width of tegmen ♂ 4-5, ♀ 7-8 ; length of post. femur ♂ 19-22, ♀ 32-33 ; maximum depth of post. femur ♂ 4-5, ♀ 7-7.5 ; length of post. tibia ♂ 16-19, ♀ 30-31.

Genus (24) *Eyprepocnemis* Fieber, 1853

27. *Eyprepocnemis rosea* Uvarov, 1942

(Text-figs. 21, 22)

Eyprepocnemis roseus Uvarov, 1942. *Ann. Mag. nat. Hist.*, 9 (11) : 597, fig. 4 R.

Eyprepocnemis rosea : Dirsh, 1958. *Proc. R. ent. Soc. Lond.*, (8) 27 (3-4) : 42, fig. 7.

Material : H. P. : 1 ♂, 2 ♀ ; P. W. D. Rest House, Mandi, 17.9.80. 2 ♂, 2 ♀ ; Mandi, 23.9.80. 3 ♂, 3 ♀ ; Water supply office, Mandi, 18.9.80. 5 ♂, 2 ♀ ; Chakkar, Mandi, 20.9.80. 2 ♀ ; Drang, Mandi, 22.9.80. 3 ♂, 6 ♀ ; Pandeh, Mandi, 18.9.80. 5 ♂, 2 ♀ ; Chakkar, Mandi, 20.9.80. 2 ♀ ; Drang ; Mandi, 21.9.80. 1 ♂, 2 ♀ ; River side, Mandi, 23.9.80. 1 ♂, 4 ♀ ; Pandeh, Mandi, 18.9.80. 6 ♂, 7 ♀ ; Mandi, 17-23.9.80. 1 ♂, 2 ♀ ; Deoghat and its vicinity, Solan, 8.11.73. 16 ♂, 12 ♀ ; Saproon, Solan, (on difference dates). 3 ♂, 1 ♀ (and 2 nymphs) ; Solan, 8.10.76. 6 ♂, 2 ♀ ; Solan, 22.11.76.

Remarks : The species was described from Simla, Dehra Dun and Shillong. We have noticed it throughout H. P. as a very common grasshopper in almost all habitats. During September we observed innumerable pairs in copulation (by mounting). Some of the females were found already gravid. Early instar nymphs were also collected.

The original description of the species holds good for the specimens at our disposal. Shortened tegmina, wings with red tinge basad and red coloured posterior tibiae are distinguishing characteristics for spot identification of the species.

Photos of both male and female added here for the first time.

Measurements : Length of body ♂ 18.2-19, ♀ 25-29 ; antennal length ♂ 8-8.5, ♀ 9-10 ; head length ♂ 2.5-3, ♀ 3.8-4 ; maximum width of head ♂ 2.2-2.8, ♀ 3-3.5 ; maximum width of face ♂ 2.5-2.6, ♀ 4-4.3 ; minimum width of interocular distance ♂ .6-.8, ♀ 1.5-1.7 ; width of frontal ridge at ocellus ♂ 1-1.2, ♀ 1-1.5 ; pronotal length ♂ 3.9-4, ♀ 5.2-5.5 ; length of prozona ♂ 2.3-2.4, ♀ 3-3.2 ; length of metazona ♂ 1.5-1.7, ♀ 2-2.5 ; maximum width of pronotum ♂ 3-3.5, ♀ 4-4.2 ; minimum width of pronotum ♂ 2.5-3.1, ♀ 3.5-3.7 ; length of tegmen ♂ 12-13, ♀ 16-17 ; maximum width of tegmen ♂ 3-3.2, ♀ 3-3.4 ; length of post. femur ♂ 12-12.5, ♀ 16-17 ; maximum depth of post. femur ♂ 3-3.5, ♀ 4.2-4.5 ; length of post. tibia ♂ 10-10.5, ♀ 13.5-14.

Genus (25) *Tylotropidius* Stål, 1873

*28. *Tylotropidius varicornis* (Walker, 1870)

Heteracris varicornis Walker, 1870. *Cat. Derm. Salt. Br. Mus.*, 4 : 667.

Tylotropidius ceylonicus Brunner, 1893. *Annali Mus. Civ. Stor. nat Genova, Giacomo Doria, Ser. 2*, 13 (33) : 164, pl. 5, fig. 57.

E. (uprepocnemis) varicornis : Kirby, 1910. *Syn. Orth. Cat.*, 3 : 561.

Tylotropidius varicornis : Kirby, 1914. *Fauna British India, Orth.*, 1 : 265, fig. 140.

Material : H. P. : 3 ♂, 3 ♀ ; Saproon, Solan ; 15.11.76. 1 ♂ ; Deoghat, Solan ; 27.12.73. 1 ♂ ; Dharidural, Solan ; 5.11.74. 4 ♂ ; Solan, 15.11.76. 1 ♀ ; Solan, 5.4.77. 2 ♂ ; Solan, 31.12.76. 1 ♀ ; Solan, 17.2.77. 1 ♂, 1 ♀ ; Solan, 6.5.71.

Remarks : The species is common in South India, Sri Lanka, Burma and Nepal. It is also very abundant in Solan district (H. P.).

Other details of the species are given by us elsewhere.

Family PYRGOMORPHIDAE

Tribe TAPRONOTINI

Subtribe AULARCHINA

Genus (26) *Aularches* Stål, 1873

*29. *Aularches punctatus* Drury, 1773

Gryllus (Locusta) punctatus Drury, 1773, *Ill. Exot. Ent.*, 2, fig. 4.

Aularches punctatus : Kirby, 1914. *Fauna British India, Orth.*, 1 : 169, fig. 112.

Material : H. P. : 7 ♂, 1 ♀ ; Near Water Supply Office, Mandi, 22.9.80. 4 ♂, 11 ♀ ; Mandi, 19.9.80. 1 ♀ ; Sallaghat, Bilaspur, 30.9.80.

Remarks : This species was known from Tibet ; Kashmir ; Garhwal (U. P.) and also from Malaya and Java. It is recorded here for the first time from the H. P.

The species was found to be abundant on the hill at Mandi P. W. D. Rest House. This locality is situated in a subtropical zone, at an altitude not more than 1200m, with very rare winter snow. The specimens of the species were very lethargic, and unlike other grasshoppers, were incapable of jumping even though touched. They remained still, making a low hissing sound while emitting white froth from their thoracic regions.

Specimens collected fit published information.

SUMMARY

The paper deals with the studies of grasshoppers of H. P. The material examined belongs to 28 species and subspecies, distributed over 25 genera and 7 sub-families of Acrididae. It also contains one species of the family Pyrgomorphidae. 14 species are new records from the state, 18 species are common with the eastern Himalayan fauna ; 10 species are present in H. P. but yet unreported from the eastern Himalayas. The male sex of *Choroedocus illustris* is described for the first time. Remarks of systematic value for other little known species have been provided. The zoogeographical significance of distribution of species have been analysed in brief. *Chorthippus* (*Glyptobothrus*) *hammerstroemi* is recorded here for the first time from India.

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*Denotes reference not seen in original.

RECORDS OF MOSQUITOES COLLECTED FROM JAMMU AND KASHMIR WITH ECOLOGICAL NOTES

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INTRODUCTION

Very little information has been added to the mosquito fauna of Jammu and Kashmir, particularly of higher altitudes, since the publication of monographs on Indian Anophelines (Christophers, 1933) and Culicines (Barraud, 1934) except a few subsequent communications (Jacob, 1950 ; Puri, 1948 ; Tariq, 1967, and Rao, 1981).

The present communication deals with the mosquito collections made during the survey of haematophagous arthropods in this region. Three short surveys were conducted between August 10 and 31, 1967 ; July 20 and September 1, 1968 ; and October 15 and December 10, 1969 ; under the auspices of Indian Council of Medical Research (Rao *et al.*, 1973).

The classification and nomenclature used here are mainly based on the synoptic catalogs of the mosquitoes of the world (Stone *et al.*, 1959 ; Stone and Delfinado, 1973 and Knight and Stone, 1977). Identification was done mainly on adult characters. Genital characters of males and the characters of immature stages were also taken into consideration whenever these forms were available. Additional ecological notes on the species collected are also given.

The altitudes of the collection localities are approximate.

COLLECTION RECORDS

TRIBE-ANOPHELINI

1. *Anopheles gigas simlensis* (James)

Anopheles gigas var *simlensis* (James, 1911)

In James and Liston, *Monogr. anoph. Mosq. India.*, ed. 2 : 66 ; Christophers, 1933 : 36-37 ; Knight and Stone, 1977 : 19 ; Rao, 1981 : 270-272.

This subspecies has been recorded from western Himalayas including the foothills, north west frontier region of Pakistan and Ceylon.

Present record : Baramulla dist. : 13 larvae and 1 ♀ reared from larva, collected from a seepage pool, Rampore (1450 m.), 5 Nov. '69.

2. *Anopheles lindesayi* Giles

Anopheles lindesayi Giles, 1900, Hand book, ed. 1 : 166 ; Christophers, 1933 : 123-129 ; Knight and Stone, 1977 : 22 ; Rao, 1981 : 267-268.

A montane species recorded from India, Pakistan, Nepal, U.S.S.R., Burma. In India it is found all along the Himalayas upto an attitude of about 3000 meters.

Present records : Doda dist. : 9 ♀ ♀ collected while biting human at dusk, at the edge of a forest-clad ravine, Khilani (1300 m.), 20 Nov. '69. Udhampur dist. : 5 ♀ ♀ collected from vegetation along a stream, Phalata (800 m.) one on 24 and four on 27 Nov. '69.

3. *Anopheles annularis* Van der Wulp

Anopheles annularis Van der Wulp, 1884, *Notes Leyden Mus.* 6 : 249 ; Christophers, 1933 : 300-307 ; Knight and Stone, 1977 : 34 ; Rao, 1981 : 448-452.

This species has a wide distribution in the Oriental region.

Present records : Baramulla dist. : 5 larvae and 1 ♂ reared from larva collected from a roadside seepage pool, Mitrang near Sopore (1630 m.), 24 Oct. '69. Udhampur dist. : 5 ♀ ♀ collected from vegetation along a stream, Phalata, 27 Nov. '69. Associated breeder was *An. maculatus willimorei*.

4. *Anopheles culicifacies* Giles

Anopheles culicifacies Giles, 1901, *Entomologist's mon. Mag.* 37 : 197 ; Christophers, 1933 : 197-202 ; Knight and Stone 1977 : 37 ; Rao, 1981 : 365-409.

The species has been recorded from India, Ceylon, Burma, Nepal, Thailand, Indochina, China, Pakistan, Afghanistan, Iran and around Persian Gulf. In India it is the primary vector of malaria in plains and is widely distributed. It has been recorded from many localities in Jammu province.

Present records : Udhampur dist. : 5 ♀ ♀ resting indoors, cattle shed ; 2 ♀ ♀ from vegetation along a stream, Phalata, respectively on 23 and 27 Nov. '69.

5. *Anopheles fluviatilis* James

Anopheles fluviatilis James, 1902, *Scient. Mem. Offrs. med. Sanit. Deps. India.* 2 : 31 ; Christophers, 1933 : 203-208 ; Knight and Stone, 1977 : 39-40 ; Rao, 1981 : 322-343.

The species has a wide distribution range, which includes India, Pakistan, Afghanistan, Nepal, Ceylon, Burma and other Southeast Asian countries, China, Kazakh S. S. R., Iraq, Arabia, Oman and Bahrein.

It is prevalent throughout India, particularly in hilly region and is an important malaria vector.

Present records : Udhampur dist. : 1 ♀ indoor resting, cattle shed, and 1 ♀ resting outdoor on vegetation near a stream, Phalata, respectively on 23 and 27 Nov. '69.

6. *Anopheles maculatus willmorei* (James)

Anopheles maculatus var. *willmorei* (James, 1903) in Theobald *Monogr. cul.* 3 : 100 ; Christophers, 1933 : 285-287 ; Knight and Stone, 1977 : 45 ; Rao, 1981 : 455-461.

Recorded from Pakistan, India, Nepal and Burma. In India, it has been recorded along the Himalayan foothills.

Present records : Baramulla dist. : 5 larvae, and 1 ♀ reared from larva collected from a roadside pool, Mitrang, 24 Oct. '69. Doda dist. : 1 ♂ and 2 ♀ ♀ reared from larvae collected from pools along paddy fields, Bhadarwah (1750 m.), 14 Nov. '69 ; 11 larvae, 3 ♂ ♂ and 4 ♀ ♀ reared from larvae collected from seepage pools along a irrigation canal, and 1 ♀ while biting human at dusk near a forest-clad ravine, Khilani, respectively on 19 and 20 Nov. '69. Udhampur dist : 1 ♂ and 2 ♀ ♀ reared from larvae ; 2 ♀ ♀ indoor resting and 1 ♀ outdoor resting, Phalata, respectively on 22, 25 and 27 Nov. '69 ; 1 ♀ reared from larva collected from a seepage pool near paddy fields, Dehari (800 m.), 29 Nov. '69. The species was found breeding in association with *An. annularis*, *C. bitaeniorhynchus* and *C. p. quinquefasciatus*.

7. *Anopheles subpictus* Grassi

Anopheles subpictus Grassi, 1899, *R. C. Accad. Lineei*. 8 : 101 ; Christophers, 1933 : 231-241 ; Knight and Stone, 1977 : 54 ; Rao, 1981 : 415-425.

The species has a wide geographic range including entire Oriental region Afghanistan, Iran, Southern China and New Guinea.

Present records : Udhampur dist. : Numerous larvae, 3 ♂ ♂ and 7 ♀ ♀ reared from larvae collected from a roadside pool with muddy water, Satani (600 m.), 6 nov. '69. Associated breeders were *C. fuscocephalus* and *C. p. quinquefasciatus*.

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8. *Aedes elsiae* (Barraud)

Aedes elsiae (Barraud, 1923), *Bull. Ent. Res.* 13 : 406 ; Barraud, 1934 : 180-183 ; Knight and Stone, 1977 : 94.

This has been recorded from India, Thailand, Indochina, and China.

Present record : Rajouri dist. : 2 ♂ ♂ and 2 ♀ ♀ reared from larvae collected from rock holes on a stream bed, Naushera (800m.), 7 Dec. '69. Associated breeders were *C. barraudi* and *C. p. quinquefasciatus*.

9. *Aedes oreophilus* (Edwards)

Aedes oreophilus (Edwards, 1916), *Bull. Ent. Res.* 6 : 357 ; Barraud, 1934 : 192-194 ; Knight and Stone, 1977 : 101.

This is one of the commonest tree hole breeding species in western Himalayas ; also found in eastern Himalayas and Nilgiris.

Present record : Ladakh. : 1 ♂ collected while hovering around a collector, Phiang (3,500 m.), 7 Aug. '68.

10. *Aedes sintoni* (Barraud)

Aedes sintoni Barraud, 1924, *Indian J. Med. Res.* 2 : 967 ; Barraud, 1934 : 200-202 ; Knight and Stone, 1977 : 104.

The species was originally described from Tangmarg in Kashmir and subsequently recorded from Murree. Apparently this species is restricted to the temperate zone of western Himalayas.

Present record : Ladakh : Numerous larvae and pupae, 16 ♂ ♂ and 14 ♀ ♀ reared from immature stages, collected from a seepage pool on Indus river bank clad with scrub vegetation, Dumgal near Batalik (3000 m.), 27 Aug. '67.

This is the first record of this species from trans-Himalayan region of India.

11. *Aedes albopictus* (Skuse)

Aedes albopictus (Skuse, 1894), *Ind. Mus. Notes.* 3 : 20 ; Barraud, 1934 : 233-235 ; Knight and Stone, 1977 : 156.

This species has a wide geographical range which includes Oriental, Australian and parts of Palaearctic and African regions. In India this is the commonest species of *Aedes* found in the peridomestic environment.

Present record : 1 ♂ collected hovering outdoors in the evening, Udhampur (800 m.), 15 Oct. '69.

12. *Aedes vittatus* (Bigot)

Aedes vittatus (Bigot, 1861), *Ann. Soc. Ent. France* (4) 1 : 227 ; Barraud, 1934 : 245-246 ; Knight and Stone, 1977 : 166.

The species is widely distributed in Ethiopian, Mediterranean and Oriental regions.

Present record : Rajouri dist. : 3 ♀ ♀ reared from eggs collected from a dry rock hole on a stream bed, Naushera, 7 Dec. '69.

13. *Aedes w-albus* (Theobald)

Aedes w-albus (Theobald, 1905), *Ann. Mus. Nat. Hung.* 3 : 74 ; Barraud, 1934 : 232-233 ; Knight and Stone, 1977 : 166.

Recorded from the Oriental region only.

Present record : Udhampur dist. : 1 ♀ collected hovering over human in the evening near inspection bungalow, Udhampur, 15 Oct. '69.

14. *Aedes vexans* (Meigen)

Aedes vexans (Meigen, 1830), *Syst. Bechr. europ. Zmeift. Insekt.* 6 : 241 ; Barraud, 1934 : 253-255 ; Knight and Stone, 1977 : 83.

The species is widely distributed in Holarctic and Oriental regions, Pacific islands and Transvaal.

Present records : Ladakh : 7 ♀ ♀ collected indoors from cattle shed, numerous larvae, 1 ♂ and 1 ♀ reared from larvae, collected from river-side pools, Kargil (2800 m.) respectively on 12 and 17 Aug. '67 ; 12 ♀ ♀ collected from vegetation on Shingo river bank, Baroo-sokh (2700 m.), 19 Aug. '67. Associated breeders were *Culiseta longiareolata*, *C. hortensis* and *C. vagans*.

15. *Culiseta longiareolata* (Macquart)

Culiseta longiareolata (Macquart, 1838), *Dipt. Exot.* 1 : 34 ; and *Mem. Soc. Sci. Lille.* 2 : 38 ; Barraud, 1934 : 88-91 ; Knight and Stone, 1977 : 277.

This species is known to be distributed in the southern Palaearctic region from Azores to Central Asia, Ethiopian region, India and Pakistan. In India, it is commonly found in the North-west and west Himalayas.

Present records : 27 larvae collected from a riverside pool, 3 ♂ ♂ reared from larvae, and 6 larvae collected from a cement tank, Kargil, respectively on 11, 12 and 17 Aug. '67. Associated breeders were *Ae. vexans*, *C. hortensis*, *C. theileri* and *C. vagans*.

16. *Culex hortensis* Ficalbi

Culex hortensis Ficalbi, 1889, *Boll. Soc. ent. ital.* 21 : 27 ; Bhat and Kulkarni, 1971 : *Oriental Insect* 5 : 583-584 ; Knight and Stone, 1977 : 250.

This species was known to be distributed in the Mediterranean region of Europe and Africa, Central Europe, Southern U. S. S. R., extending eastwards up to Iran and Tadzhik S. S. R. and westwards upto Canary Island. It was also recorded from Ladakh.

Present records : Ladakh : 1 ♂ and 2 ♀ ♀, collected from river side, vegetation ; 13 larvae, 1 pupa, 12 ♂ ♂ and 7 ♀ ♀ reared from larvae, collected from river-side pools ; 22 larvae, 1 pupa and 1 ♂ reared from pupa collected from a cement tank, Kargil, respectively on 11, 12 and 17 Aug. '69. 7 larvae and 3 pupae from a seepage pool, Horje (3500 m.) at Leh, 4 Aug. '68. 1 ♂ from vegetation, Phiang, 7 Aug. '68. Associated breeders were *C. theileri*, *C. vagans*, *Culiseta longiareolata* and *Ae. vexans*.

17. *Culex pallidothorax* Theobald

Culex pallidothorax Theobald, 1905, *Journ. Econ. Biol.* 1 : 32 ; Barraud, 1934 : 381-382 ; Knight and Stone, 1977 : 232.

A widely distributed species. The range includes India, Ceylon, Nepal, Burma, Thailand, Indochina, Malaya and through Japan to New Guinea.

Present record : 4 ♂ ♂ and 4 ♀ ♀ collected from vegetation in a ravine, Khilani, 11 Nov. '69.

18. *Culex viridiventer* Giles

Culex viridiventer Giles, 1901, *J. Bomb. Nat. Hist. Soc.* 8 : 609 ; Barraud, 1934 : 378-380 ; Knight and Stone, 1977 : 233.

A common species found in the western Himalayas from western boundary of Nepal to Kashmir.

Present records : Anantnag dist. : 27 larvae and 1 ♂ reared from larvae collected from river-side pool, Pehalgam (2250 m.), 12 Nov. '69. Udhampur dist. : 5 ♂ ♂ and 1 ♀ collected from vegetation along a stream, Dehari, 30 Nov. '69 ; 19 ♂ ♂ and 20 ♀ ♀ reared from a seepage pond, Kulwanda (1750 m.), 2 Dec. '69 ; and 1 ♂ from vegetation, Phalata, 26 Nov. '69. Associated breeders were *C. mimeticus* and *C. p. quinquefasciatus*.

19. *Culex barraudi* Edwards

Culex barraudi Edwards, 1922, *Indian J. Med. Res.* 10 : 284 ; Barraud, 1934 : 403 ; Knight and Stone, 1977 : 202.

The species has been known to be distributed in India, Nepal, Ceylon, China and Southeast Asia.

Present records : Udhampur dist. : 2 ♀ ♀ collected from vegetation along a stream, Phalata (800 m.), 26 Nov. '69. Rajouri dist. : 1 ♀ reared from larva collected from a rock pool, Naushera, 7 Dec. '69. Associated breeders were *Ae. elsiae* and *C. p. quinquefasciatus*.

20. *Culex bitaeniorhynchus* Giles

Culex bitaeniorhynchus Giles, 1901, *J. Bomb. Nat. Hist. Soc.* 13 : 607 ; Barraud, 1934 : 391-394 ; Knight and Stone, 1977 : 203.

Widely distributed species known from several countries in Oriental, Palaearctic, Ethiopian and Australian regions.

Present records : Udhampur dist. : 1 ♂ and 1 ♀ reared from larvae collected from stream-bed pools near paddy fields ; and 1 ♀ collected from nearby vegetation ; Phalata, respectively on 22 and 26 Nov. '69. Associated breeders were *An. maculatus* and *C. p. quinquefasciatus*.

21. *Culex fuscocephalus* Theobald

Culex fuscocephalus Theobald, 1907, *Monogr. Cul.* 4 : 420 ; Barraud, 1934 : 424-426 ; Knight and Stone, 1977 : 208.

Widely distributed in Oriental and eastern parts of Palaearctic regions.

Present records : Udhampur dist. : 3 ♂ ♂ and 8 ♀ ♀ collected from forest vegetation, Udhampur, 15 Oct. '69 ; 17 ♂ ♂ and 23 ♀ ♀ reared from larvae collected from a roadside seepage pool with muddy water, Satani, 6 Nov. '69. Associated breeders were *An. subpictus* and *C. p. quinquefasciatus*.

22. *Culex mimeticus* Noe

Culex mimeticus Noe, 1899, *Boll. Soc. ent. ital.* 31 : 240 ; Barraud, 1934 : 451 ; Knight and Stone, 1977 : 240.

Known from southern Palaearctic and Oriental regions.

Present records : Doda dist. : 3 ♂ ♂ and 1 ♀, and 2 ♂ ♂ and 3 ♀ ♀ reared from larvae collected from seepage pools, Bhadarwah, respectively on 14 and 16 Nov. '69. Udhampur dist. : 10 ♂ ♂ and 9 ♀ ♀ collected from vegetation along a stream, Phalata, between 24 and 27 Nov. '69 ; 1 ♀ reared from larva collected from a seepage pool, Kulwanda, 2 Dec. '69. Associated breeders were *An. maculatus*, *C. viridiventer* and *C. p. quinquefasciatus*.

23. *Culex pipiens quinquefasciatus* Say

Culex pipiens var. *quinquefasciatus* Say, 1823, *J. Acad. nat. Sci. philad.* 3 : 10 ; Knight and Stone, 1977 : 216-219.

A well known cosmotropical species and is widely distributed all over India.

Present records : Baramulla dist. : 23 ♂ ♂ and 25 ♀ ♀ reared from larvae collected from roadside pools, Bandipore (1850 m.), 30 Oct. '69.

1 ♀ collected from vegetation, Marder (1850 m.), 2 Nov. '69. Doda dist. : 31 ♂ ♂ and 38 ♀ ♀ emerged from pupae in a cement tank, Gund near Banihal (1500 m.), 13 Nov. '69 ; 1 larva, 9 ♂ ♂ and 10 ♀ ♀ reared from larvae collected from a pool, Khilani, 19 Nov. '69. Udhampur dist. : 2 ♂ ♂ from vegetation, 3 ♂ ♂ and 5 ♀ ♀ resting indoor, Udhampur, respectively on 15 Oct. and 4 Dec. '69 ; 3 ♂ ♂ and 8 ♀ ♀ resting indoor, and 3 ♂ ♂ and 6 ♀ ♀ reared from larvae collected from a drain, Satani, 6 Nov. '69 ; 2 ♀ ♀ reared from larvae collected from a seepage pool on stream bed, Phalata, 22 Nov. '69 ; 2 ♀ ♀ reared from larvae collected from a pool in a peridomestic area, 4 ♂ ♂ and 8 ♀ ♀ collected from vegetation, Dehari, 30 Nov. '69 ; 3 ♂ ♂ reared from larvae collected from seepage pool, Kulwanda, 2 Dec. '69 ; and 7 ♂ ♂ and 4 ♀ ♀ reared from larvae and pupae collected from a drain, Ramnagar (950 m.), 4 Dec. '69. Rajouri dist. : 4 ♀ ♀ resting indoor, 7 ♂ ♂ and 9 ♀ ♀ reared from immature stages collected from a rock pool, Naus-hera, respectively on 6, 7 and 8 Dec. '69.

Associated breeders were *An. maculatus*, *An. subpictus*, *Ae. elisiae*, *C. viridiventer*, *C. barraudi*, *C. bitaeniorhynchus*, *C. fuscocephalus*, *C. mimeticus* and *C. vagans*.

24. *Culex* sp.

The species closely resembles *C. gelidus* Theobald, 1901 but differs by the extent of the white ring on the proboscis. The identity needs confirmation by collecting more specimens.

Present Records : Ladakh : 2 ♀ ♀ from vegetation, Pratapgunj at Kargil ; 2 ♀ ♀ indoor resting, Longmithang at Kargil, 14 Aug. '67, 2 ♀ ♀ from vegetation, Poyen (2900 m.), 25 Jul. '68 ; and 1 ♂ from vegetation, Phiang, 7 Aug. '68.

25. *Culex theileri* Theobald

Culex theileri Theobald, 1903, *Monogr. Cul.*, 3 : 187 ; Barraud, 1934 ; 414-416 ; Knight and Stone, 1977 : 225.

The species is known from southern and eastern Ethiopian, southern Palaearctic, and northern Oriental Regions.

Present records : Ladakh : 8 ♀ ♀ from vegetation on Shingo river bank, Kargil, 11 Aug. '67 ; 2 larvae and 2 ♀ ♀ reared from larvae collected from a seepage pool, Drass (3500 m.), 31 Aug. '67 ; 4 ♀ ♀ reared from larvae collected from a seepage pool, Poyen near Kargil, 25 Jul. '68 ; 1 ♂ and 1 ♀ from vegetation, Phiang near Leh, 7 Aug. '68 ; and 1 ♂ and 4 ♀ ♀ from vegetation, Leh (3600 m.), 8 Aug. '68. Associated breeders were *Culiseta longiareolata*, *C. hortensis* and *C. vagans*.

26. *Culex vagans* Wiedemann

Culex vagans Wiedemann, 1828, *Aussereurop Zweifel Ins.* 1 : 545 ; Barraud, 1934 : 416-418 ; Knight and Stone, 1977 : 227.

The species is known to be distributed in China, Japan, Korea, Far Eastern U. S. S. R., Manchuria, Iran and Pakistan. In India, it has been recorded from the western Himalayas, Kashmir and Punjab.

Present records : 1 ♀ reared from larva collected from a pool adjacent to an irrigation channel, Pratapgunj at Kargil, 11 Aug. '67 ; 15 ♂ ♂ and 13 ♀ ♀ from vegetation, 21 ♂ ♂ and 26 ♀ ♀ reared from larvae collected from seepage pools on Shingo river bank, Kargil, 12 Aug. '67 ; 1 ♀ resting indoor in cattle shed, Longmithang at Kargil, 14 Aug. '67 ; 2 ♂ ♂ reared from larvae collected from seepage pools, Drass. 31 Aug. '67 ; 4 ♂ ♂ and 2 ♀ ♀ from vegetation, Poyen (3000 m.), 25 Jul. '68. Baramulla dist. : 15 ♂ ♂ and 21 ♀ ♀ reared from larvae collected from seepage pools adjacent to wheat field, Sopore, 22 Oct. '69 ; 2 ♀ ♀ reared from larvae from seepage pools, Bandipore (1900 m.), 30 Oct. '69.

Associated breeders were *Ae. vexans.*, *Culiseta longiareolata*, *C. hortensis* *C.p. quinquefasciatus* and *C. theileri*.

27. *Culex vishnui* Theobald

Culex vishnui Theobald, 1901, *Monogr. Cul.* 1 : 355 ; Barraud, 1934 : 400-402 ; Knight and Stone, 1977 : 228.

The species is widely distributed in Oriental region, Iraq, Iran, Pakistan, China, Korea, Japan and New Guinea, Thailand, Hong Kong, Java, Malaysia and Philippines.

Present records : Udampur dist. : 4 ♂ ♂ and 9 ♀ ♀ from forest vegetation, Udampur, 15 Oct. '69 ; 5 ♂ ♂ and 48 ♀ ♀, from vegetation along the streams, Phalata, between 24 and 27 Nov. '69 ; 9 ♀ ♀ from vegetation along streams, Dehari, 30 Nov. '69.

DISCUSSION

During the present survey in three distinct ecogeographical areas of the state, viz., Jammu, Kashmir and Ladakh, three genera comprising of 18 species of mosquitoes—six species of *Anopheles*, four species of *Aedes* and eight species of *Culex* were collected in Jammu. These include two important vector species of malaria, viz., *An. culicifacies* and *An. fluviatilis*. Only eight species of mosquitoes were collected in Ladakh. *Culex hortensis*, a member of the subgenus *Neoculex* Dyar, 1905 was recorded for the first time in Ladakh (Bhat and Kulkarni,

1971). The species was found breeding in association with *C. theileri*, *C. vagans*, *Culiseta longiareolata* and *Ae. vexans*. The mosquito fauna of Ladakh is interesting, because all the species were collected in the subalpine and alpine zones which remain snow bound during winter and is represented by palaearctic species such as *C. vagans*, *C. theileri*, and *C. hortensis*, by holarctic species such as *Ae. vexans* and by montane species such as *Culiseta longiareolata* and *Ae. sintoni*. Only five species were collected from Kashmir valley and all the species are also found elsewhere in the western Himalayas.

SUMMARY

During the survey of haematophagous arthropods in the State of Jammu and Kashmir, between August 1967 and December 1969, four genera and 27 species of mosquitoes were collected. They are *Anopheles gigas simlensis*, *An. lindesayi*, *An. annularis*, *An. culicifacies*, *An. fluviatilis*, *An. maculatus willimorei*, *An. subpictus*, *Aedes elsiae*, *Ae. oreophilus*, *Ae. sintoni*, *Ae. albopictus*, *Ae. vittatus*, *Ae. w-albus*, *Ae. vexans*, *Culiseta longiareolata*, *Culex hortensis*, *C. pallidothorax*, *C. viridiventer*, *C. barraudi*, *C. bitaeniorhynchus*, *C. fuscocephalus*, *C. mimeticus*, *C. pipiens quinquefasciatus*, *C. sp.*, *C. theileri*, *C. vagans* and *C. vishnui*. The collection records of these species with ecological notes are presented in this communication.

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STUDIES ON SOME ASPECTS OF CRANIAL ANATOMY OF
INDIAN LEIOGNATHIDS (PERCIFORMES :
LEIOGNATHIDAE). PART 1. OSTEOLOGY.

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(With 7 Text-figures)

INTRODUCTION

The perciform fishes are known to occupy a higher position in the ladder of teleostean evolution. Among them, leiognathids popularly known as silver-bellies, rank as one of the important groups of fishes. The leiognathids are known by 17 species from Indian waters but the knowledge of cranial osteology of these fishes is almost avoid in the literature. The present communication is an attempt to provide a reasonably detailed account of the cranial osteology of these fishes. In this connection it may be stated that Starks (1911) studied the osteology of *Leiognathus fasciatus* in brief and Delsman (1925) demonstrated the functional morphology of some bones associated with the protrusibility of mouth in *Equula dussumieri* (= *Leiognathus dussumieri*).

MATERIAL AND METHODS

The present study of the cranial osteology is based on the seven species of leiognathids belonging to three genera viz. *Leiognathus splendens* (Cuvier), *Leiognathus equulus* (Forsskal), *Leiognathus bindus* (Valenciennes), *Leiognathus brevirostris* (Valenciennes), *Secutor insidiator* (Bloch), *Secutor ruconius* (Hamilton) and *Gazza minuta* (Bloch).

The specimens were collected from various localities along the entire east coast of India. The specimens collected were first preserved in 10% formalin and the standard methods (Hollister, 1934 and Taylor, 1967)

* Part of Ph. D. thesis of the senior author under the guidance of the second author.

for the preparation of skulls were followed. Alzarine transparency of the above mentioned specimens were also prepared to show the limits of individual element in situ.

The skull of *Leiognathus splendens* is considered as a generalised type in order to provide a detailed description of each bone for further comparison with skull of other species under study. Osteological nomenclature basically followed here is after Harrington (1955) with some modifications.

ABBREVIATIONS USED IN THE TEXT AND FIGURES

A : Angular, AN : Retroarticular, BO : Basioccipital, BR : Branchiostegal ray, BS : Basisphenoid, CH : Ceratohyal, D : Dentary, DSPH : Dermosphenotic, E : Ethmoid, ECT : Ectopterygoid, EH : Epihyal, ENT : Entopterygoid, EO : Exoccipital, F : Frontal, H : Hypohyal, HM : Hyomandibular, IC : Intercalar, IH : Interhyal, IOP : Interopercular, LA : Lachrymal, LE : Lateral ethmoid, MPT : Metapterygoid, MX : Maxilla, NA : Nasal, OP : Opercular, P : Palatine, PA : Parietal, PM : Premaxilla, POP : Preopercular, PRO : Prootic, PS : Parasphenoid, PTO : Pterotic, PTS : Pterosphenoid, PTT : Post-temporal, Q : Quadrate, SO : Suborbital, SOC : Supraoccipital, SPH : Sphenotic, SPO : Supraorbital, SY : Symplectic, UH : Urohyal, V : Pre vomer.

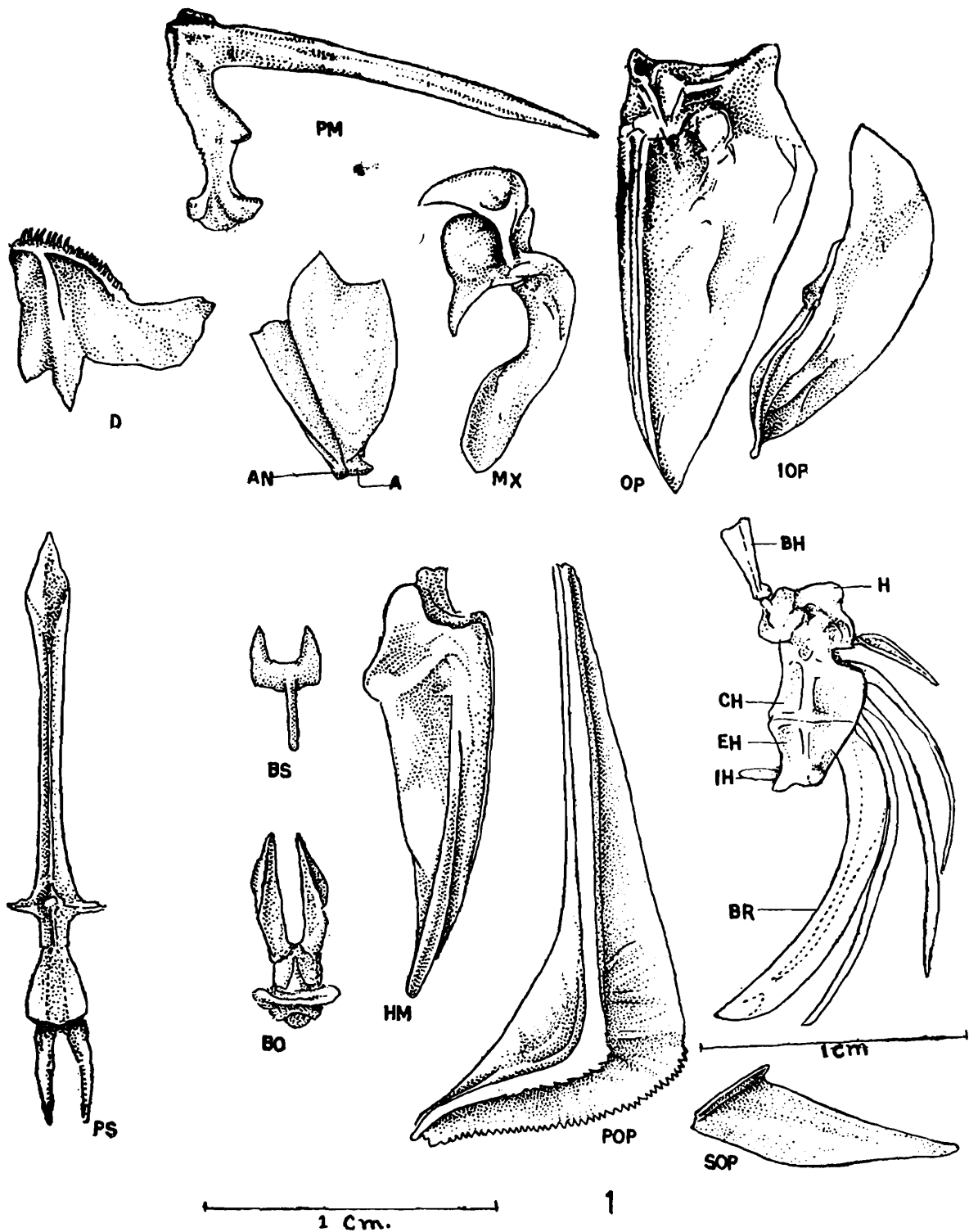
OBSERVATIONS

The skull of *Leiognathus splendens* is roughly spherical with upwardly directed supraoccipital crest and a laterally compressed orbital region which is relatively broad posteriorly. On the dorsal surface of the skull, the lateral bony ridges of the frontal along with supraoccipital form a Y-shaped structure.

The general contour of the skull in all the species of the genus *Leiognathus* is similar but the skull of the genus *Secutor* and *Gazza* differ slightly from that of *L. splendens* in having wavy rostro-occipital profile in the former and 'V' shaped structure on the dorsal aspect of the skull in the latter.

1. Olfactory Region :

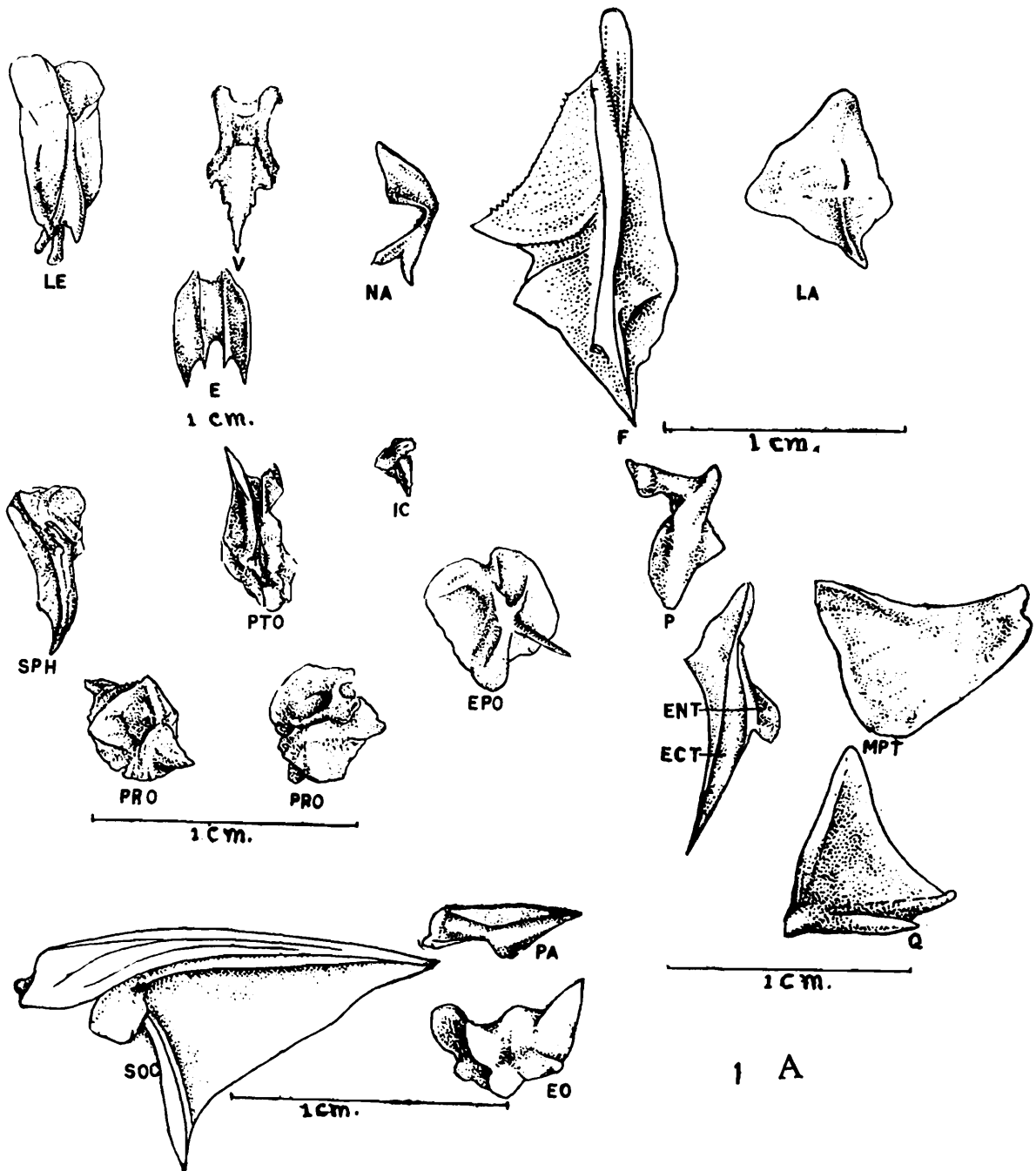
This is the anterior most region comprising paired lateral ethmoid and nasal and unpaired ethmoid and prevomer.



Text-fig. 1. Disarticulated bones of the skull of *Leiognathus splendens* (Cuvier).

1.1. Ethmoid (Text-fig. 1E and 4A) :

The ethmoid, a median endochondral bone lies between the pre-vomer and frontal. It forms the anterodorsal angle of the neurocranium and is saddle-shaped dorsally. Anteriorly it is attached to the pre-vomer by ethmovomer cartilage, laterally to the lateral ethmoid and posteriorly to the frontal. Dorsally, it is overlapped by the nasals and forms the lateral inner wall of each foramen olfactorium.



Text-fig. 1A. Disarticulated bones of the skull of *Leiognathus splendens* (Cuvier).

There is no marked difference in the disposition of this bone among the other species except that of *L. equulus* (Text-fig. 4B) and *S. ruconius* (Text-fig. 4F), where the median ridge is very much prominent. The bone is roughly lanceolate in the former species as well as in *G. minuta* (Text-fig. 4G) :

1.2. Lateral ethmoid (Text-fig. 1LE and 4A) :

The lateral ethmoid is a roughly rectangular bone, located on either side of the ethmoid and forming the outer boundary of the orbit. Posterodorsally it possesses two posteriorly directing strong antorbital spines, the outer one is more prominent than the inner. Posteroventrally, it has a narrow projection attached to the anteroventral surface

of the frontal. Laterally it forms the outer wall of the foramen olfactorium. Anterodorsally, it is attached to the lachrymal, anteriorly to the palatine and pterygoid, anterolaterally to the prevomer and posterodorsally to the nasal.

The above description equally applies to all the species although the antorbital spines are very prominent in *L. equulus*, *L. bindus* and inconspicuous in *G. minuta*. In *S. insidiator* (Text-fig. 4E), a single weak antorbital spine is present.

1.3. Prevomer (Text-fig. 1V, 4A and 5A) :

Prevomer is a toothless, square shaped bone with a thin tapering posteroventral shaft, truncated anteriorly and bears downwardly directing projections on either side. It is placed anterior to the ethmoid and forms the anteroventral part of the cranium. Overlain dorsally by premaxilla, it makes contact with maxilla anterolaterally and ethmoid posterodorsally. Laterally, the prevomer is connected with the palatine and its shaft extends into the anterodorsal groove of the parasphenoid posteroventrally.

There is no worthmentioning difference in the prevomer of other species except in *L. equuls* (Text-fig. 5B), where it is roughly dumbbell shaped and bears downwardly directed projections on either side at the anterior end with a fontanell on its ventral surface. In *S. insidiator* (Text-fig. 5E), *S. ruconins* (Text-fig. 5F), and *G. minuta* (Text-fig. 5G), it is arched along the anterior margin and bears a median fontanel on its ventral surface in the latter.

1.4. Nasals (Text-fig. 1NA and 2A) :

Each nasal is a crooked bone, located dorsal to the ethmoid and forms the roof of the nasal capsule. Anteriorly it is narrow and is attached loosely to the lachrymal and palatine and posterodorsally to the frontal and the lateral ethmoid.

The above description applies to the nasal of all the species studied, however, it is rather prominent in *L. equulus*.

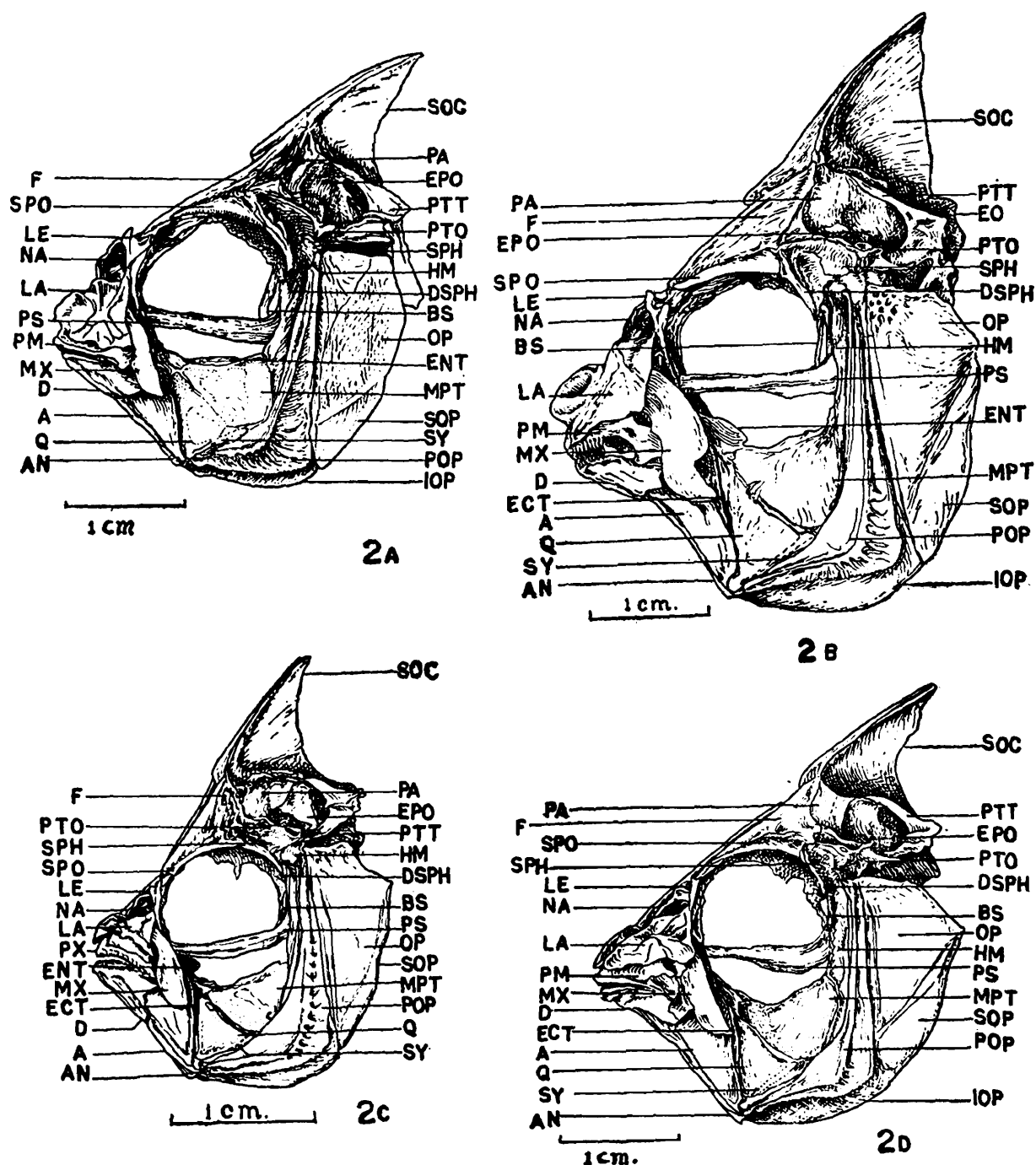
2. Orbital Region :

This region comprises all paired bones : frontal, lachrymal, supraorbital, suborbital, dermosphenotic and pterotic.

2.1. Frontal (Text-fig. 1F and 4A) :

Each frontal is a roughly hoe shaped bone and occupies nearly half of the length of the neurocranium. It lies behind the ethmoid forming the dorsal surface of the skull. Laterally it extends into a ridge forming

a Y-shaped structure which remains continuous with the lateral ridge of the supraoccipital. On the inner side of the lateral ridge, there is another poorly developed ridge at the anterior end and a comma shaped ridge, at the posterior end. Anteriorly it is broad and attached to the ethmoid, lateral ethmoid and nasal. Posteriorly it is narrow and attached to the supraoccipital along its inner surface. Anterolaterally it is fused with its respective supraorbital and posterolaterally attached to the parietal, pterotic and sphenotic.



Text-fig. 2A—D. Lateral view of the skull.

- A. *Leiognathus splendens* (Cuvier)
- B. *Leiognathus equulus* (Forsskal)
- C. *Leiognathus bindus* (Valenciennes)
- D. *Leiognathus brevirostris* (Valenciennes)

In *L. equulus* and *L. bindus*, this bone is similar to that of *L. splendens* except slightly modified in the former species where it (Text-fig. 4B) bears an irregular outgrowth on its anterodorsal surface and lacks a comma shaped ridge at the posterior extremity. It is noticed that this irregular outgrowth is well developed in bigger specimens. In *L. brevirostris* (Text-fig. 4D), the posterodorsal surface of the frontal bears an elongated somewhat curved ridge on the inner side of the lateral ridge but the comma shaped ridge is lacking. In *S. insidiator* and *S. ruconius*, frontal is identical to that of *L. splendens* except the comma shaped ridge on its posterior surface. In *G. minuta* (Text-fig. 4G), each frontal forms a V-shaped structure in continuity with the lateral ridge of the supraoccipital and the comma shaped ridge is also wanting unlike that of *L. splendens*.

2.2. Lachrymal (Text-fig. 1LA and 2A) :

Lachrymal, the first orbital bone, forming lateral wall of the nasal capsule, is roughly triangular and lies over the dorsal surface of the proximal portion of the maxilla. Anteriorly the lachrymal of either side approaches each other. Posteriorly it is attached to the nasal, laterally to the lateral ethmoid and ventrally to the palatine, maxilla and premaxilla.

The above description applies to all the species except *L. equulus* (Text-fig. 2B) and *L. brevirostris* (Text-fig. 2D) where it is comparatively well developed and elongated anteriorly.

2.3. Supraorbital (Text-fig. 1SPO and 4A) :

Supraorbital, a well developed bone of the circumorbital series and forming the dorsal roof of the orbit, is located anterolateral to the frontal. It is roughly triangular curved bone with entirely serrated margin and is attached anteroventrally to the respective lateral ethmoid and posteriorly to the dermosphenotic and the sphenotic.

It differs specifically in respect of the serration at the outer margin. In *L. equulus*, the serration is indistinct and in *L. brevirostris*, confined to the posterior region only while in *L. bindus*, the outer margin of the bone is rugose. In *S. insidiator*, *S. ruconius* and *G. minuta*, the bone is minutely serrated along its outer margin.

2.4. Dermosphenotic (Text-fig. 3A and 4A) :

Dermosphenotic, the last bone of the circumorbital series, is thin and elongated. Attached to the supraorbital proximally, it lies above the sphenotic and connects the suborbital distally.

It is identical in all the species.

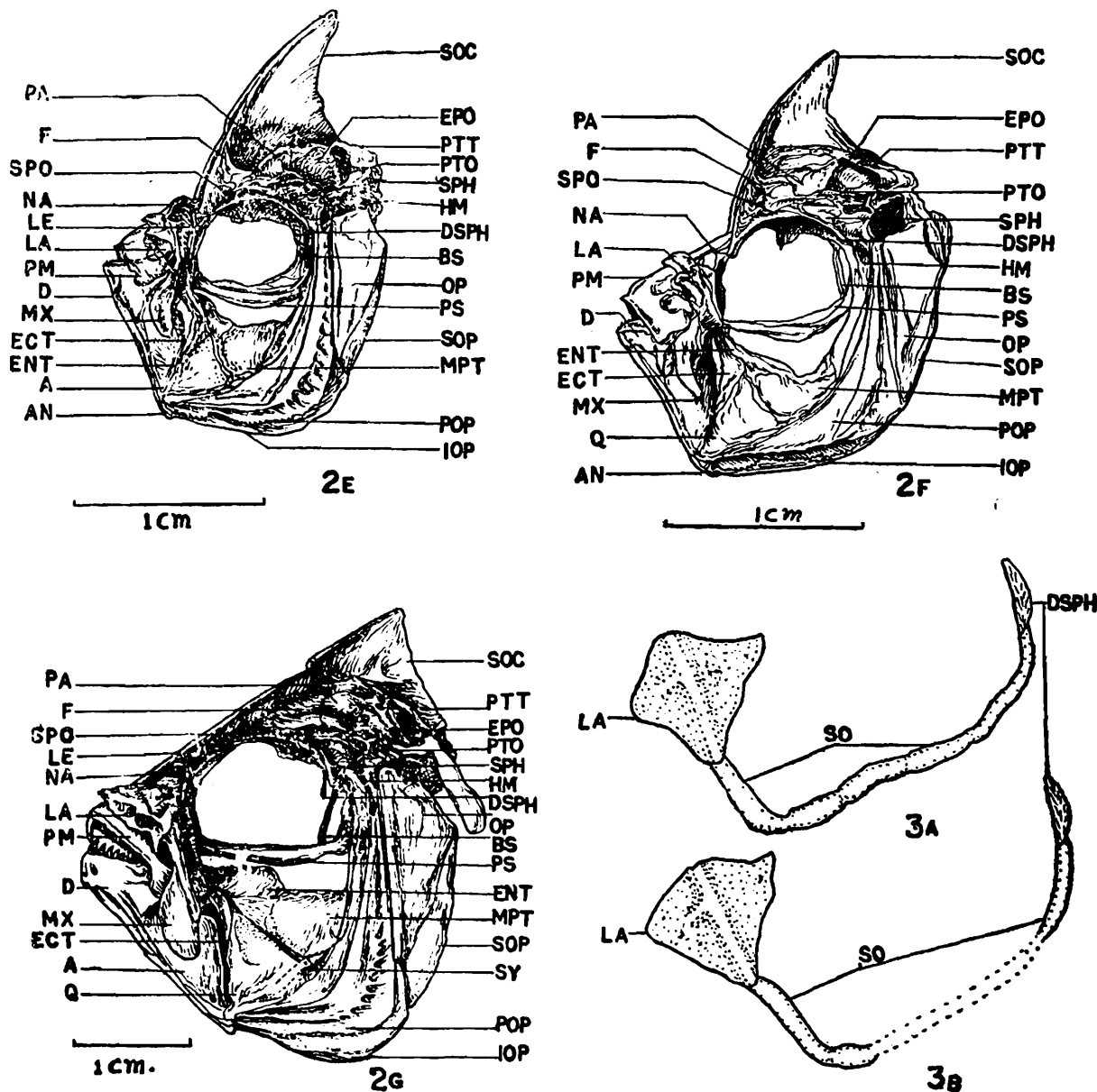
2.5. Suborbitals (Text-fig. 3A) :

The suborbital series, forming the ventral wall of the orbit is reduced to a thin bony tube and can not be demarcated into a number of discrete bones like some of other fishes.

There is no worthmentioning difference in the suborbitals of *L. equulus*, *L. brevirostris*, *S. insidiator* and *S. ruconius*. However, the suborbital series is incomplete in *L. bindus* and *G. minuta* (Text-fig. 3B).

2.6. Pterosphenoid (Text-fig. 5A) :

Pterosphenoid, a well developed irregular shaped bone, is situated anterior to the basisphenoid and prootic. Dorsoanteriorly it is attached to the sphenotic, posteriorly to the prootic and basisphenoid and mesially to its fellow of the other side.



Text-fig. 2E—G. E. *Secutor insidiator* (Bloch)
 F. *Secutor ruconius* (Hamilton)
 G. *Gazza minuta* (Bloch)

Text-fig. 3A & B. Circumorbital series.
 A. *Leiognathus splendens* (Cuvier)
 B. *Leiognathus bindus* (Valenciennes)

The above description is applicable to all the species.

3. Otic Region :

The otic region, comprises nine well ossified bones (sphenotic, pterotic, epiotic, prootic, intercalar, exoccipital, supraoccipital, parietal and posttemporal). Collectively the bones of this region form the endocranial vault and the otic capsule and provide protection to the brain and parts of the cranial nerves and also afford the attachment area to the branchiocranium as well as the vertebral column. This region also serves as a foothold for the pectoral girdle through the posttemporal.

3.1 Sphenotic (Text-fig. 1SPH and 2A) :

The sphenotic is an irregular shaped bone having an anterior thin and a posterior broad thick triangular portion. It is located anterior to the pterotic. Ventrolaterally it bears a cup like articulating facet for dorsoanterior condyle of respective hyomandibula. Proximally it is attached to the frontal and supraorbital, distally to the pterotic, ventrally to the prootic and is overlapped dorsally by the dermosphenotic.

The above description applies to the sphenotic of all the species.

3.2 Pterotic (Text-fig. 1PTO and 2A) :

The pterotic is an irregular shaped bone forming the postero-lateral surface of the cranium and lies posterior to the sphenotic. The thin proximal portion of this bone bears a sensory tunnel which proximally communicates with the frontal system of the sensory tunnel. Its heavy distal portion is triangular posteriorly and forms a cup like structure with the prootic on its ventral surface for articulation of the posterodorsal condyle of the hyomandibula. It is attached to the epiotic as well as to the exoccipital. Posteroventrally it is overlapped by the intercalar.

There is no marked difference in the disposition of this bone among the other species except *L. equulus* (Text-fig. 2B) and *L. brevirostris* (Text-fig. 2d) where a posteriorly directed postero-ventral spine like prominent process is present.

3.3. Epiotic (Text-fig. 1EPO and 2A) :

Each bone resembles a hollow cup, capping the posterodorsal surface of the cranium and encloses the posterior semicircular canals. The epiotic bears a median ridge and an outward directed epiotic process which provides the attachment area to the lateral muscles. Anterodorsally, it is partially overlapped by the parietal and is attached to the pterotic anteroventrally, to the exoccipital posteroventrally and to the

supraoccipital posteriorly. Mesially it bears a depression for receiving the dorsal arm of the posttemporal.

The above description is more or less applicable to all the species studied here.

3.4. Prootic (Text-fig. 1PRO and 5A) :

The prootic, a large irregular shaped bone, forming the anteromesial and anterodorsal wall of the auditory capsule, bears a carotid foramen and the foramen for the Vth and VIIth cranial nerves. The anterior part of the bone joins mesially with its fellow of the other side and is distally attached to the basisphenoid and laterally to the sphenotic. Dorsally, its posterior part is attached to the ventral margin of sphenotic, pterotic and intercalar, posteriorly to the exoccipital, ventrally to the parasphenoid and posteroventrally to the basioccipital.

The above description applies to prootic of all the present species.

3.5. Intercalar (Text-fig. 1IC and 5A) :

Intercalar, the smallest bone of otic region, lies posterior to the pterotic and extends to the prootic anteroventrally. It is an irregular shaped bone with somewhat concave dorsal surface. It is thicker along its outer margin, bears a horizontal ridge for providing the attachment to the ventral arm of the posttemporal and overlaps the exoccipital partially at the distal end.

There is no worthmentioning difference in the intercalar of all the species studied here.

3.6. Exoccipital (Text-fig. 1EO and 5A) :

The exoccipital is roughly fan-shaped with a dorsomedian ridge, forms the posterior wall of the cranium and lies posteroventral to the supraoccipital and epiotic. It bears three foramina for ixth and xth cranial nerves. The anterior one is smaller than the others. The bone forms the wall of the foramen magnum posteriorly and bears a condylar surface posteroventrally for the articulation with the centrum of the first vertebra. The condyle of one side joins its fellow of the other side midventrally through a median piece of cartilage. The bone is overlapped by the intercalar and is attached to the pterotic and epiotic dorsally, to the supraoccipital along its ventral margin and to the prootic anteriorly.

The exoccipital is similar in all the species except the genus *Secutor* (Text-fig. 5E and F) where two foramina are present.

3.7. Supraoccipital (Text-fig. 1SO, 2A and 4A) :

It is a well developed median bone, lying between the frontals posteriorly and forming the posterodorsal wall of the cranium. The bone is divided into a thick anterodorsal portion with a median and two lateral ridges converging posteriorly to form the supraoccipital crest. A thin, broad, blade like ventral portion of the bone extends ventrally upto the dorsal groove of the foramen magnum and forms an angle of less than 60° with the median longitudinal axis of the skull. The supraoccipital crest is convex dorsally and gradually merges to the thin portion ventrally. Anteriorly the lateral ridges of this bone are continuous with the lateral ridges of the frontals. Parietal is placed along its anterior margin but exoccipital lies ventral to it.

This bone varies specifically among all the species under study in respect of its shape, relative size and disposition. Anteriorly the median ridge of the supraoccipital forms a knob in *L. equulus* (Text-fig. 4B). In *L. bindus*, the thin ventral portion does not extend upto the furrow of the foramen magnum. In case of the species belonging to the genus *Secutor*, the supraoccipital crest is short and convex and the ventral thin blade like portion is oblique (Text-fig. 2E and F) like that of *L. splendens*. In *G. minuta* (Text-fig. 2G), the occipital crest is straight and the posterior margin of the ventral thin portion is vertical.

3.8. Parietal (Text-fig. 1PA and 2A) :

Located posterolateral to the frontal each parietal is a triradiate bone and contributes little to the formation of the roof of the cranium. It possesses a prominent concave ridge on the dorsal surface and another small ridge on the posterior surface in conjunction with the median ridge of the epiotic. Anteriorly the parietal is attached suturally to the pterotic, dorsally to the frontal and posteriorly to the supraoccipital. It overlaps the dorsal margin of the epiotic ventrally.

There is a marked difference in the shape of this bone among all the species studied here. In *L. equulus* (Text-fig. 2B) and *L. brevirostris* (Text-fig. 2D), the parietal is roughly petal shaped. In the former it does not bear a ridge like that of *L. splendens* but in latter there is a prominent ridge on its posterior surface. In *L. bindus* (Text-fig. 2C), it is roughly tetra-radiate with a prominent ridge on its posterior surface. In *S. insidiator* (Text-fig. 2E), *S. ruconius* (Text-fig. 2F) and *G. minuta* (Text-fig. 2G), this bone is irregular in shape and is elongated dorsoventrally. It is provided with a median ridge instead of anteroposterior elongation having concave ridge.

3.9 Posttemporal (Text-fig. 2A) :

Posttemporal serves as a bridge between the neurocranium and the pectoral girdle. It is a hook shaped bone having an elongated dorsal and small ventral arms. The dorsal arm is attached to the dorsomedian surface of the epiotic and the ventral arm to the intercalar. Posteriorly it is attached to the supracleithrum.

4. Basicranial Region :

This region contributes to the formation of the floor or base of the cranium and comprises the basioccipital, basisphenoid and parasphenoid of which the former two take part in the formation of auditory capsule.

4.1 Basioccipital (Text-fig. 1BO and 5A) :

This median bone takes part in the formation of the posterior wall of the myodome and is located posterior to the parasphenoid. Its lateral walls extend anteriorly so as to form a trough like structure (posterior myodome) and are attached to the prootic anterodorsally. The bone is partly overlapped by the parasphenoid. Posterodorsally it is attached to the exoccipital. The thick posterior end of the bone, has a deep concavity similar to that of centrum of a typical vertebra which bears a small median ridge at its posteroventral surface. Mesiolaterally it provides attachment to the Baudelot's ligament.

The general contour of this bone is more or less similar in all the species studied but for the shape of myodome is oval in *L. bindus* (Text-fig. 5C) and *S. insidiator* (Text-fig. 5E), conical in *L. equulus* (Text-fig. 5B), slender in *L. brevirostris* (Text-fig. 5D), *S. ruconius* (Text-fig. 5F) and *G. minuta* (Text-fig. 5G). In *L. brevirostris*, a thin elongated interoccipital septum exists at the posteroventral extremity of this bone.

4.2 Basisphenoid (Text-fig. 2A) :

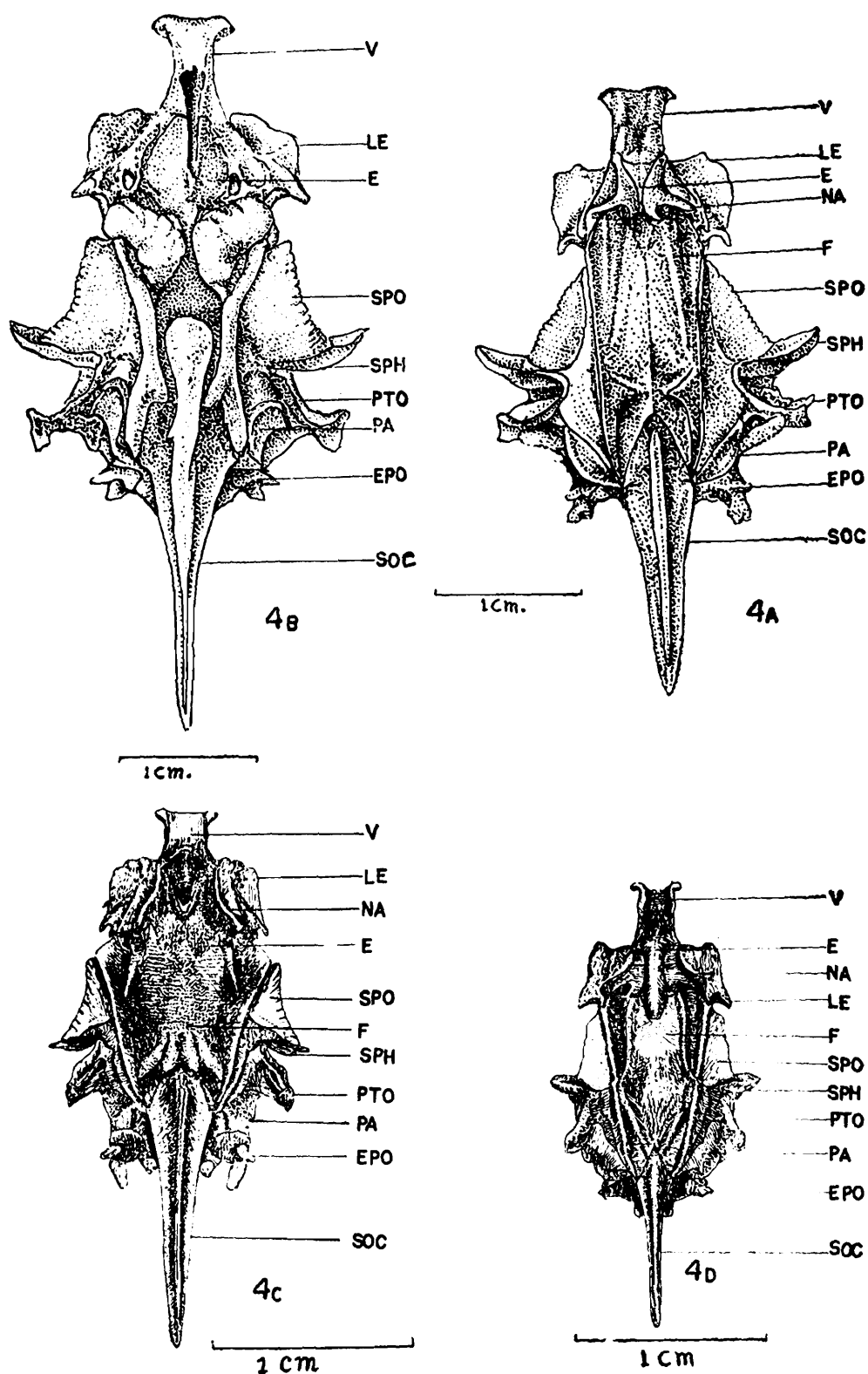
Basisphenoid is a small median Y-shaped bone and forms the ventral wall of the anterior myodome. It lies nearly vertical in the posterior region of the anterior half of the skull. The shank of Y is thin, elongated, directed downwards and forwards and is attached to the dorsomedian surface of the parasphenoid. The two arms of the Y are somewhat wide, dorsally concave and bounded by the prootic along its lateral as well as caudal region.

The bone is identical in all the species studied here.

4.3 Parasphenoid (Text-fig. 1PS and 2A) :

Parasphenoid, an elongated curved bone, bridging the otic and olfactory regions, is anteriorly dagger shaped and bears a groove for

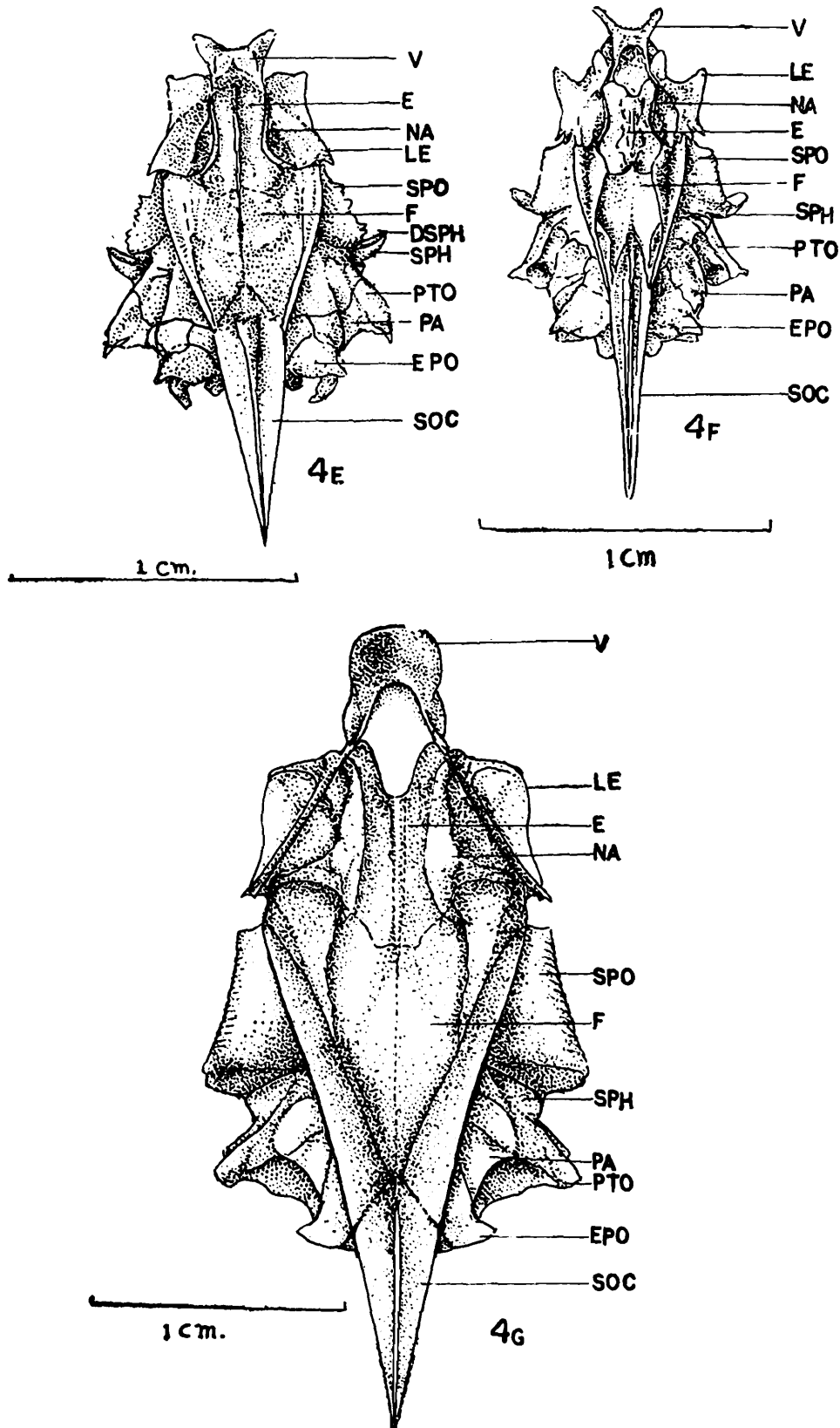
receiving posteriorly the pointed end of prevomer. Mesially it is keeled having two lateral wings, one on either side which impinges on the prootic. Posteriorly the bone bifurcates into slivers which overlap the



Text-fig. 4A—D. Dorsal view of the neurocranium.

- A. *Leiognathus splendens* (Cuvier)
- B. *Leiognathus equulus* (Forsskal)
- C. *Leiognathus bindus* (Valenciennes)
- D. *Leiognathus brevirostris* (Valenciennes)

basioccipital but do not extend up to the posterior extremity of the latter. Behind its lateral wing, it bears a small notch which is followed by a knob. It forms an angle less than 60° with the dorsomedian longitudinal axis of the skull.



Text-fig. 4E—G. E. *Secutor insidiator* (Bloch)
 F. *Secutor ruconius* (Hamilton)
 G. *Gazza minuta* (Bloch)

This bone is similar in all the species. However, in *S. insidiator* (Text-fig. 2E) and *S. ruconius* (Text-fig. 2F.), the parasphenoid forms an angle of more than 75° with dorsomedian longitudinal axis of the skull whereas in other species it forms an angle less than 60° .

5. Oromandibular Region :

The bones of this region contribute to the formation of the lower wall of the orbit, roof and floor of the mouth and connect the neurocranium with the branchiocranium through the palatine and the hyomandibula. This region comprises paired palatine, quadrate, metapterygoid, angular, pterygoid, premaxilla, maxilla, dentary and retroarticular.

5.1 Palatine (Text-fig. 1P and 6A) :

Palatine, a small and edentulous bone, connects the branchiocranium with the neurocranium. It has an anterodorsal arm and a broad ventroposterior shank which joins suturally with its respective ectopterygoid and entopterygoid distally. The proximal end of the palatine arm is overlapped by the lachrymal and is loosely connected with the nasal anterodorsally. It is attached to the lateral ethmoid dorsally, to the head of the prevomer anteroventrally and to the maxilla along its mesial and anterior end.

The above description is also applicable to *L. equulus* but in other species some differences exist. In *L. bindus* (Text-fig. 6C) and *L. brevirostris* (Text-fig. 6D), the palatine arm is thin elongated and directed upwards anteriorly. In *S. insidiator* (Text-fig. 6E), *S. ruconius* (Text-fig. 6F) and *G. minuta* (Text-fig. 6G), the arm is narrow and comma shaped.

5.2. Quadrate (Text-fig. 1A and 6A) :

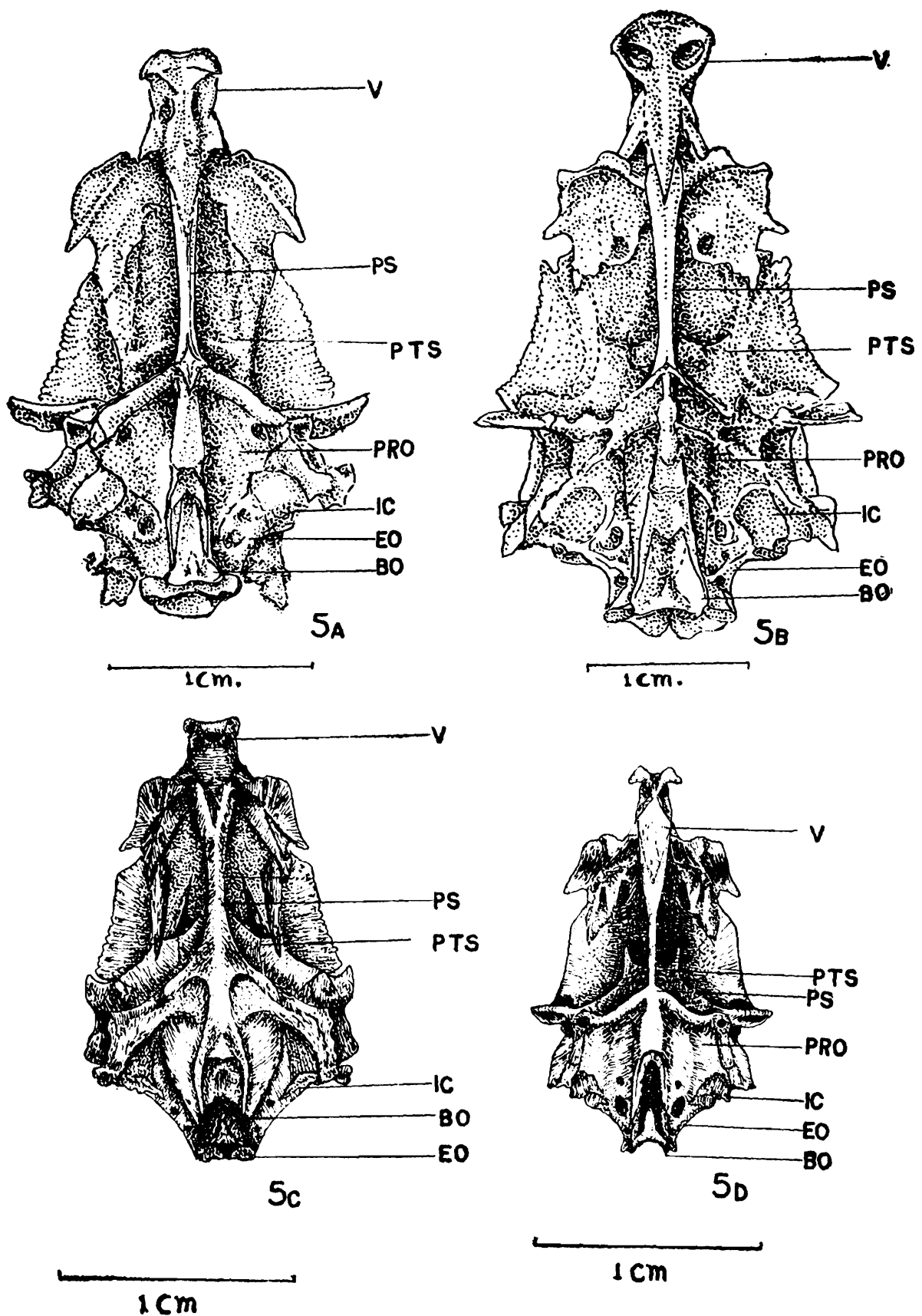
Quadrate, a triangular bone, is located anterior to the horizontal arm of the preopercular and possesses a double headed condyle along its apex that articulates with the angular. Its anterior arm forms a groove for providing attachment area to the ectopterygoid and the posterior arm is connected with the metapterygoid. Along its inner surface, it bears a groove that lodges the symplectic. Dorsoanteriorly it is attached to the entopterygoid.

There is no notable difference in respect of morphology of the quadrate in all the species studied.

5.3. Metapterygoid (Text-fig. 1MPT and 6A) :

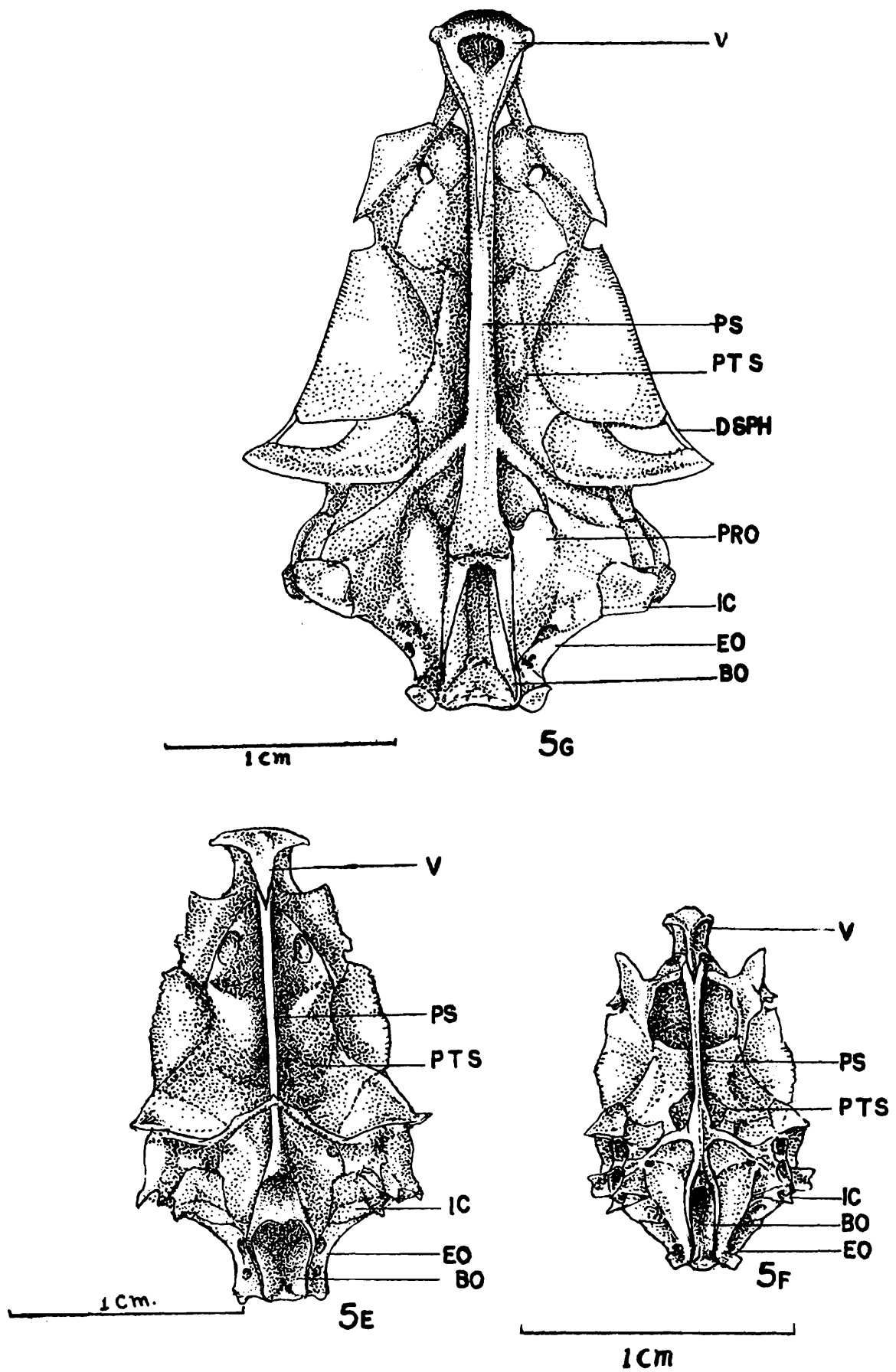
Metapterygoid, roughly crescentic, forming a part of the ventral wall of the orbit, lies dorsal to the quadrate. Anteriorly it is attached to the entopterygoid and joins the quadrate anteroventrally by a thin strip of cartilage. It is attached to the preopercular along its posterior margin and to the interhyal by ligament along its inner surface.

There is no worthmentioning difference in the metapterygoid of other species.



Text-fig. 5A—D. Ventral view of the neurocranium.

- A. *Leiognathus splendens* (Ouvier)
- B. *Leiognathus equulus* (Forsskal)
- C. *Leiognathus bindus* (Valenciennes)
- D. *Leiognathus brevirostris* (Valenciennes)



Text-fig. 5E—G. E. *Secutor insidiator* (Bloch)
 F. *Secutor ruconius* (Hamilton)
 G. *Gazza minuta* (Bloch)

5.4. Angular (Text-fig. 1A and 2A) :

Angular, roughly wedge shaped, slightly concave, lying behind the dentary, is proximally broad and inserted into the ventral pocket of the dentary. Distally the narrow portion forms the articulating facet for the head of quadrate. Anteriorly it is closely applied to the angular. The maxillo-mandibular ligament is inserted at its inner aspect.

The above description applies to the other species but in *L. equulus*, it is semiellipsoidal in shape with almost straight anterior margin.

5.5. Ectopterygoid (Text-fig. 1ECT and 6A) :

The ectopterygoid is an elongated curved bone and is located behind the palatine. Its proximally broad portion is attached with the distal surface of the palatine and the distally narrow portion running over the quadrate is attached to the entopterygoid posteriorly.

This bone is similar in all the species under study.

5.6. Entopterygoid (Text-fig. 1ENT and 6A) :

Entopterygoid, a thin irregular shaped bone, taking part in the formation of the lower wall of the orbit, lies posterior to the ectopterygoid. Proximally it is attached to the distal surface of the lateral ethmoid and distally to the quadrate and metapterygoid. The bone is not well ossified in comparison to ectopterygoid.

There is no worthmentioning difference in the entopterygoid of other species.

5.7. Premaxilla (Text-fig. 1 PM and 2A) :

Each premaxilla consists of a curved elongated ventral portion and a slender ascending process which extends posteriorly up to the posterior half of the frontal. The ventral portion bears a knob posteromedially and is rounded distally. The bone is slender and is attached to its fellow of either side proximally. It is overlapped by the maxilla distally, specially when the mouth is closed. Dorsally it is loosely attached to the lachrymal and possesses a single row of small villiform teeth along its entire portion forming the gape of mouth.

The above description applies to *L. bindus* and *L. brevirostris* except a distinct anterodorsal projection in the latter species. In *L. equulus* (Text-fig. 2B), the teeth are present only in half of its total length towards the symphysis and the bone bears a deep broad notch below the teeth bearing portion. In *S. insidiator* (Text-fig. 2E) and *S. ruconius* (Text-fig. 2F) its distal portion is flattened. In *G. minuta* (Text-fig. 2G), the distal end of this bone is triknobed and presence of a caninoid tooth along with the villiform teeth readily distinguishes this species from the other species.

5.8. Maxilla (Text-fig. 1MX) :

Maxilla, is a toothless, long, S-shaped bone and lies posterior to the premaxilla. Its proximal end bears two projections forming a cup like depression in conjunction with the fellow of the other side and provides a sliding movement to the premaxillary process. Posteriorly it extends into a shaft which is free and lies over the dentary. The bone is overlapped by the lachrymal proximally and gives the attachment to the maxillo- mandibular ligament along its inner aspect.

The bone is similar in all the species under study.

5.9. Dentary (Text-fig. 1D) :

Dentary, the anterior most element of the lower jaw, is roughly plough shaped and bears minute villiform teeth along its entire portion and forms the gape of the mouth. The anterior portion of this bone proximally meets its fellow of the other side at the symphysis and its posterior somewhat narrow portion is outwardly oblique and overlapped by the premaxilla. Posteroventrally the bone bears a pocket for the insertion of the anterior process of the angular and its narrow distal portion is attached to the retroarticular.

In *L. equulus*, *L. brevirostris* and *L. bindus*, the shape of this bone is identical with that of *L. splendens* but the arrangement of teeth differs specifically. In the first species the teeth are present in many rows along the half of its total length towards the symphysis while in *L. brevirostris*, teeth are uniformly present in many rows along its entire length (Text-fig. 2B). In *G. minuta*, the bone bears caninoid teeth (Text-fig. 2G). In *S. insidiator* and *S. ruconius*, the dentary is hook-shaped.

5.10. Retroarticular (Text-fig. 1AN) :

Retroarticular, the smallest bone of the lower jaw lies anteroventral to the angular. It is triangular in shape and bears a shallow concavity along its base for providing the attachment area to the mandibulo-interopercular ligament. It is attached posteriorly to the angular.

There is no marked difference in respect of disposition of this bone in all the species.

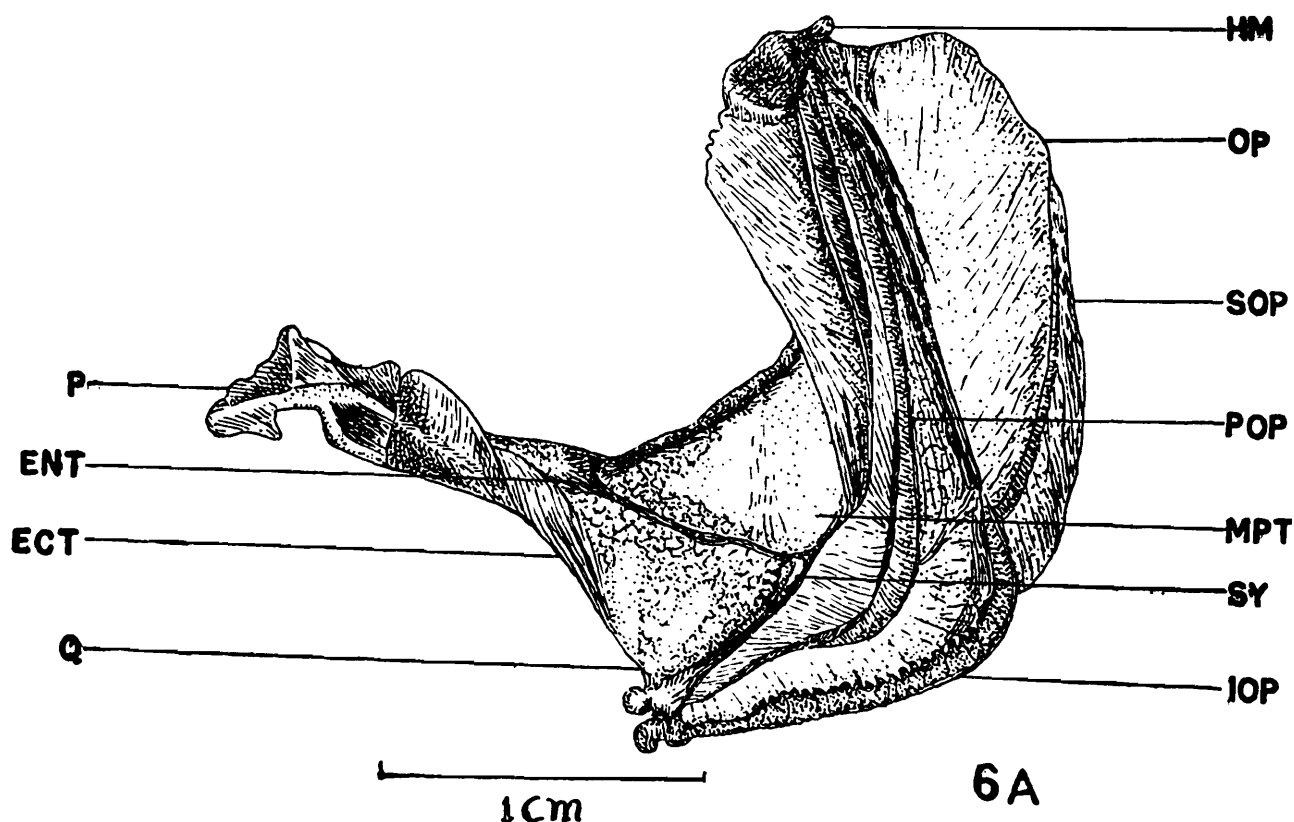
6. Hyoid Region :

The hyoid region which connects the oromandibular and the otic region is composed of paired hyomandibula, symplectic, interhyal, epihyal, opercular, preopercular, subopercular, interopercular, branchiostegal as well as unpaired urohyal and basihyal. The bones of this region take part in the respiratory and feeding movements of the jaws.

6.1. Hyomandibula (Text-fig. 1HM and 6A) :

Hyomandibula is a fan shaped bone with a distinguished head and an elongated distally narrow blade which bears a shallow groove along its posterior surface for receiving the anterodorsal arm of preopercular. Anteriorly it is bounded by the metapterygoid. The head of this bone consists of three condyles, the anterior condyles articulate with the ventrolateral facets of sphenotic and pterotic respectively and the posterior condyle articulates with the anterior articulating surface of the opercular. The hyomandibula bears a poorly developed channel like fossa on its proximal half of the ventromesial region for the passage of nerves. It connects the suspensorial bone with the neurocranium.

The above description applies also to other species as well.



Text-fig. 6A—G. Suspensorial bones of the left side.

A. *Leiognathus splendens* (Cuvier)

6.2. Symplectic (Text-fig. 2A) :

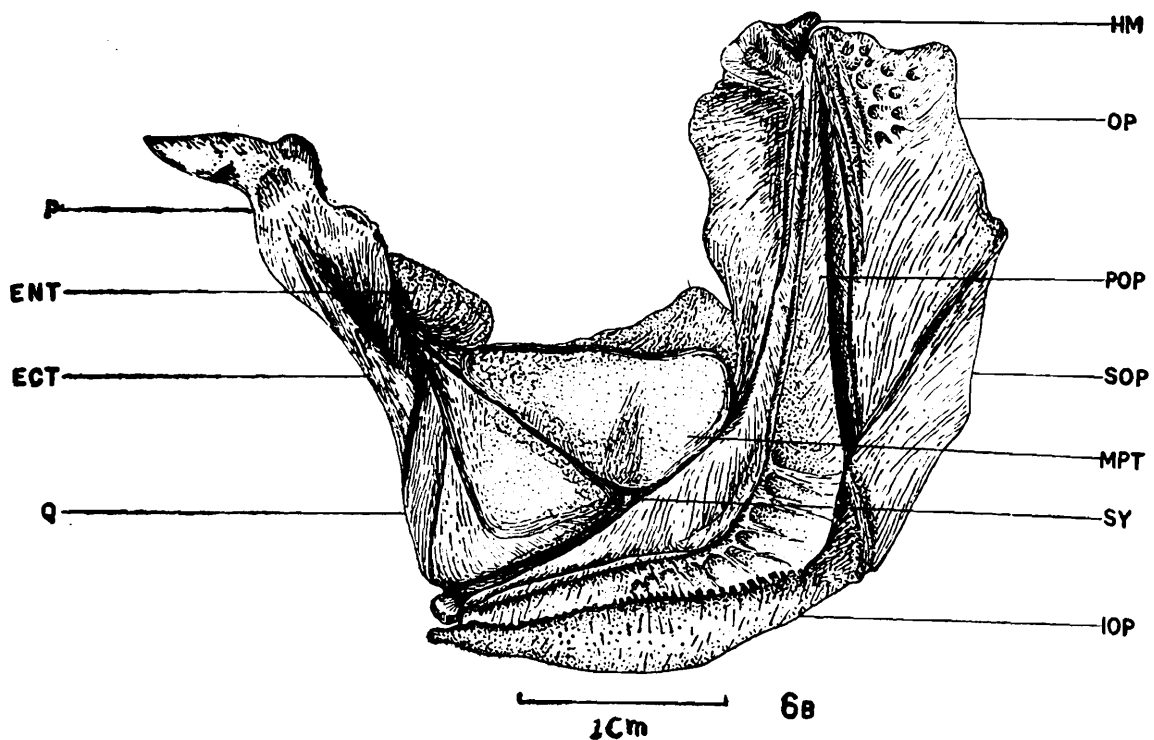
Symplectic is a poorly developed elongated bone lying in the posterior groove of the quadrate. Proximally it is attached to the metapterygoid and preopercular and joins the hyomandibula by a thin ligament.

There is no difference in respect of this bone among the species of the genera *Leiognathus* and *Gazza*. However, it is absent in *S. insidiator* and *S. ruconius*.

6.3. Interhyal (Text-fig. 1IH) :

Interhyal, a tiny rod shaped bone serving as the posterior suspensory element, is located anterior to the epihyal. At one end it is attached to the metapterygoid by ligament and at the other end to the epihyal. Laterally the bone is jointed with the preopercular and ventrally with the quadrate. Hyomandibula does not have any attachment with this bone like those of other percoid fishes.

This bone is similar in all the species under study.



Text-fig. 6B. *Leiognathus equulus* (Forsskal)

6.4. Epihyal (Text-fig. 1EH) :

Epihyal is a roughly triangular bone lying behind the interhyal with which it articulates along the narrow apex. The broad base of the bone is sutured with the ceratohyal.

The bone is similar in all the species.

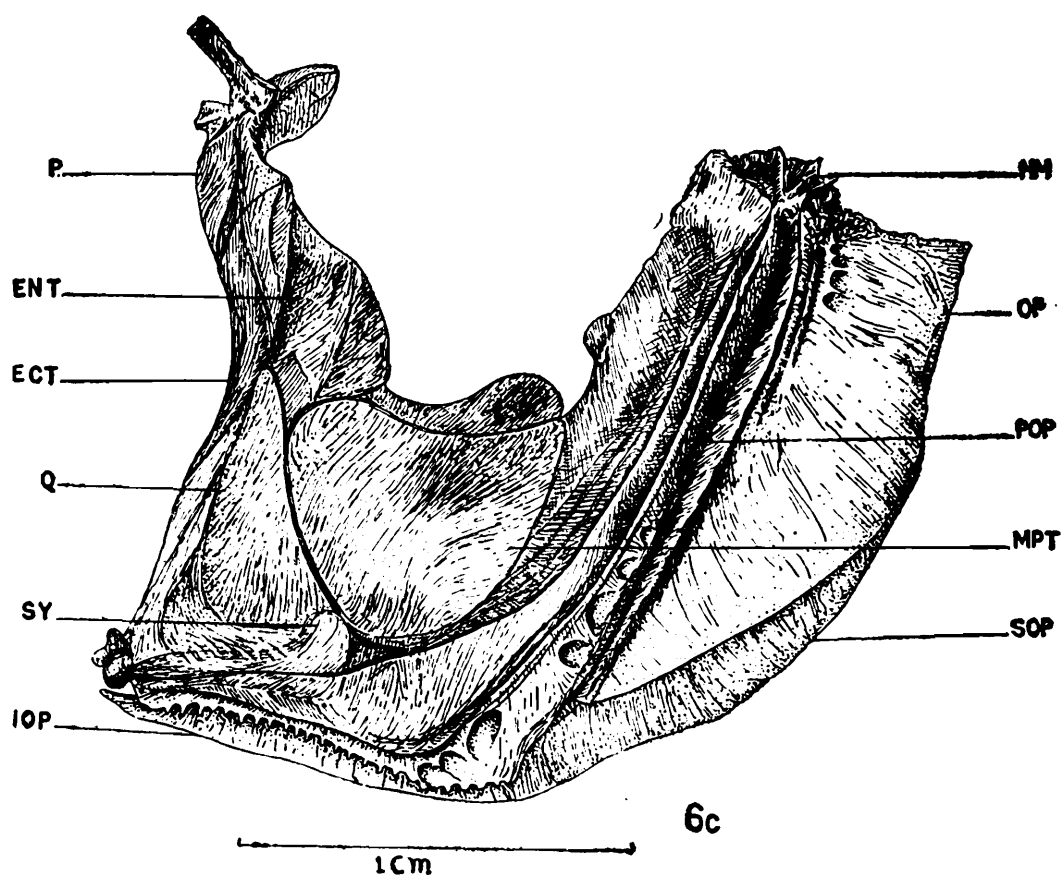
6.5. Ceratohyal (Text-fig. 1CH) :

Ceratohyal, the biggest element of the hyoid cornu, lies inner to the metapterygoid. It is narrow anteriorly and bears a knob like projection anteroventrally which articulates with the hypohyal. Posteriorly its broad portion is attached to the epihyal. Ventrally the ceratohyal gives attachment to the branchiostegal rays.

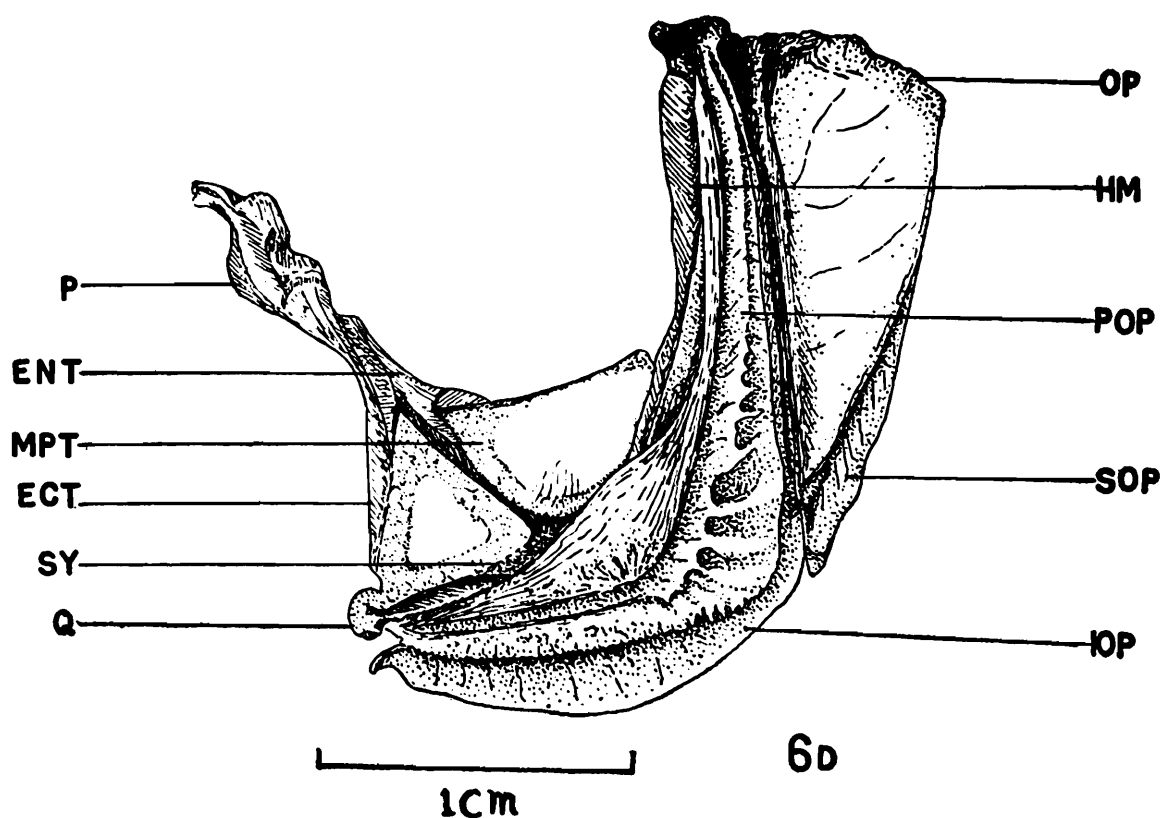
In all the species this bone is similar to that of *L. splendens*,

6.6. Hypohyal (Text-fig. 1H) :

The hypohyal presents the upper and lower elements in it. The upper element i. e. upper hypohyal is thick, broad and joins its fellow



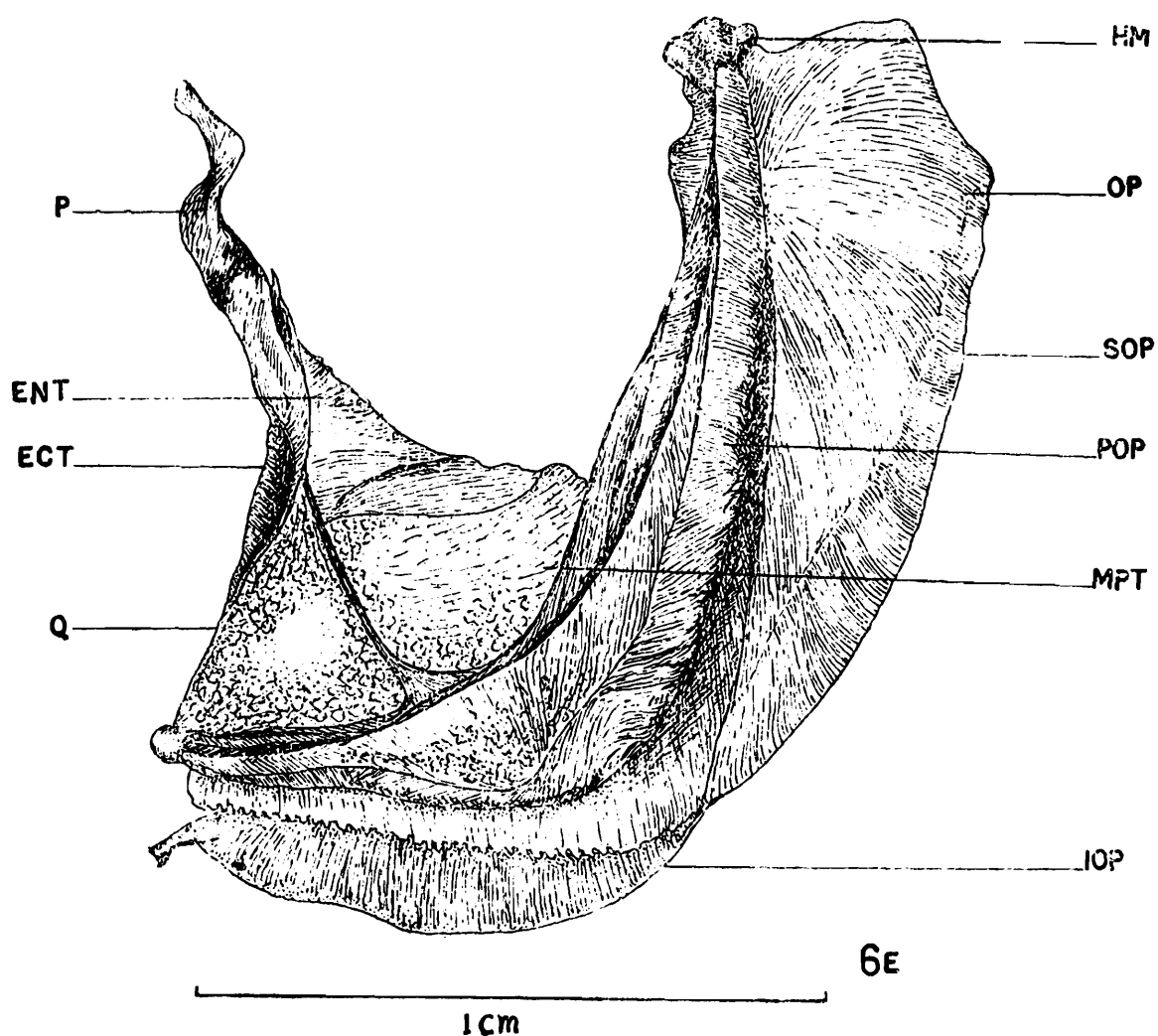
Text-fig. 6C. *Leiognathus bindus* (Valenciennes)



Text-fig. 6D. *Leiognathus brevirostris* (Valenciennes)

of the opposite side at the middle and gives attachment to the basihyal dorsoanteriorly. It is attached to the ceratohyal posteriorly and to the lower hypohyal ventrally. The lower element i. e. lower hypohyal is a comparatively small curved bone and bears a concavity for the articulation of the ceratohyal.

The above description also applies to other species.



Text-fig. 6E. *Secutor insidiator* (Bloch)

6.7. Basihyal (Text-fig. 1BH) :

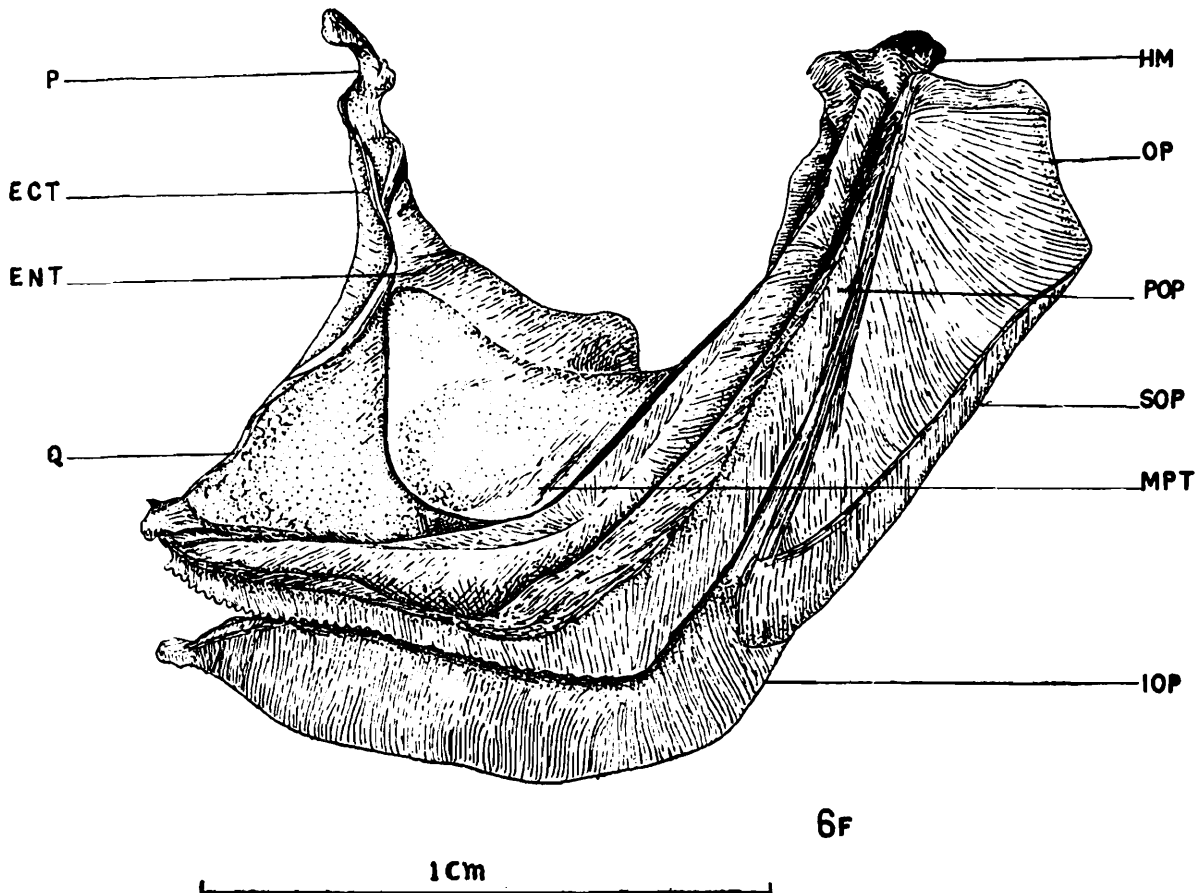
Basihyal is roughly a tumbler-shaped bone with a broad, free anterior end and narrow disc-like posterior end which is attached to the antero-dorsal surface of the hypohyals. There is a ligamentous attachment between it and hypohyals ventrally.

The above description applies to all the species studied except *L. equulus*, where it is triangular in shape.

6.8. Preopercular (Text-fig. 1POP, 2A and 6A) :

Preopercular is a crescentic bone, lying proximally over the postero-dorsal surface of the head of hyomandibula and is located anterior to

the preopercular. It consists of a narrow elongated vertical and a broad horizontal arm. It is comparatively broad at the junction between its vertical and horizontal arm. The horizontal arm is slightly oblique along its lower margin and possesses dentated edge as well as ridge. The vertical arm forms a socket anteriorly for receiving the hyomandibular blade and is attached to the opercular posteriorly. Anteromesially it is attached to the metapterygoid and to the interopercular anteroventrally.



Text-fig. 6F. *Secutor ruconius* (Hamilton)

There is no marked difference in the position of this bone among other species except that the ridge of the horizontal arm is smooth. The horizontal arm is somewhat rounded along its posterior margin in *S. insidiator* (Text-fig. 2E), *S. ruconius* (Text-fig. 2F) and *G. minuta* (Text-fig. 2G).

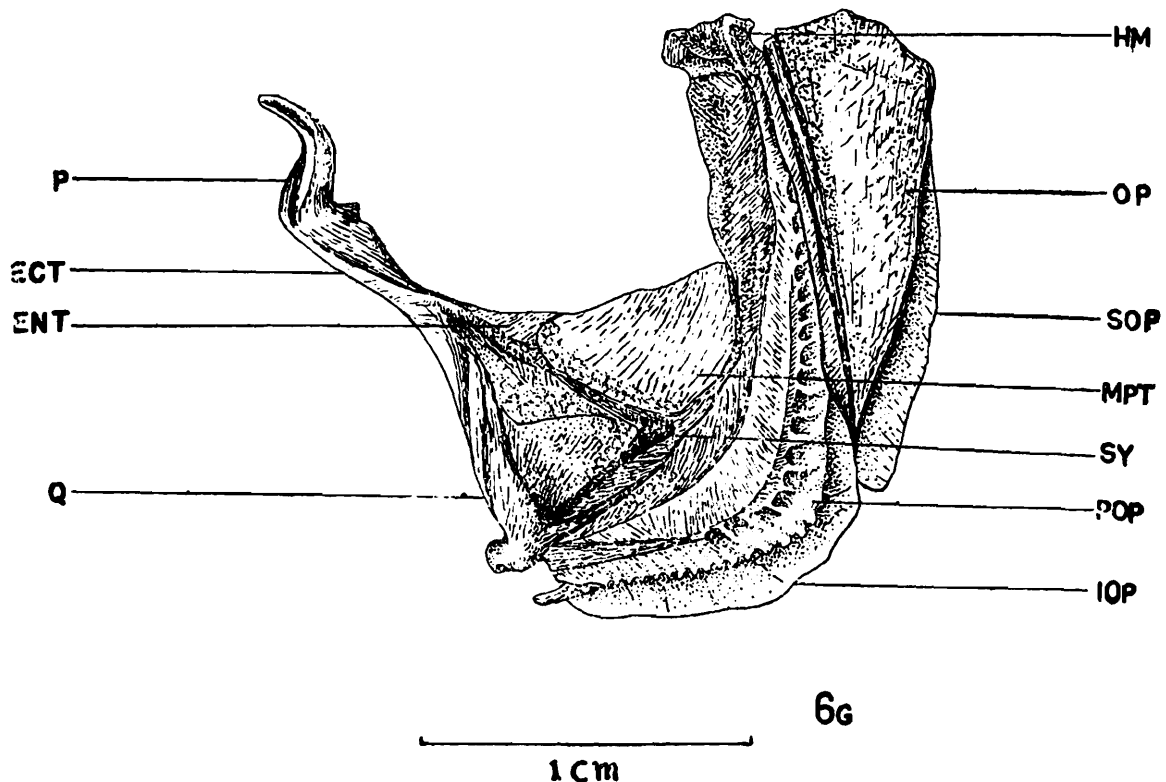
6.9. Interopercular (Text-fig. 1IOP) :

A thin chopper-shaped interopercular is situated anterior to the subopercular. It is thickened along its anterolateral margin and bears a notch ventromesially for lodging the apex of the epihyal. Proximally it is narrow and is attached to the retroarticular by mandibulo-interopercular ligament and distally to the subopercular by means of connective tissue.

The above description also applies to other species.

6.10. Subopercular (Text-fig. 1SOP and 2A) :

The subopercular is a thin flat bone with a broad blunt proximal end and a pointed distal end. Dorsally it is attached to the distal portion of the preopercular and proximally to the interopercular.



Text-fig, 6G. *Gazza minuta* (Bloch)

It is similar in all the species studied.

6.11. Branchiostegal (Text-fig. 1BS) :

There are five branchiostegal rays on the either side of the skull. Distally they are free but connected with each other by a membrane. Proximally the first four rays are attached to the ventral edge of ceratohyal and the fifth one is attached at the junction of the epihyal and ceratohyal. The fifth, posterior most ray is longest and leaf like while the others decrease in size gradually in the posteroanterior direction.

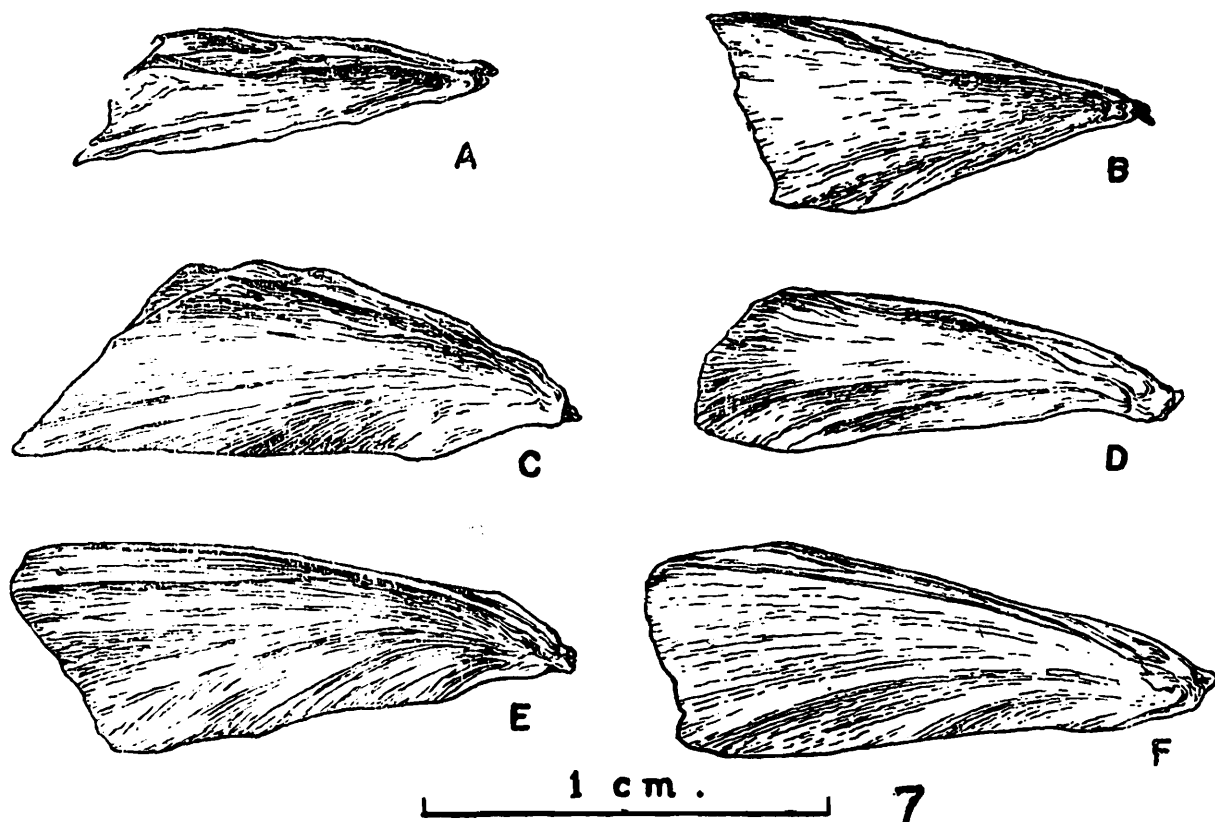
The above description applies to all the species, although in *S. insidiator*, *S. ruconius* and *G. minuta*, the last ray (5th) is attached to the epihyal only.

6.12. Urohyal (Text-fig. 7A) :

Urohyal, a well developed triradiate bone is located in the midventral line between the two halves of the hyoid cornu. It consists of one vertical and two horizontal wings. The proximal narrow and distally broad horizontal wings form a rhomboid. The urohyal is

attached to the hypohyals by ligament proximally and lies between the posteroventral surface of the cleithra distally.

The ventral aspect of this bone differs specifically. In *L. equulus* (Text-fig. 7C), it is wedge shaped, in *L. bindus* (Text-fig. 7B), spear shaped and slender in *S. insidiator*, *S. ruconius* (Text-fig. 7E), and *G. minuta* (Text-fig. 7F).



Text-fig. 7A—F. Lateral view of the urohyal.

- A. *Leiognathus splendens* (Cuvier)
- B. *Leiognathus bindus* (Valenciennes)
- C. *Leiognathus equulus* (Forsskal)
- D. *Leiognathus brevisrostris* (Valenciennes)
- E. *Secutor insidiator* (Bloch)
- F. *Gazza minuta* (Bloch)

DISCUSSION

The comparative study of the cranial osteology in the three genera (*Leiognathus*, *Secutor* and *Gazza*) comprising seven species of leiolepis reveals that the general pattern of their osteocranium agrees with the typical percoid characters. Berg (1940), Regan (1913), Starks (1911), Delsman (1925) and Greenwood *et al.* (1966) have described such characters of the percoids. The common percoid characters as listed in the seven species include protractile mouth, development of a large frequently mobile premaxilla, exclusion of maxilla from the gape of mouth, the loss of maxillary, parasphenoid and pterygoid teeth, forked

posttemporal, reduction in size of the infraorbital (=Suborbital) bones, ethmoid (=mesethmoid of Berg, 1940) in contact with the prevomer, presence of Baudelot's ligament which extends up to the basicranium, presence of basisphenoid and loss of the orbitosphenoid.

The present comparative study records a great number of intergeneric and intrageneric variations in respect of the various regions of the osteocranium. The bones of the olfactory regions exhibit some intrageneric variations in respect of the configuration of the lateral ethmoid and prevomer. For example, there is only one antorbital spine in *S. insidiator* while two such antorbital spines are present on each lateral ethmoid in all the other species. Moreover, there is a single fontanel on the ventral aspect of the prevomer in *G. minuta*, two in *L. equulus* and no fontanel in other species.

The bone of the orbital region seems to be of much taxonomic significance since they reveal intergeneric difference such as the frontals forming a Y-shaped structure in the genera *Leiognathus* and *Secutor* vs. V-shaped in *Gazza*. The intrageneric variations include the presence of comma-shaped ridge on the posterior half of the frontals in *L. splendens* and *L. bindus* while other species do not possess any such structure. In addition the circumorbital sereis are incomplete in case of *L. bindus* and *G. minuta* but complete in the rest of the species.

In the otic region three bones i. e. supraoccipital, exoccipital and parietal show differences in respect of their configuration and relative disposition at generic as well as specific level. Starks (1911) interpreted the disposition of supraoccipital crest in terms of phylogenetic relationships among the scombroid fishes. The relative size and shape of supraoccipital crest seems to be diagnostic features in the identification of leiognathids genera. For example, the supraoccipital crest is elongated and curved in the genus *Leiognathus*, short and curved in *Secutor* and short and straight in the genus *Gazza*. In *L. fasciatus*, Starks (*op. cit.*) pointed out that the supraoccipital did not reach the foramen magnum and considered it as a family character. However, such a character varies specifically inasmuch as it extends upto the furrow of the foramen magnum in all species studied except in *L. bindus*. Further, the disposition of the posteroventral margin of the supraoccipital process plays an important role in the generic diagnosis of the family Leiognathidae since it is oblique (Text-fig. 2a, b, c, d, e and f) in the genera *Leiognathus* and *Secutor* and vertical to the median longitudinal axis of the skull in the genus *Gazza*. The general contour of the exoccipital does not vary significantly but the number of foramina present on this bone reveals intergeneric differences. Starks

(1911) observed three foramina in the exoccipital of *L. fasciatus* and opined that this was a characteristic feature of the family Leiognathidae. Presence of two foramina in the species of the genus *Secutor* and three in the other species of the genera *Leiognathus* and *Gazza* clearly indicate that the number of foramina in exoccipital as well as the relative length and shape of the supraoccipital crest can not be taken as a diagnostic character of the family as pointed out by Starks (*op. cit.*).

In the basicranial region the shape of the posterior myodome and the disposition of parasphenoid vary specifically. The extension of bifurcated portion of the parasphenoid upto the posterior end of the basioccipital is a constant feature of the species belonging to the genera *Secutor* and *Gazza* while species specific variation occurs among the species of the genus *Leiognathus*. The disposition of this bone also differs at a generic level since it forms an angle of more than 75° with the dorsomedian longitudinal axis of the skull in the genus *Secutor* and less than 60° (Text-fig. 2g) in the genera *Leiognathus* and *Gazza*. It seems that the disposition of basioccipital is associated with the direction of the protrusibility of the mouth since the oral tube protrudes upwards in *Secutor* but horizontally forwards or slightly downwards in *Leiognathus* and *Gazza*.

The bones of the oromandibular region are of much taxonomic and phylogenetic significance. The movable premaxillaries with a long posterior process exhibit a typical percoid character. Moreover the configuration of this bone shows intergeneric differentiation. In the genus *Leiognathus* it bears villiform teeth and its distal end is rounded. In the genus *Secutor*, the teeth are also villiform but the distal end of the bone is truncated. In *Gazza* it bears caninoid teeth and its distal end is triknobed. Further relative size of the premaxillary process is species specific which helps in the extent of protrusion of the mouth. The ontogenic gradation of the symplectic bone, which is poorly developed in the species of the genera *Leiognathus* and *Gazza* and is totally absent in the species of the genus *Secutor*, shows a departure from other percoids where the bone remains well developed. The attachment of the interhyal with the metapterygoid instead of hyomandibula is another specialized feature of these fishes since it is attached to the hyomandibula, in other percoids. Starks (1911) reported it as a family character. Day (1887), Regan (1913), Weber and de Beaufort (1931), Munro (1955) and James (1978) reported the preopercular's edge of these fishes is serrated (a characteristic feature of the family Leiognathidae). However, we have also observed the preopercular's

ridge as serrated in two species of the genus *Leiognathus* (*L. splendens* and *L. indicus*) in addition to the serrated preopercular's edge. This character seems to be of an additional aid in elucidating the systematic identity of the species of the genus *Leiognathus*. The general contour and configuration of the urohyal bone depicts intrageneric variations (Text-fig. 7A, B, C, D, E and F).

In view of foregoing discussion it is concluded that the osteological attributes as exhibited by the osteocranium of these fishes play an important role in the derivation of phylogenetic relationships and also in delineating the taxonomic identity of various taxa at generic as well as specific level. The osteological key for differentiating the genera as well as species under each genus is provided below.

Key to the genera

1. Supraoccipital crest convex, posteroventral margin of supraoccipital process oblique forming an angle of less than 60°. Caninoid teeth absent. Distal end of premaxilla rounded or truncated. ... 2
 Supraoccipital crest straight, posteroventral margin of supraoccipital process vertical. Caninoid teeth present. Distal end of premaxilla triknobed. ... *Gazza*
2. Symplectic present, distal end of premaxilla round, parasphenoid forms an angle of less than 60° with dorsomedian longitudinal axis of the skull, exoccipital with three foramina. ... *Leiognathus*
 Symplectic absent, premaxilla with truncated distal end, parasphenoid forms an angle more than 75° with the dorsomedian longitudinal axis of the skull, exoccipital with two foramina. ... *Secutor*

Key to the species of genus *Secutor*

1. One antorbital spine, posterior myodome oval... *insidiator*
 Two antorbital spines, posterior myodome slender. ... *ruconius*

Key to the species of genus *Leiognathus*

1. Gape of mouth (premaxilla + dentary) entirely toothed. Prevomer square shaped without any fontanel on its ventral surface. Basihyal tumbler shaped. ... 2

- Gape of mouth (premaxilla+dentary) not toothed entirely. Vomer dumbbell shaped with two fontanelle on its ventral surface. Basihyal triangular. ... *equulus*
2. Circumorbital chain complete. Parietal petal shaped or triradiate. Ventral thin portion of supraoccipital extends upto furrow of foramen magnum. Urohyal rhomboidal in its ventral aspect. ... 3
- Circumorbital chain incomplete, Parietal tetraradiate. Ventral thin portion of supraoccipital not extends upto the furrow of foramen magnum. Urohyal spear shaped in its ventral aspect. ... *bindus*
3. Parietal triradiate. Frontal with a comma shaped ridge on its posterior aspect. Premaxillary process extends upto the posterior half of the frontal. Posterior myodome oval. ... *splendens*
- Parietal petal shaped. Frontal without comma shaped ridge on its posterior aspect. Premaxillary process extends upto the supraoccipital. Posterior myodome slender. ... *brevirostris*

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ON A COLLECTION OF FLOWER FLIES (DIPTERA :
SYRPHIDAE) WITH NEW RECORDS FROM
JAMMU AND KASHMIR

By

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(With 14 Text-figures)

INTRODUCTION

This report is based on the material from Jammu and Kashmir, collected by the senior author in a party led by Dr. R. C. Basu of the Zoological Survey of India in 1977. Of 25 species reported here, 18 species (with an asterisk) are recorded for the first time from the State. In addition, illustrations of male terminalia of 14 species are incorporated in an attempt to establish stability in generic and specific definition. For the preparation of terminalia studies, Nayar (1968) is followed.

SYSTEMATIC ACCOUNT

Subfamily SYRPHINAE

Tribe SYRPHINI

* 1. *Asarkina* (*Asarkina*) *ericetorum* (Fabricius)

(Text-fig. 1 a-b)

1781. *Syrphus ericetorum* Fabricius, *Spec. Insect.*, 2 : 425.

1915. *Asarcina ericetorum* (Fabricius) : Brunetti, *Rec. Indian Mus.*, 11 : 210.

1975. *Asarkina* (*Asarkina*) *ericetorum* (Fabricius) : Knutson *et al.*, *A catalog of Diptera of the Oriental Region*, 2 : 309.

Material examined : 1 ♂ (ZSI Reg. No. 5665/H₆) on flowers of *Solanum nigrum*, Talab Tiloo, Jammu, 2.x.1977 ; 1 ♂ (ZSI Reg. No. 5666/H₆) on flowers of *Lantana camara*, Circuit House campus, Jammu, 4.x.1977 ; 2 ♀ ♀ (ZSI Reg. Nos. 5667/H₆ & 5668/H₆) on *Amaranthus spinosa* and *Commelina bengalensis*, Udampur, 27.ix.1977 and 28.ix.1977.

Distribution : This species has been reported to occur throughout the Orient and has also been reported from Africa, Australia, Fiji, Moluccas, New Guinea and Samoa (Knutson *et al.*, 1975).

***2. Episyrphus balteatus (De Geer)**

1776. *Musca balteata* De Geer, *Me'm. pour serv. Hist. Ins.*, 6 : 116.
 1908. *Syrphus balteatus* (De Geer) : de Meijere, *Tijdschr. Ent.*, 51 : 297.
 1975. *Episyrphus balteatus* (De Geer) : Knutson *et al.*, *A catalog of Diptera of the Oriental Region*, 2 : 314.

Material examined : 1 ♂ (ZSI Reg. No. 5670/H₆) on *Foeniculum vulgare*, Baramula, 17.ix.1977 ; 1 ♂, 2 ♀ ♀ (ZSI Reg. Nos. 5671/H₆ - 5673/H₆) on *Cannabis* sp. and *Trifolium repens*, Bijbihara, 22.ix.1977 ; 6 ♂ ♂, 4 ♀ ♀ (ZSI Reg. Nos. 5674/H₆-5683/H₆) on *Rubus ellipticus*, *Nicotiana plumbaginifolia*, *Commelina obliqua* and *Climatis* sp., Udhampur, 27.ix.1977-28.ix.1977 ; 4 ♂ ♂, 6 ♀ ♀ (ZSI Reg. No. 5684/H₆-5693/H₆) on *Lantana camara*, *Justicia simplex*, *Commelina bengalensis* and *Climatis* sp., Jammu Circuit House area, 1.x.1977-4.x.1977 ; 1 ♂, 1 ♀, (ZSI Reg. Nos. 5694/H₆-5695/H₆) on *Justicia simplex*, Sankarnarayanpur, 20. ix. 1977 ; 1 ♂ (ZSI Reg. No. 5696/H₆) on *Lantana camara*, Anantnag, 23.ix. 1977 ; 1 ♂ (ZSI Reg. No. 5697/H₆) on *Climatis* sp., Chhatabal, 18. ix. 1977 ; 1 ♂, 2 ♀ ♀ (ZSI Reg Nos. 5698/H₆-5700/H₆) on *Launaea asplenifolia*, Gulmarg, 13.ix. 1977 ; 3 ♀ ♀ (ZSI Reg. Nos. 5701/H₆-5703/H₆) on *Duranta plumieri*, Raipur, 3. x. 1977 ; 1 ♀ (ZSI Reg. No. 5704/H₆) on *Solanum nigrum*, Talab Tiloo, 1.x. 1977.

Distribution : The species has been reported to occur in the entire Oriental region (Knutson *et al.*, 1975), and has also been reported from Australia, Bonin Islands and the Palaearctic region.

The male terminalia of the species has been illustrated by Vockeroth (1969).

***3. Ischiodon scutellaris (Fabricius)**

1805. *Scaeva scutellaris* Fabricius, *Syst. Antliat.*, p. 252.
 1975. *Ischiodon scutellaris* (Fabricius) : Knutson *et al.*, *A catalog of Diptera of the Oriental Region*, 2 : 315.

Material examined : 1 ♀ (ZSI Reg. No. 5669/H₆) on *Panicum* sp., Raipur, 3. x. 1977.

Distribution : This species has been reported to have wide distribution from the South-East Asia to Japan. This has also been reported from Australia, Hawaii and Micronesia (Knutson *et al.*, 1975). In Jammu and Kashmir the population of the species is seemingly very low.

4. Ischyrosyrphus sp.

Material examined : 1 ♂ (ZSI Reg. No. 5705/H₆) on *Cannabis sativa*, Pahalgam, 25.ix. 1977.

Remarks : The single unique specimen is left for future study with further material.

5. *Sphaerophoria scripta* (Linnaeus)

1758. *Musca scripta* Linnaeus, *Syst. Nat. Ed.*, 10 : 594.

1975. *Sphaerophoria scripta* (Linnaeus) : Knutson *et al*, *A catalog of Diptera of the Oriental Region*, 2 : 319.

Material examined : 40 ♂♂, 34 ♀♀ (ZSI Reg. Nos. 5706/H₆-5778/H₆) on *Solanum nigrum*, *Ammania* sp., *Justicia simplex*, *Digitaria sanguinalis* and *Cynodon* sp., Anantnag, 23.ix.1977 ; 74 ♂♂, 38 ♀♀ (ZSI Reg. Nos. 5779/H₆-5891/H₆) on *Cannabis* sp., *Chrysanthemum* sp., *Justicia simplex* and *Cynodon* sp., Bijbihara, 22. ix. 1977 ; 46 ♂♂, 31 ♀♀ (ZSI Reg. Nos. 5892/H₆-5968/H₆) on *Eleusine* sp., *Panicum* sp., *Cannabis sativa* and *Duranta plumieri*, *Kamarwari kamarwari*, 20. ix. 1977 ; 2 ♂♂, 3 ♀♀ (ZSI Reg. No. 5969/H₆-5973/H₆) on *Cynodon* sp., Rajbagh, 16.ix.1977 ; 12 ♂♂, 23 ♀♀ (ZSI Reg. Nos. 5974/H₆-6008/H₆) on *Solanum nigrum*, *Eleusine indica* and *Cynodon* sp., Kabutarkhana, 19. ix. 1977 ; 23 ♂♂, 17 ♀♀ (ZSI Reg. Nos. 6009/H₆-6048/H₆) on *Launaea* sp., *Eleusine* sp. and *Cynodon* sp., Gulmarg, 13. ix. 1977 ; 23 ♂♂, 17 ♀♀ (ZSI Reg. Nos. 6049/H₆-6088/H₆) on *Sida* sp., *Tridax* sp., *Sonchus asper* and *Eleusine indica*, Chhatabal, 18. ix. 1977 ; 5 ♂♂, 16 ♀♀ (ZSI Reg. Nos. 6089/H₆-6109/H₆) on *Chrysanthemum* sp., *Cannabis* sp. and *Tridax* sp., Hazratbal, 14. ix. 1977 ; 3 ♂♂, 3 ♀♀ (ZSI Reg. Nos. 6110/H₆-6115/H₆) on *Cannabis* sp. and *Cynodon* sp., Lalmandi, Srinagar, 10.ix.1977 ; 7 ♂♂, 22 ♀♀ (ZSI Reg. Nos. 6116/H₆-6144/H₆) on *Foeniculum vulgare*, *Chenopodium ambrosoides*, *Polygonum orientale* and *Eleusine* sp., Baramula, 17.ix. 1977 ; 4 ♂♂, 4 ♀♀ (ZSI Reg. Nos. 6145/H₆-6152/H₆) on *Cannabis sativa* and *Cynodon* sp., Pahalgam, 25.ix.1977 ; 1 ♂ (ZSI Reg.No. 6153/H₆) on *Cynodon* sp., Sankarnarayanpur, 28.ix.1977 ; 2 ♂♂ (ZSI Reg. Nos. 6154/H₆-6155/H₆) on *Nicotiana plumbaginifolia*, Udampur, 27.ix.77 ; 2 ♂♂ (ZSI Reg. Nos. 6156/H₆-6157/H₆) on *Cynodon* sp., Horticulture Garden, Harwan, 15.ix.1977 ; 2 ♂♂ (ZSI Reg. Nos. 6158/H₆ & 6160/H₆) on *Lantana camara*, Jammu Circuit House area, 1.x.1977 & 4.x.1977.

Distribution : This species has been reported from India (Kashmir) and Nepal, and also from Palaearctic region (Knutson *et al*, 1975).

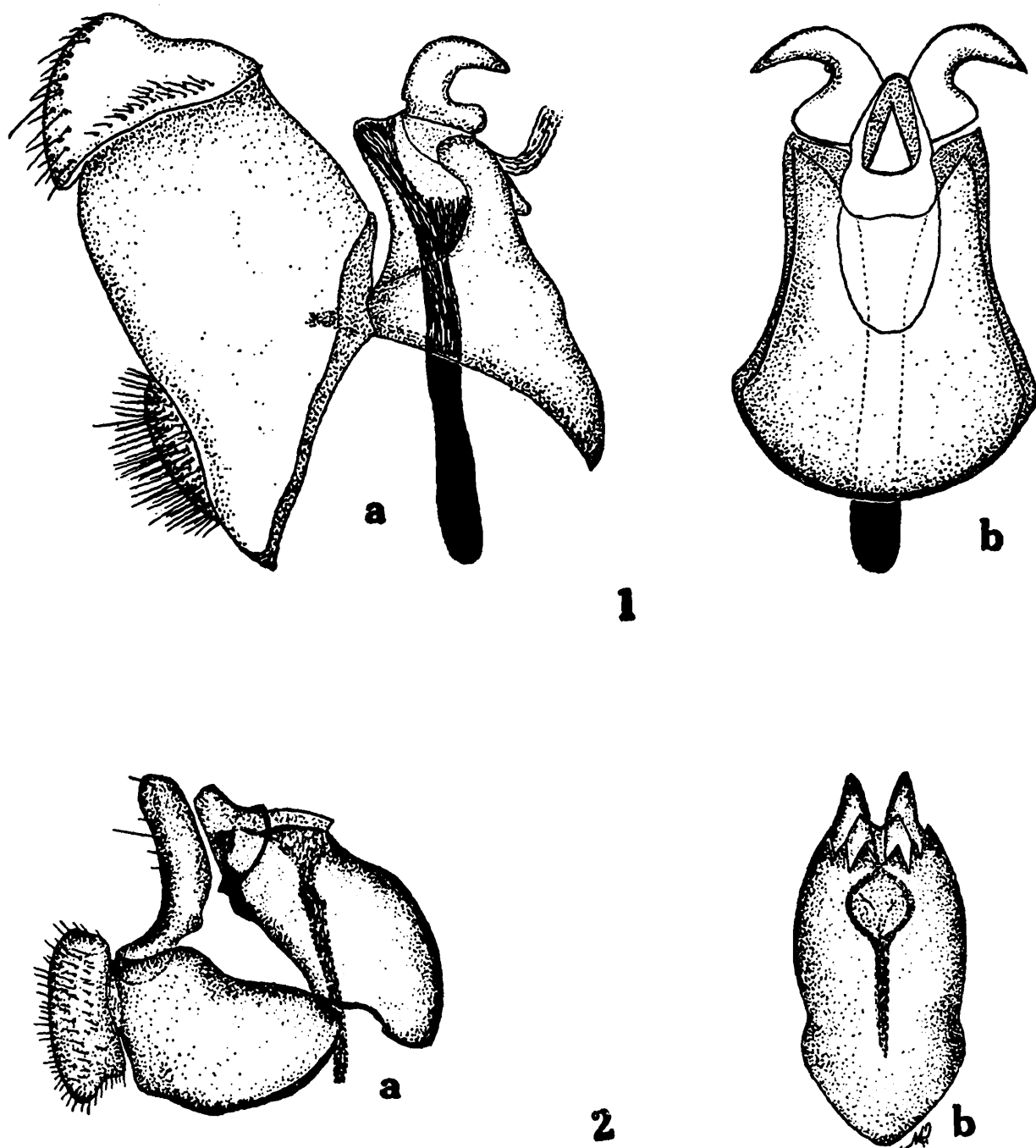
The male terminalia of the species has been illustrated by Vockeroth (1969).

6. *Sphaerophoria* sp.

Material examined : 3 ♂♂, 2 ♀♀ (ZSI Reg. Nos. 6162/H₆-6166/H₆) on *Solanum nigrum* and *Justicia simplex*, Anantnag, 23.ix.1977 ; 4 ♂♂

(ZSI Reg. Nos. 6167/H₆-6170/H₆) on *Eleusine indica* and *Sonchus asper*, Chhatabal, 18.ix.1977 ; 1 ♂ (ZSI Reg. No. 6171/H₆) on *Panicum* sp., Kamarwari, 20.ix.1977.

Remarks : On the preparation of the male terminalia this species appears to be new. But all the specimens are so damaged by the fungal growth that it is desirable not to describe the species until further material is available for studies.



Text-fig. 1. *Asarkina (Asarkina) ericetorum* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).

Text-fig. 2. *Melanostoma orientale* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).

*** 7. *Syrphus latifasciatus* (Macquart)**

1829. *Syrphus latifasciatus* Macquart, *Ins. Dipt. N. Fr.*, 4 : 94 (242).

1975. *Metasyrphus* (*Metasyrphus*) *latifasciatus* (Macquart) : Knutson *et al.*, *A catalog of Diptera of the Oriental region*, 2 : 317.

Material examined : 1 ♀ (ZSI Reg. No. 6172/H₆) on *Cannabis* sp., Bijbihara, 22.ix.1977 ; 1 ♀ (ZSI Reg. No. 6173/H₆) on *Cynodon* sp., Kamarwari, 26.ix.1977 ; 1 ♀ (ZSI Reg. No. 6174/H₆) on *Cynodon* sp., Kabutarkhana, 12.ix.1977 ; 1 ♀ (ZSI Reg. No. 6175/H₆) on *Cannabis* sp., Hazratbal, 14.ix.1977 ; 1 ♀ (ZSI Reg. No. 6176/H₆) on *Cynodon* sp., Gulmarg, 13.ix.1977 ; 1 ♀ (ZSI Reg. No. 6177/H₆) on *Polygonum* sp., Pahalgam, 25.ix.1977 ; 1 ♀ (ZSI Reg. No. 6178/H₆) on *Justicia simplex*, Anantnag, 23.ix.1977.

Distribution : All these female specimens do not run to the key to the genus given by Vockeroth (1969) but to the key to the genus and species by Brunetti (1923). Hence, the original citation has been maintained. This species has been reported to occur in India (Himachal Pradesh). The species has originally been described from France (Knutson *et al.*, 1975).

Subfamily SYRPHINAE

Tribe MELANOSTOMATINI

***8. *Melanostoma orientale* (Wiedemann)**

(Text-fig. 2 a-b)

1824. *Syrphus orientalis* Wiedemann, *Analecta Ent.* : p. 36.

1975. *Melanostoma orientale* (Wiedemann) : Knutson *et al.*, *A Catalog of Diptera of the Oriental Region*, 2 : 325.

Material examined : 2 ♂♂ (ZSI Reg. Nos. 6179/H₆-6180/H₆) on *Cannabis* sp., Bijbihara, 22. ix. 1977 ; 4 ♂♂, 15 ♀♀ (ZSI Reg. Nos. 6181/H₆-6199/H₆) on *Justicia simplex*, *Digitaria sanguinalis* and *Cynodon* sp., Sankarnarayanpur, 20. ix. 1977 ; 6 ♂♂, 4 ♀♀ (ZSI Reg. Nos. 6200/H₆-6209/H₆) on *Cynodon* sp. and *Rubus ellipticus*, Udampur, 27.ix. 1977 ; 3 ♂♂ ; 1 ♀ (ZSI Reg. Nos. 6210/H₆-6213/H₆) on *Ammania* sp. and *Solanum nigrum*, Anantnag, 18. ix. 1977 ; 1 ♂, 1 ♀ (ZSI Reg. Nos. 6214/H₆-6215/H₆) on *Sida* sp., Chhatabal, 4.x.1977 ; 2 ♂♂, 3 ♀♀ (ZSI Reg. Nos. 6216/H₆-6220/H₆) on *Lantana camara*, Jammu, 3. x. 1977 ; 1 ♀ (ZSI Reg. No. 6221/H₆) on *Cynodon* sp., Talabtiloo, 2. x. 1977 ; 1 ♀ ZSI Reg. No. (6222/H₆) on *Cynodon* sp., Raipur, 2.x.1977.

Distribution : This species has been reported to occur throughout the Orient (Knutson *et al.*, 1975).

9. *Melanostoma* sp.

Material examined : 6 ♀ ♀ (ZSI Reg. Nos. 6224/H₆-6229/H₆) on *Solanum nigrum* and *Eleusine indica*, Kabutarkhana, 12. ix. 1977 ; 4 ♀ ♀ (ZSI Reg. Nos. 6230/H₆-6233/H₆) on *Solanum nigrum*, Anantnag, 23. ix. 1977 ; 1 ♀ (ZSI Reg. 6234/H₆) on *Cynodon* sp., 13. ix. 1977 ; 2 ♀ ♀ (ZSI Reg. Nos. 6235/H₆-6236/H₆) on *Solanum nigrum*, Chhatabal, 18. ix. 1977 ; 6 ♀ ♀ (ZSI Reg. Nos. 6237/H₆-6242/H₆) on *Cannabis* sp. and *Chrysanthemum* sp., Bijbihara, 22. ix. 1977.

Remarks : This species is left for confirmation in future when male specimens will be available for studies.

Subfamily SYRPHINAE

Tribe CHRYSOTOXINI

*10. *Chrysotoxum baphyrus* Walker

(Text-fig. 3 a-b)

1849. *Chrysotoxum baphyrus* Walker, *List Dipt. Br. Mus.*, 3 : 542.

1975. *Chrysotoxum baphyrus* Walker : Knutson *et al.*, *A Catalog of Diptera of the Oriental Region*, 2 : 326.

Material examined : 1 ♂ (ZSI Reg. No. 6243/H₆) on *Cynodon* sp., Jammu C. H. Campus, 14. x. 1977 ; 1 ♀ (ZSI Reg. No. 6244/H₆) on *Ipomoea* sp., Sankarnarayanpur, 29. ix. 1977 ; 1 ♀ (ZSI Reg. No. 6245/H₆) on *Climatis* sp., Chhatabal, 18. ix. 1977.

Distribution : This species has been reported to occur in Uttar Pradesh in India (Knutson *et al.*, 1975) and has also been reported from Sri Lanka, Indochina, Laos, Nepal and possibly Java.

Subfamily SYRPHINAE

Tribe PARAGINI

* 11. *Paragus (Paragus) serratus* (Fabricius)

(Text-fig. 4 a-b)

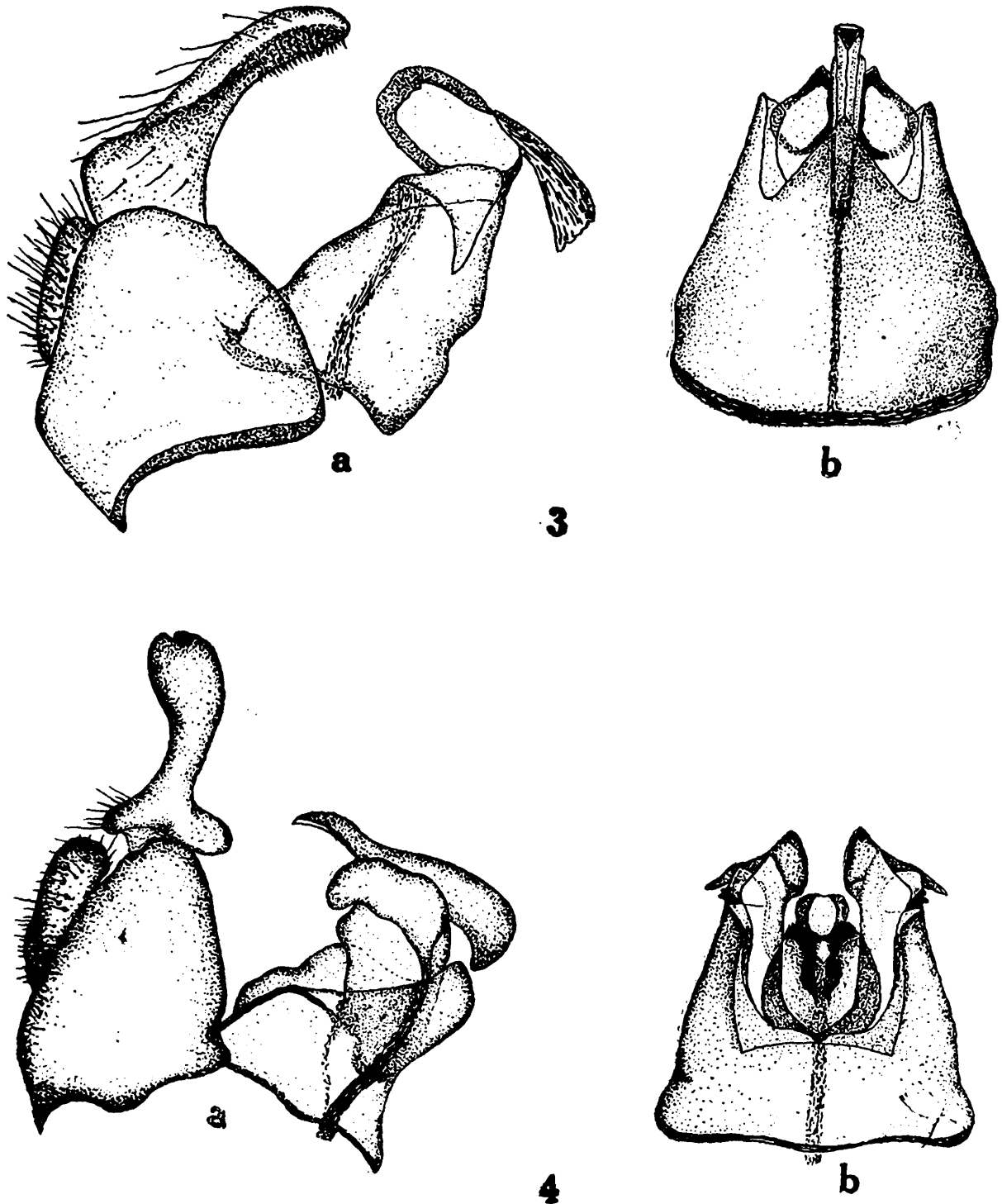
1805. *Mulio serratus* Fabricius, *Syst. Antliat.* : 186.

1830. *Paragus serratus* (Fabricius) : Wiedemann, *Aussereurop. zweifl. Insekt.*, 2 : 88.

1975. *Paragus (Paragus) serratus* (Fabricius) : Knutson *et al.*, *A Catalog of Diptera of the Oriental Region*, 2 : 327.

Material examined : 2 ♂ ♂, 1 ♀ (ZSI Reg. Nos. 6246/H₆-6248/H₆) on *Solanum nigrum*, Chhatabal, 18. ix. 1977 ; 1 ♀ (ZSI Reg. No. 6249/H₆) on *Solanum nigrum*, Sankarnarayanpur, 20. ix. 1977 ; 9 ♂ ♂, 1 ♀ (ZSI Reg. Nos. 6250/H₆-6257/H₆ and 6262/H₆-6263/H₆) on *Ageratum conyzoides*, *Polygonum orientale* and *Lantana camara*, Jammu, 1. x. 1977-4. x.

1977 ; 1 ♂ (ZSI Reg. No. 6258/H₆) on *Lantana camara*, Rangawara, 19.ix.1977 ; 1 ♂ (ZSI Reg. No. 6259/H₆) on *Solanum nigrum*, Raipur, 3.x. 1977 ; 2 ♂ ♂ (ZSI Reg. No. 6260/H₆-6261/H₆) on *Solanum nigrum*, Talabtiloo, 1.x.1977.



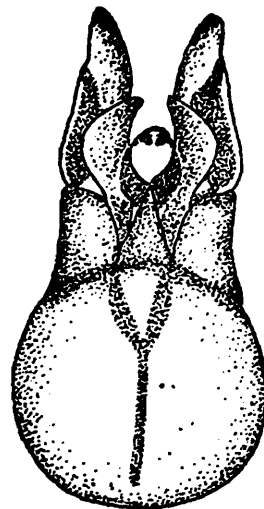
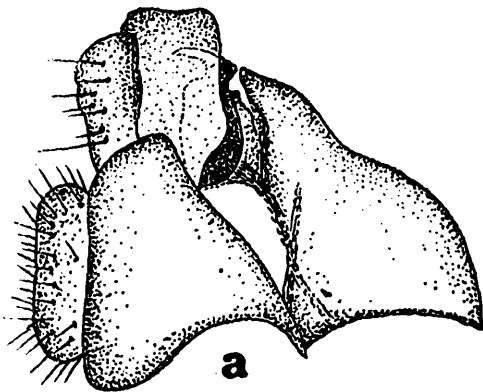
Text-fig. 3. *Chrysotoxum baphyrus* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).

Text-fig. 4. *Paragus (Paragus) serratus* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).

Distribution : This species has been reported to occur in Madhya Pradesh, Maharashtra, Tamil Nadu, Karnataka and Punjab in India (Knutson *et al*, 1975).

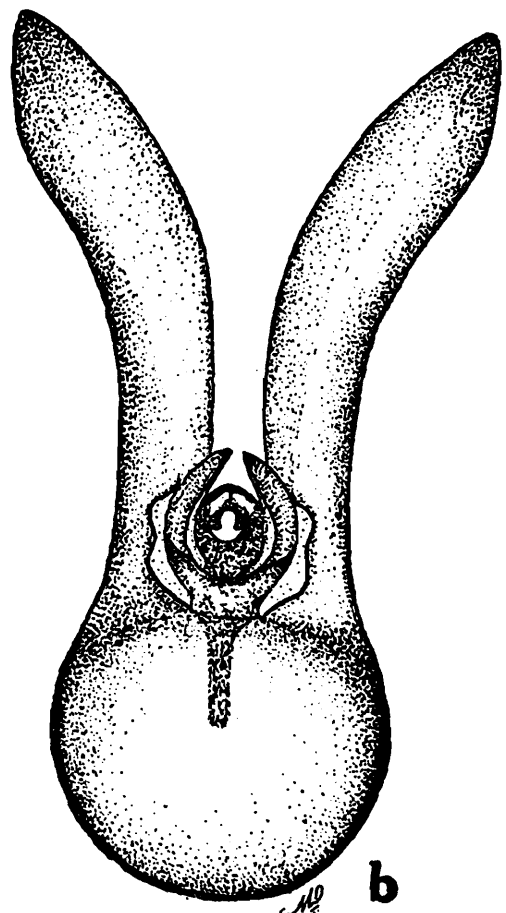
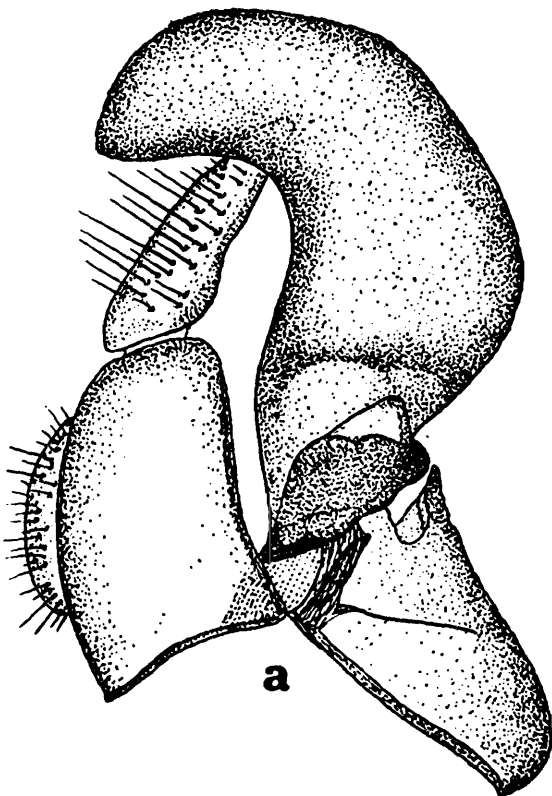
* 12 *Paragus* (*Pandasyophthalmus*) *tibialis* (Fallén)

(Text-fig. 5 a-b)

1817. *Pipiza tibialis* Fallén, *Syrphici Sueciae*, : 60.1862. *Paragus tibialis* (Fallén) : Schiner, *Fauna Austr.*, 1 : 257.1975. *Paragus* (*Pandasyophthalmus*) *tibialis* (Fallén) : Knutson *et al.*, *A Catalog of Diptera of the Oriental Region*, 2 : 328.

5

b



6

b

Text-fig. 5. *Paragus* (*Pandasyophthalmus*) *tibialis* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).Text-fig. 6. *Paragus* (*Pandasyophthalmus*) *rufiventris* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).

Material examined : 1 ♂, 1 ♀ (ZSI Reg. Nos. 6293/H₆-6294/H₆) on *Solanum nigrum*, Chhatabal, 18.ix. 1977 ; 2 ♂♂, 1 ♀ (ZSI Reg. Nos. 6295/H₆-6297/H₆) on *Cynodon* sp., Udhampur, 27.ix.1977-28.ix.1977 ; 1 ♂ (ZSI Reg. No. 6298/H₆) on *Cynodon* sp., Kabutarkhana, 12.ix.1977 ; 6 ♀♀ (ZSI Reg. Nos. 6299/H₆-6304/H₆) on *Solanum nigrum* and *Amaranthus spinosa*, Jammu, 4.x.1977 ; 2 ♀♀ (ZSI Reg.No. 6305/H₆-6306/H₆) on *Solanum* sp., Bijbihara, 22.ix.1977 ; 1 ♀ (ZSI Reg. No. 6307/H₆) on *Cynodon* sp., Sankarnarayanpur, 29.ix.1977 ; 1 ♀ (ZSI Reg. No. 6308/H₆) on *Cynodon* sp., Talabtiloo 1.x.1977, 1 ♀ (ZSI Reg. No. 6309/H₆) *Cynodon* sp., Raipur, 3.x.1977.

Distribution : This is an Oriental species occurring throughout the region (Knutson *et al.*, 1975).

*** 13. *Paragus (Pandasyophthalmus) rufiventris* Brunetti**

(Text-fig. 6 a-b)

1913. *Paragus rufiventris* Brunetti, *Rec. Indian Mus.*, 8 : 157.

1975. *Paragus (Pandasyophthalmus) rufiventris* Brunetti : Knutson *et al.*, *A Catalog of Diptera of the Oriental Region*, 2 : 328 (As subspecies of *P. (P.) tibialis* (Fallén).

Material examined : 10 ♂♂, 1 ♀ (ZSI Reg. Nos. 6264/H₆-6274/H₆) on *Lantana camara*, *Cynodon* sp. and *Solanum nigrum*, Udhampur, 27.x. 1977-28.x.1977 ; 9 ♂♂ (ZSI Reg. Nos. 6275/H₆-6283/H₆) on *Lantana camara* and *Solanum nigrum*, Jammu, 1.x.1977 and 4.x.1977 ; 5 ♂♂ (ZSI Reg. Nos. 6284/H₆-6288/H₆) on *Solanum nigrum*, Raipur, 3.x.1977 ; 2 ♂♂ (ZSI Reg. Nos. 6289/H₆-6290/H₆) on *Lantana camara*, Talabtiloo, 1.x.1977 ; 2 ♂♂ (ZSI Reg. Nos. 6291/H₆-6292/H₆) on *Solanum nigrum*, Chhatabal, 18.ix.1977.

Distribution : This species has been reported to occur in Assam, Bihar and Uttar Pradesh in India (Knutson *et al.*, 1975). This species has also been recorded from Sri Lanka, Nepal and Pakistan.

This is not treated here as subspecies for its difference in male terminalia (Text-fig. 6) from that of *P. (P.) tibialis* (Fallén).

***14. *Paragus (Pandasyophthalmus) atratus* de Meijere**

(Text-fig. 7 a-b)

1906. *Paragus atratus* de Meijere, *Nova Guinea*, 1 : 85.

1975. *Paragus (Pandasyophthalmus) atratus* de Meijere : Knutson *et al.*, *A Catalog of Diptera of the Oriental Region*, 2 : 328.

Material examined : 4 ♂♂ (ZSI Reg. Nos. 6310/H₆-6313/H₆) on *Solanum nigrum*, Udhampur, 27-28.ix. 1977 ; 1 ♂ (ZSI Reg. No. 6314/H₆) on *Cynodon* sp., Bijbihara, 23.ix. 1977.

Distribution : This species has been reported from Uttar Pradesh in India (Knutson *et al*, 1975) and has also been reported from Malaya, Java, Sumatra, Timor and New Guinea.

15. *Paragus* sp.

Material examined : 1 ♂ (ZSI Reg. No. 6315/H₆) on *Cynodon* sp., Bijbihara, 23.ix. 1977.

Remarks : This species is left for confirmation in future when further material will be available for studies.

Subfamily MILESINAE

Tribe VOLUCELLINI

*16. *Graptomyza brevirostris* Wiedemann

1820. *Graptomyza brevirostris* Wiedemann, *Nova Dipt. Gen.* : 17.

1975. *Graptomyza brevirostris* Wiedemann : Knutson *et al*, *A Catalog of Diptera of the Oriental Region*, 2 : 333.

Material examined : 1 ♀ (ZSI Reg. No. 6316/H₆) on *Herpestis* sp., Udhampur, 28.ix. 1977.

Distribution : This species has been reported from Tamil Nādu in India (Knutson *et al*, 1975). This has also been reported from Nepal, Burma, Philippines, Borneo, Java, Malaya and Sri Lanka.

Subfamily MILESINAE

Tribe ERISTALINI

*17. *Eristalinus taphicus* Wiedemann

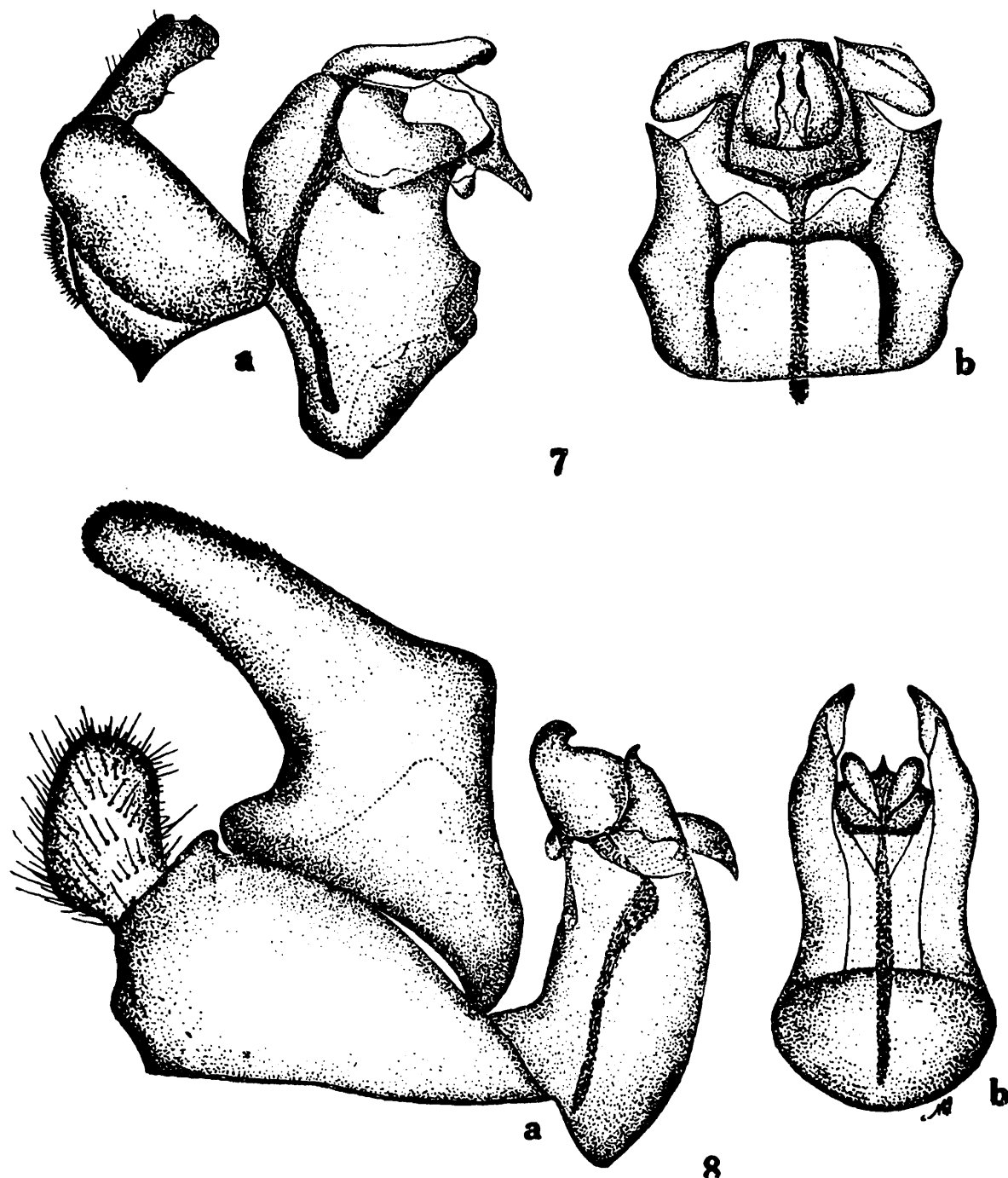
(Text-fig. 8 a-b)

1830. *Eristalis taphicus* Wiedemann, *Aussereurop. zweifl. Insekt.*, 2 : 191.

1975. *Eristalinus taphicus* (Wiedemann) : Knutson *et al*, *A Catalog of Diptera of the Oriental Region*, 2 : 347 (As variety of *E. aeneus* (Scopoli)).

Material examined : 3 ♂ ♂ (ZSI Reg. Nos. 6317/H₆-6319/H₆) on *Tridax* sp., Lalmandi, Srinagar, 10.ix. 1977 ; 1 ♂ (ZSI Reg. No. 6320/H₆) on *Zinnia* sp., Kamarwari, 20.ix. 1977 ; 1 ♀ (ZSI Reg. No. 6321/H₆) on *Tagetes patula*, Rajbagh, 16.ix. 1977 ; 2 ♀ ♀ (ZSI Reg. Nos. 6322/H₆-6323/H₆) on *Tridax* sp., Kabutarkhanna, 12.ix. 1977.

Distribution : This species has been reported to occur in Maharashtra and Uttar Pradesh in India (Knutson *et al*, 1975) and has also been reported from China, Pakistan, Cyprus, Egypt, France, Korea and Monaco.



Text-fig. 7. *Paragus (Pandasyophthalmus) atratus* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).

Text-fig. 8. *Eristalinus taphicus* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).

* 18. ***Eristalinus arvorum* (Fabricius)**
(Text-fig. 9 a-b)

1787. *Syrphus arvorum* Fabricius, *Mantissa Insect.*, 2 : 335.

1908. *Eristalis arvorum* (Fabricius) : de Meijere, *Tijdschr. Ent.*, 51 : 247.

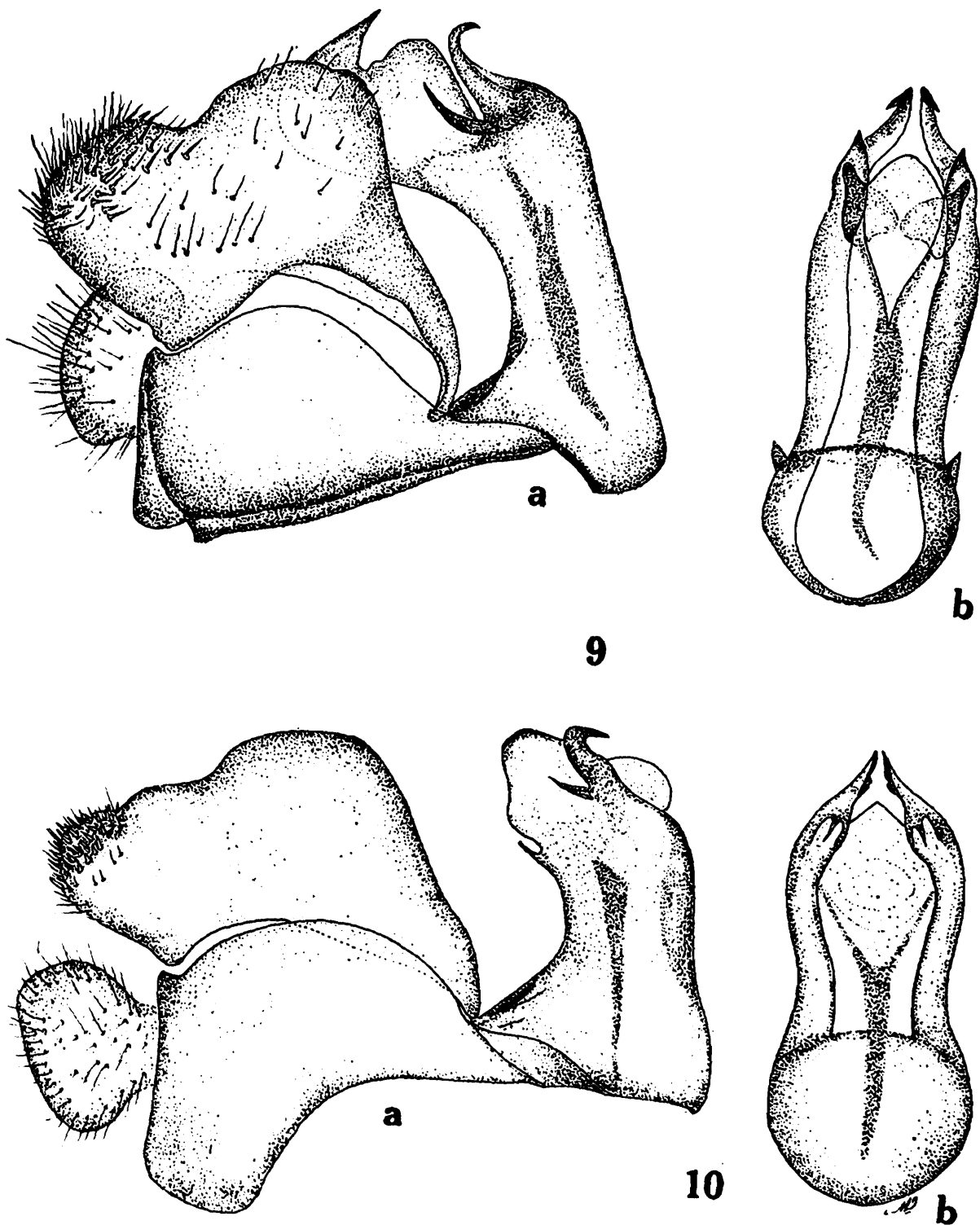
1975. *Eristalinus arvorum* (Fabricius) : Knutson *et al.*, *A Catalog of Diptera of the Oriental Region*, 2 : 347.

Material examined : 3♂♂ (ZSI Reg. Nos. 6329/H₆-6331/H₆),
Rajendra Park, 3.xi.1976. Coll. S. K. Gupta.

Distribution : This species has been reported from the entire South-East Asia (Knutson *et al*, 1975). This has also been reported from Australia, Hawaii, Japan and Micronesia.

The male terminalia drawn here (Text-fig. 9) shows differences from that by Nayar (1968).

19. ***Eristalinus laetus*** (Wiedemann)
(Text-fig. 10 a-b)



Text-fig. 9. *Eristalinus arvorum* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).

Text-fig. 10. *Eristalinus laetus* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).

1830. *Eristalis laetus* Wiedemann, *Aussereurop. zweifl. Insekt.*, 2 : 192.

1975. *Eristalinus laetus* (Wiedemann) : Knutson *et al.*, *A Catalog of Diptera of the Oriental Region*, 2 : 348.

Material examined : 1 ♂ (ZSI Reg. No. 6326/H₆) on *Tagetes patula*, Bijbihara, 22.ix.1977 ; 1 ♀ (ZSI Reg. No. 6327/H₆) on *Tagetes patula*, Kamarwari, 20.ix.1977 ; 1 ♀ (ZSI Reg. No. 6327/H₆) on *Tagetes patula*, Rajbagh, Srinagar, 16.ix.1977.

Distribution : This species has been reported from Andhra Pradesh, Maharashtra and Kashmir (Brunetti, 1923). This has also been reported from Bangladesh, Sri Lanka, China, Formosa, Malaya, Nepal, Java, Sumatra, Sumbawa and Philippines.

* 20. *Eristalinus* (*Eristalodes*) *paria* (Bigot)

(Text-fig. 11 a-b)

1880. *Eristalomyia paria* Bigot, *Annls Soc. ent. Fr.*, 10 : 218.

1975. *Eristalinus* (*Eristalodes*) *paria* (Bigot) : Knutson *et al.*, *A Catalog of Diptera of the Oriental Region*, 2 : 349.

Material examined : 1 ♂, 1 ♀ (ZSI Reg. Nos. 6324/H₆-6325/H₆) on *Helianthus* sp., Pahalgam, 25.ix.1977.

Distribution : This species has been reported from Himachal Pradesh, Tamil Nadu, Karnataka and Uttar Pradesh in India (Knutson *et al.*, 1975) and has also been reported from Sri Lanka, Formosa, Java, Laos, Malaya, Nepal, Japan and Moluccas.

* 21. *Eristalis* (*Eristalis*) *tenax* (Linnaeus)

1758. *Musca tenax* Linnaeus, *Syst. Nat. Ed.*, 10 : 591.

1975. *Eristalis* (*Eristalis*) *tenax* (Linnaeus) : Knutson *et al.*, *A Catalog of Diptera of the Oriental Region*, 2 : 351.

Material examined : 9 ♂♂, 3 ♀♀ (ZSI Reg. Nos. 6390/H₆-6401/H₆) on *Dahlia* sp., *Helianthus* sp. and *Tagetes patula*, Gulmarg, 13.ix.1977 ; 1 ♂, 4 ♀♀ (ZSI Reg. Nos. 6402/H₆-6407/H₆) on *Sonchus asper* and *Chrysanthemum* sp., Pahalgam, 25.ix.1977 ; 1 ♂, 2 ♀♀ (ZSI Reg. Nos. 6408/H₆-6410/H₆) on *Tagetes patula*, Hazratbal, 14.ix.1977 ; 1 ♂ (ZSI Reg. No. 6411/H₆) on *Blumea* sp., Kabutarkhana, 12.ix.1977 ; 1 ♀ (ZSI Reg. No. 6412/H₆) on *Sonchus asper*, Rangawara, 19.ix.1977 ; 1 ♀ (ZSI Reg. No. 6413/H₆) on *Tagetes patula*, Lalmandi, Srinagar, 10.ix.1977.

Distribution : This species has been reported to occur in the entire Oriental region (Knutson *et al.*, 1975).

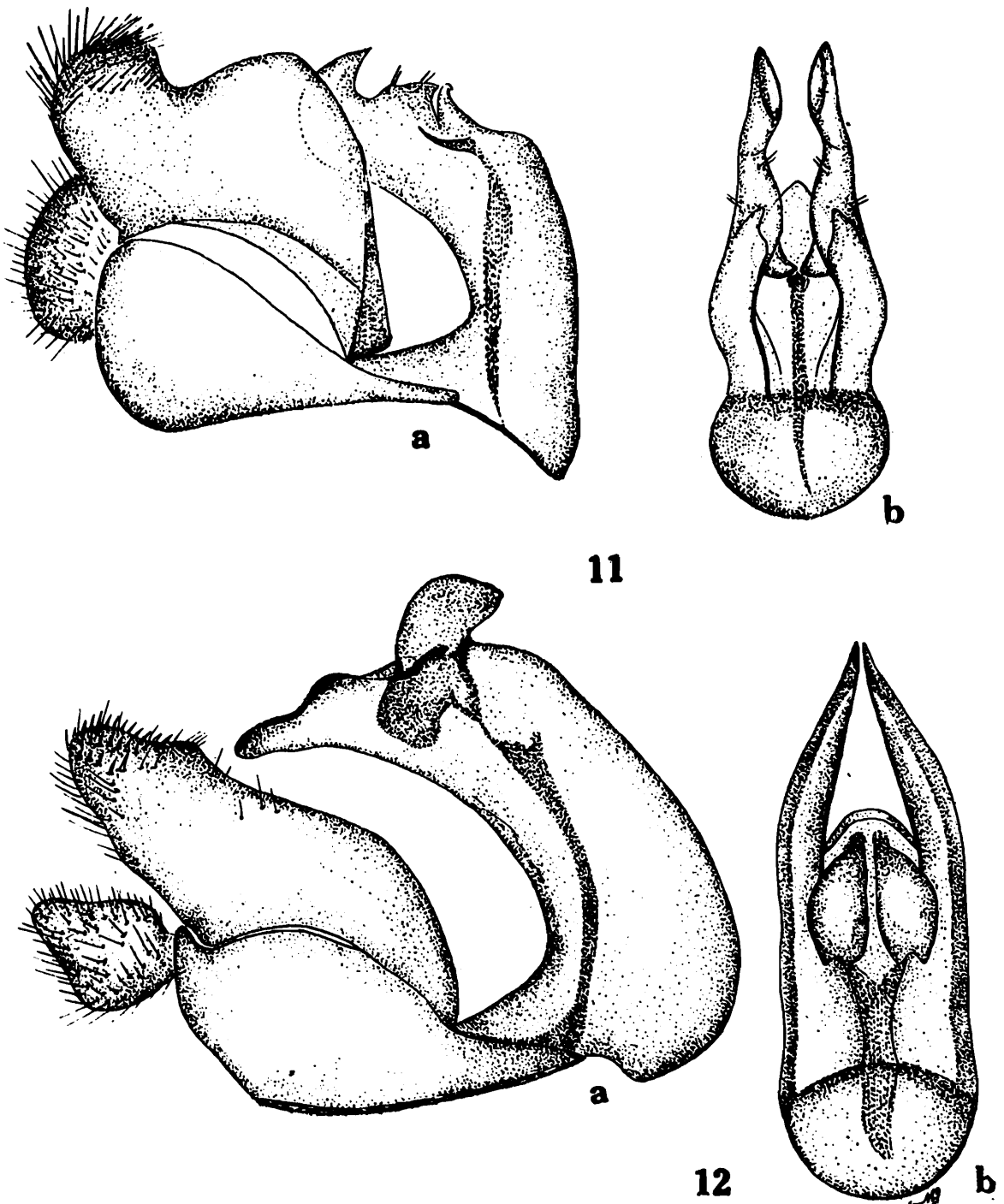
For male terminalia, see Nayar (1968).

22. *Eristalis (Eoseristalis) arbustorum* (Linnaeus)

(Text-fig. 12 a-b)

1758. *Musca arbustorum* Linnaeus, *Syst. Nat. Ed.*, 10 : 591.1975. *Eristalis (Eoseristalis) arbustorum* (Linnaeus) : Knutson *et al.*, *A Catalog of Diptera of the Oriental Region*, 2 : 351.

Material examined : 1 ♂, 1 ♀ (ZSI Reg. Nos. 6414/H₆-6414/H₆) on *Dahlia* sp., Gulmarg, 13.ix.1977 ; 1 ♂, 1 ♀ (ZSI Reg. Nos. 6416/H₆-



Text-fig. 11. *Eristalinus (Eristalodes) paria* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).

Text-fig. 12. *Eristalis (Eoseristalis) arbustorum* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).

6417/H₆) on *Tagetes patula*, Kamarwari, 20.ix.1977 ; 1 ♀ (ZSI Reg. Nos. 6418/H₆) on *Tagetes patula*, Kabutarkhana 25.ix.1977 ; 2 ♂ ♂ (ZSI Reg. Nos. 6419/H₆-6420/H₆) on *Tagetes patula*, Hazratbal, 14.ix. 1977 ; 5 ♂ ♂ (ZSI Reg. Nos. 6421/H₆-6425/H₆) on *Tagetes patula*, Lalmandi, Srinagar, 10.ix.1977 ; 5 ♂ ♂ (ZSI Reg. Nos. 6426/H₆-6430/H₆) on *Chrysanthemum* sp. and *Sonchus asper*, Pahalgam, 25.ix.1977 ; 8 ♂ ♂ (ZSI Reg. Nos. 6431/H₆-6438/H₆) on *Melilotus alba*, *Sida rhombifolia* and *Sonchus asper*, Rajbagh, Srinagar, 16.ix.1977 ; 2 ♂ ♂ (ZSI Reg. Nos. 6439/H₆-6440/H₆) on *Lindenbergia* sp., Chhatabal, 18.ix.1977.

Distribution : This species has already been reported from Kashmir (Knutson *et al*, 1975). This is mainly a Holarctic species.

For male terminalia, see Text-fig. 12 for differences from that of Nayar (1968) and Thomson (1972).

***23. *Eristalis (Eoseristalis) cerealis* Fabricius**
(Text-fig. 13 a-b)

1805. *Eristalis cerealis* Fabricius, *Syst. Antliat.* : 232.

1975. *Eristalis (Eoseristalis) cerealis* Fabricius : Knutson *et al.*, *A catalog of Diptera of the Oriental Region*, 2 : 351.

Material examined : 6 ♂ ♂, 6 ♀ ♀ (ZSI Reg. Nos. 6332/H₆-6343/H₆) on *Sonchus asper*, *Chrysanthemum* sp. and *Tagetes patula*, Pahalgam, 25.ix.1977 ; 1 ♂, 10 ♀ ♀ (ZSI Reg. Nos. 6350/H₆-6360/H₆) on *Dahlia* sp., *Helianthus* sp. and *Tagetes patula*, Gulmarg, 13.ix.1977 ; 7 ♀ ♀ (ZSI Reg. Nos. 6361/H₆-6367/H₆) on *Tagetes patula* and *Xanthium strumarium* and *Erigeron licifolia*, Kabutarkhana, 12.ix.1977 ; 6 ♀ ♀ (ZSI Reg. Nos. 6368/H₆-6373/H₆) on *Tagetes patula* and *Ricinus communis*, Lalmandi, Srinagar, 10.ix.1977 ; 5 ♀ ♀ (ZSI Reg. Nos. 6374/H₆-6378/H₆) on *Sonchus asper* and *Melilotus alba*, Rajbagh, Srinagar, 16.ix.1977 ; 1 ♀ (ZSI Reg. No. 6382/H₆) on *Tagetes patula*, Hazratbal, 14.ix.1977 ; 1 ♀ (ZSI Reg. No. 6383/H₆) on *Tagetes patula*, Kamarwari. 20.ix.1977 ; 2 ♀ ♀ (ZSI Reg. Nos. 6384/H₆-6385/H₆) on *Chrysanthemum* sp., Bijbihara, 20.ix.1977.

Distribution : This species has been reported to occur throughout the Oriental region (Knutson *et al*, 1975).

***24. *Phytomia (Phytomia) errans* (Fabricius)**

1787. *Syrphus errans* Fabricius, *Mantissa Insect.*, 2 : 337.

1975. *Phytomia (Phytomia) errans* (Fabricius) : Knutson *et al.*, *A Catalog of Diptera of the Oriental Region*, 2 : 357.

Material examined : 1 ♀ (ZSI Reg. No. 6440/H₆) on *Lantana camara*, Udhampur, 28.ix.1977.

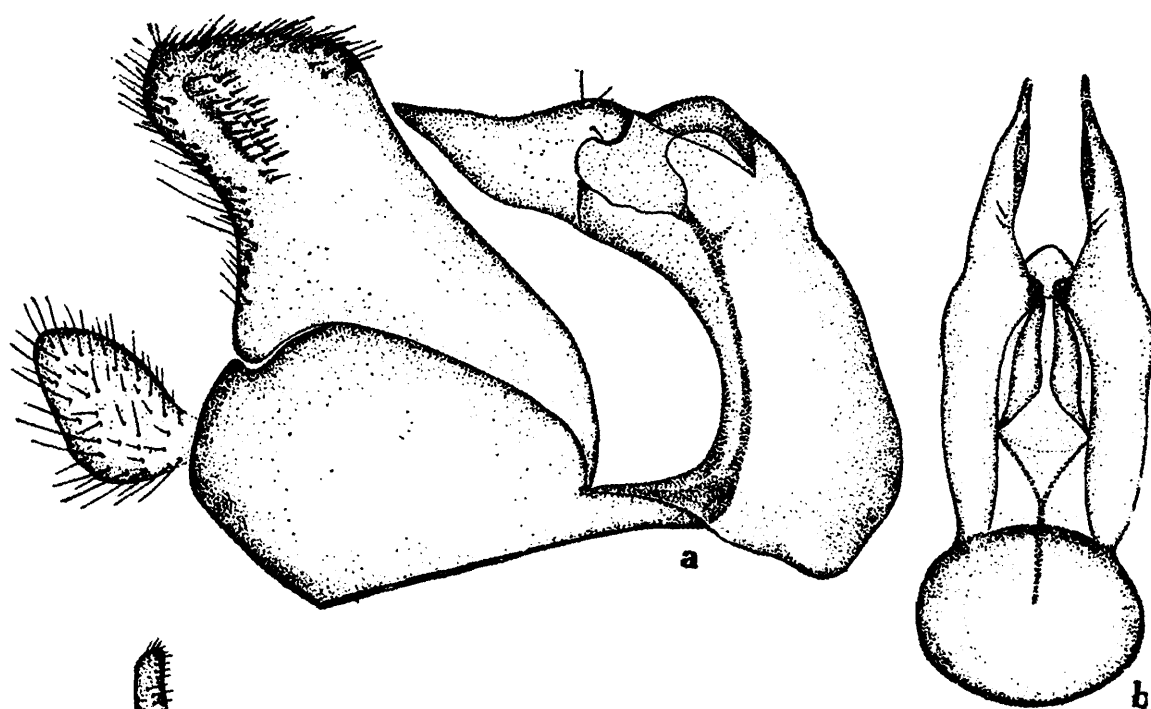
Distribution : This species has been reported to occur throughout South-East Asia (Knutson, *et al* ; 1975), and China and Japan.

Subfamily MILESINAE

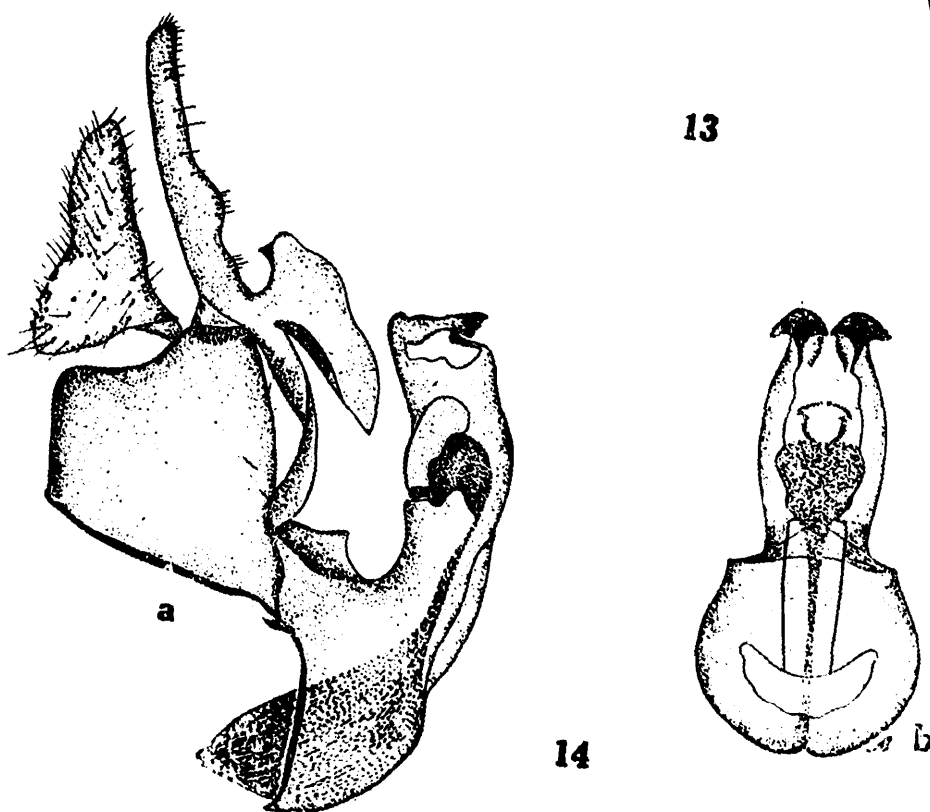
Tribe MILESINI

*25. *Syritta pipiens* (Linnaeus)

(Text-fig. 14 a-b)

1758. *Musca pipiens* Linnaeus, *Syst. Nat. Ed.*, 10 : 594.1975. *Syritta pipiens* (Linnaeus) : Knutson *et al.*, *A Catalog of Diptera of the Oriental Region*, 2 : 365.

13



14

Text-fig. 13. *Eristalis (Eoseristalis) cerealis* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).Text-fig. 14. *Syritta pipiens* : a, terminalia (lateral view) ; b, sternite 9, superior lobes and aedeagal base (ventral view).

Material examined : 16♂♂, 5♀♀ (ZSI Reg. Nos. 6441/H₆-6461/H₆) on *Duranta plumieri* and *Panicum* sp., Bijbihara, 28.ix.1977 ; 5♂♂, 1♀ (ZSI Reg. Nos. 6462/H₆-6467/H₆) on *Solanum nigrum* and *Cynodon* sp., Lalmandi, Srinagar, 10.ix.1977. 3♂♂, 2♀♀ (ZSI Reg. Nos. 6468/H₆-6472/H₆) on *Solanum nigrum* and *Amaranthus* sp., Anantnag, 23.ix.1977 ; 11♂♂ (ZSI Reg. Nos. 6473/H₆-6483/H₆) on *Duranta plumieri*, *Cannabis sativa* and *Eleusine* sp., Kamarwari, 20.ix.1977 ; 1♂ (ZSI Reg. No. 6484/H₆) on *Chloris* sp., Shalimar Garden, Srinagar, 11.ix.1977 ; 2♂♂ (ZSI Reg. Nos. 6485/H₆-6486/H₆) on *Eleusine indica*, Chhatabal, 18.ix.1977 ; 1♂ (ZSI Reg. No. 6487/H₆) on *Nicotiana* sp., Udampur, 28.ix.1977 ; 2♂♂ (ZSI Reg. Nos. 6488/H₆-6489/H₆) on *Cynodon* sp., Rajbagh, Srinagar, 16.ix.1977 ; 1♂ (ZSI Reg. No. 6490/H₆) on *Solanum nigrum*, Rangawara. 19.ix.1977 ; 1♂ (ZSI Reg. No. 6491/H₆) on *Cynodon* sp., Gulmarg, 13.ix.1977 ; 1♂ (ZSI Reg. No. 6492/H₆) on *Cannabis* sp., Hazratbal, 14.ix.1977.

Distribution : This species has been reported to occur in West Bengal, Uttar Pradesh and Himachal Pradesh in India (Brunetti, 1923), and from Nepal and Holarctic region.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. B.K. Tikader, Director of the Zoological Survey of India, Calcutta, for kindly assigning the present work and for his keen interest and encouragement. They are also thankful to Dr. F. Christian Thompson of the American Museum of Natural History, New York, U.S.A. ; to Dr. H. Hippa of the University of Turku, Finland, and to Dr. A. N. T. Joseph and Mr. P. Parui of this Organisation for kindly providing them with some pertinent literature and valuable suggestions.

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ON SOME FRESHWATER SPONGES FROM GUJARAT (INDIA)

By

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(With 6 Text-figures.)

INTRODUCTION

In the course of a faunistic survey of some freshwater bodies of Gujarat, a few specimens of sponges were collected from Bhavnagar and Rajkot. On examination, the collection was found to comprise four species, three belonging to known and the fourth showing sufficiently significant variations to warrant erection of a new species.

The paper also includes some salient limnological features of these water bodies.

***Corvospongilla bhavnagarensis* sp. nov.**

(Text-figs. 1-3)

Material : Preserved specimen and slides Z.S.I. Regd. No. P 3135/1 ;

Locality—embankment about 4 metres away from Gorishankar Lake, Bhavnagar, Gujarat. Coll. *T. D. Soota*, 24.viii.1982.

Description : Sponge forming over a large area on the surface of an embankment thick blackish encrustation showing rough and irregular surface with fragile consistency.

Megascleres : rather short, not very thick, slightly curved, amphistrongyla, inflated at extremities, entirely smooth, length range .190-.205 mm., width range .016-.018 mm.

Microscleres : represented by microbirotulates with smooth shaft, slightly curved, and terminally with 4 recurved hooks ; length of shaft varying from .041-.042 mm., diameter of rotules .008-.009 mm.

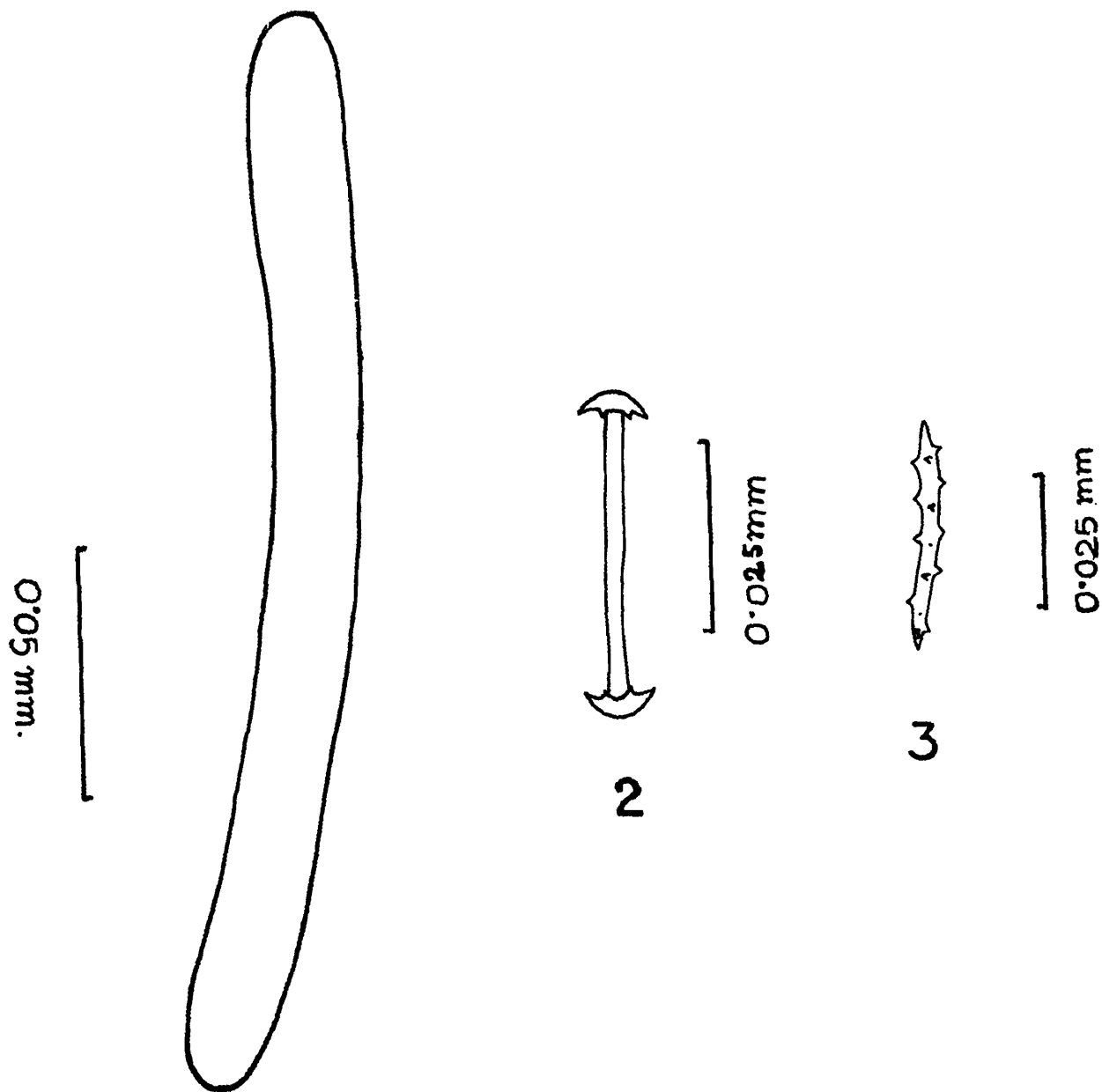
Gemmoscleres : strongly pointed amphioxea, slightly curved and covered with short acute spines ; length range .043-.045 mm., width range .0042-.0048 mm.

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Gemmules : spherical, smooth, loosely adhering to sponge surface, diameter .005-.006 mm., foramen not exactly tubular but as a conical projection.

Colour : Black in dry specimen.

Remarks : The species comes close to *Corvospongilla loricata*—*lapidosa* group in having smooth amphistrongyla megascleres and



Text-figs. 1—3. *Corvospongilla bhavnagarensis* sp. nov.

microbirotulate microscleres, but differs from all the members of the group only in shape of porus tube of gemmule which is not exactly tubular but a conical extension, and in structure of gemmoscleres which are amphioxea instead of amphistrongyla. Unfortunately, the taxonomic position of the members of the group is at present unresolved (vide Penney & Racek, 1968, pp. 53 & 55). Hence, to remove this most undesirable taxonomic complexity, work involving examination

of a series of fresh specimens has already been initiated to ultimately lead to the final revision of the group when all its members will be soundly established.

***Corvospongilla caunteri* Annandale, 1911**

Material : One lot ; Z. S. I. Regd. No. P 3136/1 ; Locality—under surface of a stone Gorishankar Lake, Bhavnagar, Gujarat. Coll. *T. D. Soota*, 24. viii. 1982. One lot ; Z. S. I. Regd. No. P 3137/1 ; Locality—under surface of a stone Kodiyar Lake, Bhavnagar, Gujarat. Coll. *T. D. Soota* ; 24. viii. 1982.

Description : Crusts thin, with smooth surface.

Megascleres : amphioxea, smooth, slightly curved, bluntly or sharply pointed at their tips ; length range .172-.258 mm., width range .0085-.0175 mm.

Microscleres : microbirotulates, shaft smooth, straight to feebly curved, terminal spines not strongly incurved ; length of shaft of rotules .0215-.043 mm., diameter of rotule .0086-.0095 mm.

Gemmoscleres : amphistrongyla, slightly curved, irregularly spiny throughout the body ; occasionally appearing like amphioxea due to presence of spines at tips ; length range .0301-.0473 mm., width range .0043-.0086 mm.

Gemmules : moderate to abundant, present freely in inner symplasm, spherical, forming a depression beneath ; diameter of gemmule .4-.45 mm ; foramen slightly elevated forming a somewhat bent tube.

Remarks : The species is recorded for the first time from Gujarat.

***Corvospongilla lapidosa* (Annandale, 1908)**

Material : One lot ; Z. S. I. Regd. No. P 3138/1 ; Locality—under surface of a stone Aji Dam, Rajkot, Gujarat. Coll. *T. D. Soota*, 24. viii. 1982.

Description : Crusts flat, thin and with rough, hard, brittle surface, practically entirely covered with gemmules.

Megascleres : amphistrongyla, feebly curved, stout and entirely smooth ; length range .175-.28 mm., width range .0172-.0236 mm.

Microscleres : microbirotulates, shaft smooth, terminally with 6-7 recurved hooks, length range .032-.035 mm., diameter of rotules .009-.01 mm.

Gemmoscleres : amphistrongyla, stout, slightly curved, covered with blunt spines ; length range .0344-.086 mm., width range .0086-.0215 mm.

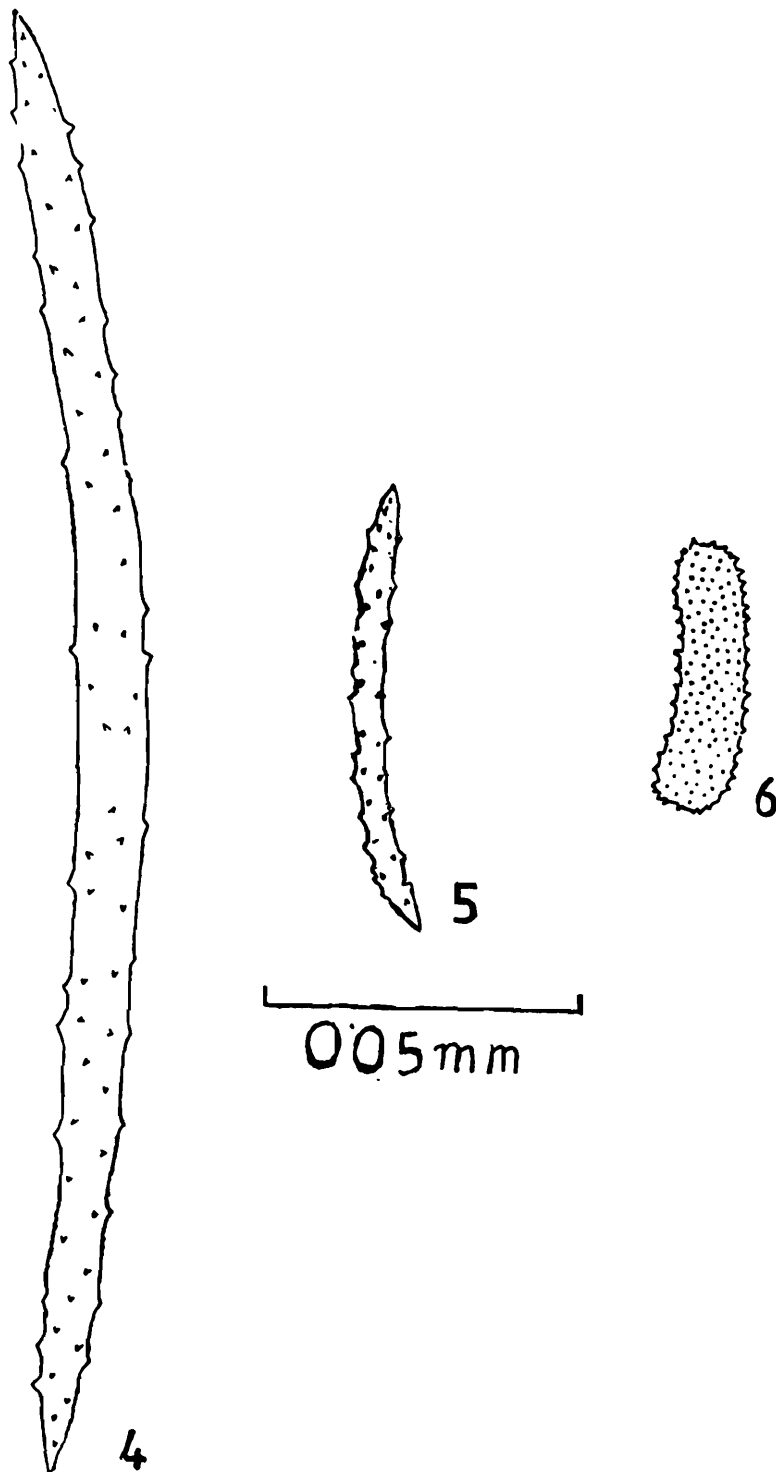
Gemmules : subspherical, abundant, very densely covering sponge surface ; diameter .7-.8 mm., foramen extended forming an elongated tube.

Remarks : The species is recorded for the first time from Gujarat.

***Stratospongilla bombayensis* (Carter, 1882)**

(Text-figs. 4-6)

Material : One lot ; Z. S. I. Regd. No. P. 3139/1 ; Locality—under surface of a stone Azi Lake, Rajkot, Gujarat. Coll. *T. D. Soota*, 24.viii. 1982.



Text-figs. 4—6. *Stratospongilla bombayensis* (Carter, 1882)

Description : Crusts thin, with smooth surface.

Megascleres : slightly curved, slender, amphioxea, covered with an irregular arrangement of small spines ; length range .1935-.2666 mm., width range .0065-.0107 mm.

Microscleres : slightly curved, slender and short, sharply pointed amphioxea, microspined throughout the body ; length range .0845-.086 mm., width range .0035-.0045 mm.

Gemmoscleres : slightly curved, amphistrongyla, entirely microspined ; length range .0387-.0473 mm., width range .0096-.0129 mm.

Gemmules : spherical, pneumatic layer thick, diameter range .45-.6 mm., foramen short, tubular.

Remarks : The species is recorded for the first time from Gujarat.

DATA ON CERTAIN HYDROLOGICAL FACTORS OF WATER BODIES

	Gorishankar Lake Bhavnagar	Kodiyar Lake, Bhavnagar	Azi Lake, Rajkot
Transparency (m)	0.25	0.30	0.25
pH	8.8	9.5	8.9
Dissolved O ₂ (ml/l)	4.5	4.2	3.6
Free CO ₂ (ppm)	Nil	Nil	Nil
CO ₃ ⁻ (ppm)	41	59	43
HCO ₃ ⁻ (ppm)	127	102	113

SUMMARY

The paper deals with four species of freshwater sponges, one of which, *Corvospongilla bhavnagarensis*, is described as new. Some salient limnological features of the water bodies concerned have also been included.

ACKNOWLEDGEMENTS

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COMPOSITION AND ECOLOGY OF
A BEETLE (COLEOPTERA) COMMUNITY IN
WEST BENGAL, INDIA

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(With 1 Text-figure and 8 Tables)

INTRODUCTION

Between January 1971 and August 1972 pit-fall traps were used to collect beetles attracted to various types of mammalian dung (Oppenheimer, 1977). As would be expected, many other organisms occurred in the traps from spiders and harvestmen (Oppenheimer and Tikader, 1976) to frogs and snakes.

This paper will present data for Coeloptera, with emphasis on beetles other than scarabaeoid dung beetles, which are treated in detail elsewhere (Oppenheimer, 1977, in prep.).

METHODS

The study was done in two villages, Burasanti and Nasibpur (E 88° 15' and N 22° 50'), 40 km NNW of Calcutta, West Bengal, India. Trapping was done in tree-shrub (TS), bamboo (BB), banana (BN), and grassy (G) sites in each village. The villages were surrounded by extensive areas of agricultural fields.

The study spanned all of 1971, which was a wetter year than average, and the first 8 months of 1972, which was a drier year than average (Table 1). Temperatures were higher in 1972 because of delay in formation of the annual monsoon cloud cover.

The number of trap-days varied per month depending on the number of weeks in the month, the number of villages traps were set in, and the number of traps set at each site. A "trap-day" consisted of a single pit-fall trap set out between 1500 and 1600 hours and picked up the following day between 0900 and 1000. Between 17 January and 8 June 1971

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traps were set twice a week in the TS, BB and BN habitats in Nasibpur, and in the G habitat in Burasanti. Between 14 June 1971 and 26 February 1972 traps were set once a week in each of the four habitats in both villages. Starting with 3 March 1972 traps were set only once a week in the four Burasanti habitats. Trapping in the grass habitats was suspended in Nasibpur between 20 November and 17 December, and in Burasanti from 23 June 1972 till the end of the study.

TABLE 1. Weather data for Singur, Hooghly District West Bengal between January 1971 and August 1972

	1971					1972	
	Jan-Feb	Mar-May	Jun-Aug	Sep-Nov	Dec-Feb	Mar-May	Jun-Aug
Total rainfall (cm)	2.28	36.88	139.14	32.43	7.44*	4.42	75.71
Max. temp (°C)	25.9	34.4	32.3	32.5	24.2	39.0	36.9
Min. temp (°C)	15.6	21.7	26.4	19.6	14.2	22.8	26.6
Weather	cool-dry	hot-moist	hot-wet	mild-moist	cool-dry	hot-dry	hot-wet

*Jan & Feb 1972—7.44 cm

Initially six pit-fall traps were used in each habitat and each was baited with a different mammalian dung type: human (H), monkey-*Presbytis entellus* (M), dog-*Canis familiaris* (D), goat (G), cattle (C) and buffalo (B). Two additional traps (elephant dung and unbaited) were added as of 14 August 1971, for a total of eight traps. From 12 May 1972 to the end of the study two of the traps were baited with human dung and six traps were unbaited at each trapping site.

All beetles collected were pinned and labelled. Specimens were primarily deposited in the Zoological Survey of India, Calcutta, and in the U. S. Museum of Natural History, Washington, D. C.

RESULTS

Over 16,000 specimens from at least 22 families, 73 genera and 207 species were obtained from pit-fall traps during the study (Table 2). Though scarabs made up over 80% of the beetles in the collection, carabids contributed more genera and species. These two families, plus aphodids and tenebrionids, contributed 62% of the genera, 80% of the species and 99% of the beetles. The dominance of scarabs in the collection can be attributed to the use of baited traps. If one looks at just unbaited control traps (August 1971 to August 1972, n=104 beetles)

scarabs made up 17.3%, carabids 19.2%, and tenebrionids 40.4% (with aphodids they totaled 82.6% of the beetles). This differs significantly from the distribution in Table 2 ($p<.001$). However, the distribution of species from each family in the unbaited traps did not differ from that given in Table 2.

TABLE 2. Taxonomic and numerical composition of beetle collection between January 1971 and August 1972

Suborder Super family	Family (Code)	Number of		Individuals	
		Genera	Species	No.	%
Adephaga					
Caraboidea	Carabidae (A)	26+	67	614	3.8
Polyphaga					
Hydrophiloidea	Hydrophilidae (B)	2	2	35	.2
Histeroidea	Histeridae (C)	4	4	67	.4
Staphylinoidea	Staphylinidae (D)	2	2	5	<.1
Scarabaeoidea	Scarabaeidae (E)	9	53	13,435	83.0
	Aphodiidae (F)	2	25	1,373	8.5
Byrrhoidea	Byrrhidae (G)	1	1	1	<.1
Elateroidea	Elateridae (H)	3	6	18	.1
Dermestoidea	Dermestidae (I)	1	1	1	<.1
Bostrychoidea	Ptinidae (J)	1	1	2	<.1
Cucujoidea					
Clavicornia	Nitidulidae (K)	1	1	2	<.1
	Erotylidae (L)	1	1	1	<.1
	Coccinellidae (M)	1	1	5	<.1
	Endomychidae (N)	1	1	2	<.1
Heteromera	Colydiidae (O)	1	1	1	<.1
	Tenebrionidae (P)	8	20	536	3.3
	Anthicidae (Q)	1	1	1	<.1
Chrysomeloidea	Cerambycidae (R)	1	1	1	<.1
	Chrysomelidae (S)	3	10	23	.1
Curculionoidea	Anthribidae (T)	1 ?	2	20	.1
	Curculionidae (U)	2 ?	5 ?	39	.2
Unidentified	Unidentified (V)	1 ?	1 ?	10	<.1
Total		73+	207	16,192	100.0

The number of species contributed by each family varied with season, and to some extent by habitat (Table 3). Tenebrionids accounted for one-quarter of the species during the winter months, but only a tenth of the species in the total study. Carabids accounted for over 30% of the species during the monsoon months of June to August and in the total study. Scarabs accounted for an average of 39% of the

TABLE 3. Distribution of species across families by seasons, habitats, and study (in percent)

	1971		Seasons			1972		Habitats			Total	
	J-F	M-M	J-A	S-N	D-F	M-M	J-A	TS	BB	BN	G	Study
Scarabaeidae	30	39	35	24	30	39	43	30	31	31	25	26
Aphodiidae	9	16	16	14	11	11	6	15	17	15	15	12
Histeridae	2	3	1	5	3	8	2	1	3	4	2	2
Hydrophilidae	0	1	2	1	0	0	0	0	0	2	2	1
Carabidae	23	29	34	29	17	16	32	31	28	22	35	32
Tenebrionidae	26	12	3	11	23	16	9	13	7	11	10	10
Misc. families	9	16	8	16	17	11	9	11	15	16	12	17
Total no. of												
species	43	90	97	85	66	38	47	88	108	109	117	207
families	8	14	12	14	13	9	9	13	17	15	15	22
trap-days	255	672	672	816	808	416	368	1033	1034	1032	908	4007

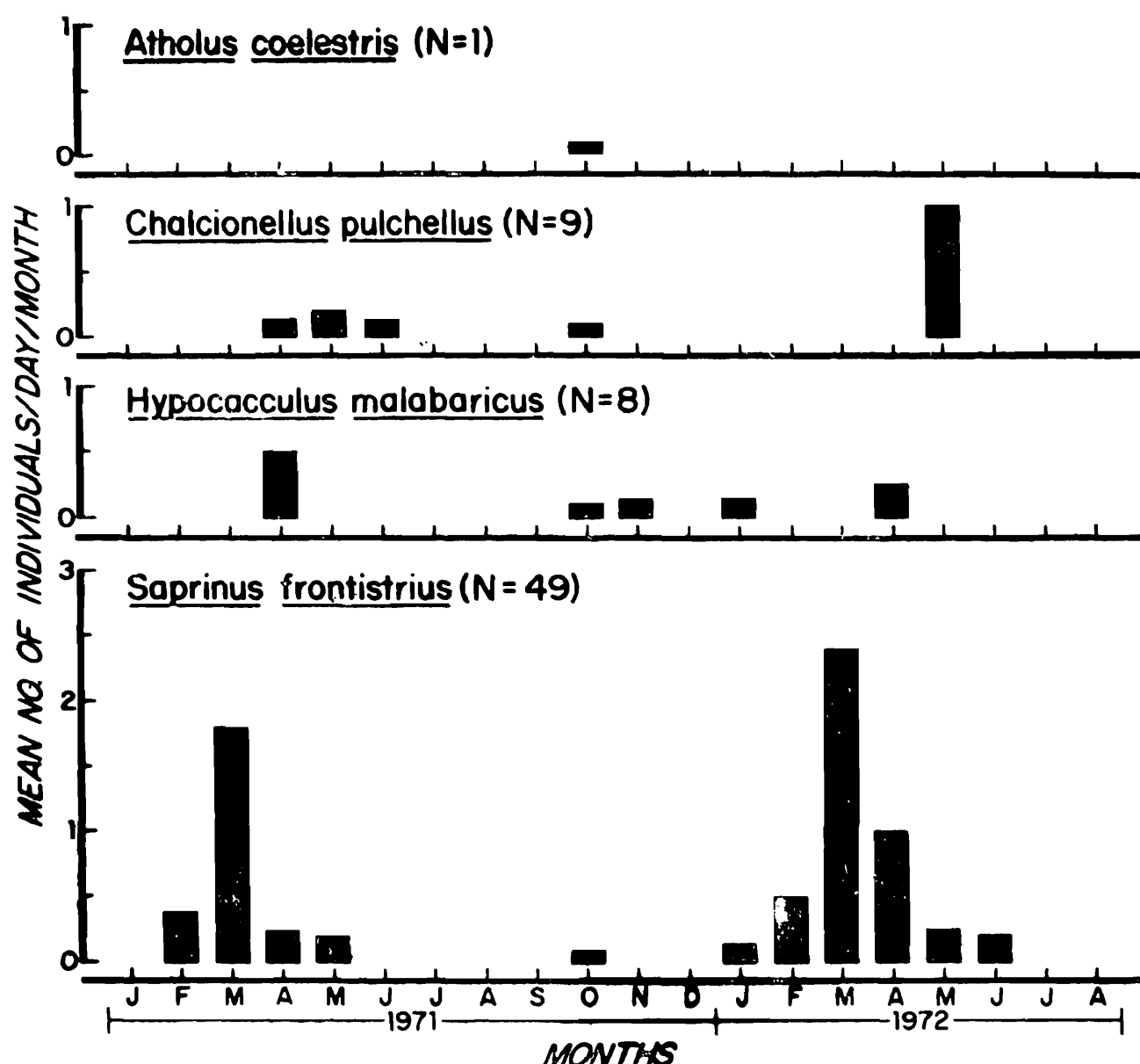
species from March to August, though they accounted for only 26% of the species in the total study. The total number of species caught per season increased with the number of trap-days per season ($r^2 = .782$, $n = 7$, $p < .05$); but such a correlation did not hold for any single family. The number of carabid species increased as the number of species of other families increased ($r^2 = .818$, $n = 7$, $p < .05$). More species occurred in the grass habitat than in the other three habitats despite the smaller number of trap-days there, though this difference was not significant.

The number of beetles obtained from the pit-fall traps per trap-day varied during the study (Table 4). The smallest number of beetles was caught in January 1971 and April 1972, which were dry months, and the largest number was caught in the months of June 1971 and August 1972, which were wet months. The number of beetles caught actually increased with the increase in total monthly rainfall up to the point where the water table reached or rose above the soil surface, as occurred in August 1971. This relationship between abundance and rainfall was apparent in both 1971 ($r^2 = 0.699$, $n = 11$, $p < .02$) and 1972 ($r^2 = 0.928$, $n = 8$, $p < .001$). This increase in abundance with increase in rainfall occurred in scarabs ($r^2 = .807$, $n = 19$, $p < .001$), aphodids ($r^2 = .659$, $n = 18$, $p < .005$, months with over 47 cm of rainfall omitted), hydrophilids ($r^2 = .764$, $n = 18$, $p < .001$) and carabids ($r^2 = .888$, $n = 18$, $p < .001$). Tenebrionids were most abundant during the cool dry months and increased in abundance with a decrease in temperature ($r^2 = -.896$, $n = 20$, $p < .001$) and rainfall ($r^2 = -.595$, $n = 20$, $p < .01$); multiple regression on temperature (y) and rainfall (x) was $R^2 = 0.90$ ($n = 20$, $z = 78.07 - 0.23x -$

TABLE 4. Monthly catch of beetles of several families caught during 4007 pit-fall trap-days between January 1971 and August 1972 (mean number of beetles per trap-days $\times$ 100)

Beetle	1971												1972									
	families	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Mean
Scarabaeidae	9	42	130	383	963	1290	863	222	245	359	185	20	15	123	79	21	70	161	804	1090	353.7	
Aphodiidae	0	5	2	32	97	234	105	18	2	34	13	7	5	7	1	1	3	11	105	52	36.7	
Histeridae	0	2	8	4	2	1	0	0	0	1	<1	0	1	2	8	4	1	1	0	0	1.8	
Hydrophilidae	0	0	0	0	1	5	5	2	2	1	0	0	0	0	0	1	0	0	0	0	0.9	
Carabidae	2	7	2	9	35	47	80	27	12	14	7	4	1	5	4	1	3	9	19	9	14.9	
Tenebrionidae	29	28	19	2	2	1	0	1	<1	5	36	35	37	23	16	6	2	3	0	0	12.3	
Misc. families	0	4	6	2	5	8	1	1	2	5	8	3	3	2	6	2	2	9	2	2	3.7	
Total beetles	39	88	168	431	1106	1586	1053	272	262	419	250	69	62	162	114	35	82	193	930	1152	423.7	
No. of trap days	66	189	240	192	240	192	192	288	256	320	240	296	256	256	160	128	128	152	96	120	4007	

2. 31y). Histerids were most abundant during warm dry months, and showed no association with rainfall ($r^2 = -.360$, $n=19$, n. s.) or temperature ($r^2 = .056$, $n=20$, n. s.); this is emphasized by their consistent pattern of abundance in both years (Table 4), despite weather differences (Table 1). *S. frontistrius* peaked in March, *H. malabaricus* in April and *C. pulchellus* in May of both years (Text-fig 1). All three of these species occurred in October at a very low level, which indicated it was a suitable but nonoptimum time for them. October was the only month in which *A. coelestris* appeared.



Text-fig. 1. Monthly distribution of four species of histerids between January 1971 and August 1972 (total number caught in parentheses). Note that each species had its peak activity in a different month and that the pattern is the same in both years.

More beetles occurred per trap day in the bamboo habitat than in the other three habitats, and the least occurred in the grass habitat (Table 5). Scarabs and aphodids were most abundant in the bamboo habitats, whereas hydrophilids and carabids were most abundant in the grass habitats, and tenebrionids in the banana groves.

TABLE 5. Habitat and trap abundance of several beetle families caught between January 1971 and April 1972 (mean number of beetles per trap-day $\times 100$)

Beetle families	Habitats				Mean	Proba- bility*	Traps and bait type						Mean	Probab- ility*
	Tree-shrub	Bamboo	Banana	Grass			Human	Monkey	Dog	Goat	Cattle	Buffalo		
Scarabaeidae	258	589	281	115	310.8	<.001	979	349	454	211	131	76	366.7	<.001
Aphodiidae	16	61	36	23	34.0	<.001	61	62	10	58	26	19	39.3	<.001
Histeridae	1	3	2	1	1.8	<.001	6	<1	2	1	1	1	1.8	<.001
Hydrophilidae	0	0	<1	4	1.0	<.001	1	1	2	1	1	1	1.2	>.100
Carabidae	8	8	22	28	16.5	<.001	19	18	21	14	18	18	18.0	>.500
Tenebrionidae	17	3	28	12	15.0	<.001	14	12	15	13	17	15	14.3	>.700
Misc. families	2	6	3	4	3.8	—	6	4	4	3	2	3	3.7	—
Total beetles	302	669	371	186	382.0	<.001	1086	446	508	302	196	133	445.5	<.001
No. of trap days	889	888	890	844			498	495	496	496	497	497		

*Chi-square test done on actual number caught with expected values assumed equal

Traps baited with human feces attracted the largest number of beetles, whereas those baited with cattle and buffalo dung attracted the smallest number (Table 5). Scarab, aphodid, and histerid families followed this pattern, whereas hydrophilid, carabid and tenebrionid families occurred with essentially equal frequency in all traps. An exception were two carabid (A) species (Table 6): *P. catoirai* was most abundant on dog dung (46%, $p<.005$) and *A. nr pallipes* was more abundant on human and buffalo dung than on monkey and goat dung ($p<.01$). The two species of hydrophilids (B) were slightly more abundant on dog dung (Table 6), but this was not significant. Only one species of histerid (C), *S. frontistrius*, was abundant enough for selectivity to be detectable ; it occurred primarily in the bamboo habitat (Table 7) and was attracted most frequently to human dung (Table 6). The other three species of histerids showed different patterns.

TABLE 6. Distribution of non-dung beetle species (between January 1971 and April 1972), which showed selectivity for dung type or might be expected to show selectivity (mean $\pm$ beetles per trap-day x 500)

Family		Dung type					Total	
Code*	Species	H	M	D	G	C	B	
A.	<i>Pheropsophus catoirai</i>	8	1	19	4	3	6	41
	<i>Abacetus nr pallipes</i>	36	19	25	15	24	31	150
B.	<i>Coelostoma</i> sp.	4	3	10	4	0	3	24
	<i>Sphaeridium</i> sp.	4	4	12	4	4	6	34
C.	<i>Saprinus frontistrius</i>	25	1	5	7	2	2	42
	<i>Hypocacculus malabaricus</i>	2	0	1	0	1	3	7
	<i>Chalcionellus pulchellus</i>	1	1	2	0	1	0	5
	<i>Atholus coelestris</i>	0	0	0	0	1	0	1
D.	<i>Anotylus foetidus</i>	1	0	0	0	0	0	1
	<i>Philonthus</i> sp.	0	1	0	0	0	0	1
	<i>Zyras</i> sp.	2	0	1	0	0	1	4

*See Table 2

As seen in the histerids in terms of dung selectivity (Table 6), where one species accounted for 76% of the beetles, the ecological distribution patterns for the families presented above were established by one or a few species that were represented by a large number of individuals (Table 7). Four of the 67 carabid species accounted for 52% of the carabid beetles, and five of the 20 tenebrionid species accounted for 83% of the tenebrionid beetles. Similar dominance of a few species

TABLE 7. Mean number of beetles per trap day (x 1000) for each season and habitat for all non-scarabaeoid species and non-coprophagous scarabs collected between January 1971 and August 1972 (based on 4007 pit-fall trap days)

Family	Genus and species	Seasons and number of trap days						Habitats & # trap days				Total	
Code*		J-F	M-M	J-A	S-N	D-F	M-M	J-A	TS	BB	BN	G	# of
and		255	672	672	816	808	416	368	1033	1034	1032	908	beetles
subfamily													
A. Bembidiini													
	<i>Bembidion</i> sp.	4	—	—	—	—	—	—	—	—	—	1	1
	<i>Elaphropus politus</i> Motch.	—	10	19	5	1	—	3	—	4	12	11	26
	<i>Elaphropus</i> sp.	—	—	3	—	—	—	—	—	—	—	2	2
	<i>E. klugi</i> Nietn.	—	1	—	1	—	—	—	—	—	—	2	2
Brachinini													
	<i>Mastax</i> sp.	—	—	4	—	—	—	—	1	—	2	—	3
	<i>Pheropsophus catoirai</i> Dej	12	28	15	7	4	—	11	1	3	35	6	45
	<i>P. bimaculatus</i> L.	—	3	—	—	—	—	—	—	2	—	—	2
	<i>P. sobrinus</i> Dej var. <i>hilaris</i> F.	—	—	—	1	—	—	—	—	—	—	1	1
Chalaenini													
	<i>Callistomimus chalcocephalus</i> Wied.	—	1	3	—	—	—	—	—	3	—	—	3
	<i>Chlaeminus quadriplagiatus</i> Chaud.	—	—	3	18	4	—	—	2	—	—	20	20
	<i>Chlaenius chlorodynus</i> Dej	—	6	3	—	—	—	—	—	3	—	3	6
	<i>C. cyaniceps</i> Bates	—	—	1	7	—	—	5	6	1	—	2	9
	<i>C. hamifera</i> Chaud.	4	—	—	—	—	—	—	—	—	—	1	1
	<i>C. poecilinus</i> Bates	—	—	6	—	—	—	—	—	3	—	1	4
	<i>C. xanthospilus</i> Wied.	—	1	—	—	—	—	—	1	—	—	—	1
	<i>Chlaenius</i> sp. #2	4	—	—	—	—	—	—	—	1	—	—	1
	<i>Chlaenius</i> sp. #3	—	—	4	1	—	—	—	3	1	—	—	4

TABLE 7. (Continued)

	J-F 255	M-M 672	J-A 672	S-N 816	D-F 808	M-M 416	J-A 368	TS 1033	BB 1034	BN 1032	G 908	Total of beetles
Masoreini												
<i>Aepheidius adeloides</i> MacI.	—	—	—	—	1	—	—	—	—	—	1	1
<i>A. opaculus</i> Zimm.	4	1	—	4	7	—	—	2	—	6	3	11
<i>Caphora humilis</i> Schm.-Goeb.	8	—	—	—	5	—	—	1	1	—	4	6
<i>Tetragonoderus notaphioides</i> Mots	4	—	—	1	2	7	—	1	—	2	4	7
<i>Tetragonoderus</i> sp.	—	—	—	—	1	2	—	2	—	—	—	2
<i>Tetragonoderus</i> (?) sp.	4	—	—	—	—	—	—	1	—	—	—	1
Oodini												
<i>Simons nigriceps</i> Wied.	—	1	7	—	—	—	16	5	2	2	3	12
Panagaenini												
<i>Dischissus</i> sp. ♂1	—	3	12	4	—	—	—	9	4	—	—	13
<i>Dischissus</i> sp. ♂2	—	—	4	—	—	—	—	—	—	3	—	3
Pterostichini												
<i>Abacetus atratus</i> Dej	—	1	—	—	—	—	—	—	—	1	—	1
<i>Abacetus</i> nr <i>antiquus</i>	—	4	100	9	—	—	—	2	4	4	74	77
<i>Abacetus</i> nr <i>pallipes</i>	—	25	186	12	—	—	—	5	10	92	46	152
<i>Abacetus</i> (?) sp. ♂35	—	—	1	—	—	—	—	—	1	—	—	1
<i>Abacetus</i> (?) sp. ♂36	—	—	—	1	—	—	—	1	—	—	—	1
<i>Caelostomous</i> nr <i>inermis</i> Bates	—	1	—	—	—	—	—	—	—	—	1	1
<i>Lesticus</i> sp.	—	—	4	—	—	—	—	—	3	—	—	3
<i>Trigonotoma indica</i> Brullé	—	3	—	—	—	—	—	1	1	—	—	2

TABLE 7. (Continued)

	J-F	M-M	J-A	S-N	D-F	M-M	J-A	TS	BB	BN	G	Total of beetles
	255	672	672	816	808	416	368	1033	1034	1032	908	
Scaritini												
<i>Clivina "attenuata" Herbst spp. ?</i>	—	12	12	1	—	—	8	1	1	3	17	20
<i>C. "sagittaria" Bates spp. ?</i>	—	19	49	10	—	—	11	16	14	16	11	58
<i>Clivina</i> sp. ♂♂ 3	—	—	—	1	—	—	—	—	1	—	—	1
Unknown subfamily												
Species ♂♂ 20	—	—	1	—	—	—	—	—	1	—	—	1
Species ♂♂ 21	—	—	—	1	—	—	—	—	—	—	1	1
Species ♂♂ 22	—	—	1	—	—	—	—	—	—	—	1	
<i>Galerita orientalis</i> Sch. Gobb (?)	—	4	3	2	—	—	3	4	3	1	—	8
Species ♂♂ 52 to 60 (lost in mail)	—	—	4	—	—	5	11	1	3	2	3	9
B. <i>Coelostoma</i> sp.	—	4	22	7	—	—	—	—	—	1	26	25
<i>Sphaeridium</i> sp.	—	—	15	—	—	—	—	—	—	2	9	10
C. <i>Saprinus frontistrius</i> Mars	12	33	—	1	6	41	3	10	23	12	3	49
<i>Hypocacculus malabaricus</i> Reicht	—	6	—	2	1	2	—	—	7	1	—	8
<i>Chalcionellus pulchellus</i> (Fab.)	—	4	1	1	—	10	—	—	1	5	3	9
<i>Atholus coelestris</i> (Mars)	—	—	—	1	—	—	—	—	—	1	—	1
D. <i>A. foetidus</i> (Cameron)	—	—	—	—	—	—	3	1	—	—	—	1
<i>Philonthus</i> sp.	4	—	—	—	—	—	—	—	—	1	—	1
<i>Zyras</i> sp.	12	—	1	—	—	—	—	1	3	—	—	4
E. Non-coprophagous												
<i>Apogonia</i> sp.	—	1	—	—	—	—	—	1	—	—	—	1
<i>Autoserica</i> sp.	—	3	—	—	—	—	—	2	—	—	—	2

TABLE 7. (Continued)

	J-F 255	M-M 672	J-A 672	S-N 816	D-F 808	M-M 416	J-A 368	TS 1033	BB 1034	BN 1032	G 908	Total of beetles
<i>Shizonycha</i> sp.	1	—	—	—	—	—	—	—	—	1	—	1
unidentified spp.	—	1	6	1	—	7	3	—	—	3	8	10
G. <i>Byrrhus murinus</i> (F.) ?	—	—	—	1	—	—	—	—	—	—	1	1
H. <i>Cardiophorus</i> sp. 1	—	—	—	1	—	—	—	—	—	1	—	1
<i>Cardiophorus</i> sp. 2	—	—	—	2	—	—	—	—	—	2	—	2
<i>Conoderus</i> sp. (?)	4	—	—	—	—	—	—	—	—	1	—	1
<i>Drasterius</i> sp. 1	—	1	—	13	—	—	—	1	1	—	11	12
<i>Drasterius</i> sp. 2	—	1	—	—	—	—	—	—	—	—	1	1
<i>Drasterius</i> (?) sp.	—	—	1	—	—	—	—	—	—	—	1	1
I. <i>Evorinea indica</i> (Arrow)	—	1	—	—	—	—	—	—	1	—	—	1
J. <i>Gibbium psylloides</i> (Czenpinski)	—	—	—	—	2	3	—	—	1	1	—	2
K. <i>Carpophilus</i> sp.	—	—	—	1	1	—	—	1	—	—	1	2
L. <i>Amblyopus</i> sp.	—	—	—	—	—	—	3	—	1	—	—	1
M. unidentified sp.	—	1	1	1	2	—	—	—	2	1	2	5
N. <i>Beccaria cardoni</i> Gorh.	—	—	—	—	2	—	—	1	—	1	—	2
O. unidentified sp.	—	1	—	—	—	—	—	—	1	—	—	1
P. <i>Caedus indicus</i> Fairmaire	12	3	3	15	162	63	5	1	—	153	21	178
<i>Gonocephalum bilineatum</i> Walker	75	3	—	11	32	10	3	20	6	25	9	61
<i>G. birmanicum</i> Kaszab	—	—	—	—	1	—	—	—	—	1	—	1
<i>G. "hoffmanseggi"</i>	4	—	—	5	16	2	—	—	—	12	8	19
<i>G. minisculum</i> Fairmaire	—	1	—	—	—	—	—	—	—	1	—	1

TABLE 7. (Continued)

	J-F 255	M-M 672	J-A 672	S-N 816	D-F 808	M-M 416	J-A 368	TS 1033	BB 1034	BN 1032	G 903	Total of beetles
<i>G. oculare</i> Kaszab	—	1	—	10	—	—	—	—	1	—	9	9
<i>G. spinicolle</i> Fairmaire	4	—	—	—	1	—	—	—	1	1	—	2
<i>G. subspinosum</i> Fairmaire	—	—	—	1	4	—	—	3	1	—	—	4
<i>G. szekessyi</i> Kaszab	94	24	—	28	21	—	—	68	4	6	—	80
<i>G. tuberculatum</i> Hope	8	7	1	43	50	10	—	35	9	8	37	87
<i>G. vagum</i> Steven	31	3	1	7	2	—	3	1	—	2	19	20
<i>G. sp. aff. crassepunctum</i> Kaszab	—	—	—	1	10	2	—	4	2	3	1	10
<i>Heterotarsus</i> sp.	—	1	—	—	—	—	—	—	—	—	1	1
<i>Leichenum canaliculatum</i> Fab.	—	—	—	—	1	—	—	—	—	—	1	1
<i>Mesomorphus latiusculus</i> chatanay	—	4	—	—	5	—	—	7	—	—	—	7
<i>M. villiger</i> Blanchard	4	—	—	—	10	—	5	2	—	—	10	11
<i>Pocadiopsis marginicollis</i> Fairmaire	8	9	—	—	—	—	—	8	—	—	—	8
<i>Scleron ferrugineum</i> Fab.	31	22	—	—	12	—	—	2	—	29	1	33
<i>S. reitteri</i> Gebien	8	—	—	—	1	—	—	—	—	2	1	3
unidentified sp. 18	—	—	—	—	—	2	—	—	1	—	—	1
Q. <i>Anthicus</i> sp.	—	1	—	—	—	—	—	—	—	—	1	1
R. <i>Dorythene</i> sp.	—	—	—	—	—	—	3	—	1	—	—	1
S. <i>Chaetocnema</i> sp. 1	—	7	4	—	—	—	—	1	4	2	1	8
<i>Chaetocnema</i> sp. 2	—	3	—	—	—	—	—	—	—	2	—	2
<i>Haltica coerulea</i> Oliv. ?	—	3	—	—	—	—	—	—	—	—	2	2
unidentified spp. 5, 6, 8-14	—	1	3	1	6	5	—	—	5	5	1	11
T. unidentified sp. 1	—	6	—	12	2	—	—	—	1	13	2	16
unidentified sp. 2	—	—	—	2	1	—	3	1	1	1	1	4

TABLE 7. (Concluded)

		J-F 255	M-M 672	J-A 672	S-N 816	D-F 808	M-M 416	J-A 368	TS 1033	BB 1034	BN 1032	G 908	Total of beetles
U.	<i>Cosmopolites sardidus</i> Germ.	—	1	—	4	4	—	—	1	—	6	—	7
	unidentified sp. ¶1	—	—	—	1	—	—	—	—	1	—	—	1
	" " sp. ¶3	—	—	—	—	—	14	27	2	—	14	—	16
	" " sp. ¶4 group	1	3	1	2	4	—	—	3	2	2	2	9
	" " sp. ¶5 group	—	3	1	1	1	—	—	—	4	2	—	6
V.	unidentified sp.	—	—	10	1	1	2	—	1	5	1	3	10

*See Table 2 for family code.

also occurred in the scarab (5 spp=76% of the beetles) and aphodid (2 spp=74% of the beetles) families.

In addition to the species that occurred in the systematic pit-fall trapping (Table 7), other species were obtained in infrequent sporadic collections by hand. Three staphylinid species were found on fresh monkey (langur) dung collected in a nearby village on 20 February 1971: *Anotylus cameroni* (Scheerpeltz), *A. latiusculus* (Kraatz), and *Tinotus* sp. One species of tenebrionid, *Cossyphus depressus* Olivier, was collected at a incandescent light at night on 8 November 1971.

DISCUSSION

The number of individuals caught per family was distorted by the use of bait at the traps. Scarabs and some of the other dung seeking beetles were attracted to the traps by odor of the bait, and may have been drawn in from a much larger area than, for example, carabids who, if drawn to the traps, would have been attracted visually by the activity of other insects. However, the composition in terms of number of species per family seemed to be unaffected by baiting. The community as seen here was primarily made up of ground active species, as only pit-fall traps were used. Comparison can thus be made with other studies that used baited pit-fall traps, and thus were looking at the same segment of the beetle community.

The composition of four such communities are presented here for comparison (Table 8). Two of the studies used only cattle dung (Hanski and Koskela, 1977 ; Merritt and Anderson, 1977), one used dung from six species of ungulates, including cattle (Hafez, 1939), and one used decomposing fish and fruit (Pirone and Sullivan, 1981).

In the current study carabid species made up a much larger proportion of the community and staphylinid species a much smaller proportion than occurred in the other studies (Kolmogorov-Smirnov, $p < .001$). These two families are primarily predaceous and may in part compete for similar resources, though this does not explain why such a shift should occur in West Bengal. There may be a gradual change in community composition with change in latitude. Staphylinids and hydrophilids seem to make up a larger proportion of the species at higher latitudes, whereas scarabs and tenebrionids seem to contribute larger proportions of species at lower latitudes (Table 8). This trend was only significant for staphylinids ($r^2 = .880$, $n = 5$, $p < .05$), and this was brought about primarily by its low representation in the West Bengal collection. In the other studies baited traps were usually set out for 2 or more days, whereas in this study they were out for less than 24 hrs. In Egypt

(Hafez, 1939) and Finland (Koskela, 1972) staphylinids reached their greatest abundance in terms of numbers of beetles after the third or fourth day, when the number of dipteran larvae was high (Hafez, 1939). However, in terms of species the Finish study showed that 71 species occurred by end of the first day and that the number of staphylinid

TABLE 8. Percent of species contributed by each family to the overall collection (all families presented that contributed at least 5% of the species to a collection)

	Location	Finland ¹	New York ²	California ³	Egypt ⁴	West Bengal ⁵
	N. latitude	61°	41°	40°	30°	22°
Families	Rainfall (cm)	—	112	61	—	145
Carabidae		2.8	10.6	0	1.9	32.4
Hydrophilidae		8.9	.5+*	13.9	5.6	1.0
Histeridae		2.2	7.8	5.6	9.3	1.9
Staphylinidae		74.9	28.4	61.1	31.5	1.0
Scarabaeidae		0	7.8	0	16.7	25.6
Aphodiidae (+ Geotropidae)		10.6	0	16.7	20.4	12.1
Nitidulidae		0	11.0	0	3.7	.5
Tenebrionidae		0	0	0	3.7	9.7
Other families		.6	33.9	2.7	7.2	15.8
Total number of :	families	6	33	5	12	22
	species	179	218+	36+	54	207
	beetles	62,500	19,992	?	?	16,192

1. Hanski and Koskela (1977). 2. Pirone and Sullivan (1981). 3. Merritt and Anderson (1977). 4. Hafez (1939). 5. This study.

*Species were unidentified, but beetles made up 7.1% of the collection.

species on the dung remained essentially the same for the next 9 days (see Table 3 in Koskela, 1972). Thus the staphylinid species present in the West Bengal community should have been adequately sampled despite the shorter trap period.

Tenebrionids occupy the same microhabitats (under stones, leaf litter, etc.) that carabids do, but in the United States they occur in more arid regions than do carabids (Borrer and Delong, 1954, p. 377). In West Bengal these two families were most abundant in the open habitats, but tenebrionids were most abundant during the dry cool months and carabids during the wet hot months. During cold winters, as in Quebec, adult carabids hibernate in the soil (Laroche, 1974) and thus would not appear in traps. These two families had similar population sizes as indicated by the number of individuals caught, but carabids were represented by three times as many genera and species.

This suggests that either carabids exploit a much wider niche space as a family, or that each species is more specialized and occupies a narrower niche than do tenebrionids. Since carabids prey on other insects (Hengeveld, 1980) and were most abundant when other insect species were most numerous in the traps, it seems likely that greater food specialization may explain why carabids were represented by more species than were tenebrionids.

In addition to the possible change in community composition with latitude discussed above, it appears that the environmental cues the species are sensitive to change with latitude. In France, at 48°N latitude, seasonal change in carabid activity was positively correlated with temperature for most species; a correlation between activity and rainfall was lacking (Benest and Cancela da Fonseca, 1980). In this study carabid activity was positively correlated with monthly rainfall and not with mean monthly temperature. Of the six families tested only tenebrionid activity showed a correlation with temperature, but it was also correlated at a lower level of significance with rainfall. Histerid activity lacked correlation with either rainfall or temperature. They seemed most sensitive to competition, at least with related species, as indicated by their activity across months. Interspecific competition may explain the activity patterns of other species in the study, but more information would be needed about their feeding habits.

Histerids, scarabs and aphodids were primarily attracted to traps baited with human dung, which was the most abundant dung type available (Oppenheimer, 1977) and which probably attracted the greatest number of prey for the histerid. The carabids, tenebrionids and hydrophilids, as family groups, seemed to be falling into the traps at random as they occurred in all traps equally, including the unbaited trap.

SUMMARY

Eight pit-fall traps were set one day a week in each of four different habitats between January 1971 and August 1972, in two villages 40 km NNW of Calcutta in West Bengal, India. Seven traps were baited with mammalian dung and one trap was unbaited. Twenty-one identified families, 73 genera and 207 species were represented in the 16,192 beetles trapped. Carabids accounted for 36% of the genera, 32% of the species, but only 4% of the individuals. Scarab dung beetles accounted for 12% of the genera, 26% of the species, and 83% of the individuals. Aphodids made up 12% of the species and 8% of the individuals. The abundance of these three families, and that of hydrophilids, was posi-

tively correlated with rainfall. Tenebrionids accounted for 11% of the genera, 10% of the species, and 3% of the individuals ; their abundance was negatively correlated with rainfall and temperature. The remaining families, including histerids and staphylinids, each made up less than 1% of the beetles. Scarabs and aphodids were most abundant on human dung and in bamboo groves. Hydrophilids and carabids were most abundant in grass habitats, and tenebrionids in banana groves ; all three families occurred with equal frequency in all traps. Detailed information is included for all species, except scarabs and aphodids.

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RECORDS OF SOME DERMAPTERA (INSECTA) FROM NORTH EASTERN INDIA

By

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INTRODUCTION

The present paper deals with some Dermaptera present at the Eastern Regional Station, Zoological Survey of India, Shillong. Altogether 24 species (excluding one species determined upto generic level which is represented by nymph only) under 17 genera are represented. The collection is mainly from three states viz., Assam, Meghalaya and Arunachal Pradesh and several new locality records for various species are recorded. Besides, some species, namely, *Cranopygia manipurensis* Srivastava (1975); *Liparura serrata* Srivastava (1977) and *Prosadiya tricota* Hebard (1923) which were hitherto known by types are reported on some additional material.

SYSTEMATIC ACCOUNT

Family PYGIDICRANIDAE

Subfamily PYGIDICRANINAE

1. *Cranopygia* sp.

Material studied.—ARUNACHAL PRADESH : Siang district : Baser, 1 nymph, 14.ii.1973, coll. R. S. Pillai.

Distribution : India (Arunachal Pradesh).

2. *Cranopygia fletcheri* Bharadwaj & Kapoor

Cranopygia fletcheri Bharadwaj & Kapoor, 1967, *Bull. Ent.*, 8 : 1.

Material studied : MEGHALAYA : Khasi hills : Shillong, 4 exs. (Risa Colony : 1 ♂, 17.vi.1972, coll. S. Biswas ; 1 ♀, 27.v.1976, coll. K. Deb ; Fisheries compound, 1 ♀, 3. vii. 1976, Coll. M. S. Jyrwa ; Fruit garden, 1 ♂, 30.vii.1976, coll. M. S. Jyrwa).

Distribution : India (Assam and Meghalaya).

3. *Cranopygia manipurens* Srivastava

Cranopygia manipurens Srivastava, 1975, *J. zool. Soc. India*, 27 (1-2) : 101.

Material studied : MANIPUR : Tarbung basti, 1 ♂, 27.iii.1975, coll. M. Dutta ; Domba, 1 ♀, 28.i.1977, coll. S. G. Patil.

Distribution : India (Manipur).

Remark : Hitherto this species was known by types only.

Family CARCINOPHORIDAE

Subfamily CARCINOPHORINAE

4. *Aborolabis pervicina* (Burr)

Anisolabis pervicina Burr, 1913, *Rec. Indian Mus.*, 8 : 137.

Material studied : ARUNACHAL PRADESH : Siang district : Baser, 1 ♂, 3 ♀ ♀, 7.ii.1973, coll. R. S. Pillai ; Along, 14 exs. (2 ♀ ♀ 10.ii.1973, 2 ♂ ♂, 10 ♀ ♀, 12.ii.1973 coll. R. S. Pillai) ; ca 2 Kms from Dale village on Baser Lekhabali road, 8 ♂ ♂, 21 ♀ ♀, 14.ii.1973, coll. R. S. Pillai ; Lekhabali, 3 ♂ ♂, 5 ♀ ♀, 16.ii.1973, coll. R. S. Pillai, ASSAM : North Cachar hills district, Garampani, 1 ♂, 2 ♀ ♀, 13.iii.1970, coll. S. K. Talukder ; Sibsagar district, Kaziranga, Mukumukh, 1 ♀, 24.ii.1974, coll. M. Dutta. MEGHALAYA : Garo hills : Napak hill, ca, 8 Kms east of Songsek, 3 ♀ ♀, 12.iv.1973, coll. S. Biswas ; Songsek, 1 ♀, 15.xi.1973, coll. S. Biswas ; Selbagiri, 1 ♀, 25.ii.1975, coll. S. Biswas ; Khasi hills : Cherrapunjee, Mawsmat, 2 ♀ ♀, 21.iii.1972, coll. R. S. Pillai ; Mawphlong, 13 exs (1 ♀, 14.v.1963, 2 ♀ ♀, 27.v.1963, coll. V. D. Srivastava ; 1 ♂, 2 ♀ ♀, 16.iv.1964, 2 ♂ ♂, 1 ♀, 28.iv.1971, coll. S. Biswas ; 4 ♀ ♀, 4.xi.1972, coll. A. K. Ghosh) ; Lumparing, 1 ♂, 2 ♀ ♀, 27.ix.1976, coll. M. S. Jyrwa ; Shillong, 3 exs. (Shillong peak, 1 ♀, 4.vii.1967, coll. R. K. Vershney ; Bishnupur, 1 ♂, 1 ♀, 4.xii.1968, coll. S. Biswas) ; Elephant falls, 1 ♀, 6.ix.1975, coll. S. K. Chanda ; Umphrenei, 3 ♂ ♂, 4 ♀ ♀, 5.v.1964, coll. S. Biswas ; Umran, 1 ♀, 16.xii.1971, coll. S. Biswas ; Umtynger, 1 ♂, 26.vi.1964, coll. S. Biswas.

Distribution : India (Arunachal Pradesh, Assam and Meghalaya) ; Nepal and Bhutan.

Remark : This species is recorded here for the first time from Meghalaya.

Family LABIDURIDAE

Subfamily NALINAE

5. *Nala lividipes* (Dufour)

Forficula pallipes Dufour, 1820, *Ann. gener. des. Sc. Phys. de Bruxelles*, 4, table 1 : 307.

Forficula lividipes Dufour, 1829, *Annls. Sci. nat.*, 13 : 140 (new name proposed).

Material studied : MEGHALAYA : Garo hills : Songsek, 1 ♂, 15.xi.1973, coll. *S. Biswas* ; Damra rest house, 1 ♂, 20.xi.1973, coll. *S. Biswas* ; Selbagiri, 1 ♂, 25.ii.1975, coll. *S. Biswas*.

Distribution : Widely distributed throughout Tropical Asia, Southern Europe, Africa and Australia.

6. *Nala nepalensis* (Burr)

Labidura nepalensis Burr, 1907, *Rec. Indian Mus.*, 1 : 208.

Material studied : ARUNACHAL PRADESH : Siang district : Kopi village, 4 ♀ ♀, 7.ii.1973 ; Michi river, 1 ♀, 7.ii.1973 ; Baser, 1 ♀, 14.ii.1973, coll. *R. S. Pillai*, MEGHALAYA : Garo hills : Rongrengiri, 1 ♀, 19.iv.1973, coll. *S. Biswas* ; Ganol river bank, 1 ♀, 14.ii.1971, coll. *G. M. Yazdani* ; Selbagiri, 1 ♀, 25.ii.1975, coll. *S. Biswas* ; Khasi hills ; Mawlodak, 5 ♀ ♀, 5 nymph, 4.iii.1970, coll. *G. M. Yazdani* ; Shillong, Sati falls, 2 ♀ ♀, 1 nymph, 25.v.1967, coll. *R. K. Vershney*.

Distribution : India, Nepal, Malaya, Indo-China and Afghanistan.

Subfamily LABIDURINAE

7. *Labidura riparia* (Pallas)

Forficula riparia Pallas, 1773, *Reise Russ. Reichs* 2 : 227.

Material studied : ARUNACHAL PRADESH : Siang district : Balorishat, 2 ♂ ♂, 12.ii.1973 ; Sargam, 1 ♂, 1 ♀, 9.ii.1973 ; Lekhabali, 1 nymph, 16.ii.1973, coll. *R. S. Pillai*, MEGHALAYA : Garo hills, Anogiri, 1 nymph, 8.xi.1973, coll. *S. Biswas* ; Kashi Hills, Shillong, 1 nymph, 21.v.1971, coll. *S. Biswas* ; Jaintia hills, Sonapurdi, 2 ♂ ♂ 3 ♀ ♀, 7.viii.1974, coll. *A. R. Lahiri*.

Distribution : Almost cosmopolitan.

8. *Forcipula decolyi* Bormans

Forcipula decolyi Bormans, 1900, *Annali. Mus. civ. Stor. nat. Giacomo Doria* 20 : 444.

Material studied : ARUNACHAL PRADESH : Siang district : Baser, 4 ♂ ♂, 5 ♀ ♀, 11 nymphs, 7.ii.1973 ; Kichi river, 2 ♂ ♂, 3 ♀ ♀, 2 nymphs, 7.ii.1973, coll. *R. S. Pillai*, ASSAM : Kamrup district, Kahitima, Hakawa river, 1 ♀, 1 nymph, 12.i.1974, coll. *A. K. Ghosh*.

Distribution : India, Nepal, Sikkim, China (Szechwan) and New Guinea.

9. *Forcipula trispinosa* (Dohrn)

Labidura trispinosa Dohrn, 1863, *Stettin. ent. Ztg.*, 24 : 310.

Material studied : MEGHALAYA : Garo hills, Selbagiri, 2 ♂♂, 25.ii.1975, coll. S. Biswas.

Distribution : India, Nepal, Bhutan and Burma.

Family APACHYIDAE

10. *Apachyus feae* Bormans

Apachyus feae Bormans, 1894, *Annali. Mus. civ. Stor. nat. Giacomo Doria*, 14 : 373.

Material studied : MEGHALAYA : Garo hills, Songkhama, 1 ♀, 15.xi.1973, coll. S. Biswas.

Distribution : India, Bhutan, Sikkim, Burma, China (Yunnan) and Vietnam.

Family LABIIDAE

Subfamily LABIINAE

11. *Labia curvicauda* (Motschulsky)

Forficesila curvicauda Motschulsky, 1863, *Bull. Soc. Imp. Nat. Moscou*, 36 : 2.

Material studied : ASSAM : Kamrup district, Kahitima, 4 ♂♂, 1 ♀, 13.i.1974, coll. S. Biswas, MEGHALAYA : Garo hills, Anogiri, 2 ♂♂, 1 ♀, 8.xi.1973, coll. S. Biswas.

Distribution : Cosmopolitan.

12. *Labia lutea* (Bormans)

Spongophora lutea Bormans, 1894, *Annali. Mus. civ. Stor. nat. Giacomo Doria*, 14 : 386

Material studied : ASSAM : Kamrup district, Kahitima, 1 ♀, 13.i.1974, coll. S. Biswas, MEGHALAYA : Garo hills, Anogiri, 4 ♂♂, 3 ♀♀, 1 nymph, 8.xi.1973, coll. S. Biswas.

Distribution : India, Burma, China, Sumatra and Hainan Is.

Remarks : This is a very variable species as far as the size of eyes, pronotum, development of wings, ultimate tergite, pygidium and forceps are concerned.

13. *Chaetospania feae* Bormans

Chaetospania feae Bormans, 1894, *Annali. Mus. civ. Stor. nat. Giacomo Doria*, 14 : 390.

Material studied : ASSAM : North Cachar hills, Jatinga, 1 ♂, 1 ♀, 24.x.1978, coll. S. Biswas.

Distribution : India, China, Ceylon, Burma, Sumatra, Java, Lombok, Philippine Isls. and Borneo.

Family SPONGIPHORINAE

14. *Spongovostox semiflavus* (Bormans)

Spongophora semiflava Bormans, 1894, *Annali. Mus. civ. Stor. nat. Giacomo Doria*, 14 : 385.

Material studied : ASSAM : Kamrup district, Kahitima beel, : Hakawa river, 1 ♂, 3 ♀ ♀, 12.i.1974, coll. A. K. Ghosh.

Distribution : India, China (Yunnan), Ceylon, Burma, Vietnam, Sumatra, Simalur, Java, Sumba and Bismark Is.

15. *Homotages feae* (Bormans)

Anechura feae Bormans, 1888, *Annali. Mus. civ. Stor. nat. Giacomo Doria*, 6 : 445.

Material studied : MEGHALAYA : Khasi hills : Mawphlong, 9 exs. (1 ♂, 1 ♀, 8.xi.1967, coll. R. K. Vershney, 2 ♂ ♂, 1 ♀, 4.xi.1972 ; 1 ♀, 5.iv.1973, coll. A. K. Ghosh ; 1 ♂, 21.x.1974, coll. S. K. Gupta ; 1 ♀, 27.xi.1974, coll. S. Biswas), Shillong, 1 ♀, 21.v.1971, coll. S. Biswas.

Distribution : India, Burma and Nepal.

Family CHELISOCHIDAE

16. *Adiathetus glaucopterus* (Bormans)

Chelisoche glaucopterus Bormans, 1888, *Annali. Mus. civ. Stor. nat. Giacomo Doria*, 6 : 441.

Material studied : ARUNACHAL PRADESH : Subansiri district, Daporijo, 1 ♂, 1 ♀, 19.ii.1975, coll. K. R. Rao, ASSAM : Sibsagar district, Kaziranga, 1 ♂, 20.ii.1974, coll. M. Dutta.

Distribution : India, Nepal, Bhutan, China (Yunnan), Burma and Vietnam.

Family FORFICULIDAE

Subfamily ALLODAHLINAE

17. *Allodahlia coriacea* (Bormans)

Anechura coriacea Bormans, 1894, *Annali. Mus. civ. Stor. nat. Giacomo Doria*, 14 : 403.

Material studied : MEGHALAYA : Garo Hills, Damgiri, south of Rest house, 1 ♂, 11.iv.1971, coll. R. S. Pillai.

Distribution : India, China, Burma, Vietnam and Borneo.

18. *Allodahlia macropyga* (Westwood)

Forficula macropyga Westwood, 1839, in *Royle Ill. Bot. Nat. Hist. Himalayan Mts.*, 1 (2) : 53.

Material studied : MEGHALAYA : Khasi hills : Cherrapunjee, 1 ♂, 20.vii.1965, coll. R. K. Varshney ; Shillong, Laitkor, 2 exs. (1 ♂, 10.vii.1965, 1 nymph, 20.viii.1965, coll. B. K. Tikader).

Distribution : India, Nepal, Bhutan, China, Burma and Thailand.

19. *Allodahlia scabriuscula* (Serville)

Forficula scabriuscula Serville, 1839, *Hist. Nat. Ins. Orth.* : 38.

Material studied : ARUNACHAL PRADESH : Siang district, Along, 1 ♀, 9.ii.1974, coll. R. S. Pillai, MEGHALAYA : Jaintia hills, Shangphung, 2 ♂ ♂, 7.xii.1975, coll. S. K. Chanda ; Khasi hills, Jaiaw, 1 ♂, 9.xi.1972, coll. R. S. Giri.

Distribution : India, Bhutan, South China, Vietnam, Sumatra, Java, Bali, Borneo, Philippine Isls., Taiwan and Japan.

Subfamily EUDOHRNINAE

20. *Eudohrnia metallica* (Dohrn)

Forficula metallica Dohrn, 1865, *Stettin. ent. Ztg.*, 26 : 90.

Material studied : MEGHALAYA : Khasi hills, Mawpat, 1 ♂, 22.vi.1964, coll. S. Biswas.

Distribution : India (Meghalaya and Sikkim), Nepal, South China, Burma and Vietnam.

Subfamily OPISTHOCOSMIINAE

21. *Liparura serrata* Srivastava

Liparura serrata Srivastava, 1977, *Orient. Insects*, 11 (2) : 193.

Material studied : MANIPUR : Shiroi, 3 ♂ ♂, 4 ♀ ♀, 24.i.1977, coll. S. G. Patil.

Distribution : India (Manipur).

Remarks : Hitherto this species was known by types only.

22. *Prosadiya tricota* Hebard

Prosadiya tricota Hebard, 1923, *Mem. Dep. Agric. India ent. Ser.*, 7 : 234.

Material studied : ASSAM : North Cachar Hills, Jatinga, 1 ♂, 29.ix.1978, coll. S. Biswas.

Distribution : India : Assam.

Remarks : This is the second subsequent record of the species.

23. *Timomenus lugens* (Bormans)

Opisthocomia lugens Bormans, 1894, *Annali. Mus. civ. Stor. nat. Giacomo Doria*, 14 : 398.

Material studied : ASSAM : North Cachar hills, Jatinga, 1 ♂, 24.ix.1978, coll. *S. Biswas*, MEGHALAYA : Garo hills, Anogiri, 1 ♂, 8.xi.1973, coll. *S. Biswas*.

Distribution : India, China (Yunnan), Burma and Malaysia.

24. *Timomenus oannes* (Burr)

Opisthocosmia oannes Burr, 1900, *Ann. Mag. nat. Hist.*, (7) 6 : 85.

Material studied : MEGHALAYA : Shillong, 3 exs (Lake side, 1 ♂, 21.ix.1959, coll. *S. N. Prasad* ; Lawsohtun, 1 ♂, 1 ♀, 28.ii.1967, coll. *R. K. Vershney*) ; Mylliem, 1 ♂, 24.ix.1966, coll. *S. K. Chanda*.

Distribution : India (Assam and Meghalaya), China (Yunnan) and Vietnam.

25. *Eparchus insignis* (Haan)

Forficula insignis Haan, 1844, *Verh. nat. Ges. nederl. Overzee. Bezitt.*, 243.

Material studied : ARUNACHAL PRADESH : Siang district, Along 1 ♂, 9.ii.1973, coll. *R. S. Pillai*. ASSAM : North Cachar hills, Garampani, 2 ♀ ♀, 26.i.1976, coll. *A. K. Ghosh* ; Jatinga, 1 ♂, 24.ix.1978, coll. *S. Biswas*. MANIPUR : Tabungbasti, 3 ♂ ♂, 27.iii.1975, coll. *M. Dutta*. MEGHALAYA : Garo hills, Damra, 1 ♂, 20.xi.1973, coll. *S. Biswas* ; Khasi Hills : Mawphlong, 1 ♂, 4.xi.1973, coll. *A. K. Ghosh* ; Shillong : Risa colony, 1 ♂, 14.xi.1972, coll. *R. S. Giri* ; Tripura Castle road, 1 ♂, 1 ♀, 27.vi.1972, coll. *S. Biswas*.

Distribution : Eastern India (Arunachal Pradesh, Assam, Manipur, Meghalaya and Sikkim), Burma, Ceylon, Indo-China, Sumatra, Java, Celebes and Hainan Is.

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SUMMARY

The present paper deals with 24 species comprising 17 genera from Assam, Meghalaya and Arunachal Pradesh. For various species new locality records are provided.

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THE LEECH FAUNA OF THE JAMMU REGION
OF JAMMU AND KASHMIR STATE, INDIA

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INTRODUCTION

Although Harding and Moore (1927), Bhatia (1934, 1939) and Soota (1955) have described a few species of leeches from the Kashmir Valley so far, there is no published account on the leech fauna of the Jammu region. The present communication deals with 22 species of leeches belonging to 14 genera and 4 families. All the 22 species are being recorded for the first time from the area. The species *Batrachobdella lobata* and *Erpobdella octoculata*, till now recorded only from the Kashmir Valley, the other side of the Pir Panchal range of the great Himalayas, are now recorded from the Poonch and Doda districts which are of zoogeographic importance. A key to the identification of the leech species of the Jammu region is also given herein.

The material of leeches was collected from various localities in the Jammu region of Jammu and Kashmir state (Districts : Kathua, Jammu, Rajouri, Poonch, Udhampur and Doda) by six parties from the High Altitude Zoology Field Station, Solan, during 1977-1980. The specimens were mostly collected by the author and by Dr. H. Khajuria, Dr. Raj Tilak, Dr. G. M. Yazdani and Mr. Rathin Mukherjee. The habitat of the leeches is more or less the same as described by Harding and Moore (1927) in the Fauna of British India—Hirudinea.

KEY TO THE IDENTIFICATION OF LEECHES OF THE JAMMU REGION

KEY TO THE SPECIES OF THE FAMILY GLOSSIPHONIDAE

1.	Mouth opening subterminal in the anterior sucker	...	...	2
	Mouth opening at the centre of the anterior sucker	...	...	6
2.	Eyes one pair	...	...	3
	Eyes three pairs	...	...	5

3.	Male gonopore between annuli 25 and 26	...	<i>Placobdella indica</i>	
	Male gonopore posterior to annulus 26	...	...	4
4.	Male gonopore between annuli 26 and 27	...	<i>Placobdella fulva</i>	
	Male gonopore between annuli 27 and 28	...	<i>Placobdella undulata</i>	
5.	Eyes on annuli 3, 4 and 7	...	<i>Paraclepsis praedatrix</i>	
	Eyes on annuli 2, 3 and 5.	...	<i>Paraclepsis vulnifera</i>	
6.	Eyes one pair	...	...	7
	Eyes more than one pair	...	...	8
7.	Eyes on annuli 3, dorsal scute between annuli 12 and 13.	...	<i>Helobdella stagnalis</i>	
	Eyes on annuli 4, dorsal scute lacking	...	<i>Helobdella nociva</i>	
8.	Crop with 6 or 7 pairs of lateral diverticula	...	...	9
	Crop with 9 or more pairs of lateral diverticula	...	...	12
9.	Crop with 6 pairs of lateral diverticula	...	<i>Glossiphonia weberi weberi</i>	
	Crop with 7 pairs of lateral diverticula	...	...	10
10.	Eyes three pairs	...	<i>Batracobdella hardingi</i>	
	Eyes two pairs	...	...	11
11.	First pair of eyes between annuli 2 and 3	..	<i>Batracobdella lobata</i>	
	First pair of eyes on annuli 4.	...	<i>Batracobdella reticulata</i>	
12.	Eyes three pairs	...	<i>Hemiclepsis bhatiai</i>	
	Eyes two pairs	...	<i>Hemiclepsis marginata marginata</i>	

KEY TO THE SPECIES OF THE FAMILY ERPOBDELLIDAE.

1.	Accessory post-cephalic eyes present	...	...	2
	Accessory post-cephalic eyes absent	...	...	3
2.	First pair of eyes on annulus 3	...	<i>Herpobdelloidea lateroculata</i>	
	First pair of eyes on annulus 4	...	<i>Nematobdella indica</i>	
3.	Eyes four pairs	...	<i>Erpoddella octoculata</i>	
	Eyes three pairs	...	<i>Barbronia weberi</i>	

KEY TO THE SPECIES OF THE FAMILY HIRUDIDAE

1.	Median ventral fissure on lip present	...	...	2
	Median ventral fissure on lip absent	...	<i>Hirudo birmanica</i>	
2.	Vaginal stalk well developed	...	<i>Poecilobdella granulosa</i>	
	Vaginal stalk absent,	...	<i>Poecilobdella javanica</i>	

SYSTEMATIC ACCOUNT

Phylum : ANNELIDA

Class : HIRUDINEA

Order : RHYCHOBDELLAE

Family : GLOSSIPHONIDAE

1. *Batracobdella hardingi* Baugh1960. *Batracobdella hardingi* Baugh, *Parasitology*, **50** : 287-301.1983. *Batracobdella hardingi*, Chandra, *Rec. Zool. Surv. India*, **80** : 265-290.

Material : 3 ex., Parel Vill., Samba, Dist. Jammu, 30.ix.78. 28 ex., near P. W. D. rest house, Samba, Dist. Jammu, 28.ix.78. 6 ex., Daskal, Akhnoor, Dist. Jammu, 12.x.78. 3 ex., Pond near Mansar, Dist. Jammu, 7.x.78.

Distribution : India : Bihar.

2. *Batracobdella lobata* (Bhatia)1934. *Glossiphonia lobata* Bhatia, *Ann. Parasit. hum. Comp.*, **12** : 121-129.1983. *Batracobdella lobata*, Chandra, *Rec. zool. Surv. India*, **80** : 265-290.

Material : 4 ex., 2 km East of Poonch, Dist. Poonch. 18.x.80.

Distribution : India : Kashmir.

Remarks : Previously it was recorded only from the Kashmir Valley

3. *Batracobdella reticulata* (Kaburaki)1921. *Glossiphonia reticulata* Kaburaki, *Rec. Indian Mus.*, **22** (5) : 689.1927. *Glossiphonia reticulata*, Harding, *Fauna Brit. India*, Hirudinea : 65.1983. *Batracobdella reticulata*, Chandra, *Rec. zool. Surv. India*, **80** : 265-290.

Material : 12 ex., Raiyan, Hira Nagar, Distt. Kathua, 23.xii.77. 2 ex., Mandera, Samba, Distt. Jammu, 29.ix.78. 6 ex., 2 km. on Udampur road, Katra, Distt. Udampur, 23.x.78.

Distribution : India : Punjab, Himachal Pradesh and Maharashtra.

4. *Glossiphonia weberi weberi* Blanchard1897. *Glossiphonia weberi* Blanchard, *Zool. Ergeb. einer Reise in Niederlandische Ost-India*, Max Weber, **4** : 332.1927. *Glossiphonia weberi* Harding, *Fauna Brit. India*, Hirudinea : 62-65.1983. *Glossiphonia weberi weberi*, Chandra, *Rec. Zool. Surv. India*, **80** : 265-290.

Material : 2 ex., Rajpura, S. W. of Kathua, 24.xii.77. 1 ex., Sungla Vill., ca. 4 km. east of Akhnoor, Distt. Jammu, 17.x.78. 115 ex., Budwari Vill., Samba, Distt. Jammu, 1.x.78. 12 ex., Pond near P. W. D.

rest house, Samba, Distt. Jammu, 28.ix.78. 25 ex., Mandera Vill. tank, Samba, Distt. Jammu, 29.ix.78., 4 ex., Pond near Mansar, Samba, Distt. Jammu, 7.x.78. 6 ex., 2 km. E. of Poonch, 18.ix.80., 2 ex., Qazi Mohra, Distt. Poonch, 22.ix.80. 10 ex., 3 km along Srinagar road, Udhampur, 2.x.80. 4 ex., 3 km west of Mendhar, Distt. Poonch, 25.ix.80. 1 ex., 2 km E. of Mendhar, Distt. Poonch, 27.ix.80. 2 ex., 4 km. west of Udhampur, 3.x.80. 30 ex., water ditch near Katra Town, Distt. Udhampur, 22.x.78. 26 ex., on Katra-Udhampur road, Katra, Distt. Udhampur, 23.x.78. 4 ex., Kota Vill. Mendhar, Distt. Poonch, 29.ix.80. 5 ex., Sangram Bata, Kishtwar, Distt. Doda, 10.x.80.

Distribution : India : Kashmir, Himachal Pradesh, Uttar Pradesh, Rajasthan, Karnataka, Madhya Pradesh, Bihar, West Bengal, Meghalaya, Manipur and Orissa.

Outside India : Pakistan, Nepal, Burma and Sumatra.

5. *Helobdella nociva* Harding

1924. *Helobdella nociva* Harding, *Ann. Mag. nat. Hist.*, Ser. 9, **14** : 489.

1927. *Helobdella nociva* Harding, *Fauna Brit. India*, Hirudinea : 70-72.

1983. *Helobdella nociva*, Chandra, *Rec. zool. Surv. India*, **80** : 265-290.

Material : 4 ex., Qazi Mohora, Poonch, Distt. Poonch, 22.ix.80. 9 ex., 3 km along Srinagar road, Udhampur, 2.x.80. 1 ex., accross river Poonch, Poonch, 21.ix.80.

Distribution : India : Himachal Pradesh, West Bengal and Orissa.

6. *Hellobdella stagnalis* (Linn.)

1758. *Hirudo stagnalis* Linnaeus, *Systema Naturae*, 10th Ed.

1927. *Hellobdella stagnalis*, Harding, *Fauna Brit. India*, Hirudinea : 68-70.

1983. *Hellobdella stagnalis*, Chandra, *Rec. zool. Surv. India*, **80** : 265-290.

Material : 3 ex., 2 km East of Poonch. Distt. Poonch, 18.ix. 80. 1 ex., 4 km West of Udhampur, Distt. Udhampur, 3.x.80. 26 ex., Katra Town, Distt. Udhampur, 29.x.78. 10 ex., 2 km on Udhampur road, Katra Town, Distt. Udhampur, 23.x.80.

Distribution : India : Kashmir and Himachal Pradesh.

Outside India : Canada, U. S. A. and Paraguay.

7. *Hemiclepsis bhatiai* Baugh

1960. *Hemiclepsis bhatiai* Baugh, *Parasitology*, **50** : 287-301.

1983. *Hemiclepsis bhatiai*, Chandra, *Rec. zool. Surv. India*, **80** : 265-290.

Material : 13 ex., Stn. No. 8, Kathua, Distt. Kathua, 20.xii.77. 17 ex., Gara Satura, Hiranagar, Distt. Kathua, 29.xii.77. 3 ex., Logate, Kathua,

Distt. Kathua, 19.xii.77. 2 ex., Chann Khetri, Hiranagar, Distt. Kathua, 27.xii.77. 10 ex., Koota, Hiranagar, Distt. Kathua, 22.xii.77. 5 ex., Daskal, Akhnoor, Distt. Jammu, 12.x.78.

Distribution : India : Bihar.

8. *Hemiclepsis marginata marginata* (Muller)

1778. *Hirudo marginata* Muller, *Vermium terrestrium et fluviatileum* 1, pars 2.4° Havnie et Lipsie, 1773-1774.

1927. *Hemiclepsis marginata marginata*, Harding *Fauna Brit. India*, Hirudinea : 83-86.

1983. *H. marginata marginata*, Chandra, *Rec. zool. Surv. India*, 80 : 265-290.

Material : 1 ex., Budhwari village, Samba, Distt. Jammu, 1.x.78. 5 ex., Qazi Mohra, Poonch, Distt. Poonch, 22.ix.80.

Distribution : India : Uttar Pradesh, Rajasthan, Maharashtra and West Bengal.

Outside India : Europe, Western Asia and Nepal.

9. *Paraclepsis praedatrix* Harding

1924. *Paraclepsis praedatrix* Harding, *Ann. Mag. nat. Hist.*, Ser. 9, 14 : 489.

1927. *Paraclepsis praedatrix* Harding, *Fauna Brit. India*, Hirudinea : 88-90.

1983. *Paraclepsis praedatrix*, Chandra, *Rec. zool. Surv. India*, 80 : 265-290.

Material : 5 ex., Gara Satura, Hiranagar, Distt. Kathua, 29.xii.77. 4 ex., Rajpura, S. W. of Kathua, 24.xii.77. 18 ex., 2 km S. W. of Akhnoor, Distt. Jammu, 13.x.78. 4 ex., a pond on Jammu road, Akhnoor, Distt. Jammu, 14.x.78. 51 ex., Budwari Vill., Samba, Distt. Jammu, 1.x.78. 29 ex., Sungal vill., Akhnoor, Distt. Jammu, 17.x.78. 15 ex., ca. 3 km. N. of Akhnoor, Distt. Jammu, 16.x.78. 69 ex., Daskal Vill., Akhnoor, Distt. Jammu, 12.x.78. 21 ex., Mandera Vill., Samba, Distt. Jammu, 29.ix.78. 4 ex., Pond near Mansar, Distt. Jammu, 7.x.78. 30 ex., 2 km W. of Mansar, Distt. Jammu, 9.x.78. 12 ex., Parel Vill., Samba, Distt. Jammu, 30.ix.78. 2 ex., Basantar river bank, Samba, Distt. Jammu, 27.ix.78. 2 ex., Pond near P. W. D. rest house, Samba, Distt. Jammu, 28.ix.78. 6 ex., water ditch near Katra town, Distt. Udhampur, 22.x.78. 1 ex., 3 km West of Mendhar, Distt. Poonch, 30.ix.80. 22 ex., Katra, Distt. Udhampur, 22.x.78. 23 ex., 2 km on Udhampur road, Katra, Distt. Udhampur, 23.x.78. 1 ex., Qazi Mohra, Poonch, Distt. Poonch, 22.x.80. 4 ex., 3 km along Srinagar road, Udhampur, Distt. Udhampur, 2.x.80.

Distribution : India : Himachal Pradesh, Haryana, Rajasthan, Bihar, Assam and Maharashtra.

10. Paraclepsis vulnifera Harding

1924. *Paraclepsis vulnifera* Harding, *Ann. Mag. nat. Hist.* Ser. 9, **14** : 489.

1927. *Paraclepsis vulnifera* Harding, *Fauna Brit. India*, Hirudinea : 91.

1983. *Paraclepsis vulnifera*, Chandra, *Rec. zool. Surv. India*, **80** : 265-290.

Material : 22 ex., Daskal, Akhnoor, Distt. Jammu, 12.x.78. 2 ex., 3 km North of Akhnoor, Distt. Jammu, 16.x.78.

Distribution : India : Himachal Pradesh, Rajasthan, Maharashtra and Tamil Nadu.

11. Placobdella fulva Harding

1924. *Placobdella fulva* Harding, *Ann. Mag. nat. Hist.* Ser. 9, **14** : 489.

1927. *Placobdella fulva* Harding, *Fauna Brit. India*, Hirudinea : 78.

1983. *Placobdella fulva*, Chandra, *Rec. zool. Surv. India*, **80** : 265-290.

Material : 3 ex., Chann Khetri, Hiranagar, Distt. Kathua, 27.xii.77.

Distribution : India : Bihar.

12. Placobdella indica Baugh

1960. *Placobdella indica* Baugh, *Zool. Anz.*, **165** : 468-477.

1983. *Placobdella indica*, Chandra, *Rec. zool. Surv. India*, **80** : 265-290.

Material : 10 ex., Raiyan, Hiranagar, Distt. Kathua, 23.xii.77 4 ex., Koota, Hiranagar, Distt. Kathua, 22.xii.77.

Distribution : India : Bihar.

13. Placobdella undulata Harding

1924. *Placobdella undulata* Harding, *Ann. Mag. nat. Hist.*, Ser. 9, **14** : 489.

1927. *Placobdella undulata* Harding, *Fauna Brit. India*, Hirudinea : 78-81.

1983. *Placobdella undulata*, Chandra, *Rec. zool. Surv. India*, **80** : 265-290.

Material : 1 ex., Sherpur, Kathua, Distt. Kathua, 18.xii.77.

Distribution : India : Himachal Pradesh and Rajasthan.

Outside India : Sri Lanka.

Order : ARHYNCHOBDELLAE

Family : ERPOBDELLIDAE

14. Barbronia weberi (Blanchard)

1897. *Dina weberi* Blanchard, *Zool. Ergeb. Reise in Neiderlandische Ost.—Indian*, **4** : 332-355.

1927. *Barbronia weberi*, Moore, *Fauna Brit. India*, Hirudinea : 135-140.

1983. *Barbronia weberi*, Chandra, *Rec. zool. Surv. India*, **80** : 265-290.

Material : 1 ex., Basholi, Distt. Kathua, 5.i.78. 7 ex., Sherpur, Kathua, Distt. Kathua, 18.xii.77. 8 ex., 4 km west of Udhampur, 3.x.80. 2 ex., Qazi Mohra, Poonch, Distt. Poonch, 22.ix.80. 29 ex., 3km North of Mendhar, Distt. Poonch, 28.ix.80. 4 ex., 3 km west of Mendhar, Distt. Poonch, 25.ix.80. 2 ex., 2 km South of Mendhar, Distt. Poonch, 26.ix.80. 5 ex., 2 km East of Mendhar, Distt. Poonch, 27.ix.80. 4 ex., 3 km East of Mendhar Distt. Poonch, 28.ix.80. 4 ex., Kheral Nala, Riasi, Distt. Udhampur, 12.vii.78. 3 ex., Stn., No. 27. South of Rajouri, Distt. Rajouri, 28.vii.78. 29 ex., 3 km West of Mendhar, Distt. Poonch, 30.ix.80. 3 ex., Kota Village, Mendhar, Distt. Poonch, 29.ix.80.

Distribution : India : Kashmir, Himachal Pradesh and Madhya Pradesh.

Outside India : Pakistan, Nepal, Java and Sumatra.

15. *Erpobdella octoculata* (Linn.)

1758. *Hirudo octoculata* Linnaeus, *Systema Naturae*, 10th ed.

1927. *Erpobdella octoculata*, Harding, *Fauna Brit. India*, Hirudinea : 130-135.

1983. *Erpobdella octoculata*, Chandra, *Rec. zool. Surv. India*, 80 : 265-290.

Material : 57 ex., along Doda road, Bhadarwah, Distt. Doda, 12.x.80.

Distribution : India : Kashmir.

Remarks : Previously it was recorded only from the Kashmir Valley.

16. *Herpobdelloidea lateroculata* Kaburaki

1921. *Herpobdelloidea lateroculata* Kaburaki, *Rec. Indian Mus.*, 18 : 689-719.

1927. *Herpobdelloidea lateroculata*, Moore, *Fauna Brit. India*, Hirudinea : 141-143.

1983. *Herpobdelloidea lateroculata*, Chandra, *Rec. zool. Surv. India*, 80 : 265-290.

Material : 1 ex., Sherpur, Kathua, Distt. Kathua, 18.xii.77. 8 ex., Mandera Vill., Samba, Distt. Jammu, 29.ix.78. 2 ex., Mansar, Distt. Jammu, 7.x.78. 10 ex., Qazi Mohra, Poonch, Distt. Poonch, 22.ix.80. 4 ex., 2 km East of Poonch, Distt. Poonch, 18.ix.80.

Distribution : India : Rajasthan, Madhya Pradesh, Maharashtra and Manipur.

17. *Nematobdella indica* Kaburaki

1921. *Nematobdella indica* Kaburaki, *Rec. Indian Mus.*, 18 : 689-719.

1927. *Herpobdelloidea indica*, Moore, *Fauna Brit. India*, Hirudinea : 144-148.

1983. *Nematobdella indica*, Chandra, *Rec. zool. Surv. India*, 80 : 265-290.

Material : 1 ex., Rajpura, Kathua, Distt. Kathua, 24.xii.77. 2 ex., Gara Satura, Hira Nagar, Distt. Kathua, 29.xii.77. 2 ex., Logate, Kathua,

Distt., Kathua, 19.xii.77. 1 ex., Stn. No. 8, Kathua, Distt. Kathua, 20.xii.77. 1 ex., Koota, Hiranagar, Distt. Kathua, 22.xii.77. 8 ex., Budhwari Vill., Samba, Distt. Jammu, 1.x.78. 1 ex., Akhnoor, Distt. Jammu, 14.x.78. 4 ex., Sungal Vill., Akhnoor, Distt. Jammu, 17.x.78. 9 ex., 2 km South of Akhnoor, Distt. Jammu, 13.x.78. 2 ex., near P. W. D. rest house, Smaba, Distt. Jammu, 28.ix.78. 12 ex., 3 km north of Akhnoor, Distt. Jammu, 16.x.78. 7 ex., Parel Vill., Samba, Distt. Jammu, 30.ix.78. 15 ex., Manderia Vill., Samba, Distt. Jammu, 29.ix.78. 6 ex., Budhwari Vill., Samba, Distt. Jammu, 1.x.78. 1 ex., Basantar river, Samba, Distt. Jammu, 27.ix.78. 3 ex., Riasi Camp, Riasi, Distt. Udhampur, 13.vii.79.

Distribution : India : Rajasthan, Madhya Pradesh, Maharashtra and Manipur.

Family : HIRUDIDAE

18. *Hirudo birmanica* (Blanchard)

1894. *Haemopsis birmanica* Blanchard, *Ann. Mus. Civico di Storia Naturale, Genova*, 2 (14) : 113-118.
 1927. *Hirudo birmanica*, Moore, *Fauna Brit. India, Hirudinea* : 192-199.
 1983. *Hirudo birmanica*, Chandra, *Rec. zool. Surv. India*, 80 : 265-290.

Material : 2 ex., Parel Vill., Samba, Distt. Jammu, 30.ix.78. 2 ex., 3 km north of Akhnoor, Distt. Jammu, 16.x.78. 1 ex., Mendera Vill., Samba, Distt. Jammu, 29.ix.78. 1 ex., Bareri, Naoshera, Distt. Rajouri, 16.vii.79. 1 ex., Kalshian, Naoshera, Distt. Rajouri, 21.vii.79. 2 ex., 8 km on Jammu road, Naoshera, Distt. Rajouri, 19.vii.79. 2 ex., 10 km on Jangarh road, Naoshera, Distt. Rajouri, 18.vii.79. 1 ex., near Tawi river, Rajouri, Distt. Rajouri, 7.x.77.

Distribution : India : Rajasthan, Uttar Pradesh, Bihar, Maharashtra, West Bengal and Tamil Nadu.

Outside India : Pakistan, Sri Lanka and Burma.

19. *Poecilobdella javanica* Wahlberg

1856. *Sanguisuga javanica* Wahlberg, *Ofversigt Kongl. vet. Akad. Forth.* : 233-234.
 1927. *Hirudinaria javanica*, Moore, *Fauna Brit. India, Hirudinea* : 210-218.
 1983. *Poecilobdella javanica*, Chandra, *Rec. zool. Surv. India*, 80 : 265-290.

Material : 1 ex., 4 km west of Udhampur, Distt. Udhampur, 3.x.80. 9 ex., Fort view R. B. Riasi, Distt. Udhampur, 13.vii.79. 1 ex., Janiqla-Nala, Rajouri, Distt. Rajouri, 27.vii.79.

Distribution : India : West Bengal, Assam and Manipur.

Outside India : Sri Lanka, Burma, Java, Sumatra, Malaysia and Phillippines.

20. *Poecilobdella granulosa* (Savigny)

1820. *Sanquisuga granulosa* Savigny, *Systeme des Annelides*, Paris.

1927. *Hirudinaria* (*Poecilobdella*) *granulosa*, Moore, *Fauna Brit. India*, Hirudinea : 218-226.

1983. *Poecilobdella granulosa*, Chandra, *Rec. zool. Surv. India*, **80** : 265-290.

Material : 1 ex., Mandera Vill., Samba, Distt. Jammu, 29.ix.78. 1 ex., Mansar Lake, Distt. Jammu, 6.x.78. 1 ex., Durgati Nala, Distt. Poonch, 6.x.77. 4 ex., Stn. No. 7, Riasi, Distt. Udhampur, 10.vii.79. 5 ex., Stn. No. 5, Riasi, Distt. Udhampur, 8.vii.79. 3 ex., Talwara, Riasi, Distt. Udhampur, 5.vii.79.

Distribution : India : Punjab, Himachal Pradesh, Uttar Pradesh, Gujarat, Maharashtra, Madhya Pradesh, and Tamilnadu.

Outside India : Sri Lanka, Nepal and Burma.

Family : HAEMADIPSIDAE

21. *Haemadipsa zeylanica agilis* Moore

1927. *Haemadipsa zeylanica agilis* Moore, *Fauna Brit. India*, Hirudinea, 266-267.

1983. *Haemadipsa zeylanica agilis*, Chandra, *Rec. zool. Surv. India*, **80** : 265-290.

Material : 2 ex., Kota village, Mendhar, Distt. Poonch, 29.ix.1981.

Distribution : India : Himachal Pradesh and Arunachal Pradesh.

Outside India : Sri Lanka.

Remarks : The species can be identified by the presence of 3rd and fourth pair of eyes on contiguous annuli ; colour reddish brown or orange mottled with black, with a median dorsal yellow or greenish line.

22. *Haemadipsa* sp.

Material : 1 ex., Gian Village, Riasi, Distt. Udhampur, 14.ii.1979.

Remarks : The material could not be identified upto specific level due to unsatisfactory condition of the specimen. The specimen may belong to *Haemadipsa zeylanica*.

SUMMARY

The present account lists 22 species of leeches, which are recorded for the first time from the Jammu region of the state of Jammu and Kashmir. Distributional records of all the species are also included. Two species, *Eatracobdella lobata* and *Erpobdella octoculata* are recorded for the first time outside the Kashmir Valley. These species have palaerctic affinities.

ACKNOWLEDGEMENTS

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ON A COLLECTION OF SHALLOW-WATER HOLOTHURIANS FROM THE LAKSHADWEEP

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(With 11 Text-figures)

INTRODUCTION

The taxonomic account of the echinoderms of the Lakshadweep excepting Holothuroidea was first published by Bell (1902), based on the collections made by Stanley Gardiner. The holothurian component was reported by Pearson (1913, 1914), but this did not contain any material from Lakshadweep. Koehler and Vaney (1905, 1908 and 1910) dealt with 18 deep sea, 8 littoral species and described one more species of holothuria from the deep water of Lakshadweep respectively. Later, James (1969) published a catalogue of 16 shallow-water species of the group, of which as many as 15 are known to occur from the Minicoy and 2 from the Chetlat Island, one species is however, common to both Minicoy and Chetlat islands. Nagabhusanam and Rao (1972) gave a list of 13 species collected from the various ecological niches of the Minicoy island and added 2 more species to the fauna. Recently, Daniel and Halder (1974), dealt with the distribution of 23 Indian ocean species on Lakshadweep, without making any further addition to the total number of species which until now totals to 41. Mary Bai (1980) dealt with the anatomy of *Holothuria (Metriatyla) scabra* Jaeger and provided keys for the common species occurring in the Seas around India without giving any details of their occurrence in the Lakshadweep.

Thus, except the Minicoy island, our knowledge of the littoral holothurians of the rest of the islands is meagre. The present paper is based on a small collection of holothurians made during 1979-80 by the Z. S. I. from Androth, Kavaratti, Kalpeni and Minicoy islands. The material contained 12 species, none of which are new to science but two of them (Marked with asterisks) proved to be new records to the fauna of Lakshadweep. References under each species is reduced to avoid repetition but includes the original description and authors responsible for major changes in nomenclature. Distribution of each species mainly in the Indo-West Pacific littoral waters is dealt with.

The paper also furnishes a list of holothurians hitherto known from Lakshadweep including the two newly recorded species dealt herein.

Order : ASPIDOCHIROTIDA Grube, 1840

Family : HOLOTHURIIDAE Ludwig, 1894

1. *Actinopyga mauritiana* (Quoy & Gaimard, 1833)

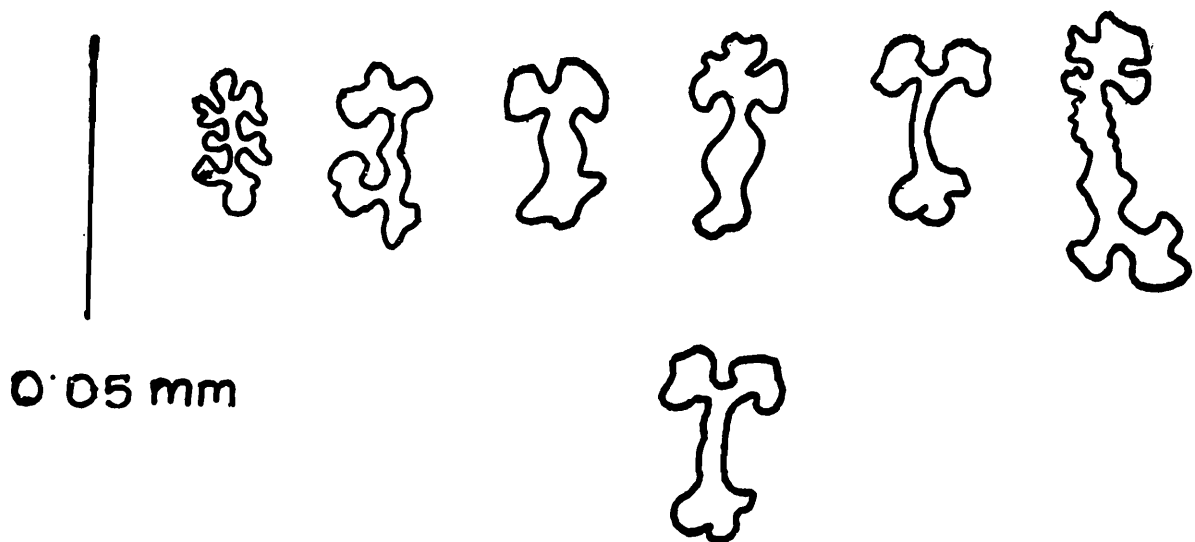
(Text-fig. 1.)

Holothuria mauritiana Quoy & Gaimard, 1833. *Voyage de decouvertes de '1' Astrolabe'* Zoologie : Zoophytes. Paris : 138.

Holothuria guamensis Quoy & Gaimard, 1833. *Voyage de decouvertes de "1" Astrolabe"*. Zoologie : Zoophytes. Paris : 137.

Actinopyga mauritiana : Panning, 1944. *Mitt. zool. Stinst. Hamb.*, 49 : 55, fig. 24 ; Rowe and Doty, 1977 *Micronesica* 13 (2) : 228-229, fig. 2f, 6d.

Material : 2 exs., Z. S. I. Reg. No. E 1387/1, North of Androth island, Lakshadweep, 19.xii.1979, Coll. B. P. Haldar ; 1 ex., Z. S. I. Reg. No. E 1423/1, exposed western reef edge, Kavaratti Island, Lakshadweep, 02.i.1980, Coll. B. P. Haldar.



Text-fig. 1. *Actinopyga mauritiana* (Quoy & Gaimard) spicules from body wall and podia.

Habitat : Exposed on reef edge amongst coralline sand and dead corals.

Description : Tentacles 25 ; pedicels evenly distributed ventrally, papillae surrounded by yellowish ring dorsally ; anus with five distinct clacified teeth ; body wall highly muscular and thick ; colour chocolate brown dorsally, whitish ventrally ; Size 45-100 mm., spicules consisting of bluntly spinose slender rods and rosettes, no table or button.

Distribution : Andaman, Nicobar & Minicoy (In India) and throughout the tropical Indo-West Pacific area except Arabian coast, Persian Gulf and Hawaiian Islands.

2. *Bohadschia marmorata* Jaeger, 1833

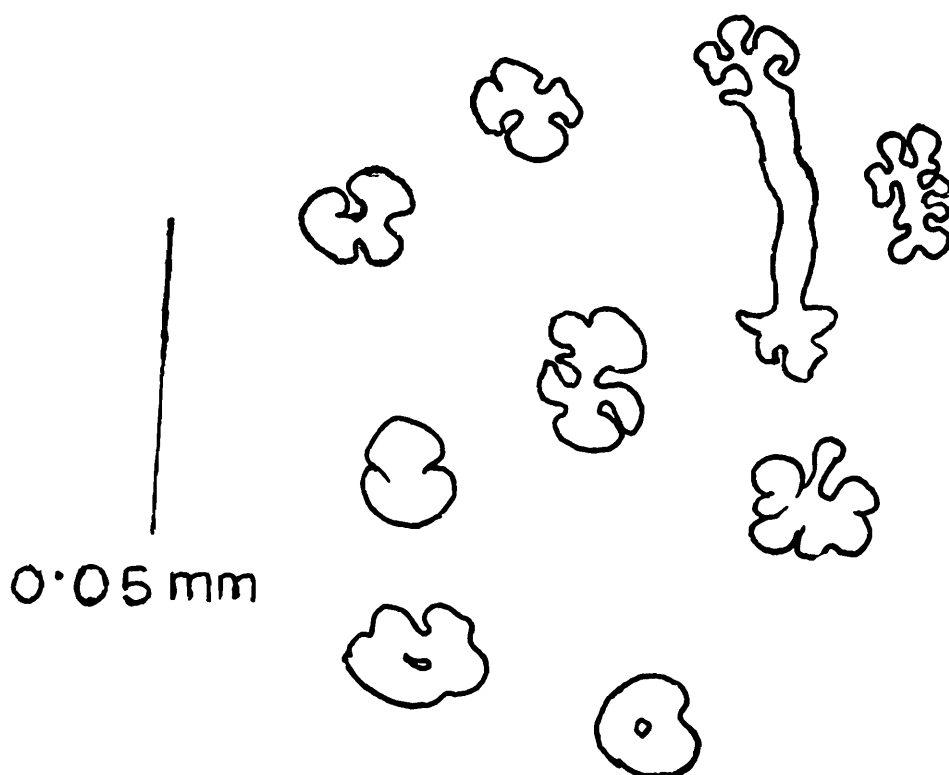
(Text-fig. 2)

Bohadschia marmorata Jaeger, 1833. *De Holothuris*. Turici : 18, pl. 3 fig. 9 ; Rowe and Doty, 1977. *Micrnesica*, 13 (2) : 229-230. fig. 3a, 6g-h.

Holothuria (Bohadschia) vitiensis : Panning, 1929. *Mitt. zool. St. Inst. Hamb.*, 44 : 122, fig. 3.

Material : 1 ex., Z. S. I. Reg. No. 1388/1, exposed S. W. reef edge, Kavaratti Island, Lakshadweep, 04.i.1980, Coll. B. P. Haldar.

Habitat : Exposed on dead coral bed covered with green algae.



Text-fig. 2. *Bohadschia marmorata* Jaeger: Spicules from body wall and podia.

Description : Tentacles 18 ; Pedicels and papillae scattered ; mouth ventral ; no anal papillae, body cylindrical, dorsoventrally compressed with thin body wall ; colour cream yellow with blackish patches on the dorsal surface ; size 75 mm. ; spicules consisting of dichotomously branched rods and grains, no table or button.

Distribution : Andaman, Bay of Bengal, Minicoy, Tuticorin (In India) and tropical Indo-West Pacific area but not represented from islands of West Indian ocean, S. E. Arabia, Persian Gulf, West coast of India, Pakistan and Maldive.

3. *Holothuria (Halodeima) atra* Jaeger, 1833

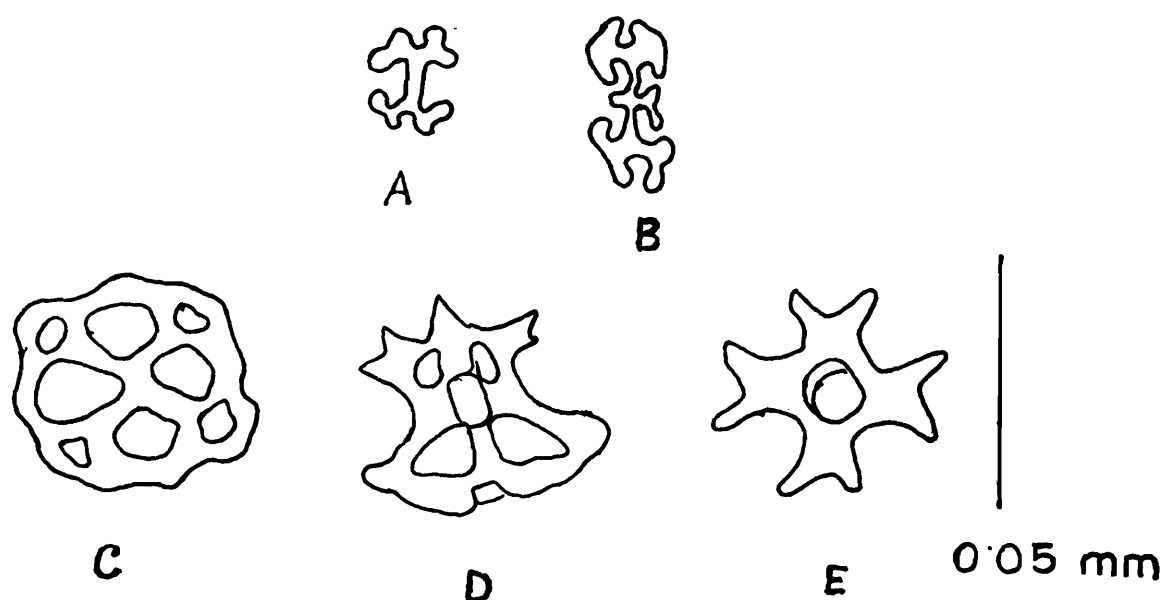
(Text-fig. 3A-E)

Holothuria atra Jaeger, 1833. *De Holothuris*. Turici : 22.

Holothuria (Halodeima) atra : Pearson, 1914. *Spolia zeylan.*, 9 (35) : 170. pl. 9, fig. 11. ; Rowe and Doty, 1977. *Micronesica*, 13 (2) : 230. fig. 3d, 7a.

Material : 7 exs., Z. S. I. Reg. No. E1371/1, From Lagoon, Kavaratti Island, Lakshadweep, 1.i.1980, Coll. B. P. Haldar.

Habitat : Shallow water lagoon bed, 4m., freely exposed.



Text-fig. 3. *Holothuria (Halodeima) atra* Jaeger A & B resettes ; C. table disc, D. table disc, E. top of spire.

Description : Tentacles 20 ; Pedicels in crowded rows to form a 'sole' like surface ventrally ; papillae few and scattered dorsally ; body wall quite thick and soft ; colour dark brown to almost deep black ; size varying from 45 to 170 mm. ; spicules consisting of tables and numerous rosettes, tables with disc reduced, spire of moderate height, no button or rod present.

Distribution : Andaman, Nicobar, Mandapam, Krusadai. Is., Minicoy, Tuticorin (In India) and Indo-West Pacific area except Mascarene Is. ; also found in a few places in the West-Indian area of the Atlantic.

4. *Holothuria (Semperothuria) cinerascens* (Brandt, 1835)

(Text-fig. 4 A-E)

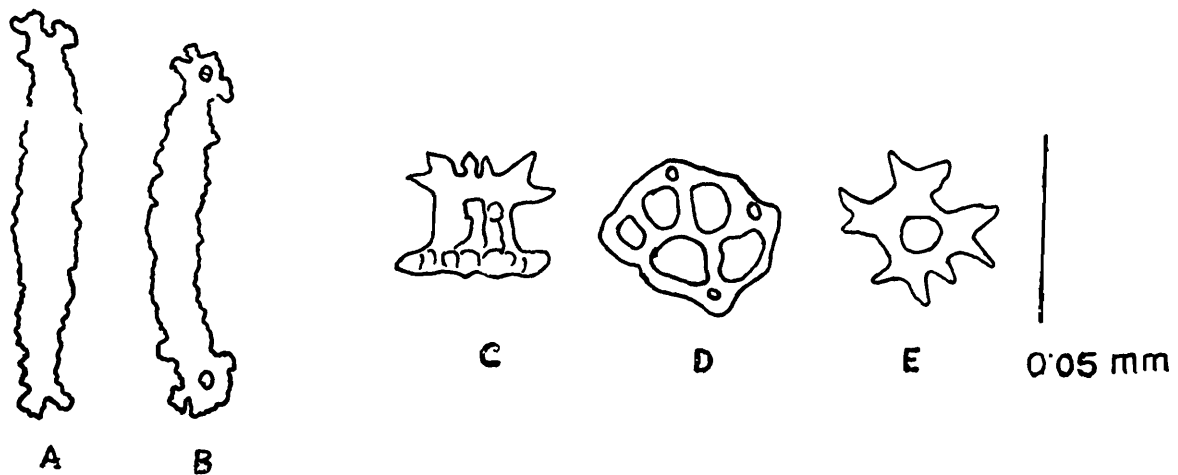
Stichopus (Gymnochirota) cinerascens Brandt, 1835. *Prodromus descriptionis animalium ab H. Mertensio in orbis terrarum circumnavigatione observatorum*. Petropoli 1 : 51.

Holothuria cinerascens Panning, 1934. *Mitt. zool. St. Inst. Hamb.*, 45 : 37, fig. 37.

Holothuria (*Semperothuria*) *cinerascens*, Rowe, 1969, *Bull. Br. Mus. nat. Hist. (Zool.)*, 18 (4) : 135 ; Clark and Rowe, 1971. *Monograph of the shallow water Indo-West Pacific Echinoderms*, London : 238, Rowe and Doty, 1977. *Micronesica*, 13 (2) : 230, fig. 3c, 7h.

Material : 4 exs., Z.S.I. Reg. No. E 1373/1, North of Androth Island, Lakshadweep, 19.xi.1979, Coll. B. P. Haldar ; 1 ex., Z.S.I. Reg. No. E 1575/1, Coral bed, W. of Kalpeni Island, 9.xii.1979, Coll. B. P. Haldar.

Habitat : Under dead coral rocks in mid-littoral zone.



Text-fig. 4. *Holothuria* (*Semperothuria*) *cinerascens* (Brandt) A & B. Spinose rods ; C. table ; D. table disc. E. top of spire.

Description : Tentacles 18 ; pedicels arranged closely on the ventral side leaving a small bare area in the middle, papillae few and scattered on the dorsal side ; body cylindrical with tapering posterior end ; colour dark brown ventrally but lighter dorsally, the papillae being lighter yellow in colour, the specimens appear to be spotted ; size 90 to 100 mm. ; spicules consisting of spiny rods and small tables, table disc small, spire low and top spiny, rods are slightly curved and highly spinous so that their borders appear to be serrated.

Distribution : Mandapam, Vizhingam, Andaman (In India) and throughout the Indo-West Pacific area except Persian Gulf.

5. *Holothuria* (*Platyperona*) *difficilis* Semper, 1868

(Text-fig. 5 A-C)

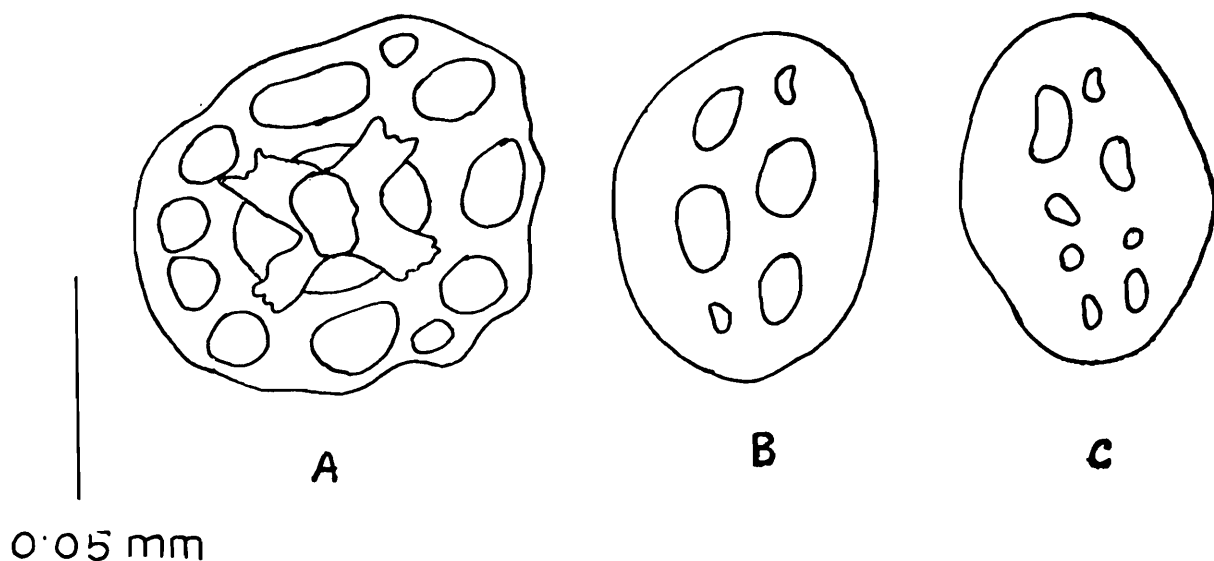
Holothuria difficilis Semper, 1868. *Reisen im Archipel der Philippinen 2. wissenschaftliche Resultate. Weisbaden Leipzig* 2 (1) : 92, pl. 30, fig. 21.

Holothuria (*Platyperona*) *difficilis* : Rowe, 1969. *Bull. Br. Mus. nat. Hist., (Zool.)* 18 (4) : 43, fig. 12 ; Rowe and Doty, 1977, *Micronesica*, 13 (2) : 232, fig. 3h.

Material : 1 ex., Z.S.I. Reg. No. E 1384/1, North of Androth Island, Lakshadweep, 19.xii.1979, Coll. B. P. Haldar ; 3 exs., Z.S.I. Reg. No. E

1426/1, Mid-littoral area, Western side of Kavaratti Island, Lakshadweep, 18.xii.1979, Coll. B. P. Haldar.

Habitat : Lie in rock pools, under dead coral rocks individually during bright light but in aggregation during twilight and also found exposed on dead coral beds with green algal growth.



Text-fig. 5. *Holothuria (platyperona) difficilis* Semper A. table disc ; B & C. buttons.

Description : Tentacles 18-20 ; pedicels scattered ventrally but in one example from Kavaratti they are arranged in rows, papillae few irregularly arranged ; tentacular collar present ; colour deep brown to almost blackish ; size small 15-50 mm ; spicules comprise of tables and buttons, tables well developed with smooth disc. peripheral holes vary from 6-15, buttons thin, oval, flat with prominent edge and 3-6 pairs of limear holes and an apparent longitudinal ridge in the middle.

Distribution : Andaman, Minicoy (In India) and throughout the tropical Indo-Pacific area.

6. *Holothuria (Mertensiothuria) fusco-cinerea* Jaeger, 1833

(Text-fig. 6 A-E)

Holothuria fuscocinerea Jaeger : 1833. *De Holothuris*, Turici : 22.

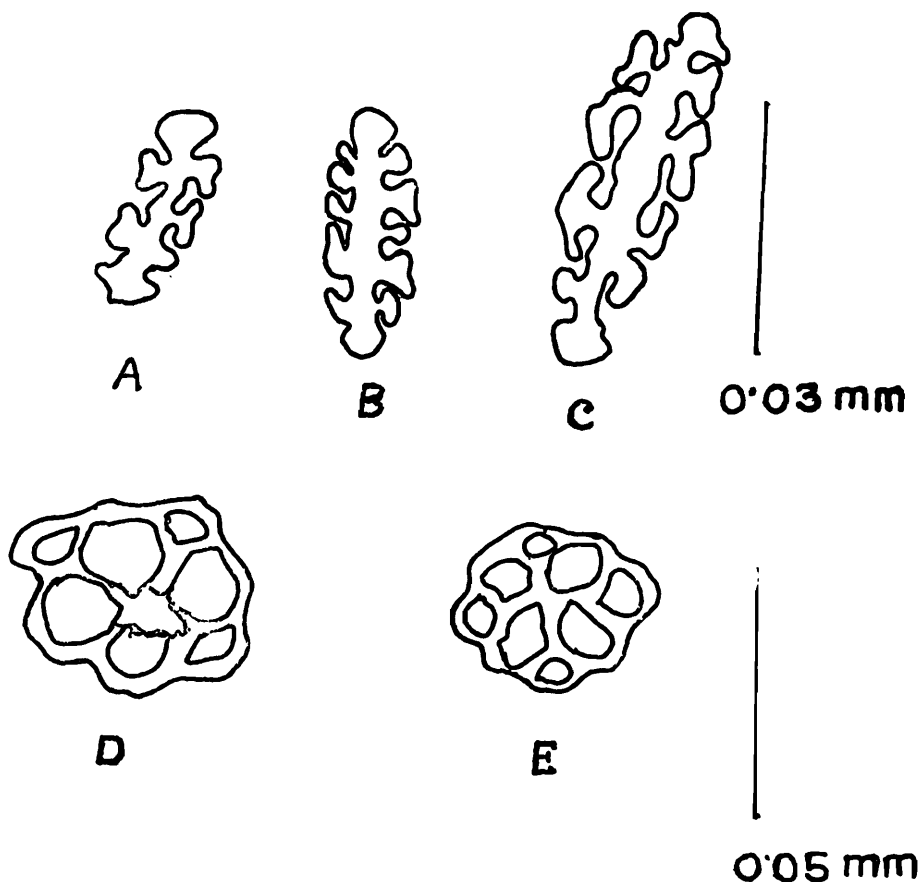
Mertensiothuria fuscocinerea : Deichmann, 1958. *Allan Hancock Pacif. Exped.*, 11 (2) : 300, pl. 3, fig. 13-23.

Holothuria (Mertensiothuria) fusco-cinerea : Rowe, 1969. *Bull. Br. Mus. nat. Hist. (zool.)*, 18 (4) : 149. Clark and Rowe, 1971. *Monograph of the shallow water Indo-west Pacific Echinoderms*, London : 178.

Material : 1 ex., Z.S.I. Reg. No. E 1385/1, North of Androth Island, Lakshadweep, 19.xii.1979, Coll. B. P. Haldar.

Habitat : Rock pool with coralline bottom.

Description : Tentacles 20 ; pedicels do not show any definite arrangement, each is surrounded by a white rim, papillae are situated on warty prominences, each row is surrounded by a broad blackish area which by joining with the dark area of the other papillae form a transverse band, thus the bivium appears to have blackish patches ; ground colour is creamy yellow ; body wall thick ; size 35 mm., spicules consisting of tables and buttons, tables with smooth disc and four larger central holes and four smaller holes alternately arranged, buttons are having a central axis from which are given off on each side three to six outgrowths and each button appears to have lost its outer wall, no complete button was found.



Text-fig. 6. *Holothuria* (*Mertensiothuria*) *fuscocinerea* Jaeger A. B. & C. buttons ; D. E. table disc.

Distribution : Ranges from Sri Lanka, Australia, Navigator Island, Philippine Island to Panamic region.

7. *Holothuria* (*Mertensiothuria*) *leucospilota* (Brandt, 1835)
(Text-fig. 7 A-G)

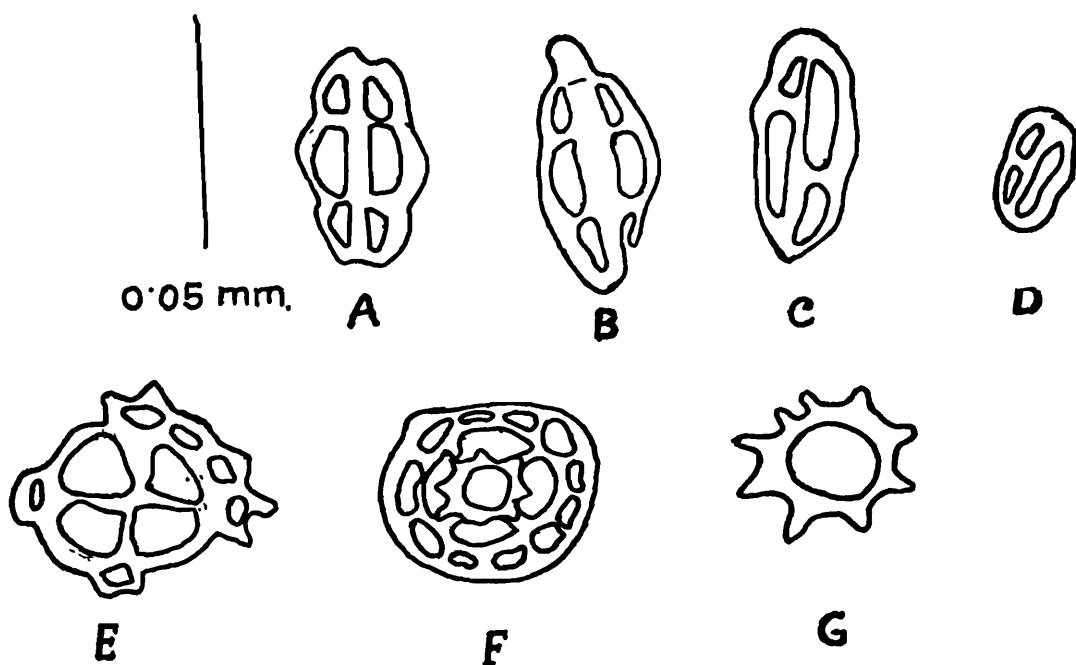
Stichopus (*Gymnochirota*) *leucospilota* Brandt, 1835. *Prodromus descriptions animalium ab H. Mertensio in orbis terrarum Circumnavigation observationum*. Petropoli : 1 : 51.

Mertensiothuria leucospilota : Deichmann, 1958. *Allan Hancock Pacif. Exped.*, **11** (2) : 297, pl. 3, fig. 1-9.

Holothuria (*Mertensiothuria*) *leucospilota* : Rowe, 1969. *Bull. Br. Mus. nat. Hist. (Zool.)*, **18** (4) : 148, fig. 14 ; Rowe and Doty, 1977. *Micronesica*, **13** (2) : 233-234, fig. 4 f, 7g.

Material : 1 ex., Z. S. I. Reg. No. E 1386/1, North of Androth Island, Lakshadweep, 19.xii.1979, Coll. B. P. Haldar ; 1 ex., Z. S. I. Reg. No. E 1574/1, Coral bed, W. of Kalpeni Island, Lakshadweep, 9.xii.1979, Coll. B. P. Haldar.

Habitat : Exposed on mid-littoral zone amongst dead corals.



Text-fig. 7. *Holothuria* (*Mertensiothuria*) *leucospilota* (Brandt) A. B. C. D. buttons ; E. F. table disc ; G. top of spire.

Description : Tentacles 20 ; Pedicels form a sole like surface ventrally, papillae irregularly arranged dorsally, body cylindrical with dark brown colour, body wall thin ; size 40 mm. and 150 mm., cuverian organs found in the larger individual from Kalpeni Is ; spicules consisting of tables and buttons, tables with spinous disc, and with a number of peripheral holes, in the matured specimen only four holes at four corners, spine low, ending in a ring of spines, buttons usually have three pairs of holes, a number of these are incomplete and irregular.

Distribution : Andaman, Kilakarai, Tuticorin, Vizhingam, Karwar, Kiltan, Minicoy Is. (In India) and a very common species of the Indo-Pacific littoral waters.

8. *Holothuria* (*Thymiosycia*) *hilla* Lesson, 1830

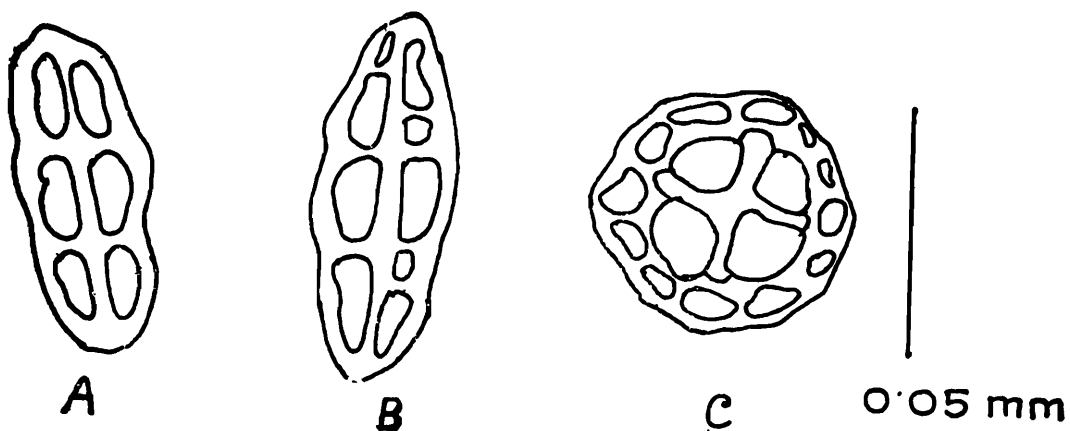
(Text-fig. 8 A-C)

Holothuria hilla Lesson, 1830. *Centurie Zoologique ou Choix d' Animaux rares, nouveaux ou imparfaitement connus*. Paris : 226, pl. 79.

Holothuria (*Thymiosycia*) *hilla* : Rowe, 1969. *Bull. Br. Mus. nat. Hist. (zool.)*, **18** (4) : 147 ; Rowe and Doty, 1977, *Micronesica*, **13** (2) : 232-233, fig. 4b, 8b.

Material : 3 exs., Z. S. I. Reg. No. E 1390/1, exposed SW reef edge, Kavaratti Island, Lakshadweep, 4.i.1980, Coll. B. P. Haldar.

Habitat : Exposed freely on dead coral bed with green algae.



Text-fig. 8. *Holothuria* (*Thymiosycia*) *hilla* Lesson A. B. buttons ; C. table disc.

Description : Tentacles 18 ; pedicels and papillae scattered ; varmi-form, body wall moderately thick ; anus surrounded by a ring of papillae ; size 25 to 45 mm., ground colour is brown with canary yellow spots of papillae and pedicels which sometimes coalesce to give a stripped appearance ; spicules consisting of tables and buttons ; tables with smooth oval disc, a central and 8-12 peripheral holes, buttons with 3-6 pairs of large holes of various sizes.

Distribution : Andaman, Kilakarai, Krusadai Is., Minicoy, Tuticorin (In India) and common throughout the Indo-Pacific area.

9. *Holothuria* (*Thymiosycia*) *impatiens* (Forskal, 1775)

(Text-fig. 9 A-D)

Fistularia impatiens Forskal, 1775. *Descriptiones animalium quae in itinere orientali observavit P. Forskal*. Hauniae : 121, pl. 39, fig. 3.

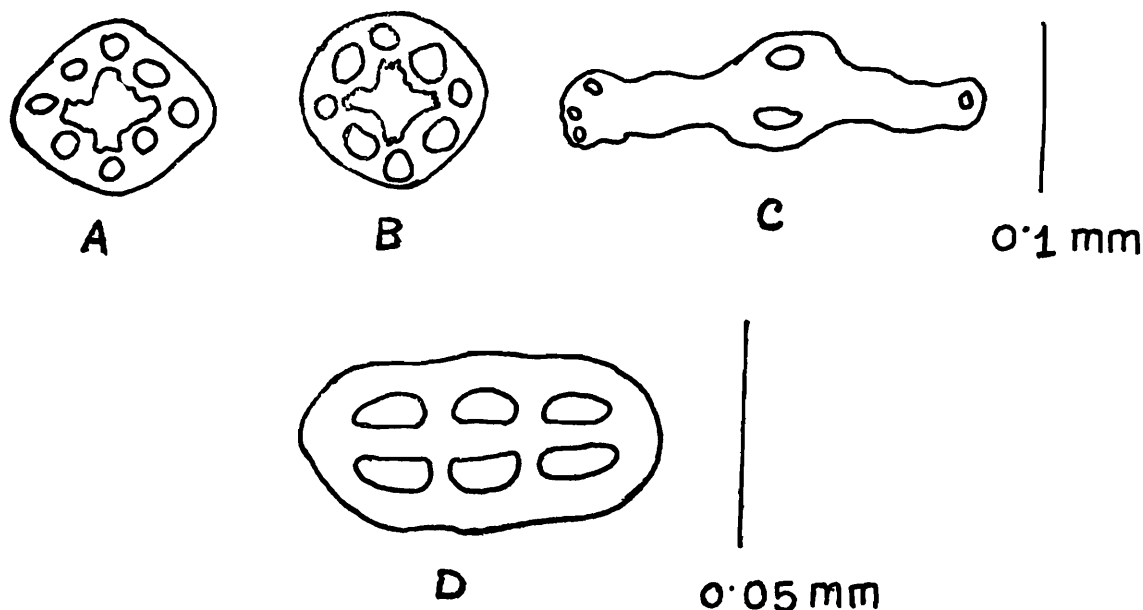
Holothuria impatiens : Panning, 1935. *Mitt. zool. St. Inst. Hamb.*, **45** (1935) : 83, fig. 72.

Holothuria (*Thymiosycia*) *impatiens* : Pearson, 1914. *Spolia zeylan*, **9** (35) : 171, pl. 8, fig. 21 ; Rowe & Doty, 1977. *Micronesica*, **13** (2) : 233, fig. 4c, 7c.

Material : 1 ex., Z. S. I. Reg. No. E 1383/1, North of Androth Island, Lakshadweep, 19.xii.1979, Coll. B. P. Haldar.

Habitat : Shallow rock pool, concealed under coral rocks covered with algal growth.

Description : Tentacles 20 ; pedicels and papillae irregularly scattered over the ventral and dorsal surface respectively without forming any row, tentacular collar of papillae apparent ; anus guarded by a circle of anal papillae ; colour creamy white with a few violet coloured bands



Text-fig. 9. *Holothuria (Thymiosycia) impatiens* (Forsk.) A. B. table disc ; C. rod ; D. button.

especially prominent on the ventral side ; size 124 mm. ; spicules consisting of tables, buttons and rods, table disc squarish with eight smooth and large peripheral holes, spire moderately high ending in a cluster of spines, buttons with 3 pairs of large, smooth holes, rods bilobed and perforated at ends, spicule surface appears polished.

Distribution : Andaman, Minicoy (in India) and Circum tropical, Indo-Pacific, Atlantic ocean and Mediterranean.

10. *Labidodemas rugosum* (Ludwig, 1875)

(Text-fig. 10 A-E)

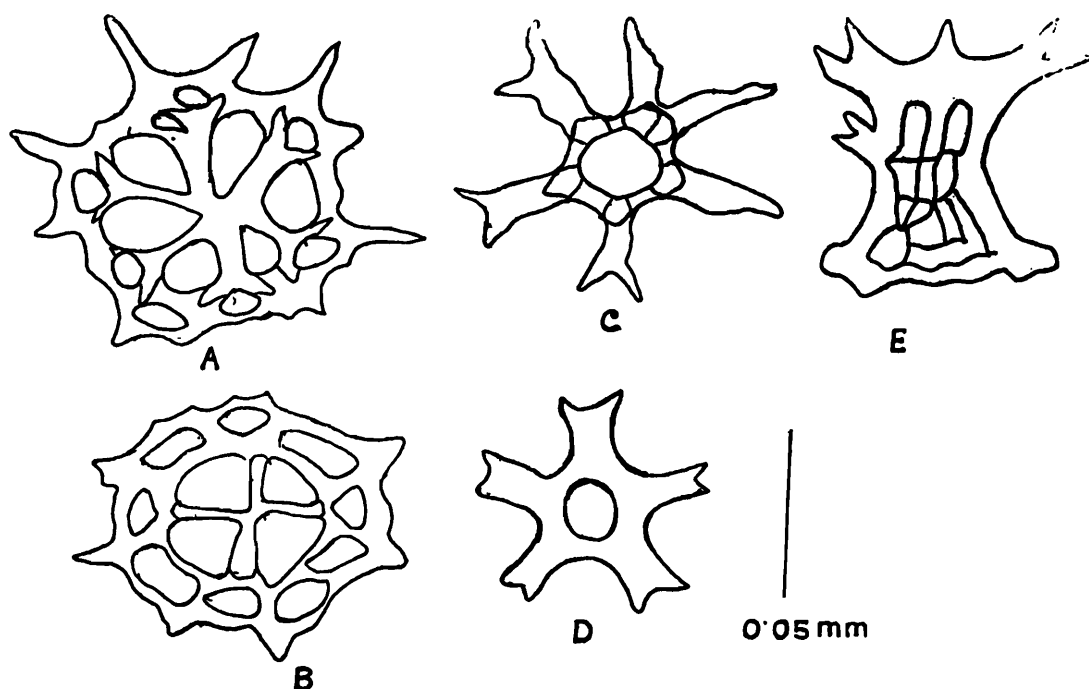
Holothuria rugosa Ludwig, 1875. *Arb. zool. Inst. Wurzburg*, 2 (2) : 85.

Labidodemas rugosum : Rowe, 1969. *Bull. Br. Mus. nat. Hist. (Zool.)* 18 (4) : 183 ;
Clark and Rowe, 1971. *Monograph of the shallow water Indo-West Pacific echinoderms*, London : 176, pl. 28, fig. 12.

Material : 2 exs., Z.S.I. Reg. No. E 1389/1, exposed SW Reef edge, Kavaratti Island, Lakshadweep, 4.i.1980, Coll. B. P. Haldar.

Habitat : Exposed on dead coral bed covered with green algae.

Description : Tentacles 20, in the larger specimen but totally absent in the smaller one ; pedicels are in three rows ventrally, the middle row being clearly double, papillae are in six rows dorsally, sometimes invisible to the naked eye ; vermiform with soft and leathery body wall ; colour creamy yellowish white ; size 130 mm and 80 mm ; spicules consisting of tables only having a central hole and a dozen peripheral holes in the disc, both the disc and top of the spire is highly spinous, spines on the top are bifid ; buttons absent.



Text-fig. 10. *Labidodemus rugosum* (Ludwig) A. B. table disc ; C. D. top of spire ; E. table.

Distribution : Andaman, Bay of Bengal (In India) and littoral region of Maldive, East Indies, N. Australia, Philippines and S. Pacific Islands of the Indo-West Pacific area.

Family : STICHOPODIDAE Haeckel, 1896

11. *Thelenota ananas* (Jaeger, 1833)

Trepang ananas Jaeger, 1833. *De Holothuris*. Turici : 24, pl. 3, fig. 1.

Thelenota ananas Clark, 1921. *Pap, Dep. Mar. Biol. Carnegie Inst. Wash.*, 10 : 184 ;
Rowe and Dotty, 1977. *Micronesica*, 13 (2) : 227, fig. 2b, 5e.

Material : One example of this huge specimen was collected at Minicoy Lagoon but could not be brought to the laboratory. It was identified provisionally by the collector *B. P Haldar* in the field and confirmed later.

Habitat : Shallow water of lagoon bed.

Description : Tentacles 20, body sub-rectangular and elongated ; dorsally papillae large united at their bases making star like appendages, ventrally pedicels arranged irregularly ; body wall very thick and shaggy ; colour chocolate brown ; size 625 mm. ; spicules consisting of simple and branched rods, the latter sometimes look like 'X' but many take the form of complex rosette.

Distribution : Minicoy Is. (in India). Maldive and Mascarene Is., East Indies, North Australia, China, S. Japan and Is. of Western Pacific.

Order : APODIDA Brandt, 1835

Family : SYNAPTIDAE Burmeister, 1837

12. **Synapta maculata** (Chamisso & Eysenhardt, 1821)

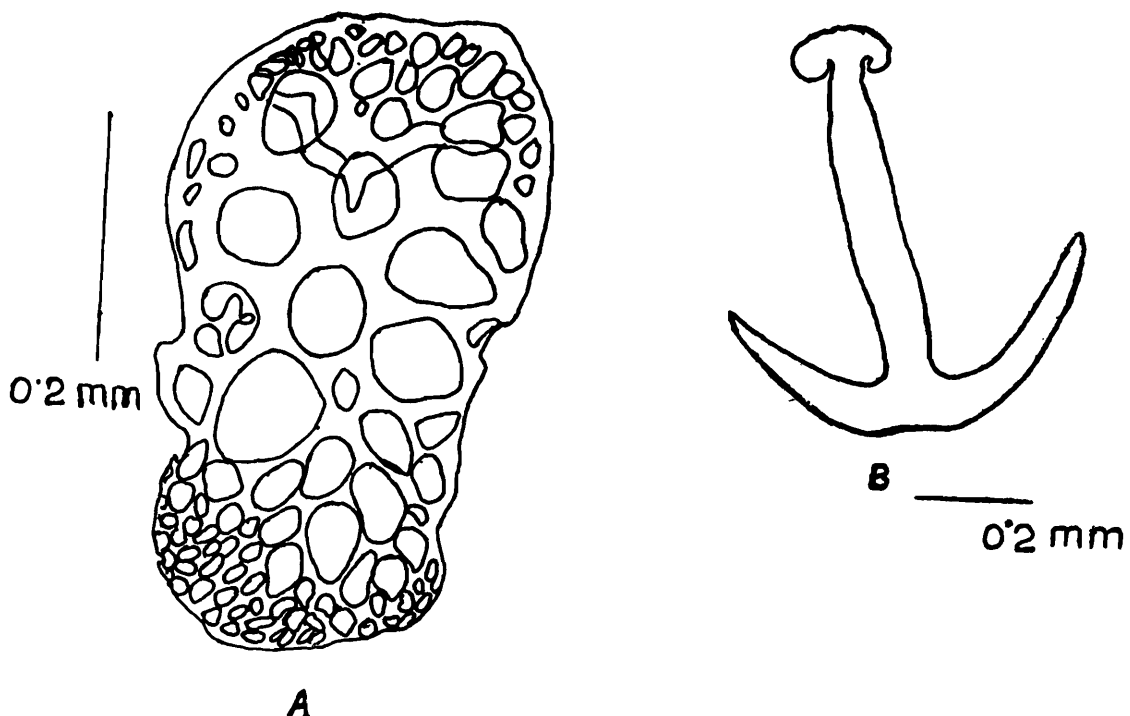
(Text-fig. 11 A, B)

Holothuria maculata Chamisso and Eysenhardt, 1821. *Nova Acta Acad. Caesar. Leop. Carol.*, 10 : 352, pl. 25.

Synapta maculata : Heding, 1928. *Vidensk. Meddr. dansk natur. Foren.*, 85 : 113, fig. 2 (1-10) ; Rowe and Doty, 1977, *Micronesica*, 13 (2) : 234-235, fig. 5a, 8a.

Material : 1 ex., Z. S. I. Reg. No. E 1372/1, from Lagoon, Kavarratti Island, Lakshadweep, 1.i.1980, Coll. B. P. Haldar.

Habitat : Shallow water of Lagoon bed, 4 m., under weed.



Text-fig. 11. *Synapta maculata* (Chamisso and Eysenhardt) A. anchor plate ; B. anchor.

Description : Tentacles 15 ; body cylindrical, snake like with terminal mouth and anus ; body wall thin, fragile, rough, sticks to finger ; colour dark with 5 distinct longitudinal dark bands of two or three different colours crossed by incomplete dark bands ; size 900 mm. ;

spicules consisting of anchors and anchorplates, anchors with smooth arms and base, anchor plates quadrangular with a number of large, smooth holes at the centre and smaller openings at the periphery.

General distribution : Andaman, Minicoy (In India) and throughout the Indo-West Pacific area except persian Gulf and the Hawaiian Islands.

List of littoral holothurians hitherto known from Lakshadweep

- Class : HOLOTHUROIDEA de Blainville, 1834
Order : ASPIDOCHIROTIDA Grube, 1840
Family : HOLOTHURIIDAE Ludwig, 1894
Genus : **Actinopyga** Bronn, 1860
Actinopyga mauritiana (Quoy and Gaimard, 1833)
A. miliaris (Quoy and Gaimard, 1833)
Genus : **Bohadschia** Jaeger, 1833
Bohadschia marmorata Jaeger, 1833
Genus : **Holothuria** Linnaeus, 1767
Subgenus : **Halodeima** Pearson, 1914
Holothuria (Halodeima) atra Jaeger, 1833
Subgenus : **Lessonothuria** Deichmann, 1958
Holothuria (Lessonothuria) pardalis Selenka, 1867
Subgenus : **Mertensiothuria** Deichmann, 1958
* *Holothuria (Mertensiothuria) fusco-cinerea* Jaeger, 1833
H. (M.) leucospilota (Brandt, 1835)
H. (M.) pervicax Selenka, 1867
Subgenus : **Metriatyla** Rowe, 1969
Holothuria (Metriatyla) ocellata Jaeger, 1833
Subgenus : **Microthele** Brandt, 1835
Holothuria (Microthele) nobilis (Selenka, 1867)
Subgenus : **Platyperona** Rowe, 1969
Holothuria (Platyperona) difficilis Semper, 1868
Subgenus : **Semperothuria** Daichmann, 1958
Holothuria (Semperothuria) cinerascens (Brandt, 1835)
Subgenus : **Thymiosycia** Pearson, 1914
Holothuria (Thymiosycia) hilla Lesson, 1830
H. (T.) impatiens (Forskal, 1775)

Subgenus : **Vaneyothuria** Deichmann, 1958
Holothuria (Vaneyothuria) integra Koehler & Vaney, 1908

Genus : **Labidodemas** Selenka, 1867

* *Labidodemas rugosum* Ludwig, 1875

Family : STICHOPODIDAE Haeckel, 1836

Genus : **Stichopus** Brandt, 1835

Stichopus chloronotus (Brandt, 1835)

S. variegatus Semper, 1868

Genus : **Thelenota** Hal-Clark, 1921

Thelenota ananus (Jaeger, 1833)

Order : DENDROCHIROTIDA Grube, 1840

Family : CUCUMARIIDAE Ludwig, 1894

Genus : *Cucumaria* de Blainville, 1884

Cucumaria ariana Koehler & Vaney, 1908

Family : PHYLLOPHORIDAE Ostergren, 1907

Genus : **Phyllophorus** Grube, 1840

Phyllophorus intermedius Koehler & Vaney, 1908

Genus : **Afrocucumis** Deichmann, 1944

Afrocucumis africans (Semper, 1868)

Order : APODIDA Brandt, 1835

Family : SYNAPTIDAE Burmeister, 1837

Genus : **Synapta** Eschscholtz, 1829

Synapta maculata (Chamisso & Eysenhardt, 1821)

Genus : **Euapta** Ostergren, 1898

Euapta godeffroyi (Semper, 1868)

Remarks on general observation :

The Lakshadweep is a chain of coral islands running roughly from north to south between 12°31' N. Lat. and 71° and 74°E. Long. in the Arabian Sea, consisting of 27 irregularly scattered reefs having a ring shaped disposition, nine of which are atolls and a total geographical area of 32 sq. km. Out of these only 10 islands are inhabited and the rest exist as satellites of them. The islands, being well within the tropics and extended to the equatorial belt, have a tropical, humid, warm and generally pleasant and equable climate, the chief rainy season being from late May to early October, the relative humidity being over 70-75%.

The following is a short account of the general observation on the holothurians made by the collector. The most conspicuous and abundant holothurians of the Lakshadweep coral reef are the thickwalled aspidochirotids : The Holothuriidae and Stichopodidae *H. (Halodeima) atra* and *H. (Thymiosycia) impatiens* are found in all the islands visited. On the other hand, population density of *H. (Platyperona) difficilis* occurs individually during bright light but in aggregation during twilight. *H. (Halodeima) atra*, *H. (Mertensiothuria) leucospilota*, *H. (Platyperona) difficilis* and *Actinopyga mauritiana* occur in abundance in the mid-littoral zone of the coral rocky bed at Androth and Kavaratti Islands. At Minicoy lagoon the giant sized stichopodian of shaggy appearance *Thelenota ananas* was found lying freely exposed. Less common forms are *H. (Semperothuria) cinerascens*, *H. (Thymiosycia) hilla*, *H. (Mertensiothuria) fuscocinerea*, *Bohadschia marmorata*, *Labidodemas rugosum* & *Synapta maculata*. The time and equipment being limited, extensive survey could not be made and as a result a small collection was brought to the laboratory.

SUMMARY

Twelve species of littoral holothurians under six genera and three families collected from Androth, Kavaratti, Kalpeni and Minicoy islands of the Lakshadweep are dealt with in this paper. Out of these, two species are new records from the area. An up-to-date list of littoral holothurians known to occur from the island is also included.

ACKNOWLEDGEMENTS

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ON ADDITIONAL TAXONOMIC CHARACTERS OF
SOMILEPTES GONGOTA (HAMILTON) WITH FEATURES
OF THE YOUNG FROM INDIA (COBITIDAE)

By

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Zoological Survey of India, Dehra Dun

(With 4 Text-figures)

INTRODUCTION

Somileptes was described by Swainson (1839) with *Cobitis gongota* Hamilton as its type-species. The taxonomy and description of *Somileptes gongota* (Hamilton) have been in confusion till Mukerji (1932) clearly described and figured the genus and the species. The description of *S. gongota* has so far been based on adult specimens (98.5-132 mm total length) and young specimens of this species have never been described. Recently, one adult specimen (92 mm total length) of this species has been collected from Moradabad district and a young one (33 mm total length) from Pilibhit district, Uttar Pradesh and it has been observed that the young example does not agree with the morphometric descriptions of this species given so far. In the absence of characters of the young examples in the description of the species, it is difficult, therefore, to identify young examples. It has been, thus, thought appropriate to give the morphometric ratios of the young of this species and compare it with those of the adult.

Further, while making a review of the genera of Cobitinae and Botiinae, Nalbant (1963) had no material of the genus *Somileptes* and he reproduced the description of Day (1878) which did not clearly describe the particular features of this species such as the details of the subdorsal scale, the suborbital spine, the swim-bladder capsule etc. which have been given weightage in the study of inter-relationship of genera of these subfamilies by Nalbant (1963). It is proposed here to describe these features of *S. gongota* also in order to facilitate any future study of inter-relationships of the genera of the subfamily Cobitinae. These features of this species were not also described by Mukerji (1932) who redescribed the species and this fact was not recorded by Nalbant (1963).

OBSERVATIONS

The material of *S. gongota*, studied here, has been collected from the following localities.

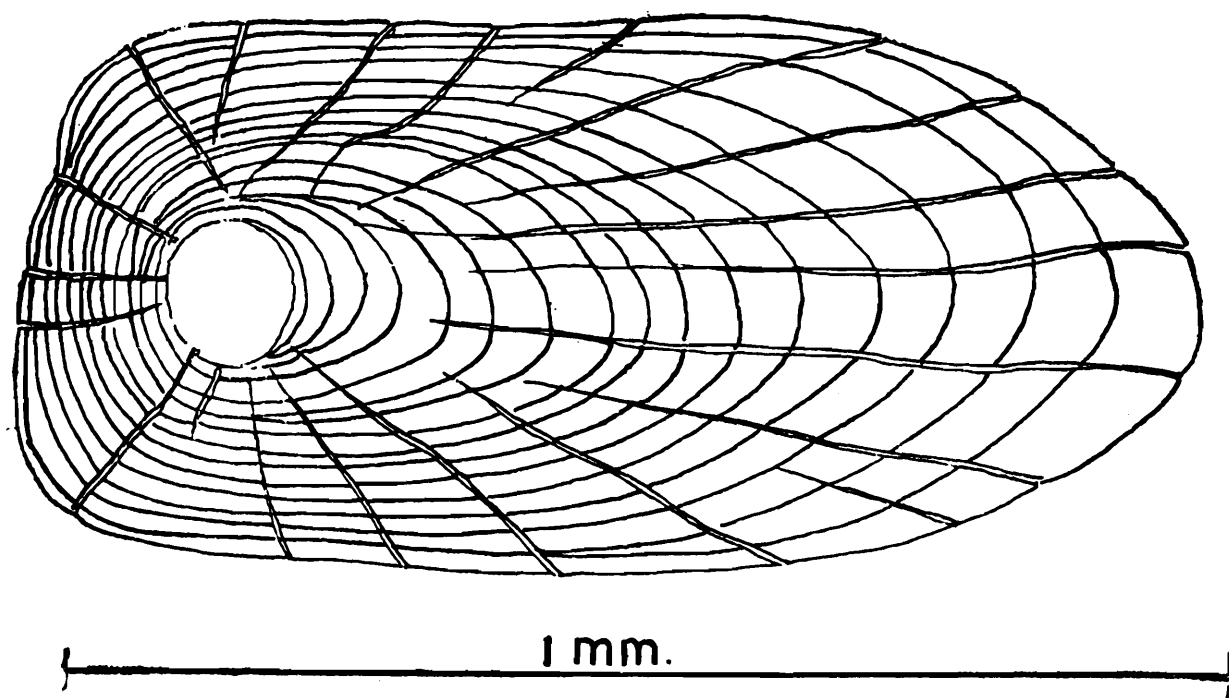
1. A young example (33 mm total length) from Bamrauli Canal, near village Bilsanda, district Pilibhit, Uttar Pradesh, 25.10.1973, A. Husain.

B. III, D. III/6, P. I/9, V. I/6, A. II/5, C. 15.

2. An adult female (92 mm total length), Sot Nadi near village Bhawanipur, Sambhal—Chandausi Road, district Moradabad, Uttar Pradesh, 5.3.1973, A. Husain.

B. III, D. III/9, P. I/9, V. I/6, A. IV/5, C. 15.

The morphology of the young specimen of *S. gongota* is quite different from that of the adult and the trenchant points of difference are given below.



Text-fig. 1. Subdorsal scale of *Somileptes gongota* (Hamilton)

The head is comparatively longer in the young, 3.20 in standard length (3.95-4.05 in adult). The characteristically high head is acquired only in the adult stage which in the young is low. Similarly, the depth of the body is also low in the young 8.92 times in total length (7.85-8.60 times in adult). The interorbital width is reduced, 4.00 times in eye diameter (2.33-3.20 times in adult), the eyes are enlarged, 4.25 times in head length (5.25-6.00 times in adult) and the snout is reduced (2.83 times in head length, 2.2-2.38 times in adult) in the young stage. The fins are comparatively longer in the young. The distance between the bases of the pectoral and the ventral fins is smaller in the young than

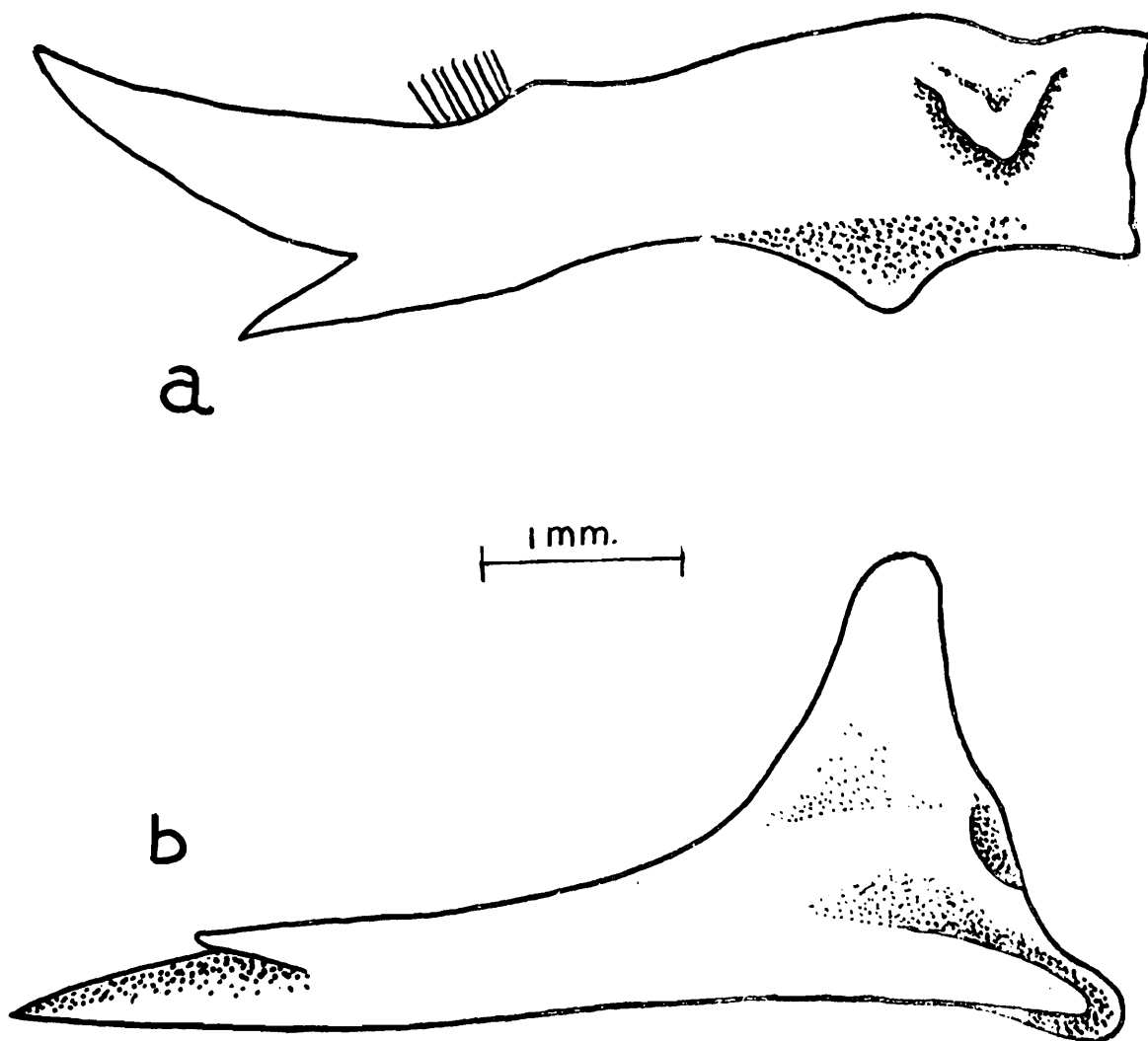
in the adult, 6.0 times in total length (4.42-4.84 times in the adult). The morphometry of the young specimen from Pilibhit district and the adult from Moradabad and Deoria districts (Uttar Pradesh) and Siliguri (West Bengal) has been compared.

The taxonomically important characters of *S. gongota* are given below :

(1) Scales (Text-fig. 1) :

The scales of the body are cycloid and imbricately arranged. In *S. gongota*, the subdorsal scales are elongated and tapering towards the apical region. The focal area is eccentric and narrow. There are 25-27 radial canals in the scales (both complete and incomplete). The circuli are close to each other and are densely packed towards the base while they are widely apart towards the apical region. These scales resemble those of *Leptobotia* Bleeker (Nalbant, 1963 : Pl. IV, fig. 1).

(2) The suborbital spine (Text-fig. 2 a, b) :

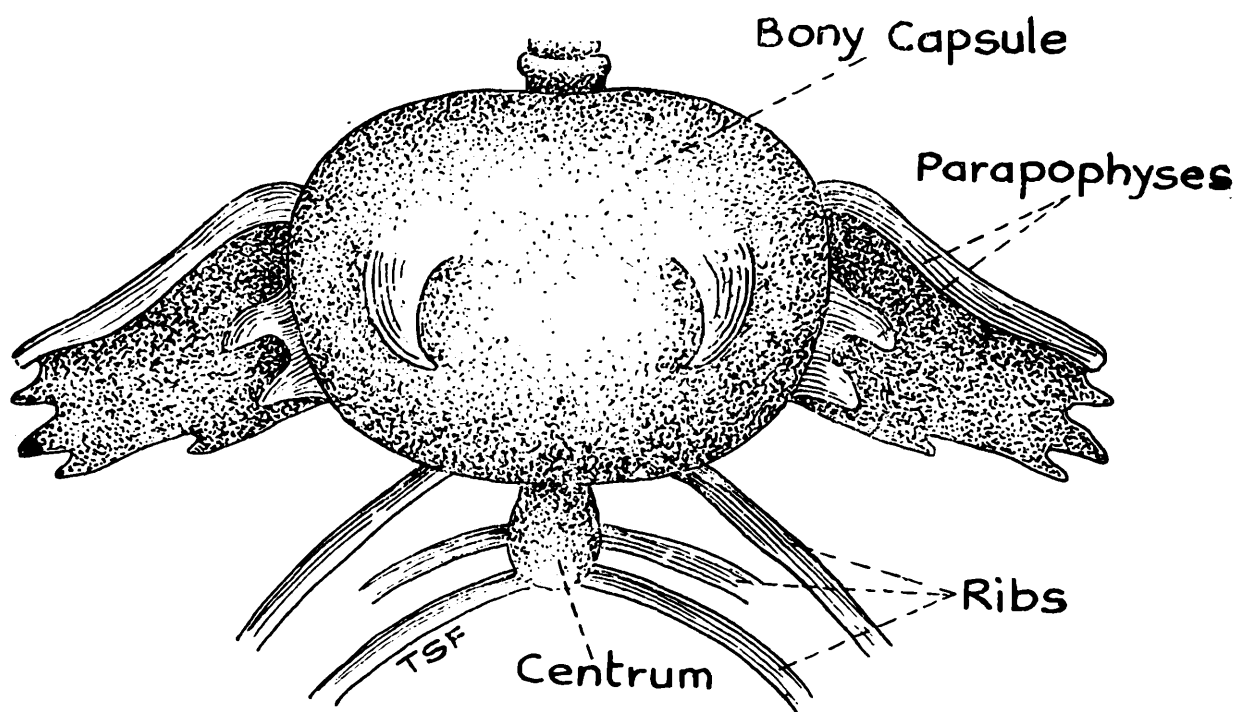


Text-fig. 2. a. Dorsal view of the lateral ethmoid, showing a bifid suborbital spine. of *S. gongota*.

b. Lateral view of the same.

The suborbital spine is of the usual cobitinous type. It is straight and slightly curved. The spine articulates antero-medially with the palatine bone through latero-rostralis process. The medio-rostralis process is very prominent and articulates with the orbitosphenoid of the skull. Opposite the medio-rostralis process, there is a small lateral process. Similarly, there is a small medial process. Both these processes give attachment to the muscles which control the outward and inward movements of the spine. The tip of the spine has two prongs, the medial is nearly three times longer than the lateral prong. These prongs are slightly curved and pointed at the tip. The suborbital spine of this species resembles that of *Acanthophthalmus* van Hasselt.

(3) Swim-bladder capsule (Text-fig. 3) :



Text-fig. 3. Swim-bladder capsule of *S. gongota*.

The anterior chamber of the swim-bladder is completely enclosed in a bony capsule. The bony capsule is globular in shape and resembles type II under Cobitinae of Nalbant (1963). From each side of the bony capsule, emerge dorsal posterior and ventro-posterior processes. There are lateral openings of the bony capsule. The Weberian apparatus is a modification of the first four vertebrae. There is a posterior opening in the capsule for maintaining a connection between the anterior and the posterior chambers of the swim-bladder. The posterior chamber of the swim-bladder is a small diverticulum.

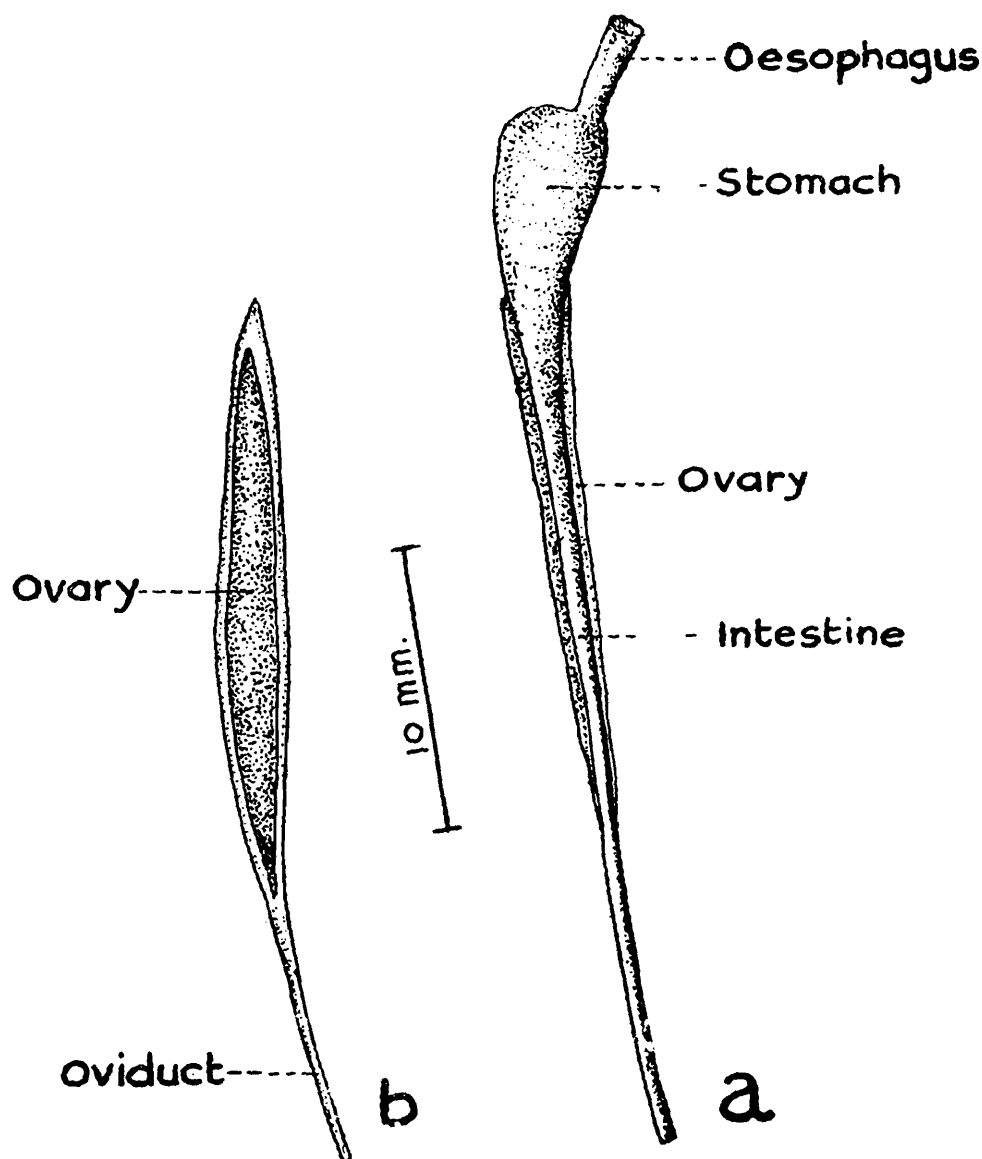
(4) Alimentary canal (Text-fig. 4a) :

The alimentary canal (from oesophagus to anal aperture) is a straight tube. The oesophagus is very small and enters into a bulbous stomach.

The stomach narrows down posteriorly into the intestine. The length of the alimentary canal is contained 2.3 times in the total length of the body in the adult specimen. The straight and the short nature of the alimentary canal suggests a carnivorous mode of feeding of this fish.

(5) Ovary (Text-fig. 4 b) :

The ovaries have fused into a single elongated spindle-shaped structure which envelope nearly half of the length of the alimentary



Text-fig. 4. a. Alimentary canal and the ovary of *S. gongota*.
b. Ovary of *S. gongota*.

canal in its middle portion. The fused ovary continues posteriorly into a single oviduct which opens behind the anal aperture. The fusion of the ovary into a single mass and the presence of a single oviduct are remarkable features of this fish.

The oocytes in the specimen captured in the month of March are in a quiescent stage and probably, this fish breeds in the coming months of monsoon.

General osteological features :

The osteocranium of *S. gongota* has been studied by Ramaswami (1953) and the salient features recorded by him are the following :

(a) The supraethmoid is present as a slight enlargement and not much developed.

(b) There is a large lateral process from the maxilla extending laterally to the pre-ethmoid in addition to the other processes.

(c) Supraoccipital has projecting processes.

(d) The pharyngeal processes of the basioccipital are fenestrated.

(e) The subtemporal fossa is quite distinct.

(f) There are many large orifices in the metapterygoid.

(g) The hyomandibuler shows a prominent spine laterally at its middle.

Distribution : *Somileptes gongota* (Hamilton) has been so far recorded from rivers of Northern Bengal towards the mountains (Hamilton, 1822), Assam and Khasi hills (Day, 1878, 1889), Terai and Duars North Bengal (Shaw and Shebbeare, 1938); Choti Gandak river, Deoria District, Uttar Pradesh (Srivastava, 1968) and Pilibhit district, Uttar Pradesh (Motwani and Saigal, 1974). The record of an adult female example from Moradabad district extends the range of distribution of this species further westwards. The present record of a young specimen from Pilibhit district confirms that of Motwani and Saigal (1974).

The mention of Orissa, Beerbhoon and Lower Bengal in the distribution of *S. gongota* by Day (1878, 1879) has been objected to by Mukerji (1932).

Relationship with other genera of Cobitinae :

Nalbant (1963) has given generic distinctions of the known genera of the subfamily Cobitinae. Among the allied genera, *Somileptes* Swainson differs from *Acanthophthalmus* Van Hasselt and *Niwaella* Nalbant in the size of head, shape of the body, caudal peduncle and relative position of fins. From the genus *Acanthopsis* Van Hasselt, it differs in the shape of caudal fin and a small focal area of the subdorsal scales. From *Acanthopsoides* Fowler, the present genus differs in the dorsal being placed behind the ventrals and nearer the base of the caudal fin, complete lateral line and focal area of the sub-dorsal scales very small.

It differs from *Enobarbichthys* Whitley (*Madrasia* Nalbant=*Jerdonia* Day) in the small dorsal fin and from *Lepidocephalus* Bleeker in having relatively large and naked head, narrow caudal peduncle, complete lateral line and the colouration of body. *Paralepidocephalus* Tchang differs from *Somileptes* in the complete absence of scales on the body, *Eucirrhichthys* Perugia in the elongated anguilliform body and the position of dorsal fin while *Neoecirrhichthys* Banareescu and Nalbant differs from all other cobitids in having no barbels and peculiar shape of the mouth. For the key generic characters of *Somileptes* in relation to other genera of Cobitinae, a reference may be made to Tilak and Husain (1981).

Taxonomic remarks :

Beavan (1877) had a drawing of a fish from the base of Khasia hills and he included it under *S. gongota* although he observed 8 barbels and the origin of the dorsal fin well behind the ventrals in that specimen. The origin of dorsal fin in *S. gongota* lies above the hinder ray or opposite the inner ray of the ventral fin (Guenther, 1868; Beavan, 1877; Day, 1878, 1889; Mukerji, 1932: Pl. XV, fig. 1; Srivastava, 1968) and there are only six barbels (Day, 1878, 1889; Mukerji, 1932, Srivastava, 1968). Therefore, the inclusion of a specimen with 8 barbels and dorsal well behind the ventrals under *S. gongota* by Beavan (1877) is incorrect.

In the present material, the origin of the dorsal fin also lies behind that of the ventral fins and opposite the base of the innermost ventral ray. There are 6 barbels which are very small, the longest is shorter than the diameter of eye. There are two rostral, two maxillary and two maxillo-mandibular barbels. The mental lobe is well developed and folded without any trace of barbel-like structures on it. There is no mention of the mental lobe in this fish by earlier workers (Beavan, 1877; Day, 1878, 1889; Mukerji, 1932, Srivastava, 1968).

The pharyngeal bone with 10 slender teeth is more or less a triangular bone and is somewhat higher than that shown by Mukerji (1932: Pl. XV. fig. 4).

SUMMARY

The morphology of *Somileptes gongota* (Hamilton) is based on adult specimens. Recently, it has been observed that the young ones of this species differ markedly from the adult. A record of the characters of the young of this species has been made here. For study of interrelationships among genera of Cobitidae, the information on the general

morphological characters of *S. gongota* has not been complete. This information about the fish, particularly the features of the scale, the suborbital spine, the alimentary canal, the ovary, the swim-bladder capsule etc. has been provided here. The range of distribution of this species has been extended here further westwards upto Moradabad district, Uttar Pradesh.

ACKNOWLEDGEMENTS

The authors feel grateful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta and Officer-in-Charge, Northern Regional Station, Zoological Survey of India, Dehra Dun for laboratory facilities and encouragement.

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NOTES ON THE TUBICOLOUS POLYCHAETE *PECTINARIA*
(*PECTINARIA*) *ANTIPODA* SCHMARDA FROM
LAKSHADWEEP, ARABIAN SEA

By

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Zoological Survey of India, Calcutta

(With 8 Text-figures)

INTRODUCTION

During a faunistic survey of the Lakshadweep undertaken by the Zoological Survey of India in the winter 1979-80, one of us (A. M.) had an opportunity to make some polychaete collections from the coralline sediments of the Kavaratti Atoll. Among the material collected, an interesting tubicolous polychaete referable to *Pectinaria* (*Pectinaria*) *antipoda* Schmarda was discovered. The present paper deals with the taxonomic and ecological observations made on the species. The occurrence of this widely distributed Indo-west-Pacific species on Lakshadweep is its second record on the Indian coast, the first one being made on Andamans (Tampi & Rangarajan, 1964).

Kavaratti, the headquarters of the Lakshadweep group, situated about 300 km off the Calicut in the West coast of India. The island is about 6 km in length and 1 km in greatest breadth, lying in north-south direction. Like most of the islands in the group, the Kavaratti is bounded by coral reef enclosing a shallow lagoon in the west and storm beaches consisting of coral pebbles and boulders in the east. Sedimentological studies (Mallik, 1976, 1979) indicate that the bottom sediments of Kavaratti lagoon consist of various types of corals of sand and gravel size produced by breaking up of the reef by mechanical processes. Besides these, the calcareous algae (*Halimeda*), shells of gastropods, bivalves, foraminifers, ostracods and bryozoans are present. The reef margins are characterised by gravel and coarse sands. In the shallow lagoon the sand varies from coarse to medium. The sands almost entirely consist of calcium carbonate.

Very little information is available on the biological aspects of these islands. The pioneering work on the general fauna of Maldives and Lakshadweep Archipelago of Gardinar (1903) is followed by scant and scattered work. Nagabhushanam and Rao (1972) while dealing with

the ecological aspects of the marine fauna of Minicoy island, gave an account of the polychaete worms of the island along with a detailed faunistic list. Rao & Misra (1983) dealt with interstitial polychaetes of Lakshadweep in connection with their studies on meiofauna.

SYSTEMATIC ACCOUNT

Class : POLYCHAETA

Family : PECTINARIDAE

Pectinaria (Pectinaria) antipoda Schmarda, 1861

(Text-figs. 1-8)

Pectinaria antipoda Schmarda, 1861, p. 46, pl. 14, fig. 199 ;

Pruvot, 1930, p. 78, pl. 3, figs. 93-95 ;

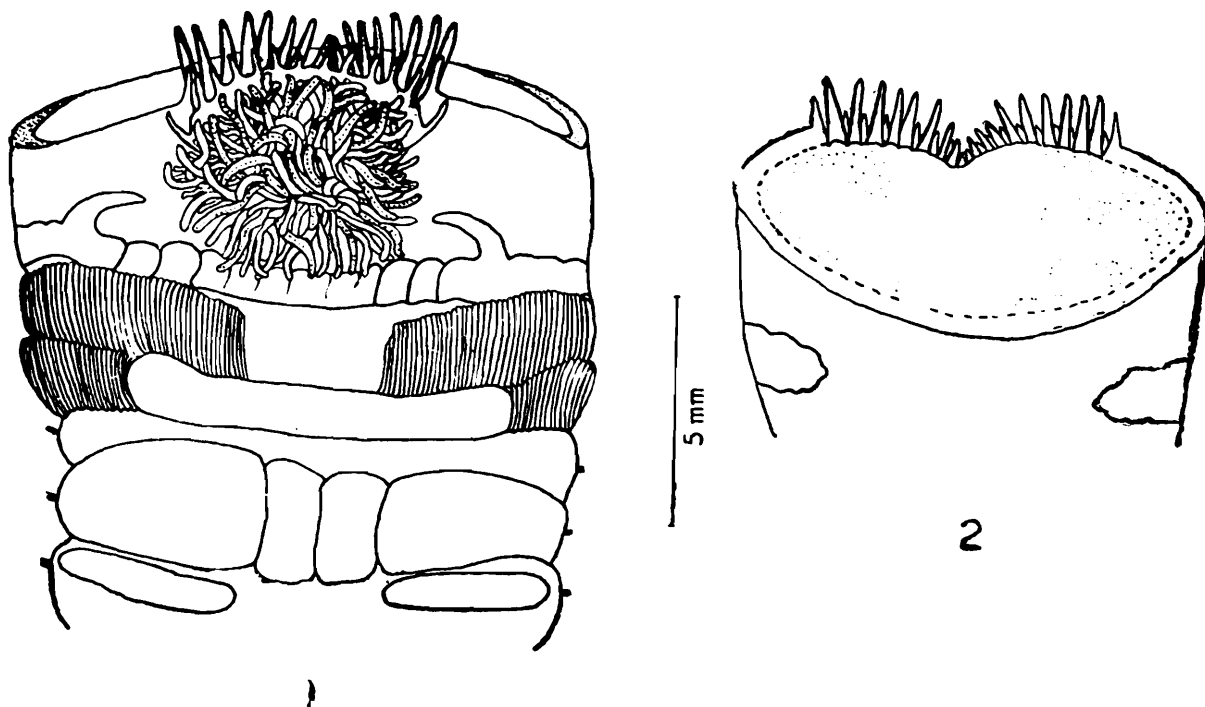
Fauvel, 1932, p. 214 ; Tampi & Rangarajan, 1964, p. 117, fig. 67-70.

Pectinaria (Pectinaria) antipoda Fauvel, 1953, p. 403, fig. 211 e-g ;

Gibbs, 1971, p. 193.

Material : 1 ex., Z. S. I. Reg. No. An 1522/1 ; B. P. Haldar & A. Misra ; Kavaratti atoll ; 1st january, 1980.

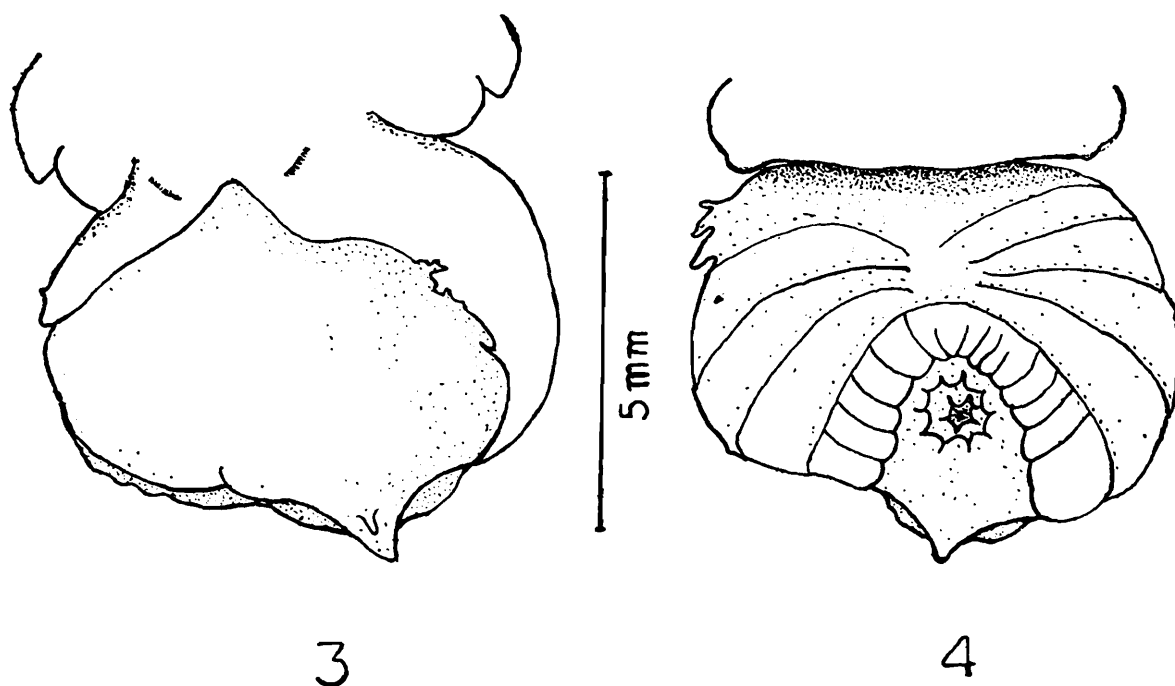
Description : Body large, reaching a length of 58 mm and 13 mm width across the operculum. Body large and stout with an anterior



Text-fig. 1-2. 1, ventral view of head 2. Dorsal view of head

operculum and three body regions. Cephalic region with 4 segments, thorax with 3 segments and abdomen with 14 segments. Opercular margin smooth, ventrally bears a fan of stout golden paleae (10 pairs), and ventro-laterally the first pair of tentacular cirri. A cephalic veil

forming a hood in front of mouth and surrounded by numerous buccal tentacles, quite free from the bases of the first pair of tentacular cirri and partly jointed to the operculum ventro-medially. The second pair of tentacular cirri on the 2nd cephalic segment mounted laterally on a flange which extends from the dorso-lateral surface accross the ventrum. Third and fourth segments with lamellated gills. Fifth, sixth and seventh with notosetae only. Fourteen abdominal segments of which thirteen with both notosetae and uncini and the next one with only notosetae. Nine to ten scaphal hooks on each side of the dorsal surface at the junction of abdomen and scaphe. Scaphe large, oval and well differentiated from the abdomen, with more or less smooth edge and broadly pointed anal ligule with a small anal cirrus. Notosetae all capillaries and of two types, one with narrow, straight, winged and smooth tips, the other with spinulose tips. Uncini with two rows of seven major teeth and three to four minor teeth above the basal gouge.



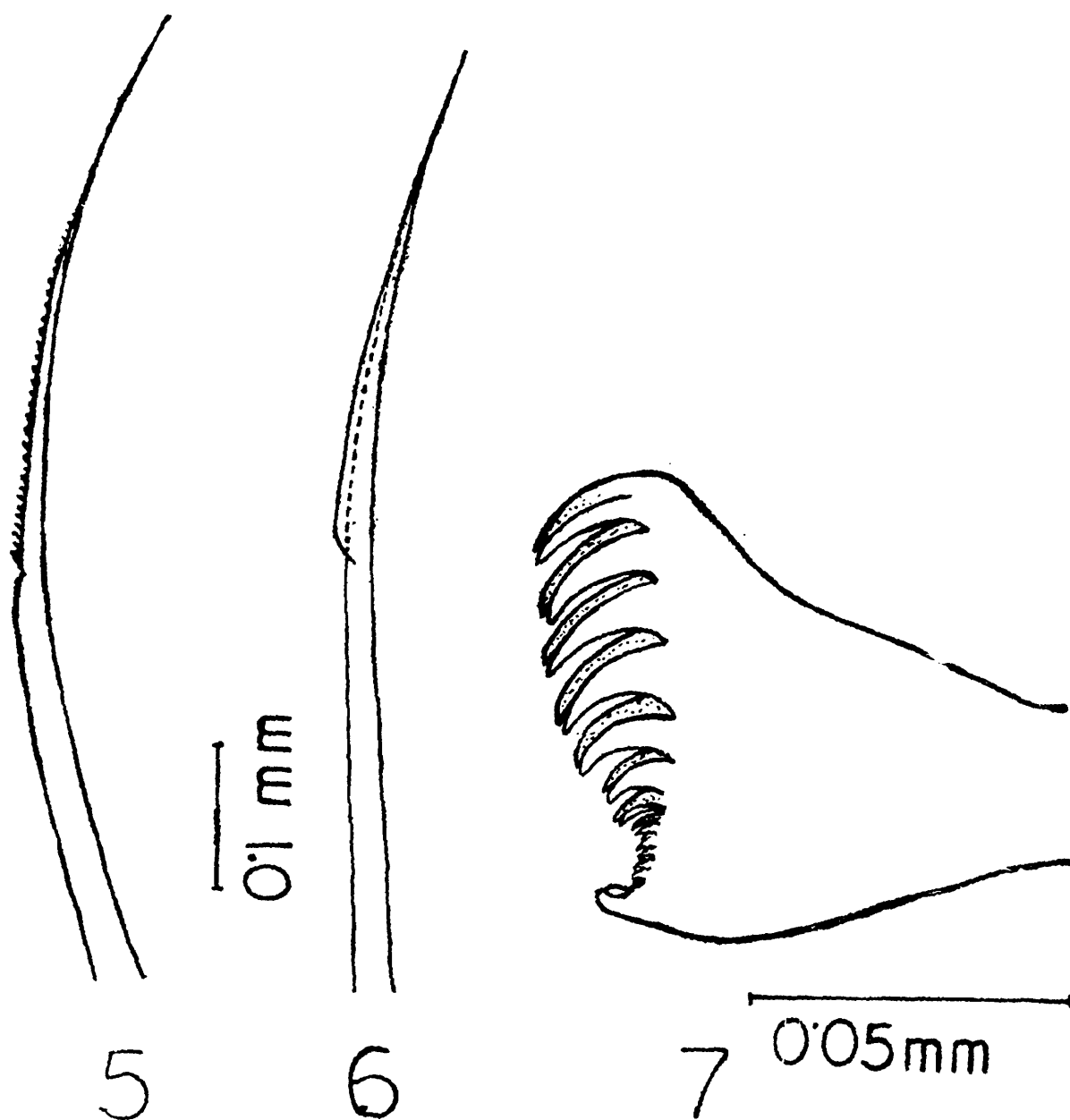
Text-figs. 3-4. 3. Dorsal view of scaphe 4. Ventral view of scaphe

The calcareous tube (Text-fig. 8) is cylindrical and hollow tusk-shaped, gradually narrowing to the posterior end. It is mostly composed of uniformly small-sized gastropod shell cemented together by calcareous substance secreted by the worm. The gastropod shells are placed uniformly directing the operculum outward. The tube is 90 mm long. Its diameter varies from 14 mm at the anterior end to 6 mm at the posterior end.

Ecological notes :

The specimen was collected at two meters depth in the lagoon bottom towards the reef. The tube opens at both the ends, absolutely

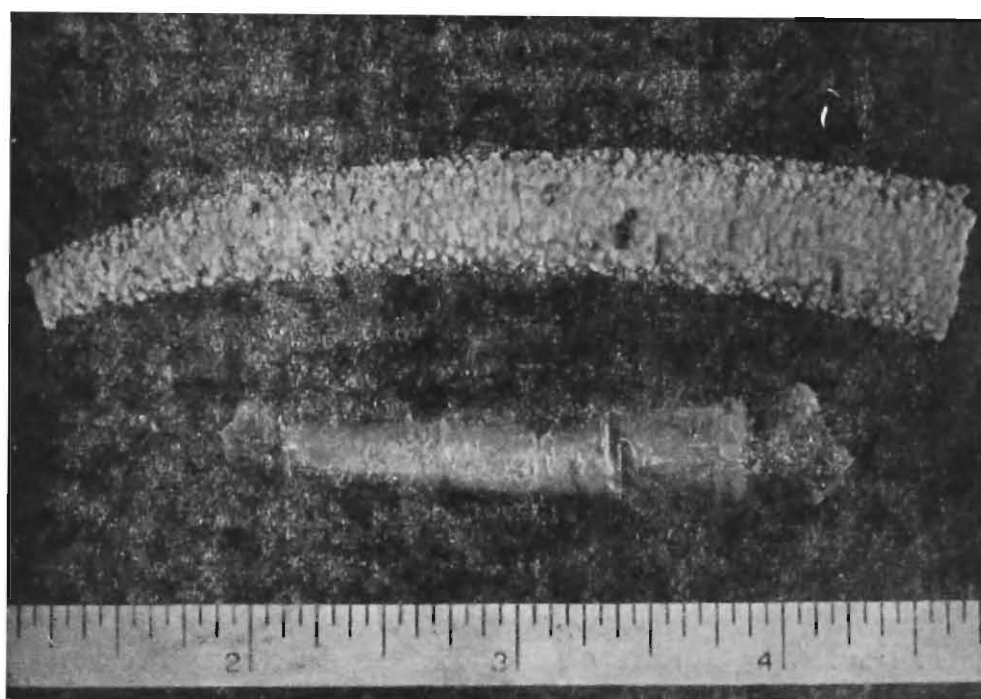
free and 3/4th of it remains buried in the loose coralline sand. The rear-end of the tube normally projects above the surface of the sand. From the position of the anterior end of the tube below the sediment surface, it appears that the species is a sub-surface detritus feeder. As the tube is free, the worm is free to move from place to place in search of food.



Text-figs. 5-7. 5 & 6. Notopodial capillaries 7. Uncinus.

Remarks : After the original description by Schmarda (1861) from New South Wales, Australia in the Pacific Ocean, the species was subsequently been reported from New Caledonia, Pacific Ocean (Pruvot, 1930); Koweit Harbour, Persian Gulf (Fauvel, 1932); Andamans, Indian Ocean (Tampi & Rangarajan, 1964) and Solomon Islands, Pacific Ocean (Gibbs, 1971). The present record from Lakshadweep, Indian Ocean helps to bridge a long distributional gap between the Persian Gulf and the Andamans in the Indian Ocean.

Taxonomically, the present specimen closely agrees with the species *Pectinaria (Pectinaria) antipoda* Schmarda except for the following minor variations. Cephalic veil partly fused to the operculum, scaphe distinctly separated from the rest of the body and neither indented nor papillose, notosetae capillaries with winged and smoothed tips, uncini with double rows of seven major teeth only. We consider that these differences can reasonably be regarded as intra-specific variations. However, the tube of the species is characteristic in that the building material composed mostly of very carefully selected small gastropod shells cemented together by the calcareous substance and placing the opercular surface of all the shells outwards.



Text-fig. 8. Calcareous tube and the entire worm.

Though the surface sediment is richer in organic content, the top few centimeters of the substrate below to it contain organic matter richer in bacteria. The worm obtains its food with the help of buccal tentacles extending them through the sediment and collecting the organic material into the mouth in much the same way as the worms that feed at the surface. Thus, the species is protected better from any predators than those of the surface feeders. But as the detritus could not be collected very rapidly in the sub-surface sediment, the worm is frequently compelled to move out from place to place. Such a report of free movement is well known in *Pectinaria* and *Cistenides* (MacGinitie & Mac Ginitie, 1968). This involves the risk of damage to the tube in the long run and ultimately the utility of the tube in providing a shelter to the worm.

SUMMARY

The tubicolous polychaete *Pectinaria (Pectinaria) antipoda* Schmarda discovered for the first time from Lakshadweep is redescribed. The taxonomic and ecological observations made on the species are discussed. The calcareous tube of the species is characteristic in that the building material are carefully selected small gastropod shells.

ACKNOWLEDGEMENTS

We are grateful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for kindly providing the laboratory facilities and to Dr. G. C. Rao, Zoologist for guidance, going through the manuscript and offering valuable suggestions.

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TAXONOMIC STUDIES ON FOUR SPECIES
OF THE GENUS *MYSTUS* SCOPOLI, 1777
(SILURIFORMES : BAGRIDAE)

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INTRODUCTION

Catfishes of the family Bagridae from the Indian sub continent received considerable attention (Bhimachar, 1934, Hora, 1937, Hora & Law, 1941, Ahmad, 1951, Jayaram, 1954, 1955, 1956, 1959, 1962, 1966, 1968, 1971a & b, 1977a & b, David, 1963). Of the 28 genera so far known only 7 are represented in the Indian subcontinent (Jayaram, 1977b) : *Mystus* Scopoli, *Aorichthys* Wu, *Rita* Bleeker, *Rama* Bleeker, *Batasio* Blyth, *Horabagrus* Jayaram and *Chandramara* Jayaram.

Genus *Mystus* Scopoli, 1777 is represented in the Indian subcontinent by 20 species (Jayaram, 1966). Jayaram (1954) revised the genus. He (1962) clarified the nomenclatural status of the genus and designated the type species. Jayaram and Bhimachar (1967), Tilak (1965) described the osteological features of some species included under the genus *Mystus*. There is still need for the redefinition of some of the species taking into consideration the intraspecific variation. In the present communication four species of the genus *Mystus* viz. *bleekeri*, *cavasius*, *vittatus*, and *gulio* are redescribed.

MATERIAL AND METHODS

The material for systematic study was collected from the fish market at Guntur, Andhra Pradesh (lying between 15° 45' to 16° 50' N and 79° 10' to 80° 55' E). In taking biometric data the methodology of Hubbs and Lagler (1947) has been followed. All morphometric data are expressed as percentages of standard length except eyediameter, snout length and interorbital width, which are expressed as percentages of head length. The range of each morphometric character as percentage is given, followed by mean in parenthesis. The following abbreviations are used in text :

BMNH : British Museum (Natural History), London ; MNHN : Museum National d' Histoire Naturelle, Paris ; RMNH : Rijksmuseum van Natuurlijke Historie, Leiden ; ZMB : Institut fur Spezielle Zoologie und Zoologisches Museum, Berlin ; ZSI : Zoological Survey of India, Calcutta.

Subfamily BAGRINAE Regan, 1911

The two genera represented in the area of study can be identified by the following provisional key :

no interneural shield	<i>Mystus</i> Scopoli, 1777
interneural shield present	<i>Aorichthys</i> Wu, 1939

Mystus Scopoli, 1777

Mystus Gronow, 1763, *Zoophyl. Gronoviana Anilal.*, Fas. 1 : 124, Pl. 8a, Fig. 6 (type not designated) ; admissible for nomenclatural considerations—opinion 89 of ICZN). —Scopoli, 1777, *Introd. Hist. Nat.*, : 451, (type species not designated). —Jayaram, 1954, *Rec. Indian Mus.*, 51 : 527-558 ; (Type : *Silurus pelusius* Solander = *Mys'us pelusius* (Solander) ; revision.—Jayaram, 1962, *Proc. First All India Cong. Zool.* : 633-634, (Type species, *Bagrus halepensis* Valenciennes, 1839) ; generic synonymy and designation of type species.

Four species of genus *Mystus* described herein can be identified by the following provisional key :

1 a. median fontanel short, not reaching base of occipital process ; base of adipose dorsal short, less than 33 per cent in standard length	...	2
b. median fontanel long, reaching base of occipital process ; base of adipose dorsal long, more than 33 per cent in standard length	...	3
2 a. body uniform grey in colour, no. of gill rakers on lower arm 28-34	...	<i>M. gulio</i>
b. body with horizontal bands extending from behind the opercle to caudal peduncle, no. of gill rakers on lower arm 22-27	...	<i>M. vittatus</i>
3 a. maxillary barbels long, extending to between end of adipose dorsal and caudal fin, no. of gill rakers on lower arm 14-18	...	<i>M. cavasius</i>
b. maxillary barbels extend to between tip of ventrals and middle of anal fin, no. of gill rakers on lower arm 9-11	...	<i>M. bleekeri</i>

***Mystus bleekeri* (Day, 1877)**

Bagrus keletius Bleeker, 1853 (*nec Valenciennes*), *Beng. en Hind.*, 91 : 115 (type locality : Calcutta, river Hooghly).

Macrones bleekeri Day, 1877, *Fish. India* : 451, Pl. 101, Fig. 1.

Mystus (Mystus) bleekeri : Jayaram, 1954, *Rec. Indian Mus.*, 51 (4) : 530 ; revision.

Material examined : 80 examples, 60-115 mm SL ; RMNH : 6869, 2 examples, 82 and 110 mm SL (syntypes of *Bagrus keletius* Bleeker).

Description : B. 7-9 ; D. II, 7 ; P. I, 9-10 ; V. 6 : A. ii-iii, 8-9 ; GR. 3-4+9-11.

As percentage of standard length : Head length 24.00-25.60 (24.79), body depth 19.44-25.27 (22.38), head width 14.60-18.18 (16.12), pre dorsal distance 33.33-37.80 (36.26), base of rayed dorsal 13.33-16.27 (15.29), base of adipose dorsal 40.36-45.83 (42.56), anal base 8.20-10.71 (9.89), dorsal height 16.50-21.90 (19.74), caudal peduncle height 9.00-11.68 (19.58)

As percentage of head length : eye diameter 19.23-29.32 (23.68), snout length 33.33-43.75 (38.57), interorbital width 27.27-33.33 (29.76).

Median fontanel long, reaches the base of occipital process, occipital process reaches tip of basal bone of rayed dorsal. Maxillary barbels reach base of anal fin, nasal barbels reach preopercle, outer mandibular barbels extend to a little beyond base of pectoral fin, inner mandibular barbels just reach the origin of pectoral fin ; first dorsal spine small closely opposed to base of prominent second spine, second dorsal spine not serrated along its posterior face, pectoral fin reaches to below second dorsal spine, its spine serrated along the inner edge, number of serrations range between 11-15, origin of pelvic fin below last dorsal ray, pelvics do not reach anal origin.

Colour and pigmentation : three indistinct horizontal greyish bands formed of small, discrete melanophores ; one along dorsal surface, two on flanks above and below lateral line ; diffuse grey blotch behind opercle above the pectoral fin ; dark spot at the base of origin of dorsal fin ; interradiial membrane of distal half of dorsal, ventral and anal fins and inner margin of lower caudal lobe greyish ; distal margin of adipose dorsal with melanophores.

Taxonomic notes : Bleeker (1853) described *Bagrus keletius* [= *M. bleekeri* Day, 1877] from Calcutta in *Beng. en Hind* (p. 115) (*M. Boesemann, in litt.*) and not in *Nat. & Geneesk. Arch. Ned. Ind.* III (2) (p. 135) as cited in Jayaram (1974) and Menon (1974). In the latter publication, Bleeker only listed *Bagrus keletius* and stated that he had not observed the species in East Indies.

Indication of lectotype : Day's (1877) specimens (syntypes) of *Macrones bleekeri* were sent to the following Museums (*M. clarke*, *in litt.*) : ZSI, Calcutta, Nos. 1076, 781 ; AMS, Sydney, No. B 7999 ; NMV, Vienna, No. 44168 ; RMNH, Leiden No. 3024.

According to Mrs. Clarke (*in litt.*) the two specimens in ZSI, Day figures (Pl. 101, Fig. 1) the specimen bearing No. 1076 (Talwar, *in litt.*) ; as per the Code (Art. 74 B) this specimen should be the lectotype of *Macrones bleekeri* Day 1877.

This is the first report of this species from peninsular India. Jayaram (1954 : 532, 556) and Menon (1974 : 61) recorded it earlier from Northern India Assam and Burma.

TABLE 1

M. bleekeri : frequency distribution of meristic characters.

Character	n	Range	mean	S. E.
1. Branchiostegal rays	73	7-9	8.24	± 0.08
2. Pectoral fin rays	75	8-10	9.28	± 0.02
3. Anal fin rays	75	10-12	11.25	± 0.05
4. Gill rakers				
a. upper arm	80	9-11	10.05	± 0.01
b. lower arm	63	12-15	13.24	± 0.11

***Mystus cavasius* (Hamilton, 1822)**

Pimelodus cavasius Hamilton, 1822, Fish. Ganges, 203, 379, Pl. 40, Fig. 67 (type locality : Gangetic province).

Bagrus nigriceps Valenciennes, 1839, Hist. Nat. Poiss., 14 : 412 (type locality : Java).

Mystus (Mystus) cavasius : Jayaram, 1954, *Rec. Indian Mus.*, 51 (4) : 532-534 ; revision.

Material examined : 111 examples, 50-160 mm SL., ZSI, Regd. Nos. 425, 293 and 784-5, 3 examples, 125-142 mm SL ; ZSI : Regd. Nos. 122/2, F 10322/1, 2 examples of *M. nigriceps*, 129 and 204 mm SL.

Description : B. 7-9 ; D. II, 7 ; P. I, 8-10 ; V. 6 ; A. 11-13 ; G. R. 5-6+14-18.

As percentage of standard length : head length 22.15-27.53 (24.21), body depth 17.37-23.56 (20.89) ; predorsal distance 32.74-37.36 (34.86), base of rayed dorsal fin 12.50-15.79 (14.57), base of adipose dorsal fin 37.96-44.44 (41.50), anal base 7.84-11.30 (9.79) ; caudal peduncle height 8.52-11.20 (9.62).

As percentage of head length : eye diameter 20.00-28.12 (24.49), snout length 33.75-44.69 (38.99), interorbital width 26.08-32.85 (29.40).

Median fontanel reaches base of occipital process, occipital process long narrow, reaches basal bone of rayed dorsal; maxillary barbels extend to between posterior margin of adipose dorsal, and caudal, nasal barbels extend to preopercles, outer mandibular barbels reach tip of pectoral, inner mandibular barbels extend slightly beyond origin of pectoral; first spine of dorsal small, closely apposed to base of second prominent dorsal spine, second dorsal spine smooth along anterior edge, slightly serrated along posterior edge in larger specimens; pectoral reaches to below first or second dorsal ray, its spine serrated along its inner edge, number of serrations 11-19; origin of pelvics below or just behind last dorsal ray, pelvics do not reach anal origin; adipose fin long, its base contiguous with that of rayed dorsal, reaches its maximum height behind middle, posterior edge rounded; caudal forked, upper lobe longer than lower.

Colour and pigmentation : dorsal side of body leaden, colour fading down the flanks; upper flanks with pale yellow and green tinge; abdomen silvery white; dorsal side of head and snout grey on yellow base; maxillary barbels grey; dark blotch at base of first dorsal spine, a series of dark spots one at base of each ray; anterior edge of distal half of second spine and upper edge of dorsal grey; surface of adipose dorsal with small discrete melanophores, increasing in number towards its dorsal margin which is dark; interradi al membrane of dorsal, ventrals and anal with melanophores; inner edge of caudal grey; indistinct greenish-yellow blotch behind operculum and above pectorals.

Taxonomic note : Dutt and Sharma (in press) adduced evidence to show that *Mystus nigriceps* (Valenciennes, 1839) is a junior synonym of *Mystus cavasius* (Hamilton, 1822).

TABLE 2

M. cavasius : frequency distribution of meristic characters.

<i>Character</i>	<i>n</i>	<i>Range</i>	<i>mean</i>	<i>S. E.</i>
1. Branchiostegal rays	101	7- 9	8.41	± 0.02
2. Pectoral fin rays	99	8-10	9.84	± 0.03
3. Anal fin rays	80	13-15	13.68	± 0.07
4. Gill rakers				
a. upper arm	111	4-6	5.05	± 0.05
b. lower arm	111	14-18	16.37	± 0.10

Mystus vittatus (Bloch, 1797)

Silurus vittatus Bloch, 1797, *Ichthyol. Hist. nat.*, 11 : 40, pl. 371, Fig. 2 (type locality : Tranquebar, South India).

Pimelodus carcio Hamilton, 1822, *Fish. Ganges.*, : 181, 377, Pl. 23, Fig. 60 (type locality : Northern Bengal) (written erroneously below the figure as *Pimelodus batasius*, discussed by Day, 1865 : 190-191 and Jayaram, 1954 : 535-536).

Pimelodus tengara Hamilton, 1822. *Fish. Ganges.*, : 183, 377, Pl. 3, Fig. 61 (type locality : lower Bengal).

Mystus (Mystus) vittatus : Jayaram, 1954, *Rec. Indian Mus.*, 51 (4) : 534 ; revision.

Mystus (Mystus) tengara : Jayaram, 1954, *Rec. Indian Mus.*, 51 (4) : 538 ; revision.

Material examined : 88 examples, 50-110 mm SL ; ZMB : Regd. No. 2939, 1 example 84.5 mm SL (holotype of *Silurus vittatus* Bloch) ; ZSI : Regd. Nos. 3785, 7668 and 7669, 4 examples of *Mystus tengara*, 50-65 mm SL ; ZSI : Regd. Nos. 11382/1, 468/2, 133, 2595/2, 4 examples of *Mystus vittatus*, 52-85 mm SL ; 20 examples of *Mystus vittatus* from Calcutta, 60-80 mm SL.

Description : B. 9 ; D. II, 7 ; P. I, 7-8 ; V. 6 ; A. 10-13 ; GR. 7-9+22-27.

As percentage of standard length : head length 25.23-30.98 (28.59), body depth 21.42-30.37 (25.76) ; predorsal distance 34.65-42.62 (39.21) ; rayed dorsal base 13.91-17.31 (16.01), adipose dorsal base 21.33-30.66 (25.75), anal base 9.89-13.55 (11.73) ; caudal peduncle height 10.89-13.51 (12.19).

As percentage of head length : eye diameter 20.00-23.80 (22.26), snout length 27.27-37.50 (32.67), interorbital width 30.95-37.50 (33.87).

Median fontanel reaches to between posterior margin of orbit and base of occipital process, constricted in the middle ; occipital process reaches basal bone of dorsal fin, upper jaw slightly longer than lower ; maxillary barbels extend to between origin of ventral and middle of anal, nasal barbels reach pre-opercle, outer mandibular barbels extend to middle of pectorals, inner mandibular barbels extend to origin of pectoral ; first dorsal spine short, closely apposed to base of prominent second spine ; second spine with 4-7 indistinct serrations along its posterior edge and with 2-3 serrations towards its tip on its anterior edge ; pectorals extend to below second or third dorsal ray ; pectoral spine with serrations along its inner edge ; number of serrations 9-15 in the length range examined ; origin of adipose dorsal separated from rayed dorsal, its base equal to or longer than base of rayed dorsal.

Colour and pigmentation : upper surface of body and head leaden ; four horizontal bands along flanks formed by melanophores, another band along mid-dorsal line from nape to caudal base ; abdomen yellow ; black blotch behind opercle and above pectoral, very distinct in fresh specimens ; interradi al membrane of the distal half of rayed dorsal, outer margin of adipose dorsal, distal half of anal fin, inner margin of caudal fin with melanophores ; in fresh specimens, pectorals and ventral hyaline ; maxillary barbels dusky.

Taxonomic note : The specimens conform to the original description and to the holotype of *Silurus vittatus* in Zoologisches Museum, Berlin (ZMB, Regd. No. 2939), which was re-examined by me (Pl. IV, Fig. 3).

Hamilton (1822) erected four species of *Pimelodus* referable to genus *Mystus* : *carcio*, *tengara*, *gulio* and *cavasius* from northern parts of Bengal. Of these, latter two are valid. There is confusion in the treatment of the former two species of Hamilton by later workers. In his description of *P. tengara* he states (p. 183) : "The *Silurus vittatus* of Bloch (*Ichth. Tome. II* p. 40, Pl. CCCLXXI Fig. 2) has some affinity to the *Tengara*, but the prickles on the back is indented behind." Gunther (1864) treated *carcio* as a synonym of *tengara* (under genus *Macrones*) in spite of the fact that the species name *carcio* has page priority in Hamilton-Buchanan's work. Day (1878, 1889) considered *P. carcio* Hamilton-Buchanan as a synonym of *Macrones vittatus* (Bloch) and *tengara* as a distinct species. Hora (1949) treated both *carcio* and *tengara* as synonyms of *vittatus*, but Jayaram (1954) considered *tengara* as a synonym of *M. tengara* (Ham. Buch), but if the species *tengara* is valid, it should be called *M. carcio* since the species name *carcio* has page priority over *tengara*. Rossel (1964) placed *tengara* in the synonymy of *M. vittatus*. Menon (1974) considered both *carcio* and *tengara* of Hamilton as synonyms of *M. vittatus*. The problem could have been easily solved had Hamilton left behind types.

To clearly establish the validity or otherwise of the nominal species *carcio* and *tengara* and their relationship to *vittatus*, the following procedure has been adopted :

I. re-examination of :

- i. the holotype of *Silurus vittatus* Bloch, 1797 in the Zoologisches Museum, Berlin.
- ii. four specimens of *Mystus vittatus* (Regd. Nos. 11382/1, 468/2, 133, 2595/1) in ZSI (collected by Shaw & Shebbeare, Drs. Herre, Rao & Nair, Dr. S. L. Hora and Drs. B. Prasad and Hora respectively).

- iii. the four specimens labelled *Mystus tengara* (Regd. No. 3784, 3785, 7668 and 7669) in ZSI (collector not indicated).

II. examination of fresh material :

- i. 20 specimens (60-80 mm SL) collected from the market at Calcutta on 10-6-1974 (Calcutta is within the area which forms the type locality of Ham. Buch, 's species)
- ii. a statistically adequate number (88) of specimens from Guntur district, to take intraspecific variation into consideration.

III. comparison of data from the original and later descriptions of *carcio* and *tengara* with the above data.

The holotype (ZMB, Reg. No. 2939) of *Silurus vittatus* Bloch (Pl. IV, Fig. 3) has the following diagnostic characters :

- i. the median fontanel extends to just beyond the border of the orbit, and does not reach the base of the occipital process
- ii. maxillary barbels reach the origin of adipose dorsal fin
- iii. base of adipose dorsal fin is about two times the base of rayed dorsal and there is a gap between the rayed and adipose dorsal fins.

Following Day (1878), Jayaram (1954) and Srivastava (1968) record the following characters of *M. vittatus* :

- i. median fontanel is short and does not reach the base of occipital process
- ii. maxillary barbels reach to nearly middle of the body
- iii. four grey coloured bands along length of body.

Jayaram (1954 : 539) in his description of *Mystus (Mystus) tengara* remarks : "This species is allied to *M. (Mystus) vittatus* from which it is distinguished by the anteriorly serrated teeth in the dorsal spine, 8 to 10 teeth in pectoral spine ; median groove reaching base of occipital process and the length of caudal fin contained 4.3 times in total length (*versus* 5.5 times in *Mystus (Mystus) vittatus*." A critical comparison may be made of the so-called differences between *vittatus* and *tengara* :

1. presence of anteriorly serrated teeth on dorsal spine in *M. tengara* :

Day (1878, 1889) states that there are 2 or 3 teeth on the anterior side of the dorsal spine in the young of *M. vittatus*. Srivastava (1968) and Rao & Chattopadhyay (1969) also refer to the anterior serrations on the dorsal spine of *M. vittatus*. In my specimens also, I have observed 2-3 small serrations towards the tip of dorsal spine, on its anterior edge.

2. number of serrations on the inner side of pectoral spine :

Jayaram (op. cit.) distinguished *tengara* from *vittatus* by the presence in the former of 8-10 serrations on the inner side of pectoral spine, as against 16 in the latter. According to Srivastava (1968) there are 14-16 serrations in *M. vittatus* (3 specimens, 98-114 mm TL), and 14 serrations in *M. tengara* (2 specimens, 72-77 mm TL). Rao and Chattopadhyay (1969) recorded 12 serrations in *M. vittatus* (3 specimens 90-113 mm SL) and observed that the number agrees with that of *M. vittatus horai* Jayaram but not with that of *M. vittatus vittatus* (15-16 serrations). None of the above authors have taken into consideration the possibility that the apparent differences between the two nominal species could be because of the differences in size of specimens examined by them. My material shows that the number of serrations increases with growth (Table 7) and ranges from 9-15. Rao and Chattopadhyay (op. cit.) state (p. 101) "It is possible that this species *M. vittatus* contains many intraspecific groups and our collections may belong to a group different from both *Mystus v. vittatus* and *Mystus v. horai*." This statement is untenable because the number of specimens examined by them is too small (3 specimens, 90-113 mm SL). The types of *Mystus vittatus horai* Jayaram are not traceable (Talwar, in litt.).

3. extension of median fontanel :

According to Day (1878, 1889), Jayaram (1954) and Srivastava (1968), the median fontanel is long and reaches the base of occipital process in *M. tengara*, but in *M. vittatus* it is short and does not reach the base of occipital process. Rossel (1964) examined a total of 66 specimens of *M. vittatus* from different localities in Assam, from the Ganges (type locality of Hamilton's species) at Benaras and from Madhya Pradesh in the length range 29-88 mm SL. In placing *tengara* in the synonymy of *vittatus* he refers to the fact that the two have often been

considered as separate species on the basis of differences in the length of the fontanel, which is considered as reaching the base of supra-occipital process in *tengara* and only to between the eyes and the process in *vittatus*. In his material he observed all stages between the two extremes. The smaller specimens have mostly, but not always, a long fontanel and the larger specimens a shorter one. He felt that the difference could not be related to age and also that it was not indicative of a subspecies or population, because he came across all varieties in a given series. He therefore felt that two species should be synonymised.

Although my material (50-110 mm SL) does not include such small specimens as those examined by Rossel, in none of the specimens examined by me does the fontanel reach the base of the occipital process, although there is some variation with regard to the point in the front of the base of the occipital process where it terminates.

The median fontanel does not reach the base of occipital process in four specimens labelled *Mystus tengara* in ZSI (50-86 mm SL) ; they conform in all respects to *vittatus*.

Thus, all the characters used by earlier workers to distinguish *vittatus* from *tengara* are not consistent and useful. In view of the above evidence, Hamilton's *Pimelodus carcio* and *Pimelodus tengara* are considered as junior synonyms of *Silurus [=Mystus] vittatus* Bloch, 1797.

TABLE 3

M. vittatus: frequency distribution of meristic characters

Character	n	Range	mean	S. E.
1. Branchiostegal rays	82	8- 9	8.8	± 0.17
2. Pectoral fin rays	60	7- 8	7.42	± 0.01
3. Anal fin rays	64	10-13	11.37	± 0.03
4. Gill rakers				
a. upper arm	59	7- 9	7.77	± 0.02
b. lower arm	88	22-27	23.97	± 0.05

TABLE 4

M. vittatus : frequency distribution of number of serrations on the inner side of the pectoral spine in relation to total length

Total length in cm	No. of serrations*						
	9	10	11	12	13	14	15
6	9	3	—	—	—	—	—
7	1	3	6	1	—	—	—
8	1	—	3	2	—	—	—
9	—	—	3	2	1	—	—
10	—	—	—	1	7	6	—
11	—	—	—	—	2	7	—
12	—	—	—	—	—	3	1
13	—	—	—	—	—	1	3

*the serrations on spine of the left pectoral fin only were counted

Mystus gulio (Hamilton, 1822)

Pimelodus gulio Hamilton, 1822, Fish. Ganges, : 201, 371, Pl. 23, fig. 66 (type locality : estuaries of river Ganga).

Mystus (Mystus) gulio : Jayaram, 1954, *Rec. Indian Mus.*, 51 (4) : 542-543, text-fig. 7 ; revision.

Material examined : 100 examples, 74-155 mm SL ; ZSI : Regd. No. 387, 1 example, 84 mm SL ; 10 examples, locality Calcutta, 80-110 mm SL.

Description : B. 9-10 ; D. II, 7 ; P. I, 7-8 ; V. 6 ; A. iii-iv, 10-11 ; GR. 9-11+28-34.

As percentage of standard length : head length 26.57-30.37 (28.31), head width 18.94-22.25 (20.76) ; body depth 21.29-29.20 (25.61) ; predorsal distance 34.14-40.78 (38.38), base of rayed dorsal fin 10.82-12.38 (11.63), height of dorsal spine 13.82-13.27 (10.38), base of adipose dorsal 8.25-13.27 (10.38), anal base 11.30-15.48 (13.47), caudal peduncle height 10.65-13.96 (12.76)

As percentage of head length : eye diameter 17.57-22.22 (19.38), snout length 31.25-38.64 (35.04), interorbital width 35.14-40.54 (30.73).

Median fontanel lanceolate in shape, extending to posterior margin of orbit ; occipital process extends to basal bone of rayed dorsal fin ; upper jaw slightly longer than lower ; maxillary barbels reach origin of anal fin, nasal barbels reach pre-opercle, outer mandibular barbels

reach tip of pectoral fin and inner mandibular barbels extend to base of pectoral fin. First dorsal spine short, closely apposed to the base of prominent second spine, the second spine with 2-3 serrations on its anterior edge towards the tip and 7-9 serrations along posterior edge first ray of dorsal is the longest and about one and half times longer than the second spine ; pectoral fin extends to below second ray of dorsal, its spine with serrations along its inner edge ; origin of pelvics behind rayed dorsal, reaching origin of anal in juveniles ; origin of adipose dorsal some distance behind rayed dorsal, and behind vertical from origin of anal. Caudal forked, with rounded lobes.

Colour and pigmentation : dorsal side of head and body leaden, becoming dull on flanks, belly white ; a diffuse greyish blotch behind opercle and above pectoral fin ; upper margin of dorsal, outer margin of adipose dorsal, interradi al membrane of ventrals and anal with melanophores ; inner margin of lower and upper lobes of caudal fin dusky ; bases of pectorals, ventrals and anal yellow ; maxillary barbels grey.

Remarks : Jayaram (1954 : 529) includes *M. gulio* in the group with 'occipital process not reaching basal bone of dorsal fin,' but in his text-fig. 7a on p. 543, the tip of the occipital process is shown as reaching the basal bone of dorsal fin. Day (1878) in footnote on p. 445 states that "This interspace [between the tip of occipital process and basal bone of dorsal fin] seems to be absent in the immature but increases with age." Rossel (1964) observed that in some specimens examined by him, the occipital process does not reach the predorsal plate (=basal bone) of dorsal fin. He could not establish any relationship between the length of the supra-occipital process and body length. In my material (74-115 mm SL), the supra-occipital process does reach the tip of the basal bone of dorsal fin. Rao and Chattopadhyay (1969) also did not observe any space between the tip of the occipital process and the basal bone of dorsal fin.

TABLE 5

M. gulio : frequency distribution of meristic characters.

Character	n	Range	mean	S. E.
1. Branchiostegal rays	48	9-10	9.29	± 0.01
2. Pectoral fin rays	48	7- 8	7.64	± 0.01
3. Anal fin rays	65	13-15	14.03	± 0.02
4. Gill rakers				
a. upper arm	100	9-11	8.91	± 0.01
b. lower arm	104	28-34	30.39	± 0.05

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CERTAIN AQUATIC INSECTS OF REWA WITH NOTES ON THEIR HABITAT

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INTRODUCTION

This paper presents an account of the aquatic insects of Mauganj, Teonthar, Sirmour and Huzur tahsils of Rewa district. Trips were made to various tahsils for collections. At Teonthar tahsil specimens were collected from river Tamas, at Sirmour from Semaria pond, at Mauganj from Mauganj pond, at Huzur tahsil from river Behar and Lalpa, Lakhoribag, Bahurian ponds.

Paper lists seventeen species of aquatic insects representing four families under two orders.

SYSTEMATICS

Order : HEMIPTERA
Family : NEPIDAE

1. *Laccotrephes ruber* (Linn.)

1764. *Laccotrephes ruber*, Linn., (Nepa) *Mus. Lud. Ulr.* p., 165. 2.

1939. *Laccotrephes ruber*, Distant., *Fauna of British India. Rhynchota. III*, p. 18.

Femora of all the legs are marked with fuscus shading but the shadings of anterior femora are much more prominent. Length of the body is greater than that of respiratory siphons. Total length of head and thorax is greater than the anterior femora. Other characters as in Hafiz and Pradhan (1947).

Measurements : Length of male and female specimens vary from 25-27 and 35.5-39 mm. respectively.

Locality : Specimens were collected from Chirahula pond and ditches near Sanik School, Rewa.

Habitat : These are lentic and live in between *Hydrilla verticillata* plants.

Distribution : India : West Bengal, Bihar, Uttar Pradesh, Madras, Bombay.

2. *Laccotrephes griseus* (Guer.)

1829. *Laccotrephes griseus*, Guer., *Iconogr. Règne. Anim ; Ins*, P. 352.

1939. *Laccotrephes griseus*, Distant., *Fauna of British India. Rhynchota. V*, p. 314.

These have fuscus shadings on the femora, shadings on the anterior femore are much more prominent. Length of the respiratory siphons is greater than the body. Length and breadth of the pronotum are equal. Total length of the head and thorax is greater than the anterior femora. Other characters as in Hafiz and Pradhan (1947).

Measurements : Length of male and female, specimens vary from 14-17 and 17-19 mm. respectively.

Locality : Specimens were collected from Lalpa, Bahurian and Mauganj ponds.

Habitat : These are lentic and live in between *Hydrilla Verticillata* plants.

Distribution : India ; West Bengal, Bihar, Orrisa, Uttar Pradesh, Punjab, Bombay and Madras.

3. *Laccotrephes maculatus* (Fabr.)

1775. *Laccotrephes maculatus*, Fabr. (Nepa), *Syst. Ent*, p. 692.

1939. *Laccotrephes maculatus*, Distant., *Fauna of British India. Rhynchota. III*, p. 19.

Femora of all the legs with fuscus shadings. Respiratory siphons a little longer than the body. Total length of the head and the thorax is greater than the anterior femora.

Measurements : Length of male and female specimens vary from 49.5-50.5-60 mm. respectively.

Locality : Specimens were collected from Lakhauribag, Bahurian and Mauganj ponds.

Habitat : These are lentic and live in between *Hydrilla verticillata* plants.

Distribution : India : West Bengal, Assam, Bombay. It is unreported from Patna State (Orrisa).

4. *Ranatra elongata* (Fabr.)

1790. *Ranatra elongata*, Fabr., *Skrivt. of Naturh, Selsk. I*, i, p. 228.

1908. *Ranatra elongata*, Distant., *Fauna of British India. Rhynchota. III*, pp. 20, 21.

Respiratory siphons longer than the body. Total length of the head and the thorax is greater than the anterior femora. Dorsal surface of

pronotum bears a pair of dull coloured dotted longitudinal streaks. The vertex bears a 'Y' shaped elevation. Other characters as in Hafiz and Pradhan (1947).

Measurements : Length of male and female specimens vary from 95-100 and 101-102 mm. respectively.

Locality : Specimens were collected from Behar, Tamas rivers and Lalpa, Lakhauribag ponds.

Habitat : These are lotic and lentic in habitat and live in between *scirpus articulatus* and *Hydrilla verticillata* plants respectively.

Distribution : India : Kashmir, West Bengal, Bombay, Nilgiri hills.

5. *Ranatra digitata* (Hafiz and Pradhan)

1947. *Ranatra digitata*, Hafiz and Pradhan., *Rec. Ind. Mus.* Vol. XLV, p. 364.

Total length of the head and thorax is greater than the anterior femora. Hook shaped paramer broadest in the middle, narrow and semi-circularly curved in distal parts with narrow apical upward and backwardly directed blunt process. Other characters as in Hafiz and Pradhan (1947).

Measurements : Length of male and female specimens vary from 54-55 and 57-58 mm. respectively.

Locality : These specimens were collected from Chirahula pond.

Habitat : These are lentic and live in between *Hydrilla verticillata* plants.

Distribution : India : Patna state (Orrisa).

6. *Ranatra sordidula* (Dohrn.)

1860. *Ranatra sordidula*, Dohrn., *Stett. ent. Zeit.* XXI, p. 409.

1903. *Ranatra sordidula*, Distant., *Fauna of British India. Rhynchota III*, p. 25.

The description of the species (*vide* distant 1906) is meagre. The characters observed in the examples collected are noted below.

The posterior femora reach upto the middle of the genital segment. Prothoracic sterna bear two shallow grooves at their anterior end, meta sternal process ovate, a little foveate with a central longitudinal carinata line. Second antennal joint thumb shaped and blackish at the tip. The third elongate and curved. Respiratory siphons shorter than the body. Length of the head and thorax is greater than the anterior femora.

Measurements : Length of male and female specimens vary from 46-47 and 47.5-48 mm. respectively.

Locality : Specimens were collected from Lalpa pond and ditches near Chirahula temple Rewa.

Habitat : These are lentic and live in between *Hydrilla verticillata* plants.

Distribution : India : West Bengal, Madhya Pradesh.

7. *Ranatra titiaensis* (Hafiz and Pradhan)

1947. *Ranatra titiaensis*, Hafiz and Pradhan., *Rec. Ind. Mus. Vol. XLV* p. 369.

Total length of the body is greater than the respiratory siphons. Length of the head and the prothorax is equal to that of anterior femora. Other characters as in Hafiz and Pradhan (1947).

Measurements : Length of male and female specimens vary from 33-34 and 34.5-35 mm. respectively.

Locality : Specimens were collected from Semaria and Lalpa ponds.

Habitat : These are lentic and live in between *Hydrilla verticillata* plants.

Distribution : India : Patna state (Orrisa), Madhya Pradesh.

Family : BELOSTOMATIDAE

8. *Sphaerodema annulatum* (Fabr.)

1803. *Sphaerodema annulatum*, Fabr. (Nepa) *Syst. Rhyn.* p. 106.

1939. *Sphaerodema annulatum*, Distant., *Fauna of British India. Rhynchota. III*, p. 35.

Hemelytra lacking the spot of fine bristles, hind wing lacking the fold, Hemelytra bears a row of fine hair at its distal end. Anterior tarsus two jointed and bear a pair of claws. Antennal foveae lie comparatively at a shorter distance from eyes than in *Sphaerodema molestum*. Antenna are four segmented, the third segment is slightly prolonged on its inner and outer sides.

Measurements : Length of male and female specimens vary from 25-26 and 26-27 mm. respectively.

Locality : Specimens were collected from Lalpa, Lakhauribag and Bahurian ponds.

Habitat : These are lentic and live in between *Nymphoides cristatum* and *Hydrilla verticillata* plants.

Distribution : India : West Bengal, Uttar Pradesh, Bombay.

9. *Sphaerodema molestum* (Duf.)

1863. *Sphaerodema molestum* Duf. (Appasus) *Ann. Soc. Ent. Fr.*, p. 395.

1939. *Sphaerodema molestum*, Distant., *Fauna of British India. Rhynchota. III*, p. 36.

Hemelytra bears a spot of fine bristles on the middle towards its inner side. Hind wing bears a fold. The fold is shorter than that of *Sphaerodema rusticum*. Anterior tarsus one jointed and bears a pair of claws. Antennae four segmented, second and the third segments are prolonged to form processes on their inner sides. Antennal favae lie comparatively at a farer, distance from the eyes, than in *Sphaerodema annulatum*.

Measurement : Length of male and female specimens varies from 16-17 and 19-20 mm. respectively.

Locality : Specimens were collected from Lakhaauribag, Bahurian, Lalpa ponds and ditches near Chirahula temple Rewa.

Habitat : These are lentic and live in between *Nymphoides cristatum* and *Hydrilla verticillata* plants.

Distribution : India : West Bengal, Bombay, Uttar Pradesh.

10. *Sphaerodema rusticum* (Fabr.)

1803. *Sphaerodema rusticum*, Fabr. (Nepa) *Syst. Rhynq.*, p. 106.

1939. *Sphaerodema rusticum*, Distant., *Fauna of British India. Rhynchota. III*, p. 36.

Hemelytra bears a spot of the fine bristles on the middle towards its inner side. Hind wing bears a distinct fold. Anterior tarsus one jointed and bears a pair of claws. In *Sphaerodema rusticum* antennal fovae lie at a comparatively shorter distance from the eye than in *Sphaerodema annulatum* and *Sphaerodema molestum*. Antennae four segmented, second and third segments are prolonged to form processes on their inner sides.

Measurements : Length of the male and female specimens varies from 17-18 and 18-19 mm. respectively.

Locality : Specimens were collected from Lakhaauribag, Bahurian, Lalpa ponds and also from river Behar.

Habitat : These are lotic and lentic in habitat and live in between *Scirpus articulatus* and *Hydrilla verticillata* plants respectively.

Distribution : India : West Bengal, Bihar, Uttar Pradesh.

11. **Belostoma indicum** (Lep. et Serv.)

1775. *Belostoma indicum*, Lep. & Serv., *Encycl. Meth.* X, p. 272.

1939. *Belostoma indicum*, Distant., *Fauna of British India. Rhynchota. III*, p. 38.

Elongate giant, bugs, Antoculus moderately developed. Eyes longer than its width, beak relatively shorter and stout. Second, third and fourth antennal segment bear dorsally a finger like appendage, the fourth segment in addition to appendages also bears a pair of small projections. Front femur strongly dilated and bears two grooves for reception of tibia, front tarsus three segmented, tarsus and tibia dorsally and laterally compressed. Corium with strong anastomosing longitudinal veins, with numerous branches which form elongate narrow cells.

Measurements : Length of male and female specimens vary from 67-68 and 84-85 mm. respectively.

Locality : Specimens were collected from river Behar and Bahurian, Lalpa, Lakhauribag ponds.

Habitat : These are lotic and lentic in habitat and live in between *scirpus articulatus* and *Hydrilla verticillata* plants, respectively.

Distribution : India : Bombay, West Bengal, Uttar Pradesh.

Order : ODONATA

Family : COENAGRIIDAE

12. Larva : **Copera marginipes** (Ramb.)

1842. *Platycnemis marginipes*, Ramb., *Ins. Ne'vrop*, p. 240.

1890. *Copera marginipes*, Kirby., *Cat. odon*, p. 129.

1933. *Copera marginipes*, Fraser., *Fauna of British India. odonata. I*, p. 192.

Length of the tracheal gills is equal to the total length of the head and thorax. These are dark brown in colour. A peculiar feature of these larvae is that their tracheal gills are carried spread over their abdomen like the sting of a scorpion. The tracheal gills are flat, triangular structures and bear filamentous processes. These are ornamented with brown patches. Other characters as in Kumar (1973).

Measurements : Length of male and female specimens vary from 13-16 and 16-18 mm. respectively.

Locality : Specimens were collected from Behar and Tamas rivers.

Habitat : These are lotic and prefer to live in between *Ipomea crossicaulis* plants.

13. Larva : Pseudagrion decorum (Rambur.)

1842. *Agrion decorum*, Ramb., *Ins. Nevrop*, p. 258.

1876. *Pseudagrion decorum*, Selys., *Bull. Acad. Belg. (2)* Vol. XIii, p. 504.

1933. *Pseudagrion decorum*, Fraser., *Fauna of British India. Odonata, I*, p. 286.

Length of the tracheal gill is less than the total length of head and the thorax. These are yellowish green in colour. Each of the dorsal and ventral margin of the tracheal gill bears a mid dorsal and a mid ventral spine. Other characters as in Kumar (1973).

Measurements : Length of male and female specimens vary from 22-25 and 22-26 mm. respectively.

Locality : These specimens were collected from Behar and Tamas rivers and also from Lakhaauribag pond.

Habitat : These are lotic and lentic in habitat. Animals living in ponds are found in between *Hydrilla verticillata* and those living in river in between *Polygonum barbatum* plants.

14. Larva : Ceriagrion coromandelianum (Fabr.)

1798. *Agrion coromandelianum*, Fabr., *Ent. Syst. Suppl.*, p. 287.

1876. *Ceriagrion coromandelianum*, Selys., *Bull. Acad. Belg. (2)* Vol. XIii, p. 528.

1933. *Ceriagrion coromandelianum*, Fraser., *Fauna of British India. Odonata. I*, p. 314.

Length of the tracheal gill is less than the total length of head and the thorax. Tracheal gills are lanceolate in shape. Other characters as in Kumar (1973).

Measurements : Length of male and female specimens vary from 19-21 and 22-22 mm. respectively.

Locality : These specimens were collected from Bahurian pond.

Habitat : These are lentic and live in between *Trapa bispinosa* and *Najas minor* plants.

15. Larva : Ischnura delicata (Hagen.)

1858. *Agrion delicatum*, Hagen., *Verh. Zool. bot. Ges. Wien*, Vol. Viii, p. 479.

1876. *Ischnura delicata*, Selys., *Bull. Acad. Belg. (2)* Vol. Xli, p. 281.

1933. *Ischnura delicata*, Fraser., *Fauna of British India. Odonata. I*, p. 360.

Length of the tracheal gills is less than the total length of the head and the thorax. The tracheal gills are oblong in shape. Tips of the tracheal gills in *Ischnura delicata* are more pointed in comparison to

the tracheal gills of *Ischnura senegalensis*. Other characters as in Kumar (1973).

Measurement : Length of male and female specimens vary from 15-16 and 17-19 mm, respectively.

Locality : These specimens were collected from Lalpa, Lakhaauribag ponds and also from river Behar.

Habitat : These are lotic and lentic in habitat, those in habiting ponds live in between *Hydrilla verticillata* and those of river live in between *Polygonum barbatum* plants.

16. Larva : *Ischnura senegalensis* (Rambur.)

1876. *Agrion senegalensis*, Ramb. *Ins. Nevrop*, p. 276.

1876. *Ischnura senegalensis*, Selys., *Bull. Acad. Belg.* (2) Vol. Xli, p. 273.

1933. *Ischnura senegalensis*, Fraser., *Fauna of British India. Odonata. I*, p. 348.

Length of the tracheal gills is less than the total length of the head and the thorax. Tips of the tracheal gills in *Ischnura senegalensis* are less pointed in comparison to the tracheal gills of *Ischnura delicata*. Other characters as in Kumar (1973).

Measurements : Length of male and female specimens vary from 14-17 and 18-19 mm. respectively.

Locality and Habitat : Is similar to that of *Ischnura delicata*.

Family : ACRIDAE

17. *Libellago lineata* (Burmeister.)

1839. *Calopteryx lineata*, Burmeister., *Handb. Ent.* Vol. ii, p. 826.

1840. *Libellago lineata*, Selys., *Mon. Lib. Eur*, p. 200.

1984. *Libellago lineata*, Fraser., *Fauna of British India. Odonata. II*, p. 60.

Length of the siphons is less than the total length of the head and the thorax. These are deep brown in colour. Posterior end of the abdomen bears a pair of cylindrical, conical structures. Tracheal gills are absent. In *Libellago lineata* epiproct is absent and is replaced by a small stumpy projection ; cerci from long cylindrical structures.

Measurements : Length of male and female specimens vary from 19-20 and 21-22 mm. respectively.

Locality : These specimens were collected from Behar and Tamas rivers.

Habitat : These are lotic in habitat and live in between *Polygonum barbatum* plants.

GENERAL OBSERVATIONS

These aquatic insects inhabit cool and undisturbed sheets of water preferably areas of shaded standing waters. These are scarce in the big lakes even having all their many fold niches for aquatic life. In big lakes, factors such as wave action, wind velocity and scarcity of emergent vegetation presumably act as deterrents (Macan 1963), small ponds with pleuston consisting of *Vallisneria*, *Hydrilla*, *Najas*, *Nymphoides*, *Polygonum* and similar but submerged vegetation on the banks, provide necessary shade and suitable retreat near the surface. The aerial mode of respiration and incapacity to remain submerged for longer time in *Nepidae* and *Belostomatidae* plays an important role in the distribution of these insects. It is then reasonable that the presence of algal scum is unfavourable to them since its growth hinders their surfacing activity.

Aquatic insect population is quite abundant and active during the months of July to March and during remaining summer months they are rather difficult to collect. It has been noticed that at cooler and much shaded places like Semaria, Mauganj and Bahurian ponds the insect population is quite abundant even in the peak summer months.

SUMMARY

The authors are grateful to Dr. B. K. Tikader, Director, Zoological Survey of India for the facilities given for the publication of this paper. Paper describes nineteen species of aquatic insects found in variety of habitats of Rewa district. Short descriptions of the insects have been given with a view to enable one to identify them even in field. The general composition is predominated by members of the family *Nepidae* and the larval forms of *Zygopterous* dragonflies.

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ON COLLECTIONS OF PAPILIONIDAE FROM ORISSA, INDIA

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(With 1 Table and 1 Map)

INTRODUCTION

An attempt is made to present a faunistic account of enlisted species and forms of Papilionidae from the less explored state of Orissa located at latitudes 17°49'-22°33' N and longitudes 81°27'-87°57' E in the eastern Peninsula of India. The material, most of which are new records for the state, were collected during 1971-1973 by different parties of Zoological Survey of India. These comprise ten species and infra-specific forms in three genera and tribes of Papilioninae. Besides, two known species and three subspecies, not available at hand, are just cited in the list to give a rather comprehensive idea of the state-fauna concerned. The classification is basically followed *sensu* Munroe (1961), but with the adoption of 'infra-specific nomenclature used by Talbot (1939). A table of global distribution and state-map with district-wise plotting of the elements accompanied by a general review of their earlier investigation, biogeography and miscellaneous notes are also incorporated. All the material examined are in the National Collections at Z. S. I.

EARLIER INVESTIGATION

The pioneering faunistic work on butterflies including the Papilionids from Orissa dates back to Taylor & de Nicéville (1888) who prepared a list of material from Khurda in the Puri district. Later, Crawford (1921) noted butterflies from Sambalpur, while Annandale & Dover (1921) published an account of the fauna from the Barkuda Island at Ganjam. Thus, except in these few districts out of a total of thirteen in the state, no further exploration could hitherto be made. Incidentally, Wynter-Blyth (1957) restored the lacuna of Talbot's (1939) non-citation of the Orissa-locality for *Papilio chaon* Westwood which was already recorded from Sambalpur by Crawford (*loc. cit.*).

BIOGEOGRAPHY

As discussed by Annandale & Dover (1921), the lower end of the Chilka Lake at Ganjam of southern Orissa forms the overlapping zone

through which the wide-ranging and adaptable species of the Papilionids and other butterflies infiltrate into the northern and southern areas of the concerned Peninsula. The general pattern of faunal distribution is nonetheless selectively influenced by the important climatological factors, such as topography, climate, vegetations and animals including predators. All these factors play a significant role on the survival of elements also in other districts surveyed, namely, Puri in the south, Cuttack in the east, Dhenkanol, Mayurbhanj, Keonjhar, Sundargarh and Sambalpur in the north with varied inclinations and Bolangir in the west of the state. These have a bearing on the abundance and scarcity of the members, some of which may be common resident forms like *Pachliopta hector* (Linnaeus) feeding on *Canavalia ensiformis*, while others may be rare immigrants like *P. a. aristolochiae* (Fabricius) feeding on *Aristolochia* spp. not known to grow in a given locality like Barkuda. No Papilionid sample could, however, be ever explored at the remaining four districts of the state including Koraput, Balasore, Baudhkondmals and Kalahandi. The district of Mayurbhanj represents the richest faunistic abode in Orissa where all but one species amidst the present lots occur (*vide* Map).

Pachliopta hector (Linnaeus) is the only species which is so far known exclusively from the southern districts of Ganjam and Puri, while *Graphium* (*Pathysa*) *antiphates naira* (Moore), *Papilio c. clytia* Linnaeus and *P. p. polymnestor* Cramer constitute new locality records for the entire state and the remaining six for the parts thereof. The evidence of wide occurrence of the species under study is further based on the fact that Talbot (1939) and Wynter-Blyth (1957) compiled the distributional range from the Himalayan, through the peninsular, to the insular areas of India, as relevant to the material. Out of an estimate of about 25% of the Papilionid species from the entire Indian Peninsula, a little over half the number occurs at Orissa. Of these, a few are endemic in the peninsular area and some are distributed almost throughout India. The material, mostly oriental in origin, show affinities more with the Sino-Malayan than with the Palaearctic fauna. These are, however, poorly represented in the Central Himalayas and also in the Ethiopian and Australo-Papuan regions of the globe (*vide* Table).

MISCELLANEOUS NOTES

Apart from the sexual, seasonal or individual variation, as mentioned under the relevant forms in the text, the female of *Papilio polytes romulus* Cramer exhibits the phenomenon of balanced polyphenism, in

which the different forms are supposed to occur at a more or less static condition in a particular area. Interestingly enough, such a maintenance of forms is not strictly observed in certain habitats of the concerned state. For instance, the female form *stichius* (Hübner) is not apparently found in association with any other form of that sex in the subspecies at least in northern Orissa.

As expected, the males and females of butterflies would occur in nearly equal number, but it is certainly not the invariable rule. For example, in the present collections made during all the seasons and represented by as many as 180 specimens in eleven lots from different districts of the state, all the forms except *Pachliopta hector* (Linnaeus) show an overall predominance of males over females, while *P. hector* is solely represented by females. Such a disparity in distribution of sexes is more apparent than real, since the seemingly rarer sex may be equally abundant but less frequently collected due to its different habits and habitats.

Finally, certain specimens of *Papilio polytes romulus* Cramer, *P. p. polymnestor* Cramer and *P. d. demoleus* Linnaeus exhibit the phenomenon of dwarfism, possibly due to their impoverished nutrition.

LIST OF PAPILIONID SPECIES AND FORMS FROM ORISSA

Family PAPILIONIDAE

Subfamily PAPILIONINAE

Tribe I. Leptocircini

1. *Graphium* (*Graphium*) *doson eleius* (Fruhstorfer)
- *1(a). *Graphium* (*Graphium*) *doson axion* (Felder & Felder)
2. *Graphium* (*Pathysa*) *antiphates naira* (Moore)
3. *Graphium* (*Pathysa*) *nomius nomius* (Esper)

Tribe II. Papilionini

4. *Papilio clytia clytia* (Linnaeus)
 - (i) *f. clytia* Linnaeus
 - (ii) *f. dissimilis* Linnaeus
5. *Papilio polytes romulus* Cramer
 - f. ♀ stichius* (Hübner)
6. *Papilio polymnestor polymnestor* Cramer
7. *Papilio chaon chaon* Westwood

* Not dealt with in the Systematic Account (for distribution, *vide* Table).

TABLE I. TABLE SHOWING THE GEOGRAPHICAL DISTRIBUTION OF PAPILIONIDAE FROM ORISSA

No. † of	P	E	ORIENTAL																	
Spp./	A	T	INDIAN															M	P	A
Sspp.	L	H	C	Himalayan			Peninsula				Insular					a	A	U		
	A	I	h	N. West-	Cen-	N. East-	West-	North-	Eastern		South-	South-	S.	l	P	S				
	E	O	i	ern	tral	ern	ern	ern	ORISSA				Else-	ern	ern	East-	a	U	T	
	A	P	n						West-	North-	East-	South-	where			ern	y	A	R	
	R	I	e						ern	ern	ern	ern					a	N	A	
	C	A	s														n		L	
	T	N	e																I	
	I																		A	
	C																		N	
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	
Sp. 1	+		+	+		+	+			+		+	+	+	+		+			
Ssp.										N'		+	+	+						
*Ssp. 1 (a)			+	+		+				+							+			
Sp. 2			+			+	+	+		N			+	+	+	+	+			
Ssp.							+			N				+						
Sp. 3			+			+	+	+		N'		+	+	+	+		+			
Ssp.						+	+	+		N'		+	+	+	+					
Sp. 4			+	+		+	+	+		N				+	+	+	+			
Ssp.				+		+	+	+		N				+						
Sp. 5	+		+	+		+	+	+	N'	N'		+	+	+	+	+	+			
Ssp.			+	+		+			N'	N'		+	+	+	+		+			

TABLE I. (Concluded)

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX
Sp. 6.						+	+	+		N			+	+	+				
Ssp.						+	+	+		N			+	+					
Sp. 7			+		+	+				+				+			+		
Ssp.					+	+				+									
Sp. 8	+	+	+	+		+	+	+	N'	N'	N'	+	+	+	+		+	+	+
Ssp.	+			+		+	+	+	N'	N'	N'	+	+	+	+				
*Sp. 8 (a)	+		+	+		+	+			+				+			+		
*Ssp.				+		+	+			+				+			+		
Sp. 9							+					+	+	+	+	+			
Sp. 10			+	+		+	+			N'	N'	+	+	+	+	+	+		
Ssp.				+		+	+	+		N'	N'	+	+	+	+		+		
*Sp. 10 (a)			+			+	+			+			+	+		+	+	+	
Ssp.			+			+				+			+	+			+		

N. B. : †, as marked in the list ; ↓ not dealt with in the systematic account ; N, exclusively & N', partially new records for the state ; +, known distribution.

8. *Papilio demoleus demoleus* Linnaeus

f. *demoleinus* Oberthür

*8(a). *Papilio paris decorosa* Fruhstorfer

Tribe III. Troidini

9. *Pachliopta hector* (Linnaeus)

10. *Pachliopta aristolochiae aristolochiae* (Fabricius)

*10(a). *Troides helena cerberus* (Felder & Felder).

SYSTEMATIC ACCOUNT

Family PAPILIONIDAE

Subfamily PAPILIONINAE

Tribe I. Leptocircini

1. *Graphium* (*Graphium*) *doson eleius* (Fruhstorfer)

Material examined : 2 ♂♂, 1 ♀, Jauabil Forest, MAYURBHANJ, 20. iii. 1973, S. K. Gupta leg.

*Wing expanse***: ♂♂ 76, ♀ 78 mm.

Distribution : INDIA : West Bengal ; Orissa (Mayurbhanj ; Ganjam) southern Peninsula.

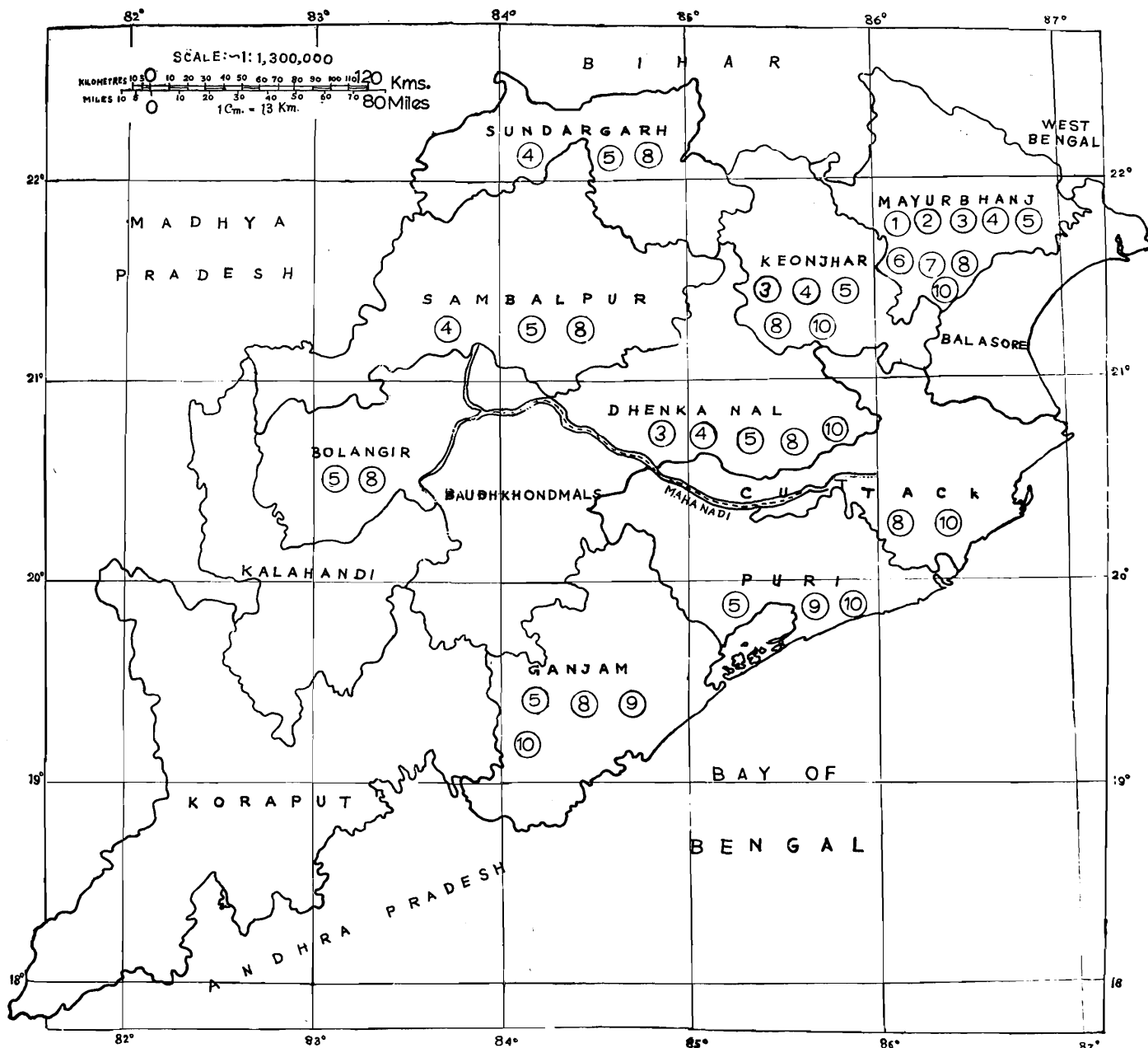
Remarks : This is one of the two known Indian subspecies of *G.* (*G.*) *doson* (Felder & Felder) which occurs from South Japan to South China, Sri Lanka and the Sundaland, extending westwards to India. It differs from ssp. *axion* (Felder & Felder) of the Sino-Indo-Malayan belts by the fore wings with yellowish green apical spots, broad discal band, prominently green subbasal line and hind wings with pale median vein. These subspecies are already known from southern and northern Orissa respectively. The present specimens, which are new record for northern Orissa, fit well in ssp. *eleius* in well accordance with its known distribution, being common but endemic in the Indian Peninsula. It is quite interesting to note that the occurrence of both the subspecies in the same area indicates further adaptability of the concerned species towards sympatric evolution.

2. *Graphium* (*Pathysa*) *antiphates naira* (Moore)

Material examined ; 3 ♂♂, Astia, Baripada, MAYURBHANJ, 20-21.iii.1973, S. K. Gupta leg.

Wing expanse : 70-76 mm.

** tip-to-tip measurement of the bilaterally spread fore wings across mesothorax of pinned specimens.



DISTRIBUTION OF THE PAPILIONIDAE IN

ORISSA

(Encircled number of species marked as in order of the text)

Distribution : INDIA : Maharashtra (Western Ghat) ; Orissa (Mayurbhanj) ; Karnataka (Coorg ; Karwar) ; Kerala (Malabar).

Remarks : This is one of the three known Indian subspecies of *G. (P.) antiphates* (Cramer) which occurs from China to Lesser Sunda Islands through India. It differs from ssp. *pompilius* (Fabricius) of the Sino-Indo-Malayan belts and ssp. *epaminondas* (Oberthür) of the Andaman Islands by the fore wings with terminal and subterminal bands united at Cu_{1a} before reaching dorsum. The specimens, which are recorded new for Orissa, are referred to ssp. *naira*. They are of the dry season form, being distinguished from the wet season form by the fore wings with narrower and shorter black bars and hind wings paler, with both the subterminal and terminal black markings obsolete. Endemic in the Indian Peninsula, this subspecies is rare, though the females are known to be fairly common during the wet season in the areas other than Orissa.

3. *Graphium (Pathysa) nomius nomius* (Esper)

Material examined : One ♂, Baripada, 26. iv. 1972, A. R. Bhowmik leg., 1 ♂, Bangriposhighat, MAYURBHANJ, 25. iii., 2 ♀ ♀, Ghatgaon, 1 ♀, Atci Reserve Forest, KEONJHAR, 28-29. iii., 1 ♂, Laboneji, Angul, DHENKANOL, 11. iv. 1973, S. K. Gupta leg.

Wing expanse : ♂ ♂ 76-78, ♀ ♀ 74-82 mm.

Distribution : INDIA : Sikkim ; Assam ; Gujarat ; Uttar Pradesh (Lucknow) ; Madhya Pradesh ; southern Bihar ; West Bengal ; Orissa (Mayurbhanj ; Keonjhar ; Dhenkanol ; Ganjam) ; Karnataka ; Tamil Nadu (Shevaroy ; southern Nilgiris, c 925-2140 m) ; Kerala. SRI LANKA.

Remarks : This is one of a couple of the known Indian subspecies of *G. (P.) nomius* (Esper) which occurs in the Oriental region. It differs from ssp. *swinhoei* (Moore) of the Sino-Indo-Malayan belts by the fore wings dorsally with the fifth black band extending up to the posterior angle of cell and ventrally with the fourth band below the cell also black, hind wings dorsally with the terminal band traversed by a series of white lunules and ventrally with the precostal spur not edged black. The specimens from northern Orissa, from where the species has not been previously recorded, are referred to ssp. *nomius* being locally common in the Indian subregion and already known from the south of the state.

Tribe II. Papilionini

4. *Papilio clytia clytia* Linnaeus

Material examined : One ♂, Trensa House Garden, Barsuan, SUNDARGARH, 14. ix, S. Khera leg. ; 1 ♀, Badrama, SAMBALPUR,

23. xii. 1972, 1 ♀, Upardhia, 3. iii., 1 ♀, Ghatgaon, 2 ♀ ♀, Atci Reserve Forest, KEONJHAR, 29. iii., 1 ♂, Hamilton Garden, Baripada, 1 ♂, Deopata, Biso, MAYURBHANJ, 17, 28. iii., 1 ♀, Laboneji, Angul, DHENKANOL, 11. iv. 1973, S. K. Gupta leg.

Wing expanse : ♂ ♂ 98-106, ♀ ♀ 86-116 mm.

Distribution : INDIA : Himachal Pradesh (Kangra) ; Sikkim ; Assam (c 2290 m) ; Maharashtra (Bombay) ; Madhya Pradesh ; Orissa (Sundargarh ; Sambalpur ; Keonjhar ; Mayurbhanj ; Dhenkanol) ; Karnataka (Karwar) ; Tamil Nadu (southern Nilgiris, c 925 m). BURMA.

Remarks : This is one of the two known Indian subspecies of *P. clytia* Linnaeus which occurs from South China to Timor through India. It differs from spp. *flavolimbatus* (Oberthür) of the Andaman Islands by the fore wings dorsally with subterminal white spots irregular, spot in M_3 inwardly shifted and hind wings ventrally with a prominent series of terminal yellow spots. The specimens from Orissa, from where the species has not been previously recorded, are referred to the nominate subspecies being locally common to very rare in the Indian subregion. They are of the following first two out of six principal morphs, viz., f. *clytia* Linnaeus, f. *dissimilis* Linnaeus, f. *dissimillima* (Evans), f. *casyapa* Moore, f. *panope* Linnaeus and f. *commixtus* Rothschild, the last being very rare in Sikkim and Assam.

(i) f. *clytia* Linnaeus : This is recognised by the fore wings with a subapical spot, hind wings with cell neither white nor touched by the discal white sagittate streaks and both wings with ground colour dark velvety black. A good mimic of *Euploea core* (Cramer), it is as widely distributed as the subspecies, but not recorded so far from Dhenkanol. It is known to be common at Karwar during the monsoon, at the southern Nilgiris during the spring and in the North-western Himalayas during the summer and winter. Also from the above data, it appears to be not rare at Orissa. It shows larger wing expanse at least in the female, varying between 106-116 mm., as compared to the next form.

(ii) f. *dissimilis* Linnaeus : This is recognised by the fore wings with creamy white cell-streaks united at base, spotted discal area, postdiscal series of streaks, hind wings with white cell touched by discal streaks and both wings not velvety black. It mimicks a different Danaid species, *Danaus limniace* (Cramer) and occurs from the North-west Himalayan to the peninsular sectors of India where it is known to be locally common. It is represented by a couple of females from Dhenkanol and Keonjhar, having a smaller wing expanse, varying between 86-93 mm, as compared to the preceding form,

5. *Papilio polytes romulus* Cramer

Material examined : 3 ♂♂, H. S. L. Rest House and Valley, Barsuan, 13. i., 1 ♂, Govt. Seed Farm, Jharsuguda, 19. i., 1 ♀, Kalimandir Road, SUNDARGARH, 22. ix., 2 ♀♀, 1 ♂, Badrama, 7. xi., 21, 23. xii., 1 ♂, Pump House, 27. xi., 2 ♂♂, along the bank of R. Mahanadi, SAMBALPUR, 28. xi., 1 ♂, Chhatamakhna, 1 ♂, Sarishagura Village, 1 ♂, Rly. colony, Titilagarh, BOLANGIR, 1, 4-5. x., *S. Khera*, *J. M. Julka*, *A. K. Mandal* & *K. Rai* leg. ; 1 ♂, Karatpeta. Angul, 29. ix., 1 ♂, Amlapara, 1 ♂, Shankarpur, DHENKANOL, 5, 7. x., 1 ♂, Dayarsani Temple, Bisoi, 15. viii., 1 ♂, Aasna, Bangriposhi, 15. x. 1972, 1 ♂, Palbani, Baripada, 2 ♂♂, Jeuabil Forest, MAYURBHANJ, 18. 20. iii. 1973, *S. K. Gupta* & *S. K. Mitra* leg. ; 1 ♀, Badand, 4. ix., 1 ♂, Bhatsai, 20. ix. 1972, *K. Rai* leg., 1 ♂, Ananapur, KEONJHAR, 4. iv. 1973, *S. K. Gupta* & *S. K. Mitra* leg. ; 1 ♂, Banpada, Konark, PURI, 9. xi., 1 ♂, 1 ♀, near backwater, Gopalpur, GANJAM, 1, 5. x. 1972, *S. Khera* leg.

Wing expanse : ♂♂ 78-102, ♀♀ 92-108 mm.

Distribution : VIETNAM : Tonkin. INDIA : North-western Himalayas (c 925 m) ; North-eastern Himalayas (c 1530 m) ; southern Bihar ; West Bengal ; Orissa (Sundargarh ; Sambalpur ; Bolangir ; Dhenkanol ; Mayurbhanj ; Keonjhar ; Puri ; Ganjam) ; southern Peninsula. BURMA. SRI LANKA. MALAY PENINSULA. BORNEO. SULAWESI.

Remarks : This is one of the three known Indian subspecies of *P. polytes* Linnaeus which occurs from West China and India to the Moluccas, Timor and adjoining islands except Tenimber. The male of this subspecies, which occurs in a single form, differs from that of ssp. *stichioides* Evans of the Andaman Islands and of ssp. *nikobarus* Felder of the Nicobar Islands by the fore wings with prominent terminal white spots, hind wings dorsally with discal white band of even width and ventrally with red subterminal lunules. The specimens, which are already known only from southern Orissa, are referred to ssp. *romulus* being common in the Indian mainland including the state concerned. The female, on the other hand, is represented by three principal polyphenic forms, viz., f. ♀ *stichius* (Hübner), f. ♀ *cyrus* Fabricius and f. ♀ *romulus* Cramer, of which the first is concerned with the present specimens and, dealt with hereunder.

f. ♀ *stichius* (Hübner) : This is recognised by the fore wings basally and terminally dark with distinct intra-cellular streaks and hind wings velvety black, with anal area distally red and sprinkled with blue scales, subterminal and terminal series of red markings. It is a good mimic of *Pachliopta aristolochiae* (Fabricius). The occurrence of the f. ♀ *stichius* not in association with its other allies in northern Orissa

seemingly goes against the phenomenon of balanced polyphenism. As compared to the females, certain males in the present collections are appreciably smaller in relation to the normal wing expanse starting from 90 mm. in both sexes.

6. *Papilio polymnestor polymnestor* Cramer

Material examined : One ♂, Hamilton Garden, Baripada, 17. iii., 3 ♂ ♂, Meghasoni, MAYURBHANJ, 19.iii.1973, S. K. Gupta leg.

Wing expanse : 110-124 mm.

Distribution : INDIA : Sikkim ; Maharashtra (Bombay ; Western Ghat) ; Madhya Pradesh ; southern Bihar ; West Bengal (Calcutta) ; Orissa (Mayurbhanj) ; Tamil Nadu (Nilgiris, c 620-2140 m).

Remarks : This is the only Indian subspecies of *P. polymnestor* Cramer which occurs in the south of the Indian subregion, being only a straggler at Sikkim in the north *sensu* Wynter-Blyth (1957). It is recognised by the fore wings with blue band and hind wings with blue area dorsally narrow in male. The female, which is not presently available, is known to have pale internervular streaks extending into the cell of fore wings, the band of which is ventrally also narrow. The specimens from Orissa, from where the species was not earlier recorded, are referred to the nominate subspecies occurring in the wet niches. They alight on flowers and repose with wings held in a roof-like manner as the moths do, being locally common up to an altitude of c 2140 m at Nilgiris during the dry season, but rare in the plains. Only one of the specimens under study is quite smaller with an expanse of 110 mm as compared to the normal scale starting from 120 mm.

7. *Papilio chaon chaon* Westwood

Material examined : One ♂, Jeuabil Forest, 1 ♂, Deopata, Bisoī, MAYURBHANJ, 20.iii.1973, S. K. Gupta leg.

Wing expanse : 114-120 mm.

Distribution : NEPAL. INDIA : Assam ; Orissa (Mayurbhanj ; Sambalpur). NORTH BURMA.

Remarks : This is the only Indian subspecies of *P. chaon* Westwood which occurs exclusively in the Oriental region amidst the lowly wooded hills. It is recognised by the fore wings with intra-cellular streaks, yellowish brown scales and hind wings with four white discal spots. Also, it is known to exhibit sexual dimorphism in which the

male is brighter and with smaller markings than the female. The specimens, which were earlier known from Sambalpur and presently recorded from one more district, i.e., Mayurbhanj of northern Orissa, are referred to the nominate subspecies being common both in the Central and North-eastern Himalayas, but seemingly rare in Orissa.

8. *Papilio demoleus demoleus* Linnaeus

Material examined : One ♂, Teak Plantation, east of F. R. H., Panposh, 21.vi., 7 ♂♂, 3 ♀♀, in and around H. S. L., Barsuan, Dhutura Village, 2 ♂♂, 1 ♀, Trensa Colony, 13-15, 18.ix., 1 ♂, near Raj Badi, SUNDARGARH, 23. x., 9 ♂♂, 9 ♀♀, c 4.5 kms. east, west, north and south of F. R. H., 2-4.vi., 1 ♂, Hirakud Dam, 1 ♂, near, Sambalpur Jail, 1 ♂, 1 ♀, Pump House, 2 ♀♀, along the bank of R. Mahanadi, 2 ♂♂, 2 ♀♀, Brooke's Hills, 5 ♂♂, 2 ♀♀, Badrama Reserve Forest, SAMBALPUR, 25, 29. ix., 7. xi., 21-23.xi., 1 ♂, c 6 kms. south of F.R.H., Mahakand, 29. v., 1 ♀, Chhatamakha, 1. x., 1 ♂, 2 ♀♀, near Rly. Colony, Titilagarh, BOLANGIR, 5. x., 10. xi., *D. P. Sanyal, A. K. Mandal, S. Khera & J. M. Julka* leg. ; 1 ♂, Barsasoni, 2 ♀♀, Puranagarh, 20, 27, 29.ix., 3 ♀♀, Puranokote, 30.ix., 2 ♂♂, 4 ♀♀, Jharpara, 1 ♂, Lingorajori, 1 ♂, Jubilee Town, 1 ♂, 1 ♀, Laboneji, Angul, 2-3, 6, 10.x.1972, 1 ♀, Horticulture Garden, 1 ♂, Progeny Orchard, DHENKANOL, 7-9, 11.iv.1973, *Y. Chaturvedi & S. K. Gupta* leg., 2 ♂♂, 1 ♀, Manoda, 1 ♀, Bhalupahari, 1 ♂, Gosanipal, 14-16.ix. 1972, 2 ♂♂, 1 ♀, Astia, Baripada, 1 ♀, Chandanpur, Bangriposhi, MAYURBHANJ, 16, 21, 25.iii.1973, *K. Rai & S. K. Gupta* leg., 1 ♂, 3 ♀♀, Badand, KEONJHAR, 20.ix., *K. Rai* leg., 2 ♂♂, Ansupa Lake, Athgarh, 29.viii. 1972, 2 ♀♀, C. R. R. I., CUTTACK, 13.iv.1973, *S. K. Mitra & S. K. Gupta* leg. ; 1 ♂ Forest Rest Shed, 23.ix., 2 ♂♂, 1 ♀, near back water, Gopalpur, GANJAM, 9, 11.x.1972, *Y. Chaturvedi* leg.

Wing expanse : ♂♂, ♀♀ 70-98 mm.

Distribution : EASTERN ARABIA. IRAN. PAKISTAN : Baluchistan. INDIA : North-western and North-eastern Himalayas (c 2140 m) ; peninsular areas including Orissa (Sundargarh ; Sambalpur ; Bolangir ; Dhenkanol ; Mayurbhanj ; Keonjhar ; Cuttack ; Ganjam). NORTH BURMA. SRI LANKA.

Remarks : This is the only known Indian subspecies of *P. demoleus* Linnaeus which has a wide range of distribution in the Old World except Europe. It is very common in the plains of India and recognised by the fore wings with basal half of cell sprinkled with yellow scales and a narrow discal band of yellowish spots. The specimens from northern, western and eastern Orissa, from where the species was not

earlier recorded, are referred to the nominate subspecies being already known from the southern districts of the state. Some of them are appreciably smaller with the wing expanse of 70 mm as against the scale starting from 80 mm. Only the females of the material examined are of a single morph known from the Indian subregion and dealt with hereunder.

f. demoleinus Oberthür : This is recognised by the hind wings with anal red spot anteriorly reduced and separated from the blue lunules by a black spot. Apparently, it is exclusively represented by the females, although there is no such earlier mention of the given sex for this form unlike in the ssp. *romulus*, as already mentioned.

Tribe III. Troidini

9. *Pachliopta hector* (Linnaeus)

Material examined : 3 ♀ ♀, along the Rly. track, Tikarpara, Banpada, Konark, PURI, 14, 19. ix. 1972, 2 ♀ ♀, c 8 kms. north-east of the camp near foot-hill, Rambha, Gopalpur, GANJAM, 9. xi.,-x. 1971-1972, D. P. Sanyal & Y. Chaturvedi leg.

Wing expanse : 90-108 mm.

Distribution : INDIA : Maharashtra ; southern Bihar ; West Bengal ; Orissa (Puri ; Ganjam) ; Tamil Nadu (Nilgiris, c 320-2440 m) ; the Andaman Islands. SRI LANKA.

Remarks : Amongst the three other Indian species of *Pachliopta* Reakirt, viz., *P. jophon* (Gray), *P. pandiyana* (Moore) and *P. aristolochiae* (Fabricius), the present one is distinguished by the fore wings with prominent white central and apical bands and hind wings with discal and subterminal row of red spots. It is known to exhibit sexual dimorphism in which the females differ from the males by the fore wings with paler discal and subterminal markings and abdomen black up to the anal end. Also, it acts as a model of *Papilio polytes romulus*, ♀ f. *romulus* Cramer which is not, however, presently available but cited by Annandale and Dover (1921) from southern Orissa. It is very rare in West Bengal and the Andaman Islands but common elsewhere. Eaton (1880) observed the roosting of the species in a multitude at Maharashtra. The present specimens, which are referred to *P. hector*, confirm their earlier record for southern Orissa. Interestingly enough, these are not represented by male which is more or less preponderant for the remaining elements under study, nor known from Mayurbhanj, the faunistically richest district of all in Orissa, nor provided with sharp geographical variations so as to be assigned to subspecific status.

10. *Pachliopta aristolochiae aristolochiae* (Fabricius)

Material examined : 2 ♂♂, 1 ♀, Bagmunda, 1.i., V. C. Agarwal leg., 2 ♀♀, Jharpara, 20.ix., 1 ♂, Nisa, Angul, 1.x., 1 ♂, Amlapara, 1 ♂, Jubilee Town, 1 ♀, Shankarpur, 5-7.x.1972, K. Rai leg., 1 ♂, Progeny Orchard, DHENKANOL, 8. iv., 2 ♀♀, Ghatgaon, 1♂, Atci Reserve Forest, KEONJHAR, 28-29. iii. 1973, S. K. Gupta leg., 1♂, Manbhanj, Bangriposhi, 17. ix. 1972, K. Rai leg., 2 ♂♂, Baripada, 5 ♀♀, Palbani, MAYURBHANJ, 16, 18. iii. 1973, S. K. Gupta leg., 1 ♀, Rajatgarh, 2 ♀♀, Anukulmandia Forest, CUTTACK, 29-30. viii., 1 ♀, Tikarpara, PURI, 14. ix., 2 ♀♀, Dhonard, Balugaon, GANJAM, 30. ix. 1972, S. K. Mitra & Y. Chaturvedi leg.

Wing expanse : ♂♂, ♀♀ : 82-104 mm.

Distribution : INDIA : North-western Himalayas (c 925 m) ; North-eastern Himalayas (c 1530 m) ; peninsular areas (c 2440 m) including Orissa (Dhenkanol ; Keonjhar ; Mayurbhanj ; Cuttack ; Puri ; Ganjam), SRI LANKA. JAVA. SULAWESI.

Remarks : This is one of the five known Indian subspecies of *P. aristolochiae* (Fabricius) which is known from the Oriental region. It is remarkable for emitting rosy odour and showing gregarious habit on flowers particularly during the spring and rainy season. It is distinguished from ssp. *goniopeltis* (Rothschild) of the Sino-Indo-Malayan belts, ssp. *sawi* (Evans) of Car Nicobar, ssp. *camorta* (Moore) of the Nicobar Islands and ssp. *kondulana* (Evans) of Great Nicobar by the fore wings basally black up to a little beyond the origin of Cu_{1b} , with long stripes in the area of dorsum and hind wings dorsally without cell-spot and ventrally with a red anal spot. It occurs commonly in almost identical niches of *Papilio polytes romulus*, f. ♀ *stichius* (Hübner) as well as the diurnal Zygaenid moth, *Histia flabellicornis* Fabricius amidst the Citrus plantations mainly in response to the model-mimic relation. The specimens from northern and eastern Orissa, from where the species was not earlier recorded, are referred to the nominate subspecies which is already known from south of the state.

About half the number of specimens examined are provided with the discal series of white spots between M_2 and Cu_{1b} proximally reduced and thus remote from the cell and the rest with those proximally produced and close to the cell of hind wings. These variations were already noted by Talbot (1939) under "f. *aristolochiae* (Fabr.)" and "f. *diphilus* (Esper)" respectively. Talbot (*loc. cit.*) also observed that both these "forms" are more or less common in their similar niches of flight. It is apparent from the present data that the concept of remote or close orientation of discal spots in relation to the hind wing cell

along with other features for these "forms" gives a clue to separate speciation. In fact, Munroe (1961) revived "*f. diphilus*" as the type species of the genus concerned. Presently, however, all the specimens are considered under sp. *aristolochiae*, but without being referred to any of the aforesaid "forms" after Talbot (*loc. cit.*).

SUMMARY

The paper incorporates a faunistic list and account of species and their infraspecific forms of Papilionidae from the state of Orissa in India. The material including new records of nine species have been collected from different districts of the state by several parties of Zoological Survey of India. One table and map have also been provided to highlight the distribution of the fauna.

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FOOD AND FEEDING HABITS OF *CARANGOIDES*
MALABARICUS (BLOCH AND SCHN.) AND *ALEPES*
KALLA (CUV. AND VAL.) OFF PORTO NOVO COAST. *

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(With 2 Text-figures and 8 Tables)

INTRODUCTION

Knowledge of what the fish eats, its natural growth rate, its nutritional needs and its general trophic ecology are of paramount importance in any mariculture venture. Fish farming cannot be a success without a knowledge on food and feeding habits of particular fish used in culture. The food habits of fishes provide information on their shoaling and migratory habits and feeding adaptation as well. Therefore any information on this subject will contribute to knowledge needed for optimum management of fish stocks.

Our knowledge regarding the food and feeding habits of carangid fishes of India were confined to some detailed observations made by Tandon (1960) on *Selaroides leptolepis* from the east coast of India, by Kagwade (1971) on *Caranx kalla* and by Sreenivasn (1974) on *Megalaspis cordyla* from the west coast of India. Other works were mostly confined to observations on a few specimens with casual remarks. The present study deals with the food and feeding habits of two commercially important carangid fishes, *Carangoides malabaricus* and *Alepes kalla* occurring along Porto Novo coast.

MATERIAL AND METHODS

The materials for the present study were collected weekly from the commercial trawl catches of Porto Novo. A total of 1274 specimens of *C. malabaricus* (441 females, 380 males & 453 juveniles) and 1314 specimens of *A. kalla* (578 females, 406 males & 330 juveniles) were examined. The specimens were weighed, T. L. of each specimen as also its sex and maturity stage were noted. The stomach was then removed and preserved in 7% neutral formalin for study. The stomach was here defined as that part of the gut between the last gill arch and the pyloric

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caecae. The intestines were not examined (Randall, 1967 ; Kionka and Windell, 1972 ; Gannon, 1976).

Special attention was given to the regurgitation problem. Shrunken stomachs containing mucus were considered as empty whereas completely empty stomachs with expanded walls were identified as regurgitated and hence discarded (Dann, 1973).

Numerous methods have been employed for analysing the food habits of fishes. Pillay (1952) suggested that the method to be adopted must depend entirely on the particular diet of the fish. The Index of preponderance' method as suggested by Natarajan and Jhingran (1962) and adopted by James (1967) for ribbon fishes and by Ramanathan (1977) for flat fishes, was found to be suitable for carnivorous fishes feeding on fishes, prawns, other crustaceans, molluscs etc. and was therefore employed in the present study. The index of preponderance was worked out by using the formula :

$$I = \frac{VO}{\sum VO} \times 100$$

(where 'V' and 'O' represent the percentage of volume and occurrence of each item of food respectively and 'I' the index). The index provides a definite and measurable basis for grading the various food elements since it gives a combined picture of frequency of occurrence as well as bulk. The volume of each food item was measured by the volumetric (displacement) method and the percentage volume for different items was calculated from the total volume of all the items of food.

The food items were identified upto generic level depending on their digested state. Their occurrence was noted and the percentage was calculated. All the unidentifiable fishes were included in the category 'fishes'. The presence of sand grains is considered only accidental although taken into consideration in the analysis, but was actually left out while grading the various food items.

To ascertain feeding intensity during various months, all the stomachs were classified into 'gorged' when the stomach was full of food with its wall being thin or transparent and 'full' when the stomach was filled with food, its wall being thick and intact. Similarly, they were classified ' $\frac{3}{4}$ full' ' $\frac{1}{2}$ full' ' $\frac{1}{4}$ full' depending upon their relative fullness and the space occupied by the stomach contents. A stomach was designated and termed 'little' when the contents occupied less than one fourth the capacity of the full stomach. Those stomachs which were termed 'empty' contained practically nothing and only little mucus was present in them. Such empty stomachs had only shrunken walls,

To find the food preference during different maturity stages, four categories were considered (Venkataramani, 1979). They were categorised as immature (Stage I in males and females), maturing (Stages II and II in females ; stage II in males) mature (stage IV in females and stage III in males) and spent and recovering (stage VII in females and stage IV in males) to detect the food preference if any, during different levels of maturity. The males and females were treated separately. Female specimens with fully mature gonads (Stages V and VI), which occupied the entire body cavity, had only empty stomachs and were not included.

RESULTS AND DISCUSSION

Carangoides malabaricus

Food composition : The food components of *C. malabaricus* were grouped into crustaceans, fishes, molluscs, polychaetes, diatoms and foraminifers. Crustaceans were the major food item and fishes ranked next while molluscs, polychaetes, diatoms and foraminifers were consumed in smaller quantities. Among crustaceans, *Lucifer* spp., *Acetes* spp. and mysids were consumed more. Among juvenile fishes, *Leiognathus* spp., *Stolephorus* spp. and *Thrysa* spp. were predominant. Molluscs were eaten less and that too only *Cresis* spp. was preferred. Polychaetes, diatoms and foraminifers were consumed in meagre quantities.

From Table 1, it was evident that the food of *C. malabaricus* consists mostly of planktonic forms. It seems to prefer planktonic crustaceans most as its food.

Food of juveniles and adults : The food of juveniles and adults were analysed separately to know about the variations if any. From Tables 1 & 2, it could be seen that the juveniles mainly feed on crustaceans, particularly *Acetes* spp., prawn larvae and mysids. It feeds on other food items such as molluscs, foraminifers and diatoms have been recorded only occasionally.

Adults were sexed and their stomach contents were separately analysed. The results (Table 1) showed that there was not much variation in the food between males and females of *C. malabaricus*. Among crustaceans, *Acetes* spp., *Lucifer* spp., prawns and mysids formed the major food items. Other crustaceans such as larval crabs, *Squilla* larvae, amphipods, prawn larvae etc. were also consumed in lesser quantities. Among teleostean fishes, *Leiognathus* spp., *Thryssa* spp., *Stolephorus* spp. and *Thrissina* spp. were consumed in appreciable amounts in certain months ; *Drepane* spp., *Pomadasy* spp., *Johnius* spp. etc. were found in traces. Molluscs like *Cresis* spp., *Sepia* spp., etc. were

found occasionally. The food of adults clearly showed that besides crustaceans as major food, fishes were also eaten in appreciable numbers.

Seasonal variations in the food of juveniles and adults : Seasonal variations in the food of juveniles and adults of *C. malabaricus* were presented in Tables 1 & 2.

Acetes spp. and mysids formed the food of juveniles during most of the year. *Lucifer* spp., formed the major food item in May. Prawn larvae appeared in moderate amounts during January and February. Other planktonic crustaceans, fishes and molluscs were found in lesser amounts in the food of juveniles during other months of the year.

In adults, *Acetes* spp., mysids, and *Lucifer* spp. were the major food items during most of the months. Other crustaceans like, prawn larvae, juvenile prawns and *Squilla* larvae could be found in appreciable quantities in certain months. Among fishes, *Leiognathus* spp. formed the important food item in February. *Thryssa* spp. was recorded in appreciable quantities in January, April and October. Beside this, other teleostean fishes were also recorded in lesser quantities, during various months of the year. Foraminifers occurred in the gut contents in July and also from October to February.

Food preferences during maturity stages : The food preference during maturity stages of males and females were analysed separately to study the variations if any.

MALES

Immature specimens fed mainly on *Acetes* spp. and *Lucifer* spp., while maturing specimens preferred *Leiognathus* spp. and mysids and specimens with mature testis fed mainly on *Lucifer* spp. and *Acetes* spp. In spent and recovering specimens *Stolephorus* spp. and *Acetes* spp. were more in the gut contents (Table 3).

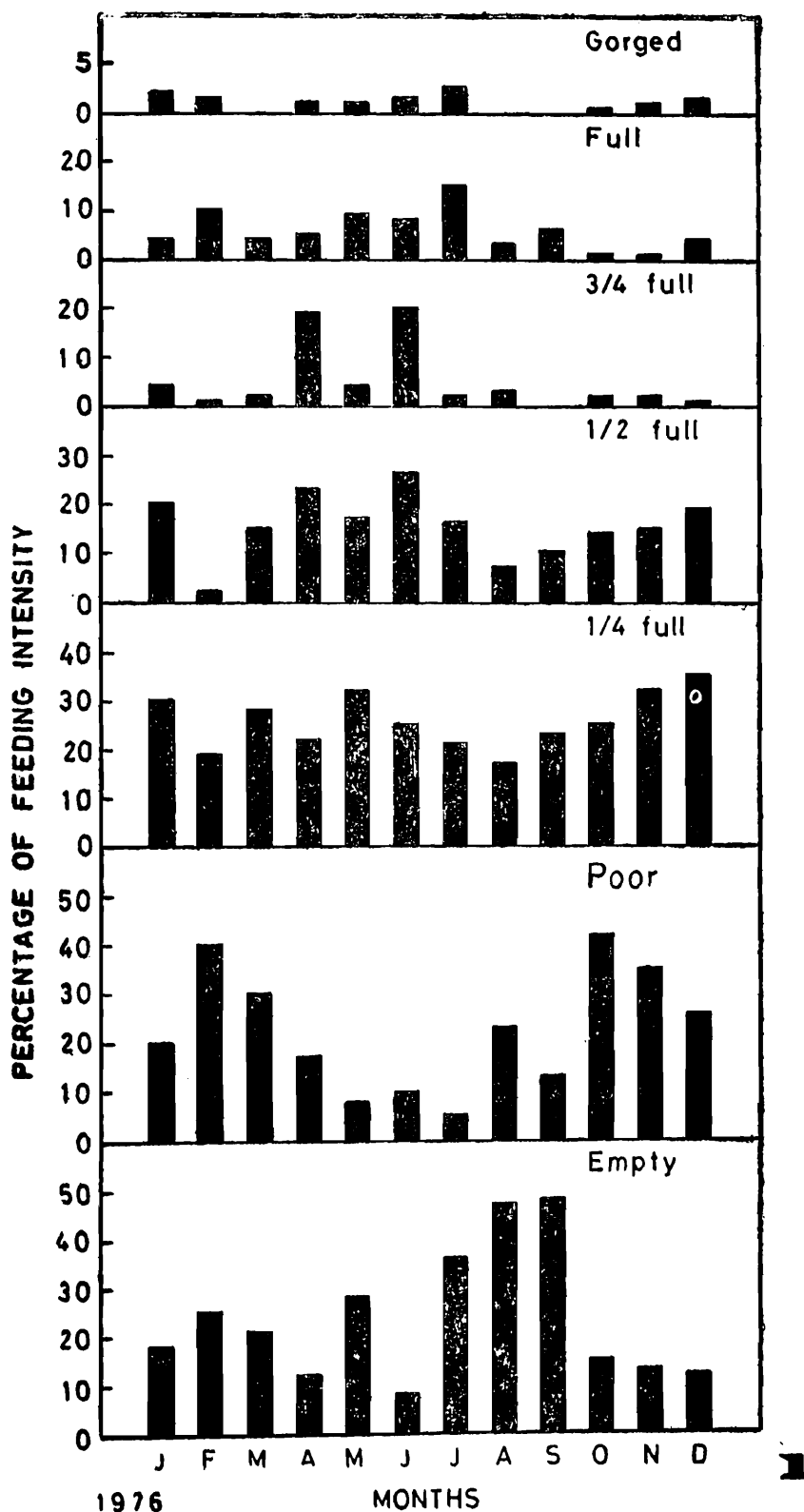
FEMALES

Immature and maturing females seem to feed on *Acetes* spp. and juvenile prawns, while females with mature ovaries appeared to prefer *Acetes* spp. and *Lucifer* spp. When the ovaries occupied the full body cavity (Stages V and VI), the stomachs were found to be empty. Spent and recovering females prefer to feed on *Leiognathus* spp. and *Stolephorus* spp. (Table 4).

Thus in juveniles and in immature adults of both sexes, planktonic crustaceans dominated in the gut contents. When it attains maturation gradually, besides crustaceans, fishes were also supplemented. Spent

and recovering specimens preferred *Stolephorus* spp. and *Leiognathus* spp. in appreciable quantities as food.

Feeding intensity : The percentage occurrence of feeding intensities for *C. malabaricus* was shown in Text-fig. 1. The percentages of 'gorged' 'full' ' $\frac{3}{4}$ full' were always less. The percentages of ' $\frac{1}{2}$ full' and ' $\frac{1}{4}$ full' stomachs (combined) were more than 50%.



Text-fig. 1. Monthly percentage frequency of different feeding intensities in *Carangoides malabaricus*

The empty stomachs were found commonly in all the months of year and their percentages were more in the months of July, August and September which was the major spawning period for this species along Porto Novo coast (Venkataramani, 1979).

Alepes kalla

Food composition : The food components of *A. kalla* were grouped under six major categories i. e., crustaceans, fishes, molluscs, foraminifers, polychaetes and diatoms. Among crustaceans, copepods, *Lucifer* spp., *Acetes* spp. and crab larvae comprised the major food items. Among fishes it showed preference to *Leiognathus* spp. and *Thryssa* spp. Among molluscs *Cresis* spp. was preferred in certain months. Polychaetes, foraminifers, and diatoms appeared in traces.

Kagwade (1971) while studying the food habits of *Alepes kalla* (= *Caranx kalla* Cuv. and Val.) from the west coasts of India observed the occurrence of crustaceans as major food. Fishes were rare in his observation but in the present study they ranked next to crustaceans. Molluscs ranked next to crustaceans in his observation, which were rare in the present study except *Cresis* spp. which formed appreciable amount only during certain months. Dinoflagellates observed by Kagwade (1971) were not recorded presently.

Food of juveniles and adults : In order to know the variations in the food of juveniles and adults, their stomach contents were analysed separately (Tables 3 & 4).

From the results, it can be seen that juveniles preyed mainly upon planktonic crustaceans particularly *Lucifer* spp., *Acetes* spp. copepods and crab larvae. Teleosts, foraminifers and molluscs formed only a minor part of its food.

The results showed no significant variations in the food of males and females. Both the sexes preferred *Acetes* spp., copepods, *Squilla* larvae, crab larvae, *Lucifer* spp., *Leiognathus* spp., *Thryssa* spp. and *Johnius* spp. *Cresis* spp. formed a moderate amount in April for both sexes. Other food items were found in traces.

Seasonal variations in the food of juveniles and adults : Seasonal variations in the food of juveniles and adults of *A. kalla* were presented in Tables 5 and 6.

The juveniles seem to feed mostly on crustaceans like *Lucifer* spp., copepods, *Acetes* spp. and crab larvae during all the months. Fishes formed only a minor part of food in certain months of the year.

The adults also, like juveniles, were found to feed mostly on *Acetes* spp., *Lucifer* spp., copepods. *Squilla* larvae and larval crabs formed major bulk of the food in November and December. Copepods, *Acetes* spp. and crab larvae formed major bulk of the food in October. *Acetes* spp. was the most common food from June to October with peaks in July and September. *Lucifer* spp. formed the major food item in May. Copepods and *Cresis* spp. were found in appreciable quantities, in April, copepods and *Leiognathus* spp. in March and *Squilla* larvae and crab larvae in February and January.

Among fishes, juveniles of *Thryssa* spp., *Johnius* spp. and *Leiognathus* spp. were found in appreciable quantities in certain months of the year. Other teleostean fishes, molluscs, diatoms, polychaetes and foraminifers were recorded in lesser quantities.

Copepods were found to be one of the main food items of this species as observed by Kagwade (1971) from the west coast of India. The occurrence of *Acetes* spp. was encountered only in August by Kagwade (1971) in adults. Presently *Acetes* spp. was found to be the major bulk of the food in adults and in juveniles. Fishes were considered as of minor importance in the observation of Kagwade (1971), but in the present study, fishes were next in importance to crustaceans. *Leiognathus* spp. and *Thryssa* spp. were found in moderate amounts in the gut contents. The occurrence of fishes was more in adults compared to juveniles.

Food preference during maturity stages

MALES

Copepods and *Lucifer* spp. formed the major food items of specimens with immature testis. *Thryssa* spp. and *Lucifer* spp. appeared as major food items in specimens with maturing testis. *Leiognathus* spp. and *Squilla* larvae were more in mature specimens and in spent and recovering specimens *Acetes* spp. and *Squilla* larvae formed major food items (Table 7).

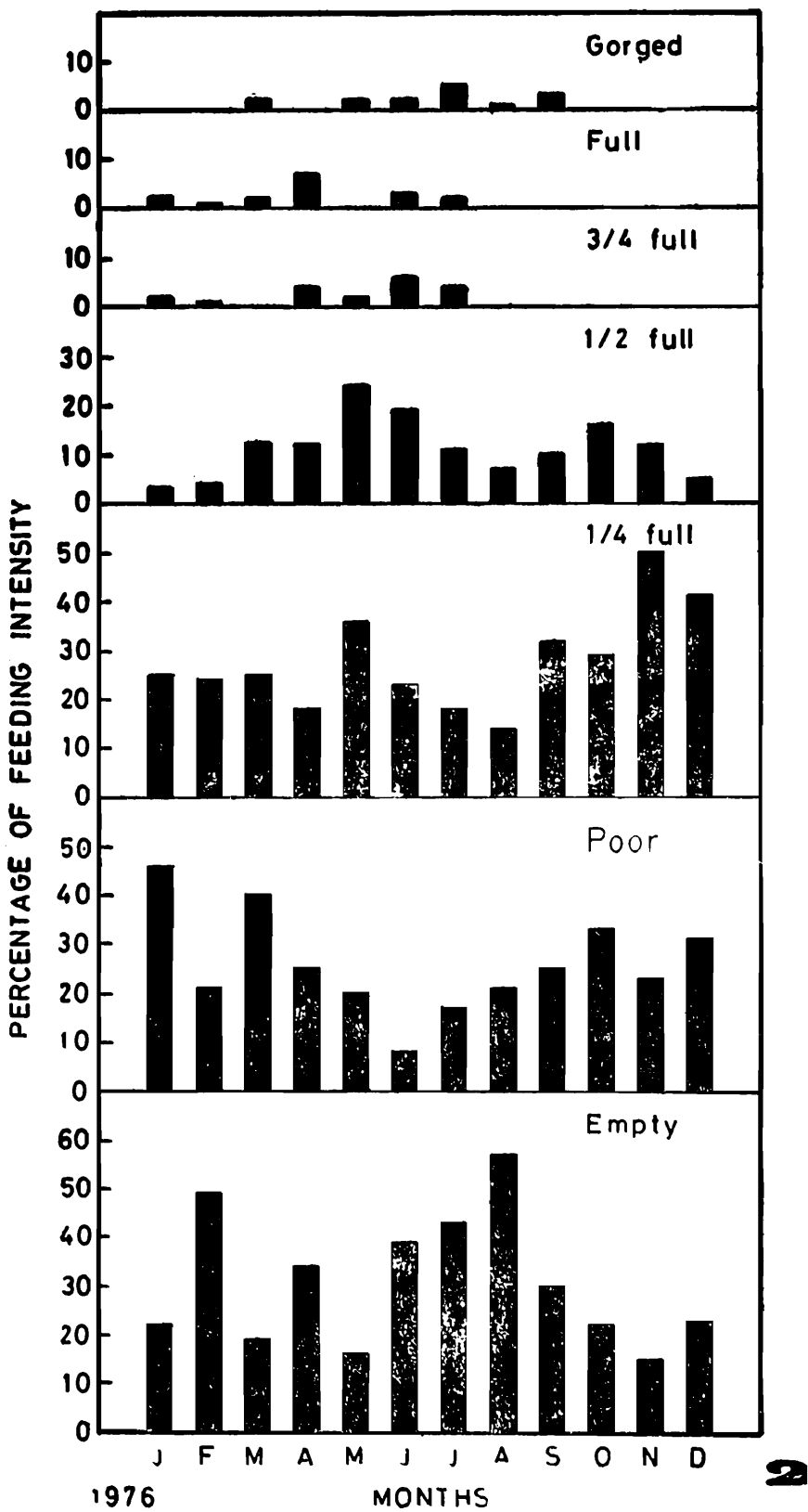
FEMALES

Specimens with immature and maturing ovaries fed more on *Acetes* spp. and *Lucifer* spp. specimens with mature ovaries fed more on *Squilla* larvae and specimens with spent and recovering ovaries fed on *Acetes* spp. and *Squilla* larvae. During advanced maturity stages of the ovary, only empty stomachs with little mucus were encountered (Table 8).

Feeding intensity : The feeding intensity during different months was shown in Text-fig. 1. In *A. kalla* the percentages of 'gorged' 'full' and

' $\frac{3}{4}$ full' were much less. The ' $\frac{1}{2}$ full' and ' $\frac{1}{2}$ full' (combined) were more than 50% and were more than stomachs with 'little' food during most of the months.

The empty stomachs appeared in higher percentage during major spawning season from June to August and in February (Venkataramani, 1979). Similar observation has been made by Kagwade (1971) also in this species during peak spawning season from Calicut waters.



Text-fig]2. Monthly percentage frequency of different feeding intensities in *Alepes kalla*

GENERAL REMARKS

From the above observations, it is evident that juveniles and adults of both the species are carnivores, planktonic crustaceans being the major food items supplemented by juvenile teleostean fishes in adults. The molluscs, diatoms, polychaetes and foraminifers were rarely eaten. The present observation on the food habits of the two species were in agreement with other carangid species studied by Chacko (1949), Datar (1954), Tandon (1960) and Kagwade (1971).

No plant material was recorded presently in the gut contents of both the species as also by earlier workers in other carangid species (Lebour, 1918 ; Chacko, 1949 ; Tham Ahkow, 1950 ; Datar, 1954 ; Mitani, 1960 ; Bellinger and Avault, 1971 ; Kagwade, 1971 ; Sreenivasan, 1974). But Tandon (1960) and Chabanne Jacques (1972) recorded vegetable matter in *S. leptolepis* and *Caranx* spp. respectively.

Reuben (1968) in his preliminary study on the food of *C. malabaricus* recorded euphausiids on examining 24 specimens from Waltair (North east coast of India). Presently on examining more than 1200 specimens, euphausiids could not be found in the gut contents.

In both the species teeth were minute though pharyngeal teeth were well developed. Well developed gill rakers and minute teeth indicate that *A. kalla* and *C. malabaricus* were adapted to feed mainly on smaller organisms, as confirmed by the present and earlier observations. Thus, *A. kalla* and *C. malabaricus* are primary carnivores feeding mainly on crustaceans and juvenile fishes.

The stomach with 'little' food was recorded during all the months. This may be due to the fact that most of the specimens were examined from commercial landings in the morning from 7 to 11 a. m. This suggests the possibility of the fish feeding during the night and the process of digestion being much advanced by the time they were obtained in the commercial catches. Hence the occurrence of food items in most of the stomachs in partially digested condition.

In the present investigation empty stomachs were recorded during all the months. Such frequent occurrence of empty stomachs is dependent on the ratio between the size of the fish and size of the prey as cited by Allen (1935) or on the calorific value of the diet as explained by Longhurst (1957). Presently, in all fully matured specimens in both the species, stomachs were found to be empty containing little mucus. This suggests that the voluminous ripe ovaries press on the wall of the stomach leaving them empty (Thomas, 1969 ; Sobhana, 1976). Hence in the major spawning months in both the species, empty stomachs appear in good percentages.

TABLE 1. Percentage of index of various food items of *C. malabaricus* during different months of the year 1976. (M-Male ; F-Female ; J-Juvenile)

Food items	January			February		
	M	F	J	M	F	J
Lucifer	—	1.60	—	—	0.86	5.98
Crab larva	—	0.53	—	—	—	—
Prawn larva	9.17	7.48	30.00	3.94	0.69	61.56
Prawn	17.44	3.91	—	10.10	3.44	—
Acetes	31.38	12.10	35.00	3.00	0.39	13.67
Copepods	—	—	—	0.78	3.05	—
Amphipods	—	—	—	3.42	—	—
Cymathoa	0.35	—	—	—	—	—
Mysids	—	1.07	—	0.52	—	13.67
Squilla larva	0.09	—	10.01	—	—	—
Fish larvae	—	—	—	—	—	—
Sciaenids	—	—	—	1.18	0.62	—
Caranx	—	—	—	0.26	0.37	—
Gobids	—	—	—	2.29	—	—
Leiognathus	0.27	25.69	—	20.46	12.15	—
Drepane	—	—	—	13.06	1.84	—
Pomadasys	0.80	1.07	—	—	1.66	—
Stolephorus	7.69	8.89	—	—	55.27	5.12
Johnius	—	—	—	—	0.37	—
Thryssa	16.23	—	—	26.24	8.17	—
Gazza	—	—	—	—	1.54	—
Thrissina	0.36	34.80	—	—	—	—
Setipinna	—	—	—	0.53	—	—
Pterois	—	—	—	—	0.80	—
Trichiurus	—	0.19	22.49	—	0.62	—
Lutjanids	—	—	—	2.10	0.62	—
Therapon	—	—	—	2.10	—	—
Alepes	—	—	—	—	—	—
Cepola	—	—	—	1.05	—	—
"Fishes"	1.76	1.60	2.50	3.28	1.54	—
Platycephalus	—	—	—	—	0.18	—
Bivalve juveniles	—	—	—	1.04	1.18	—
Donax	—	—	—	—	—	—
Gastropod juveniles	—	—	—	0.91	1.37	—
Sepia	—	0.89	—	—	—	—
Gastropod veligers	—	—	—	1.18	—	—
Turritella	—	0.18	—	—	—	—
Polychaetes	0.70	—	—	0.52	—	—
Diatoms	—	—	—	—	—	—
Foraminifers	13.75	—	—	1.32	2.59	—

TABLE 1. *Continued*

Food items	March			April		
	M	F	J	M	F	J
Lucifer	0.31	—	—	93.24	26.50	6.87
Crab larva	—	4.70	—	—	—	—
Prawn larva	13.76	9.41	0.67	—	0.85	0.36
Prawn	—	—	—	—	0.48	16.78
Acetes	—	32.95	26.68	2.96	1.20	39.45
Copepods	0.29	14.11	0.26	0.43	4.81	0.18
Amphipods	0.08	—	—	—	0.36	—
Cymathoa	—	—	—	—	—	—
Mysids	45.63	17.64	72.25	1.40	31.24	26.96
Squilla larva	—	—	0.07	—	—	0.67
Fish larvae	—	—	—	—	—	—
Sciaenids	—	—	—	—	—	—
Caranx	—	—	—	—	—	—
Gobids	—	—	—	—	—	0.27
Leiognathus	38.59	—	0.07	—	—	—
Drepane	—	—	—	—	—	—
Pomadourys	—	—	—	—	—	—
Stolephorus	0.21	—	—	—	—	1.41
Johnius	—	—	—	—	—	2.79
Thryssa	0.21	21.19	—	0.17	32.62	4.47
Gazza	—	—	—	—	—	—
Thrissina	—	—	—	—	—	—
Setipinna	—	—	—	—	—	—
Pterois	—	—	—	—	—	—
Trichiurus	0.42	—	—	—	—	0.20
Lutjanids	—	—	—	—	—	—
Therapon	—	—	—	—	—	—
Alepes	—	—	—	1.80	—	—
Cepola	0.05	—	—	—	—	—
"Fishes"	—	—	—	—	0.96	0.09
Platycephalus	—	—	—	—	—	—
Bivalve juveniles	0.08	—	—	—	—	—
Donax	—	—	—	—	—	—
Gastropod juveniles	—	—	—	—	—	—
Sepia	—	—	—	—	—	—
Gastropod veligers	0.21	—	—	—	0.98	—
Turritella	—	—	—	—	—	—
Cresis	—	—	—	—	—	—
Polychaetes	0.16	—	—	—	—	—
Diatoms	—	—	—	—	—	—
Foraminifers	—	—	—	—	—	—

TABLE 1. *Continued*

Food items	May			June		
	M	F	J	M	F	J
Lucifer	64.41	81.50	45.77	3.27	1.47	0.15
Crab larva	—	—	0.05	0.40	0.03	0.12
Prawn larva	—	—	—	5.56	0.15	1.38
Prawn	0.54	—	0.40	0.97	0.10	0.20
Acetes	11.41	16.09	22.37	39.75	97.70	92.91
Copepod	0.27	—	—	—	0.04	—
Amphipod	—	—	—	—	—	—
Cymatoda	—	—	—	—	—	—
Mysids	16.31	0.50	31.13	19.62	0.28	4.60
Squilla larva	0.61	0.72	0.14	29.44	0.12	0.62
Fish larvae	0.47	—	—	—	—	—
Sciaenids	—	—	—	—	0.02	—
Caranx	—	—	—	—	—	—
Gobids	—	—	—	—	—	—
Leiognathus	—	—	—	—	—	—
Drepane	—	—	—	—	—	—
Pomadasys	—	—	—	—	—	—
Stolephorus	5.91	0.54	—	—	—	—
Johnius	—	—	—	—	—	—
Thryssa	—	0.57	—	0.66	0.02	—
Gazza	—	—	—	—	—	—
Thrissina	—	—	—	—	—	—
Setipinna	—	—	—	—	—	—
Pterois	—	—	—	—	—	—
Trichiurus	—	—	—	—	—	—
Lutjanids	—	—	—	—	—	—
Therapon	—	—	—	—	—	—
Alepes	—	—	—	—	—	—
Cepola	—	—	—	—	—	—
"Fishes"	0.07	0.08	0.14	0.33	—	0.02
Platycephalus	—	—	—	—	—	—
Bivalve juveniles	—	—	—	—	—	—
Donax	—	—	—	—	—	—
Gastropod juveniles	—	—	—	—	0.06	—
Sepia	—	—	—	—	—	—
Gastropod veligers	—	—	—	—	—	—
Turritella	—	—	—	—	—	—
Cresis	—	—	—	—	—	—
Polychaetes	—	—	—	—	—	—
Diatoms	—	—	—	—	—	—
Foraminifers	—	—	—	—	—	—

TABLE 1. *Continued*

Food items	July			August		
	M	F	J	M	F	J
Lucifer	57.55	3.04	—	93.14	—	—
Orab larva	—	—	—	—	—	—
Prawn larva	—	—	—	—	—	—
Prawn	20.23	4.29	—	—	0.38	—
Acetes	9.07	89.86	35.50	1.74	84.97	—
Copepods	0.22	—	—	0.18	0.78	—
Amphipods	—	0.09	—	0.06	—	—
Cymathoa	—	—	—	—	—	—
Mysids	3.79	1.05	62.13	4.88	11.14	—
Squilla larva	—	—	—	—	—	—
Fish larvae	—	—	—	—	0.78	—
Sciaenids	—	0.04	—	—	0.65	—
Caranx	—	0.04	—	—	—	—
Gobids	—	—	—	—	—	—
Leiognathus	—	—	—	—	—	—
Drepane	—	—	—	—	—	—
Pomadasy	—	—	—	—	—	—
Stolephorus	1.04	—	—	—	—	—
Johnius	—	—	—	—	—	—
Thryssa	1.63	—	—	—	0.26	—
Gazza	—	—	—	—	—	—
Thrissina	—	—	—	—	—	—
Setipinna	—	—	—	—	—	—
Pterois	—	—	—	—	—	—
Trichiurus	—	—	—	—	—	—
Lutjanids	—	—	—	—	—	—
Therapon	—	—	—	—	—	—
Alepes	—	—	—	—	—	—
Cepola	—	—	—	—	—	—
"Fishes"	—	—	—	—	—	—
Platycephalus	—	—	—	—	—	—
Bivalve juveniles	—	—	—	—	—	—
Donax	—	—	—	—	—	—
Gastropod juveniles	—	0.11	—	—	—	—
Sepia	—	—	—	—	—	—
Gastropod veligers	—	—	—	—	—	—
Turritella	—	—	—	—	—	—
Greeis	1.04	0.21	—	—	—	—
Polychaetes	—	—	—	—	1.04	—
Diatoms	0.45	—	—	—	—	—
Foraminifers	4.98	1.28	2.37	—	—	—

TABLE 1. *Continued*

Food items	September			October		
	M	F	J	M	F	J
Lucifer	0.35	22.65	0.64	—	31.70	1.28
Crab larva	—	0.89	—	—	—	—
Prawn larva	—	0.33	—	—	—	—
Prawn	—	1.77	2.03	—	—	3.24
<i>Acetes</i>	82.64	56.61	48.03	13.74	8.12	79.16
Copepods	1.20	—	4.07	3.92	—	3.19
Amphipods	9.00	8.00	1.78	—	—	0.22
Cymathoa	—	—	—	—	—	—
Mysids	1.20	4.88	41.68	44.43	0.97	9.46
<i>Squilla larva</i>	5.61	4.43	—	—	—	0.15
Fish larvae	—	—	1.02	—	—	—
Sciaenids	—	—	—	—	—	—
<i>Caranx</i>	—	—	—	—	13.03	—
Gobids	—	0.44	—	—	—	—
<i>Leiognathus</i>	—	—	—	—	—	—
<i>Drepane</i>	—	—	—	—	—	—
<i>Pomadasys</i>	—	—	—	—	—	—
<i>Stolephorus</i>	—	—	—	3.92	0.64	0.64
<i>Johnius</i>	—	—	—	—	—	—
<i>Thryssa</i>	—	—	—	2.61	41.44	0.12
<i>Gazza</i>	—	—	—	—	—	—
<i>Thrissina</i>	—	—	—	—	—	—
<i>Setipinna</i>	—	—	—	—	—	—
<i>Pterois</i>	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	—	—
Lutjanids	—	—	—	—	—	—
<i>Therapon</i>	—	—	—	0.65	—	—
<i>Alepes</i>	—	—	—	—	—	—
<i>Cepola</i>	—	—	—	—	—	—
"Fishes"	—	—	0.50	0.65	0.70	0.09
<i>Platycephalus</i>	—	—	—	—	—	—
Bivalve juveniles	—	—	—	—	—	0.05
<i>Donax</i>	—	—	—	—	—	—
Gastropod juveniles	—	—	—	—	—	—
<i>Sepia</i>	—	—	—	—	—	—
Gastropod veligers	—	—	—	—	—	—
<i>Turritella</i>	—	—	—	—	—	—
<i>Cresis</i>	—	—	—	10.46	2.27	2.00
Polychaetes	—	—	0.25	1.31	—	—
Diatoms	—	—	—	—	—	—
Foraminifers	—	—	—	18.31	1.13	0.40

TABLE 1. *Concluded*

Food items	November			December		
	M	F	J	M	F	J
Lucifer	—	0.68	0.16	0.38	0.17	0.66
Crab larva	—	—	—	—	—	—
Prawn larva	0.18	30.19	0.18	13.89	0.59	30.31
Prawn	0.12	7.28	0.19	4.95	5.50	0.33
<i>Acetes</i>	93.95	10.05	88.01	61.73	87.31	30.18
Copepods	0.09	0.58	—	0.51	—	—
Amphipods	—	5.41	0.21	5.41	0.03	—
Cymathoa	—	—	—	—	0.04	—
Mysids	0.28	29.60	6.42	7.84	1.04	8.45
<i>Squilla</i> larva	0.02	—	0.03	0.06	0.12	0.82
Fish larvae	—	—	—	—	—	—
Sciaenids	—	1.17	0.14	—	—	4.97
<i>Caranx</i>	—	—	—	—	—	1.25
Gobids	—	0.10	—	—	—	1.99
<i>Leiognathus</i>	4.05	11.70	0.96	—	3.34	12.93
<i>Drepane</i>	—	—	—	—	—	0.08
<i>Pomadasys</i>	—	—	—	—	—	1.74
<i>Stolephorus</i>	0.07	0.19	0.46	—	—	—
<i>Johnius</i>	—	—	—	—	—	—
<i>Thryssa</i>	1.23	0.97	2.27	0.06	0.47	1.00
<i>Gazza</i>	—	—	—	2.33	—	—
<i>Thrissina</i>	—	—	—	—	0.62	—
<i>Setipinna</i>	—	—	0.55	—	—	—
<i>Pterois</i>	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	0.07	—
Lutjanids	—	—	—	—	—	—
<i>Therapon</i>	—	—	—	—	—	—
<i>Alepes</i>	—	—	—	—	—	—
<i>Cepola</i>	—	—	—	—	—	0.82
"Fishes"	—	0.39	0.18	2.58	0.04	2.98
<i>Platycephalus</i>	—	—	0.18	—	—	—
Bivalve juveniles	—	—	—	—	—	0.34
<i>Donax</i>	—	—	—	—	—	—
Gastropod juveniles	—	—	—	—	—	—
<i>Sepia</i>	—	—	—	—	—	—
Gastropod veligers	—	—	—	—	—	—
<i>Turritella</i>	0.01	—	—	—	—	—
<i>Cresis</i>	—	0.77	—	—	—	—
Polychaetes	—	—	—	0.26	0.03	—
Diatoms	—	—	—	—	—	—
Foraminifers	—	0.92	—	—	0.13	0.53

TABLE 2. Ranks obtained by the various food items of *C. malabaricus* during different months of the year 1976.

Food items	January			February		
	M	F	J	M	F	J
<i>Lucifer</i>	—	7	—	—	17	3
Crab larva	—	10	—	—	—	—
Prawn larva	5	5	2	5	13	1
Prawn	2	6	—	4	4	—
<i>Acetes</i>	1	3	1	8	15	2
Copepods	—	—	—	16	5	—
Amphipods	—	—	—	6	—	—
Cymathoa	10	—	—	—	—	—
Mysids	—	8	—	—	—	—
<i>Squilla</i> larva	12	—	4	19	—	2
Fish larva	—	—	—	—	—	—
Sciaenids	—	—	—	12	14	—
<i>Caranx</i>	—	—	—	20	16	—
Gobids	—	—	—	9	—	—
<i>Leiognathus</i>	11	2	—	2	2	—
<i>Drepane</i>	—	—	—	—	7	—
<i>Pomadasys</i>	8	8	—	3	8	—
<i>Stolephorus</i>	6	4	—	—	1	4
<i>Johnius</i>	—	—	—	—	16	—
<i>Thryssa</i>	3	—	—	1	3	—
<i>Gazza</i>	—	—	—	—	9	—
<i>Thrissina</i>	10	1	—	—	—	—
<i>Setipinna</i>	—	—	—	18	—	—
<i>Pterois</i>	—	—	—	—	12	—
<i>Trichiurus</i>	—	11	3	—	14	—
Lutjanids	—	—	—	10	14	—
<i>Therapon</i>	—	—	—	10	—	—
<i>Alepes</i>	—	—	—	—	—	—
<i>Cépola</i>	—	—	—	13	—	—
<i>Platycephalus</i>	—	—	—	—	18	—
"Fishes"	7	7	5	7	9	—
Bivalve juveniles	—	—	—	14	11	—
<i>Donax</i>	—	—	—	—	—	—
Gastropod juveniles	—	—	—	15	10	—
<i>Sepia</i>	—	9	—	—	—	—
Gastropod veligers	—	—	—	12	—	—
<i>Turritella</i>	—	12	—	—	—	—
Oresis	—	—	—	17	11	—
Polychaets	9	—	—	19	—	—
Diatoms	—	—	—	—	—	—
Foraminifers	4	—	—	11	6	—

TABLE 2. *Continued*

Food items	March			April		
	M	F	J	M	F	J
<i>Lucifer</i>	5	—	—	1	3	4
Crab larva	—	6	—	—	—	—
Prawn larva	3	5	3	—	8	9
Prawn	—	—	—	—	9	3
<i>Acetes</i>	—	1	2	2	5	1
Copepods	6	—	4	5	4	12
Amphipods	9	4	—	—	10	—
Cymathoa	—	—	—	—	—	—
Mysids	1	3	1	4	2	2
<i>Squilla</i> larva	—	—	5	—	—	8
Fish larva	—	—	—	—	—	—
Sciaenids	—	—	—	—	—	—
<i>Caranx</i>	—	—	—	—	—	—
Gobids	—	—	—	—	—	10
<i>Leiognathus</i>	2	—	5	—	—	—
<i>Drepane</i>	—	—	—	—	—	—
<i>Pomadasys</i>	—	—	—	—	—	—
<i>Stolephorus</i>	7	—	—	—	—	7
<i>Johnius</i>	—	—	—	—	—	6
<i>Thryssa</i>	7	2	—	6	1	5
<i>Gazza</i>	—	—	—	—	—	—
<i>Thrissina</i>	—	—	—	—	—	—
<i>Setipinna</i>	—	—	—	—	—	—
<i>Pterois</i>	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	—	11
Lutjanids	4	—	—	—	—	—
<i>Therapon</i>	—	—	—	—	—	—
<i>Alepes</i>	—	—	—	3	—	—
<i>Cepola</i>	10	—	—	—	—	—
<i>Platycephalus</i>	—	—	—	—	—	—
"Fishes"	—	—	—	—	7	13
Bivalve juveniles	9	—	—	—	—	—
<i>Donax</i>	—	—	—	—	—	—
Gastropod juveniles	—	—	—	—	—	—
<i>Sepia</i>	—	—	—	—	—	—
Gastropod veligers	7	—	—	6	—	—
<i>Turritella</i>	—	—	—	—	—	—
Oresis	—	—	—	—	—	—
Polychaetes	8	—	—	—	—	—
Diatoms	—	—	—	—	—	—
Foraminifer	—	—	—	—	—	—

TABLE 2. *Continued*

Food items	May			June		
	M	F	J	M	F	J
<i>Lucifer</i>	1	1	1	5	2	6
Crab larva	—	—	6	8	9	7
Prawn larva	—	—	—	4	4	3
Prawn	6	—	4	6	6	5
<i>Acetes</i>	3	2	3	1	1	1
Copepods	8	—	—	—	8	—
Amphipods	—	—	—	—	—	—
Cymathoa	—	—	—	—	—	—
Mysids	2	6	2	3	3	2
<i>Squilla</i> larva	5	3	5	2	5	4
Fish larva	7	—	—	—	—	—
Sciaenids	—	—	—	—	10	—
<i>Caranx</i>	—	—	—	—	—	—
Gobids	—	—	—	—	—	—
<i>Leioqnathus</i>	—	—	—	—	—	—
<i>Drepane</i>	—	—	—	—	—	—
<i>Pomadasys</i>	—	—	—	—	—	—
<i>Slotephorus</i>	4	5	—	—	—	—
<i>Johnius</i>	—	—	—	—	—	—
<i>Thryssa</i>	—	4	—	7	10	—
<i>Gazza</i>	—	—	—	—	—	—
<i>Thrissina</i>	—	—	—	—	—	—
<i>Setipinna</i>	—	—	—	—	—	—
<i>Pterois</i>	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	—	—
Lutjanids	—	—	—	—	—	—
<i>Therapon</i>	—	—	—	—	—	—
<i>Alepes</i>	—	—	—	—	—	—
<i>Cepola</i>	—	—	—	—	—	—
<i>Platycephalus</i>	—	—	—	—	—	—
"Fishes"	9	7	5	9	—	8
Bivalve juveniles	—	—	—	—	—	—
<i>Donax</i>	—	—	—	—	—	—
Gastropod juveniles	—	—	—	—	7	—
<i>Sepia</i>	—	—	—	—	—	—
Gastropod veligers	—	—	—	—	—	—
<i>Turritella</i>	—	—	—	—	—	—
Cresis	—	—	—	—	—	—
Polychaetes	—	—	—	—	—	—
Diatoms	—	—	—	—	—	—
Foraminifers	—	—	—	—	—	—

TABLE 2 *Continued*

Food items	July			August		
	M	F	J	M	F	J
<i>Lucifer</i>	1	3	—	1	—	—
Crab larva	—	—	—	—	—	—
Prawn larva	—	—	—	—	—	—
Prawn	2	2	—	—	6	—
<i>Acetes</i>	3	1	2	3	1	—
Copepods	9	—	—	4	4	—
Amphipods	—	8	—	5	—	—
Cymathoa	—	—	—	—	—	—
Mysids	5	5	1	2	2	—
<i>Squilla</i> larva	—	—	—	—	—	—
Fish larva	—	—	—	—	4	—
Sciaenids	—	9	—	—	5	—
<i>Caranx</i>	—	9	—	—	—	—
Gobids	—	—	—	—	—	—
<i>Leiognathus</i>	—	—	—	—	—	—
<i>Drepane</i>	—	—	—	—	—	—
<i>Pomadasys</i>	—	—	—	—	—	—
<i>Stolephorus</i>	7	—	—	—	—	—
<i>Johnius</i>	—	—	—	—	—	—
<i>Thryssa</i>	6	—	—	—	7	—
<i>Gazza</i>	—	—	—	—	—	—
<i>Thrissina</i>	—	—	—	—	—	—
<i>Setipinna</i>	—	—	—	—	—	—
<i>Pterois</i>	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	—	—
Lutjanids	—	—	—	—	—	—
<i>Therapon</i>	—	—	—	—	—	—
<i>Alepes</i>	—	—	—	—	—	—
<i>Cepola</i>	—	—	—	—	—	—
<i>Platycephalus</i>	—	—	—	—	—	—
"Fishes"	—	—	—	—	—	—
Bivalve juveniles	—	—	—	—	—	—
<i>Donax</i>	—	—	—	—	—	—
Gastropod juveniles	—	7	—	—	—	—
<i>Sepia</i>	—	—	—	—	—	—
Gastropod veligers	—	—	—	—	—	—
<i>Turritella</i>	—	—	—	—	—	—
Ostris	7	6	—	—	—	—
Polychaetes	—	—	—	—	3	—
Diatoms	8	—	—	—	—	—
Foraminifers	4	4	3	—	—	—

TABLE 2 *Continued*

Food items	September			October		
	M	F	J	M	F	J
<i>Lucifer</i>	5	2	7	—	2	6
Crab larva	—	7	—	—	—	—
Prawn larva	—	9	—	—	—	—
Prawn	—	6	4	—	—	3
<i>Aceles</i>	1	1	1	3	4	1
Copepods	4	—	3	5	—	4
Amphipods	2	3	5	—	—	9
Cymathoa	—	—	—	—	—	—
Mysids	4	4	2	1	7	2
<i>Squilla</i> larva	3	5	—	—	—	10
Fish larva	—	—	6	—	—	—
Sciaenids	—	—	—	—	—	—
<i>Caranx</i>	—	—	—	—	3	—
Gebids	—	8	—	—	—	—
<i>Leiognathus</i>	—	—	—	—	—	—
<i>Drepane</i>	—	—	—	—	—	—
<i>Pomadasys</i>	—	—	—	—	—	—
<i>Stolephorus</i>	—	—	—	5	9	7
<i>Johnius</i>	—	—	—	—	—	—
<i>Thryssa</i>	—	—	—	6	1	11
<i>Gazza</i>	—	—	—	—	—	—
<i>Thrissina</i>	—	—	—	—	—	—
<i>Setipinna</i>	—	—	—	—	—	—
<i>Pterois</i>	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	—	—
Lutjanids	—	—	—	—	—	—
<i>Therapon</i>	—	—	—	8	—	—
<i>Alepes</i>	—	—	—	—	—	—
<i>Cepola</i>	—	—	—	—	—	—
<i>Platycephalus</i>	—	—	—	—	—	—
"Fishes"	—	—	8	8	8	12
Bivalve juveniles	—	—	—	—	—	13
<i>Donax</i>	—	—	—	—	—	—
Gastropod juveniles	—	—	—	—	—	—
<i>Sepia</i>	—	—	—	—	—	—
Gastropod veligers	—	—	—	—	—	—
<i>Turritella</i>	—	—	—	—	—	—
Oresis	—	—	—	4	5	5
Polychaetes	—	—	9	7	—	—
Diatoms	—	—	—	—	—	—
Foraminifers	—	—	—	2	6	8

TABLE 2 *Concluded*

Food items	November			December		
	M	F	J	M	F	J
<i>Lucifer</i>	—	11	10	9	8	12
Carb larva	—	—	—	—	—	—
Prawn larva	5	1	9	2	6	2
Prawn	6	5	8	5	2	14
<i>Acetes</i>	1	4	1	1	1	1
Copepods	7	12	—	8	—	—
Amphipods	—	6	7	4	13	—
Cymathoa	—	—	—	—	12	—
Mysids	4	2	2	3	4	4
<i>Squilla</i> larva	9	—	12	11	10	11
Fish larva	—	—	—	—	—	—
Sciaenids	—	7	11	—	—	5
<i>Caranx</i>	—	—	—	—	—	9
Gobids	—	15	—	—	—	7
<i>Leiognathus</i>	2	3	4	—	3	3
<i>Drepane</i>	—	—	—	—	—	15
<i>Pomadasys</i>	—	—	—	—	—	8
<i>Stolephorus</i>	8	14	6	—	—	—
<i>Johnius</i>	—	—	—	—	—	—
<i>Thryssa</i>	3	8	3	11	7	10
<i>Gazza</i>	—	—	—	7	—	—
<i>Thrissina</i>	—	—	—	—	5	—
<i>Setipinna</i>	—	—	5	—	—	—
<i>Pterois</i>	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	11	—
Lutjanids	—	—	—	—	—	—
<i>Therapon</i>	—	—	—	—	—	—
<i>Alepes</i>	—	—	—	—	—	—
<i>Cepola</i>	—	—	—	—	—	—
<i>Platycephalus</i>	—	—	9	—	—	11
"Fishes"	—	13	9	6	12	6
Bivalve juvenile	—	—	—	—	—	14
<i>Donax</i>	—	—	—	—	—	—
Gastropod juveniles	—	—	—	—	—	—
<i>Sepia</i>	—	—	—	—	—	—
Gastropod veligers	—	—	—	—	—	—
<i>Turritella</i>	10	—	—	—	—	—
<i>Cresis</i>	—	10	—	—	—	—
Polychaetes	—	—	—	10	13	—
Diatoms	—	—	—	—	—	—
Foraminifers	—	9	—	—	9	13

TABLE 3. Percent index of various food of *C. malabaricus* in different maturity stages—female.

Food items	Immature		Maturing		Mature		Spent & spent recovering	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank
<i>Lucifer</i>	5.07	3	5.82	5	24.57	2	—	—
Crab larva	0.17	18	—	—	0.54	16	—	—
Prawn larva	0.56	15	0.54	9	1.31	11	2.29	6
Prawn	10.54	2	31.86	2	0.95	14	6.85	4
<i>Acetes</i>	66.43	1	32.73	1	36.69	1	23.94	3
Copepods	0.56	15	0.17	13	1.13	13	0.07	12
Amphipods	0.43	16	0.32	12	0.90	15	0.06	13
Mysids	3.26	4	2.88	6	8.11	3	2.52	5
<i>Squilla</i> larva	1.68	6	—	—	2.14	8	—	—
Fish larva	0.12	20	—	—	—	—	—	—
Sciaenids	0.80	12	0.16	14	1.26	12	0.10	10
<i>Caranx</i>	0.16	19	0.11	15	2.03	9	—	—
Gobid	0.10	—	—	—	—	—	—	—
<i>Leiognathus</i>	1.59	7	15.57	3	3.88	5	30.46	1
<i>Drepane</i>	0.03	22	0.06	18	—	—	—	—
Pomadasyds	0.87	10	0.11	15	—	—	0.08	11
<i>Stolephorus</i>	—	—	0.33	11	2.99	6	29.29	2
<i>Johnius</i>	1.46	8	—	—	2.86	7	—	—
<i>Thryssa</i>	1.07	9	6.18	4	7.77	4	2.29	6
<i>Gazza</i>	1.74	5	—	—	—	—	—	—
<i>Thrissina</i>	0.67	14	0.08	16	—	—	0.76	8
<i>Setipinna</i>	0.32	—	—	—	—	—	—	—
<i>Pterois</i>	—	—	0.08	16	—	—	—	—
<i>Trichiurus</i>	—	—	0.43	10	—	—	0.11	9
Lutjanids	—	—	0.16	14	0.06	18	—	—
<i>Therapon</i>	—	—	—	—	0.06	18	—	—
"Fishes"	0.67	14	0.06	17	—	—	0.06	13
Bivalve								
juveniles	—	—	—	—	0.84	16	—	—
Gastropod								
juveniles	0.13	21	—	—	—	—	—	—
<i>Sepia</i>	—	—	—	—	—	—	0.08	—
Gastropod								
veligers	—	—	0.11	15	—	—	—	—
<i>Turritella</i>	—	—	—	—	—	—	0.02	15
<i>Cresis</i>	0.75	13	0.79	8	—	—	—	—
polychaetes	—	—	—	—	0.48	17	0.05	15
Foramini- fers	0.82	11	1.25	7	1.43	10	0.97	7

TABLE 4. Percentage index of various food items of *C. malabaricus* in different maturity stages—male.

[illegible]

TABLE 5. Percentage of index of various food items of *A. kalla* during different months of the year 1976. (M-Male ; F-Female ; J-Juvenile).

Food items	January			February		
	M	F	J	M	F	J
<i>Lucifer</i>	—	—	—	—	6.64	—
Crab larva	15.51	28.46	—	28.09	2.83	—
Prawn larva	—	0.06	—	5.77	—	—
Prawn	0.22	0.03	—	53.82	9.64	—
<i>Acetes</i>	0.68	29.17	—	13.47	—	—
Copepods	0.84	0.21	—	—	—	—
Amphipods	0.22	0.80	—	—	0.78	—
Cymathoa	—	—	—	—	3.86	—
Mysids	—	0.16	—	—	—	—
<i>Squilla</i> larva	11.12	39.35	—	0.64	48.16	—
Fish larva	0.45	—	—	—	—	—
Sciaenids	—	0.13	—	—	—	—
<i>Leiognathus</i>	2.01	0.03	—	—	0.77	—
<i>Pomadasys</i>	—	—	—	—	—	—
<i>Stolephorus</i>	2.67	—	—	—	—	—
<i>Johnius</i>	3.34	—	—	—	23.12	—
<i>Thryssa</i>	46.50	—	—	—	—	—
<i>Gazza</i>	—	—	—	—	—	—
<i>Thrissina</i>	—	—	—	—	—	—
<i>Setipinna</i>	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	—	—
<i>Anguilla</i>	—	—	—	—	—	—
<i>Cepola</i>	—	—	—	—	—	—
<i>Caranx</i>	—	—	—	—	—	—
<i>Upeneus</i>	—	—	—	—	—	—
"Fishes"	3.90	0.13	—	—	0.26	—
Lutjanids	—	—	—	—	—	—
Bivalve juveniles	—	—	—	0.65	5.65	—
<i>Donax</i>	—	—	—	1.28	2.05	—
Gastropod juveniles	—	—	—	—	0.13	—
<i>Cresis</i>	12.48	1.18	—	1.28	—	—
Polychaetes	—	—	—	—	1.02	—
Diatoms	—	—	—	—	1.09	—
Foraminifers	—	0.29	—	—	—	—

TABLE 5. *Continued*

Food items	March			April		
	M	F	J	M	F	J
<i>Lucifer</i>	0.91	0.98	—	8.22	—	7.69
Crab larva	—	1.71	—	0.33	3.11	—
Prawn larva	0.23	0.82	—	1.17	—	—
Prawn	0.61	—	—	1.96	0.16	87.18
<i>Acetes</i>	27.09	1.77	—	5.08	10.27	—
Copepods	32.15	20.25	—	26.01	15.26	—
Amphipods	0.15	10.88	—	—	—	—
Cymathoa	0.30	—	—	—	0.16	—
Mysids	0.23	0.69	—	0.39	—	—
<i>Squilla</i> larva	1.52	8.42	—	9.97	20.55	—
Fish larva	—	0.03	—	—	0.38	—
Sciaenids	—	—	—	2.61	—	—
<i>Leiognathus</i>	31.87	49.86	—	0.97	—	5.13
<i>Pomadasys</i>	—	—	—	—	—	—
<i>Stolephorus</i>	—	—	—	3.66	—	—
<i>Johnius</i>	—	—	—	—	—	—
<i>Thryssa</i>	—	—	—	14.66	0.47	—
<i>Gazza</i>	—	—	—	1.36	—	—
<i>Thrissina</i>	—	—	—	—	—	—
<i>Setipinna</i>	—	—	—	1.57	—	—
<i>Trichiurus</i>	—	0.19	—	—	—	—
<i>Anguilla</i>	—	0.13	—	—	—	—
<i>Cepola</i>	—	—	—	—	—	—
<i>Caranx</i>	—	3.79	—	0.78	—	—
<i>Upeneus</i>	—	—	—	0.38	—	—
"Fishes"	2.97	1.33	—	1.30	1.40	—
Lutjanids	—	—	—	—	—	—
Valve juveniles	—	0.06	—	—	—	—
<i>Donax</i>	—	—	—	—	—	—
Gastropod juveniles	1.75	0.17	—	—	—	—
<i>Cressis</i>	—	—	—	19.58	19.58	—
Polychaetes	0.22	0.02	—	—	—	—
Diatoms	—	—	—	—	—	—
Foraminifers	—	—	—	—	—	—

TABLE 5. *Continued*

Food items	May			June		
	M	F	J	M	F	J
<i>Lucifer</i>	71.61	53.76	89.17	14.09	9.45	5.66
Crab larva	9.97	3.58	0.41	0.76	37.12	1.20
Prawn larva	0.09	0.05	—	0.30	0.15	0.16
Prawn	0.04	—	0.03	—	—	—
<i>Acetes</i>	—	—	6.65	54.59	48.38	47.80
Copepods	3.98	0.09	1.77	24.57	1.02	35.61
Amphipods	—	—	—	—	0.10	—
Cymathoa	—	0.03	—	—	—	—
Mysids	—	14.03	—	—	0.47	9.17
<i>Squilla</i> larva	0.89	0.34	—	—	0.35	—
Fish larva	0.07	—	0.86	—	—	0.03
Sciaenids	—	—	—	0.45	—	—
<i>Leiognathus</i>	—	—	—	1.52	—	0.04
<i>Pomadasys</i>	2.24	—	—	—	—	—
<i>Stolephorus</i>	—	—	0.55	—	—	0.02
<i>Johnius</i>	—	—	—	—	—	—
<i>Thryssa</i>	—	25.46	0.29	—	—	0.02
<i>Gazza</i>	—	—	—	—	—	—
<i>Thrissina</i>	—	—	—	1.90	—	0.02
<i>Setipinna</i>	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	—	—
<i>Anguilla</i>	—	—	—	—	—	—
<i>Cepola</i>	—	—	0.17	—	—	—
<i>Caranx</i>	—	—	—	—	—	—
<i>Upeneus</i>	—	—	—	—	—	—
"Fishes"	0.11	—	—	1.82	2.90	0.27
Lutjanids	—	—	0.10	—	—	—
Bivalve juveniles	—	—	—	—	—	—
<i>Donax</i>	—	—	—	—	—	—
Gastropod juveniles	—	—	—	—	—	—
<i>Cresis</i>	11.00	2.66	—	—	—	—
Polychaetes	—	—	—	—	0.03	—
Diatoms	—	—	—	—	0.03	—
Foraminifers	—	—	—	—	—	—

TABLE 5. *Continued*

Food items	July			August		
	M	F	J	M	F	J
<i>Lucifer</i>	9.68	10.84	98.67	2.60	8.26	0.13
Crab larva	—	—	0.08	0.05	0.75	0.51
Prawn larva	—	—	—	0.09	0.38	—
Prawn	—	0.82	—	—	—	—
<i>Acetes</i>	87.23	72.24	0.13	32.59	12.16	0.04
Copepods	0.16	9.13	0.30	62.01	55.66	99.15
Amphipods	—	—	—	—	0.33	0.11
Cymathoa	—	0.64	0.22	—	—	—
Mysids	0.29	1.07	—	0.29	17.90	—
<i>Squilla</i> larva	—	1.07	0.06	0.03	0.75	0.06
Fish larva	0.07	0.18	0.20	0.11	—	—
Sciaenids	0.32	—	—	—	—	—
<i>Leiognathus</i>	0.07	—	—	—	—	—
<i>Pomadasys</i>	—	—	—	—	—	—
<i>Stolephorus</i>	—	—	—	—	—	—
<i>Johnius</i>	—	0.36	—	—	—	—
<i>Thryssa</i>	0.54	0.43	—	—	—	—
<i>Gazza</i>	—	—	—	—	—	—
<i>Thrissina</i>	—	—	—	—	—	—
<i>Setipinna</i>	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	—	—
<i>Anguilla</i>	—	—	—	—	—	—
<i>Cepola</i>	—	—	—	—	—	—
<i>Caranx</i>	—	—	—	—	—	—
<i>Upeneus</i>	0.16	—	—	—	—	—
"Fishes"	0.04	0.86	—	—	—	—
Lutjanids	—	—	—	—	—	—
Bivalve juveniles	—	—	—	—	—	—
<i>Donax</i>	—	—	—	—	—	—
Gastropod juveniles	—	1.22	—	—	—	—
<i>Cresis</i>	—	0.57	—	—	—	—
Polychaetes	—	—	—	1.90	—	—
Diatoms	—	—	—	—	—	—
Foraminifers	1.44	0.57	0.34	0.33	3.76	—

TABLE 5. *Continued*

Food items	September			October		
	M	F	J	M	F	J
<i>Lucifer</i>	0.66	3.50	3.72	5.75	—	—
Crab larva	0.06	0.06	36.85	8.63	15.25	11.77
Prawn larva	—	—	—	—	—	—
Prawn	—	0.25	0.05	—	0.08	8.40
<i>Acetes</i>	98.20	84.40	11.86	26.57	62.47	25.21
Copepods	0.32	10.44	47.02	36.42	3.30	37.83
Amphipods	—	—	—	—	0.45	8.39
Cymathoa	—	—	—	0.24	—	—
Mysids	0.33	0.15	—	—	0.75	—
<i>Squilla</i> larva	0.04	0.68	0.30	—	5.46	—
Fish larva	—	—	—	0.96	—	—
Sciaenids	—	—	—	—	—	—
<i>Leiognathus</i>	0.26	0.05	—	13.41	—	—
<i>Pomadasys</i>	—	—	—	—	0.50	—
<i>Stolephorus</i>	0.07	0.17	—	—	0.22	—
<i>Johnius</i>	—	—	—	—	0.22	—
<i>Thryssa</i>	—	0.25	—	—	0.17	—
<i>Gazza</i>	—	0.05	—	—	—	—
<i>Thrissina</i>	—	—	—	—	—	—
<i>Setipinna</i>	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	—	—
<i>Anguilla</i>	—	—	—	—	—	—
<i>Cepola</i>	—	—	—	—	—	—
<i>Caranx</i>	—	—	—	—	—	—
<i>Upeneus</i>	—	—	—	—	—	—
"Fishes"	—	—	0.20	4.79	0.34	8.40
Lutjanids	—	—	—	—	—	—
Bivalve juveniles	—	—	—	—	—	—
<i>Donax</i>	—	—	—	—	—	—
Gastropod juveniles	—	—	—	—	—	—
<i>Cresis</i>	—	—	—	2.15	10.73	—
Polychaetes	0.06	—	—	—	0.06	—
Diatoms	—	—	—	—	—	—
Foraminifers	—	—	—	1.08	—	—

TABLE 5. *Concluded*

Food items	November			December		
	M	F	J	M	F	J
<i>Lucifer</i>	—	—	5.73	—	0.64	—
Crab larva	4.77	85.71	45.70	2.18	21.31	—
Prawn larva	—	—	—	—	—	—
Prawn	—	—	—	—	0.49	—
<i>Acetes</i>	—	—	—	—	2.76	—
Copepods	—	—	48.57	0.35	1.62	—
Amphipods	—	—	—	—	0.99	—
Cymathoa	—	—	—	—	—	—
Mysids	—	—	—	—	—	—
<i>Squilla</i> larva	95.08	14.29	—	95.73	70.31	—
Fish larva	—	—	—	—	—	—
Sciaenids	—	—	—	—	—	—
<i>Leiognathus</i>	—	—	—	0.58	0.40	—
<i>Pomadasys</i>	—	—	—	—	—	—
<i>Stolephorus</i>	—	—	—	—	1.18	—
<i>Johnius</i>	—	—	—	—	—	—
<i>Thryssa</i>	—	—	—	1.16	—	—
<i>Gazza</i>	—	—	—	—	—	—
<i>Thriassina</i>	—	—	—	—	—	—
<i>Setipinna</i>	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	—	—
<i>Anguilla</i>	—	—	—	—	—	—
<i>Cepola</i>	—	—	—	—	—	—
<i>Caranx</i>	—	—	—	—	—	—
<i>Upeneus</i>	—	—	—	—	—	—
"Fishes"	0.15	—	—	—	—	—
Lutjanids	—	—	—	—	—	—
Bivalve juveniles	—	—	—	—	—	—
<i>Donax</i>	—	—	—	—	0.15	—
Gastropod juveniles	—	—	—	—	—	—
<i>Cresis</i>	—	—	—	—	—	—
Polychaetes	—	—	—	—	0.15	—
Diatoms	—	—	—	—	—	—
Foraminifers	—	—	—	—	—	—

TABLE 6. Rank obtained by the various food items of *A. kalla* as during different months of the year 1976.

Food items	January			February			March		
	M	F	J	M	F	J	M	F	J
<i>Lucifer</i>	—	—	—	—	12	—	7	11	—
Crab larva	2	3	—	2	6	—	—	7	—
Prawn larva	—	10	—	4	—	—	10	9	—
Prawn	11	11	—	1	3	—	8	—	—
<i>Acetes</i>	9	2	—	3	—	—	3	6	—
Copepods	8	7	—	—	—	—	1	2	—
Amphipods	11	5	—	—	10	—	12	3	—
Cymathoa	—	—	—	—	5	—	9	—	—
Mysids	—	8	—	—	—	—	10	10	—
<i>Squilla</i> larva	4	1	—	7	1	—	6	4	—
Fish larva	10	—	—	—	—	—	—	—	—
Sciaenids	—	9	—	—	—	—	—	—	—
<i>Leiognathus</i>	7	11	—	—	11	—	2	—	—
<i>Pomadasys</i>	—	—	—	—	—	—	—	—	—
<i>Stolephorus</i>	6	—	—	—	—	—	—	—	—
<i>Johnius</i>	5	—	—	—	2	—	—	—	—
<i>Thryssa</i>	1	—	—	—	—	—	—	—	—
<i>Gazza</i>	—	—	—	—	—	—	—	—	—
<i>Thrissina</i>	—	—	—	—	—	—	—	—	—
<i>Setipinna</i>	—	—	—	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	—	—	—	12	—
<i>Anguilla</i>	—	—	—	—	—	—	—	14	—
<i>Cepola</i>	—	—	—	—	—	—	—	—	—
<i>Caranx</i>	—	—	—	—	—	—	—	5	—
<i>Upeneus</i>	—	—	—	—	—	—	—	—	—
Lutjanids	—	—	—	—	—	—	—	—	—
"Fishes"	4	9	—	—	13	—	4	8	—
Bivalve juveniles	—	—	—	6	4	—	—	15	—
<i>Cresis</i>	3	4	—	—	—	—	—	—	—
Polychaetes	—	—	—	5	9	—	11	17	—
Diatoms	—	—	—	—	8	—	—	—	—
Foraminifers	—	6	—	—	—	—	—	—	—
<i>Donax</i>	—	—	—	5	7	—	—	—	—
Gastropod juveniles	—	—	—	—	14	—	5	13	—

TABLE 6. *Continued*

Food items	July			August			September		
	M	F	J	M	F	J	M	F	J
<i>Lucifer</i>	2	2	1	3	4	3	2	3	4
Carb larva	—	—	7	9	6	2	7	8	2
Prawn larva	—	—	—	8	7	—	—	—	—
Prawn	—	7	—	—	—	—	—	5	7
<i>Acetes</i>	1	1	6	2	3	6	1	1	3
Copepods	7	3	3	1	1	1	4	2	1
Amphipods	—	—	—	—	7	4	—	—	—
Cymathoa	—	8	4	—	—	—	—	—	—
Mysids	6	5	—	6	—	—	3	7	—
<i>Squilla</i> larva	—	5	8	10	6	5	8	7	5
Fish larva	8	12	5	7	—	—	—	—	—
Sciaenids	5	—	—	—	—	—	—	—	—
<i>Leiognathus</i>	8	—	—	—	—	—	5	9	—
<i>Pomadasys</i>	—	—	—	—	—	—	—	—	—
<i>Stolephorus</i>	—	—	—	—	—	—	6	6	—
<i>Johnius</i>	—	11	—	—	—	—	—	—	—
<i>Thryssa</i>	4	—	—	—	—	—	—	5	—
<i>Gazza</i>	—	—	—	—	—	—	—	9	—
<i>Thriszina</i>	—	—	—	—	—	—	—	—	—
<i>Setipinna</i>	—	—	—	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	—	—	—	—	—
<i>Anguilla</i>	—	—	—	—	—	—	—	—	—
<i>Cepola</i>	—	—	—	—	—	—	—	—	—
<i>Caranx</i>	—	—	—	—	—	—	—	—	—
<i>Upeneus</i>	7	—	—	—	—	—	—	—	—
Lutjanids	—	—	—	—	—	—	—	—	—
"Fishes"	9	6	—	—	—	—	—	—	—
Bivalve juveniles	—	—	—	—	—	—	—	—	—
<i>Oresis</i>	—	9	—	—	—	—	—	—	—
Polychaetes	—	—	—	4	—	—	7	—	—
Diatoms	—	—	—	—	—	—	—	—	—
Foraminifers	3	9	2	5	5	—	—	—	—
<i>Donax</i>	—	—	—	—	—	—	—	—	—
Gastropod juveniles	4	—	—	—	—	—	—	—	—

TABLE 6. *Concluded*

Food items	October			November			December		
	M	F	J	M	F	J	M	F	J
<i>Lucifer</i>	5	—	—	—	—	3	—	7	—
Carb larva	4	2	3	2	1	2	2	2	—
Prawn larva	—	—	—	—	—	—	—	—	—
Prawn	—	12	4	—	—	—	—	—	—
<i>Acetes</i>	2	1	2	—	—	—	—	3	—
Copepods	1	5	1	—	—	1	5	4	—
Amphipods	—	8	5	—	—	—	—	6	—
Cymathoa	10	—	—	—	—	—	—	—	—
Mysids	—	—	6	—	—	—	—	—	—
<i>Squilla</i> larva	—	4	—	1	2	—	1	1	—
Fish larva	9	—	—	—	—	—	—	—	—
Sciaenids	—	—	—	—	—	—	—	—	—
<i>Leiognathus</i>	3	—	—	—	—	—	4	9	—
<i>Pomadasys</i>	—	7	—	—	—	—	—	—	—
<i>Stolebhorus</i>	—	10	—	—	—	—	—	5	—
<i>Johnius</i>	—	10	—	—	—	—	—	—	—
<i>Thryssa</i>	—	11	—	—	—	—	3	—	—
<i>Gazza</i>	—	—	—	—	—	—	—	—	—
<i>Thrissina</i>	—	—	—	—	—	—	—	—	—
<i>Setipinna</i>	—	—	—	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	—	—	—	—	—	—	—
<i>Anguilla</i>	—	—	—	—	—	—	—	—	—
<i>Cepola</i>	—	—	—	—	—	—	—	—	—
<i>Caranx</i>	—	—	—	—	—	—	—	—	—
<i>Upeneus</i>	—	—	—	—	—	—	—	—	—
Lutjanids	—	—	—	—	—	—	—	—	—
"Fishes"	5	9	4	3	—	—	—	—	—
Bivalve juveniles	—	—	—	—	—	—	—	—	—
<i>Cresis</i>	7	3	—	—	—	—	—	—	—
Polychaetes	—	—	—	—	—	—	—	10	—
Diatoms	—	—	—	—	—	—	—	—	—
Foraminifers	—	—	—	—	—	—	—	—	—
<i>Donax</i>	8	—	—	—	—	—	—	10	—
Gastropod juveniles	—	—	—	—	—	—	—	—	—

TABLE 7. Percentage index of various food items of *A. kalla* in different maturity stages - female

Food items	Immature		Maturing		Mature		Spent & spent recovering	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank
<i>Lucifer</i>	40.56	2	34.00	2	11.67	4	0.95	4
Crab larva	4.50	4	3.81	5	3.37	6	5.81	3
Prawn larva	0.06	9	—	—	0.51	13	—	—
Prawn	—	—	0.18	11	0.90	10	0.68	6
<i>Acetes</i>	41.59	1	34.98	1	13.75	3	26.32	2
Copepods	11.20	3	19.88	3	0.54	12	0.32	11
Amphipods	—	—	0.46	8	0.42	15	0.23	13
Cymathoa	—	—	0.37	10	—	—	—	—
Mysids	0.52	5	0.76	6	1.41	9	0.30	12
<i>Squilla</i> larva	—	—	4.01	4	41.68	1	61.4	1
Fish larva	0.39	6	0.43	9	4.59	—	—	—
Sciaenids	—	—	0.10	13	—	—	—	—
<i>Leiognathus</i>	—	—	—	—	2.44	7	0.37	10
<i>Stolephorus</i>	0.39	6	—	—	—	—	0.88	6
<i>Johnius</i>	—	—	—	—	15.23	2	0.18	14
<i>Thryssa</i>	—	—	—	—	0.80	11	0.61	10
<i>Gazza</i>	—	—	—	—	—	—	0.68	6
<i>Thrissina</i>	0.10	8	—	—	—	—	—	—
<i>Trichiurus</i>	—	—	0.18	11	—	—	—	—
<i>Anguilla</i>	—	—	0.12	12	—	—	—	—
"Fishes"	—	—	—	—	—	—	0.09	15
<i>Caranx</i>	—	—	—	—	0.32	16	—	—
Bivalve juveniles	0.05	9	—	—	—	—	—	—
<i>Donax</i>	—	—	—	—	0.10	17	—	—
Gastropod juveniles	0.25	7	—	—	0.05	18	—	—
<i>Cresis</i>	—	—	—	—	1.72	8	0.62	7
Polychaetes	—	—	—	—	—	—	0.07	16
Foraminifers	0.39	6	0.72	7	0.50	14	0.39	9

TABLE 8. Percentage index of various food items of *A. kalla* in different maturity stage—male.

Food items	Immature		Maturing		Mature		Spent & spent recovering	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank
<i>Lucifer</i>	16.09	2	14.85	2	3.91	7	1.57	6
Crab larva	9.36	4	1.16	13	0.59	12	0.72	8
Prawn larva	—	4	0.58	15	1.78	10	—	—
Prawn	0.75	10	0.77	14	3.24	8	—	—
<i>Acetes</i>	13.47	3	4.08	7	13.49	4	51.84	1
Copepods	39.66	1	3.01	8	1.07	11	0.53	9
Amphipods	—	—	0.21	17	0.41	15	0.05	14
Cymathoa	0.37	11	—	—	0.24	17	—	—
Mysids	1.22	9	2.33	9	8.70	5	0.43	16
<i>Squilla</i> larva	—	—	9.60	3	15.09	2	32.26	2
Fish larva	—	—	—	—	0.47	14	—	—
Sciaenids	—	—	8.53	5	—	—	—	—
<i>Leiognathus</i>	—	—	1.46	12	28.40	1	1.63	5
<i>Pomadasys</i>	2.24	8	—	—	—	—	—	—
<i>Stolephorus</i>	3.37	7	0.39	16	—	—	0.10	13
<i>Johnius</i>	5.23	6	—	—	—	—	—	—
<i>Thryssa</i>	—	—	31.42	1	—	—	6.91	3
<i>Thrissina</i>	0.75	—	—	—	—	—	—	—
"Fishes"	7.49	5	—	—	14.33	3	2.64	4
<i>Caranx</i>	—	—	1.35	12	0.30	16	—	—
<i>Upeneus</i>	—	—	—	—	2.14	9	—	—
Bivalve juveniles	—	—	—	—	0.18	18	—	—
Gastropod juveniles	—	—	2.23	10	—	—	—	—
<i>Cresis</i>	—	—	2.04	11	4.03	6	1.07	7
Polychaetes	—	—	6.79	6	0.06	19	0.15	11
Diatoms	—	—	—	—	0.51	13	—	—
Foraminifers	—	—	9.12	4	1.07	11	0.11	12

SUMMARY

Analyses of the food and feeding in *Carangoides malabaricus* and *Alepes kalla* reveal that the juveniles feed on planktonic crustaceans, but the adults prefer juvenile fishes also in addition. In both the species no difference could be seen between the food of males and females. The stomach contents in general reveal that the fishes are carnivores. During maturation, preference to particular food items could be noted in *Carangoides malabaricus*. Juveniles and immature fishes of both sexes, feed more on the planktonic crustaceans, mature fishes consume both crustaceans and fishes, and spent and recovery specimens prefer more juvenile fishes like *Stolephorus* spp. *Leiognathus* spp. In both the species, in females, during the advanced maturity stages only empty stomachs with little mucus are encountered. The percentage occurrence of 'gorged' 'full' and ' $\frac{3}{4}$ full' stomachs are always less in all the months.

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