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Dr. J. R. B. ALFRED
Director
Zoological Survey of India

AN APPEAL

In order to enrich the “*National Zoological Collection*” (NZC) and to up date information on the occurrence and distribution of animal species in India Scientists/Naturalists and researchers working on animal taxonomy/systematics are requested to deposit their identified specimens to the Zoological Survey of India at the following address :

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Dr. J. R. B. ALFRED
Director
Zoological Survey of India

RECORDS OF THE ZOOLOGICAL SURVEY OF INDIA

Vol. 101 (Part 3-4)

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MARINE INVERTEBRATES OF DIGHA COAST AND SOME RECOMENDATIONS ON THEIR CONSERVATION

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Zoological Sruvey of India, M-Block, New Alipore, Kolkata 700 053, India

INTRODUCTION

The first study on marine fauna of Digha coast is known from the work of Bharati Goswami during 1975-87 (Bharati Goswami, 1992). Other workers, viz., Bairagi, Bhadra, Mukhopadhyaya, Misra, Reddy (1995); Subba Rao *et. al.*, (1992, 1995); Talukdar *et. al.*, (1996); Ramakrishna and Sarkar (1998); Sastry (1995, 1998) and Mitra *et. al.*, (2002) also reported some marine invertebrates under different faunal groups from Hughly-Matla estuary, including Digha. But uptil recently there is no comprehensive updated list of marine invertebrates from Digha coast and adjoining areas. With the establishment of Marine Aquarium and Research Centre, Digha in the year 1990, opportunity was launched for undertaking an extensive exploration and studying seasonal changes that have been taken place on the coastal biodiversity in this area. Accordingly, the authors of the present work, started collecting the detailed faunal information from Digha and adjoining coastal areas [Fig. 2 and 3].

During the study, it has transpired that exploitation of coastal resources has very abruptly increased in recent years. Several new fishing gears are employed, a number of new marine organisms are recognized as commercial fish and non fish resources. Also, the number of trawlers has increased to a large extent.

The present paper based on the observations from 1990 to 2000 (including the current records upto January, 2002), is an uptodate database for the available species of marine invertebrates from this area.

MATERIALS AND METHODS

Digha is situated at 21° 36' 30" N latitude and 87° 32' E longitude and has a potential coast line of about 12 km. of its own (Udipore to Digha mohona), of which the western part (Udipore to Digha hospital ghat) is considered to be the accretion zone, whereas the eastern part (Sea Hawk ghat to Shankarpur) is considered as eroded zone.

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The observation and collection of specimens for this work were made as follows :

1. Considering the diurnal catch pattern, daily collections were made from the fishing gears and also from discarded bycatch, cast off on beach [Fig. 4 and 5].
2. Spot collection of specimens and collection of necessary informations were made on weekly and fortnightly basis.
3. Collections were made from individuals cruises of fishing vessels of Shankarpur and Digha mohana.
4. Collections were also made from bag net or Bagda net (triangular net made for collection of post larva of *Penaeus monodon*), [Fig. 3].
5. Collection of rare specimens from fishermen and stray collections from auction yard of Digha mohona and Shankarpur fishing harbour were made.
6. Across and vertical survey of shore in different tide times for collections of shore animals of different habitat and niche was also undertaken.

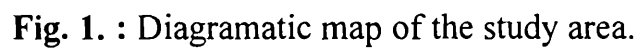
AREAS OF COLLECTION (STUDY AREAS)

During this study, several areas were considered according to the local name of those areas; viz., Udiapore ghat; West Gadadharpur; Ongaria ghat; Bat tala ghat (New Digha ghat); Marine aquarium ghat (Hospital ghat); Old Digha ghat; Sea Hawk ghat; Gadadharpur; Digha mohona; Shankarpur; Jalda khoti; Dadanpatrabar and Junput (Fig-1).

These collecting localities cover the total shore length of about 40 km. The till date collection of different animal species available from the Digha beach and adjoining areas are charted in the form of a checklist (Table 1). Seasonal occurrence of some of the species is listed in Table 2.

Table 1. A checklist of invertebrate fauna of Digha coast and adjoining areas. (* Reported for first time).

Scientific Name	Common Name
I. PHYLUM CNIDARIA	
Class HYDROZOA	
Order CHONDROPHORA	
Family PORPITIDAE	
1. <i>Porpita porpita</i> Linnaeus [Fig. 6]	Blue disc/blue dollar
Family VELELLIDAE	
*2. <i>Velella velella</i> (Linnaeus) [Fig. 7]	
Order SIPHONOPHORA	
Family PHYSALIDAE	
3. <i>Physalia physalis</i> (Linnaeus).	Portuguese man-o-war.



Family DIPHYIDAE	
4. <i>Diphyes bojani</i> (Chun).	
Order THECATA	
Family CAMPANULARIIDAE	
*5. <i>Obelia spinulosa</i> (Bell) [Fig. 8]	Sea fir.
Class SCYPHOZOA	
Order CORONATAE	
Family ATOLLIDAE	
*6. <i>Atolla wyvillei</i> Haeckel.	Medusa/jellyfish.
Order SEMAEOSTOMAE	
Family CYANEIDAE	
*7. <i>Cyanea purpurea</i> Kishinouye.	do
Order RHIZOSTOMEAE	
Family CATOSTYLIDAE	
8. <i>Acromitus flagellatus</i> (Maas).	do
9. <i>A. rabanchatu</i> Annandale [Fig. 9]	do
*10. <i>Crambionella annandalei</i> Rao.	do
Family CEPHEIDAE	
*11. <i>Netrostoma typhlodendrium</i> Schultz.	do
Family CASSIOPEIDAE	
*12. <i>Cassiopea andromeda</i> (Forskal).	do
Family VERSURIGIDAE	
*13. <i>Versuriga anadyomene</i> (Maas)	do
Class ANTHOZOA	
Subclass HEXACORALLIA	
Order ACTINARIA	
Family EDWARDSIIDAE	
14. <i>Edwardsia tinctoria</i> Annandale	Sea anemone.
15. <i>Halianthus limnicola</i> Annandale	do
Family HALOCLAVIDAE	
16. <i>Metapeachia tropica</i> (Panikkar)	do
Family HALIACTIDAE	
17. <i>Pelocoetes exul</i> Annandale.	do
18. <i>Phytocoetes gangeticus</i> Annandale.	do
19. <i>P. chilkaeus</i> Annandale.	do

Family HALCAMPACTIIDAE	
20. <i>Phytocoeteopsis ranwanii</i> Panikkar.	do
Family ACTINIIDAE	
21. <i>Anemonia</i> sp.	Snake lock sea anemone
22. <i>Paracondylactis indicus</i> Dave [Fig. 10]	Sea anemone
23. <i>Gyrostoma glaucus</i> Annandale.	do
Family METRIDIIDAE	
24. <i>Metridium schillerianum</i> (Stoliczka)	Plumose anemone
Subclass OCTOCORALLIA	
Order PENNATULACEA	
Family VERETILLIDAE	
25. <i>Cavernularia elegans</i> Herklots	Sea pansy/Sagar Kadamba [†]
26. <i>C. obesa</i> Valenciennes.	do
27. <i>C. lutkenii</i> Kolliker	do
28. <i>C. orientalis</i> Thompson & Simpson.	do
Family VIRGULARIIDAE	
29. <i>Virgularia elegans</i> Gray.	Walking stick (Sea pen)
Family PTEROEIDIDAE	
*30. <i>Pteroeides esperi</i> Herklots [Fig. 11]	Feathered Sea pen/Sea feather
II. PHYLUM CTENOPHORA	
Class TENTACULATA	
Order CYDIPPIDA	
Family PLEUROBRACHIDAE	
31. <i>Pleurobrachia globosa</i> Mosser [Fig. 12]	Sea gooseberry.
Class NUDA	
Order BEROIDA	
Family BEROIDAE	
*32. <i>Beroe</i> sp. [Fig. 13]	Comb jelly
III. PHYLUM ANNELIDA	
Class POLYCHAETA	
Family POLYNOIDAE	
33. <i>Lepidonotus tenuisetosus</i> (Gravier)	Scale worm.
34. <i>Gaudichaudius cimex</i> (Quatrafages)	do

[†]According to (Prof.) Dr. Amalesh Choudhury, Dept. Marine Science, Calcutta University.

Family AMPHINOMIDAE	
35. <i>Chloeia parva</i> Baird [Fig. 14]	Fire worm
36. <i>C. rosea</i> Potts.	do
Family NEREIDIDAE	
37. <i>Nereis chingrighattensis</i> Fauvel.	Rag worm or Sand worm
38. <i>N. chilkaensis</i> Southern	do
39. <i>Perinereis nuntia</i> (Savigny) var. <i>heterodonta</i> Gravier.	
40. <i>P. nuntia</i> (Savigny) var. <i>brevicirris</i> (Grube).	
41. <i>P. nuntia</i> var. <i>typica</i> Savigny.	
42. <i>P. cultrifera</i> Grube.	
43. <i>P. nigropunctata</i> Horst.	
44. <i>Dendronereis heteropoda</i> Southern.	
45. <i>Namalyeastis fauveli</i> Rao.	
46. <i>Ceratonereis burmensis</i> Monro.	
Family EUNICIDAE	
47. <i>Marphysa graveleyi</i> Southern.	Rock worm
Family ONUPHIDAE	
*48. <i>Onuphis emerita</i> Annandale & M. Edwards	
49. <i>Diopatra neopolitana</i> delle Chiaje.	
50. <i>D. cuprea</i> (Bosc).	
Family LUMBRINERIDAE	
51. <i>Lumbriconereis heteropoda</i> Morenzeller.	
52. <i>L. notocirrata</i> Fauvel.	
Family NEPHTHYDIDAE	
53. <i>Nephtys dibranchis</i> Grube.	
54. <i>N. oligobranchia</i> Southern	
Family SPIONIDAE	
55. <i>Polydora ciliata</i> Johnston.	Spiroid worm
Family OWENIIDAE	
*56. <i>Owenia fusiformis</i> delle Chiaje.	
Family GLYCERIDAE	
*57. <i>Glycera alba</i> (Muller).	
*58. <i>G. convoluta</i> Keferstein.	
Family TERESELLIDAE	
*59. <i>Loimia medusa</i> (Savigny)	

Family MALDANIDAE	
60. <i>Euclymene annandalae</i> Southern.	
Family PHYLLODOCIDAE	
*61. <i>Etone barantollae</i> Fauvel.	
Family HESIONIDAE	
*62. <i>Telashapia annandalei</i> Fauvel.	
IV. PHYLUM ECHIURA	
Class ECHIURIDA	
Order ECHIUROINEA	
Family THALASSEMATIDAE	
Subfamily THALASSEMATINAE	
63. <i>Anelassorhynchus branchiorhynchus</i> (Annandale & Kemp)	
64. <i>A. dendrorhynchus</i> (Annandale & Kemp)	
65. <i>A. microrhynchus</i> (Prasad)	
V. PHYLUM ARTHROPODA	
Class CRUSTACEA	
Subclass CIRRIPIEDIA	
Order THORACICA	
Family BALANIDAE	
66. <i>Balanus amphitrite</i> Darwin.	Acorn barnacle
*67. <i>Balanus variegatus</i> (Darwin)	do
*68. <i>Megabalanus tintinnabulum</i> Newman & Ross	Giant Acorn barnacle
Family CHTHAMALIDAE	
69. <i>Chthamalus stellatus</i> (Poli) [Fig. 20]	Star barnacle
Family LEPADIDAE	
*70. <i>Lepas anatifera indica</i> Annandale.	Goose barnacle
Family POECILASMATIDAE	
*71. <i>Octolasmis warwickii</i> Gray [Fig. 21]	do
Subclass MALACOSTRACA	
Order STOMATOPODA	
Family SQUILLIDAE	
72. <i>Squilla nepa</i> Laterille.	Mantis shrimp
73. <i>Oratosquilla interrupta</i> (Kemp)	
74. <i>Harpiosquilla raphidea</i> (Fabricius)	
75. <i>Gonadactylus chiracra</i> (Fabricius).	

Order MYSIDACEA	
Family MYSIDACEAE	
76. <i>Rhopalophthalmus egregius</i> Hansen.	Mysis
77. <i>Castrosaccus muticus</i> Tattersall.	
78. <i>Macropsis orientalis</i> Tattersall.	
Order AMPHIPODA	
Family PHOTIDAE	
79. <i>Cleantis natalensis</i> Barnard.	
Order ISOPODA	
Family IDOTEIDAE	
80. <i>Chetripotis megacheles</i> (Giles)	
Family BOPIRIDAE	
81. <i>Bopyrus</i> sp.	Parasitic Isopod
Family CYMOTHOIDAE	
82. <i>Nerocila serra</i> (Schioedt & Meinrt)	
Family LIGIIDAE	
83. <i>Ligia exotica</i> Roux.	Beach wood louse
Order DECAPODA	
Family SCYLLARIDAE	
84. <i>Thenus orientalis</i> (Lund) [Fig. 21]	Flat-head locust lobster
Family PALINURIDAE	
85. <i>Panulirus polyphagus</i> (Herbst)	Mud spiny lobster
86. <i>P. ornatus</i> (Fabricius)	Ornate spiny lobster
Family ALPHEIDAE	
87. <i>Alpheus euphrosyne</i> De man.	Snapping shrimp
88. <i>A. malabaricus</i> Fabricius	do
Family HIPPOLYTIDAE	
89. <i>Exhippolysmata ensirostris</i> (Kemp)	Hunter shrimp
90. <i>Saron marmoretus</i> (Oliver)	do
Family PALAEMONIDAE	
91. <i>Expalaemon styliferus</i> (H. Milne Edwards)	Rashna prawn
92. <i>Macrobrachium equidens</i> (Dana)	Rough river prawn
93. <i>M. malcolmsonni</i> (H. Milne Edwards)	Monsoon river prawn
94. <i>M. rosenbergii</i> De Man.	Giant river prawn
95. <i>M. rude</i> (Heller)	Hairy river prawn

96. <i>M. scabriculum</i> (Heller)	Prawn
97. <i>M. mirabile</i> (Kemp)	
98. <i>M. villosimanus</i> Tiwari.	
99. <i>M. lamarrai</i> (H. Milne Edwards)	
100. <i>Nematopalaemon teuipes</i> (Henderson)	Spider prawn
Family PENAEIDAE	
101. <i>Atypopenaeus stenodactylus</i> (Stimpson)	Periscope shrimp
102. <i>Metapenaeus brevicornis</i> (H. Milne Edwards)	Yellow shrimp
103. <i>M. affinis</i> (H. Milne Edwards)	Jhinga shrimp
104. <i>M. dobsoni</i> (Miers)	Kadal shrimp
105. <i>M. lysianassa</i> (De Man)	Bird shrimp
106. <i>M. monoceros</i> (Fabricious)	Spected shrimp
107. <i>Parapenaeopsis occlivirostris</i> Alcock.	Hawknosed shrimp
108. <i>P. coromandelica</i> Alcock.	Coromandel shrimp
109. <i>P. sculptilis</i> (Heller)	Rainbow shrimp
110. <i>P. maxillipeda</i> Alcock.	Torpedo shrimp
111. <i>P. uncta</i> Alcock.	Uncta shrimp
112. <i>P. longipes</i> Alcock	Flamingo shrimp
113. <i>P. stylifera</i> (H. Milne Edwards)	
114. <i>P. hardwickii</i> (Miers)	
115. <i>Penaeus indicus</i> H. Milne Edwards.	Indian white shrimp
116. <i>P. canaliculatus</i> (Oliver)	Witch prawn
117. <i>P. monodon</i> (Fabricius)	Giant tiger prawn
118. <i>P. semisulcatus</i> De Haan.	Green tiger prawn
119. <i>P. japonicus</i> Bate.	
120. <i>P. merguiensis</i> De Mann.	Banana prawn
121. <i>P. penicillatus</i> Alcock.	
122. <i>Trachypenaeus curvirostris</i> (Stimpson)	Southern rough shrimp
Family SERGESTIDAE	
123. <i>Acetes indicus</i> H. Milne Edwards	Sergested shrimp
124. <i>A. erythraeus</i> Nobilis.	
Family SOLENOCERIDAE	
125. <i>Solenocera choprai</i> Nataraj.	Ridge back shrimp
126. <i>S. indica</i> Nataraj.	
127. <i>S. crassicornis</i> (H. Milne Edwards)	Coastal mud shrimp

Family DIOGENIDAE	
128. <i>Diogenes custus</i> (Fabricius)	Hermit crab
129. <i>D. miles</i> (Herbst)	do
130. <i>D. affinis</i> (Henderson)	do
131. <i>D. platimanus</i> Henderson.	do
132. <i>D. averus</i> Heller.	do
133. <i>D. rectimanus</i> Meirs.	Hermit crab
134. <i>D. costatus</i> Henderson.	do
135. <i>D. investigatoris</i> Alcock.	do
136. <i>Dardanus hessii</i> Meirs.	do
137. <i>Clibanarius padavensis</i> De Man.	do
138. <i>C. clibanarius</i> (Herbst)	do
139. <i>C. infraspinatus</i> Hilgendorf.	do
140. <i>C. olivaceus</i> Henderson	do
Family COENOBITIDAE	
*141. <i>Coenobita cavipes</i> Stimpson [Fig. 22]	do
Family DORIPPIDAE	
142. <i>Dorippe faechino</i> De Hann.	Crab
Family MATUTIDAE	
143. <i>Matuta victor</i> Fabricius.	Swimming crab
Family PORTUNIDAE	
144. <i>Portunus sanguinolentus</i> (Herbst) [Fig. 15]	Three-spotted crab
145. <i>P. pelagicus</i> (Linnaeus)	Blue crab or Neptune crab
146. <i>Charybdis affinis</i> Dana.	Cross & Angle crab
147. <i>C. quadrimaculata</i> A.M. Edwards	
148. <i>C. elongatus</i> A.M. Edwards	
149. <i>C. crucifera</i> A.M. Edwards [Fig. 16]	
150. <i>Scylla serrata</i> De Haan.	Giant Mud crab
Family MAIIDAE	
*151. <i>Doclea hybrida</i> (Fabricius)	
Family OCYPODIDAE	
152. <i>Ocypoda macrocera</i> H.Milne Edwards [Fig. 17]	Red crab or racing crab
153. <i>O. ceratophthalma</i> (Palas)	Ghost crab
154. <i>Macrophthalmus sulcatus</i> M. Edward	
155. <i>M. transversus</i> (Latreille)	

156. <i>M. pectinipes</i> Guerin.	
157. <i>M. depressus</i> Ruppel.	
158. <i>U. (Celuca) triangularis bengali</i> Crane [Fig. 18]	Fiddler crab/Dhobi crab
159. <i>Uca (Celuca) lactea annulipes</i> (M. Edward) [Fig. 19]	do
160. <i>U. (Deltuca) rosea</i> (Tweedie)	do
161. <i>U. acuteus</i> Stimpson.	do
162. <i>Dotilla inermis</i> De Man.	Soldier crab
Class MEROSTOMATA	
Order XIPHOSURIDA	
Family XIPHOSURIDAE	
163. <i>Tachypleus gigas</i> (Müller)	Horse-shoe crab
164. <i>Carcinoscorpius rotundicauda</i> (Latreille) [Fig. 23]	Smooth-tailed Horse-shoe crab
VI. PHYLUM MOLLUSCA	
Class SCAPHOPODA	
Family SIPHONODONTALIIDAE	
165. <i>Cadulus clavatum</i> (Gould)	Tusk shell
Family DENTALIIDAE	
166. <i>Dentalium variable</i> Deshayes	Tooth shell
167. <i>D. octangulatum</i> Donovan	do
Class GASTROPODA	
Order ARCHAEOGASTROPODA	
Family FISSURELLIDAE	
168. <i>Scutus abnormis</i> Nevill	
Family TROCHIDAE	
169. <i>Umbonium vestiarium</i> (Linnaeus)	Button shell
Family TURBINIDAE	
170. <i>Turbo brunneus</i> (Roeding)	Turban shell
Family NERITIDAE	
171. <i>Nerita (Amphinerita) lineata</i> Gmelin	Nerite shell
172. <i>Nerita (Theliostyla) chamaeleon</i> Linnaeus	do
173. <i>N. undata</i> Linnaeus	do
174. <i>Neritina (Dostina) violacea</i> (Gmelin)	
Order MESOGASTROPODA	
Family LITTORINIDAE	
175. <i>Littorina (Littorina) undulata</i> (Gray)	Periwinkle
176. <i>Littorina (Littorinopsis) melanostoma</i> Gray	do
177. <i>Littorina (Littorinopsis) scabra scabra</i> (Linnaeus)	do

Family TURRITELLIDAE	
178. <i>Turritella attenuata</i> Reeve	Turret shell/Screw shell
Family POTAMIDIDAE	
179. <i>Cerithidea (Cerithideopsis) cingulata</i> (Gmelin)	Horn shell
180. <i>Cerithidea (Cerithidea) obtusa</i> Lamarck	do
181. <i>Telescopium (Telescopium) telescopium</i> Montfort	
Family EPITONIIDAE	
182. <i>Acrilla gracilis</i> (Sowerby)	
Family CYPRAEIDAE	
183. <i>Monetaria moneta</i> (Linnaeus)	Cowrie
184. <i>Ornamentaria annulus</i> Linnaeus	Gold ringer/Ringed money cowrie
Family NATICIDAE	
185. <i>Natica chemnitaii</i> Reclutz	Moon shell
186. <i>N. lineata</i> Lamarck	Lined Moon
187. <i>N. petuvariana</i> (Reclutz)	
188. <i>N. globosa</i> Chemnitz	
189. <i>N. vitellus</i> (Linnaeus)	Banded moon
190. <i>N. maculosa</i> (Lamarck)	
191. <i>N. tigrina</i> (Roeding)	
192. <i>N. gualteriana</i> Reclutz	
193. <i>Sinum neritoideum</i> (Linnaeus)	
194. <i>Polinices mammilla</i> (Linnaeus)	
195. <i>P. tumidus</i> (Roeding)	
196. <i>P. dydima</i> (Swainson)	
Family ARCHITECTONICIDAE	
197. <i>Architectonica perspectiva</i> (Linnaeus)	Sun-dial shell
Family THIARIDAE	
198. <i>Larnia burmana</i> (Blanford)	
Family EULIMIDAE	
199. <i>Nisso pyrramidelloides</i> G & H Nevill	
200. <i>Eulima cuspidata</i> A. Adams	
Family BURSIDAE	
201. <i>Bursa spinosa</i> (Lamarck)	Long-spined Frog shell
202. <i>B. rana</i> (Linnaeus)	Frog shell

Family TONNIDAE	
203. <i>Tonna maculata</i> (Lamarck)	Tun shell
204. <i>T. dolium</i> (Linnaeus)	do
205. <i>T. sulcosa</i> (Born)	do
Family FICIDAE	
*206. <i>Ficus gracilis</i> (Sowerby)	Graceful Fig
*207. <i>F. variegata</i> Roeding	Variegated Fig
Order NEOGASTROPODA	
Family MURICIDAE	
208. <i>Murex tribulus</i> Linnaeus	Rock shell
209. <i>Rapana rapiformis</i> (Born)	
210. <i>Cymia lacera</i> (Borne)	
Family THAIDIDAE	
211. <i>Thais bufo</i> (Lamarck)	
212. <i>T. carinifera</i> (Lamarck)	
213. <i>Cuma disjuncta</i> Annandale	
Family MELONGENIDAE	
214. <i>Semifusus pugilinus</i>	Crown Conch
215. <i>Pugilinus cochlidium</i> (Linnaeus)	
Family NASSARIIDAE	
216. <i>Nassarius foveolatus</i> (Dunker, Reeve)	Mud-flat snail
217. <i>N. stolatus</i> (Gmelin)	
Family OLIVIDAE	
218. <i>Oliva ispudula</i> Linnaeus	Olive shell
219. <i>O. vidua</i> (Roeding)	Globular'Olive
220. <i>Olivancillaria gibbosa</i> (Borne)	
221. <i>Amalda ampla</i> (Gmelin)	
Family TURRIDAE	
222. <i>Drillia crenularis</i> (Lamarck)	Turrid shell
223. <i>Turricula javana</i> (Linnaeus)	
224. <i>Turridrupa bijubata</i> (Reeve)	
225. <i>Brachytoma crenularis</i> (Lamarck)	
Family TEREBRIDAE	
226. <i>Terebra durgella</i> Ray	Augur shell
227. <i>T. tenera</i> Hinds	do
228. <i>T. tricineta</i> Smith	do

Family CANCELLARIIDAE	
229. <i>Scalptia scalariformis</i> (Lamarck)	
Family MARGINELLIDAE	
230. <i>Persicula ventricosa</i> (Fischer)	
Order ENTAMOTAENIATA	
Family PYRAMIDELLIDAE	
231. <i>Pyramidella dolabrata</i> terebellum (Mueller)	
232. <i>Turbonilla felicitas</i> Laseron	
233. <i>Odostomia oxia</i> Watson	
234. <i>O. babylonica</i> Winkleworth	
Family RINGICULIDAE	
235. <i>Ringicula encarpiferens</i> de Folin	
236. <i>R. propinquans</i> Hinds	
Family CYLICHNIDAE	
237. <i>Cylichna protracta</i> Gould	
Family RETUSIDAE	
238. <i>Retusa pyramidata</i> (A. Adams)	
Family AGLAJIDAE	
*239. <i>Melanochlamys</i> sp. [Fig. 25]	Black Sea-slug
Order ARCHITECTONOIDAE	
Family AMATHINIDAE	
*240. <i>Amathina tricarinata</i> (Linnaeus) [Fig. 24]	Limpet
Order NOTAPSIDEA	
Family PLEUROBRANCHIDAE	
241. <i>Pleurobranchea</i> sp.	
Order NUDIBRANCHIA	
Family ARMINIDAE	
242. <i>Armina (Pleurophyllidia)</i> sp.	
Family POLYCERIDAE	
243. <i>Kalinga ornata</i> Alder & Hancock.	
Order BASOMATOPHORA	
Family ELLOBIIDAE	
244. <i>Elobium gangeticum</i> (L. Pfeiffer)	
245. <i>Cassidula nucleus</i> Mortyn.	
246. <i>Pythia plicata</i> Ferussac	

Order SOLEOLIFERA	
Family ONCHIDIIDAE	
*247. <i>Onchidium typhae</i> Buchannan	
Class BIVALVIA	
Order ARCOIDA	
Family ARCIDAE	
248. <i>Anadara inequivalvis</i> (Bruguiere)	Ark shell
249. <i>A. granosa</i> (Linnaeus)	do
250. <i>Scapharca deyrollei</i> Jousneume	
251. <i>S. inequivalvis</i> (Bruguiere)	
Order MYTILOIDA	
Family MYTILIDAE	
252. <i>Perna viridis</i> (Linnaeus) [Fig. 27]	Green Mussel
253. <i>Modiolus tulipa</i> (Lamarck)	Horse Mussel
254. <i>M. striatulus</i> (Henley)	do
Family PINNIDAE	
*255. <i>Pinna (Atrina) pectinata pectinata</i> Linnaeus	Pen shell
Order PTEROIDA	
Family ANOMIIDAE	
256. <i>Anomia achaeus</i> Gray	Jingle shell
Order OSTREOIDA	
Family PECTINIDAE	
257. <i>Pecten (Chlamys) tranquebarica</i> (Gmelin)	Scalop
Family OSTREIDAE	
258. <i>Crassostrea gryphoides</i> (Schlotheim)	Giant Rock oyster
259. <i>C. mytiloides</i> (Lamarck)	Rock oyster
260. <i>C. dentculata</i> Borne	do
261. <i>C. imbricata</i> (Lamarck)	do
262. <i>C. madrasensis</i> Preston	do
263. <i>Saccostrea cucullata</i> (Born)	do
Order VENEROIDA	
Family CARDIIDAE	
264. <i>Cardium coronatum</i> Splengler	Cockle
265. <i>C. asiaticum</i> Bruguiere	do
Family VENERIDAE	
266. <i>Meretrix meretrix</i> (Linnaeus)	
267. <i>Sunetta scripta</i> (Linnaeus)	

268. <i>Pelecypora trigona</i> Reeve	
269. <i>Paphia textilis</i> (Gmelin)	
270. <i>P. malabarica</i> (Schroeter)	
271. <i>Timoclea (Glycodonta) imbricata</i> (Sowerby)	
Family MACTRIDAE	
272. <i>Macra elegans</i> Sowerby	Surf clam
273. <i>Macra violacea</i> Gmelin	do
274. <i>Macra (Coelomactra) turgida</i> Gmelin	do
275. <i>Macra (Macrinula) luzonica</i> Deshayes	do
276. <i>Macra (Macrinula) mera</i> Deshayes	do
277. <i>Macra (Macrinula) plicataria</i> Linnaeus	do
278. <i>Standella pellucida</i> (Chemnitz)	
Family CULTELLIDAE	
279. <i>Pharella javanicus</i> (Lamarck)	
280. <i>Siliqua radiata</i> (Linnaeus) [Fig. 26]	Sunset shell
281. <i>S. albida</i> Dunker	
Family PSAMMOBIIDAE	
282. <i>Sanguinolaria (Soletellina) acuminata</i> Deshayes	
Family CORBICULIDAE	
283. <i>Polymesoda (Gelonia) bengalensis</i> (Lamarck)	
Family DONACIDAE	
284. <i>Donax (Hecuba) scortum</i> Linnaeus	Wedge Clam/Leather Donax
285. <i>Donax (Latona) incarnatus</i> Gmelin	
286. <i>D. lubricus</i> Henley	
Family TELLINIDAE	
287. <i>Tellina angulata</i> Linnaeus	Tellin shell
288. <i>T. sinuata</i> Scclenger	
289. <i>T. planissima</i> Anton	
290. <i>Strigilla splendida</i> (Anton)	
291. <i>Macoma birmanica</i> (Philippi)	
292. <i>Macoma (Psammacoma) truncata</i> (Jones)	
293. <i>Apolymetis edentula</i> Spengler.	
Order ADAPEDONTA	
Family SOLENIDAE	
294. <i>Solen brevis</i> Gray	
Family GLAUCONOMIDAE	
295. <i>Glaucanome orientalis</i> (Gmelin)	

Order MYOIDA	
Family PHOLADIDAE	
296. <i>Pholas orientalis</i> (Gmelin)	Boring clam
297. <i>P. candida</i> Linnaeus.	do
298. <i>Martesia vivicola</i> Sowerby	
299. <i>Barnea candida</i> (Linnaeus)	
Family TEREDIIDAE	
300. <i>Teredo clava</i> Gmelin.	Wood-boring shipworm
Order PHOLADOMYOIDA	
Family PANDORIDAE	
301. <i>Pandora obtusa</i> Leach.	
302. <i>P. ceylonica</i> Sowerby	
Family LATERNULIDAE	
303. <i>Laternula truncata</i> (Lamarck)	
Class CEPHALOPODA	
Order SEPIOIDEA	
Family SEPIIDAE	
304. <i>Sepiella inermis</i> (Ferussac & Orbigny) [Fig. 28]	Spineless cuttlefish
305. <i>S. aculeata</i> Orbigny.	Spined cuttlefish
*306. <i>Sepia pharaonis</i> Ehrenberg.	Stripped cuttlefish
Order TEUTHOIDEA	
Family LOLIGINIDAE	
307. <i>Loliolus investigatoris</i> Goodrich [Fig. 29]	Squid
308. <i>Loligo duvauceli</i> Orbigny.	do
*309. <i>L. bengalensis</i> Jothynayagam.	do
310. <i>Doryteuthis singhalensis</i> Ortmann.	White squid
Order OCTOPODA	DEVIL FISH
Family OCTOPODIDAE	
311. <i>Octopus globosus</i> (Appelloef)	Globe octopus
*312. <i>O. rugosus</i> Bose.	
*313. <i>O. macropus</i> Risso.	
VII. PHYLUM BRACHIOPODA	
Class INARTICULATA	
Family LINGULIDAE	
314. <i>Lingula anatina</i> Lamarck [Fig. 34]	Lamp shell
VIII. PHYLUM PHORONIDA	
315. <i>Phoronis bhadurai</i> Ganguly & Majumdar	

IX. PHYLUM ECHINODERMATA	
Class HOLOTHUROIDEA	
Order DENDROCHIROTIDA	
Family CUCUMARIIDAE	
316. <i>Thorsonia investigatoris</i> (Koehler & Vaney) [Fig. 32]	“U” shaped Sea cucumber
Order MOLPADIA	
Family MOLPADIDAE	
317. <i>Molpadia musculus</i> (Risso)	Sea cucumber
Family CAUDINIDAE	
318. <i>Acaudina molpadioides</i> (Semper)	do
Class ASTEROIDEA	
Order PAXILLOSIDA	
Family ASTROPECTINIDAE	
319. <i>Astropecten euryacanthus</i> Luetken [Fig. 30]	Feathered-arm Sea-star
320. <i>A. indicus</i> Doederlein.	Burrowing starfish
321. <i>A. mauritanus</i> Gray.	Sea star
Family GONIASTERIDAE	
322. <i>Goniodiscaster vallei</i> (Koehler)	do
323. <i>Stellaster equestris</i> (Retzius)	do
Class OPHIUROIDEA	
Order OPHIURIDA	
Family OPHIACTIDAE	
324. <i>Ophiactis delagoa</i> Balinsky.	Brittle star
325. <i>O. modesta</i> Brock.	do
Family OPHIOTRICHIDAE	
*326. <i>Ophiocnemis marmorata</i> (Lamarck) [Fig. 31]	do
327. <i>Macrophiothrix longipede</i> (Lamarck)	do
Class ECHINOIDEA	
Order TEMNOPLEUROIDA	
Family TEMNOPLEURIDAE	
328. <i>Temnopleurus toreumaticus</i> (Leske) [Fig. 33]	Small Sea urchin
Order CLYPEASTEROIDA	
Family CLYPEASTERIDAE	
*329. <i>Clypeaster rarispinus</i> de Meijere	Sand dollar
Family LAGANIDAE	
*330. <i>Lagenum decagonale</i> (de Blainville)	do
Family ASTRICLYPEIDAE	
*331. <i>Echinodiscus auritus</i> Leske [Fig. 35]	do

Table 2. : Seasonal occurrence of major invertebrates, recorded at Digha-Shankarpur-Junput coast.

Major Groups & Species	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
CNIDARIA :												
<i>Porpita porpita</i> & <i>Velella velella</i>	–	–	–	+	+	–	–	–	–	–	–	–
SIPHONOPHORES	+	+	+	–	–	–	–	–	–	–	–	+
<i>Physalia physalis</i>	–	–	–	+	+	–	–	–	–	–	–	–
JELLY FISHES :	+	+	+	+	–	–	–	+	+	+	–	+
SEA ANEMONES :	+	+	+	+	+	+	+	+	+	+	+	+
SEA PENS :	+	+	+	+	–	–	–	–	–	–	–	+
CTENOPHORES :	+	+	+	+	–	–	–	–	–	–	–	+
POLYCHAETES :	+	+	+	+	+	+	+	+	+	+	+	+
ECHIURIDS :	+	+	+	+	+	–	–	–	–	–	–	+
CRUSTACEA :												
Acorn Barnacles :	+	+	+	+	+	+	+	+	+	+	+	+
Goose Barnacles :	+	+	+	–	–	–	–	–	–	+	+	+
<i>Squilla</i> sp.	+	+	+	+	+	+	+	+	+	+	+	+
ISOPODS :	+	+	+	+	+	+	+	+	+	+	+	+
PRAWNS :	+	+	+	+	+	+	+	+	+	+	+	+
HERMIT CRABS :	+	+	+	+	+	+	+	+	+	+	+	+
Other CRABS :	+	+	+	+	+	+	+	+	+	+	+	+
HORSE-SHOE CRABS:	+	+	+	+	+	–	–	–	–	–	+	+
Trilobite larva :	+	+	+	+	+	–	–	–	–	–	–	+
MOLLUSCA :												
SCAPHOPODS :	+	+	+	–	–	–	–	–	–	–	–	+
<i>Umbonium vestiarius</i>	+	+	+	+	+	+	+	+	+	+	+	+
<i>Turbo brunneus</i>	+	+	+	+	+	+	+	+	+	+	+	+
<i>Littorina</i> spp.	+	+	+	+	+	+	+	+	+	+	+	+
<i>Nerrita</i> spp.	+	+	+	+	+	+	+	+	+	+	+	+

Table 2. : (Cont'd.).

Major Groups & Species	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
<i>Natica</i> spp.	+	+	+	+	+	+	+	+	+	+	+	+
<i>Acrilla</i> spp.	+	+	+	+	+	+	+	+	+	+	+	+
<i>Tonna</i> spp.	+	+	+	+	+	+	+	+	+	+	+	+
<i>Murex tribulus</i> :	+	+	+	+	+	+	+	+	+	+	+	+
<i>Polinices</i> spp.	+	+	+	+	+	+	+	+	+	+	+	+
<i>Cerithidia</i> spp.	+	+	+	+	+	+	+	+	+	+	+	+
<i>Amalda ampala</i> .	+	+	+	+	-	-	-	-	+	+	+	+
NUDIBRANCHS :	+	+	+	+	-	-	-	-	-	+	+	+
<i>Perna viridis</i>	+	+	+	+	-	-	-	-	-	-	+	+
<i>Crassostraea</i> spp.	+	+	+	+	+	+	+	+	+	+	+	+
<i>Macra</i> spp.	+	+	+	+	+	+	+	+	+	+	+	+
<i>Macoma</i> spp.	+	+	+	+	+	-	-	-	-	+	+	+
<i>Donax</i> spp.	+	+	+	+	+	+	-	-	-	+	+	+
SQUIDS :	+	+	+	+	+	-	-	-	+	+	+	+
CUTTLE FISHES :	+	+	+	+	+	-	-	-	+	+	+	+
<i>Octopus</i> spp.	+	+	+	-	-	-	-	-	-	-	-	+
BRACHIOPODS :	+	+	+	+	-	-	-	-	-	-	-	+
PHORONIDS :	+	+	+	-	-	-	-	-	-	-	-	+
ECHINODERMATA												
Star Fishes	+	+	+	+	+	-	-	-	-	+	+	+
Brittle Stars :	+	+	+	-	-	-	-	-	-	-	+	+
<i>Temnopleurus toreumaticus</i> :(URCHIN)	+	+	+	-	-	-	-	-	-	-	+	+
Sea Cucumbers :	+	+	+	+	+	+	-	-	+	+	+	+

[+ Available, - Not recorded]

SUMMARY OF OBSERVATIONS

In this study a total of 331 species under 207 genera, 137 families, 44 orders, 4 subclasses, 18 classes and 9 phyla have been counted.

The multidirectional observations across the coastal environment indicate that over the last ten years certain fauna (*Paracondylactis indica*, *Virgularia elegans*, *Pteroeides esperi*, *Ocypoda macrocera*, *Carcinoscorpius rotundicauda*, *Tachypleus gigas*, *Dentalium* spp., most of the nudibranchs, *Perna viridis*, *Pecten*, *Lingula anatina*, *Astropecten euryacanthus*, *Goniodiscaster vallei* and *Temnopleurus toreumaticus*) have become rare due to overexploitation of the marine biological resources, while others, formerly unrecorded (37 species) from this area, have been collected and identified (* marked).

Beside these, one species of mole crab (*Albunia* sp.), a burrowing decapod; one species of nudibranch and one species of bryozoa (*Membranipora* sp.) are also collected by authors, but failed to identify properly during this study.

It is also observed that, *Amalda ampla*, is also being increasingly threatened in Digha coast due to uncontrolled collection of live specimen by local women for some ornamental purposes.

The present record of *Cadulus clavatum* and *Stellaster equestris* are based only upon the previous record (Goswami, 1992; Subba Rao, *et al.*, 1992 and Sastry, 1998 respectively). No live specimen, neither a single shell have not been found.

Since Digha beach became familiar, large number of visitors came for pleasure trip and also for zoological excursions. Very often they continued their works while collecting a large number of specimens. Simultaneously, they also collected a number of species which are now rare due to destruction of their habitat and over exploitation.

With this, the recent development of aquaculture has introduced a new economic group along with fishermen and their daily activities destroy a good numbers of invertebrates (including their egg capsules) and also the fish spawn at the time of collecting the post larva of tiger shrimp (*Penaeus monodon*) [Fig. 3, 4 and 5].

In view of faunal richness which is now threatened by exploitation of marine fishery resources, tourism without ecofriendly awareness and overall socio-economic development, this coastal zone demands more protective measures.

RECOMMENDATIONS REGARDING CONSERVATION OF BIODIVERSITY

1. A programme for the awareness of fishermen, tourists, collectors of zoological samples has to be undertaken, as the fishermen and also the over-enthusiastic tourists destroy the living organism (with or without their knowledge).
2. Restrictions must be imposed on fishing activities except permicible seasons, and also on the mesh size of fishing nets.

3. Dragging on intertidal areas is to be banned or restricted and selective sorting and releasing of bycatch organisms in the sea before their death must be made compulsory.
4. Overexploitation by repeatedly collecting the same organisms (especially the various species of live Sea anemone, Sea pen, Hermit crab, Red crab, Horse-shoe crab, bivalve and Sea star) year after year from beach by the study team from various educational institutions for display in their museum should be restricted.

General tourists as well as excursion team often collect a lot of specimen in the first flush of enthusiasm but it is observed that most of those are finally dumped on the beach where the animals are allowed to die and rot. This has also to be banned.

In this context an alternative way might be taken as taking a number of photographs of the organisms from various angles without disturbing them and to collect only very few examples of each species, particularly of rare and poorly populated species.

5. Comprehensive assesment (chemical, biological and environmental) of bycatch organisms in the light of fishery exploitation and bio-medical studies may be invited.

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REFERENCES

- B. C. Bharati Goswami, 1992. Marine Fauna of Digha Coast of West Bengal, India. *J. mar. biol. Ass. Ind.*, **34**(1&2) : 115-137.
- Bairagi, N. 1995. Ocypodidae : Decapoda : Crustacea. *Est. Ecos. Ser., Hughly-Matla Estuary., Zool. Surv. Ind.*, Part-2 : 327-338.
- Bhadra, Sipra. 1995. Portunidae : Decapoda : Crustacea. *Est. Ecos. Ser., Hughly-Matla Estuary., Zool. Sur. Ind.*, Part-2 : 249-268.
- Mukhopadhyaya, S. K. 1995. Holothuroidea : Echinodermata. *Est. Ecos. Ser., Hughly-Matla Estuary., Zool. Sur. Ind.* Part-2 : 339-344.
- Misra, A. 1995. Polychaetes. *Est. Ecos. Ser., Hughly-Matla Estuary., Zool. Sur. India.*, Part-2 : 93-155.
- Mitra, S., Chatterjee, T. K. and Haldar, B. P. 2002. On the occurrence of an Echiurid, *Anelassorhynchus microrhynchus* (Prasad) [Echiura : Echiurida : Echiuroinea] From Digha Coast of West Bengal (Abs.), *Proc. Ind. Sc. Cong. Ass.* [Sec : Zoology, Entomology & Fisheries], 45.
- Reddy, K. Narapu, 1995. Hermit Crabs (Crustacea : Decapoda), *Est. Ecos. Ser. Hughly-Matla Estuary, Zool. Sur. Ind.*, Part-2 : 199-215.
- Reddy, K. Narapu, 1995. Prawns and Shrimps (Crustacea : Decapoda), *Est. Ecos. Ser., Hughly-Matla Estuary, Zool. Sur. Ind.*, Part-2 : 289-314.
- Ramakrishna and Sarkar, J. 1998. Faunal Diversity in India : Ctenophora., *ENVIS, Zool. Sur. Ind.*, 45-48.
- Ramakrishna and Sarkar, J. 2003. On the Scyphozoa from East Coast of India, including Andaman & Nicobar Islands. *Rec. zool. Surv. India.* **101**(1-2) : 25-56.
- Subba Rao, N. V., Dey, A. and Barua, S. 1992. Estuarine and Marine Molluscs. *State Fauna Series* 3. Fauna of West Bengal : *Zool. sur. Ind.*, Part-9 : 129-268, 3 pcs.
- Subba Rao, N. V., Dey, A. and Barua, S. 1995. Molluscs. *Est. Ecos. Ser., Hughly-Matla Estuary Zool. Sur. India.*, Part-2 : 41-90.
- Sastry, D. R. K. 1995. Asteroidea, Ophiuroidea and Echinoidea (Echinodermata). *Est. Ecos. Ser., Hughly-Matla-Estuary : Zool. Surv. Ind.*, Part-2 : 327-338.
- Sastry, D. R. K. 1998. Echinodermata. *State Fauna Ser. 3 : Fauna of West Bengal : Zool Sur. Ind.*, Part-10 : 463-489.
- Talukdar, S., Sarkar, J. and Ramakrishna. 1996. New fishing gear at Digha (West Bengal) threatens biodiversity. *J. Andaman Sc. Ass.* **12**(1 & 2) : 94-96.

PLATE I



Fig. 2. Mud flat area near Jalda khoti : Ideal habitat of Fiddler crabs, Hermit crabs, *Scylla serrata*, *Lingula*, *Polychaetes*, *Littorina*, *Cerithidea*, *Telescopium*, *Acrilla* etc.



Fig. 3. Collection of post-larva of *Pinnax monodon* by fixed bag net at Digha-Shankarpur coast.

PLATE II



Fig. 4. Sorting of post-larva of *Penaeus monodon* from other invertebrates, fished in bagda net.



Fig. 5. Discarded bicatch material after sorting of post-larva of *P. monodon*; which include a large number of invertebrates of almost all faunal groups.

PLATE III

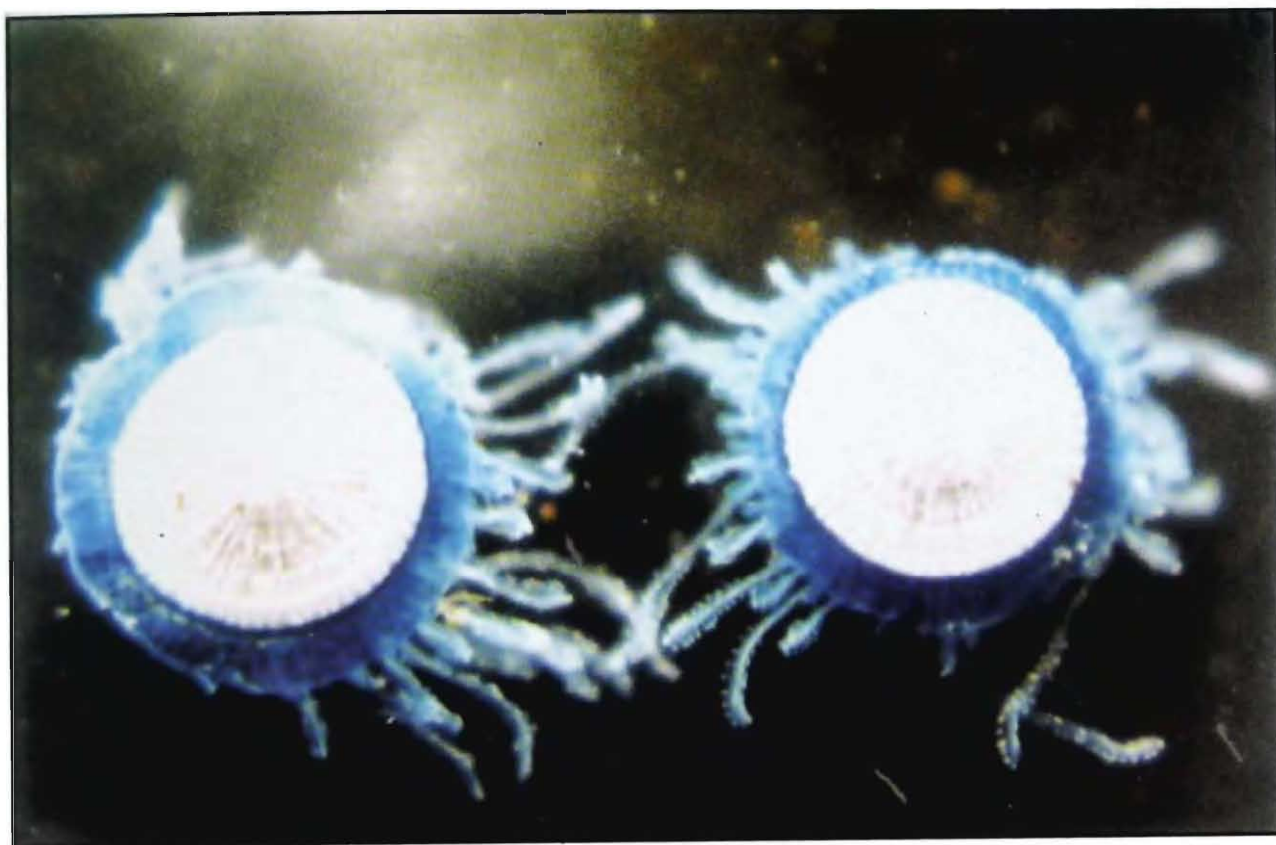


Fig. 6. Blue disc : *Porpita porpita* Linnaeus.

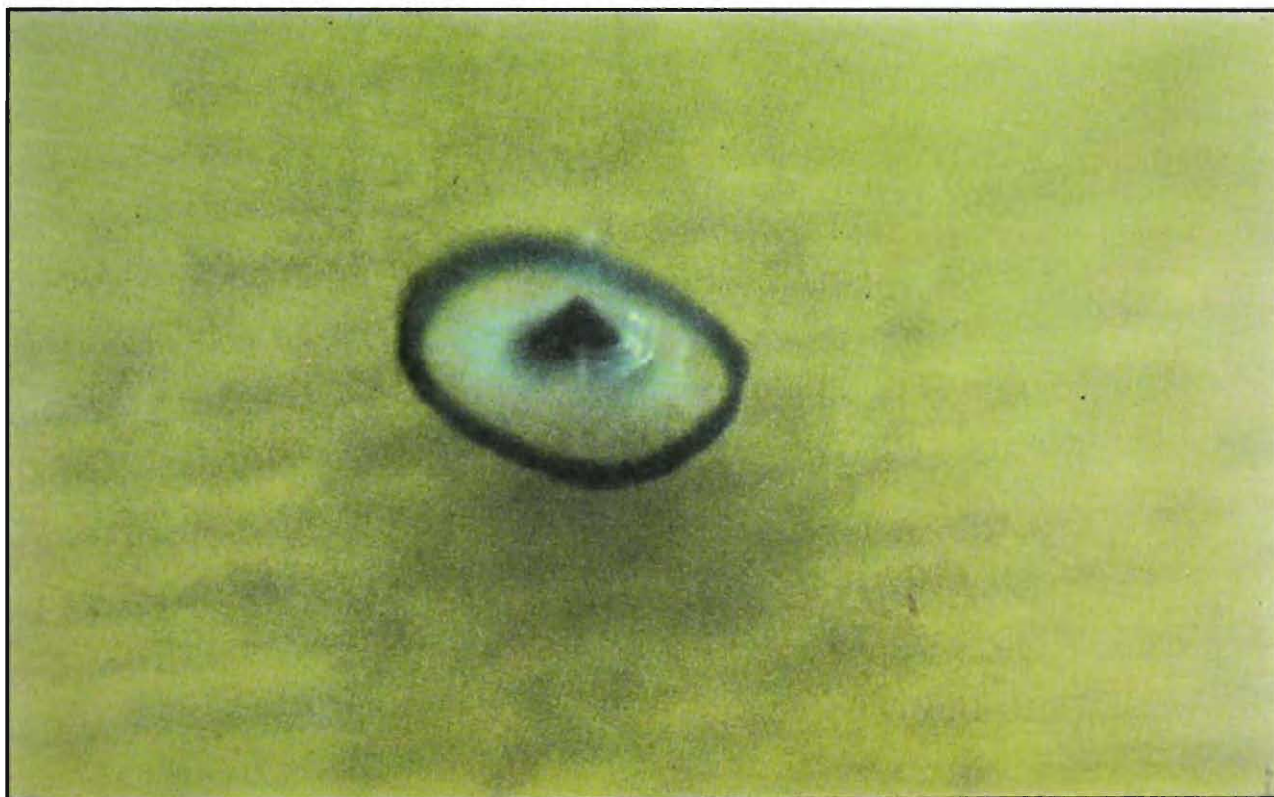


Fig. 7. *Velella velella* (Linnaeus).

PLATE IV



Fig. 8. Colonies of Sea fan : *Obelia spinulosa* (Bell) on the shell of live *Donax incarnatus*.



Fig. 9. Jelly fish : *Acromitus rabanchatu* Annandale.

PLATE V

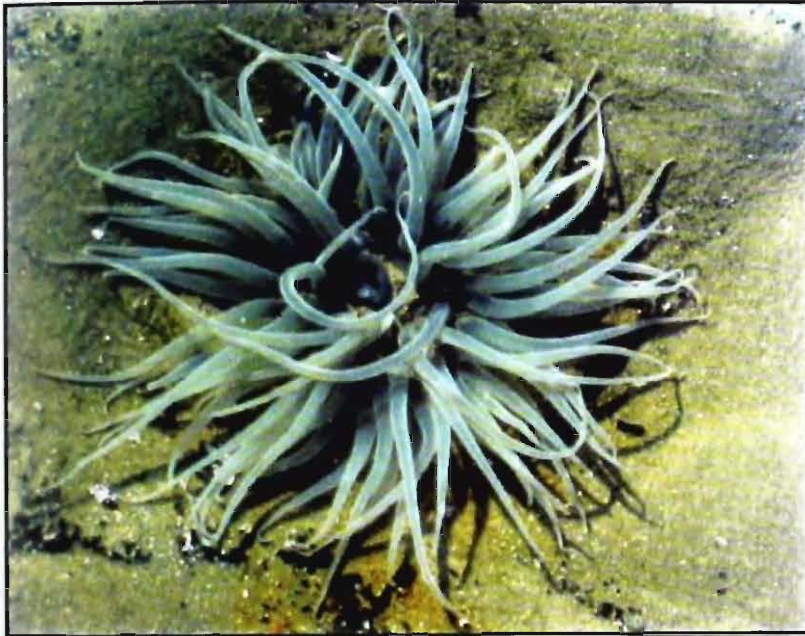


Fig. 10. Sea anemone : *Paracondylactis indicus* Dave.



Fig. 11. Feathered Seapen : *Pteroeides esperi* Herklots.



Fig. 12. Sea gooseberry : *Pleurobrachia globosa* Mosser.

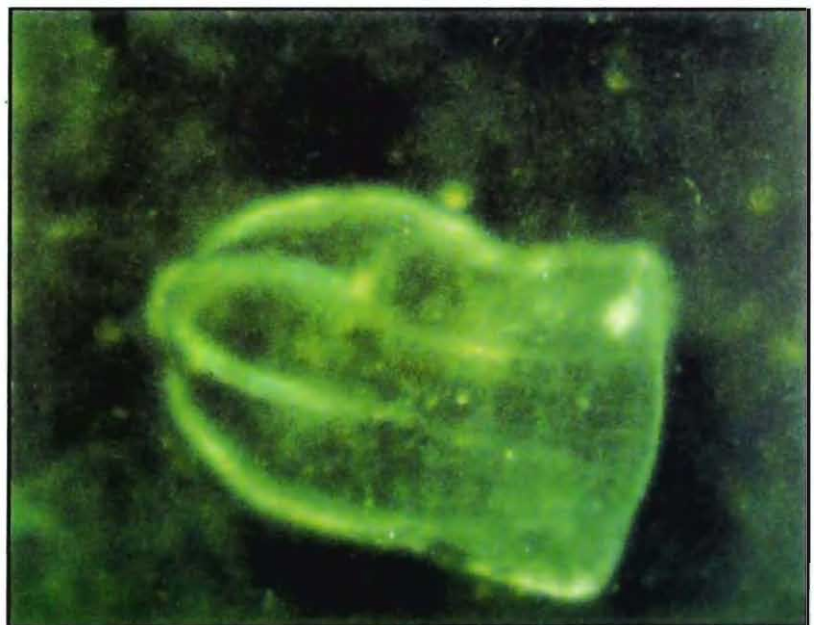


Fig. 13. Comb jelly : *Beroe* sp.

PLATE VI



Fig. 14. Fire worm : *Chloeia parva* Baird.



Fig. 15. Three-spotted crab : *Portunus sanguinolentus* (Herbst).



Fig. 16. Cross & Angle crab : *Charybdis* sp.

PLATE VII



Fig. 17. Red crab : *Ocypoda macrocera* H. Milne Edwards.



Fig. 18. Fiddler crab : *Uca triangularis*.



Fig. 19. Fiddler crab : *Uca lactea*.

PLATE VIII



Fig. 20. Star barnacle : *Chthamalus stellatus* (Poh.) on intertidal boulders.

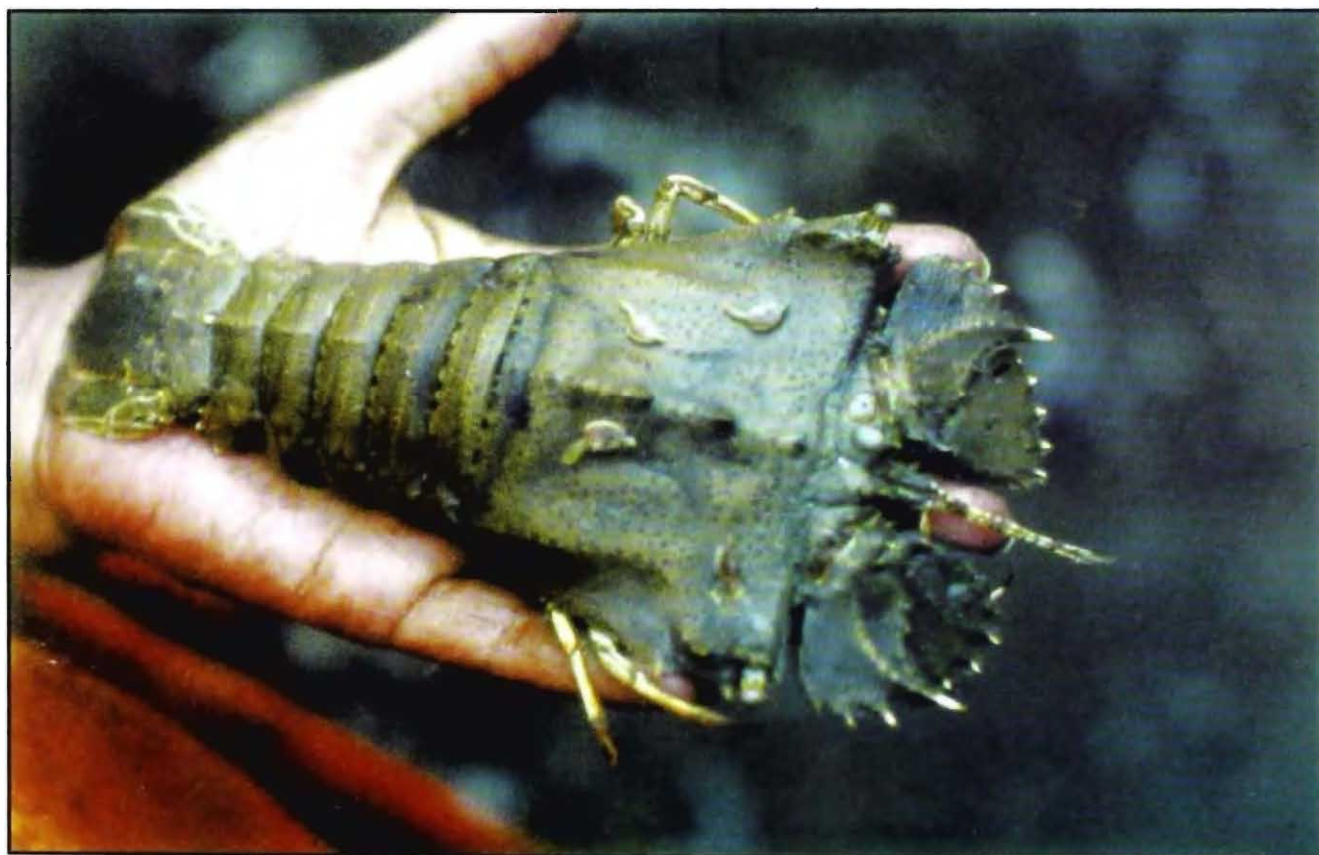


Fig. 21. *Octolasmis warwicki* Gray on Flat-head locust lobster, *Thamus orientalis* (Lund).

PLATE I X



Fig. 22. Hermit crab : *Coenobita cavipes* Stimpson.

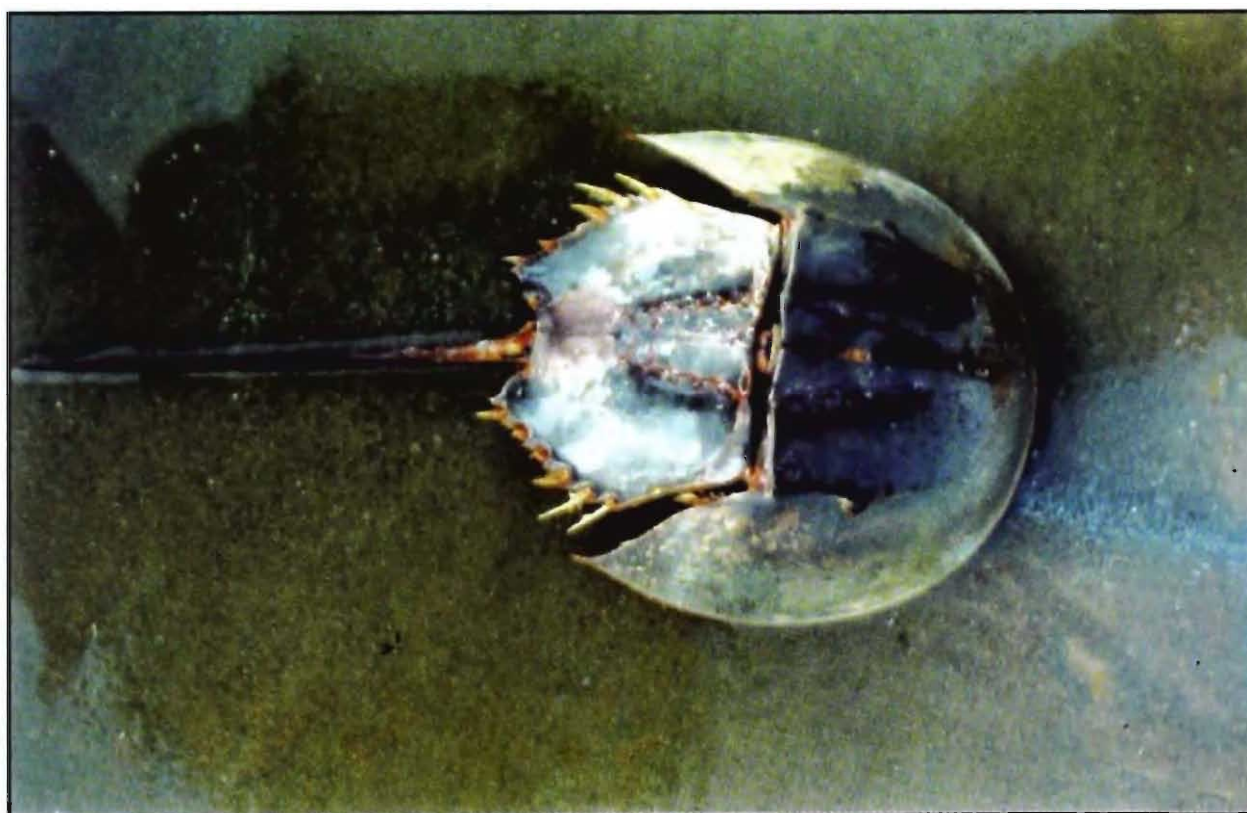


Fig. 23. Smooth-tailed Horse-shoe crab : *Carinoscorpius rotundicauda* (Latreille)

PLATE X



Fig. 24. Limpet, *Amathina tricarinata* (Linnaeus) on oyster shell.



Fig. 25. Black Sea-slug : *Melanochlamys* sp.



Fig. 26. *Siliqua radiata* (Linnaeus).



Fig. 27. Green mussel : *Perna viridis* (Linnaeus).

PLATE XI



Fig. 28. Spineless cuttle fish : *Sepiella inermis* (Ferussac & Orbigny).



Fig. 29. Squid : *Loliolus investigatoris* Goodrich.



Fig. 30. Feathered-arm Sea-star : *Astropecten euryacanthus* Luetken.



Fig. 31. Brittle star : *Ophiocnemis marmorata* (Lamarck).

PLATE XII

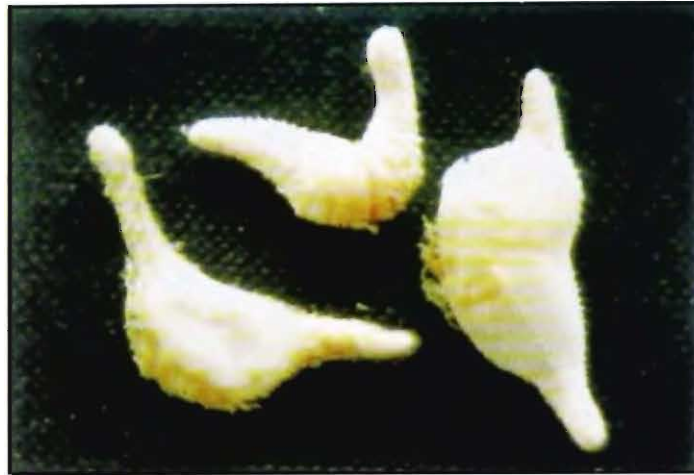


Fig. 32. 'U' shaped Sea cucumber : *Thorsonia investigatoris* (Kochler & Vaney).

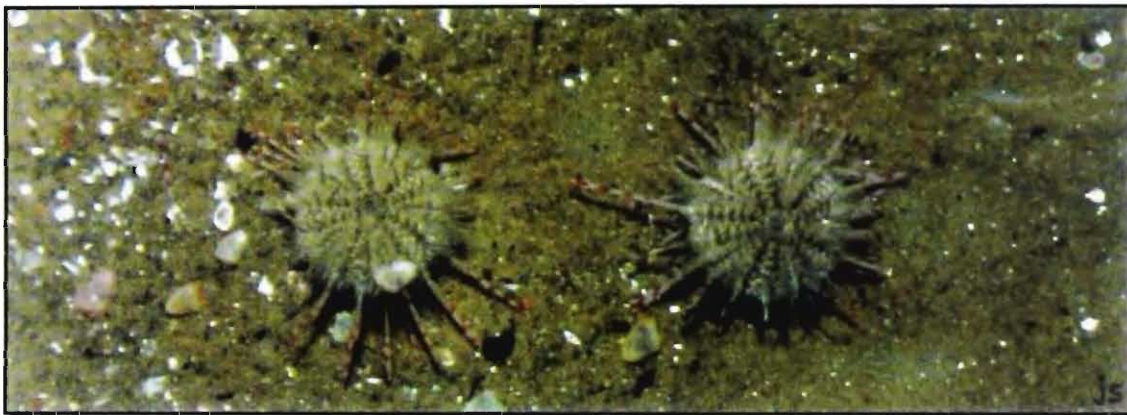


Fig. 33. Small Sea urchin : *Temnopleurus torquaticus* (Leske).



Fig. 34. Lamp shell : *Lingula anatina* Lamarck.

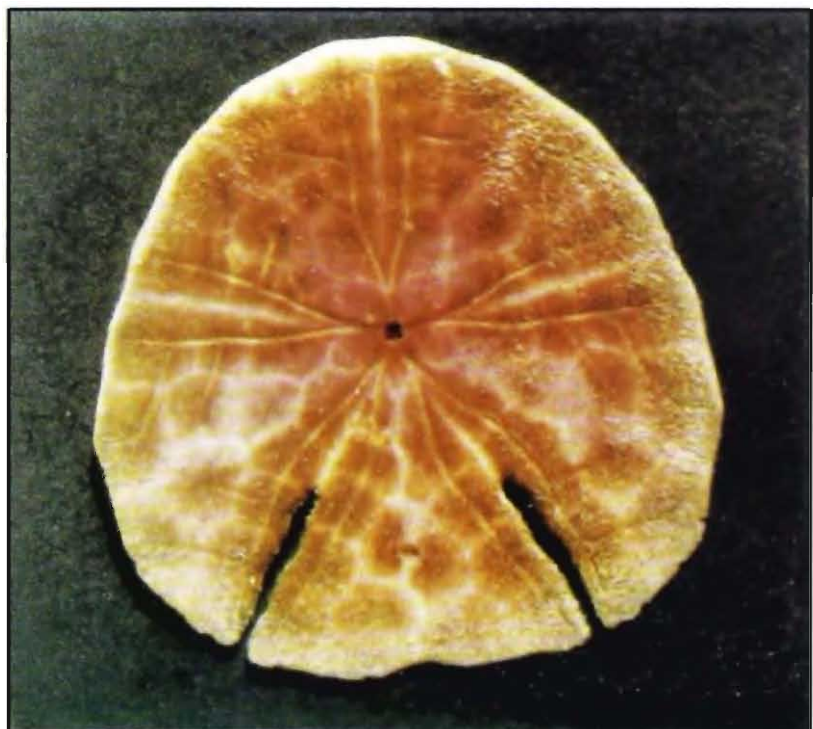


Fig. 35. Lamp shell : *Echinodiscus auritus* Leske.

POPULATION DYNAMICS AND BIOLOGY OF AQUATIC GASTROPOD, *GYRAULUS CONVEXIUSCULUS* (HUTTON) IN A SMALL POND

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INTRODUCTION

One of the most important features of the ponds, man-made lakes and reservoirs of the south eastern region of West Bengal state of the country, is the abundance of gastropods in littoral zones. The most common and abundant malacofauna comprised of several species belonging mainly to genera *Pila*, *Thiara*, *Bellamya* and *Gabia* among prosobranchs and *Endoplanorbis*, *Lymnaea*, and *Gyraulus* among pulmonates. A number of species belonging to families Planorbidae and Lymnaeidae have got considerable attention because of their role in the transmission of helminthes parasitic diseases.

Gyraulus convexiusculus (Hutton) is one of the most important species of the genus that has been reported to act as intermediate host for several trematode parasites. In spite of its importance, it is surprising that very little information is available on the population dynamics and biology of the species from its entire range of distribution which includes Iran, Afghanistan and Philippines, besides Indian subcontinent. However, the species of *Gyraulus* occurring in New World has been the subject of ecological studies by some workers (Gillespie, 1969; Ekblad, 1971, 1973), but works on this species too is not as intensive as on some other pulmonates like *Lymnaea* spp. (Berrie, 1965; Borey, 1964, Eisenberg, 1966, 1970),

The present report is a part of the detailed studies on the ecology of some important gastropods of this region and deals with the seasonal fluctuation in the abundance, population cycle and growth rate of *Gyraulus convexiusculus* (Hutton) in a small pond of Calcutta, India.

MATERIAL AND METHODS

The study area

The pond, known as Manohar Das Pukur, is situated in central Calcutta urban area, and is a small water body of about 2 ha. It is primarily meant for recreation/aesthetic purposes but used by a large number of people for various undesirable uses. With the result it was highly eutrophic and covered by dense strands of water hyacinth *Eichhornea* sp. during the entire period of investigation. No commercial or sport fishing operations is carried out.

Study period

The studies were carried out for two consecutive years (annual cycles), 1995-96 and 1996-97, starting from February 1995. The annual cycles were divided into three major seasons *viz.* Premonsoon (March–June), Monsoon (July–September) and Postmonsoon (November–February), each consisting of two parts-early (I) and late (II). These have been designated as PRM-I and PRM-II (premonsoon), M-I and M-II (monsoon) POM-I and POM-II (postmonsoon).

Sample collection and analysis

Samples were collected from littoral zones at three different centres with the help of a $0.5 \times 0.5 \times 0.5$ m wooden frame net covered from all side except one on top (opening/mouth) by mosquito net cloth of 0.5 mm mesh size. This net covered an area of 0.5 m^2 . For quantitative collections, the net was placed firmly upside down in the Littoral zone between the water depth of 0.25 to 0.45 m and all macrophytes and top 15 cm layer of soil was excavated by inserting a sharp edged iron sheet, almost of the size of the net mouth. The net was gradually turned up keeping the mouth covered by the iron sheet. The content of net was thoroughly examined and all the gastropods were picked up and fixed in 4% formaldehyde solution. The sorting of the individuals of the species was done in laboratory. The sizes were measured with the help of a dial caliper to nearest 0.1 mm and grouped into separate size classes. The individuals were further grouped into youngones, juveniles and adults. The weight was measured to nearest 100 mg with the help of jeweler's double pan balance. Dry weight measurements were carried out after drying in an oven at 65°C for 4 days.

The rate of population changes or instantaneous rate of population growth 'r' was calculated as

$$R = \ln N_t - \ln N_0 / t$$

Where N_t and N_0 are the numbers in the population at the time of sampling and t days earlier.

Mean biomass was determined by multiplying the number of Individuals in each size class with the mean dry weight of the size class and summing them as already described (Khan and Choudhury, 1984) for another gastropod species.

RESULTS

SYSTEMATIC POSITION

Phylum MOLLUSCA

Class GASTROPODA

Subclass PULMONATA

Order BSOMMATOPHORIA

Family PLANORBIDAE

Genus *Gyraulus*

Species *G. convexiusculus*

1894. *Planorbis convexiusculus* Hutton, *J. Asiat. Soc. Beng.*, 18(12) : 657 (Type Locality Afghanistan).

Salient features : Very small discoidal shell; apex and whorl on same plane, not exceeding 0.5 cm in diameter, greatly depressed, periphery subungulate, obliquely striate. Whorls 4-5 rounded, widely coiled. Coils almost abruptly increasing without transverse ribs, last one relatively large but embracing only a little part of the preceding whorl. When viewed vertically, all whorls are seen. Aperture oval shaped; lips simple. Redula well developed, sharp and pointed; bicuspid central tooth, inner lateral bicuspid, out lateral tricuspid, marginal multicuspid.

Distribution : Asian species, occurs between Iran and Philippines, covering south-east Asia.

Habitat : Occurs abundantly in almost all types of freshwaters, especially with macrophytes.

Host : *G. convexiusculus* acts as intermediate host to several trematode parasites. Larval forms of *Gastrothylax erumenifer*, *Paramphistomum explanatum*, *Fassciola elongatus* and other cercariae viz. *C. chugtali*, *C. gyraulusi*, *C. rithorensis* and *C. furgolensis* have been reported to use the species as their intermediate host (Subba Rao, 1989)

Annual cycle

The life cycle of the species was traced for two consecutive years (1995-96 and 1996-97). The length frequency distribution graph (Figs 1a and 1b) clearly depicted the seasonal and annual patterns of the abundance of the species. In PRM-I of the first annual cycle (1995-96), when the studies commenced, there were two modes visible, first, the older one at a modal length of 3.75 mm size group, forming smaller peak and second one pertaining to young individuals of the population at modal length of 1.75 mm, forming the larger peak. The abundance of smallest size group individuals during this period clearly signified the breeding of the species. During the following period (PRM-II), the two peaks progressed further forming modes at 4.35 and 2.75-mm size groups respectively. During subsequent period (M-I), there was again an abundance of younger individuals forming mode at 1.75 mm size group, indicating second spawning. The oldest mode of earlier period was not seen and the second mode further moved forming peak at 3.25-mm size group. During next period (M-II), the two existing modes progressed forming modes at 3.75 and 2.25-mm size group. No entry of new individuals in the population was noticed during both periods of postmonsoon season and only existing individuals grew forming modes at 4.35 and 2.75 size groups during POM-I and at 4.75 and 3.25 mm in POM-II. POM-II period was characterized by the existence of largest sized individuals in the population. During the next annual cycle (1996-97), almost similar pattern was noticed.

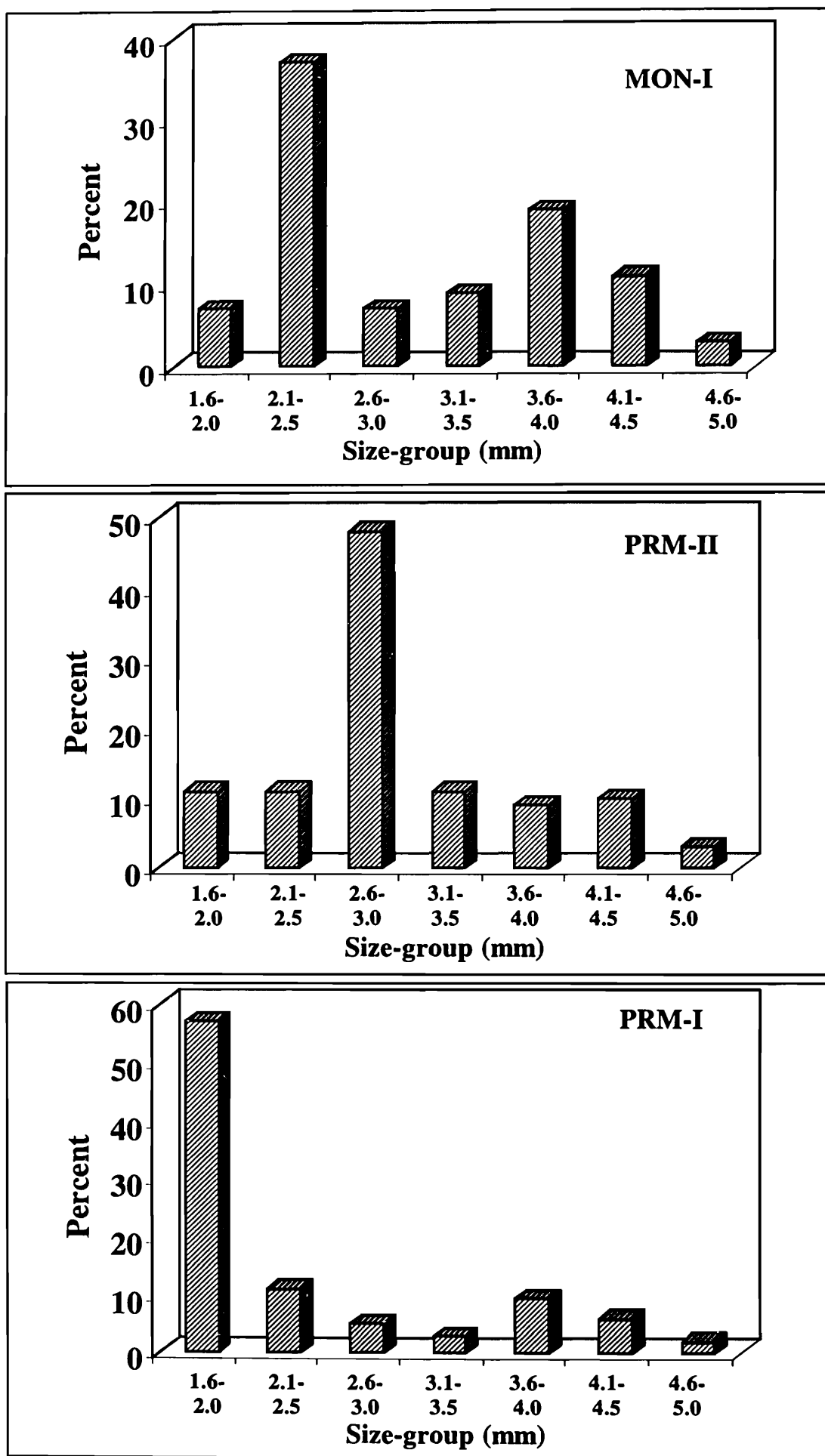


Fig. 1a. Size frequency distribution of *G. convexiusculus* during PRM-I, PRM-II and MON-I of 1995-96.

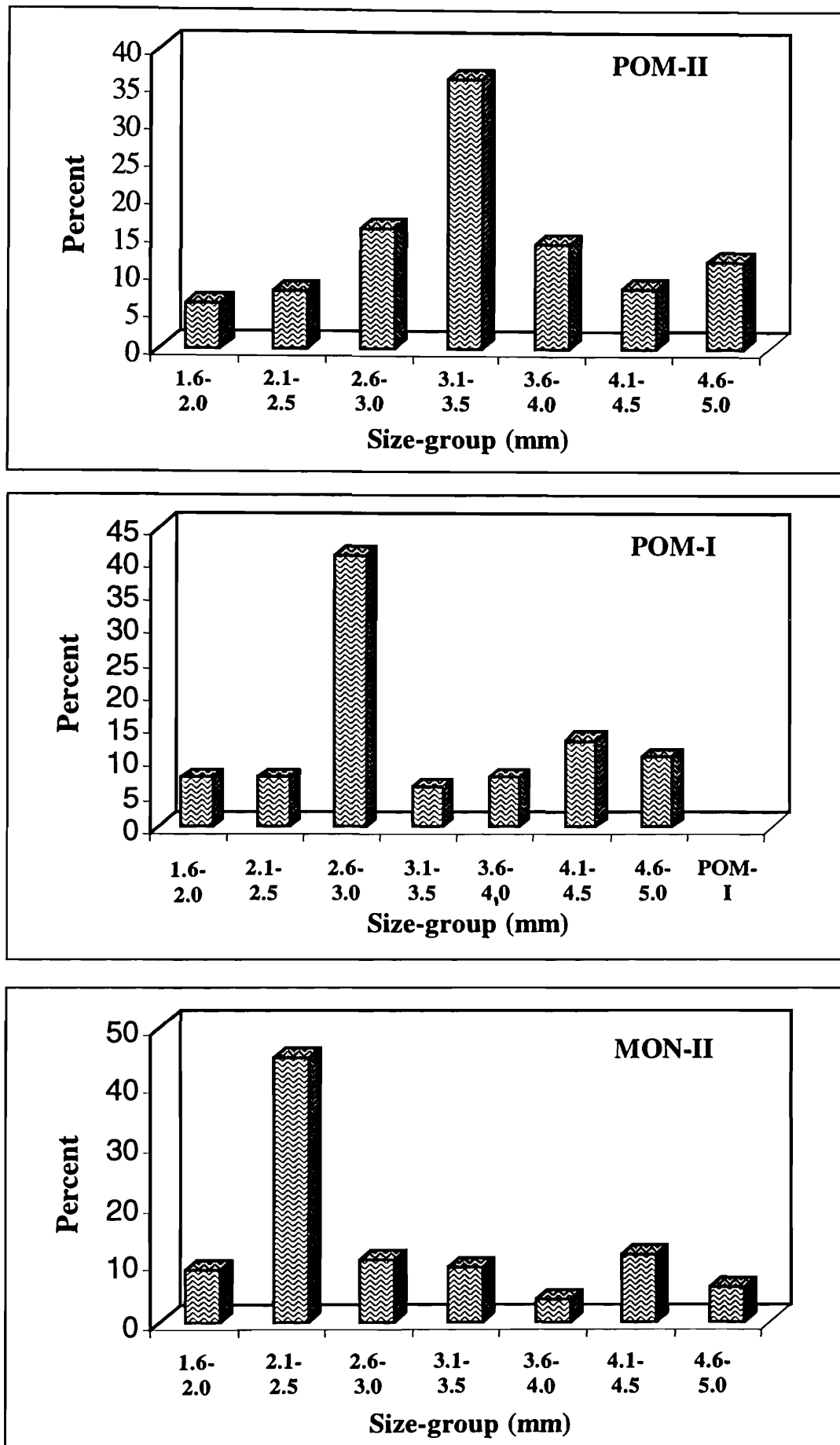


Fig. 1b. Size frequency distribution of *G. convexiusculus* during MON-II, POM-I and POM-II of 1995-96.

Age

From the size-frequency graph (Figs. 1a and 1b) it is clear that there were two spawning in each annual cycle, first during PRM-I and second during MON-I periods. During all other periods modes were at higher size groups. Further, the snails of above 4.75-mm length group were never seen. The contribution of this size class was lowest in the population during all periods of both annual cycles. This indicated the maximum size attained by the species in the pond. The drastic decrease or total absence of this size group in subsequent samples also indicated their elimination from the population. The duration from the appearance of new individuals in the population to the time they attained this maximum size was found to be 12 months (PRM-I to POM-II). This was possibly the maximum life span of the species.

Growth rate of Individuals

Growth rate of individuals was estimated from the mean modal lengths from size-frequency graph (Table 1). The smallest mode of 1995-96 annual cycle at 1.75 mm (PRM-I), which belonged to just reproduced individuals, grew to 4.75 mm at the end of the year in POM-II. Therefore total length increment gained during a full year was approximately 3.00 mm which gave the mean growth rate of 0.5 mm per period.

Table 1. Mean model length during different seasons of *G. convexiusculus*. as derived from length frequency distribution graph.

Season	1 st Mode		2 nd Mode		3 rd Mode	
1995-96	Mean Length (mm)	Length Increment	Mean length (mm)	Length increment	Mean length (mm)	Length increment
PRM-I	3.32	—	1.75	—	—	—
PRM-II	4.25	0.50	2.75	1.00	—	—
MON-I	—	—	3.25	0.50	1.75	—
MON-II	—	—	3.35	0.50	2.25	0.50
POM-I	—	—	4.25	0.50	2.75	0.50
POM-II	—	4.75	4.75	0.50	3.25	0.50
1996-97						
PRM-I	4.25	—	1.75	—	—	—
PRM-II	4.25	0.50	2.25	0.50	—	—
MON-I	4.75	0.50	3.25	1.00	1.75	—
MON-II	—	—	3.75	0.50	2.25	0.50
POM-I	—	—	4.25	0.50	2.75	0.50
POM-II	—	—	4.75	0.50	3.25	0.50

Relative composition

The species occurred throughout the year during both annual cycles and alongwith the prosobranch, *Bellamya bengalensis* (Lamarck) formed the bulk of total gastropod population (Fig. 2). There occurred three other gastropod species in the pond namely *Lymnaea acuminata* (Lamarck), *Indoplanorbis exustus* (Deshayes) and *Thiara lineata* (Gray) but their densities were always very low. The contribution of the species to total gastropod population was considerably higher during major part of the year and varied between 34.66% (PRM-I) and 63.42 % (MON-II) during first annual cycle and between 38.50% and 60.25% during second annual cycle.

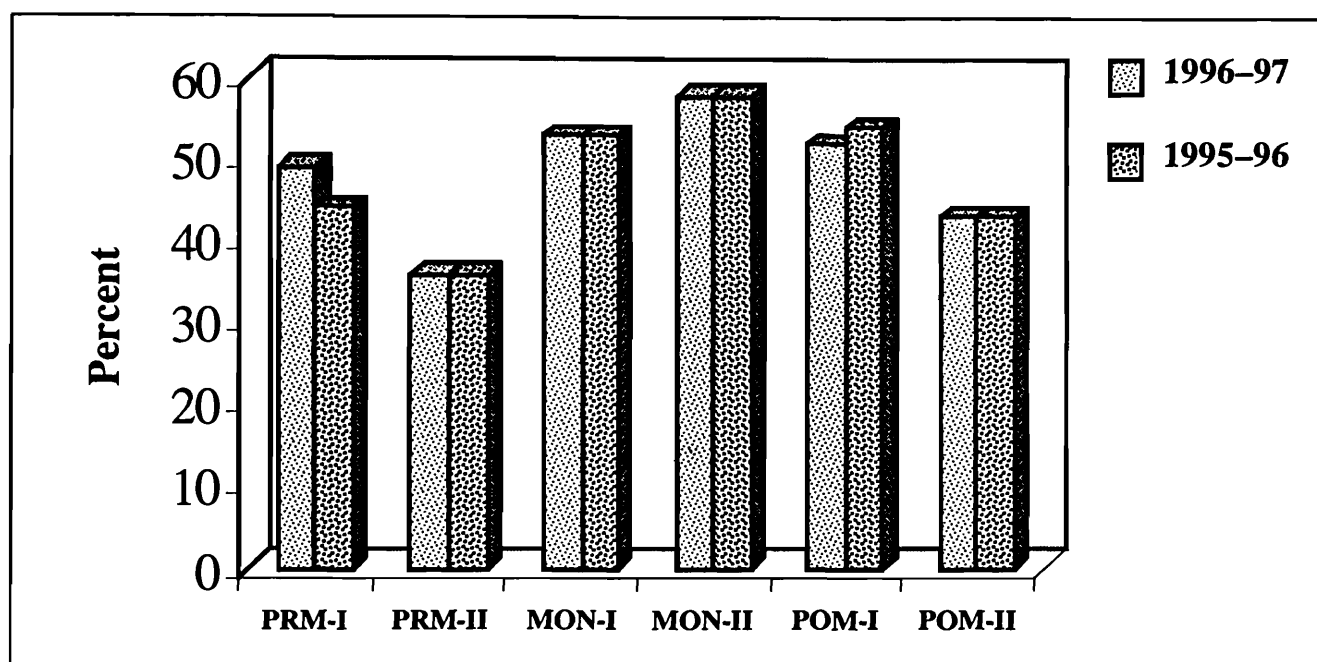


Fig. 2. Seasonal variation in the Relative composition of *G. convexiusculus* to total Gastropods.

Population Structure

The juveniles of the species formed the most consistent and sizable part of the population throughout the year (Fig. 3). The contribution of youngones was higher only during the breeding periods. The mean annual ratio of youngones, juveniles and adults were 26.5 : 38.0 : 35.5 during first annual cycle and 21.8 : 42.8 : 35.4 during second annual cycle.

Population density

During first annual cycle, its mean density varied between 187 individuals/m² in PRM-I to 57 individuals/m² in POM-II with an annual mean of 119.16/m². There were two period of increased occurrence, first in PRM-I and second in MON-I. Both the peaks were due to the entrance of newly bred individuals in the population. During second annual cycle the density varied between 260 (PRM-I) and 85 (POM-II) individuals/m² with annual mean of 157 individuals/m². A bimodal pattern of increased density was observed during both annual cycles (Fig. 4).

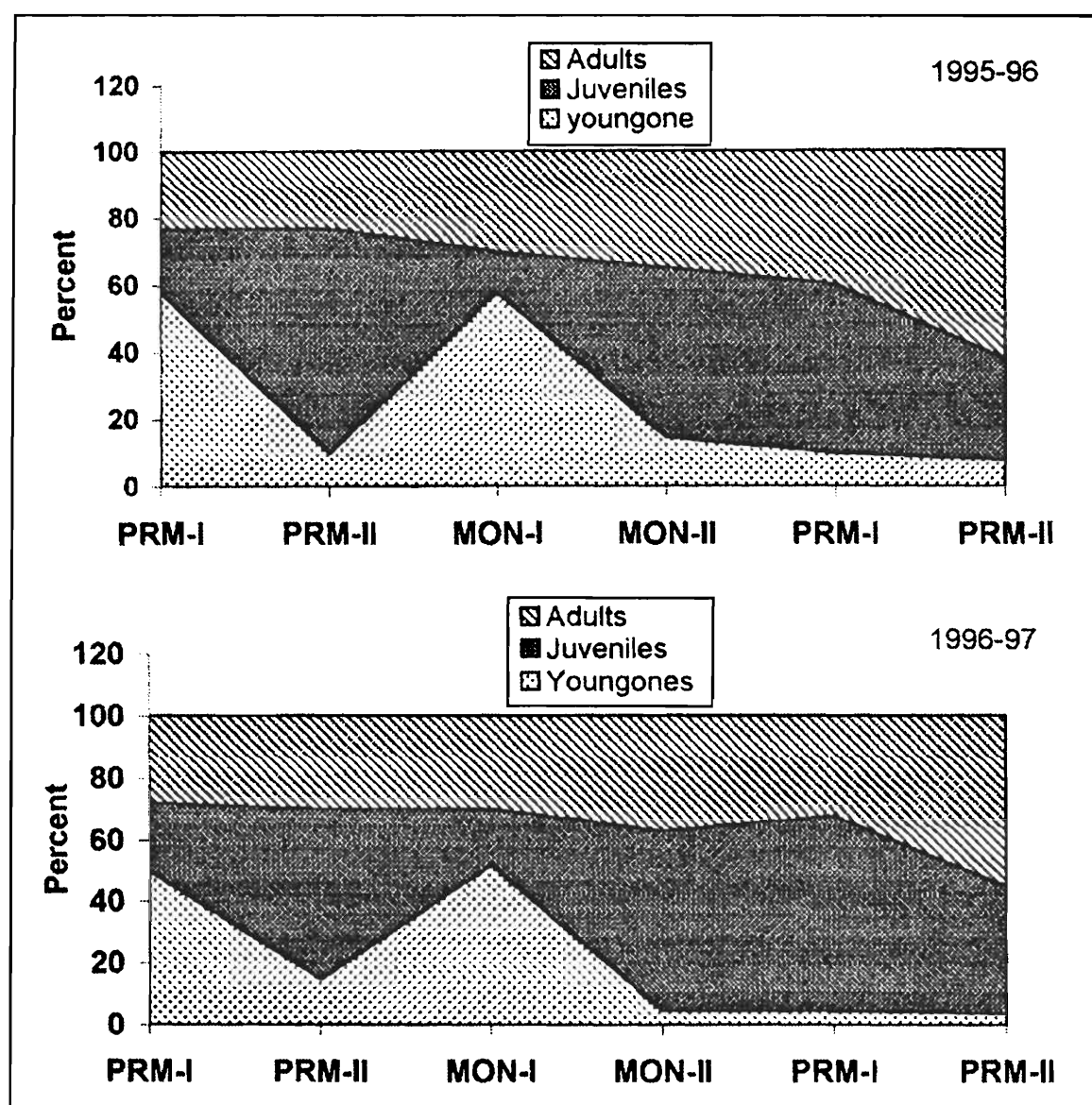


Fig. 3. Seasonal variations in the population structure of *G. convexiusculus*.

Biomass

Highest biomass (Fig. 5) was recorded in PRM-I of 1996-97. In spite of wide variations in mean individual weight, the pattern of total standing crop biomass generally followed density trends. This was due to the availability of a large number of individuals during the period when the mean individual weights were low i.e. breeding period. However, the bimodal pattern of fluctuation was not clear as in case of density.

Rate of population change

Table 2 gives the rate of population change 'r' in number and biomass during different period of the two annual cycles. The analysis revealed that except during the two breeding period (PRM-I and MON-I), the growth rate in number was negative throughout the year. The rate of change in biomass gave a slightly different picture. Contrary to the rate of change in number, the values for biomass increased progressively excepting between PRM-II and MON-I, the intervening period between two spawning period.

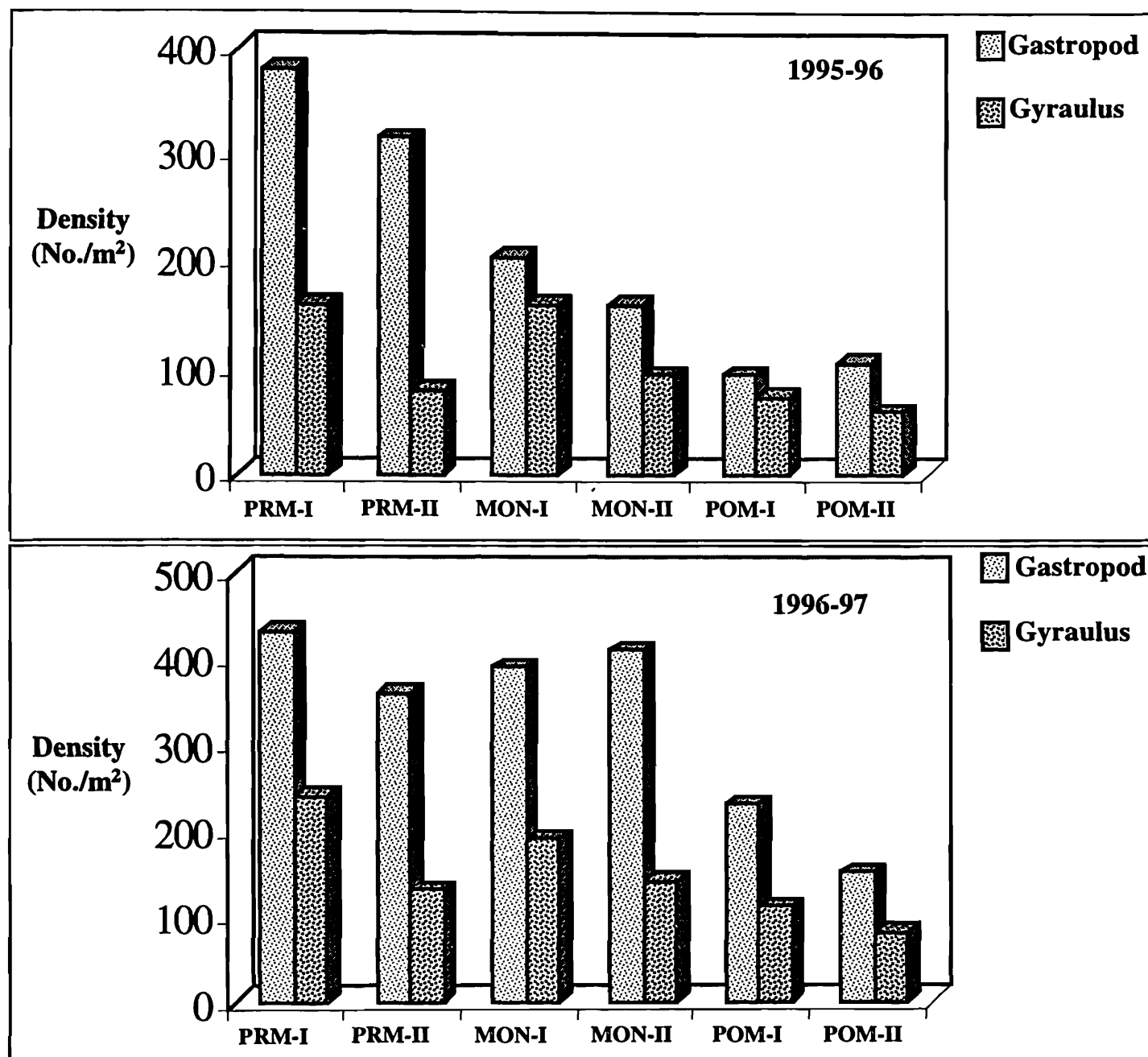


Fig. 4. Seasonal variations in the density of *G. convexiusculus*.

DISCUSSION

The gastropod community of the pond was always dominated by two species viz., *G. convexiusculus* and *Bellamya bengalensis* and both together formed nearly 82.6 and 83.46 % of the total gastropod population during the two annual cycles respectively. The other three species, which occurred in the pond, contributed very little. It appears that dominance of *G. convexiusculus* was a salient feature of this pond, as this species is known to occur in low numbers in other ponds of the region where such studies were carried out. Raut (1981), while studying the population dynamics of gastropods from this region reported that structure of gastropod biocoenosis varied from pond to pond and from season to season. Out of 5 ponds studied, he observed the dominance

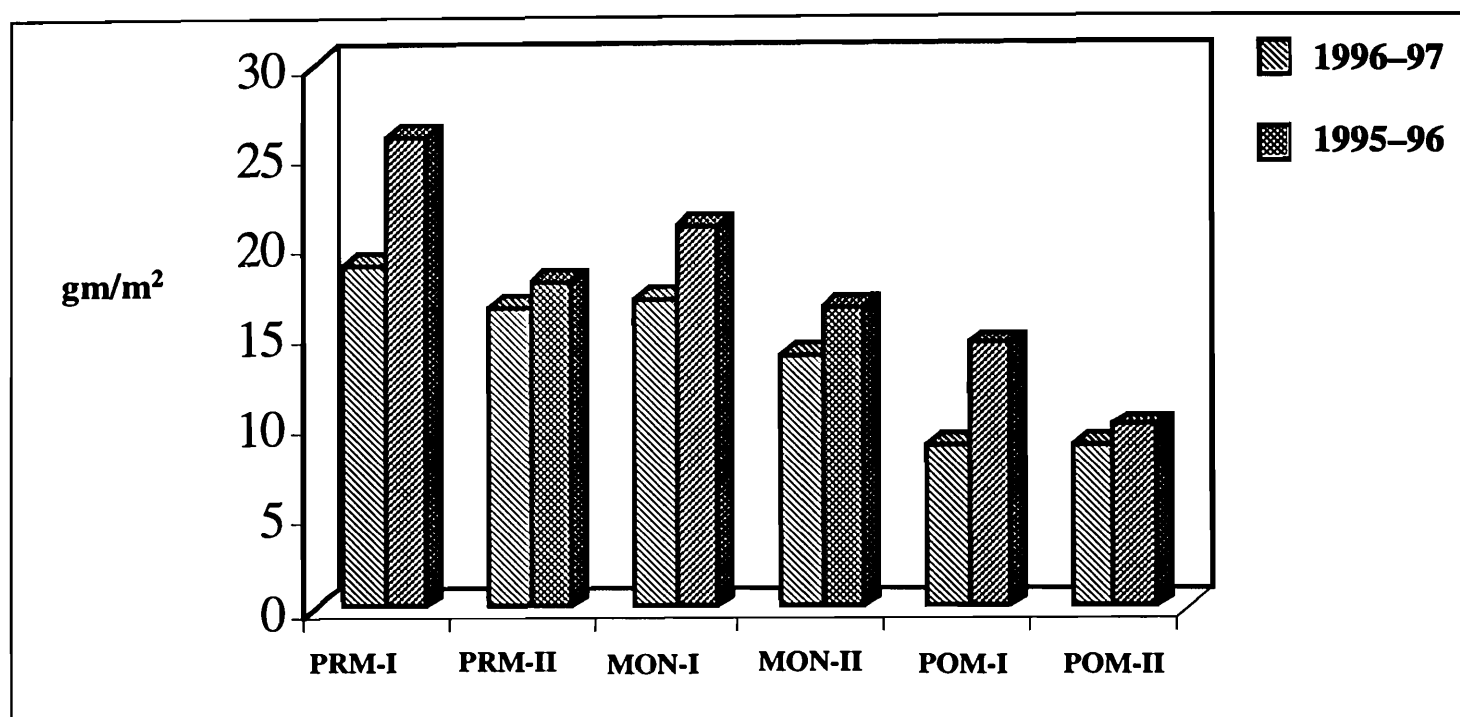


Fig. 5. Seasonal variations in the biomass (gm/m²) of *G. convexiusculus*.

Table 2. Population density, mean individual weight, biomass and rate of population change (r) of *G. convexiusculus*.

Season	Density (No/m ²)	Rate of Change (r)	Mean Individual weight (W)	Biomass (gm/m ²)	Rate of Change (r)
1995-96					
PRM-I	187		0.105	19.035	0.0048
PRM-II	125	0.0066	0.141	17.620	0.0086
MON-I	170	0.0050	0.110	18.700	0.0025
MON-II	111	0.0070	0.128	14.208	0.0017
POM-I	65	0.0087	0.142	9.230	0.0011
POM-II	57	0.0011	0.152	8.660	
1996-97					
PRM-I	258		0.105	27.09	
PRM-II	152	0.0086	0.128	19.45	0.0032
MON-I	199	0.0044	0.108	21.49	0.0027
MON-II	150	0.0046	0.116	17.46	0.0012
POM-I	110	0.0051	0.125	14.96	0.0017
POM-II	73	0.0067	0.136	9.93	0.0024

of *B. bengalensis* followed by *L. accuminata* in three ponds and dominance of *L. accuminata* followed by *B. bengalensis* in two ponds. Similarly, *B. bengalensis* was also found to dominate in a large man made lake (Khan and Choudhury, 1984). Not only in this part of the country but in general, different aquatic habitats are characterised by different gastropod community structure. Herman (1968), after surveying 562 habitats of New York, found that the three common species of the region, *Lymnaea palustris*, *Gyraulus parvus* and *Physa integra* do not commonly exist together. Rout (1981) further observed that there existed a strong competition for food and shelter within the community between the dominant species. However, during present investigation, there was no apparent competition either for food or shelter between the two dominant species, *B. bengalensis* and *G. convexiusculus*. This was probably possible due to niche segregation. While *B. bengalensis* generally occupied the bottom of littoral zone, *G. convexiusculus* was mostly found attached with the macrophyte *Eichhornia* sp. The other two gastropods, *Lymnaea accuminata* and *Indoplanorbis exustus* were also inhabitants of floating and submerged macrophytes but it appears that during competition, the density of these two species was heavily suppressed by *G. convexiusculus*. The latter species was able to utilize the resources of the habitat in a better way. The phenomenon supported the competitive exclusion principle that no two species of almost similar requirements can flourish together in same niche.

The seasonal variation in the abundance of the species followed a bimodal pattern with peaks in early postmonsoon and early monsoon. It has earlier been reported that in this region of the country, there is atleast one period of abundance in any gastropod species in a year (Annandale and Sewell, 1921; Raut, 1980). Bimodal pattern of abundance has also been observed in case of *Bellamya bengalensis* (Khan and Choudhury, 1984) but the period of abundance was different. In the absence of any other report on this species, its period of abundance in the region can not be generalized particularly when great variations have been reported in the life cycle patterns of gastropod between different habitats (Russell-Hunter, 1964).

Among the factors affecting the natural populations of gastropods, temperature and rainfall have been reported to play an important role, besides food supply. The population density of *G. convexiusculus* was not found to be very much affected by the temperature variations. Contrary to temperate waters or colder regions of the country, where cessation of growth or mass mortality during winter period occurs (Clampitt, 1970; Ekblad, 1973), the gastropod population of this region of the country do not appear to be affected markedly by temperature, as already reported (Khan and Choudhury, 1984). This is probably due to comparatively little variation in mean daily temperature over major part of the year. Except for a brief period during POM-II, the mean monthly temperature fluctuated around 30°C (mean of daily maximum and minimum). During postmonsoon period of late December and early January moderate drop in temperature occurs but it lasts only for a brief period of time.

Rainfall affected the population of the species considerably. The breeding during MON-I period corresponded well to other gastropods where normal breeding occurs just after monsoon (Annadale

and Sewell, 1922; Raut, 1981). The second breeding of the species during PRM-I was probably influenced by some other factors including the physiology of the species. Since no other account of its breeding is available, at present it can not be definitely said whether the twice in a year breeding was influenced by some local factor or the species normally breeds twice in a year. Further studies are required to understand the breeding behaviour of the species.

SUMMARY

Various aspects of the life cycle and population dynamics of freshwater pulmonate gastropod *Gyraulus convexiusculus* (Hutton) were studied in a small pond of Calcutta (West Bengal) for two years. The species occurred abundantly throughout the year and contributed about 34-65% to total gastropod population. Alongwith *Bellamya bengalensis* (Lamarck), it constituted the bulk of total gastropod density. The density of other three gastropods, *Lymnaea acuminata* (Lamarck), *Indoplanorbis exustus* (Deshayes) and *Thiara lineata* (Gray), which also occurred in the pond, was greatly reduced. Although significant variations in the density of the species between seasons and between two years were noticed, the pattern was almost similar during both years. Two peak periods of abundance were recorded, first in early premonsoon, and second in early Monsoon, both due to the abundance of newborn individuals. Excepting this period, juveniles always dominated the population composition.

Length frequency analysis revealed clear progressive modes during different seasons. The abundance of newly born individuals during early premonsoon and early monsoon signified the two breeding of the species in a year. The species grew upto 4.75 mm in length and its estimated life span was around 12 months.

The rate of population change (r) in numbers showed that except immediately after recruitment during the two periods, the population growth rate was negative during rest of the period. However, the change in mean weight continued to be positive because of progressive and rapid increase in individual weight

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REFERENCES

- Annandale, N. and Sewell R. B. S. 1921. The banded snail of India (*Viviparus bengalensis*). *Rec. Indian. Mus.*, **22** : 215-292.
- Berrie, A. D. 1965. On the life cycle of *Lymnaea stagnalis* (L.) in the west of Scotland. *Proc. malac. soc. Lond.*, **36** : 283-295.

- Borey, J. C. 1964. Studies on the ecology of *Lymnaea tomentosa* in the intermediate host of *fasciola hepatica*. 1. History, geographical distribution and environment. *Aust. J. Zool.*, **12** : 217-230.
- Clampitt, P. T 1970. Comparative ecology of snail, *Physa gyrinad*, *Physa integra*. *Malacologia*, **10** : 113-151.
- Ekblad, J. W. 1971. Weight-length regression models for there aquatic gastropod populations. *Amer. Midl. Natur.*, **85** : 271-274.
- Ekblad, J. W. 1973. Population studies of three aquatic gastropods in an intermittent backwater. *Hydrobiologia*, **41** : 199-219.
- Eisenberg, R. M. 1966. The regulation of density in natural population of pond snail, *Lymnaea elodes*. *Ecology*, **47** : 890-906.
- Eisenberg, R. M. 1970. The role of food in the regulation of pond snail, *Lymnaea elodes*. *Ecology*. **51** : 690-694.
- Gillespie, D. M. 1969. Population studies of four species of Mollusca in the Madison River, Yellowstone National Park. *Limn. Oceanogr.*, **14** : 101-114.
- *Herman, W. N. 1968. The distribution and ecology of aquatic gastropods of central New York with Illustrated keys to species and genera. *Ph.D. Thesis, Cornell University* : 398 pp.
- Khan, R. A. And Choudhury, S 1984). The population and production ecology of a freshwater snail, *Bellamya bengalensis* (Lamarck) (Gastropoda : Viviparidae) in an artificial lake of Calcutta, India. *Bull. zool. Surv. India*, **5** : 59-76.
- Rout, S. K. 1980. Preliminary observations on the breeding of banded pond snail. *Viviparus bengalenses* (Lamarck) (Gastropoda :Viviparidae). *Bull. Zool. Sur. India*, **3** : 47-50.
- Raut, S. K. 1981. Population interaction among freshwater snails. *Proc. Symp. Ecol. Anim.Pop., zool.Surv.India*, Pt.2 : 163-171.
- Russel-Hunter, W. 1964. Annual variations in the growth and density of natural freshwater snails of west Scotland. *Proc. Zool. Soc. Lond.* **136** : 219-263.
- Subba Rao, N. V. 1989. *Handbook of Freshwater Molluscs of India*. *Zool. Surv. India*. Calcutta : pp. 1-289.

ON A NEW SPECIES OF THE GENUS *BAYADERA* SELYS (ODONATA : EUPHAEIDAE) FROM INDIA WITH NOTES ON ITS INDIAN REPRESENTATIVE

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INTRODUCTION

Fraser (1934) provided a comprehensive account of Indian *Bayadera* species. Cowley (1936) described *B. kali* from Meghalaya. In recent times Indian species of the genus have also been dealt with by Kumar (1973), Singh and Prasad (1974), Lahiri (1975, 1987), Kumar and Prasad (1981), Prasad and Ghosh (1984) and Mitra (1999). Asahina (1978) described a genus closely allied to *Bayadera* Selys, e.g., *Schmidtiphaea* from Manipur. In the present paper a new species *Bayadera chittaranjani* has been described from Manipur together with some additional note on *B. indica* (Selys) and a revised key for identification of the known Indian species of the genus.

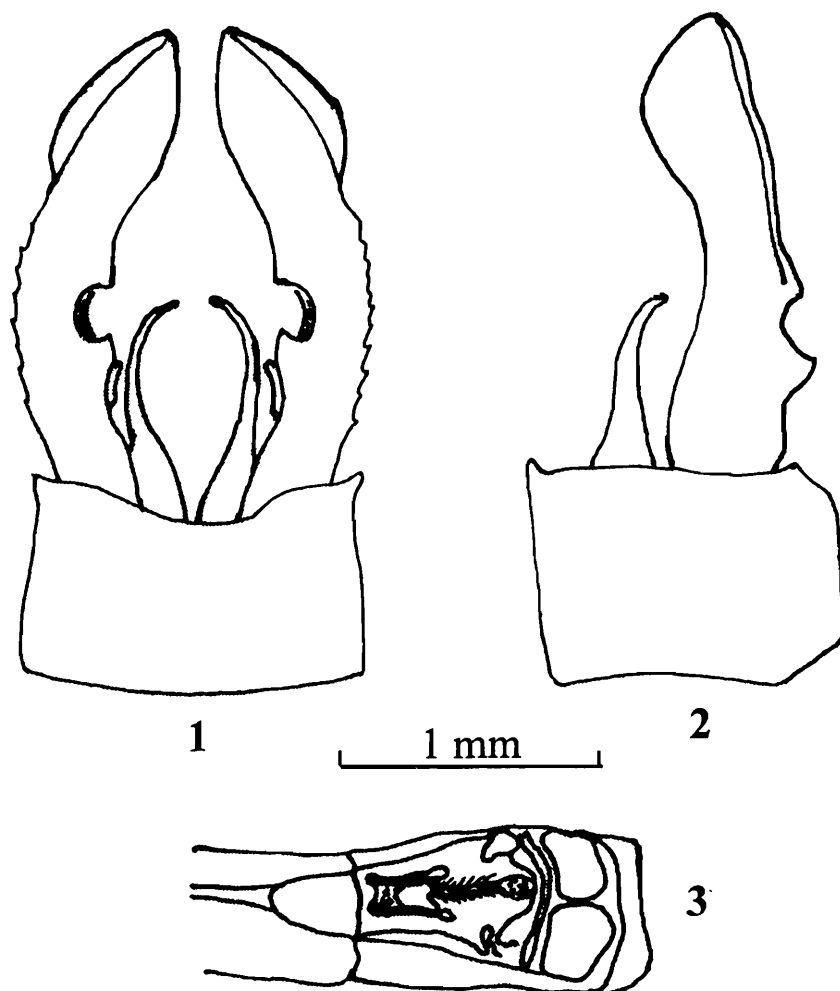
SYSTEMATIC ACCOUNT

Bayadera chittaranjani sp. nov.¹

(Figs. 1–3)

Description : Male : Black, with basal half of labial palpi and dorsum of head anteriorly covering face, frons, genae and vertex upto base of antennae yellow; the yellow colour also extending narrowly along the eyes backward upto ocellar space. Rest of body black unmarked. Wings hyaline; Rs fusing with R₁ at its origin for about six cells in forewing, for four cells in hindwing. Only one cubital nervure. R₃ originates distal to subnode by about 2 cells; pterostigma black and narrow covering 6 cells; 20 antenodal nervures in forewing, 17–19 in hindwing; 25–28 postanodal nervures in forewing, 26–27 in hindwing. Anal appendage (Figs. 1 and 2) black. Superiors about thrice as long as segment 10 of abdomen, in dorsal view broad at base, thereafter gently narrowing and curved inwards but expanding into a fusiform dilatation covering apical third of the length of the organ and ending in a subacutely pointed apex; the inner margin is marked by a deep semirounded excavation just before the middle; base of the excavation is produced as a robust tooth along the upper margin while the lower margin beneath the tooth is also marked by a narrow quadrate expansion that appears as a small ventral spine in semilateral view; the inner margin is also marked by a smaller tooth or tubercle

¹The species is named in memory of my beloved father Chittaranjan.



Figs. 1-3. *Bayadera chittaranjani* sp. nov., male; Figs. 1 and 2, anal appendage in dorsal and lateral view respectively; Fig. 3, genitalia.

at the apex of the excavation before the apical dilatation; the outer margin of superiors minutely serrated from near base to the base of the apical dilatation; in lateral view the superous broad at base and directed straight backwards with the submedian excavation and tooth partially visible and the apical dilatation visible only along lower margin; inferiors about half the length of the superiors, broad at base, gently narrowing upto apex, the apices curled inwards as seen from above, but curled upwards as seen in lateral view. Genitalia as in Fig. 3, penis shaft hairy.

Length : abd. + app. 53.00 mm; hindwing 35.00 mm.

Material studied : Holotype ♂ 15 km south of Chandil, Chandil district, Manipur, 18.2.1992, coll. R. S. Mathew (Z.S.I. Regd. No. 4074/H₁₃), deposited in the National Zoological collection.

Comparison : *Bayadera chittaranjani* sp. nov. differs from allied species of the genus in size, in its restricted (yellow) markings and unique shape of the anal appendages.

It comes close to *B. forcipata* Needham in its large size but differs from the same in the shape of the superior anal appendages and in having thorax and abdomen absolutely devoid of marking.

It is much larger than *B. hyalina* Selys, *B. bidentata* Needham, *B. kali* Cowley, *B. brevicauda* Fraser and *B. longicauda* Fraser (abdomen 53.00 mm vs 40.00 mm. or less) and also differs from them in the shape of the male anal appendage.

It differs from *B. indica* (Selys) in having hyaline wings (vs tipped with black) and the shape of the superior anal appendages (apex fusiform vs spatulate and shallowly notched).

From allied genus *Schmidtphaea* Asahina, also described from Manipur state it differs in having the vein Rs actually fused with R₁ (vs running close but parallel) for a longer distance (6 cells vs 4 cells in forewing, 4 cells vs 2 cells in hindwing).

Distribution : India : Manipur.

***Bayadera indica* (Selys)**

1853. *Epallage indica* Selys, *Syn. Cal.* : 49.

1890. *Bayadera indica* (Selys) : Kirby, *Syn. Cat. Neur. Odon.* : 108.

Material studied : 7 ♂♂, 5 ♀♀ Mon area, Nagaland, 12.6.1999. coll. Y N. P. Sinha.

Remarks : The species is recorded here for the first time from Nagaland. The specimens studied vary from published description of the species in being smaller in size (abdomen : ♂ : 31.00 mm vs 38.00–41.00 mm, ♀ : 33.00 mm vs 37.00 mm). Further, heavily pruinosed synthorax renders antehumeral stripes almost obscured.

Distribution : India : Uttar Pradesh, North Bengal, Sikkim, Meghalaya, Nagaland. Outside India : Bangladesh, Nepal and China.

Revised key for identification of Indian *Bayadera* species (Male)

1. Wings tipped with black *indica* (Selys)
 - Apices of wings hyaline 2
2. Smaller species with hindwing < 27.00 mm in length. *Kali* Cowley
 - Larger species with hindwing > 30.00 mm in length 3
3. Very large species (abdomen > 50.00 mm in length). Superior anal appendage with inner margin deeply excavated medially that is preceded by a robust tooth along upper edge besides ventral expansion *chittaranjani* sp. nov.
 - Moderately large species (abdomen about 40.00 mm or less in length). Superior anal appendage without median excavation and tooth as above 4
4. Ventral spine of superior anal appendage long *hyalina* Selys
 - Ventral spine of superior anal appendage small and shaped like a tubercle
..... *longicauda* Fraser

DISCUSSION

So far known, the genus *Bayadera* is known from five species in India of which *B. indica* (Selys) appears to be most well distributed one, its range of occurrence extending from Western

Himalayas, North Bengal, Sikkim to Meghalaya and Nagaland. Remaining four species of the genus are restricted in distribution, being confined to the states of Manipur (*B. chittaranjani* sp. nov.), Sikkim (*B. longicauda* Fraser) or Meghalaya (*B. kali* Cowley and *B. hyalina* Selys).

SUMMARY

Bayadera chittaranjani sp. nov. is described from Manipur and *B. indica* (Selys) reported from Mon area of the Nagaland state. A revised key for identification of all five species of the genus known from India is provided in the text.

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REFERENCES

- Asahina, S. 1978. A remarkable new damselfly allied to *Bayadera* (Odonata : Euphaeidae) *Proc. Japanese Soc. Syst. Zool.*, **14** : 43-46.
- Cowley, J. 1936. A new species of *Beyadara* (Odonata). *Ann. Mag. nat. Hist. London* (10), **18** : 477-482.
- Fraser, F. C. 1934. *Fauna of British India including Ceylon and Burma* 2 : xiii+398 pp. Taylor and Francis, London.
- Kumar, A. 1973. Descriptions of the last instar larvae of Odonata from Dehradun Valley (India) with notes on biology. I. Suborder : Zygoptera *Orient. Ins.*, **7** : 85-118.
- Kumar, A. and Prasad, M. 1981. Field ecology, zoogeography and taxonomy of the Odonata of Western Himalaya, India. *Rec. zool. Surv. India*, Occ. Pap. No. **20** : 1-118 pp.
- Lahiri, A. R. 1975. A note on behaviour of *Bayadera hyalina* Selys in the rain. (Zygoptera : Euphaeidae). *Odonatologica*, **4** : 255-257.
- Lahiri, A. R. 1987. Studies on the Odonate fauna of Meghalaya. *Rec. zool. Surv. India*, Occ. Pap. No. **99** : 1-402 pp, Figs.
- Mitra, T. R. 1999. Geographical distribution and zoogeography of Odonata (Insecta) of Meghalaya. *Rec. zool. Surv. India*, Occ. Pap. No. **173** : 1-63 pp.
- Prasad, M. and Ghosh, S. K. 1984. A note on the Odonata (Insecta) from Sikkim, India. *J. Bombay nat. Hist. Soc.*, **80** : 435-438.
- Singh, A. and Prasad, M. 1974. New records of Odonata from North-West India. *J. Bombay nat. Hist. Soc.*, **70** : 403-405.

A CHECKLIST OF SPIDERS (ARACHNIDA : ARANEAE) OF JABALPUR, MADHYA PRADESH, INDIA

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Jabalpur district lies in the eastern half of the state of Madhya Pradesh. A checklist of 88 species of spiders belonging to 18 families from Jabalpur is given. The checklist includes spider species collected in and around Jabalpur and identified by the author during July, 1997 to December, 2000. Some species collected by the scientists of Central Regional Station, Zoological Survey of India, Jabalpur have also been included in the list. Area-specific studies on the Indian araneae have been conducted by naturalists like Pocock (1900), Tikader (1970, 1977, 1980, 1982), Patel (1975), Tikader & Biswas (1981) and Gajbe & Rane (1992). However, spider fauna of Jabalpur was almost unknown before Gajbe & Gajbe (1999, 2000) and Bhandari & Gajbe (2001), who have described many new species of spiders from Jabalpur, thus, adding to our knowledge of the Indian araneae.

For the study, spiders were looked for in a variety of habitats such as cultivated fields, woods, hills, orchards, human dwellings, old buildings, gardens, fallow land and around water bodies like ponds and tanks. Specimens were also looked for under stones and loose bark, in leaf litter, on flowers and on the ground. Some spiders were hand collected, for collecting some, a sweep net was used, while many spiders were obtained by beating bushes with a stick and then collecting the falling spiders in an inverted umbrella. The spiders were preserved in 70% ethyl alcohol in small glass vials with screw caps. Each vial was provided with a label having the name of type-locality, collector's name and date of collection recorded on it. The spiders were examined under a binocular microscope and identified with the help of literature. The type specimens collected are deposited in the National Collection, Zoological Survey of India, Kolkata.

A total of 88 species of spiders belonging to 54 genera distributed in 18 families were recorded (Table-1). The family Araneidae (21 species) was the largest group, followed by Thomisidae (14 species), Gnaphosidae (13 species), Lycosidae (10 species), Philodromidae (7 species) and Oxyopidae (5 species).

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Table 1 : Checklist of spiders of Jabalpur, Madhya Pradesh.

S. No.	FAMILY/SPECIES	S. No.	FAMILY/SPECIES
I.	SCYTODIDAE	27.	<i>Neoscona rumpfi</i>
1.	<i>Scytodes sp.</i>	28.	<i>Neoscona elliptica</i>
II.	PHOLCIDAE	29.	<i>Neoscona theis</i>
2.	<i>Artema atlanta</i>	30.	<i>Neoscona platnicki</i>
3.	<i>Pholcus sp.</i>	31.	<i>Neoscona biswasi</i>
III.	OONOPIDAE	X.	LYCOSIDAE
4.	<i>Triaeris sp.</i>	32.	<i>Hippasa partita</i>
IV.	ERESIDAE	33.	<i>Hippasa pisaurina</i>
5.	<i>Stegodyphus sarasinorum</i>	34.	<i>Hippasa hansae</i>
V.	OECOBIIDAE	35.	<i>Hippasa fabreae</i>
6.	<i>Oecobius putus</i>	36.	<i>Hippasa wigglesworthi</i>
VI.	HERSILIIDAE	37.	<i>Pardosa mukundi</i>
7.	<i>Hersilia savignyi</i>	38.	<i>Pardosa birmanica</i>
VII.	ULOBORIDAE	39.	<i>Pardosa jabalpurensis</i>
8.	<i>Uloborus danolius</i>	40.	<i>Arctosa indicus</i>
9.	<i>Uloborus jabalpurensis</i>	41.	<i>Lycosa nigrotibialis</i>
VIII.	TETRAGNATHIDAE	42.	<i>Lycosa shaktae</i>
10.	<i>Eucta sp.</i>	XI.	OXYOPIDAE
IX.	ARANEIDAE	43.	<i>Oxyopes jabalpurensis</i>
11.	<i>Leucauge decorata</i>	44.	<i>Oxyopes ketani</i>
12.	<i>Nephila maculata</i>	45.	<i>Oxyopes pankaji</i>
13.	<i>Argiope aemula</i>	46.	<i>Peucetia jabalpurensis</i>
14.	<i>Chorizopes tikaderi</i>	47.	<i>Peucetia ashae</i>
15.	<i>Cyrtophora cicatrosa</i>	XII.	AGELENIDAE
16.	<i>Cyrtophora citricola</i>	48.	<i>Tegenaria sp.</i>
17.	<i>Cyrtophora jabalpurensis</i>	XIII.	DICTYNIDAE
18.	<i>Cyclosa moonduensis</i>	49.	<i>Dictyna shiprae</i>
19.	<i>Cyclosa confraga</i>	XIV.	GNAPHOSIDAE
20.	<i>Cyclosa spirifera</i>	50.	<i>Gnaphosa poonaensis</i>
21.	<i>Larinia chloris</i>	51.	<i>Callilepis rukminiae</i>
22.	<i>Larinia bharatae</i>	52.	<i>Callilepis lambai</i>
23.	<i>Zygeilla indica</i>	53.	<i>Scopodes maitraiae</i>
24.	<i>Araneus mitifica</i>	54.	<i>Megamyrmeleon ashae</i>
25.	<i>Neoscona nautica</i>	55.	<i>Scotophaeus poonaensis</i>
26.	<i>Neoscona mukerjei</i>	56.	<i>Liodrassus tikaderi</i>

S. No.	FAMILY/SPECIES	S. No.	FAMILY/SPECIES
57.	<i>Drassodes oppenheimeri</i>	72.	<i>Thomisus rajani</i>
58.	<i>Sosticus jabalpurensis</i>	73.	<i>Runcinia yogeshi</i>
59.	<i>Sergiolus lamhetaghatensis</i>	74.	<i>Oxyptila amkhasensis</i>
60.	<i>Poecilochroa barmani</i>	75.	<i>Oxyptila jabalpurensis</i>
61.	<i>Herpyllus goaensis</i>	76.	<i>Xysticus minutus</i>
62.	<i>Zelotes jabalpurensis</i>	77.	<i>Xysticus bengalensis</i>
XV.	HETEROPODIDAE	78.	<i>Xysticus jabalpurensis</i>
63.	<i>Heteropoda sp.</i>	79.	<i>Xysticus bharatae</i>
XVI.	PHILODROMIDAE	80.	<i>Xysticus tikaderi</i>
64.	<i>Philodromus durvei</i>	81.	<i>Synaema decorata</i>
65.	<i>Philodromus jabalpurensis</i>	82.	<i>Monaeses jabalpurensis</i>
66.	<i>Philodromus ashae</i>	83.	<i>Tmarus jabalpurensis</i>
67.	<i>Philodromus pali</i>	84.	<i>Misumenoides sp.</i>
68.	<i>Tibellus jabalpurensis</i>	XVIII.	SALTICIDAE
69.	<i>Thanatus jabalpurensis</i>	85.	<i>Marpissa dhakuriensis</i>
70.	<i>Thanatus ketani</i>	86.	<i>Marpissa mandali</i>
XVII.	THOMISIDAE	87.	<i>Phidippus sp.</i>
71.	<i>Thomisus sundari</i>	88.	<i>Rhene sp.</i>

REFERENCES

- Bhandari, R. & Gajbe, P. 2001. A study of three new species of spiders of the genera *Chorizopes* Cambridge, *Larinia* Simon and *Neoscona* Simon (Araneae : Araneidae) from M.P., India. *Rec. zool. Surv. India*, **99**(1-4) : 59-63.
- Bhandari, R. & Gajbe, P. 2001. Description of three new species of spiders of the genera *Thomisus* Walckenaer, *Oxyptila* Simon and *Xysticus* Koch (Araneae : Thomisidae) from M.P., India. *Rec. zool. Surv. India*, **99**(1-4) : 81-85.
- Bhandari, R. & Gajbe, P. 2001. Description of four new species of the families Uloboridae, Philodromidae, Gnaphosidae and Lycosidae (Arachnida : Araneae) from M.P., India. *Rec. zool. Surv. India*, **99**(1-4) : 87-93.
- Gajbe, U. A. & Rane, P. D. 1992. A new *Monaeses* spider from Madhya Pradesh, India (Araneae : Thomisidae). *Rec. zool. Surv. India*, **91**(3-4) : 395-397.
- Gajbe, U. A. & Gajbe, P. 1999. Two new species of *Peucetia* Thorell (Araneae : Oxyopidae) from Jabalpur, M.P. *Geobios*, **18**(1) : 9-12.
- Gajbe, U. A. & Gajbe, P. 1999. Two new species of *Oxyopes* Latreille (Araneae : Oxyopidae) from Jabalpur, M.P. *Geobios*, **18**(1) : 13-16.

- Gajbe, U. A. & Gajbe, P. 1999. A new species of the genus *Tmarus* Simon (Araneae : Thomisidae) from M.P., India. *Rec. zool. Surv. India*, **97**(3) : 141-143.
- Gajbe, U. A. & Gajbe, P. 1999. On two new species of spiders of the genus *Xysticus* Koch (Araneae : Thomisidae) from M.P., India. *Rec. zool. Surv. India*, **97**(3) : 145-148.
- Gajbe, U. A. & Gajbe, P. 1999. A new species of spider of the genus *Tibellus* Simon from M.P. (Araneae : Philodromidae). *Rec. zool. Surv. India*, **97**(3) : 191-193.
- Gajbe, U. A. & Gajbe, P. 1999. A new species of spider of the genus *Philodromus* Walckenaer (Araneae : Philodromidae) from M.P., India. *Rec. zool. Surv. India*, **97**(3) : 195-197.
- Gajbe, U. A. & Gajbe, P. 1999. A new species of spider of the genus *Thanatus* Koch (Araneae : Philodromidae) from M.P., India. *Rec. zool. Surv. India*, **97**(3) : 199-201.
- Gajbe, U. A. & Gajbe, P. 1999. On three new species of spiders of the genus *Hippasa* Simon (Araneae : Lycosidae) from Jabalpur, M.P., India. *Rec. zool. Surv. India*, **97**(4) : 23-28.
- Gajbe, U. A. & Gajbe, P. 1999. A new *Cyrtophora* spider (Araneae : Araneidae) from Jabalpur, M.P., India. *Rec. zool. Surv. India*, **97**(4) : 29-31.
- Gajbe, U. A. & Gajbe, P. 1999. A new species of the genus *Philodromus* Walckenaer (Araneae : Philodromidae) from M.P., India. *Rec. zool. Surv. India*, **97**(4) : 91-93.
- Gajbe, U. A. & Gajbe, P. 1999. A new species of the genus *Pardosa* Koch (Araneae : Lycosidae) from M.P., India. *Rec. zool. Surv. India*, **97**(4) : 95-97.
- Gajbe, U. A. & Gajbe, P. 1999. A new species of the genus *Sergiolus* Simon from M.P., India (Araneae : Gnaphosidae). *Rec. zool. Surv. India*, **97**(4) : 99-101.
- Gajbe, U. A. & Gajbe, P. 2000. A new species of the genus *Philodromus* Walckenaer (Araneae : Philodromidae) from M.P., India. *Rec. zool. Surv. India*, **98**(2) : 51-53.
- Gajbe, U. A. & Gajbe, P. 2000. A new species of spider of the genus *Thomisus* Walckenaer (Araneae : Thomisidae) from M.P., India. *Rec. zool. Surv. India*, **98**(2) : 55-57.
- Gajbe, U. A. & Gajbe, P. 2000. A new species of spider of the genus *Neoscona* Simon (Araneae : Araneidae) from M.P., India. *Rec. zool. Surv. India*, **98**(2) : 119-121.
- Gajbe, U. A. & Gajbe, P. 2000. A new species of spider of the genus *Oxyopes* Latreille (Araneae : Oxyopidae) from M.P., India. *Rec. zool. Surv. India*, **98**(2) : 123-125.
- Gajbe, U. A. & Gajbe, P. 2000. A new species of the genus *Runcinia* Simon (Araneae : Thomisidae) from M.P., India. *Rec. zool. Surv. India*, **98**(2) : 51-53.
- Patel, B. H. 1975. Studies on some spiders of Family Argiopidae (Araneae : Arachnida) from Gujarat, India. *Vidya, Journ. of the Univ.*, **18**(1) : 153-167.
- Pocock, R. I. 1900. Fauna of British India, Arachnida. *Taylor & Francis, London*, pp. 279.
- Tikader, B. K. 1966. Studies on some spiders of the genus *Dictyna* (Family Dictynidae) India. *Proc. Linn. Soc. Lond.*, **177** : 45-54.
- Tikader, B. K. 1970. Spider fauna of Sikkim. *Rec. zool. Surv. India*, **64**(1-4) : 1-84.

- Tikader, B. K. 1974. Studies on some jumping spiders of the genus *Marpissa* from India (Family-Salticidae). *Proceedings of the Indian Academy of Sciences*, Vol. LXXIX, Sec. 'B', No. 5 : 204-215.
- Tikader, B. K. & Malhotra, M. S. 1974. Studies on some rare spiders of the family Oonopidae from Maharashtra, India. *Oriental Insects*, Vol. 8(4) : 495-501.
- Tikader, B. K. 1977. Studies on spider fauna of Andaman and Nicobar islands, Indian Ocean. *Rec. zool. Surv. India*, 72 : 153-212.
- Tikader, B. K. 1980. Fauna of India, Araneae Spiders, Vol. I., *Zool Surv. India, Kolkata*, pp. 447.
- Tikader, B. K. 1982. Fauna of India, Araneae Spiders, Vol. II., *Zool. Surv. India, Kolkata*, pp. 536.
- Tikader, B. K. & Biswas, B. 1981. Spider fauna of Calcutta and vicinity. *Rec. zool. Surv. India, Occ. Paper No. 30* : 1-148.

**NEW RECORD OF THE GENUS *GORGORHYNCHOIDES* CABLE
& LINDEROTH, 1963 (ACANTHOCEPHALA :
PALAEACANTHOCEPHALA) WITH *G. INDICUS* N. SP. FROM
CARANGIID FISH OF INDIAN COAST**

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INTRODUCTION

Cable & Linderoth (1963) erected the genus *Gorgorhynchoides* with the type species *G. elongatus*. The type species was described on the basis of a single female specimen obtained from a marine fish, *Caranx chrysos* at Curacao, North of South America. Later, Cable & Mafarchisi (1970) re-examined the type material and rediagnosed the genus with little corrections. Present authors also collected a number of parasites from the intestine of a carangiid fish, *Megalaspis cordyla* in its marine habitat at Chennai coast. These are described as *Gorgorhynchoides indicus* n. sp. with minor addition of characters to the generic diagnosis. The occurrence of *G. indicus* in the host species in Indian coast is a new record for the genus *Gorgorhynchoides*.

MATERIALS AND METHODS

The live specimens available from the marine fish host at Chennai were first cleaned in normal saline solution. The specimens were then taken in distilled water to allow the probosces to come out. Then these were pressed and killed in 70% alcohol. Whole mounts were prepared after staining in borax carmine. The specimens were studied and camera lucida drawings were made. All the measurements are in millimetres unless otherwise stated.

SYSTEMATIC ACCOUNT

Phylum ACANTHOCEPHALA Rudolphi, 1801

Class PALAEACANTHOCEPHALA Meyer, 1931

Order ECHINORHYNCHIDA Southwell et MacFie, 1925

Family ARHYTHMACANTHIDAE Yamaguti, 1935 emend

Genus *Gorgorhynchoides* Cable and Linderoth, 1963

Diagnosis of the genus *Gorgorhynchoides* Cable & Linderoth, 1983 emend.

Diagnosis : Proboscis clavate, with anterior hooks arranged quincunxically in more than 20 longitudinal rows of at least 10 hooks per row. First three or four hooks in each row large, bladelike followed by an abrupt reduction in size of hooks after which they gradually increase in length to about midlevel of the proboscis and then decrease; bladelike hooks with prominent roots; hooks somewhat stouter on ventral than dorsal region of proboscis. Neck well developed. Trunk with narrow, cylindrical or slightly tapering anterior portion armed with numerous spines, followed by a swelling which may or may not encompass trunk or bear spines; swelling most conspicuous dorsally. Trunk posterior to swelling unarmed, with pseudosegmentation in females. Proboscis receptacle with double muscle wall, attached at base of proboscis; brain at about mid-level of receptacle. Lemnisci with many nuclei, slender, sinuous, much longer than proboscis receptacle. Ligament sacs open, uterus long, vagina short. Eggs smooth, oval to broadly spindle shaped, without polar prolongations of middle shell membrane. Testes not contiguous, oval or bean shaped, well apart. Cement gland six, tubular, forming a slender bundle in which some glands reach posterior testis. Bursa with rays and numerous papillae. Parasites of marine fishes particularly of the family Carangedae.

Type species : *Gorgorhynchoides elongatus* Cable & Linderoth, 1963.

Distribution : Curacao, North America.

***Gorgorhynchoides indicus* n. sp.**

(Figs. 1-6)

Four male and six female specimens, collected from the intestine of a marine fish, *Megalaspis cordyla* (Fam. Carangedae) at Chennai coast, Tamil-Nadu are described below :

Description : *Male* : Body long, slender, tubular. Proboscis clavate, with hooks arranged in 20-26 longitudinal rows with 10-16 hooks in each row; anterior hooks quincunxically arranged; first 3-4 hooks of each row large, bladelike, and with strong roots followed by few small hooks near mid-proboscis and then increase in size but further decrease at base; ventral hooks somewhat stouter than dorsal hooks. Neck well developed. Trunk with narrow, cylindrical or slightly tapering anterior portion armed with numerous spines, followed by a swelling either dorsally or ventrally, or both; dorsal swelling more conspicuous. Trunk posterior to swelling unarmed. Trunk spines in 24-30 longitudinal rows dorsally and 20-25 rows ventrally; spines not reaching the swelling; no spines in the swelling. Proboscis receptacle double walled with ganglion near middle. Lemnisci very long, slender, sinuous, much longer than proboscis receptacle, generally more than half of the body length. Testes oval or bean shaped, well apart. Cement gland six, long, tubular, forming a slender bundle, some of which reach posterior testis Cement reservoir massive, longer than broad. Bursa sometimes protruded or not.

Female : Mature females usually larger than mature males, with pseudosegmentation in live specimens. Proboscis clavate, hooks as in males. Nature of distribution of trunk spines, trunk

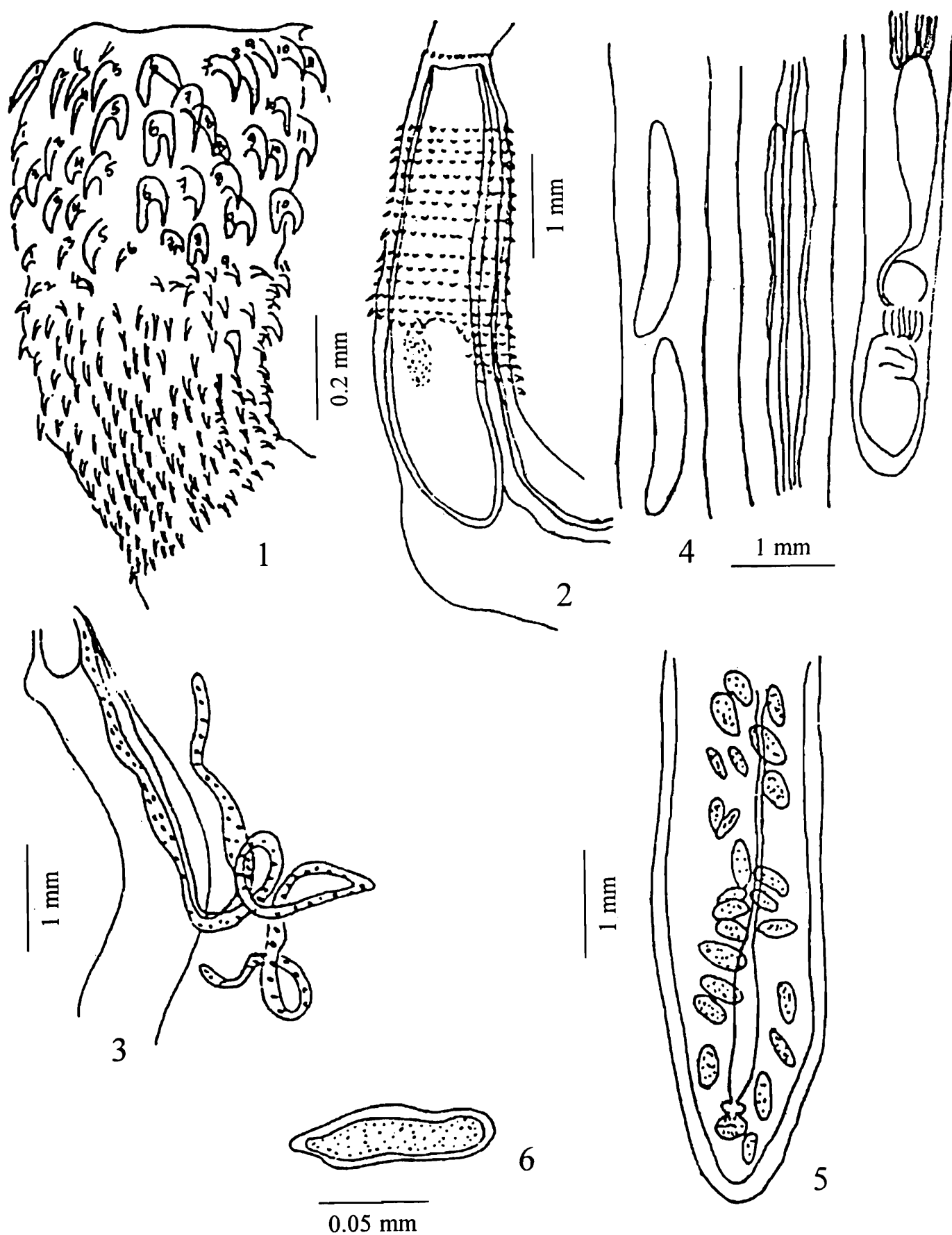


Fig. 1. *Gorgorhynchoides indicus* n. sp.

1-proboscis; 2-anterior body with buldge; 3-coiled lemnisci; 4-gonads in male; 5-posterior end of female showing subterminal genital aperture; 6-egg.

swelling, same as in males. Female genital aperture sub-terminal. Eggs smooth, oval without polar prolongation of the middle shell.

Measurements :

Male : Body 17.00-60.75 long and 1.00-1.5 wide. Proboscis 0.5-0.925 long and 0.3-0.4 wide. Proboscis hooks : 1st 0.0913-0.099 long and 0.0166 wide; 2nd 0.099-0.124 long and 0.0249 wide; 3rd 0.083-0.107 long and 0.0415 wide; 4th 0.083-0.091 long and 0.0415 wide; 5th 0.033-0.091 long and 0.0166 wide; 6th 0.041-0.0581 long and 0.0166 wide; 7th 0.083 long; basal hooks 0.0332-0.033 long. Roots of proboscis hooks : 1st-3rd 0.083-0.107 long and 0.0249 wide; 4th 0.083-0.099 long and 0.0249 wide. Neck 0.24-0.375 long and 0.25-0.35 wide. Proboscis receptacle 1.5-2.5 long and 0.35-0.4 wide. T_1 -0.85-1.625 long and 0.275-0.4 wide. T_2 -0.825-1.75 long and 0.3-0.35 wide. Cement reservoir 1.375 long and 0.55 wide.

Comparison of *G. indicus* n. sp. with Caribbean spp.

	<i>G. elongatus</i> Host : <i>Caranx chrysos</i> Loc. : CURACAO, N.A.	<i>G. lintoni</i> Host : <i>Seriola lalandi</i> Loc. : MASSACHUSETTS	<i>G. bullocki</i> Host : <i>Caranx hippos</i> Loc. : G. of FLORIDA	<i>G. indicus</i> Host : <i>Megalospis cordyla</i> Loc. : CHENNAI
BODY M.	—	64.5-66.00	39.00	17.00-60.75
F.	30.00	48.00-74.00	52.00	45.00-63.00
TRUNK SPINES ON SWELL.	7 Spines	2-3 circles of Spines	No Spines	No Spines
PROBOSCIS	0.75	0.80-1.34	0.63-0.69	0.50-1.125
P. SHEATH	—	—	2.09-2.17	1.5-2.5
P. HOOKS	2nd 0.70	0.124-0.154 (Largest Ant. Hooks)	0.074-0.083 (Largest Ant. Hooks)	1st 0.0913 2nd 0.124
	3rd 0.68	0.095-0.105 (Largest middle) 0.025-0.030 (BASE)	0.024-0.032 (Smallest middle) 0.48-0.60 (Post. Prob. Hook)	3rd 0.107 4th 0.091 5th 0.041 6th 0.0581 7th 0.083 Base 0.0332
CEM. RES.	—	—	—	1.375-0.55
TESTES	—	T_1 -2.16-2.56 T_2 -2.1-2.4	T_1 -1.38 T_2 -1.71	T_1 -0.85-1.625 T_2 -0.825-1.75
GENITAL PORE	Sub-Terminal	1.1 From Post End	0.25-0.28 From Post End	0.6 From Post End

Female : Body 45.00-63.00 long and 0.625-1.00 wide. Proboscis 0.925-1.125 long and 0.3-0.5 wide. Genital aperture 0.6 mm away from the end point. Eggs 0.04-0.064.

Host : *Megalaspis cordyla* (Carangedae).

Locality : Chennai coast, Tamil-Nadu, India.

Type specimens : Registration No. W8299/1 in the Helminthological collection, Zoological Survey of India, Calcutta.

DISCUSSION

The parasitic species of the genus *Gorgorhynchoides* Cable and Linderorth (1963) which is typical of the carangeid fish hosts of the Caribbean Sea, is recorded for the first time in a carangeid fish *Megalaspis cordyla* in Indian coast. Altogether four species under the genus have been reported so far from carangeid fish.

The type species of the genus *G. elongatus* Cable & Linderorth, 1963 has been reported from *Caranx chrysos* at Curacao, North America. *G. bullocki* Cable & Mafarchisi, 1970 has been reported from *Caranx hippos* at Gulf of Florida. *G. lintoni* Cable and Mafarchisi, 1970 at Woods Hole, Massachusetts. All the hosts belong to the family Carangedae.

Wang (1986) has reported *G. epinephali* in a marine fish, *Epinephalus awaora* at Fujian China which belongs to the family Epinephalidae. *G. epinephali* is the first record of occurrence in the fish other than a member of the family Carangedae.

The present form has been compared with all the Caribbean species as shown in the comparison chart. *G. Bullocki* comes close to the present form in respect of anterior trunk swelling and absence of spines in the swelling. As a matter of fact, *G. Bullocki* bears inconspicuous ventral trunk swelling as well as dorsal swelling. But the species under report differs *G. bullocki* in having greater length of proboscis, more number of proboscis hooks per row, and in having greater size of anterior proboscis hooks. The position of genital aperture from the posterior end of the female of the former also differs from that of the latter.

G. elongatus and *G. lintoni* basically differ from the species under report by possessing spines in the trunk swelling. The most significant difference among the three species is the difference of position of female genital aperture. Genital pore is much farther from the posterior end of *G. lintoni* than that of *G. elongatus* whereas it is in between in the present form.

According to the figures shown in the literature by the authors of the Caribbean Sp., the anterior proboscis hooks of all the caribbean species possess roots but their measurements have not been provided with. The present form with its strong roots of proboscis hooks claims its distinction from these species.

G. epinephali Wang, 1986, owing to its occurrence in marine fish of the family, Epinephalidae shows a greater degree of inter-specific variation with regard to number of proboscis hooks, size

of hooks, number and extension of trunk spines etc. The occurrence of *G. epinephali* in the fish of the family, Epinephalidae may throw light in the knowledge of adaptability of the Gorgorhynchoidid worms in other than carangeid fish hosts.

Gupta and Fatma (1979) erected a new genus *Neogorgorhynchoides* with its type species *N. cablei* from *Caranx kalla* at Mandapam, Tamil-Nadu. According to the literature, it appears that the description of *N. cablei* is based on sub-adult specimens. Therefore, the acceptance of the status of the new genus *Neogorgorhynchoides* is unwise till further studies on adult species of the genus are made.

Thus, the present form is distinguishable from all the species described so far under the genus. Therefore, the species under report is designated as a new species and is offered as *Gorgorhynchoides indicus* n. sp. for its reception. The occurrence of the species in the new carangeid fish at Chennai forms a new record from the Indian coast.

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REFERENCES

- Amin, O. M. 1989. Key to the families and subfamilies of Acanthocephala with the erection of a new class (Polyacanthocephala) and a new order (Polyacanthorhynchida) J. of Parasitology. **73**(6).
- Antony, M. *et al.* 1990. *Metarhadinorhynchus valiyathura* sp. nov. an acanthocephalid worm, parasitic in marine fish, *Caranx melampygus* Zool. Anz. **225** (1990) 5/6, s. 377-382.
- Cable, R. M. & Quick, L. A. 1954. Some Acanthocephala from Puerto Rico with the description of a new genus and three new species. Tr. Am. Micr. Soc. **73**(4) : 393-400.
- Cable and Linderoth, 1963. Taxonomy of some Acanthocephala from Curacao, North America and Jamaica, West Indies. J. Parasit **49** : 706-716.
- Cable, R. M. & Mafarchisi, B. A. 1970. Acanthocephala of the genus *Gergorhynchoides*, parasitic in marine fishes. H. D. Srivastava Commem. vol. pp. 255-261.
- Gupta, V & Fatma, S. 1979. On three new species of acanthocephalan parasites and of marine fishes of Mandapam, Tamil-Nadu. *Indian J. Helminth.* **31** : 45-53.
- Wang 1986. *Gorgorhynchoides epinephali* n. sp. from the marine fish, *Epinephalus orientalis* of the family Epinephalidae at Fujian China.

DIVERSITY IN SOIL ORIBATID (ACARI) MITES OF TRIPURA

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INTRODUCTION

Mites are the predominating group among the soil inhabiting fauna in different habitats. Among the four orders of mite Oribatida or Cryptostigmata, commonly called “beetles” or “moss” mites, are numerically the most abundant in the soil ecosystem. They are very common in occurrence in soil, litter, humus, compost heaps, lichens, moss, leaf, bark of trees, bird nests, house dusts, caves, lava-caves, nests of small mammals and various other habitats like pasture soils, coniferous taiga, forest and in polar regions. They show a high degree of diversity in structure, habit and habitat.

Oribatid mites are of great economic importance because of their direct and indirect effect on human beings and other animals. They play a major role in promoting soil fertility through humification of organic matter. The mites are also used as agent for biological control of pests. The saprophytic oribatids play an important role in regulating soil nematode population. These mites also feed on higher plants, transmit helminth diseases caused by anoplocephaline cestodes to domestic animals and some act as agents of respiratory allergic diseases in man.

STUDIES ON SOIL ORIBATID MITES IN TRIPURA

The soil oribatid mite in India was first studied by Pearce (1906). Later several workers described and recorded these mites from different states of India and till date 425 species/subspecies of oribatid mites are known from India.

The study of these mites in Tripura was started in recent times. Subias and Sarkar (1982) first studied the oribatids of Tripura and described three new species. Later Sarkar and Subias (1982, 1983, 1984), Sarkar (1983, 1985, 1986, 1990, 1991a, 1991b, 1992), Subias and Sarkar (1983, 1984), Bhattacharya and Halder (1984), Bhattacharya *et al.* (1985), Bondjema *et al.* (1991), Chakrabarti and Bhattacharya (1992), Bhattacharya and Chakrabarty (1995), Saha and Sanyal (1996), Sanyal and Saha (1996) and Sanyal *et al.* (2000) described and recorded a good number of genera and species of oribatid mites from the state.

RANGE OF DIVERSITY

The total number of taxa of oribatid mites known from the soils of Tripura is 44 families, 98 genera and 160 species. When the number of oribatid mite species of Tripura is compared with the

total number of oribatid species known from Indian soils, it is noted that Tripura represents nearly 40% of Indian oribatid fauna and occupies second position among the Indian states.

The detailed analysis of the status of different taxa of soil oribatid mites in Tripura, indicated that 24 species have been described as new to science from this state. It is also recorded that among the species known from the state only a few viz., *Scheloribates praeincisus interruptus*, *S. fimbriatoides*, *Galumna flabellifera*, *Lamellobates palustris*, *Xylobates seminudus*, *Oppia yodai*, *Archegozetes magnus longisetosus* are to be considered as numerically dominant in the soils of the state.

The distribution of soil oribatid in Tripura shows that they have adapted themselves to live in different habitats like grassland, forest, cropland and fallow land.

ENDEMICITY AND ZOOGEOGRAPHICAL DISTRIBUTION

The analysis of data on localities surveyed (Table-1) for collection of soil oribatids in Tripura reveals that the West and South districts of Tripura are thoroughly explored but North district is very little surveyed, hence the distribution data of these mites so far available are insufficient and it is rather difficult to make any comment on the degree of endemism in soil oribatid mite taxa (138) which are identified upto species level. However, on the basis of data so far available it may be commented that distribution of 36 species of soil oribatid is still restricted to India and of these 24 species are described from Tripura. Of the total number of identified species (138), distribution of 72 species and 42 genera though known from outside India, we are still restricted to the state i.e. not known from other states of India.

The zoogeographical distribution and relationship of oribatid mites so far known from Tripura is shown in Figure-1. The analysis of data indicates that it would be premature to make any specific

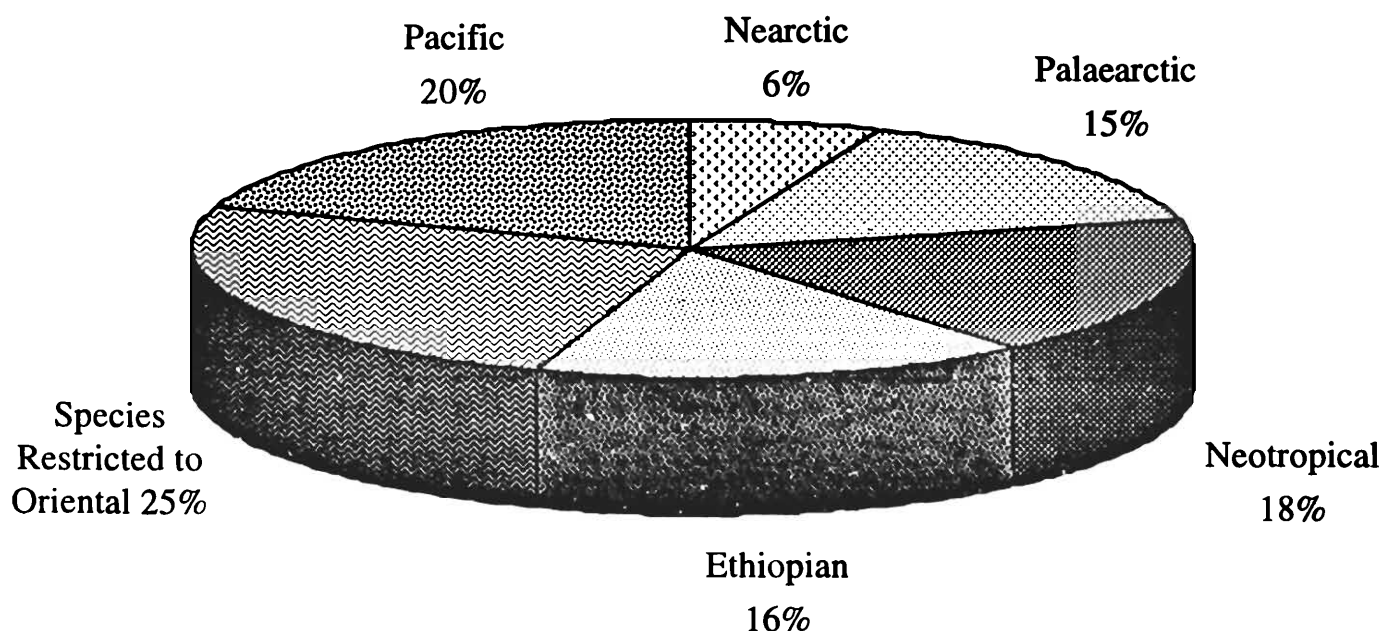


Fig. 1. Zoogeographical distribution of Oribatid species of Tripura.

Table-1. Collection localities in the districts of Tripura

West District	
1. Mekiban	24. Jagendranagar
2. Khowai	25. Madhuban
3. Padamabari	26. Ananthanagar
4. Mohanpur	27. Kamlasagar
5. Sonatala	28. Madhupur
6. Padmabill	29. Anandanagar
7. Narsinga	30. Lakshmipur
8. Chebri	31. Atharamura R. F.
9. Ramchandraghat	32. Teliamura
10. Lembuchhara	33. Jampaijala
11. Cinathani	34. Bisalgar
12. Ramnagar	35. Sipahijala
13. Maharanipur	36. Brajapur
14. Kalyanpur	37. Matinagar
15. Kunjaban	38. Nalchhara
16. Abhoynagar	39. Khedabari
17. Central Jail	40. Melaghar
18. Subhasnagar	41. Rudrasagar
19. Agartala town	42. Sonamura
20. M. B. B. College Campus	43. Battala
21. Khayerpur	44. Jatrapur
22. Badharghat	45. Durlavpur
23. Jirania	
South District	
46. Garjanmura	62. Malbasa
47. Totabari	63. Paharpur
48. Udaipur	64. Jatanbari
49. Kankraban	65. Jarimura
50. Murapara	66. Ekchhari
51. Matarbari	67. Karbuk
52. Batsabari	68. Santirbazar
53. Baisalbari	69. Radhakishoreganj
54. Joalikhamer	70. Lakshmipur
55. Matipocha	71. Puranarajbari
56. Ampinagar	72. Radhanagar
57. Birganj	73. Joalbari
58. Maharani	74. Pulchari
59. Amarpur	75. Manubazar
60. Rangtang	76. Uttarkalapani
61. Brichandranagar	77. Bellamukhi
North District	
78. Manu	79. Ambasa

comments on zoogeographic relationship at the present state, as the knowledge on soil oribatid fauna of the state is still insufficient. However, the oribatid species recorded from Tripura show maximum similarity with species of the Pacific region. The other regions in order of degree of similarity are Neotropical, Ethiopian, Palaearctic and Nearctic. There is no species common with Antarctic species. Only four genera viz., *Trimalaconothrus*, *Oppia*, *Scheloribates* and *Galumna* are found to occur both in Tripura and Antarctica.

DISTRIBUTION OF SOIL ORIBATID IN TRIPURA

The distribution of different taxa of soil oribatids in three districts of Tripura is shown in Table-2 and Figure-2. These indicate that oribatid mites are known from all the districts, but due to very little exploration these mites are present in North district by only 15 species where as South

Table-2. Distribution of Oribatid Taxa in different districts of Tripura

Districts	Oribatid Taxa		
	Family	Genera	Species
North	10 (22.7%)	12 (12.2%)	15 (9.4%)
South	35 (79.5%)	62 (63.2%)	83 (52.0%)
West	32 (72.7%)	64 (65.3%)	108 (68.0%)

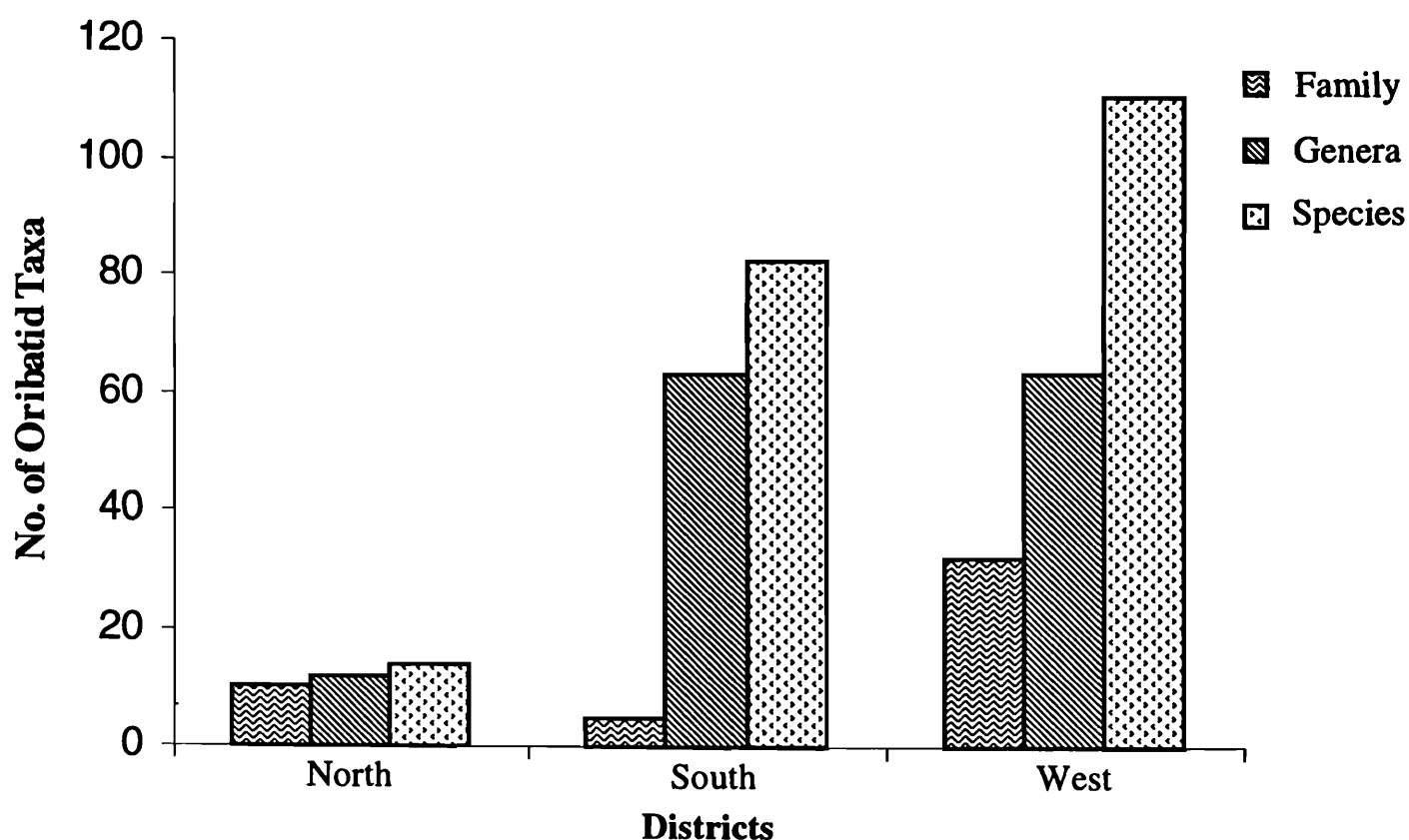


Fig. 2. District-wise distribution of Oribatid Mites in Tripura.

and West districts recorded 83 and 108 species respectively. The table also shows that West district alone represents 72.7% of families, 65.3% of genera and 68.0% of species out of the total soil oribatid taxa known from Tripura and it occupies highest position among the other two districts. The occurrence of maximum number of taxa in the district is due to the fact that the district in respect to others has been surveyed thoroughly for study of soil oribatid mites.

SUMMARY

The study of soil inhabiting oribatid mite fauna of Tripura was initiated by Subias and Sarkar in 1982. Later, many workers studied taxonomy and ecology of soil mites and till date 160 species under 98 genera and 44 families are known from the state. The mites have been recorded from all the three districts, in which West district occupies highest position in number of species. Of the total number of species known from Tripura, distribution of 36 species is still restricted to India of which 24 are described from the state. The oribatid species show maximum similarity in species composition with Pacific region (20%). The genera like *Scheloribates*, *Galumna* and *Lamellobates* are to be considered as numerically dominant in the soils of the state.

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REFERENCES

- Bhattacharya, T and Chakrabarti, P. 1995. Community structure of soil Oribatida of a young rubber plantation and an adjacent wasteland in Tripura (India). In : *Advances in Ecology and Environmental Sciences* (eds. Mishra *et al.*) : 65-77.
- Bhattacharya, T and Halder, G. 1984. New records of soil oribatid mite from Tripura. *Entomon*, 9(4) : 293-294.
- Bhattacharya, T., Halder, G. and Saha, R. K. 1985. Soil microarthropods of a rubber plantation and a natural forest. *Environment and Ecology*, 3(2) : 143-147.
- Boudjema, G., Julien, J. M., Sarkar, S., Cancelli DA and Fonseca, J. P. 1991. Etude par l'analyse statistique multidimensionnelle de l'impact des facteurs physico-chimiques sur l'abondance des Microarthropods edaphiques d'une foret de mousson en Inde orientale. *Rev. Ecol. Biol. Sol.*, 28(3) : 303-322.
- Chakrabarti, P. and Bhattacharya, T. 1992. Soil microarthropods of a rubber plantation and an adjacent wasteland in Tripura, India. *Proc. zool. Soc., Calcutta*, 45(2) : 163-172.
- Saha, S. and Sanyal, A. K. 1996. Two new species of the genera *Malaconothrus* (Acari : Oribatei) from Tripura, India. *Entomon*, 21(1) : 105-109.

- Sanyal, A. K. and Saha, S. 1996. A new species of the genus *Peloribates* (Acari Oribatei) from Tripura, India. *Hexapoda*, **8**(2) : 71-76.
- Sanyal, A. K., Sengupta, D., Saha, S. and Chakrabarti, S. 2000. The genus *Arcoppia* (Acari, Oribatei, Oppiidae) from Indian soils. *Rec. zool. Surv. India*, **98** (Part-2) : 99-118.
- Sarkar, Sadhana 1983. New representatives of oribatid mites (Acari : Oribatei) from soil of Tripura, India, *Orient. Zool.*, **3** : 91-98.
- Sarkar, Sadhana 1985. A new species of the genus *Archegozetes* Grandjean, 1931 (Acari Oribatei) from Tripura, India. *Uttar Pradesh J. Zool.*, **5**(1) : 82-85.
- Sarkar, Sadhana 1986. Notes on zoogeographic affinity of the oribatid mites of Tripura, India. *Proceedings III Oriental Entomology Symposium, Trivandrum*, 49-54.
- Sarkar, Sadhana 1990. Studies on microarthropod community in one undisturbed habitat of Tripura (India) with special reference to oribatid mites. *Rev. Ecol. Biol. Sol.*, **27**(3) : 307-329.
- Sarkar, Sadhana 1991a. Studies on microarthropod community in one undisturbed habitat of Tripura with special reference to oribatid mites. In : *Advances in Management and Conservation of soil Fauna* (eds. G. K. Veeresh, D. Rajagopal and C. A. Viraktamath), Bangalore, 777-788.
- Sarkar, Sadhana 1991b. Taxonomy of oribatid mites from the soils of Tripura. I. Two new species of *Allonothrus* and *Eremulus*. In *Advances in Management and Conservation of soil Fauna*, (eds. G. K. Veeresh, D. Rajagopal and C. A. Viraktamath), Bangalore, 727-731.
- Sarkar, S. 1992. Three new species of the genus *Microzetes* (Acarina Oribatida Microzetidae) from the soil of Tripura. New record of the genus *Schizozetes* in India. *Bull. Life Science*, **2** : 31-39.
- Sarkar, S. and Subias, L. S. 1982. Some new macropyline oribates (Acarida) from India. (Hypochthoniidae, Cosmochthonoidea and Epilomanniidae). *Eos*, **58**(1-4) : 311-318.
- Sarkar, S. and Subias, L. S. 1983. *Papillonotus tricarinatus* sp. nov. from india (Acarina : Oribatida Oppiidae). *Butll. Inst. Cat. Hist. Nat.*, **49** (Sec. zool., 5) : 85-86.
- Sarkar, S. and Subias, L. S. 1984. New Lohmannids (Acarida : Oribatida) from India. *Oriental Insects*, **18** : 25-30.
- Subias, L. S. and Sarkar, S. 1982. New representatives of nothroides oribatids (Acarida) from India (Trhypochthoniidae and Malaconothridae). *Redia*, **65** : 39-49.
- Subias, L. S. and Sarkar, S. 1983. Some new Oppiidae from India (Acarida, Oribatida). *Redia*, **66** : 435-447.
- Subias, L. S. and Sarkar, S. 1984. Three new species of ptyctimines Oribates (Acari) from India (Mesoplophoridae and Phthiracaridae). *Folia Ent. Hung.*, **45**(1) : 215-220.

DIVERSITY OF PHYTOPHAGOUS AND PREDATORY MITES ON MANGROVE AND AGRI-HORTICULTURAL CROPS IN SUNDARBAN BIOSPHERE RESERVE, WEST BENGAL

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INTRODUCTION

Sundarban Biosphere Reserve (SBR) is very rich with at least 36 species of mangrove vegetation of the 55 species of mangrove plants that are known to occur in the world. Besides, during the past 2-3 decades, agricultural horticultural crops have been started growing in different re-claimed areas of SBR which have further added to the vegetational richness of this area. Expectedly, the plant mite fauna w.s.r. to those occurring on mangrove vegetation and diverse types of agri-horticultural crops are also likely to be diverse. Unfortunately, the knowledge about the plant mite faunal wealth of this region is very inadequately explored as appeared from the fact that only 6 species are so far known occurring on mangrove vegetation of that region (Gupta, 1992) and practically nothing is known about the phytophagous and predatory mite fauna occurring on agri-horticultural crops. Hence, with a view to exploring the plant mite faunal diversity of SBR and to study their bio-ecological aspects, this project was taken up and the present paper gives an idea about the Species Richness Index, Species Diversity Index, Index of Dominance, Relative Abundance, based on the observations made at Bamankhali, Sagar Island, during November, 2000 to October, 2001. This is the first such attempt to collect information of this kind on plant mite fauna from SBR and surprisingly such information is rather unavailable from most parts of India.

MATERIALS AND METHODS

The population data pertaining to phytophagous and predatory mites occurring on mangrove vegetation and agri-horticultural crops of SBR was collected from the experimentation station located at Bamankhali in Sagar Island about 100 kms. Southeast of Calcutta. Two species of Mangrove vegetation (*Avicennia alba* & *Rhizophora mucronata*.) and two types of horticultural crops (*Psidium guajava* & *Citrus* sp.) were selected. For *A. alba* and *Rhizophora*, 10 and 5 trees respectively were selected and tagged with labels. From each of the *A. alba* tree, 10 leaves and from each of the *Rhizophora* tree, 8 leaves of same age and size were plucked and population of phytophagous and predatory mites was counted from the under surface of the whole leaf under stereo binocular microscope and number of each of the species present was recorded. Hence, for *Avicennia alba*, a total of 100 leaves and for *Rhizophora mucronata* 40 leaves were examined.

Likewise, for *Psidium guajava* and *Citrus* sp., 8 and 5 trees respectively were selected and tagged with labels and from each guava tree 10 leaves (total $8 \times 10 = 80$ leaves) and from each citrus tree 10 leaves (total $5 \times 10 = 50$ leaves) were plucked and population was counted from under surface of each of the entire leaf. The observation was recorded at monthly interval. The phytophagous and predatory mite fauna collected from each type of tree was identified and respective number of each species was counted.

The data thus collected was used to calculate Relative Abundance (RA) which was assessed following Tamura (1967) season wise for determining the nature and proportion of mite assemblage, Species Diversity Index ($\bar{H}$) was calculated following Shannon & Weaner (1949, 1949a), Index of Dominance(c) was calculated month wise to isolate the favourable and unfavourable months for diversity, Richness Index (d) was calculated following Menthnick (1964). The data towards abiotic factors like temperature, RH and rainfall were collected from Alipore Meteorological Department, Calcutta.

RESULTS AND DISCUSSION

The identification of mite species indicates the presence of 26 species (Table-1) collected during the study period, of those, 15 belonged to predatory group and 11 to phytophagous group.

Table-1. List of the Phytophagous and predatory mites.

No.	Predatory Mites	No.	Phytophagous Mites
1	<i>Amblyseius largoensis</i>	16	<i>Tetranychus urticae</i>
2	<i>Amblyseius alstoniae</i>	17	<i>Tetranychus neocaledonicus</i>
3	<i>Amblyseius fallacis</i>	18	<i>Schizotetranychus</i> sp.
4	<i>Amblyseius multidentatus</i>	19	<i>Tetranychus</i> sp.
5	<i>Amblyseius pruni</i>	20	<i>Schizotetranychus hindustanicus</i>
6	<i>Amblyseius coccineae</i>	21	<i>Eutetranychus orientalis</i>
7	<i>Amblyseius ovalis</i>	22	<i>Eotetranychus hicoriae</i>
8	<i>Iphiseius andamanicus</i>	23	<i>Brevipalpus phoenicis</i>
9	<i>Phytoseius macropilis</i>	24	<i>Brevipalpus essigi</i>
10	<i>Phytoseius indicus</i>	25	<i>Tenuipalpus</i> sp.
11	<i>Typhlodromus communis</i>	26	<i>Phyllocoptruta oleirvora</i>
12	<i>Phytoseius kapuri</i>		
13	<i>Pronematus fleschneri</i>		
14	<i>Parapronematus</i> sp.		
15	<i>Tydeus</i> sp.		

The Relative Abundance (RA) : The Table 3, indicates that the most abundant species was *Amblyseius largoensis* (Muma) and *Amblyseius pruni* Gupta among predatory mites while among phytophagous mites, *Tetranychus* sp. *Schizotetranychus hindustanicus* (Hirst) and *Eotetranychus hicoriae* (McGregor), on all the plants in post monsoon period. During premonsoon period, the most dominant species were *Amblyseius largoensis*, *Amblyseius multidentatus* (Swirski & Shechter), *Amblyseius pruni*, *Amblyseius coccineae* Gupta, among predatory group and *Schizotetranychus hindustanicus* and *Eotetranychus hicoriae* among the phytophagous group. The dominant predatory and phytophagous species during monsoon months were *Amblyseius largoensis*, *Amblyseius alstoniae* Gupta, *Amblyseius pruni*, *Amblyseius coccineae* in the former group and *Schizotetranychus hindustanicus* and *Eotetranychus hicoriae* in the latter group. The remaining species, as per their frequency of occurrence, belonged to subdominant or rare category.

While studying the occurrence of different mite species in different groups of plants (Table-2), it was found that predatory mites like *Amblyseius largoensis*, *Amblyseius pruni*, *Pronematus fleschneri* Baker and phytophagous mites like *Tetranychus urticae* Koch, *Brevipalpus phoenicis* (Geijskes) were dominant on *Avicennia alba* during postmonsoon period, *Amblyseius alstoniae*, *Amblyseius fallacis* (Garman), *Amblyseius coccineae* and *Tetranychus neocaledonicus* Andre were sub dominant on the same host while the occurrence of other species was rare.

During premonsoon period, *Amblyseius largoensis*, *Amblyseius alstoniae*, *Amblyseius multidentatus*, *Amblyseius pruni*, *Amblyseius coccineae*, *Amblyseius fallacis* (among predatory mites) and *Tetranychus urticae*, *Tetranychus neocaledonicus* (among phytophagous group) were dominant. During monsoon period, the predatory mites like *Amblyseius pruni* and *Amblyseius coccineae*, were dominant and phytophagous species like *Tetranychus neocaledonicus*, *Tetranychus urticae* and *Schizotetranychus* sp. were subdominant.

In case of *Rhizophora mucronata*, *Amblyseius largoensis*, *Amblyseius pruni*, *Amblyseius coccineae* and *Pronematus fleschneri* among predatory group and *Brevipalpus phoenicis*, among phytophagous group were found dominant during post monsoon period; while during premonsoon period, predatory mites. *Amblyseius largoensis*, *Amblyseius pruni*, *Amblyseius coccineae*, and among phytophagous group, *Tetranychus urticae*, *Brevipalpus phoenicis*, *Brevipalpus essigi* Baker were dominant. The dominant species during monsoon period on the same host were *Amblyseius largoensis*, *Amblyseius multidentatus*, *Amblyseius pruni* and *Amblyseius coccineae*. The occurrence of phytophagous species during that period was rare.

In case of *Citrus* sp., as usually, the dominant species were *Amblyseius largoensis* among predatory species and *Schizotetranychus hindustanicus*, and *Eutetranychus orientalis* (Klein) among phytophagous mites were dominant in post monsoon period. During premonsoon period, the dominant species were *Amblyseius largoensis*, *Amblyseius pruni*, *Amblyseius coccineae*, among the predatory mites and *Schizotetranychus hindustanicus* and *Eutetranychus orientalis* among the phytophagous group were found dominant. Finally, during monsoon period, *Amblyseius largoensis*, *Amblyseius pruni*, *Amblyseius coccineae*, *Pronematus fleschneri*, and *Tydeus* sp. among the predatory

Table-2. Relative Abundance of mite fauna in different plants (RA).

	Post monsoon				Pre monsoon				Monsoon			
	<i>A.. alba</i>	<i>Rhizophora</i> Sp.	<i>Citrus</i> sp.	<i>Guava</i>	<i>A.. alba</i>	<i>Rhizophora</i> sp	<i>Citrus</i> sp.	<i>Guava</i>	<i>A.. alba</i>	<i>Rhizophora</i> sp	<i>Citrus</i> sp.	<i>Guava</i>
1	44.36	37.5	7.37	5.29	35.50	33.75	12.16	0	4.41	44.77	6.80	19.64
2	4.77	0	3.27	0	11.01	0	0	0	29.04	0	0	0
3	3.41	0	0	0	12.80	0	0	0	0	0.232	0	0
4	1.02	1.47	0	0	6.29	2.50	2.28	12.5	0	9.28	0	7.54
5	10.23	20.58	4.91	4.85	6.51	14.58	18.25	20.90	6.01	16.93	7.14	16.84
6	3.75	16.91	0.819	2.57	7.86	18.75	15.58	31.46	6.43	19.25	8.84	20.17
7	1.70	0	0	0	2.69	0	0	0	1.65	0	0	0
8	0	0	0	0	0.674	0	0	0	0	0	0	0
9	0	0	0	0	0.898	0	0	0	0	4.17	0	0
10	0	0	0	0	0.674	0.833	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0.207	0	0	0
12	0	0	0	0	0	0.416	0	0	0	0.696	0	0
13	6.82	5.14	2.04	0	0.674	1.66	0	0	0	1.16	5.10	0
14	0.682	4.41	0	0	0	0	2.66	0	0	1.16	0	0
15	0	0	0	0	0	0	0	0	0	0	11.90	0
16	9.89	3.67	0	0	7.19	10.83	0	0	4.14	0.696	0	0
17	3.75	2.94	0	0	6.51	2.50	0	0	4.14	0	0	0
18	0	0	0	0	0	0	0	0	4.14	0	0	0
19	0	0	0	17.98	0	0.416	0	12.50	0	0	0	15.43
20	0	0	64.75	0	0	0	37.64	0	0	0	37.07	0
21	0	0	13.93	0	0	0	11.02	0	0	0	23.12	0
22	0	0	0	6.91	0	0	0	21.55	0	0	0	20.35
23	5.11	7.35	2.86	0	0.674	7.08	0.380	0	0	1.62	0	0
24	2.73	0	0	0.151	0	6.66	0	1.07	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0		0	0	0	0	0

Species name 1 to 26 are listed in the Table-1. R. A. Value > 5 = Dominant species. O. A. Value 2 to 5 = Subdominant. R. A. Value > 2 = Rare.

Table-3. Showing Relative Abundance against total mite population in three different periods.

Sp. Name	Post monsoon		Premonsoon		Monsson	
	total mite population	Relative Abundance (%)	Total mite population	Relative Abundance (%)	Total mite population	Relative Abundance (%)
1	268	15.56	271	19.19	538	30.27
2	22	1.11	49	3.47	140	7.87
3	10	0.506	57	4.03	1	0.056
4	5	0.253	98	6.94	83	4.67
5	134	6.78	209	14.80	219	12.32
6	70	3.54	267	18.90	255	14.35
7	5	0.253	12	0.849	8	4.50
8	0	0	3	0.212	0	0
9	0	0	4	0.283	18	1.01
10	0	0	5	0.354	0	0
11	0	0	0	0	1	0.056
12	0	0	1	0.070	3	0.168
13	32	1.61	7	0.495	20	1.12
14	8	0.404	7	0.495	5	0.281
15	0	0	0	0	35	1.96
16	34	1.72	58	4.10	23	1.29
17	15	0.759	35	2.47	20	1.12
18	0	0	0	0	20	1.12
19	237	11.99	59	4.17	88	4.95
20	158	7.99	99	7.01	109	6.13
21	34	1.72	29	2.05	68	3.82
22	912	46.15	100	7.08	116	6.52
23	22	1.11	21	1.48	7	0.393
24	10	0.506	21	1.48	0	0
25	0	0	0	0	0	0
26	0	0	0	0	0	0

Species name 1 to 26 are listed in the Table-1.

R. A. Vaue > 5 = Dominant species.

R. A. Value 2 to 5 = Sub dominant.

R. A. Value > 2 = Rare species.

mites and *Schizotetranychus hindustanicus* and *Eutetranychus orientalis* among the phytophagous group were found dominant. The other species were sub dominant or rare (Table 3).

In case of Guava (*Psidium guajava*), the most abundant species were *Amblyseius largoensis* and *Tetranychus* sp., during post monsoon period. In premonsoon period, *Amblyseius pruni*, *Amblyseius coccineae*, *Amblyseius multidentatus* among the predatory mites and *Tetranychus* sp. and *Eotetranychus hicoriae* among phytophagous mites were dominant. Almost the similar trend in population prevailed during monsoon period excepting the addition of *Amblyseius largoensis* as one of the dominant predatory species.

Species Diversity Index (H) : Table-4 indicates that in *Avicennia alba*, the maximum species diversity index (1.826) was found in March, 2001 and minimum (1.127) was in October, 2001. In case of *Citrus* sp and guava, the highest values 1.491 on *Citrus* and 1.637 on guava were found in April, 2001 and their respective lowest values were 0.470 and 0.582 were during January, 2001. In *Rhizophora*, the highest diversity value (1.972) and lowest (1.072) were seen during March, 2001 and January, 2001 respectively.

The Index of dominance (c) : Table-5 indicates that the index of dominance values were different in four different plants chosen for this study. In *Avicennia alba*, the maximum (c) value (0.388) was found in January, 2001 and minimum (0.173) was in March, 2001. In *Rhizophora mucronata*, the highest (c) value (0.407) was seen in October, 2001 and lowest (0.145) seen in February, 2001. In *Citrus*, the highest was in January, 2001 (0.764) and lowest (0.120) was in February, 2001. Finally, on guava, the highest (0.663) and lowest (0.211) were found in January and April, 2001 respectively.

Species Richness Index (d) : Table-6 gives the values of species richness index in four species of plants studied. In *Avicennia alba*, the highest value (1.152) was in November, 2000 and lowest (0.363) was in August and September, 2001. In *Rhizophora*, the highest value (1.077) was in December, 2000 and lowest (0.383) was in October, 2001. In *Citrus*, highest (0.639) and lowest (0.384) were seen in April and in September, 2001, respectively while on guava, the highest (0.532) and lowest (0.011) were found in April, 2001 and December, 2000 respectively.

DISCUSSION

From the data presented in Tables 2-6, it is evident that the species diversity is not uniform in all the four plants on which study was conducted. It also appeared that the dominant pest species on guava were *Tetranychus* sp. and *Eotetranychus hicoriae* and on *Citrus* the dominant pests were *Eutetranychus orientalis* and *Schizotetranychus hindustanicus*. Surprisingly, both the mangrove plants were relatively free from phytophagous species though harboured a reasonably good number of predatory species. The overall predatory species which were found dominant during the entire study period on all the four types of plants were *Amblyseius largoensis*, *Amblyseius pruni*, *Amblyseius coccineae* and *Amblyseius multidentatus*. This pioneer study attempted to find out the incidence of

Table-4. Species Diversity Index ($\bar{H}$).

Plant species	Nov. 2000	Dec. 2000	Jan. 2001	Feb. 2001	Mar. 2001	Apr. 2001	May 2001	June 2001	Jul. 2001	Aug. 2001	Sept. 2001	Oct. 2001
<i>Avicennia alba</i> .	1.428	1.760	1.146	1.489	1.826 (H)	1.761	1.578	1.330	1.129	1.277	1.355	1.127 (L)
<i>Rhizophora mucronata</i>	1.492	1.627	1.072 (L)	1.557	1.972 (H)	1.452	1.502	1.566	1.448	1.445	1.245	1.207
<i>Citrus sp.</i>	0.797	0.815	0.470 (L)	1.346	0.792	1.491 (H)	0.885	1.189	1.079	1.237	1.049	1.290
Guava	0.894	0.934	0.582 (L)	0.951	1.354	1.637 (H)	1.067	1.277	1.355	1.091	1.446	1.193

H = highest value and L = lowest value.

Table-5. Index of Dominance (c).

Plant species	Nov. 2000	Dec. 2000	Jan. 2001	Feb. 2001	Mar. 2001	Apr. 2001	May 2001	June 2001	Jul. 2001	Aug. 2001	Sept. 2001	Oct. 2001
<i>Avicennia alba</i> .	0.178	0.206	0.388 (H)	0.338	0.173 (L)	0.211	0.192	0.334	0.378	0.254	0.262	0.370
<i>Rhizophora mucronata</i>	0.271	0.222	0.345	0.145 (L)	0.147	0.267	0.497	0.250	0.286	0.263	0.328	0.407 (H)
<i>Citrus sp.</i>	0.637	0.461	0.764 (H)	0.120 (L)	0.474	0.260	0.449	0.340	0.345	0.332	0.394	0.345
Guava	0.484	0.456	0.663 (H)	0.438	0.262	0.211 (L)	0.352	0.410	0.262	0.336	0.268	0.339

H = Highest value and L = Lowest value.

Table-6. Species Richness Index (d).

Plant species	Nov. 2000	Dec. 2000	Jan. 2001	Feb. 2001	Mar. 2001	Apr. 2001	May 2001	June 2001	Jul. 2001	Aug. 2001	Sept. 2001	Oct. 2001
<i>Avicennia alba</i> .	1.152 (H)	0.773	0.676	0.858	0.721	0.769	0.514	0.679	0.458	0.363 (L)	0.363 (L)	0.454
<i>Rhizophora mucronata</i>	0.832	1.077 (H)	1.133	0.935	0.878	0.848	0.927	0.848	0.635	0.689	0.601	0.383 (L)
<i>Citrus sp.</i>	0.485	0.547	0.625	0.650	0.600	0.639 (H)	0.462	0.384	0.437	0.488	0.384 (L)	0.589
Guava	0.021	0.011 (L)	0.159	0.232	0.436	0.532 (H)	0.279	0.340	0.428	0.325	0.338	0.298

H = Highest value and L = Lowest value.

different mites on mangrove and agri-horticultural crops. Unless this study is carried out for a longer period and the indication in population trend is confirmed, no definite conclusion can be arrived at this stage. The role of abiotic factors on the mite population will be dealt with in a separate paper.

SUMMARY

The present paper discusses the Relative Abundance (RA) of phytophagous and predatory mite species on two each of mangrove plants, viz. *Avicennia alba* and *Rhizophora mucronata* and two each of fruit trees, viz. guava and citrus in Sundarban Biosphere Reserve during November, 2000-October, 2001 (post monsoon, premonsoon and monsoon periods) along with discussing their Richness Index (d), Species Diversity Index ($\bar{H}$) and Index of Dominance (c).

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REFERENCES

- Gupta, S. K. 1992. Arachnida : Plant mites (Acari). In : *State Fauna Series 3, Fauna of West Bengal, Part-3*, p. 61-211.
- Menthnick, E. F., 1964. A comparison of some species diversity indices applied to samples of field insects. *Ecology*, **45** : 859-861.
- Shannon, C. E. & Weaver, W. 1949. Measurement of diversity. *Nature*, **163** : 688.
- Shannon, C. E. & Weaver, W. 1949a. *The mathematical theory of Communication*. University of Illinois Press, p. 220.
- Tamura, H. 1967. Some ecological observations on Collembola in Sappore, Northern Japan. *Journal. Fac. Sci. Hokkaido Univ. Ser. VI. Zool.*, **16**(2) : 238-252.

PHYTOPHAGOUS AND PREDATORY MITE FAUNA OF SUNDARBAN BIOSPHERE RESERVE : I. SOME PHYTOPHAGOUS MITES OCCURRING ON MANGROVE VEGETATION AND AGRI-HORTICULTURAL CROPS

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INTRODUCTION

So far no detailed taxonomic account regarding plant mite fauna of the Sundarban Biosphere Reserve (SBR) is available though it is a fact that the said area is rich with luxuriant vegetation both of mangrove plants and of diverse types of agri-horticultural crops. Gupta (1992) reported only 6 species on mangrove plants from that area.

Hence, with a view to exploring the plant mite fauna of that region, this project was undertaken and the present paper reports 21 species belonging to 10 genera and 4 families of those 6 species (*Eotetranychus hicoriae*, *Brevipalpus rugulosus*, *Tenuipalpus micheli*, *Tenuipalpus pernicious*, *Aceria guerreronis*, and *Aceria saccharini*) form new records from West Bengal and 7 plants form new host records. The entire collection was made by the first and second authors and the material is deposited in the SDMBRI.

SYSTEMATIC ACCOUNT

Family 1. TETRANYCHIDAE Donnadieu

1875. Tetranychidae Donnadieu, Faculty des. Sciences de Lyon, p. 9.

Key to the Subfamilies, tribes and genera of Tetranychidae recorded in Sundarban Biosphere Reserve (SBR)

1. Tarsus I dorsally with a single set of usually loosely associated duplex setae or duplex setae absent Tribe **Eurytetranychini***
*female with 2 pairs of anal setae, 4th pair of dorso-central setae in normal position Genus *Eutetranychus*
- Tarsus I dorsally with two sets of closely associated duplex setae Tribe **Tetranychini**, 2
2. With two pairs of para anal setae 3
- With one pair of para anal setae 5

3. Empodium claw like, entire or splits bilaterally into two claw like structures 4
— Empodium ending into a tuft of hairs Genus *Eotetranychus*
4. Empodium a single claw like structure..... Genus *Panonychus*
— Empodium splits bilaterally into two claw like structures usually with appendent hairs.....
..... Genus *Schizotetranychus*
5. Tarsus one with duplex setae distal and approximate Genus *Oligonychus*
— Tarsus one with duplex setae well separated dividing segments into three more or less equal parts Genus *Tetranychus*

Subfamily 1. TETRANYCHINAE Berlese

1950. Tetranychinae Reck, *Trudy. inst. zool. Akad. Nauk. Gruz. SSR.*, **9** : 123.
1987. Tetranychinae, Smith-Meyer, *Ent. mem. dept. agr. and water supply. Repub. South Africa*, No. **69** : 74.
1994. Tetranychinae, Gupta & Gupta, *Mem. Zool. Surv. India*, **18(1)** : 27.

Tribe Eurytetranychini Reck

1950. Eutetranychini Reck, *Akad. Nauk. Grug. SSR* : **99** : 123.
1994. Eutetranychini, Gupta & Gupta, *Mem. Zool. Surv. India*, **18** : 27.

Genus 1. *Eutetranychus* Banks

1917. *Neotetranychus (Eutetranychus)* Banks, *Ent. News.* **28** : 197.
1950. *Eutetranychus*, McGregor, *Am. midl. nat.*, **44** : 257.
1987. *Eutetranychus*, Smith-Meyer, *Ent. mem. dept. agr. and water supply, Repub. S. Africa.*, **69** : 76.
1994. *Eutetranychus*, Gupta & Gupta, *Mem. Zool. Surv. India*, **18(1)** : 27.

1. *Eutetranychus orientalis* (Klein)

1936. *Anychus orientalis* Klein, *Bull. Agric. Res. Stn. Rehovoth*, **21** : 3.
1960. *Eutetranychus orientalis*, Baker & Pritchard, *Hilgardia*, **29** : 464.
1987. *Eutetranychus orientalis*, Smith-Meyer, *Ent. mem. Dept. Agr. and Water Supply, Repub. S. Africa*, **69** : 80-82.
1994. *Eutetranychus orientalis*, Gupta & Gupta, *Mem. Zool. Surv. India*, No. **18(1)** : 35-39.

Collection Records : 10(F), 3(M), West Bengal, 24-Parganas (South), Sagar Island, Bamankhali; ex *Ocimum sanctum*, and *Solanum melongena*, 5.8.2000; 2(F), Chemaguri, ex Guava, 14.11.2000; Several (M) & (F), Bamankhali, ex *Citrus* 29.12.2001.

Distribution : India (almost in all the states), Afghanistan, Iran, Taiwan, Hong Kong, Israel, Japan, Thailand, Philippines, South Africa, Sudan, Pakistan.

Remarks : This is a cosmopolitan species and its occurrence has been recorded in SBR mainly on vegetables and fruit trees but it has not been recorded on mangrove vegetation. On *Citrus* sp., it was found on upper surface of leaves and the colonies were covered with dusty web.

Tribe **Tetranychini** Reck

1950. Tetranychini Reck, *Trudy. Inst. Zool. Akad. Nauk. Gruz. SSR.*, 9 : 123.

1994. Tetranychini, Gupta & Gupta, *Mem. Zool. Surv. India*, 18(1) : 50.

Genus 2. ***Eotetranychus*** Oudemans

1931. *Eotetranychus* Oudemans, *Ent. Ber.*, 8(178) : 224.

1994. *Eotetranychus*, Gupta & Gupta, *Mem. Zool. Surv. India*, 18(1) : 56.

2. ***Eotetranychus hicoriae*** (McGregor)

1950. *Tetranychus hicoriae* McGregor, *An. Midl. Nat.*, 44.

1955. *Eotetranychus hicoriae*, Pritchard & Baker, *Pacific coast ent. Soc. Mem. Ser.*, 2 : 211.

1973. *Eotetranychus hicoriae*, Lakkundi, *M. Sc. Thesis, UAS, Bangalore*, p. 1-62.

1994. *Eotetranychus hicoriae*, Gupta & Gupta, *Mem. Zool. Surv. India*, 18(1) : 66.

Collection Records : Several males and females, West Bengal, Sagar Island, Bamankhali, ex Guava, 31.1.2001.

Distribution : India (Karnataka, West Bengal), U.S.A.

Remarks : Earlier this species has been reported to infest guava in Karnataka and its occurrence in West Bengal was so far unknown. It was found to severally infest guava in Sagar Island, which caused yellowing of leaves and later brownish patches developed on such leaves.

Genus 3. ***Oligonychus*** Berlese

1886. *Oligonychus* Berlese, *Acari. dannosialle. piante. coltivati*, 31 : 24.

1994. *Oligonychus*, Gupta & Gupta, *Mem. Zool. Surv. India*, 18(1) : 99.

Key to the species of *Oligonychus* recorded in SBR

1. Aedeagus bent ventrad, tarsus I with not more than a single tactile seta on venter just distal of duplex setae. *
- *Bent portion of aedeagus forming an acute angle with shaft. *mangiferus*
- Aedeagus bent dorsal, although the distal end may be directed ventral, tarsus 1 with 2 tactile setae on venter just distal of duplex setae 2
2. Aedeagus with distal end enlarged *indicus*
- Aedeagus with distal end not enlarged 3
3. Aedeagus with distal end strongly sigmoid *sacchari*
- Aedeagus with distal end not strongly sigmoid *oryzae*

3. *Oligonychus indicus* (Hirst)

1953. *Paratetranychus indicus* Hirst, *Proc. zool. Soc. Lond.* Part-4 : 990.
 1955. *Oligonychus indicus*, Pritchard & Baker, *Pacific coast. ent. Soc. Mem. Ser.*, 2 : 354-355.
 1994. *Oligonychus indicus*, Gupta & Gupta, *Mem. Zool. Surv. India*, 18(1) : 104-105.

Collection Records : Several males and females, West Bengal, Sagar Island, Bamankhali, ex Sugarcane, 19.10.2000; 1(F), 2(M), Chemaguri ex Neem, 14.11.2000; several females and males, Gosaba, ex Sugarcane, 8.11.2001.

Distribution : India (almost in all the states), Pakistan.

Remarks : This species was found to infest sugarcane crop in Tagore Society Agricultural Field Station producing characteristic reddening patches on under surface of leaves. Most of the leaves in the field had shown this damage symptoms.

4. *Oligonychus mangiferus* (Rahman & Sapra)

1940. *Paratetranychus mangiferus* Rahman & Sapra, *Proc. Indian Acad. Sci.*, 11B : 192.
 1955. *Oligonychus mangiferus*, Pritchard & Baker. *Pacific Coast Ent. Soc. Mem. Ser.*, 2 : 330.
 1994. *Oligonychus mangiferus*, Gupta & Gupta, *Mem. Zool. Surv. India*, 18(1) : 108-110.

Collection Records : 3(F), West Bengal, 24-Parganas(S), Bhagabatpur, ex *Mangifera indica*, 18.10.2000; 7(F), 2(M), Lothian Island, ex *Mangifera indica*, 19.10.2000.

Distribution : India (Haryana, Himachal Pradesh, Punjab, Bihar, Gujarat, West Bengal, Meghalaya, Karnataka), Mauritius, South Africa.

Remarks : This mite formed colonies on upper surface of leaves but produced no noticeable damage symptoms.

5. *Oligonychus oryzae* (Hirst)

1926. *Paratetranychus oryzae* Hirst, *Proc. Zool. Soc. Lond.* p. 830.
 1955. *Oligonychus oryzae*, Pritchard & Baker. *Pacific coast ent. Soc. Mem. Ser.*, 2 : 337.
 1994. *Oligonychus oryzae*, Gupta & Gupta, *Mem. Zool. Surv. India*, 18(1) : 110-112.

Collection Records : 5(F), 3(M), West Bengal, 24-Parganas(S), Chandanpidi, ex *Oryza sativa*, 18.10.2000.

Distribution : India (Andaman Nicobar Island, West Bengal, Orissa, Tamil Nadu, Punjab), Thailand.

Remarks : The population of this mite in the field was very poor and no noticeable damage symptoms were recorded.

6. *Oligonychus sacchari* (McGregor)

1942. *Paratetranychus sacchari* McGregor, *J. Univ. Puerto-Rico*. 26 : 91.
 1955. *Oligonychus sacchari*, Pritchard & Baker. *Pacific coast ent. Soc. Mem. Ser.*, 2 : 355-357.
 1994. *Oligonychus sacchari*, Gupta & Gupta, *Mem. Zool. Surv. India*, 18(1) : 114-115.

Collection Records : 2(F) West Bengal, 24-Parganas(S), Bhagabatpur Island, Ex. Sugarcane, 18.10.2000.

Distribution : India (Gujarat, M.P., West Bengal, Orissa), South America.

Genus 4. *Panonychus* Yokoyama

1929. *Panonychus* Yokoyama, *Nippon. Sangyo. Gaichu. Zensho*, 569 : 531.
 1994. *Panonychus*, Gupta & Gupta, *Mem. Zool. Surv. India*, 18(1) : 52.

7. *Panonychus citri* (McGregor)

1916. *Tetranychus citri* McGregor, *Ann. Ent. Soc. Am.*, 9 : 284.
 1919. *Panonychus citri*, McGregor, *Smithsonian. Inst. Proc. U.S. nat. Mus.*, 56 : 641-679.
 1994. *Panonychus citri*, Gupta & Gupta, *Mem. Zool. Surv. India*, 18(1) : 53-54.

Collection Records : Several females and males West Bengal, 24-Parganas(S), Gosaba island ex cashew nut, coconut and papaya, 8.11.2001.

Distribution : India (Himachal Pradesh, Manipur, Tripura, U.P., Meghalaya, West Bengal, Jammu and Kashmir), Nepal, South America, U.S.A., Central America, China, Japan, Middle East, South-Africa, Thailand, Taiwan, Hongkong.

Remarks : Although this species was recorded on a number of hosts but none of these hosts had shown any damage symptoms.

Genus 5. *Schizotetranychus* Tragardh

1915. *Schizotetranychus* Tragardh, *Zts. Ang. Ent.*, 2 : 277.
 1994. *Schizotetranychus*, Gupta & Gupta, *Mem. Zool. Surv. India*, 18 : 86.

8. *Schizotetranychus hindustanicus* (Hirst)

1924. *Tetranychus (Schizotetranychus) hindustanicus* Hirst, *Ann. Mag. nat. Hist. London*, 9(14) : 829.
 1955. *Schizotetranychus hindustanicus*, Pritchard & Baker. *Pacific coast ent. Soc. Mem. Ser.*, 2 : 266-267.
 1994. *Schizotetranychus hindustanicus*, Gupta & Gupta, *Mem. Zool. Surv. India*, 18(1) : 95.

Collection Records : Several females and males West Bengal, 24-Parganas(S) Chandanpidi, ex Citrus, 14.11.2000; Several males and females, Bamankhali, ex Citrus, 31.1.2002.

Distribution : India (Tamil Nadu, Kerala, West Bengal).

Remarks : This mite was found severely infesting citrus plantation in a private orchard at Bamankhali producing yellowish and greenish stipplings, the characteristic damage symptoms produced by this species. It was found to occur both on the upper and lower surfaces of the leaves.

Genus 6. *Tetranychus* Dufour

1832. *Tetranychus* Dufour. *Annls. Sci. Nat.*, **25** : 276.

Key to the species of *Tetranychus* recorded in SBR

1. Proximal duplex setae on tarsus-I of female distal to tactile setae 2
- Proximal duplex setae on tarsus-I of female more or less in line with tactile setae 4
2. Aedeagus with a knob distally 3
- Aedeagus very long slender tapering distally *fijiensis*
3. Aedeagal knob with very small anterior and posterior projections; empodium II of male with proximo ventral tridigitate spurs *macfarlanei*
- Aedeagal knob with anterior acute projection while posterior projection absent, empodium II of male with 3 pairs of proximo ventral hairs and small distinct mediodorsal spurs ... *ludeni*
4. Upper surface of aedeagal knob straight or rounded with some kind of projection *
- *empodium I of male with strong mediodorsal spur *urticae*
- Upper surface of aedeagal knob concave with anterior or posterior rounded projections berry like *neocaledonicus*

9. *Tetranychus fijiensis* Hirst

1924. *Tetranychus fijiensis* Hirst, *Ann. Mag. Nat. Hist.*, **9** (14) : 523.

1994. *Tetranychus fijiensis*, Gupta & Gupta, *Mem. Zool. Surv. India*, **18**(1) : 121-123.

Collection Records : 5(F), 3(M), West Bengal, 24-Parganas(S), Sagar Island, ex *Tabernaemontana coronaria* and *Rhizophora* sp., 5.8.2000; 3(F) and 3(M) Lothian Island, ex-bitter gourd, 19.10.2000.

Distribution : India (Assam, Karnataka, Tamil Nadu, Kerala, Nicobar Island), Nokuoro Island, Fiji, Thailand, Liki Island.

Remarks : This species is known to infest Coconut in the coastal regions of India and also in other countries. The present hosts on which this mite has been recorded in Sagar Island are hitherto unknown.

10. *Tetranychus ludeni* Zacher

1913. *Tetranychus ludeni* Zacher, *Berlin. Mitt. Boil. Anst. H.*, **14** : 40.

1994. *Tetranychus ludeni*, Gupta & Gupta, *Mem. Zool. Surv. India*, **18**(1) : 127-129.

Collection Records : 5(F) West Bengal, Sagar Island, Bamankhali, ex *Tabernaemontana coronaria*, 6.8.2000; 3(F) and 5(M), Lothian Island, ex Okra and a trailing plant locally called 'Pui sag', 19.10.2000; 3(M) Bhagabatur Island ex guava and papaya, 18.10.2000.

Distribution : India (West Bengal, Delhi, Karnataka, Gujarat, U.P., Bihar, Tamil Nadu), South Africa, U.S.A., South America, New Zealand, Europe.

Remarks : This is a very important pest species known to occur on a wide range of vegetables mainly on beans on which it causes severe damage. In the present study, though this mite was seen to infest vegetables like lady's finger, Pui sag, chilli etc. and some ornamental plants but the characteristic damage symptoms of this species were not discernible except on lady's finger.

11. *Tetranychus macfarlanei* Baker and Pritchard

1960. *Tetranychus macfarlanei* Baker & Pritchard, *Hilgardia*, **29** : 537.

1994. *Tetranychus macfarlanei*, Gupta & Gupta, *Mem. Zool. Surv. India*, **18**(1) : 129-131.

Collection Records : 4(F), Lothian Island ex bitter gourd, 19.10.2000.

Distribution : India (West Bengal, Madhya Pradesh, Andaman Nicobar Island, Rajasthan, Gujarat, Tamil Nadu, Karnataka), Mauritius.

Remarks : In western parts of India, this mite was reported to infest brinjal and cotton seriously but in present investigation its infestation was not found on bitter gourd in serious form.

12. *Tetranychus neocaledonicus* Andre

1933. *Tetranychus neocaledonicus* Andre, *Bull. Mus. natn. Hist. Nat. Paris* (2) **5** : 302.

1994. *Tetranychus neocaledonicus*, Gupta & Gupta, *Mem. Zool. Surv. India*, **18**(1) : 131-133.

Collection Records : 3(F), 2(M) Sagar Island, Bamankhali, ex *Tabernaemontana coronaria*, Pui sag, chilli, 5.8.2000.

Distribution : India (Throughout the country), Cosmopolitan.

Remarks : This mite was reported to occur on over 200 host plants (Smith Meyer, 1987; Gupta and Gupta 1994) and is considered to be one of the most important pest species of crop plants. Its infestation in the present study was never found as serious.

13. *Tetranychus* sp.

Collection Records : 2(F) Sajnakhali ex Pasur (*Xylocarpus* sp.), 8.11.2001.

Remarks : Due to non availability of male, the specific determination could not be made. No tetranychid mite has been reported earlier on *Xylocarpus* sp. from any part of the world.

Family II. TENUIPALPIDAE Berlese

1913. Tenuipalpidae Berlese, *Acarotheca. Italica. Firenze, Tipografia di M. Ricci.* p. 17.

1985. Tenuipalpidae, Gupta, *Handbk. Plant Mites of India*, p. 118.

Key to the genera of Tenuipalpidae known to occur in SBR

1. Hysterosoma normally with penultimate pair of dorsolateral setae flagelliform *Tenuipalpus*
- Hysterosoma normally with penultimate pair of dorso lateral setae of normal length *Brevipalpus*

Genus 7. *Brevipalpus* Donnadieu

1875. *Brevipalpus* Donnadieu, *Recherches. pour. servir. a. l'histoire. des. Tetranyques*, p. 143-145.

1985. *Brevipalpus*, Gupta, *Handbk. Plant Mites of India*, p. 123.

Key to the species of Brevipalpus known to occur in SBR

1. Hysterosoma with six dorsolaterals *essigi*
- Hysterosoma with five dorsolaterals 2
2. Propodosoma without reticulation on dorsomedian region *phoenicis*
- Propodosoma with irregular broken striations *rugulosus*

14. *Brevipalpus essigi* Baker

1949. *Brevipalpus essigi* Baker, *Amer. Midl. Nat.*, **42** : 367.

1979. *Brevipalpus essigi*, Gupta & Ghosh, *Rec. zool. Surv. India*, **77** : 199.

1985. *Brevipalpus essigi*, Gupta, *Handbk. Plant Mites of India*, p. 128.

Collection Records : 1(F) Gosaba, Tagore Society Agricultural Field Station, ex *Hibiscus rosa-sinensis*, 8.11.2001.

Distribution : India (Car Nicobar Island, West Bengal), U.S.A., Mexico.

15. *Brevipalpus phoenicis* (Geijskes)

1939. *Brevipalpus phoenicis*, Geijskes, *Meded. Landb. Hooges. Wageningen*, **42** : 230.

1961. *Brevipalpus phoenicis*, Das, *Two & Bud.*, **8** : 3-4.

1985. *Brevipalpus phoenicis*, Gupta, *Handbk. Plant Mites of India*, p. 130-131.

Collection Records : 5(F) Bamankhali, ex brinjal, 5.8.2000.

Distribution : India (Almost from all the States), Cosmopolitan.

Remarks : This is an important pest species and is known to infest over 100 host plants throughout the world. Often it causes serious damage specially to fruit trees and ornamental plants.

16. *Brevipalpus rugulosus* Chaudhri, Akbar and Rasool

1974. *Brevipalpus rugulosus* Chaudhri, Akbar and Rasool, *Univ. Agril. Lyallpur.*, p. 45-48.

1980. *Brevipalpus rugulosus*, Sadana and Chhabra, *Sci. and Cult.*, **46** : 369-370.

1985. *Brevipalpus rugulosus*, Gupta, *Handbk. Plant Mites of India*, p. 132.

Collection Records : 2(M) Sajnakhali, ex Sundari (*Heritiera fomes*), 8.11.2001; 1(F), Gosaba Tagore Society agricultural field station, ex *Oryza sativa*, 8.11.2001.

Distribution : India (Punjab, West Bengal), Pakistan.

Remarks : The occurrence of this species on Sundari (*Heritiera fomes*) and paddy form new hosts. Earlier, Sundari has no record of infestation by any tenuipalpid mite. The leaves became brittle due to its infestation.

Genus 8. *Tenuipalpus* Donnadieu

1875. *Tenuipalpus* Donnadieu, *Recherches pour servir a l'histoire des Tetranyques.*, p. 139-145.

1985. *Tenuipalpus*, Gupta, *Handbk. Plant Mites of India*, p. 138.

Key to the species of the *Tenuipalpus* known to occur in SBR

1. Hysterosoma with a differentiated extension anterior to coxa-III *micheli*
- Hysterosoma without a differentiated extension anterior to coxa-III *pernicis*

17. *Tenuipalpus micheli* Lawrence

1940. *Tenuipalpus micheli* Lawrence, *J. Ent. Soc. South Africa*, **3** : 111.

1974. *Tenuipalpus micheli*, Nageshchandra & ChannaBasavanna, *IV Int. Congr. Acarology, Austria*.

1985. *Tenuipalpus micheli*, Gupta, *Handbk. Plant Mites of India*, p. 146.

Collection Records : 1(F), Sajnakhali, ex Sundari, 8.11.2001.

Distribution : India : Karnataka, Andaman Islands, West Bengal (South 24-Parganas), South Africa.

Remarks : This species is recorded in West Bengal for the first time and its occurrence on 'Sundari (*Heritiera fomes*) forms new host record.

18. *Tenuipalpus pernicis* Chaudhri, Akbar and Rasool

1974. *Tenuipalpus pernicis* Chaudhri, Akbar and Rasool, *Univ. Agril. Lyallpur.*, p. 85.

1978. *Tenuipalpus pernicis*, Maninder & Ghai, *Oriental. Ins.*, **12** : 225.

1985. *Tenuipalpus pernicis*, Gupta, *Handbk. Plant Mites of India*, p. 146-147.

Collection Records : 3(F), 5(M) Bhagabatpur, ex papaya and guava, 17.10.2000.

Distribution : India : Delhi, West Bengal, (South 24-Parganas), Pakistan.

Remarks : No record of the species was available from West Bengal earlier and the two hosts on which it has been recorded now also form two additional host records.

Family III. ERIOPHYIDAE Nalepa

1898. *Eriophyidae* Nalepa, Das. *Tierreich.*, 4 : 5.

Genus 9. *Aceria* Keifer

1944. *Aceria* Keifer, *Bull. Calif. Dep. Agr.*, 33 : 22.

1985. *Aceria*, Gupta, *Handbk. Plant Mites of India*, p. 180-181.

19. *Aceria guerreronis* (Keifer)

1965. *Eriophyes guerreronis* Keifer, *Eriophyid studies*, B-14. *Calif. Dept. Agric. Bureau of Entomol.*, 20 pp.

Collection Records : Several males and females, Gosaba, ex *Cocos nucifera*, 8.11.2001.

Distribution : India (Kerala, Karnataka, Andhra Pradesh, West Bengal), Mexico, Venezuela, Brazil, West Africa.

Remarks : This mite was collected from underneath perianths of fallen nuts having white 'V' shaped scars. This is the first record of the species from West Bengal. It is known to cause severe damage on coconut plantation specially in Southern India and for that the planters suffer heavy economic loss amounting to lakhs of rupees.

20. *Aceria saccharini* Wang

1964. *Aceria saccharini* Wang, *Rept. Taiwan, Ser. Exp. Sta.*, 33 : 83-94.

1966. *Aceria sacchari* ChannaBasavanna, *Univ. Agri. Sci. Bull.*, p. 55-57.

1985. *Aceria saccharini*, Gupta, *Handbk. Plant Mites of India*, p. 202-203.

Collection Records : Several females, Gosaba, Tagore society agricultural field station, ex Sugarcane, 8.11.2001.

Distribution : India : Karnataka, Tamil Nadu, Andhra Pradesh, Punjab, West Bengal (South 24-Parganas).

Remarks : This mite was seen producing reddish blisters on inner leaf sheath.

Family IV TARSONEMIDAE Karmer

1877. *Tarsonemidae* Kramer, *Archiv. Fur, Naturgesch.*, 43 : 215.

Genus 10. *Polyphagotarsonemus* Beer & Nucifora

1965. *Polyphagotarsonemus* Beer & Nucifora, *Bull. Zool. Agri. Bachic.*, (2) 7 : 19-43.

21. *Polyphagotarsonemus latus* (Banks)

1904. *Tarsonemus latus* Banks, *Proc. U. S. Nat. Mus.*, 32(1553) : 615.

1958. *Hemitarsonemus latus*, Dutt. *Indian Farm.*, 8 : 10-12.

1985. *Polyphagotarsonemus latus*, Gupta, *Handbk. Plant Mites of India*, p. 292-294.

Collection Records : 4(F), 1(M), Sajnakhali, ex Garjan (*Rhizophora apiculata*) and Sundari (*Heritiera fomes*), 8.11.2001.

Distribution : India (Almost in all States), West Bengal (South 24-Parganas), cosmopolitan.

Remarks : This mite is a serious pest of vegetables, ornamental plants and fruit trees in India, causing mostly crinkling and curling of young leaves. Hence, its occurrence on Sundari and Garjan is interesting and both form new host records. However, no crinkling and curling symptoms were seen in the present study on the host plants.

SUMMARY

The present paper provides a taxonomic account of phytophagous mite fauna occurring on mangrove vegetation and agri-horticultural crops in the Sundarban. Biosphere Reserve and reports 21 species belonging to 10 genera and 4 families of those 6 species viz. *Eotetranychus hicoriae* (McG.), *Brevipalpus rugulosus* Chaudhri *et al.*, *Tenuipalpus micheli* (Lawrence), *Tenuipalpus pernicious* Chaudhri *et al.*, *Aceria guerreronis* (Keifer) and *Aceria saccharini* Wang are recorded from West Bengal for the first time and 7 plants form new host records.

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REFERENCES

- Gupta, S. K. 1992. Arachnid : Plant mites (Acari). In : *State Fauna Series 3, Fauna of West Bengal, Part-3*, 61-211.
- Gupta, S. K. & Gupta, Y. N. 1994. A taxonomic review of Indian Tetranychidae (Acari : Prostigmata) with descriptions of new species, re-descriptions of known species and keys to genera and species. *Mem. Zool. Surv. India*, **18**(1) : 1-196.
- Smith-Mayer, M. K. P. 1987. African Tetranychidae (Acari : Prostigmata) with reference to the world genera. *Ent. Mem. Dept. Agr. and water suppl. Repub. S. Africa*, **69** : 1-174.

FISH FAUNA OF NORTH EAST INDIA WITH SPECIAL REFERENCE TO ENDEMIC AND THREATENED SPECIES

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INTRODUCTION

North East India with its sister states have unique topography, varied watershed pattern and physiography. The area is enriched with diversified fish fauna. A perusal of literature reveals that the area is blessed with 291 species under 119 genera, 38 families and 12 orders (Hora, 1921a, 1921b, 1936; Jayaram 1963, 1999; Malhotra and Suri, 1969; Sen, 1977, 1995, 1999a, 1999b; Barman, 1984, 1992, 1994; Sen, 1985; Singh & Singh, 1985; Vishwanath & Singh, 1986; Datta, Barman & Jayaram, 1987; Talwar & Jhingran, 1991; Bhagowati & Biswas 1992; Vishwanath, 1993; Sen & Biswas, 1994; Nath & Dey, 1997; Keishing & Vishwanath, 1998, 1999; Kumar & Singh, 1998; Vishwanath *et al.* 1998; Vishwanath & Kosygin, 1999, 2000a, 2000b, 2001; Arunkumar, 2000a, 2000b; Arunkumar & Singh, 2000; Menon *et al.* 2000).

The recorded and reported species along with their distribution in different States of N. E. India, status, type locality and endemism have been shown in Table 1. Controversy is there regarding total number of species occurring in North East India. Regarding endemic species also differences of opinion persist. Sen (1985) identified 48 species to be endemic to Assam and neighbouring North Eastern States. Sarkar and Ponniah (2000) reported 66 species endemic to this region. Ghosh and Lipton (1982) reported 33 species as restricted in their distribution to this region. The present paper is worked out to get a total picture of the fish species recorded and reported so far from this region, as well as the endemic and threatened species occurring in N. E. India. The classification and nomenclature followed after Jayaram (1999).

As per Darlington (1957), endemic means, “confined to, occurring nowhere except in the place in question” Lagler *et al.* (1962) also opined that endemic means confined to a given place or area; occurring nowhere else. As per biological terms also endemic means “native”, restricted to a certain region or part of region (Holmes Sandra 1979).

As per above definition the following species are only endemic to North East India :

	Species	Type loc.	Status*
1	<i>Moringua hodgarti</i> Chaudhuri	Arunachal (Abor)	CR
2	<i>Barilius dogarsinghi</i> Hora	Manipur	EN

	Species	Type loc.	Status*
3	<i>Barilius lairokensis</i> Arunkumar & Singh	Manipur	ne**
4	<i>Danio naganensis</i> Chaudhuri	Nagaland	VU
5	<i>Danio yuensis</i> Kumar & Singh	Manipur	ne
6	<i>Brachydanio acuticephala</i> (Hora)	Manipur	VU
7	<i>Tor progenius</i> (McClelland)	Assam	DD
8	<i>Puntius shalynius</i> Yazdani & Talukdar	Meghalaya	VU
9	<i>Semiplotus manipurensis</i> Vishwanath & Kosygin	Manipur	ne
10	<i>Garra elongata</i> Vishwanath & Kosygin	Manipur	ne
11	<i>Garra kempi</i> Hora	Arunachal	VU
12	<i>Garra lissorhynchus</i> (McClelland)	Meghalaya	VU
13	<i>Garra litanensis</i> Vishwanath	Manipur	CR
14	<i>Garra manipurensis</i> Vishwanath & Sarojnalini	Manipur	CR
15	<i>Garra naganensis</i> Hora	Nagaland	VU
16	<i>Garra rupecula</i> (McClelland)	Arunachal	VU
17	<i>Acanthocobitis pavonaceus</i> (McClelland)	Assam	EN
18	<i>Schistura arunachalensis</i> (Menon)	Arunachal	EN/N
19	<i>Schistura barapaniensis</i> (Menon)	Meghalaya	EN
20	<i>Schistura manipurensis</i> (Chaudhuri)	Manipur	VU
21	<i>Schistura nagaensis</i> (Menon)	Nagaland	EN
22	<i>Schistura prashadi</i> (Hora)	Manipur	ne
23	<i>Schistura singhi</i> (Menon)	Nagaland	CR
24	<i>Mesonemacheilus sijuensis</i> (Menon)	Meghalaya	VU
25	<i>Mesonemacheilus reticulofasciatus</i> (Singh & Banarescu)	Meghalaya	EN
26	<i>Aborichthys garoensis</i> Hora	Meghalaya	CR
27	<i>Aborichthys tikaderi</i> Barman	Arunachal	EN
28	<i>Neoeucirrhichthys maydelli</i> Banarescu & Nalbant	Assam	VU
29	<i>Acantophthalmus longipinnis</i> (Menon)	Manipur	ne
30	<i>Lepidocephalus irrorata</i> (Hora)	Manipur	VU
31	<i>Kryptopterus indicus</i> Datta, Barman & Jayaram	Arunachal	CR
32	<i>Nangra assamensis</i> Sen & Biswas	Assam	ne
33	<i>Myerglanis jayrami</i> Vishwanath & Kosygin	Manipur	ne
34	<i>Chaudhuria (Pillaia) indica</i> (Yazdani)	Meghalaya	VU
35	<i>Chaudhuria</i> (Garo) khajuriai (Talwar, Yazdani & Kundu)	Meghalaya	EN

*As per CAMP Workshop (1998);

**ne-status not evaluated.

If we consider original description of a species, then there are 71 species which have their type locality in North Eastern Region (Table 1) but their overall distribution reveals that all of them are not endemic to this region only.

STATUS OF ENDEMIC SPECIES

Out of 35 endemic species, the status of 27 species were evaluated (CAMP, 1998), the rest 8 species are yet to be evaluated. 27 species include 6 critically endangered, 8 endangered and 12 vulnerable species; 1 species is data deficient.

STATUS OF TOTAL SPECIES

Major percentage of 291 species recorded and reported so far from N.E. India belongs to Cypriniformes (161 spp.) followed by Siluriformes (77 spp.), Perciformes (25 spp.), Synbranchiformes (9 spp.), Clupeiformes (7 spp.), Anguilliformes (3 spp.) Beloniformes (2 spp.), Mugiliformes (2 spp.), Osteoglossiformes (2 spp.), Cyprinodontiformes (1 sp.), Gasterosteiformes (1 sp.) and Tetraodontiformes (1 sp.) (Fig. 1)

Of the 291 species, status of only 172 species have so far been evaluated, the rest 119 species are yet to be evaluated (Fig. 2). 172 evaluated species include 107 threatened species (9 critically endangered, 40 endangered, 57 vulnerable and 1 extinct in wild); the rest 65 species are low risk (either LRlc/LRnt).

DISCUSSION

The N.E. India is one of the global hotspot for faunal diversity. With reference to Pisces, the region is enriched with 291 species belonging to 38 families and 12 orders. Considering the status of 172 species (evaluated so far), it is alarming to note that 107 threatened species are occurring in this region. The status of 119 species are yet to be evaluated which include rarely occurring species to this region like *Pisodonophis boro*, *Oreochthys cosuatis*, *Barilius gatensis*, *B. radiolatus*, *Danio regina*, *Puntius gelius*, *Schizopygopsis stoliczkae*, *Garra mcClellandi*, *Homaloptera modesta*, *Schistura beavani*, *S. cincticauda*, *S. savona*, *Acantopsis choirorhynchos*, *Acantophthalmus longipinnis*, *Mystus menoda*, *Silurus berdmorei*, *Conta conta*, *Erethistes pussilus*, *Erethistoides montana*, *Exostoma berdmorei*, *E. labiatum*, *E. stuarti*, *Gogata gagata*, *Glyptothorax annandalei*, *Chaca chaca*, *Olyra horai*, *O. longicaudata*, *Apocryptes bato*, *Microphis deocata* which have to be evaluated though they may not have commercial value.

Status of all the species have to be evaluated so that necessary measures could be taken for the conservation of the threatened species, otherwise rich heritage of fish germplasm of this region will be lost in near future.

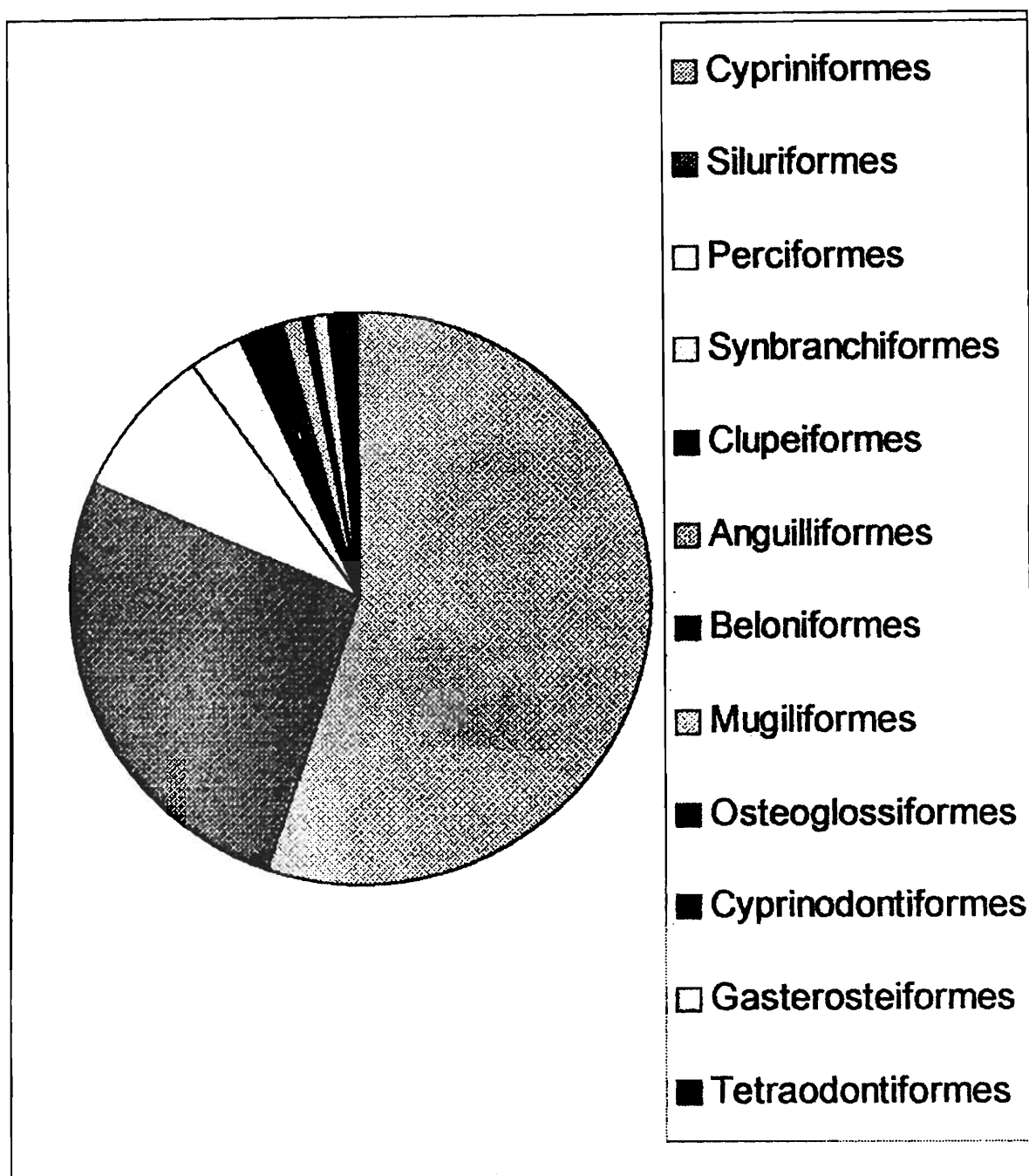


Fig - 1

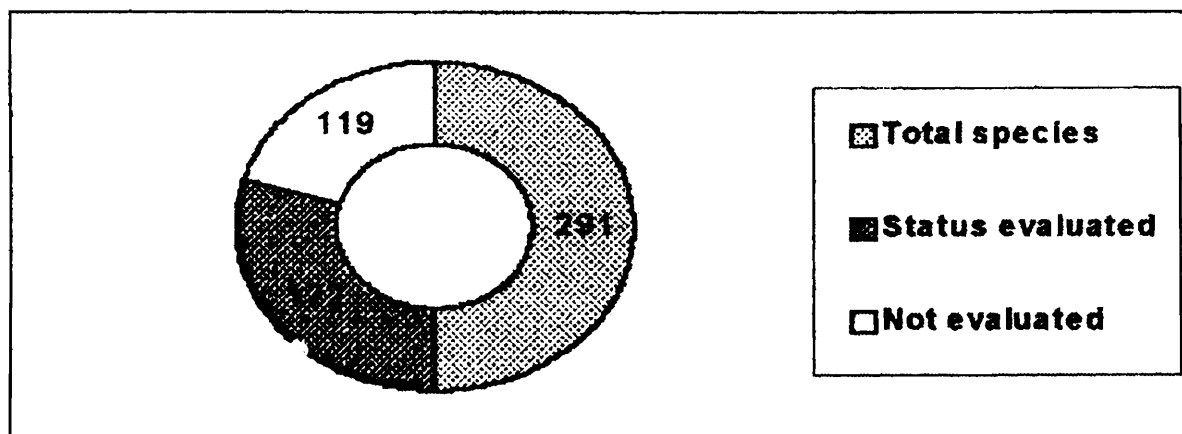


Fig - 2

Table 1. : Fish Fauna of N. E. India (Recorded and Reported).

SI No.	Ord	Fam	Species	Type locality	M	A	AP	MI	N	MN	T	Status	Ende
1.	OSTEOGLOSSIFORMES	NOTOPTERIDAE	<i>Notopterus notopterus</i> (Pallas)	?Indian ocean	+	+	+	-	-	+	+	LRnt	
2.	OSTEOGLOSSIFORMES	NOTOPTERIDAE	<i>Chitala chitala</i> (Hamilton-Buchanan)	R. of Beng & Bihar	+	+	-	-	-	-	+	EN/N	
3.	ANGUILLIFORMES	ANGLUILLIDAE	<i>Anguilla bengalensis bengalensis</i> (Gray&Hardwicks)	Ganges R.	+	+	+	-	-	+	+	EN	
4.	ANGUILLIFORMES	MORINGUIDAE	<i>Moringua hodgarti</i> Chaudhuri	Arunachal (Abor)	-	-	+	-	-	-	-	CR	NE
5.	ANGUILLIFORMES	OPHICHTHIDAE	<i>Pisodonophis boro</i> (Hamilton-Buchanan)	Hooghly estuary	-	+	-	-	-	-	-	ne	
6.	CLUPEIFORMES	CLUPEIDAE	<i>Hilsa (Tenuulosa) ilisha</i> (Hamilton-Buchanan)	Ganges estuary	-	+	-	-	-	-	+	VU/N	
7.	CLUPEIFORMES	CLUPEIDAE	<i>Gudusia chapra</i> (Hamilton-Buchanan)	Gang. R. (N. Bihar)	+	+	+	-	-	+	+	LRic/N	
8.	CLUPEIFORMES	CLUPEIDAE	<i>Gudusia variegata</i> (Day)	Burma (Irrawaddy)	-	+	-	-	-	-	-	ne	
9.	CLUPEIFORMES	CLUPEIDAE	<i>Nematalosa nasus</i> (Bloch)	Malabar	-	-	-	-	-	-	+	ne	
10.	CLUPEIFORMES	CLUPEIDAE	<i>Goniolosa manmina</i> (Hamilton-Buchanan)	Ganges R.	-	+	-	-	-	-	-	VU/N	
11.	CLUPEIFORMES	PRISTIGASTERIDAE	<i>Ilsha melanostoma</i> (Schneider)	Tamil Nadu	-	+	-	-	-	-	-	ne	
12.	CLUPEIFORMES	ENGRAULIDAE	<i>Setipinna phasa</i> (Hamilton-Buchanan)	Brack R. Bengal	+	+	+	-	-	+	-	ne	
13.	CYPRINIFORMES	CYPRINIDAE	<i>Hypophthalmichthys molitrix</i> (Valenciennes)	China	-	+	-	-	-	-	+	ne	
14.	CYPRINIFORMES	CYPRINIDAE	<i>Securicula gora</i> (Hamilton-Buchanan)	Ganges R.	+	+	+	-	-	-	-	ne	
15.	CYPRINIFORMES	CYPRINIDAE	<i>Salmostoma bacalla</i> (Hamilton-Buchanan)	Gangetic Prov.	+	+	+	-	-	+	+	LRic/N	
16.	CYPRINIFORMES	CYPRINIDAE	<i>Salmostoma clupeoides</i> (Bloch)	Fresh Water, India	-	+	-	-	-	-	+	LRic/N	
17.	CYPRINIFORMES	CYPRINIDAE	<i>Salmostoma phulo phulo</i> (Hamilton-Buchanan)	N.E. parts (Beng.)	+	+	+	-	-	-	-	ne	
18.	CYPRINIFORMES	CYPRINIDAE	<i>Salmostoma sladoni</i> (Day)	Burma (Irrawaddy)	-	-	-	-	-	+	-	ne	
19.	CYPRINIFORMES	CYPRINIDAE	<i>Aspidoparia jaya</i> (Hamilton-Buchanan)	N. Bihar	-	+	+	-	-	-	+	VU/N	
20.	CYPRINIFORMES	CYPRINIDAE	<i>Aspidoparia morar</i> (Hamilton-Buchanan)	R. Yamuna & Teesta	-	+	+	+	-	+	+	LRnt/N	
21.	CYPRINIFORMES	CYPRINIDAE	<i>Barilius barila</i> (Hamilton-Buchanan)	R. of N. Bengal	+	+	-	-	+	+	+	VU/N	
22.	CYPRINIFORMES	CYPRINIDAE	<i>Barilius barna</i> (Hamilton-Buchanan)	Yamuna & Brah. R.	+	+	+	-	+	+	+	LRnt/N	
23.	CYPRINIFORMES	CYPRINIDAE	<i>Barilius bendelisis</i> (Hamilton-Buchanan)	Mysore	+	+	+	+	+	+	+	LRnt/N	
24.	CYPRINIFORMES	CYPRINIDAE	<i>Barilius bola</i> (Hamilton-Buchanan)	R. Brahmaputra	+	+	+	-	-	+	+	VU/N	
25.	CYPRINIFORMES	CYPRINIDAE	<i>Barilius dogarsinghi</i> Hora	Manipur	-	-	-	-	+	+	-	EN	NE

TABLE 1. : Cont'd.

SI No.	Ord	Fam	Species	Type locality	M	A	AP	MI	N	MN	T	Status	Ende
26.	CYPRINIFORMES	CYPRINIDAE	<i>Barilius gatensis</i> (Valenciennes)	Pennin. India	-	-	-	-	-	+	+	ne	
27.	CYPRINIFORMES	CYPRINIDAE	<i>Barilius lairokensis</i> Arunkumar & Singh	Manipur	-	-	-	-	-	+	-	ne	NE
28.	CYPRINIFORMES	CYPRINIDAE	<i>Barilius radiolatus</i> Gunther	Madhya Pradesh	-	-	-	-	-	-	+	ne	
29.	CYPRINIFORMES	CYPRINIDAE	<i>Barilius guttatus</i> (Day)	Burma	-	-	-	-	-	+	-	EN/N	
30.	CYPRINIFORMES	CYPRINIDAE	<i>Barilius shacra</i> (Hamilton-Buchanan)	Kosi R. (U.P.)	-	+	+	-	-	+	+	LRnt/N	
31.	CYPRINIFORMES	CYPRINIDAE	<i>Barilius tileo</i> (Hamilton-Buchanan)	Kosi R. (U.P.)	+	+	+	-	-	+	+	LRnt/N	
32.	CYPRINIFORMES	CYPRINIDAE	<i>Barilius vagra vagra</i> (Hamilton-Buchanan)	Ganges R. Patna	-	+	+	+	-	+	-	VU/N	
33.	CYPRINIFORMES	CYPRINIDAE	<i>Chela cachi</i> (Hamilton-Buchanan)	Ganges R.	+	+	+	-	-	+	+	ne	
34.	CYPRINIFORMES	CYPRINIDAE	<i>Chela laubuca</i> (Hamilton-Buchanan)	N. E. parts (Beng.)	+	+	+	-	-	+	+	LRlc/N	
35.	CYPRINIFORMES	CYPRINIDAE	<i>Chela fasciatus</i> (Silas)	Kerala	-	-	-	-	-	+	-	ne	
36.	CYPRINIFORMES	CYPRINIDAE	<i>Esomus danricus</i> (Hamilton-Buchanan)	R. & Ponds, Beng.	+	+	+	-	+	+	+	LRlc/N	
37.	CYPRINIFORMES	CYPRINIDAE	<i>Danio aequipinnatus</i> (McClelland)	Assam	+	+	+	+	+	+	+	LRnt/N	
38.	CYPRINIFORMES	CYPRINIDAE	<i>Danio dangila</i> (Hamilton-Buchanan)	Bihar	+	+	+	+	+	+	+	ne	
39.	CYPRINIFORMES	CYPRINIDAE	<i>Danio devario</i> (Hamilton-Buchanan)	R. & Ponds, Beng.	+	+	+	-	-	-	+	LRnt/N	
40.	CYPRINIFORMES	CYPRINIDAE	<i>Danio naganensis</i> Chaudhuri	Nagaland	-	-	-	-	+	+	-	VU	NE
41.	CYPRINIFORMES	CYPRINIDAE	<i>Danio regina</i> Fowler	Burma	-	+	-	-	-	-	-	ne	
42.	CYPRINIFORMES	CYPRINIDAE	<i>Danio yuensis</i> Kumar & Singh	Manipur	-	-	-	-	-	+	-	ne	NE
43.	CYPRINIFORMES	CYPRINIDAE	<i>Brachydanio acuticephala</i> (Hora)	Manipur	-	-	+	-	+	+	-	VU	NE
44.	CYPRINIFORMES	CYPRINIDAE	<i>Brachydanio rerio</i> (Hamilton-Buchanan)	Kosi R. (U.P.)	+	+	+	+	+	+	+	LRnt/N	
45.	CYPRINIFORMES	CYPRINIDAE	<i>Rasbora daniconius</i> (Hamilton-Buchanan)	R. of S. Bengal	+	+	+	-	-	+	+	LRnt/N	
46.	CYPRINIFORMES	CYPRINIDAE	<i>Rasbora rasbora</i> (Hamilton-Buchanan)	Ponds of Bengal	+	+	+	-	+	+	+	ne	
47.	CYPRINIFORMES	CYPRINIDAE	<i>Bengana elanga</i> (Hamilton-Buchanan)	R. & Ponds, Beng.	+	+	+	-	-	-	+	ne	
48.	CYPRINIFORMES	CYPRINIDAE	<i>Amblypharyngodon mola</i> (Hamilton-Buchanan)	Gangetic Prov.	+	+	+	-	-	+	+	LRlc/N	
49.	CYPRINIFORMES	CYPRINIDAE	<i>Ctenopharyngodon idellus</i> (Valenciennes)	China	+	+	-	-	-	-	+	ne	
50.	CYPRINIFORMES	CYPRINIDAE	<i>Cyprinus carpio communis</i> Linnaeus	Europe	+	+	+	-	-	+	+	ne	

TABLE 1. : Cont'd.

Sl No.	Ord	Fam	Species	Type locality	M	A	AP	MI	N	MN	T	Status	Ende
51.	CYPRINIFORMES	CYPRINIDAE	<i>Cyprinus carpio specularis</i> Lacepede	Europe	+	-	-	-	-	-	-	ne	
52.	CYPRINIFORMES	CYPRINIDAE	<i>Tor mosal</i> (Hamilton-Buchanan)	Kosi R. (U.P.)	-	+	-	-	-	-	-	EN/N	
53.	CYPRINIFORMES	CYPRINIDAE	<i>Tor progenius</i> (McClelland)	Assam	-	+	-	-	+	+	-	DD	NE
54.	CYPRINIFORMES	CYPRINIDAE	<i>Tor putitora</i> (Hamilton-Buchanan)	Eastern Bengal	+	+	+	-	-	+	+	EN/N	
55.	CYPRINIFORMES	CYPRINIDAE	<i>Tor tor</i> (Hamilton-Buchanan)	Mahananda R. (WB)	+	+	+	+	+	+	+	EN/N	
56.	CYPRINIFORMES	CYPRINIDAE	<i>Naziritor chelynoides</i> (McClelland)	Simla	+	+	-	-	-	-	-	EN	
57.	CYPRINIFORMES	CYPRINIDAE	<i>Neolissocheilus hexagonolepis</i> (McClelland)	Upp. Assam	+	+	+	+	+	+	+	ne	
58.	CYPRINIFORMES	CYPRINIDAE	<i>Neolissocheilus hexastichus</i> (McClelland)	India	+	+	+	+	+	-	-	VU/N	
59.	CYPRINIFORMES	CYPRINIDAE	<i>Neolissochellus stracheyi</i> (Day)	Burma	-	-	-	-	-	+	-	ne	
60.	CYPRINIFORMES	CYPRINIDAE	<i>Osteobrama belangeri</i> (Valenciennes)	Bengal	-	-	-	-	-	+	-	EW	
61.	CYPRINIFORMES	CYPRINIDAE	<i>Osteobrama cotio cotio</i> (Hamilton-Buchanan)	R. & Ponds, Beng.	+	+	+	-	-	+	+	LRnt/N	
62.	CYPRINIFORMES	CYPRINIDAE	<i>Osteobrama cotio cunma</i> (Day)	Burma	-	-	-	-	-	+	-	ne	
63.	CYPRINIFORMES	CYPRINIDAE	<i>Chagunius chagunio</i> (Hamilton-Buchanan)	Bihar & Bengal	+	+	+	+	-	+	+	ne	
64.	CYPRINIFORMES	CYPRINIDAE	<i>Chagunius nicholsi</i> (Myers)	Upp. Burma	-	-	-	-	-	+	-	ne	
65.	CYPRINIFORMES	CYPRINIDAE	<i>Oreochthys cosuatis</i> (Hamilton-Buchanan)	Kosi R. (U.P.)	+	+	+	-	-	-	-	ne	
66.	CYPRINIFORMES	CYPRINIDAE	<i>Puntius chola</i> (Hamilton-Buchanan)	N. E. parts (Beng.)	+	+	+	-	-	+	+	VU	
67.	CYPRINIFORMES	CYPRINIDAE	<i>Poropuntius clavatus</i> (McClelland)	Sikkim, N. Bengal	+	+	-	-	+	+	+	EN	
68.	CYPRINIFORMES	CYPRINIDAE	<i>Poropuntius burtoni</i> (Mukherji)	Burma	-	-	-	-	-	+	-	ne	
69.	CYPRINIFORMES	CYPRINIDAE	<i>Puntius conchoni</i> (Hamilton-Buchanan)	N. Beng. & Kosi R.	+	+	+	+	+	+	+	VU/N	
70.	CYPRINIFORMES	CYPRINIDAE	<i>Puntius filamentosus</i> (Valenciennes)	Kerala	+	+	-	-	+	-	+	ne	
71.	CYPRINIFORMES	CYPRINIDAE	<i>Puntius fraseri</i> (Hora & Misra)	Maharashtra	-	+	-	-	-	-	-	ne	
72.	CYPRINIFORMES	CYPRINIDAE	<i>Puntius gelius</i> (Hamilton-Buchanan)	N. E. parts (Beng.)	+	+	-	-	-	-	+	ne	
73.	CYPRINIFORMES	CYPRINIDAE	<i>Puntius gunganio</i> (Hamilton-Buchanan)	R. Brah. & Yamuna	+	+	+	-	-	-	-	LRnt	
74.	CYPRINIFORMES	CYPRINIDAE	<i>Puntius jayarami</i> Singh & Singh	Manipur	-	-	-	-	-	+	-	EN	
75.	CYPRINIFORMES	CYPRINIDAE	<i>Puntius manipurensis</i> Menon, Rema Devi & Vishwanath	Manipur	-	-	-	-	-	+	-	ne	

TABLE 1. : Cont'd.

SI No.	Ord	Fam	Species	Type locality	M	A	AP	MI	N	MN	T	Status	Ende
126.	CYPRINIFORMES	PSILORHYNCHIDAE	<i>Psilorhynchus microphthalmus</i> Vishwanath & Manojkumar	Manipur	-	-	-	-	-	+	-	CR	
127.	CYPRINIFORMES	PSILORHYNCHIDAE	<i>Psilorhynchus sucatio</i> (Hamilton-Buchanan)	N. Bengal	+	+	+	-	-	-	+	EN	
128.	CYPRINIFORMES	PSILORHYNCHIDAE	<i>Psilorhynchoides homaloptera</i> (Hora & Mukherji)	Nagaland	+	+	+	-	+	+	-	VU	
129.	CYPRINIFORMES	BALITORIDAE	<i>Homaloptera modesta</i> (Vinciguerrae)	Lower Burma	-	-	-	-	-	+	-	ne	
130.	CYPRINIFORMES	BALITORIDAE	<i>Balitora brucei</i> Gray	Meghalaya	+	+	-	-	-	+	-	LRnt/N	
131.	CYPRINIFORMES	BALITORIDAE	<i>Acanthocobitis botia</i> (Hamilton-Buchanan)	N. E. parts (Beng.)	+	+	+	-	+	+	+	LRnt	
132.	CYPRINIFORMES	BALITORIDAE	<i>Acanthocobitis pavonaceus</i> (McClelland)	Assam	-	+	-	-	-	-	-	EN	NE
133.	CYPRINIFORMES	BALITORIDAE	<i>Acanthocobitis zonalternans</i> (Blyth)	Burma	-	-	+	-	+	+	-	DD/N	
134.	CYPRINIFORMES	BALITORIDAE	<i>Nemacheilus corica</i> (Hamilton-Buchanan)	Kosi R. (U.P.)	+	+	+	-	-	-	-	LRnt/N	
135.	CYPRINIFORMES	BALITORIDAE	<i>Neonemacheilus labeosus</i> (Kottelat)	Burma-Thai border	-	+	-	-	-	-	-	VU/N	
136.	CYPRINIFORMES	BALITORIDAE	<i>Neonemacheilus peguensis</i> (Hora)	Burma	-	-	-	-	-	+	-	EN/N	
137.	CYPRINIFORMES	BALITORIDAE	<i>Schistura arunachalensis</i> (Menon)	Arunachal Pradesh	-	+	+	-	-	-	-	EN/N	NE
138.	CYPRINIFORMES	BALITORIDAE	<i>Schistura barapaniensis</i> (Menon)	Meghalaya	+	-	-	-	-	-	-	EN	NE
139.	CYPRINIFORMES	BALITORIDAE	<i>Schistura beavani</i> (Gunther)	Kosi R. (U.P.)	+	+	+	-	-	-	-	ne	
140.	CYPRINIFORMES	BALITORIDAE	<i>Schistura cincticauda</i> (Blyth)	Burma	+	-	+	-	-	-	-	ne	
141.	CYPRINIFORMES	BALITORIDAE	<i>Schistura devdevi</i> (Hora)	North Bengal	+	-	+	-	-	-	-	EN	
142.	CYPRINIFORMES	BALITORIDAE	<i>Schistura kangjupkhulensis</i> (Hora)	Manipur	-	+	+	-	+	+	-	VU	
143.	CYPRINIFORMES	BALITORIDAE	<i>Schistura manipurensis</i> (Chaudhuri)	Manipur	-	+	+	+	+	+	-	VU	NE
144.	CYPRINIFORMES	BALITORIDAE	<i>Schistura montanus</i> (McClelland)	Simla	+	+	-	-	-	-	-	EN	
145.	CYPRINIFORMES	BALITORIDAE	<i>Schistura multifasciatus</i> (Day)	Darjeeling & Assam	+	+	+	+	+	+	-	EN/N	
146.	CYPRINIFORMES	BALITORIDAE	<i>Schistura nagaensis</i> (Menon)	Nagaland	-	-	+	-	+	-	-	EN	NE
147.	CYPRINIFORMES	BALITORIDAE	<i>Schistura prashadi</i> (Hora)	Manipur	+	-	-	-	+	+	-	ne	NE
148.	CYPRINIFORMES	BALITORIDAE	<i>Schistura rupecula inglishi</i> (Hora)	E. Himalayas	+	-	-	-	-	-	-	ne	
149.	CYPRINIFORMES	BALITORIDAE	<i>Schistura savona</i> (Hamilton-Buchanan)	Kosi R. (U.P.)	+	+	+	-	-	-	+	ne	
150.	CYPRINIFORMES	BALITORIDAE	<i>Schistura scaturigina</i> (McClelland)	Assam	+	+	+	+	+	-	+	VU	

TABLE 1. : Cont'd.

Sl No.	Ord	Fam	Species	Type locality	M	A	AP	MI	N	MN	T	Status	Ende
151.	CYPRINIFORMES	BALITORIDAE	<i>Schistura sikmaiensis</i> (Hora)	Manipur	+	+	+	-	+	+	-	EN/N	
152.	CYPRINIFORMES	BALITORIDAE	<i>Schistura singhi</i> (Menon)	Nagaland	-	-	-	-	+	-	-	CR	NE
153.	CYPRINIFORMES	BALITORIDAE	<i>Schistura vinciguerra</i> (Hora)	Burma	-	-	-	-	-	+	-	EN/N	
154.	CYPRINIFORMES	BALITORIDAE	<i>Mesonemacheilus sijuensis</i> (Menon)	Meghalaya	+	-	-	-	-	-	-	VU	NE
155.	CYPRINIFORMES	BALITORIDAE	<i>Mesonemacheilus reticulofasciatus</i> (Singh & Banareescu)	Meghalaya	+	+	-	-	-	-	-	EN	NE
156.	CYPRINIFORMES	BALITORIDAE	<i>Aborichthys elongatus</i> Hora	Darjeeling Himal.	+	+	+	-	-	-	-	EN	
157.	CYPRINIFORMES	BALITORIDAE	<i>Aborichthys garoensis</i> Hora	Meghalaya	+	-	-	-	-	-	-	CR	NE
158.	CYPRINIFORMES	BALITORIDAE	<i>Aborichthys kempi</i> Chaudhuri	Arunachal (Abor)	+	-	+	-	-	-	-	VU	
159.	CYPRINIFORMES	BALITORIDAE	<i>Aborichthys tikaderi</i> Barman	Arunachal Pradesh	-	-	+	-	-	-	-	EN	NE
160.	CYPRINIFORMES	COBITIDAE	<i>Botia berdmorei</i> (Blyth)	Burma	-	+	-	-	-	+	-	EN/N	
161.	CYPRINIFORMES	COBITIDAE	<i>Botia dario</i> (Hamilton-Buchanan)	Northern R. (Beng.)	+	+	+	+	+	+	+	ne	
162.	CYPRINIFORMES	COBITIDAE	<i>Botia histrionica</i> (Blyth)	Burma	+	+	-	-	-	+	-	VU/N	
163.	CYPRINIFORMES	COBITIDAE	<i>Botia rostrata</i> Gray	Ganges R. (Beng.)	+	+	+	-	-	-	+	EN	
164.	CYPRINIFORMES	COBITIDAE	<i>Neoeucirrhichthys maydelli</i> Banareescu & Nalbant	Assam	-	+	-	-	-	-	-	VU	NE
165.	CYPRINIFORMES	COBITIDAE	<i>Acanthophthalmus longipinnis</i> (Menon)	Manipur	-	-	-	-	-	+	-	ne	NE
166.	CYPRINIFORMES	COBITIDAE	<i>Acanthophthalmus pangia</i> (Hamilton-Buchanan)	N. E. parts (Beng.)	+	+	-	-	+	+	-	VU/N	
167.	CYPRINIFORMES	COBITIDAE	<i>Somileptes gongota</i> (Hamilton-Buchanan)	N. Bengal (Himal.)	+	+	+	-	-	-	+	LRnt/N	
168.	CYPRINIFORMES	COBITIDAE	<i>Lepidocephalus annandalei</i> Chaudhuri	Jalpaiguri, Siliguri	+	+	+	-	-	+	+	LRnt	
169.	CYPRINIFORMES	COBITIDAE	<i>Lepidocephalus berdmorei</i> (Blyth)	Burma	+	-	+	-	+	+	+	EN	
170.	CYPRINIFORMES	COBITIDAE	<i>Lepidocephalus guntea</i> (Hamilton-Buchanan)	Bengal	+	+	+	+	+	+	+	ne	
171.	CYPRINIFORMES	COBITIDAE	<i>Lepidocephalus irrorata</i> (Hora)	Manipur	+	+	-	-	+	+	-	VU	NE
172.	CYPRINIFORMES	COBITIDAE	<i>Lepidocephalus menoni</i> (Pillai & Yazdani)	Assam	+	+	+	-	-	-	-	VU/CR	
173.	CYPRINIFORMES	COBITIDAE	<i>Acantopsis choirorhynchus</i> (Bleeker)	Sumatra	-	+	-	-	-	+	-	ne	
174.	SILURIFORMES	BAGRIDAE	<i>Rita rita</i> (Hamilton-Buchanan)	Estuaries of Beng.	-	+	-	-	-	-	+	LRnt/N	
175.	SILURIFORMES	BAGRIDAE	<i>Batasio batasio</i> (Hamilton-Buchanan)	North Bengal	+	+	+	+	-	-	+	ne	

TABLE 1. : Cont'd.

Sl No.	Ord	Fam	Species	Type locality	M	A	AP	MI	N	MN	T	Status	Ende
176.	SILURIFORMES	BAGRIDAE	<i>Batasio tengana</i> (Hamilton-Buchanan)	Assam	+	+	+	-	-	+	-	ne	
177.	SILURIFORMES	BAGRIDAE	<i>Chandramara chandramara</i> (Hamilton-Buchanan)	North Bengal	+	+	+	-	-	-	-	ne	
178.	SILURIFORMES	BAGRIDAE	<i>Rama rama</i> (Hamilton-Buchanan)	R. Brahmaputra	+	+	-	-	-	-	-	ne	
179.	SILURIFORMES	BAGRIDAE	<i>Mystus bleekeri</i> (Day)	Bengal	+	+	+	-	+	+	+	VU	
180.	SILURIFORMES	BAGRIDAE	<i>Mystus cavasius</i> (Hamilton-Buchanan)	Gangetic Prov.	+	+	+	-	-	+	+	LRnt/N	
181.	SILURIFORMES	BAGRIDAE	<i>Mystus menoda</i> (Hamilton-Buchanan)	R. Kosi & Mahananda	-	+	-	-	-	-	-	ne	
182.	SILURIFORMES	BAGRIDAE	<i>Mystus microphthalmus</i> (Day)	Burma (Irrawaddy R.)	-	-	-	-	-	+	-	ne	
183.	SILURIFORMES	BAGRIDAE	<i>Mystus montanus</i> (Jerdon)	Kerala	+	+	+	-	-	-	-	VU	
184.	SILURIFORMES	BAGRIDAE	<i>Mystus tengara</i> (Hamilton-Buchanan)	N. parts of Bengal	-	+	-	-	-	-	-	ne	
185.	SILURIFORMES	BAGRIDAE	<i>Mystus pulcher</i> Chaudhuri	Burma	-	-	-	-	-	+	-	ne	
186.	SILURIFORMES	BAGRIDAE	<i>Mystus vittatus</i> (Bloch)	Tamil Nadu	+	+	+	-	-	-	+	VU/N	
187.	SILURIFORMES	BAGRIDAE	<i>Aorichthys aor</i> (Hamilton-Buchanan)	Beng. & Gang. estua.	-	+	+	+	-	+	+	ne	
188.	SILURIFORMES	BAGRIDAE	<i>Aorichthys seenghala</i> (Sykes)	Rivers at Poona	+	+	+	-	-	+	+	ne	
189.	SILURIFORMES	SILURIDAE	<i>Ompok bimaculatus</i> (Bloch)	Malabar	+	+	+	-	+	+	+	EN/N	
190.	SILURIFORMES	SILURIDAE	<i>Ompok pabda</i> (Hamilton-Buchanan)	R. & Ponds (Bengal)	+	+	+	-	-	+	+	EN/N	
191.	SILURIFORMES	SILURIDAE	<i>Ompok pabo</i> (Hamilton-Buchanan)	R. Brahmaputra	+	+	+	-	-	-	-	ne	
192.	SILURIFORMES	SILURIDAE	<i>Wallago attu</i> (Bloch & Schneider)	Malabar	+	+	+	-	-	-	+	LRnt/N	
193.	SILURIFORMES	SILURIDAE	<i>Silurus afghana</i> Gunther	Afghanistan	-	+	+	-	-	-	-	EN/N	
194.	SILURIFORMES	SILURIDAE	<i>Silurus berdmorei</i> (nec. Valenciennes)	Burma	-	+	-	-	+	-	-	ne	
195.	SILURIFORMES	SILURIDAE	<i>Silurus torrentis</i> Kobayakawa	Thailand & E. Burma	-	-	+	-	-	-	-	ne	
196.	SILURIFORMES	SILURIDAE	<i>Kryptopterus indicus</i> Datta, Barman & Jayaram	Arunachal Pradesh	-	-	+	-	-	-	-	CR	NE
197.	SILURIFORMES	SCHILBEIDAE	<i>Ailia coila</i> (Hamilton-Buchanan)	Bengal	+	+	+	-	-	-	+	VU/N	
198.	SILURIFORMES	SCHILBEIDAE	<i>Ailia punctata</i> (Day)	Jamuna rivers	+	+	-	-	-	+	-	VU/N	
199.	SILURIFORMES	SCHILBEIDAE	<i>Pseudeutropius atherinoides</i> (Bloch)	Tamil Nadu	+	+	+	-	-	-	+	EN/N	
200.	SILURIFORMES	SCHILBEIDAE	<i>Clupisoma garua</i> (Hamilton-Buchanan)	Gangetic Prov.	+	+	+	+	-	+	+	VU/N	

TABLE 1. : Cont'd.

SI No.	Ord	Fam	Species	Type locality	M	A	AP	MI	N	MN	T	Status	Ende
201.	SILURIFORMES	SCHILBEIDAE	<i>Clupisoma montana</i> Hora	Teesta R.	-	-	-	-	-	-	+	ne	
202.	SILURIFORMES	SCHILBEIDAE	<i>Eutropiichthys murius</i> (Hamilton-Buchanan)	North Bengal	+	+	-	-	-	-	+	LRnt/N	
203.	SILURIFORMES	SCHILBEIDAE	<i>Eutropiichthys vacha</i> (Hamilton-Buchanan)	Gangetic Prov.	+	+	-	-	-	+	+	EN/N	
204.	SILURIFORMES	SCHILBEIDAE	<i>Silonia silondia</i> (Hamilton-Buchanan)	Gangetic estuary	-	-	-	-	-	-	+	LRnt/N	
205.	SILURIFORMES	SCHILBEIDAE	<i>Pangasius pangasius</i> (Hamilton-Buchanan)	Estuaries of Beng.	-	+	-	-	-	-	+	CR	
206.	SILURIFORMES	AMBLYCIPITIDAE	<i>Amblyceps mangois</i> (Hamilton-Buchanan)	N. Bihar	+	-	+					LRnt/N	
207.	SILURIFORMES	SISORIDAE	<i>Bagarius bagarius</i> (Hamilton-Buchanan)	Ganges R.	+	+	+	-	-	+	+	VU	
208.	SILURIFORMES	SISORIDAE	<i>Gagata cenia</i> (Hamilton-Buchanan)	North Begnal	+	+	+	+	-	+	+	ne	
209.	SILURIFORMES	SISORIDAE	<i>Gagata gagata</i> (Hamilton-Buchanan)	R. & estuaries (Beng.)	-	+	-	-	-	-	-	ne	
210.	SILURIFORMES	SISORIDAE	<i>Gagata sexualis</i> (Tilak)	Bihar	+	+	-	-	-	-	-	LRnt	
211.	SILURIFORMES	SISORIDAE	<i>Nangra assamensis</i> Sen & Biswas	Assam	-	+	-	-	-	-	-	ne	NE
212.	SILURIFORMES	SISORIDAE	<i>Nangra nangra</i> (Hamilton-Buchanan)	R. Kosi, (U.P.)	-	+	-	-	-	-	+	VU/N	
213.	SILURIFORMES	SISORIDAE	<i>Nangra viridescens</i> (Hamilton-Buchanan)	North Bengal	+	+	-	-	-	-	+	LRnt/N	
214.	SILURIFORMES	SISORIDAE	<i>Erethistes pussilus</i> Muller & Troschel	Assam	-	+	+	-	-	+	+	ne	
215.	SILURIFORMES	SISORIDAE	<i>Erethistoides montana montana</i> Hora	Assam	-	+	-	-	-	-	-	ne	
216.	SILURIFORMES	SISORIDAE	<i>Hara hara</i> (Hamilton-Buchanan)	Kosi R. (U.P.)	+	+	+	-	+	+	+	ne	
217.	SILURIFORMES	SISORIDAE	<i>Hara horai</i> Misra	North Bengal	-	+	-	-	-	-	-	EN	
218.	SILURIFORMES	SISORIDAE	<i>Hara jerdoni</i> Day	Bangladesh	-	+	+	-	-	-	-	ne	
219.	SILURIFORMES	SISORIDAE	<i>Conta conta</i> (Hamilton-Buchanan)	N. E. parts (Bengal)	+	+	+	-	+	-	-	ne	
220.	SILURIFORMES	SISORIDAE	<i>Laguvia manipurensis</i> Arunkumar	Manipur	-	-	-	-	-	+	-	ne	
221.	SILURIFORMES	SISORIDAE	<i>Laguvia ribeiroi</i> Hora	North Bengal	+	+	+	-	-	-	+	LRnt	
222.	SILURIFORMES	SISORIDAE	<i>Laguvia shawi</i> Hora	Darjeeling Himal.	+	+	-	-	-	-	-	EN	
223.	SILURIFORMES	SISORIDAE	<i>Glyptothorax annandalei</i> Hora	Nilgiri hills	-	-	+	-	-	-	-	ne	
224.	SILURIFORMES	SISORIDAE	<i>Glyptothorax brevipinnis</i> Hora	India	-	-	+	-	-	-	-	VU	
225.	SILURIFORMES	SISORIDAE	<i>Glyptothorax cavia</i> (Hamilton-Buchanan)	North Bengal	+	+	+	-	-	-	+	EN	

TABLE 1. : Cont'd.

SI No.	Ord	Fam	Species	Type locality	M	A	AP	MI	N	MN	T	Status	Ende
226.	SILURIFORMES	SISORIDAE	<i>Glyptothorax coheni</i> Ganguli, Dutt & Sen	Bihar	-	-	+	-	-	-	-	ne	
227.	SILURIFORMES	SISORIDAE	<i>Glyptothorax conirostrae conirostrae</i> (Steindachner)	Simla	+	-	+	+	-	-	+	ne	
228.	SILURIFORMES	SISORIDAE	<i>Glyptothorax indicus</i> Talwar	North Bengal	-	-	+	-	-	-	-	VU/N	
229.	SILURIFORMES	SISORIDAE	<i>Glyptothorax manipurensis</i> Menon	Manipur	-	-	-	-	-	+	-	ne	
230.	SILURIFORMES	SISORIDAE	<i>Glyptothorax pectinopterus</i> (McClelland)	Simla	-	-	+	-	-	+	-	LRnt/N	
231.	SILURIFORMES	SISORIDAE	<i>Glyptothorax platypogonoides</i> (Bleeker)	Sumatra	-	+	+	+	+	+	-	ne	
232.	SILURIFORMES	SISORIDAE	<i>Glyptothorax sinense manipurensis</i> (Regan)	Manipur	-	-	-	-	-	+	-	ne	
233.	SILURIFORMES	SISORIDAE	<i>Glyptothorax striatus</i> (McClelland)	Meghalaya	+	+	+	-	-	-	-	VU	
234.	SILURIFORMES	SISORIDAE	<i>Glyptothorax telchitta telchitta</i> (Hamilton-Buchanan)	Bengal & Bihar	+	-	-	+	-	-	+	LRnt/N	
235.	SILURIFORMES	SISORIDAE	<i>Glyptothorax trilineatus</i> Blyth	Burma	-	-	-	-	-	+	-	ne	
236.	SILURIFORMES	SISORIDAE	<i>Euchiloglanis hodgarti</i> Hora	Nepal, Abor hills	+	-	+	-	-	-	-	VU/N	
237.	SILURIFORMES	SISORIDAE	<i>Euchiloglanis kamengensis</i> Jayaram	Arunachal Pradesh	-	-	+	-	-	-	-	EN	
238.	SILURIFORMES	SISORIDAE	<i>Myerghlanis jayrami</i> Vishwanath & Kosygin	Manipur	-	-	-	-	-	+	-	ne	NE
239.	SILURIFORMES	SISORIDAE	<i>Exostoma berdmorei</i> Blyth	Burma	-	-	+	-	-	-	-	ne	
240.	SILURIFORMES	SISORIDAE	<i>Exostoma labiatum</i> (McClelland)	Meghalaya	+	-	+	-	+	-	-	ne	
241.	SILURIFORMES	SISORIDAE	<i>Exostoma stuarti</i> Hora	N. Burma	-	-	+	-	-	+	-	ne	
242.	SILURIFORMES	SISORIDAE	<i>Pseudecheneis sulcatus</i> (McClelland)	Meghalaya	+	+	+	-	+	+	-	VU/N	
243.	SILURIFORMES	SISORIDAE	<i>Sisor rhabdophis</i> Hamilton-Buchanan	Bengal & Bihar	-	-	+	-	-	+	-	EN/N	
244.	SILURIFORMES	SISORIDAE	<i>Clarias batrachus</i> (Linnaeus)	Asia & Africa	+	+	+	-	-	+	+	VU	
245.	SILURIFORMES	HETEROPNEUSTIDAE	<i>Heteropneustes fossilis</i> (Bloch)	Tamil Nadu	+	+	+	-	+	-	+	VU/N	
246.	SILURIFORMES	CHACIDAE	<i>Chaca chaca</i> (Hamilton-Buchanan)	N. E. parts (Bengal)	+	+	-	-	-	-	+	ne	
247.	SILURIFORMES	OLYRIDAE	<i>Olyra burmanica</i> Day	Burma	-	-	-	-	+	-	-	ne	
248.	SILURIFORMES	OLYRIDAE	<i>Olyra horae</i> (Prasad & Mukherji)	Upp. Burma	+	+	-	-	+	-	-	ne	
249.	SILURIFORMES	OLYRIDAE	<i>Olyra kempii</i> Choudhuri	Assam	-	+	-	-	-	-	-	ne	
250.	SILURIFORMES	OLYRIDAE	<i>Olyra longicaudata</i> McClelland	Meghalaya	+	+	+	-	+	-	+	ne	

TABLE 1. : Cont'd.

Sl No.	Ord	Fam	Species	Type locality	M	A	AP	MI	N	MN	T	Status	Ende
251.	MUGILIFORMES	MUGILIDAE	<i>Rhinomugil corsula</i> (Hamilton-Buchanan)	Ganges R.	+	-	-	-	-	-	+	VU/N	
252.	MUGILIFORMES	MUGILIDAE	<i>Sicamugil cascasia</i> (Hamilton-Buchanan)	Northern R. Beng.	+	+	-	-	-	-	+	VU/N	
253.	BELONIFORMES	BELONIDAE	<i>Strongylura strongylura</i> Van Hasselt	Vizagapatnam	-	-	-	-	+	-	+	ne	
254.	BELONIFORMES	BELONIDAE	<i>Xenentodon cancila</i> (Hamilton-Buchanan)	Gangetic Prov.	+	+	+	+	-	+	+	LRnt/N	
255.	CYPRINODONTIFORMES	APLOCHEILIDAE	<i>Aplocheilichthys panchax</i> (Hamilton-Buchanan)	Bengal	+	+	-	-	-	-	+	DD	
256.	GASTEROSTEIFORMES	SYNGNATHIDAE	<i>Microphis deocata</i> (Hamilton-Buchanan)	North Bengal & Bihar	-	+	+	-	-	-	-	ne	
257.	SYNBRANCHIFORMES	SYNBRANCHIDAE	<i>Monopterus albus</i> (Zuiew)	Asiatic Russia	+	+	+	-	-	-	-	ne	
258.	SYNBRANCHIFORMES	SYNBRANCHIDAE	<i>Monopterusuchia</i> (Hamilton-Buchanan)	S. E. parts (Bengal)	+	+	+	-	+	+	+	LRnt/N	
259.	SYNBRANCHIFORMES	SYNBRANCHIDAE	<i>Ophisteron bengalense</i> McClelland	Hooghly R. (W.B.)	-	-	-	-	-	+	-	ne	
260.	SYNBRANCHIFORMES	MASTACEMBELIDAE	<i>Macrognathus aral</i> (Bloch & Schneider)	Tamil Nadu	+	+	+	-	+	-	+	LRnt	
261.	SYNBRANCHIFORMES	MASTACEMBELIDAE	<i>Macrognathus pancalus</i> (Hamilton-Buchanan)	Gangetic Prov.	+	+	+	-	-	+	+	LRnt	
262.	SYNBRANCHIFORMES	MASTACEMBELIDAE	<i>Macrognathus morehensis</i> Arunkumar & Singh	Manipur	-	-	-	-	-	+	-	ne	
263.	SYNBRANCHIFORMES	MASTACEMBELIDAE	<i>Mastacembelus armatus</i> (Lacepede)	Not mentioned	+	+	+	+	+	+	+	ne	
264.	SYNBRANCHIFORMES	CHAUDHURIDAE	<i>Chaudhuria (Pilliaia) indica</i> (Yazdani)	Meghalaya	+	+	+	-	-	-	-	VU	NE
265.	SYNBRANCHIFORMES	CHAUDHURIDAE	<i>Chaudhuria (Garo) khajuria</i> (Talwar, Yazdani & Kundu)	Meghalaya	+	+	-	-	-	-	-	EN	NE
266.	PERCIFORMES	CHANDIDAE	<i>Chanda nama</i> (Hamilton-Buchanan)	Bengal	+	+	+	-	-	+	+	ne	
267.	PERCIFORMES	CHANDIDAE	<i>Parambassis baculis</i> (Hamilton-Buchanan)	N. E. parts (Bengal)	+	+	+	+	-	-	+	ne	
268.	PERCIFORMES	CHANDIDAE	<i>Parambassis lala</i> (Hamilton-Buchanan)	Gangetic Prov.	-	+	-	-	-	-	-	ne	
269.	PERCIFORMES	CHANDIDAE	<i>Parambassis ranga</i> (Hamilton-Buchanan)	Gangetic Prov.	+	+	+	+	-	+	+	ne	
270.	PERCIFORMES	SCIAENIDAE	<i>Johnius coitor</i> (Hamilton-Buchanan)	R. Ganges	-	-	-	-	-	-	+	ne	
271.	PERCIFORMES	NANDIDAE	<i>Badis badis</i> (Hamilton-Buchanan)	Gangetic Prov.	+	+	+	+	+	+	+	ne	
272.	PERCIFORMES	NANDIDAE	<i>Nandus nandus</i> (Hamilton-Buchanan)	Gangetic Prov.	+	+	+	-	-	+	+	LRnt	
273.	PERCIFORMES	CICHLIDAE	<i>Oreochromis mossambica</i> (Peters)	Mozambique	+	+	-	-	-	+	+	ne	
274.	PERCIFORMES	GOBIIDAE	<i>Glossogobius giuris</i> (Hamilton-Buchanan)	Gangetic Prov.	+	+	+	+	-	+	+	LRnt/N	
275.	PERCIFORMES	GOBIIDAE	<i>Apocryptes bato</i> (Hamilton-Buchanan)	Estuaries of Ganges	-	-	-	-	-	-	+	ne	

TABLE 1. : Cont'd.

SI No.	Ord	Fam	Species	Type locality	M	A	AP	MI	N	MN	T	Status	Ende
276.	PERCIFORMES	ANABANTIDAE	<i>Anabas oligolepis</i> Bleeker	Borneo	-	+	-	-	-	-	-	VU/N	
277.	PERCIFORMES	ANABANTIDAE	<i>Anabas testudineus</i> (Bloch)	? Java	+	+	+	-	-	+	+	VU/N	
278.	PERCIFORMES	BELONTIDAE	<i>Ctenops nobilis</i> (McClelland)	Sikkim	-	+	-	-	-	-	-	ne	
279.	PERCIFORMES	BELONTIDAE	<i>Colisa fasciatus</i> (Schneider)	Tamil Nadu	+	+	+	-	-	+	+	LRnt/N	
280.	PERCIFORMES	BELONTIDAE	<i>Colisa labiosa</i> (Day)	Burma	-	+	+	-	-	-	-	ne	
281.	PERCIFORMES	BELONTIDAE	<i>Colisa lalia</i> (Hamilton-Buchanan)	Gangetic Prov.	-	+	-	-	+	+	-	ne	
282.	PERCIFORMES	BELONTIDAE	<i>Colisa sota</i> (Hamilton-Buchanan)	Ganges R.	+	+	-	-	+	+	+	ne	
283.	PERCIFORMES	OSPHRONEMIDAE	<i>Osphronemus goramy</i> Lacépède	? Mauritius	-	-	-	-	-	-	+	ne	
284.	PERCIFORMES	CHANNIDAE	<i>Channa barca</i> (Hamilton-Buchanan)	R. Brahmaputra	+	+	-	-	-	-	+	LRlc	
285.	PERCIFORMES	CHANNIDAE	<i>Channa marulius</i> (Hamilton-Buchanan)	Gangetic Prov.	+	+	+	-	-	-	+	LRnt/N	
286.	PERCIFORMES	CHANNIDAE	<i>Channa orientalis</i> (Schneider)	India	+	+	+	+	+	+	+	VU/N	
287.	PERCIFORMES	CHANNIDAE	<i>Channa gachua</i> (Hamilton-Buchanan)	Bengal	-	-	-	-	-	+	-	ne	
288.	PERCIFORMES	CHANNIDAE	<i>Channa punctatus</i> (Bloch)	Coromandal coast	+	+	+	-	+	+	+	LRnt/N	
289.	PERCIFORMES	CHANNIDAE	<i>Channa stewartii</i> (Playfair)	Assam	+	+	+	-	-	-	+	ne	
290.	PERCIFORMES	CHANNIDAE	<i>Channa striatus</i> (Bloch)	Malabar	+	+	+	-	+	+	+	LRlc/N	
291.	TETRAODONTIFORMES	TETRAODONTIDAE	<i>Tetraodon cutcutia</i> (Hamilton-Buchanan)	R. Ganges	+	+	+	-	-	+	+	LRnt/N	

*As per CAMP Workshop (1998), CR–Critical, EN–Endangered, VU–Vulnerable, EW–Extinct in wild, LRlc–Low risk least concerned, LRnt–Low risk not threatened,

DD–Data deficient, ne–Not evaluated, EN/N–at national level, VU/N–at national level, LRlc/N–at national level, LRnt/N–at national level.

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REFERENCES

- Arunkumar, L. 2000a. Spiny eels of the genus *Macrogathus* Lecepede from Manipur with description of a new species *Journ. Bombay nat. Hist. Soc.* 97(1) : 117-122.
- Arunkumar, L. 2000b. *Laguvia manipurensis*, a new species of sisorid catfish (Pisces : Sisoridae) from Yu river system of Manipur. *Indian Jr. Fish.* 47(3) : 193-200.
- Arunkumar, L. & Singh, H. T. 2000. Bariline fishes of Manipur, India, with the description of a new species; *Barilius lairokensis*. *Journ. Bombay nat. Hist. Soc.*, 97(2) : 247-252.
- Barman, R. P. 1984. A new cobitid fish of the genus *Aborichthys* Chaudhuri (Pisces : Cobitidae) from India. *Journ. Bombay nat. Hist. Soc.*, 81(3) : 680-683.
- Barman, R. P. 1992. New record of a croaker, *Johnius coitor* (Hamilton-Buchanan) (Pisces : Sciaenidae) from Tripura, North-East India. *Journ. Bombay nat. Hist. Soc.*, 89(1) : 135-136.
- Barman, R. P. 1994. Fish fauna of Tripura, North-East India. *Journ. Bombay nat. Hist. Soc.*, 91(1) : 37-46.
- BCPP, C. A. M. P. 1999. Freshwater fishes of India. Report summary, 1998, *Zoos' Print*, XIV, No. 3 : 1-28.
- Bhagowati, A. K. & Biswas, B. K. 1992. Record of *Colisa labiosa* (Day) (Pisces : Belontiidae) from India. *Journ. Bombay nat. Hist. Soc.*, 88(2) : 293.
- Darlington, P. J. Jr. 1957. Zoogeography : The Geographical distribution of animals. Museum of comparative zoology. Harvard University, p.24.
- Datta, A. K., Barman, R. P. & Jayaram, K. C. 1987. On a new species of *Kryptopterus* (Pisces : Siluroidea, Family : Siluridae) from Namdapha Wildlife Sanctuary, Arunachal Pradesh, India. *Bull. zool. Surv. India.* 8(1-3) : 29-32.
- Ghosh, S. K. & Lipton, A. P. 1982. Ichthyofauna of the N. E. H. Region with special reference to their economic importance. *ICAR Spl. Bulletin No. 1 (ICAR Research Complex, Shillong)*, 119-126.
- Holmes, Sandra 1979. Henderson's Dictionary of Biological terms.
- Hora, S. L. 1921a. Fish & fisheries of Manipur with some observations on those of the Naga Hills. *Rec. Indian Mus.*, 22(3) : 165-214.
- Hora, S. L. 1921b. On some new and rare species of fish from the Eastern Himalayas. *Rec. Indian Mus.*, 22(5) : 731-744.

- Hora, S. L. 1936. On a further collection of fish from Naga Hills. *Rec. Indian Mus.*, **38** 317-331.
- Jayaram, K. C. 1963. A new species of Sisorid fish from the Kameng frontier division NEFA. *Jr. zool. Soc. India*. **15**(1) : 85-87.
- Jayaram, K. C. 1999. The freshwater fishes of the Indian region. Narendra Publishing House, Delhi, pp. XXVII + 551.
- Keishing, S. & Vishwanath, W. 1998. A new record of *Homaloptera modesta* (Vinciguerra), Cyprinidae from Manipur. *Journ. Bombay nat. Hist. Soc.*, **95**(2) 352-354.
- Keishing, S. & Vishwanath, W. 1999. A new record of freshwater bagrid fish *Mystus pulcher* Chaudhuri from India. *Journ. Bombay nat. Hist. Soc.*, **96**(3) : 436-437.
- Kumar, L A. & Singh, H. T 1998. Fishes of the genus *Danio* (Hamilton-Buchanan) from Manipur, with description of a new species. *J. Nat. Conserv.*, **10**(1) 1-6.
- Lagler, K. F., Barcach, J. E. & Miller, R. R. 1962. Ichthyology : The study of fishes, p. 456.
- Malhotra, Y R. & Suri, S. N. 1969. Fishes of Nagaland. *J. Assam. Sci. Soc.*, **12** : 145-155.
- Menon, A. G. K., Rema Devi, K. & Vishwanath, W. 2000. A new species of *Puntius* (Cyprinidae : Cyprininae) from Manipur, India. *Journ. Bombay nat. Hist. Soc.*, **97**(2) : 263-268.
- Nath, P. & Dey, S. C. 1997. Fish & fisheries of North-East India, Vol. 1. Arunachal Pradesh, xviii + 201 pp.
- Sarkar, U. K. & Ponniah, A. G. 2000. Evaluation of North East Indian Fishes for their potential as cultivable, sport and ornamental fishes alongwith their conservation and endemic status, *Workshop on North-East Indian fish germplasm inventory and conservation (Abstracts)* : 1-17.
- Sen, N. 1977. On a small collection of fishes from Mizoram. *Bull. Meghalaya Sci. Soc.*, **26** : 21-22.
- Sen, N. 1995. State Fauna Series 4. Fauna of Meghalaya (*Pisces*), *Part I*. Vertebrates pp. 483-606 (Published by ZSI, Calcutta).
- Sen, N. 1999a. On a collection of fishes from Subansiri and Siang districts of Arunachal Pradesh. *Rec. zool. Surv. India*, **97**(1) : 141-144.
- Sen, N. 1999b. Notes on a collection of fishes from Lohit, Tirap and Changlang districts of Arunachal Pradesh, *Rec. zool. Surv. India*, **97**(2) 189-204.
- Sen, N. & Biswas, B. K. 1994. On a new species of *Nangra* Day (*Pisces* : Siluriformes : Sisoridae) from Assam, N. E. India with a note on comparative studies of other known species. *Rec. zool. Surv. India*, **94**(2-4) : 441-446.
- Sen, T K. 1985. The fish fauna of Assam and the neighbouring N. E. States of India. *Rec. zool. Surv. India, Occassional Paper No. 64* : 1-216.
- Singh, W. V. & Singh, H. T 1985. On a collection of fishes from Tengenoupal district of Manipur with some new records. *Int. Acad. Ichthyol.*, Modinagar. **Vol. 6**(1-2) : 85-90.

- Talwar, P. K. & Jhingran, A. G. 1991. Inland Fishes of India and adjacent countries-Oxford & IBH publishing Co. Pvt. Ltd., N. Delhi, 2 volumes : XIX + 1158.
- Vishwanath, W. 1993. Collection of fishes of the genus *Garra* Hamilton from Manipur, India with description of a new species. *J. Fresh. Biol.*, **5**(1) : 59-68.
- Vishwanath, W. & Kosygin, L. 1999. New sisorid catfish of the genus *Myeroglanis* Hora and Silas, 1951 from Manipur, India. *Journ. Bombay nat. Hist. Soc.*, **96**(2) : 291-296.
- Vishwanath, W. & Kosygin, L. 2000a. Fishes of the cyprinid genus *Semiplotus* Bleeker, 1859, with description of a new species from Manipur, India. *Journ. Bombay nat. Hist. Soc.*, **97**(1) : 92-102.
- Vishwanath, W. & Kosygin, L. 2000b. *Garra elongata*, a new species of the subfamily Garrinae from Manipur, India (Cyprinidae, Cypriniformes). *Journ. Bombay nat. Hist. Soc.*, **97**(3) : 408-414.
- Vishwanath, W. & Kosygin, L. 2001. Species status of *Poropuntius burtoni* (Mukherjee, 1934), (Cypriniformes : Cyprinidae) with a systematic note on *Poropuntius clavatus* (McClelland, 1845). *Journ. Bombay nat. Hist. Soc.*, **98**(1) : 31-37.
- Vishwanath, W., Majoikumar, W. & Keishing, S. 1998. First record of cyprinid fish *Chagunius nicholsi* (Myers) from India. *Journ. Bombay nat. Hist. Soc.*, **95**(2) : 255-257.
- Vishwanath, W. & Singh, H. T. 1986. A new species of the genus *Puntius* Hamilton from Manipur. *Rec. zool. Surv. India*, **83**(1 & 2) : 129-134.

POPULATION DYNAMICS OF PLANKTONIC CLADOCERA AND COPEPODA OF A FRESHWATER FISH TANK BIBINAGAR, HYDERABAD, A.P. (PART III)

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INTRODUCTION

The data on seasonal population dynamics of freshwater Cladocera and Copepoda of India is inadequate. The important work in this regard is of workers like Das and Srivastava (1956), Pahwa and Mehrotra (1966), Michael (1964), Sumitra (1970), Patil (1976) and others. This investigation describes annual changes in the population of Cladocera and Copepoda of subtropical freshwater fish tank of Hyderabad on the basis of one year study.

MATERIAL AND METHODS

Description of the present water body under study, Bibinagar, is given in the paper Part I of this series (Patil and Panda, 1997). During one year, (Jan, 1985 to Dec, 1985) collection of plankton were made with the help of a (Nylon satin) plankton net once in a month from five different sampling stations. Forty litres of water was filtered through the net and the plankton concentrate was preserved in 4% formalin. The quantitative estimation was made with the help of "Sedgwick Rafter cell" under compound binocular microscope. Three counts were made from each samples. Mean concentration was calculated from the mean value of the total count per litre.

RESULTS AND DISCUSSION

Twelve species of Cladocera were recorded in the present study (Table 1). As per annual percentage composition of zooplankton, Cladocera was the dominant group forming 38-81% of the average annual population (Table 2). The reason might be due to the reduced fish population. The annual fish production of the tank is only 500 kg/hect/year. This clearly shows that the fish production is very low and in the presence of reduced population of predator (fishes) the cladocera dominated in the tank. This is further supported by Harbacek *et al.* (1961) in Poultruba tank that when the fish stock was low, a large sized *Daphnia* comprised 80% of the population. *Moina micrura* was the only cladoceran observed almost throughout the year of investigation.

Table 1. Average annual range of various physico-chemical parameters.

Transparency cm.	..	..	30 — 90
Temp. of water °C	..	..	19 — 28
Temp. of air °C	..	..	27 — 43
pH	..	..	8.2 — 9.7
CO ₂ mg/L.	..	..	0 — 35
CO ₃ mg/L.	..	..	34 — 80
HCO ₃ mg/L.	..	..	170 — 370
D.O. mg/L.	..	..	5.1 — 6.9
Total hardness mg/L.	..	..	190 — 220
Ca mg/L.	..	..	65 — 120
Mg mg/L.	..	..	40 — 50
Chloride mg/L.	..	..	64 — 130
Total PO ₄ mg/L.	..	..	0.32 — 0.40
Nitrate - Nitrogen mg/L.	..	..	0.58 — 0.65
Sulphate mg/L.	..	..	8 — 10
Sp. conductivity ug ohm/Cm.	..	..	486 — 600

The occurrence of this species is “euryplastic” and can tolerate wide range of temperature. Similar observation was made by Nayar (1970) for one species of rotifer while working on the freshwater ponds at Pilani, Rajasthan.

Ceriodaphnia cornuta was observed for about 7 months from April to October, 1983. *Diaphanosoma sarsi*, *Simocephalus vetulus*, *Macrothrix spinosa*, *Chydorus sphaericus* and *Chydorus eurynotus reticulatus* were the species slightly better represented in the samples of the tank and their occurrence was about 5 to 7 months, whereas, *Scapholeberis kingi*, *Alona rectangula* and *Pleuroxus aduncus* were sparse in the samples and their occurrence was irregular. Thus, it can be concluded that the cladocera in the reservoir may not have any fixed seasonal pattern of abundance. Nordoli (1976) found that two types of zooplankton assemblages occurred in Florida lake, one type is poor in cladocera and rich in rotifers and the other type rich in cladocera with variable in numbers of rotifers. The second type of assemblage is found in the present reservoir with no oxygen stratification and chaoborus larvae are not present in the tank. The diversity of Cladocerans in reservoir might be related to vegetation like *Hydrilla*, *Ceratophyllum* etc. This is in conformity with the findings of Shireman and Martin (1978), Quade (1969), as the abundance of cladoceran was noticed in the macrophytes. Two peaks of cladocera were observed in a one year study with a

Table 2. Percentage composition of zooplankton.

	Jan,85	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec,85	Average Annual % Composition zooplankton
Rotifera	48.98	10.39	36.12	29.65	33.47	39.86	36.73	34.70	22.91	39.84	6.70	48.07	32.30
Cladocera	29.78	62.31	33.13	42.15	29.29	33.78	36.73	36.87	24.30	33.83	66.49	37.08	38.81
Copepoda	18.29	19.95	18.07	10.75	27.19	20.27	15.92	24.94	45.83	26.31	20.72	8.24	21.37
Copepodid	0	3.12	12.65	8.72	4.18	2.70	4.08	2.60	0	0	5.87	12.09	3.75
Nauplii	2.97	4.16	0	8.72	5.86	3.38	6.53	0.86	6.94	0	0	5.49	3.74

Table 3. List of species of Cladocera and Copepoda.

CLADOCERA

Diaphanosoma sarsi Richard
Ceriodaphnia cornuta Sars
Moina micrura (Jurine) Kurz
Simocephalus vetulus Schodler
Scapholeberis kingi Sars
Pleuroxus aduncus (Jurine)
Macrothrix spinosa king
Chydorus eurynotus reticulatus Sars
C. sphaericus O. F. Muller
C. denticulatus Sars
Alona intermedia Sars
Alona rectangula Sars

COPEPODS

Mesocyclops hyalinus Rehberg
Cyclops sp.
Diaptomus spp.
Copepodids
Nauplii

minor peak in April. This is not true for copepods distribution. Twelve species of cladocerans were recorded, the most dominant tropical species were *Diaphanosoma sarsi*, *Ceriodaphnia cornuta*, *Moina micrura* and *Simocephalus vetulus*. Temperature of water was in the range of 19° C to 28° C. Swar & Fernando (1980) pointed out that different group of zooplankton have their major peaks in different months of the year. Further opines that these were not definitely related to temperature changes. Thus temperature does not play any role in the seasonal abundance of Crustacea population and in the present study also this was found true. Das & Srivastava (1956), Bayly (1963), Moitra & Bhattacharya (1965) and Jana (1973) have found that zooplankton vary inversely with pH. However, in the present study the pH was in the range 8.2 to 9.7 and there does not seem to be any significant variation in zooplankton with pH. This is in conformity with Swar & Fernando (1980). During the monsoon, the population was found to be low. It may be due to rain water bringing about changes in physical, chemical and biological factors.

After one year of study all species population size did not exhibit what it had been a year before when sampling was began, this is in contrary to the observations of Keen (1976) on chydorid Cladocera of southern Michigan Marl Lake.

Copepods were represented only by three genera *Cyclops*, *Mesocyclops* and *Diaptomus*. These copepods were present in the samples throughout the period of investigation. The maximum intensity shown by copepods was in the montgh of Sept. The annual percentage of the copepods was 21.37%. This shows that copepods population was better represented in the tank.

Das and Srivastava (1956) have shown peak period of copepods in the month of September and October. In the present study, the major peak was observed in September and two minor peaks were seen in the months of May and October.

Kow (1953) has observed that the peaks of phytoplankton and copepods coincided with each other showing direct relationship. But in the present investigation, the peaks of phytoplankton and copepods did not exactly coincide with each other but follow one another showing a definite relationship as shown by Patil (1976), and will be discussed elsewhere. The copepodid stages of the copepods were counted and their percentage was only 3.75%. The occurrence of these copepodids was irregular and appear in certain months of the year.

Nauplii were also present in the samples of the tank with definite peaks in the months of April, July and September. In a year round study Nauplius showed three peaks which perhaps indicate the active period of reproduction as stated by Patil (1976).

Vaas and Vanoven (1959) have stated that generally microcrustaceans feed on minute phytoplanktonic forms, epiphyton and detritus. Sumitra (1970) has also shown direct relation between the seasonal fluctuations in the density of cladocera with the fluctuations in the availability of food. The present data reveal a some what direct relationship between the crustaceans and phytoplankton. This is further supported by the study made by Pahwa and Mehrotra (1966). The tanks at Nagpur studied by Patil (1976) were very rich in phytoplankton as compared to the phytoplankton population of the present tank. The phytoplankton in the present tank was very poor and the annual average units/litres was only 6980.

SUMMARY

Seasonal population dynamics of 12 species of Cladocera and 3 species of Copepoda were studied. The Cladocera fauna of the tank was well represented in the absence of predators like fishes. *Moina micrura* the only cladoceran was found almost throughout the year except May, 1985. The peak of Cladocera and Copepoda were observed in the month of November and September respectively. Nauplii were poorly represented in the samples.

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REFERENCES

- Bayly, I. A. E. 1963. Reversed diurnal vertical migration of planktonic crustacea in inland waters of low hydrogen ion concentration. *Nature*, **200** : 704 - 705.
- Das, S. M. and Srivastava, V K. 1956. Quantitative studies on freshwater plankton I. Plankton of a fish tank in Lucknow, India. *Proc. Nat. Acad. Sci. India*, B **26** 85-92.
- Hrbacek, J., Dvorakova, M., Korinek, L. and Prochazkova, L. Komo, 1961. For changes consequent upon alternation in fish stock in Bohemian ponds. *Proc. Intern. Assoc. Theor. Appl. Limnol.*, **14** : 195.
- Jana, B. B. 1973. Seasonal periodicity of plankton in a freshwater pond in West Bengal, India. *Hydrobiologia*, **58**, 127-143.
- Keen, R., 1976. Population dynamics of the chydorid cladocera of Southern Michigan Marl lake. *Hydrobiologia*, **48**, 3, 269-276.
- Kow, A. H. 1953. A preliminary study of the physical, chemical and biological characteristic of Singapore. *Streit. Fish Publ. Lond.*, **1**(4).
- Micheal, R. G. 1964. Limnological investigations of Pond Plankton, macrofauna and chemical constituents of water and their bearing on fish population. Ph.d., Thesis, Calcutta University.
- Moitra, S. K. and Bhattacharya, B. K. 1965. Some hydrobiological factors affecting plankton production in a fish pond in Kalyani, West Bengal, India. *Ichthyologia*, **4** 8-12.
- Nayar, C. K. G. 1970. Studies on the rotifer population of two ponds at Pilani Rajasthan. *J. Zool. Soc. India*, **22**(1 & 2) : 21-34.
- Nordli, F. G. 1976. Plankton communities of three central Florida lakes. *Hydrobiologia*, **48**, 65-78.
- Pahwa, D. V. and Mehrotra, S. N. 1966. Observation on the fluctuations in the abundance of plankton in relation to certain hydrobiological conditions of Ganga river. *Proc. Nat. Acad. Sci. India*, Sect. B. (Biol. Sci.) **36**(2) : 157-187.
- Patil, S. G. 1976. Plankton ecology of few water bodies of Nagpur area. Ph.d., Thesis submitted to Nagpur University, Nagpur pp. 149.
- Patil, S. G. and Panda, P. 1997. Limnological studies of freshwater reservoir Bibinagar tank Part I, abiotic factors. *Rec. zool. Surv. India*, No. **96**(1 + 4) 173-178.
- Guade, H. W. 1969. Cladocerans fauna associated with aquatic Macrophytes in some lake in northwestern Minnesota. *Ecology*, **50**, 170-179.

- Shireman, V. and Martin R. G. 1978. Seasonal and diurnal zooplankton investigations of a South Central Florida lake. *Florida Sci.*, **41**(4), 193-201.
- Sumitra, V. 1970. Seasonal events in natural population of *Daphnia carinata* King. *Proc. Ind. Acad. Sci.* II 5, 193-203.
- Swar, D. B. and Fernando, C. H. 1980. Some studies on the ecology of limnetic crustacean zooplankton in lakes Bengnae and Rupa, Pokhara Valley Nepal. *Hydrobiologia*, **70**, 235-245.
- Vaas, K. F. and Vanoven Vass, 1959. A studies on the production and utilization of Natural food in Indonesian Carp ponds. *Hydrobiologia*, **12** : 308-392.

ON THE FISH FAUNA OF KOIL SAGAR, MAHBUBNAGAR DISTRICT, ANDHRA PRADESH, SOUTH INDIA WITH SUGGESTIONS FOR CONSERVATION OF ITS VULNERABLE SPECIES

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INTRODUCTION

The present study is based on a collection of fishes from the Koil sagar (Longitude 77.46°E and Latitude 16.44°N), Mahbubnagar district, Andhra Pradesh during a faunistic survey for the collection of freshwater fishes of Andhra Pradesh by the author (Barman, 1993). It appears that there is no faunal account of the fishes of the Koil sagar reservoir which has been constructed in one of the tributaries of the River Krishna of the south India. Therefore, an attempt has been made to make an account of the fishes of this reservoir. A total number of 39 species belonging to 26 genera, 12 families and 5 orders have been recorded in this work. In addition to this, the endemic species and threatened species (endangered, vulnerable and rare) of our country, occurring in the Koil sagar have been designated as per the definitions and guidance of the IUCN for determining the status of the fishes. The arrangement of the classification is followed here is that of Greenwood *et al.*, (1966) and Jayaram (1981). Local names of the fishes are given along with the names of the species.

TOPOGRAPHY OF THE KOIL SAGAR RESERVOIR

Koil sagar project is one of the important reservoirs of the Mahbubnagar district (15.55° to 17.20°N and 77° to 79.12°E), Andhra Pradesh for the irrigation water resources and for the development of fisheries in the district. This reservoir is situated at a distance of 35 kms from Mahbubnagar district, the district head quarters. The construction of this reservoir was started in the year 1949 and was completed in the year 1955. The reservoir has been constructed across Peddavagu, one of the tributaries of the River Krishna and Nakklavagu. Water spread area of this reservoir is about 800 hectares and maximum depth is 15.8 m. Average rain fall of this region is 68.6 cm. The bed is composed of sand rocks, mud etc. The feeding source of this reservoir is rain water which comes from 38.4 kms through Peddavagu and 11.2 kms from Nakkalavagu. The surplus water joins in the river Krishna after a distance of 57.6 kms from the reservoir.

**SYSTEMATIC LIST OF THE FISHES
COLLECTED FROM THE KOIL SAGAR WITH THEIR LOCAL NAMES**

Order I Osteoglossiformes

Family (1) NOTOPTERIDAE

Genus (i) *Notopterus* Lacepede

1. *N. notopterus* (Pallas) ... Ulakathatta, Mangali katti (Telugu)

Order II Cypriniformes

Family (2) CYPRINIDAE

Genus (ii) *Salmostoma* Swainson

2. *S. clupeoides* (Bloch) ... Vellachee candee, Negteli, Vellichi, Nettelai (Tamil)
3. *S. novacula* (Valenciennes) ... Nil (Endemic species)
4. *S. untrahi* (Day) ... Untrahi (Oriya) (Endemic species)

Genus (iii) *Esomus* Swainson

5. *E. danricus* (Hamilton) ... Asta pakke (Telugu)
6. *E. thermoicos* (Valenciennes) ... Messai paravai (Tamil)

Genus (iv) *Danio* Hamilton

7. *D. aequipinnatus* (McClelland) ... Salai paravai (Tamil)

Genus (v) *Parluciosoma* Howes

8. *P. daniconius* (Hamilton) ... Jobidayee, Narangi (Telugu)

Genus (vi) *Barilius* Hamilton

9. *B. bendelisis* (Hamilton) ... Aguskitti, Marritan candee, Vannathi kendai (Tamil)

Genus (vii) *Barbodes* Bleeker

10. *B. sarana sarana* (Hamilton) ... Kannaku, Kakoo, Kadoon, Kunnamoo, Paraga, Goodha paraga, Kanga pakki (Tamil) (Vulnerable species)

Genus (viii) *Puntius* Hamilton

11. *P. chola* (Hamilton) ... Chaddu paddaka, Pakki (Telugu) (Vulnerable species)
12. *P. conchoni* (Hamilton) ... Pittia kerundi (Oriya) (Vulnerable species)
13. *P. parrah* Day ... Parrah perlee (Malayalam) (Endemic and Endangered species)
14. *P. sophore* (Hamilton) ... Budda pakka, Chadu parega, Chedu perigi (Telugu)
15. *P. ticto* (Hamilton) ... Parigi (Telugu)

Genus (ix) *Osteobrama* Heckel

16. *O. cotio cotio* (Hamilton) ... Patta kunj (Tamil)

Genus (x) *Labeo* Cuvier

17. *L. ariza* (Hamilton) ... Coal, Kolarinjan, Coali Kendai (Tamil) (Endemic and Endangered species)
 18. *L. calbasu* (Hamilton) ... Kaki bontha, Kaki gandi, Kaki bocha, Nallachithraya, Nalla gandu meenu (Telugu)
 19. *L. fimbriatus* (Bloch) ... Yerra gandu meenu, Gandu meenu (Telugu)
 20. *L. rohita* (Hamilton) ... Kannadi kendai (Tamil)

Genus (xi) *Cirrhinus* Oken

21. *C. mrigala* (Hamilton) ... Yerra mosu, Bellala mosu (Telugu)
 22. *C. reba* (Hamilton) ... Arju, Yerra thoka mosu, Eele mosu, Chittahri, Chitthrai (Telugu) (Vulnerable species)

Genus (xii) *Catla* Valenciennes

23. *C. catla* (Hamilton) ... Botchee, Krishna botcha, Botcha (Telugu)

Genus (xiii) *Garra* Hamilton

24. *G. gotyla gotyla* (Gray) ... Bettwa (Orya) (Vulnerable species)

Order III Siluriformes

Family (3) BAGRIDAE

Genus (xiv) *Mystus* Scopoli

25. *M. cavasius* (Hamilton) ... Thella jella, Muti jella, Nahara jella (Telugu)
 26. *M. vittatus* (Bloch) ... Suku jella, Erra jella (Telugu) (Vulnerable species)

Genus (xv) *Aorichthys* Wu

27. *A. seenghala* (Sykes) ... Multi jellah, Senghala, Nara jella, Keeru jella (Telugu) (Vulnerable species)

Family (4) SILURIDAE

Genus (xvi) *Ompok* Lacepede

28. *O. bimaculatus* (Bloch) ... Duka dumu, Jella, Theenuva (Telugu) (Endangered species)

Genus (xvii) *Wallago* Bleeker

29. *W. attu* (Schneider) ... Valuga, Wallagah, Valaga (Telugu)

Family (5) CLARIIDAE

Genus (xviii) *Clarias* Scopoli

30. *C. batrachus* (Linnaeus) ... Marpoo, Marpulu (Telugu) (Vulnerable species)

Family (6) HETEROPNEUSTIDAE

Genus (xix) *Heteropneustes* Muller

31. *H. fossilis* (Bloch) ... Ingilayee, Mapu jella, Marpu (Telugu) (Vulnerable species)

Order IV Channiformes

Family (7) CHANNIDAE

Genus (xx) *Channa* Scopoli

32. *C. marulius* (Hamilton) ... Poola malle, Poola matta, Pula chapa, Sowarah (Telugu)
 33. *C. punctatus* (Bloch) ... Mitta, Matta gidassa, Kodhadhalau, Curru meenu, Muttah (Telugu)

Order V Perciformes

Family (8) CHANDIDAE

Genus (xxi) *Chanda* Hamilton

34. *C. nama* (Hamilton) ... Akku rati, Aku rati (Telugu)

Genus (xxii) *Pseudambassis* Bleeker

35. *P. ranga* (Hamilton) ... Laal chandee (Oriya), Kannadi meen (Tamil)

Family (9) CICHLIDAE

Genus (xxiii) *Eetroplus* Cuvier

36. *E. suratensis* (Bloch) ... Cahimara, Duvvena chapa (Telugu)

Family (10) MUGILIDAE

Genus (xxiv) *Rhinomugil* Gill

37. *R. corsula* (Hamilton) ... Mazhugu meen (Tamil) (Vulnerable species)

Family (11) GOBIIDAE

Genus (xxv) *Glossogobius* Gill

38. *G. giuris giuris* (Hamilton) ... Bullee-kokah, Taika dondu (Telugu)

Family (12) ANABANTIDAE

Genus (xxvi) *Anabas* Cuvier

39. *A. testudineus* (Bloch) ... Sennal, Pauni eyri, Panaieeri kendai, Panai yeri kendai (Tamil)
 (Vulnerable species)

DISCUSSIONS

The present work has recorded 39 species under 26 genera, 12 families and 5 orders from the Koil sagar reservoir, Mahbubnagar district, Andhra Pradesh. This list of fishes shows that this water body harbours 14 threatened (3 endangered and 11 vulnerable species) besides 4 endemic species of freshwater fishes of India (Molur & Walker, 1998) and (Menon, 1999). It has been noted that among the high priced commercial important fishes of this reservoir are different species of *Labeo* Cuvier such as *L. ariza*, *L. calbasu*, *L. fimbriatus*, *L. rohita* and some other economically important species are *Catla catla*, *Aorichthys seenghala*, *Ompok bimaculatus*, *Wallago attu*, *Clarias batrachus*, *Heteropneustes fossilis*, *Channa marulius*, *Channa punctatus*, *Rhinomugil corsula*, *Glossogobius giuris* and *Anabas testudineus*.

CONSERVATIONS METHODS SUGGESTED

Since Koil sagar may be treated as one of the wetlands of India its faunal resources particularly the fish fauna should be monitored and a proper management of its faunal contents as a whole are very much needed. It may be mentioned here that wetlands are the breeding grounds of many commercially important riverine fishes, therefore, their proper maintenance and preservation are very essential for supplying animal protein to the local people residing nearby the areas of this water body in particular. Two important riverine edible fishes of India, viz., *Wallago attu* and *Catla catla* are found in this Koil sagar and these two riverine fishes also utilize this water body for their breeding grounds. The connection between the River Krishna and the Koil sagar should be monitored and properly maintained. Otherwise migration of these two very important commercial fishes will be disturbed which may lead to decline of their populations in near future. In addition to these, 11 vulnerable and 3 endangered species of freshwater fishes of India are also found in this reservoir. Considering the above facts habitat alteration of these fishes due to expanding agricultural practices, removal of gravel and sand from the bed of this water body should be carefully considered. Since fishes are very sensitive to the pollution, discharge of effluents to this water body should be prevented or prohibited. At the same time overfishing of the Koil sagar specially during the breeding seasons should monitored and controlled to protect the riverine commercially important fishes. Since 14 threatened and 4 endemic species of freshwater fishes of India are found in this water body conservation measures may be considered to maintain their population in an adequate number.

ACKNOWLEDGEMENTS

I am grateful to Dr. J. R. B. Alfred, Director and to Dr. S. K. Chanda, Deputy Director, Zoological Survey of India, Calcutta for their encouragements and necessary facilities. Thanks are also due to the Director of Fisheries, Govt. of Andhra Pradesh, Hyderabad and to Shri B. S. Prakash Rao, the

then Inspector of Fisheries, Mahbubnagar district, Andhra Pradesh for necessary assistance during the period of my survey of the Koil sagar.

REFERENCES

- Barman, R. P. 1993. Fauna of Andhra Pradesh, Part-I : Fishes. *State Fauna Series*. **5** : 89-334. Zoological Survey of India publication, Govt. of India.
- Greenwood, P. H., Rosen, D. E., Weitzman, S. H. and Myers, G. G. 1966. Phyletic studies of teleostean fishes with a provisional classification of the living fishes forms. *Bull. Am. Mus. nat. Hist.*, **131** : 339-456, pls. 21-23
- Jayaram, K. C. 1981. The Freshwater Fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka. A hand book, Zoological Survey of India, Govt. of India, xxii + 475
- Menon, A. G. K. 1999. Check list of Freshwater Fishes of India. *Rec. zool. Surv. India. Occ. Paper No.* : **175** : i-xxviii + 1-366.
- Molur, S. & Walker, S. (eds.) (1998). Report of the workshop "Conservation Assessment and Management Plan for Freshwater Fishes of India", Zoo Outreach Organisation, Conservation Breeding Specialist Group, India, Coimbatore, India. 156 p.

SAC-SPIDERS OF BANGLADESH : GENUS *CHEIRACANTHIUM* KOCH (ARANEAE : CLUBIONIDAE)

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INTRODUCTION

'Sac-spiders' (Family : Clubionidae) are one of the common predators of insect pests in the crop-fields and gardens. Very little informations are available on this group of spiders in Bangladesh (Chowdhury & Pal, 1984; Biswas, *et. al.*, 1993; Okuma, *et. al.*, 1993; Begum & Biswas, 1997; Biswas & Raychaudhuri, 1994) although a great number of works took place in Indian Sub-continent and elsewhere (Pocock, 1900; Caporiacco, 1935; Tikader, 1962, '75, '76, '81; Tikader & Biswas, 1981; Singh, 1970; Biswas, 1984; Majumder & Tikader, 1991; Dondale & Redner, 1982; Comstock, 1965; Kaston, 1948; Locket & Millidge, 1951; Patel & Patel, 1973; Platnick & Shadab, 1974a, b; Reiskind, 1969; Roberta, 1985; Paik, 1985, '90; Chen & Zhang, 1989; Koh, 1989; Yaginuma, 1986).

Majumder and Tikader (1991) made a revisional study on the family Clubionidae of India and described 84 species with their distribution and biological note. The present paper deals with 4 (four) species of the genus *Cheiracanthium* Koch from Bangladesh of which *C. tagorei* is described as new to science.

Genus *Cheiracanthium* Koch, 1839

1839. *Cheiracanthium* Koch, *Die Arachn.* Schster Band : 9.

Type species : *Cheiracanthium punctorium* Villers.

Distribution ASIA; AUSTRALIA; EUROPE; SOUTH AMERICA.

Key to the species

1. Abdomen cylindroid-oval (Fig. 20); antero-median eyes closely opposed, their margins embracing each other (Fig. 20); sternum elongate (Fig. 23); 4th leg always longer than the first *tagorei* n. sp.
- Abdomen never cylindrical but broadly oval; anteromedian eyes always seporate; sternum short and broad; 4th leg always shorter than the first 2

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2. Abdominal dorsum distinctly decorated (Fig. 14); maxillae and labium extremely broad and flat (Fig. 16); 2nd leg longer than 3rd..... *sikkimensis*
- Abdominal dorsum never decorated, if at all with faint transverse short markings; maxillae and labium never so broad; 2nd leg shorter than third 3
3. Posterolateral angles of cephalothorax produced (Fig. 8); cheliceral teeth closely placed (Fig. 9); epigynum as in fig. 12; each of tibia and metatarsi I and II with 3 pairs of ventral spines *mysorensis*
- Posterolateral angles of cephalothorax never produced (Fig. 1); cheliceral teeth placed far apart (Fig. 2); epigynum never as above (Fig. 5); each of tibia and metatarsi I and II with 1 pair of ventral spines *melanostoma*

***Cheiracanthium melanostoma* (Thorell)**

(Figs. 1-7)

1895. *Eutitha melanostoma* Thorell, *Spiders of Burma*, London : 44.

1931. *Cheiracanthium melanostoma* : Gravely, *Rec. Indian Mus.*, 33(3) : 26.

1981. *Cheiracanthium melanostoma* : Tikader & Biswas, *Rec. zool. Surv. India*, Occ. Pap. No. 30(1) : 69.

1991. *Cheiracanthium melanostoma* : Majumder & Tikader, *Rec. zool. Surv. India*, Occ. Pap. No. 102 : 62.

General : Cephalothorax yellow brown; legs yellow and abdomen grey. Total length (Female) 7.30 mm. Carapace length 3.00 mm; carapace width 2.50 mm. Abdomen length 4.30 mm; abdominal width 3.00 mm; Total length (Male) 7.00 mm. Carapace length 3.00 mm; carapace width 2.45 mm. Abdomen length 4.00 mm; abdominal width 2.90 mm.

Material examined 1♀, 1♂ Harinkhana, Bagerhat, 9.VII.1991, Coll. V Biswas; 1♀ Pirojpur, 7.III.1991, Coll. V Biswas; 2♀ Chandpur, Comilla, 18.IX.1992, Coll. V. Biswas; 1♀, 1♂, Joydevpur, Dhaka, 1.VII.1990, Coll. V Biswas; 1♂, ADI, Faridpur, 9.VIII.1991, Coll. V Biswas; 1♀ BARI, Jessore, 7.IX.1992, Coll. V. Biswas, 1♀ Shikerpur, Jhenidah, 7.IX.1990, Coll. V Biswas; 1♀, 1♂, Teroshri, Manikganj, 18.III.1993, Coll. V Biswas; 1♀ Mirjaganj, Rajshahi, 1.III.1992, Coll. V Biswas.

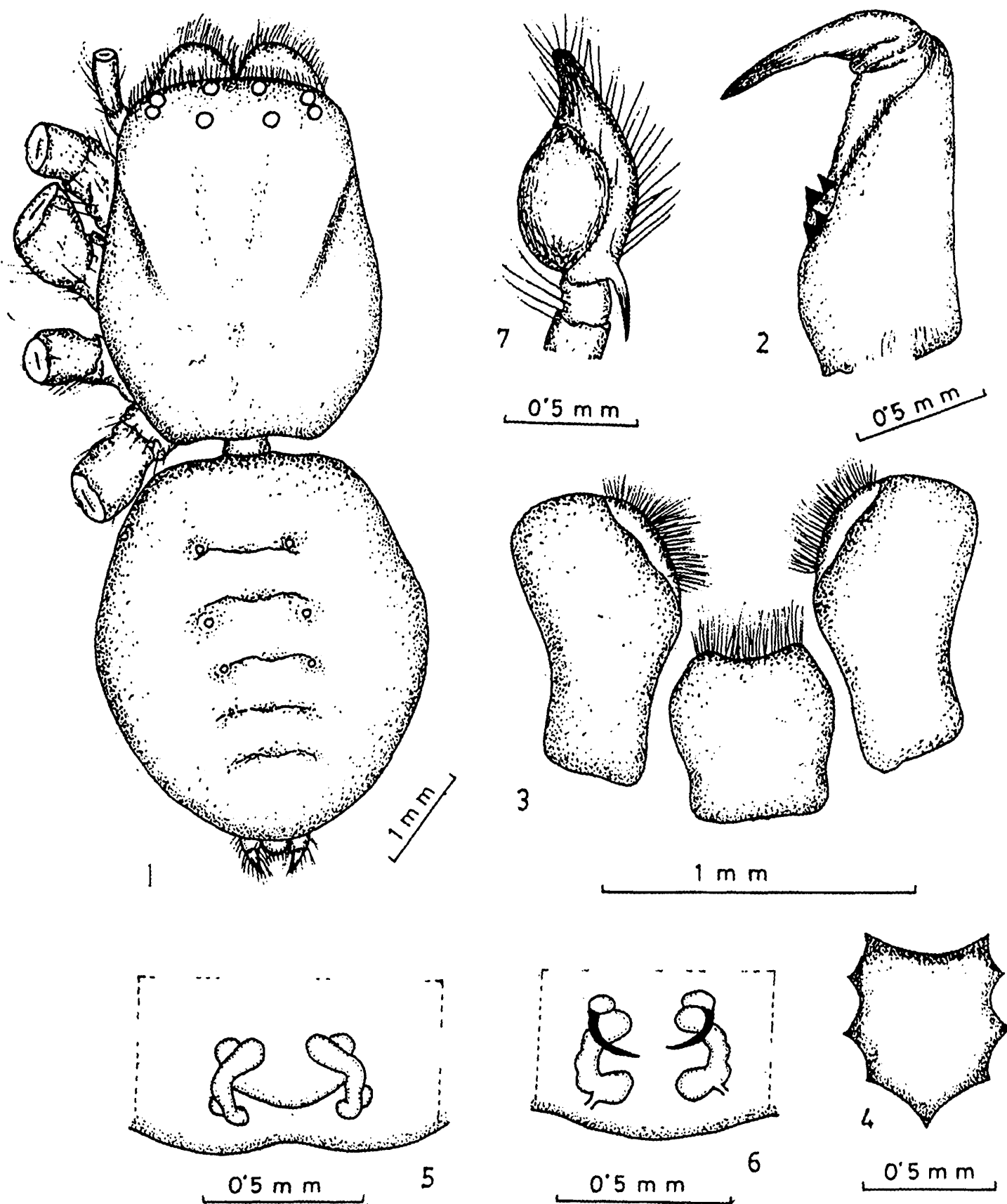
Distribution : BANGLADESH : Bagerhat, Barisal, Comilla, Dhaka, Faridpur, Jhenidah, Jessore, Manikganj, Rajshahi; MYANMAR; INDIA (Majumder and Tikader, 1991).

***Cheiracanthium mysorensis* Majumder & Tikader**

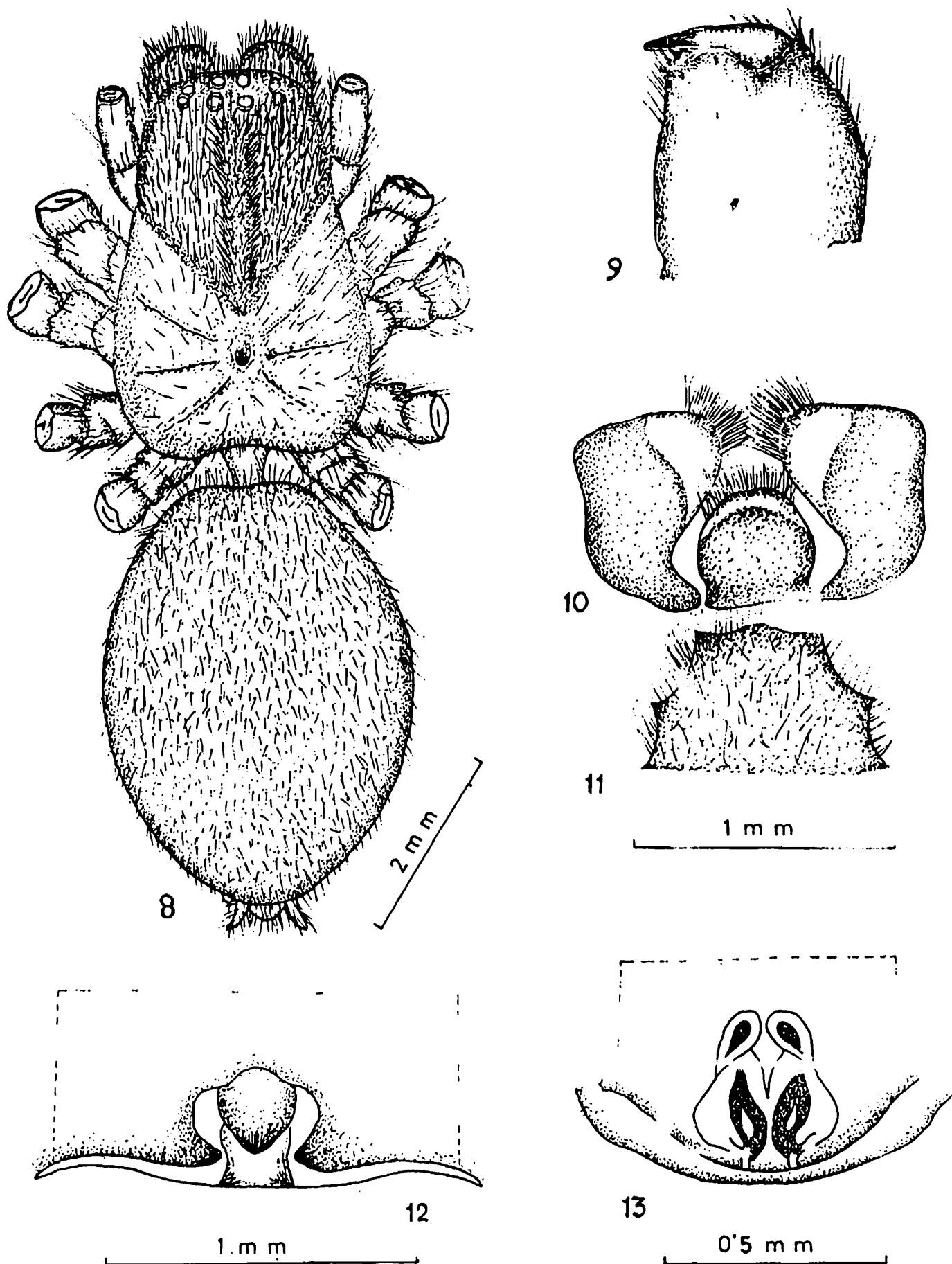
(Figs. 8-13)

1991. *Cheiracanthium mysorensis* Majumder & Tikader, *Rec. zool. Surv. India*, Occ. Pap. No. 102 : 79.

General : Cephalothorax and legs brown. Abdomen pale yellow. Total length 5.70 mm. Carapace length 2.65 mm; carapace width 2.00 mm. Abdomen length 3.05 mm; abdominal width 2.00 mm.



Figs. 1-7 : *Cheiracanthium melanostoma* (Thorell). 1. Whole body (dorsal view); 2. Chelicerae; 3. Maxillae and Labium; 4. Sternum; 5. Epigynum; 6. Internal genitalia and 7. Male palp.



Figs. 8-13 : *Cheiracanthium mysorensis* Majumder & Tikader. 8. Whole body (dorsal view); 9. Chelicerae; 10. Maxillae and Labium; 11. Sternum; 12. Epigynum and 13. Internal genitalia.

Material examined : 1♂ Basabati, Bagerhat, 3.VII.1991, Coll. V. Biswas; 2♀ Nazirpur, Barisal, 17.VIII.1992, Coll. V. Biswas; 2♀ Khajura, Jessore, 15.VIII.1991, Coll. V. Biswas; 2♀ Jhenidah, 18.VI.1990, Coll. V. Biswas; 2♀ Nagarpur, Tangail, 18.V.1992, Coll. V. Biswas.

Distribution : BANGLADESH : Bagerhat, Barisal, Jessore, Jhenidah, Khulna, Tangail; INDIA.

***Cheiracanthium sikkimensis* Majumder & Tikader**

(Figs. 14-19)

1991. *Cheiracanthium sikkimensis* Majumder & Tikader, *Rec. zool. Surv. India*, Occ. Pap. No. 102 : 77.

General : Cephalothorax yellow brown and legs yellow. Abdomen pale yellow. Total body length 4.70 mm. Carapace length 2.15 mm; carapace width 1.52 mm. Abdomen length 2.55 mm; abdominal width 2.10 mm.

Material examined : 1♂ Harinkhana, Bagerhat, 3.VII.1991, Coll. V. Biswas; 2♀ Barisal, 5.II.1990, Coll. V. Biswas; 1♂ Savar, Dhaka, 25.V.1991, Coll. V. Biswas; 1♂ Khajura, Jessore, 27.IX.1991, Coll. V. Biswas; 2♀ Jhenidah, 19.XI.1993, Coll. V. Biswas; 2♀ Teroshri, Manikganj, 18.V.1992, Coll. V. Biswas; 2♀ Digba, Rajshahi, 4.II.1992, Coll. V. Biswas; 2♀ Kajla, Rajshahi, 3.II.1992, Coll. V. Biswas.

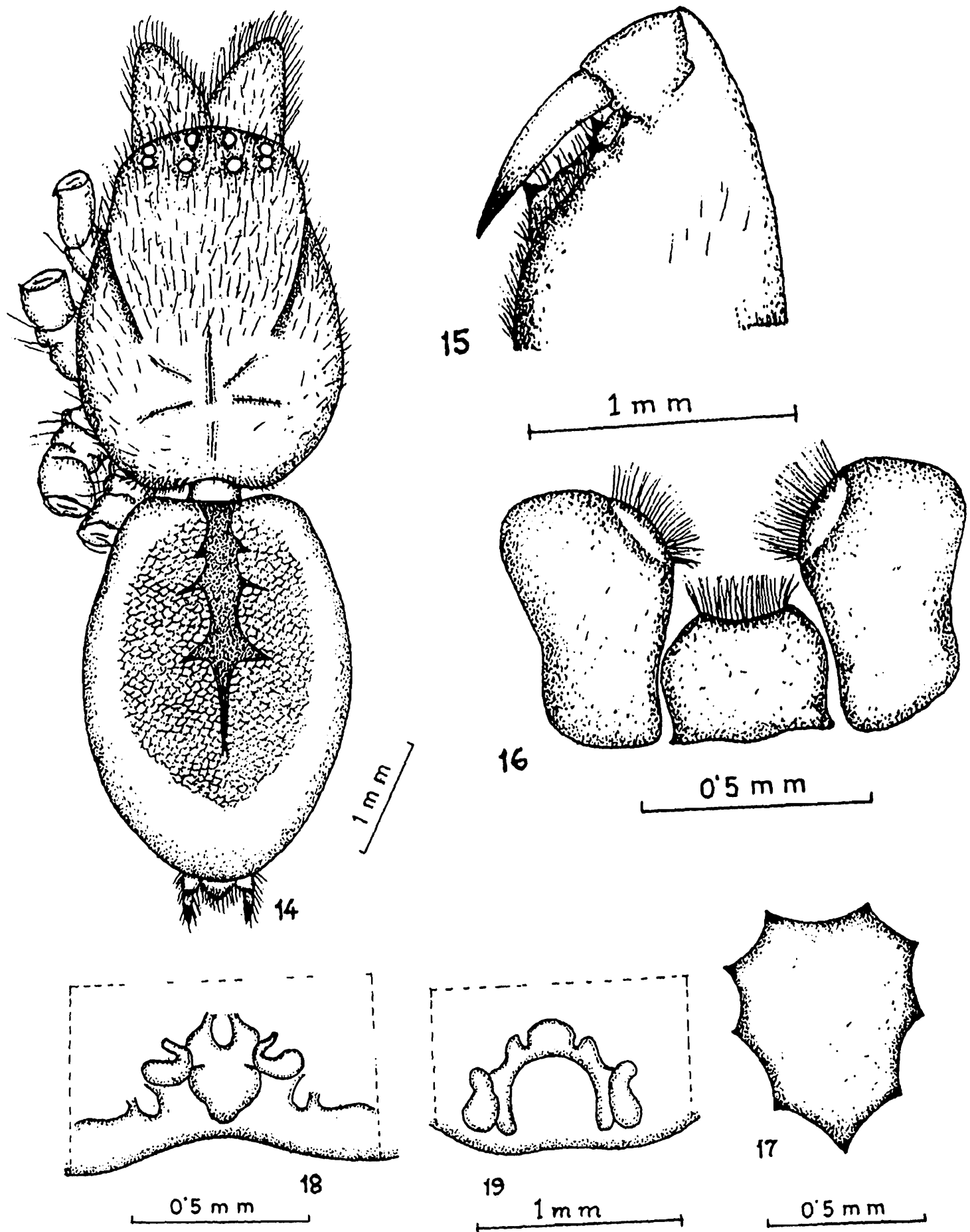
Distribution : BANGLADESH : Bagerhat, Barisal, Dhaka, Jessore, Jhenidah, Manikganj, Rajshahi; INDIA (Majumder & Tikader, 1991).

***Cheiracanthium tagorei* n. sp.**

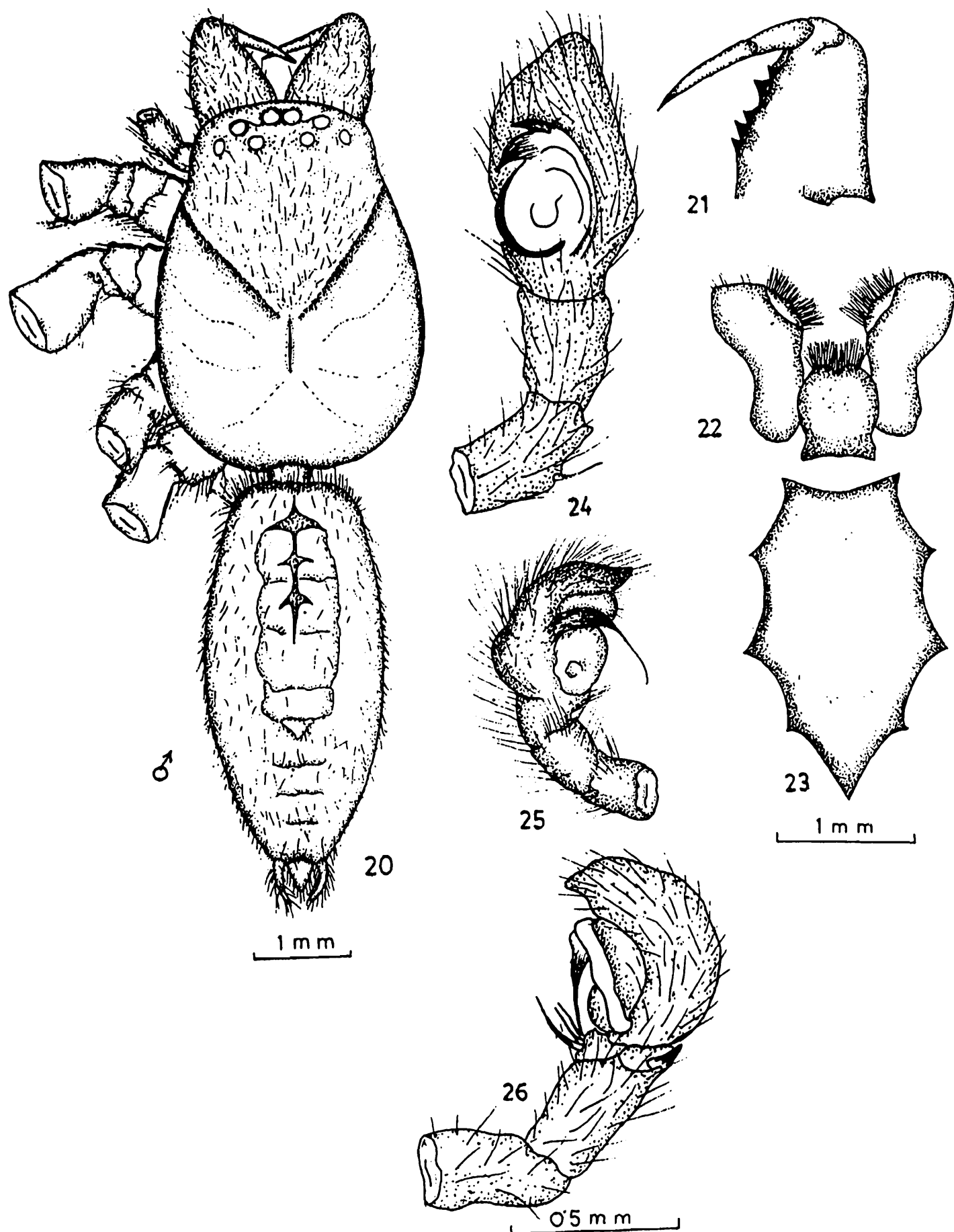
(Figs. 20-26)

General : Cephalothorax brown, with chelicerae blackish. Abdomen pale-brown, covered with silky pubescence. Legs blackish-brown. Total body length 8.50 mm. Carapace 4.50 mm long, 2.80 mm wide; Abdomen 4.00 mm long, 1.50 mm wide.

Cephalothorax : Robust, longer than abdomen, anteriorly narrowed, posteromedially broad, with a brown distinct fovea; radial striae distinct; cephalic region weakly raised; cervical furrows faintly distinct. Eyes black; anterior row recurved and posterior row faintly procurved; ocular quad wider than long, narrowed anteriorly. Chelicerae black, longer than wide, inner margin with 3 and outer margin with 2 teeth (Fig. 21). Maxillae red-brown, long (Fig. 22). Labium little darker, scopulate (Fig. 22). Sternum elongate, oval, pointed posteriorly, covered with hairs, these posteriorly brown, erect, appearing spines (Fig. 23). Legs long and strong; tibiae and metatarsi I and II with 2 and 3 strong spines respectively; leg formula 4213 and the measurements (in mm) in Table 1.



Figs. 14-19 : *Cheiracanthium sikkimensia* Majumder & Tikader. 14. Whole body (dorsal view); 15. Chelicerae; 16. Maxillae and Labium; 17. Sternum; 18. Epigynum and 19. Internal genitalia.



Figs. 20-26 : *Cheiracanthium tagorei* n. sp. 20. Whole body (dorsal view); 21. Chelicerae; 22. Maxillae and Labium; 23. Sternum; 24. Male palp (ventral view); 25. Male palp (retrolateral view) and 26. Male palp (lateral view).

Table-1 : Length of legs of female (♀) holotype of *Cheiracanthium tagorei* n. sp. (in mm).

Leg	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	2.0/2.0	1.1/1.1	2.5/2.5	2.3/2.3	1.0/1.0	8.9/8.9
II	2.5/2.5	1.1/1.1	2.8/2.8	2.0/2.0	1.5/1.5	9.9/9.9
III	1.5/1.6	0.6/0.6	1.8/1.8	2.1/2.1	0.9/0.9	6.9/7.0
IV	2.7/2.7	0.8/0.8	2.7/2.7	3.5/3.5	1.2/1.2	10.9/10.9

Male palp as figs. in 24, 25 and 26.

Abdomen : Cylindroid, longer than wide, anterior margin wavy, posteriorly narrowed appearing pointed, medially ridged, these appear reticular; dorsum with silvery pubescence all over.

Male : Unknown.

Holotype : Male in spirit.

Type-locality : BANGLADESH : Shilaidah, Dist. Kustia, 15.II.92, Coll. V. Biswas.

Etymology : The species is named after the famous poet Rabindra Nath Tagore.

Remarks : None of the congeneric species (Majumder & Tikader, 1991, Dondale & Redner, 1982; Paik, 1985; Koh, 1989; Yaginuma, 1980) like the present species are known to have contiguous anteromedian eyes. Male palpus being anteriorly, the species, following key of Majumder and Tikader (1991) may be related to *C. trivialis* (Thorell) but its points of distinction are too many :

- (1) Lateral eyes widely placed
- (2) Cephalothorax much larger than abdomen
- (3) Fangs segmented; inner margin of chelicerae with 3 teeth
- (4) Labium basally constricted and anteriorly concave
- (5) Sternum elongate and
- (6) Typical male palp

The species, is therefore, described as new to science.

SUMMARY

The present paper deals with 4 (four) species of sac-spiders of the genus *Cheiracanthium* Koch from Bangladesh. Of these, *C. tagorei* is recognised as new to science and rest 3 (three) species is described and illustrated.

The types are at present in the collection of the Department of Zoology, Government P. C. College, Bagerhat, Bangladesh and will be deposited to the Museum of the Department of Zoology, University of Dhaka, Dhaka-1000, Bangladesh, in due course of time.

ACKNOWLEDGEMENTS

We are grateful to Dr. S. C. Majumder, Scientist-SD, Sunderban Field Research Station, Zoological Survey of India, Canning, West Bengal, for confirming the identity of the species and the Head, Department of Zoology, University of Calcutta, for providing the laboratory facilities.

REFERENCES

- Begum, A. and V. Biswas, 1997. A list of the spider fauna of Barisal division, Bangladesh (Araneae : Arachnida). *Bangladesh j. zool.*, **25**(2) : 207-210.
- Biswas, B. K. 1984. Description of six new species of spiders of the families Clubionidae, Gnaphosidae and Salticidae from India. *Bull. zool. Surv. India*, **6**(1-3) : 119-127.
- Biswas, V. and D. Raychaudhuri, 1994. Clubionid spiders of Bangladesh-I : Genus *Clubiona* Latreille. *Proc. Recent Adv. Life Sc., Dibrugarh*, **1** : 191-210.
- Biswas, V., H. R. Khan, N. Q. Kamal and A. Begum, 1993. A preliminary study of the rice-field spiders in Jhenidah, Bangladesh. *Bangladesh j. Zool.*, **21** : 85-92.
- Caporiacco, L. 1935. Aranidi dell' Himalaia e dell Karakoram, raccolto. *Mem. Soc. ent. ital.*, **13** : 26-263.
- Chen, Z. F. and Z. H. Zhang, 1989. Fauna of Zhejiang, Araneida. *Zhejiang Sci. & Tech. Pub. House*, 356 pp.
- Chowdhury, S. H. and S. K. Pal, 1984. Further report on rice-field spiders from Bangladesh. *Chittagong Univ. Studies*, II, **8** : 25-39.
- Comstock, J. H. 1965. The spider book. *Comstock Pub. Assoc. Ithaca*, New York : 1-729.
- Dondale, C. D. and J. H. Redner, 1982. The sac-spiders of Canada and Alaska. Araneae : Clubionidae and Anaphanaeidae. *The Insect and Arachnids of Canada, Part-9* : 1-193.
- Kaston, B. J. 1948. Spiders of Connecticut. *Bull. Conn. St. Geol. Nat. Hist. Surv.*, **70** : 1-874.
- Koh, J. K. H. 1989. A Guide to Singapore spiders. *Singapore Science Centre*. 160 pp.
- Locket, G. H. and A. F. Millidge, 1951. British Spiders, Vol. I, *Ray-Society*, London, 310 pp.
- Majumder, S. C. and B. K. Tikader, 1991. Studies on some spiders of the family Clubionidae from India. *Rec. zool. Surv. India, Occ. Pap.* No. 102 : 1-175.
- Okuma, C., N. Q. Kamal, Y. Hirashima, Z. Alam and T. Ogata, 1993. Illustrated Monograph on the spiders of Bangladesh. *IPSA-JAICA, Salna, Gazipur* : 1-93.
- Paik, K. Y. 1985. Three new species of clubionid spiders from Korea. *Korean Arachnol.*, **1**(1) : 1-11.
- Paik, K. Y. 1990. Korean spiders of the genus *Cheiracanthium* (Araneae; Clubionidae). *Korean Arachnol.*, **6**(1) : 1-30.

- Patel, B. H. and H. K. Patel, 1973. On some new species of spiders of the family Clubionidae (Araneae Arachnida) with a record of genus *Castianeira* Keyserling from Gujrat, India. *Proc. Indian Acad. Sci.*, **78**(1) : 1-9.
- Platnick, N. I. and S. U. Shadab, 1974a. A revision of the *tranquillus* and *speciosus* groups of the spiders genus *Trachelas* (Araneae : Clubionidae) in North and central America. *Am. Mus. Novit.*, No. **2553** : 1-34.
- Platnick, N. I. and S. U. Shadab, 1974b. A revision of the *bispinosus* and *bicolor* groups of the spider genus *Trachelas* (Araneae : Clubionidae) in North and Central America and West Indies. *Am. Mus. Novit.*, No. **2560** : 1-34.
- Pocock, R. I. 1900. The Fauna of British India, including Ceylon and Burma (Arachnida). *Taylor & Francis*, London : 1-279 p.
- Reiskind, J. 1969. The spider sub-family Castianeirinae of North and Central America (Araneae : Clubionidae). *Bull. Mus. Comp. Zool. Harv.*, **138** : 162-325.
- Roberts, M. J. 1985. The spiders of Great Britain and Ireland. Vol. I & II. *Harely Books, Colchester* 1-204 pp.
- Singh, G. 1970. Description of a new species of the genus *Clubiona* Latreille (Clubionidae : Araneae) from India. *Science & Culture*, **36** : 410-412.
- Tikader, B. K. 1962. Studies on some Indian spiders (Araneae : Arachnida). *J. Linn. Soc. London Zool.*, **44** : 561-584.
- Tikader, B. K. 1975. A new species of spider of the genus *Cheiracanthium* Koch (Family : Clubionidae) from India. *J. Bombay nat. Hist. Soc.*, **72**(1) : 43-45.
- Tikader, B. K. 1976. Two new species of spiders of the genus *Cheiracanthium* Koch and *Clubiona* Latreille (Family : Clubionidae) from India. *J. Bombay nat. Hist. Soc.*, **73**(1) : 175-177.
- Tikader, B. K. 1981. Studies on spiders of the genus *Castianeira* Keyserling (Family; Clubionidae) from India. *Bull. zool. Surv. India*, **4**(3) : 257-265.
- Tikader, B. K. and B. Biswas, 1981. Spider fauna of Calcutta and Vicinity. *Rec. zool. Surv. India*, Occ. Pap. No. **34**(1) : 1-149.
- Yaginuma, T. 1986. Spiders of Japan in colour (new ed.). *Hoikusha Pub. Co.*, Osaka, 305 pp.

NOTES ON THE TYPE OF *CRANOPYGIA PLUTO* HEBARD (INSECTA : DERMAPTERA)

G. K. SRIVASTAVA*

Zoological Survey of India, Kolkata

INTRODUCTION

Cranopygia pluto was described on a Male from Myanmar by Hebard (1923) but without giving details of genitalia. At that time the concepts of genitalia was not well estabed, for the discrimination of species in Pygidicranoidea. For this reason the taxonomic position of this species remaind in doubt (Hincks, 1959 and Srivastava, 1993).

The Type Male is examined and the genitalia described for the first time. It comes close to members of *Cranopygia* (Cumingi—Group) on the basis of parameres but differs in having the virga long, thin and forming coils apically. Shape of penultimate sternite and forceps is also distinctive.

I am thankful to the Director, Zoological Survey of India, Calcutta for providing necessary facilities. My sincere thanks are also due to Dr. Daniell Otte, Chairman, Department of Entomology, Philadelphia Academy of Sciences, Philadelphia, PA, U.S.A. for placing at my disposal the above 'Type' specimen for study.

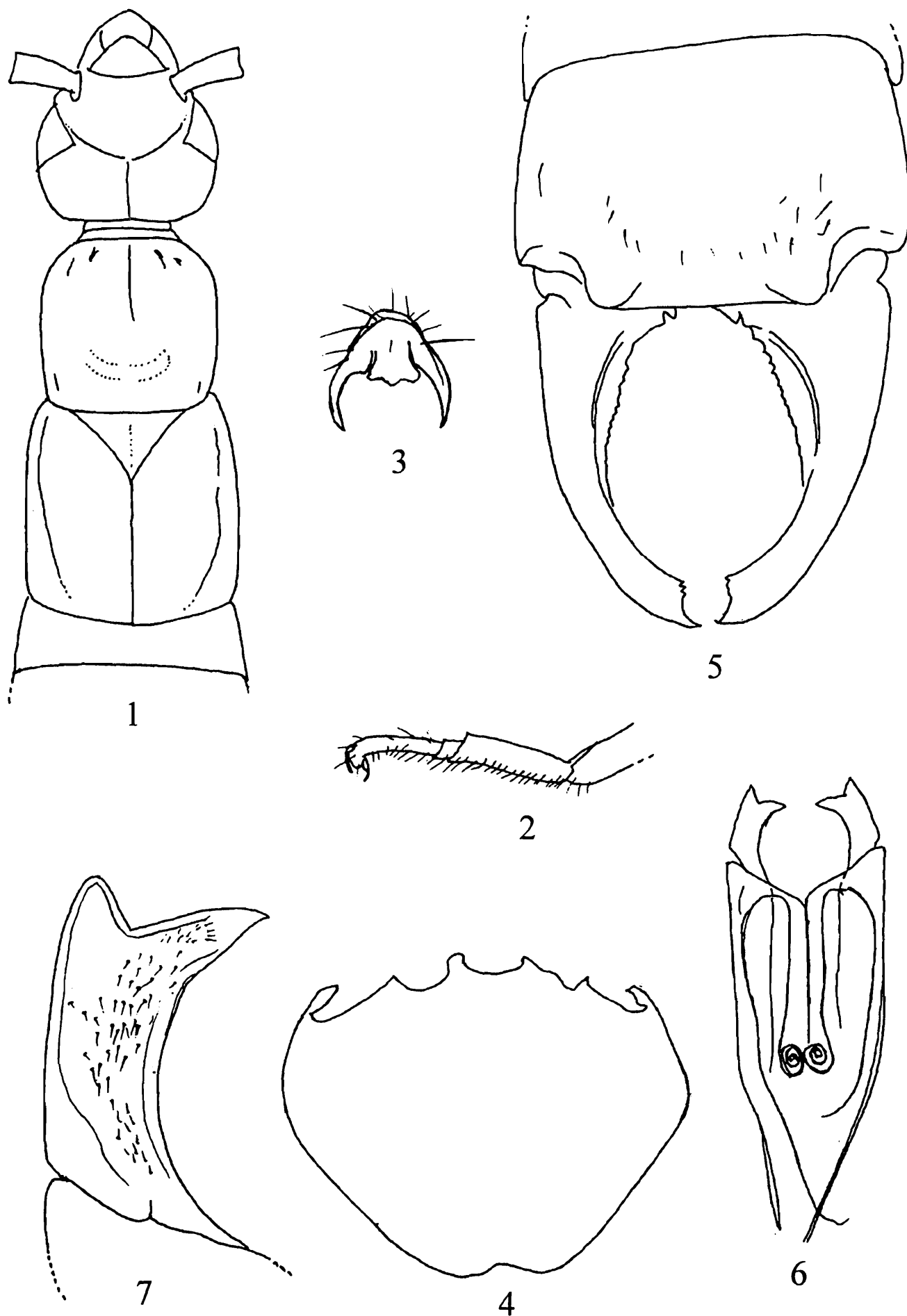
Cranopygia pluto Hebard

(Figs. 1-7)

1923. *Cranopygia pluto* Hebard, *Mem. Dep. Agric. India ent. Serv.*, 7 : 200, pl. xx, fig. 18 (Type Male; Chin Hills, Burma, 1909 (Venning), Hebard Collection Type No. 775).
1959. *Cranopygia pluto*; Hincks, *syst. Mono. Dermaptera*, 2 : 107.
1976. *Cranopygia pluto*; Srivastava, *Rec. zool. Surv. India, Occ. Pap.*, 2 : 7.
1986. *Cranopygia pluto*; Steinmann, *Das Tierreich*, 102 : 265.
1985. *Cranopygia pluto*; Sakai, 1985, *Dermapterorum Cat.*, XVI-XVIII : 777 (Photograph of Type Male).
1993. *Cranopygia? Pluto*; Srivastava, *Rec. zool. Surv. India*, 92(1-4) (1992) : 44.

Material examined : Type Male labelled as : (i) Chin Hills, Burma, Venning 1909—white handwritten label and (ii) *Cranopygia pluto* Hebard 775 TYPE—pink label all in the hand of

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Figs. 1-7. *Cranopygia pluto* Hebard, Type Male, 1. Anterior portion of body, without legs; 2. Hind tarsi; 3. Claw; 4. Penultimate sternite; 5. Ultimate tergite and forceps; 6. Genitalia; 7. Left paramere, enlarged.

Hebard except the word 'Type' which is printed; genitalia mounted between two coverslips and pinned with the specimen (Philadelphia Academy of Sciences).

<i>Measurements</i> : (in mm) :	<i>Holotype</i> <i>Male</i>
Length of body	27.5
Length of forceps	6.9
Length of pronotum	3.5
Length of eye	1.2
Post ocular length	1.0
Length of 1st antennal segment	1.1
Distance between scapi	1.5

(Difference in the length of body may be due to repair in body parts subsequently).

General colour dark brownish black, head somewhat yellowish brown in the middle; pronotum feebly yellowish on sides; legs clear yellow.

Head smooth, sutures faint. Pronotum slightly longer than broad, sides straight, depressed and parallel sided, hind margin subtruncate, median sulcus distinct; prozona and metazona moderately raised, demarcated by a transverse depression. Elytra abbreviated, meeting along the middle line, a triangular scutellum visible. Wings not visible. Legs with femora compressed and carinate; hind metatarsus slightly longer than the combined length of meso- and protarsus; claw with an arolium which is triangular in shape and produced into three small lobes posteriorly. Abdomen covered with fine pubescence, gradually enlarging posteriorly, finely punctulate. Penultimate sternite narrowed posteriorly with slight emargination in middle of posterior margin. Ultimate tergite transverse, rugulose, faintly tumid above roots of forceps. Pygidium concealed. Forceps heavy, strongly incurved, tapering apically internally at base with a dorsal and ventral large teeth, inner ventral margin projecting and provided with a series of minute tubercles, at a little before apex a short tooth followed by several minute ones present. Genitalia with virga long, thin and coiled apically.

Remarks : This species is known by Type Male and the genitalia is figured here for the first time which is quite characteristic in having long and thin virga, coiled apically.

(Type appears to be not in a very good condition; except right basal antennal segment rest are missing; middle and hind leg on the right side are present and rest are missing).

REFERENCES

- Hebard, M. 1923. Studies in Indian Dermaptera. *Mem. Dep. Agric. India ent. Ser.*, 7 : 195-242, pls. 19-21.
- Hincks, W. D. 1959. A Systematic Monograph of Dermaptera of the world based upon the material in British Museum (Natural History), Pt. II, Pygidicranidae excluding Diplatyinae, 218 pp, 214 figs., London, British Museum (Natural History).
- Srivastava, G. K. 1993. Taxonomic status of certain genera of Pygidicranidae (Dermaptera). *Rec. zool. Surv. India*, 92(1-4) (1992) : 41-52.

NEMATODES FROM RAJASTHAN, INDIA.

IV. SEVENTEEN SPECIES AS NEW RECORD FROM THE STATE

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Baqri (2000) reported 20 species for the first time and reviewed literature on survey, identification and taxonomy of plant and soil nematodes from Rajasthan. While adding six new species as new to science, Baqri & Bohra (2001) initiated a series of papers on nematodes from Rajasthan. This fourth paper of the series reports 17 species of nematodes belonging to orders Tylenchida (4 spp.) Dorylaimida (9 spp.) and Mononchida (4 spp.) as new records from the state. Besides, brief descriptions, illustrations and the information on host(s) and locality(ies) of these species have also been provided.

MATERIALS AND METHODS

Nematodes were fixed in hot 4% formalin and mounted in anhydrous glycerine. All the specimens included in the present study have been deposited and registered with the National Collection of Zoological Survey of India, Jodhpur.

Order TYLENCHIDA Thorne, 1949

Family TYLENCHIDAE Orley, 1880

1. *Filenchus vulgaris* (Brezeski, 1963) Lownsbery & Lownsbery, 1985

(Fig. 1, A-B)

Measurements : Females (2) : L = 0.56–0.61 mm; a = 35; b = 5.6–5.8; c = 5.0–6.1; c = 9.1–10.0; V = 9–10 59–65.

Description : Female : Body slightly arcuate upon fixation. Cuticle transversely striated, about 0.5 μ m apart. Lateral fields marked by four incisures. Lip region continuous striated. Stylet 10–11 μ m long, with small knobs. Oesophageal median bulb at 41–42% from anterior end. Basal bulb pyriform. Excretory pore at 92–95 μ m from anterior end. Posterior uterine sac about 0.6–0.7 vulval body-width long. Tail filiform, 91–121 μ m or 1.0–1.5 times the vulva anus distance.

Male : Not found.

Habitat and Locality : Collected from soil around roots of wheat (*Triticum aestivum*) at Tonk, district Tonk, Rajasthan.

2. *Basiria graminophila* Siddiqi, 1959

(Fig. 1, C-E)

Measurements : Females (4) : L = 0.68–0.76 mm; a = 30–40; b = 5–6; c = 5.9–6.0; c' = 9.0–9.5; V = ¹²⁻¹³63–64.

Males (2) : L = 0.65–0.67 mm; a = 39–40; b = 5.9–6.0; c = 5–6; T = 55–60; Spicules = 16–18 µm; Gubernaculum = 4–5 µm.

Description : Female : Body more or less straight upon fixation. Cuticle striated, striae about 1 µm apart. Lip region marked by slight depression, with flat apex, narrower than body. Lateral fields marked by four incisures. Stylet 11–12 µm long, with rounded basal knobs. Dorsal oesophageal gland opening at 9–10 µm posterior to stylet base. Median oesophageal bulb poorly developed, 45–55% of oesophageal length from anterior end. Basal bulb set off from intestine. Cardia distinct. Female reproductive system mono-prodelphic. Ovary outstretched. Spermatheca lobed. Post vulval -uterine sac about half vulval body-width long. Vulva -anus distance more than one tail length. Tail elongate filiform, 112–128 µm long, with fine rounded terminus.

Male (2) : Similar to female in general shape and morphology except in tail shape and reproductive system. Bursa adanal. Spicules 16–18 µm long. Gubernaculum simple fixed.

Habitat and Locality : Collected from soil around roots of wheat (*Triticum aestivum*) at Darrah, district Kota and two females were collected around roots of *Sorghum vulgare* at Peeh, district Nagaur.

Family DOLICHODORIDAE Chitwood in Chitwood & Chitwood, 1950

3. *Telotylenchus aerolatus* Baqri & Jairajpuri, 1969

(Fig. 1, F-G)

Measurements : Female (1) : L = 0.80 mm; a = 38; b = 5.3; c = 17.7; c' = 3.0; V = ¹⁰53⁹

Description : Female : Body slightly curved ventrally. Cuticle marked with distinct transverse striae, about 1 µm apart. Lip region set off, flat at apex, marked by 8 striae. Labial framework sclerotized. Lateral fields marked by four incisures, outer ones are crenate. Lateral fields irregularly aerolated throughout the length. Stylet 17 µm long, with rounded posteriorly sloping basal knobs. Dorsal oesophageal gland opens 2 µm posterior to stylet base. Oesophagus overlapping intestine for about two body-width. Female reproductive system amphidelphic. Vulva transverse. Tail elongate, 45 µm, cylindrical, with rounded terminus; marked with 36 striae; three anal body-widths long. Phasmids in anterior third of tail.

Male : Not found.

Habitat and Locality : Collected from soil around roots of millet (*Pennisetum typhoides*) at Jas Nagar, district Nagaur.

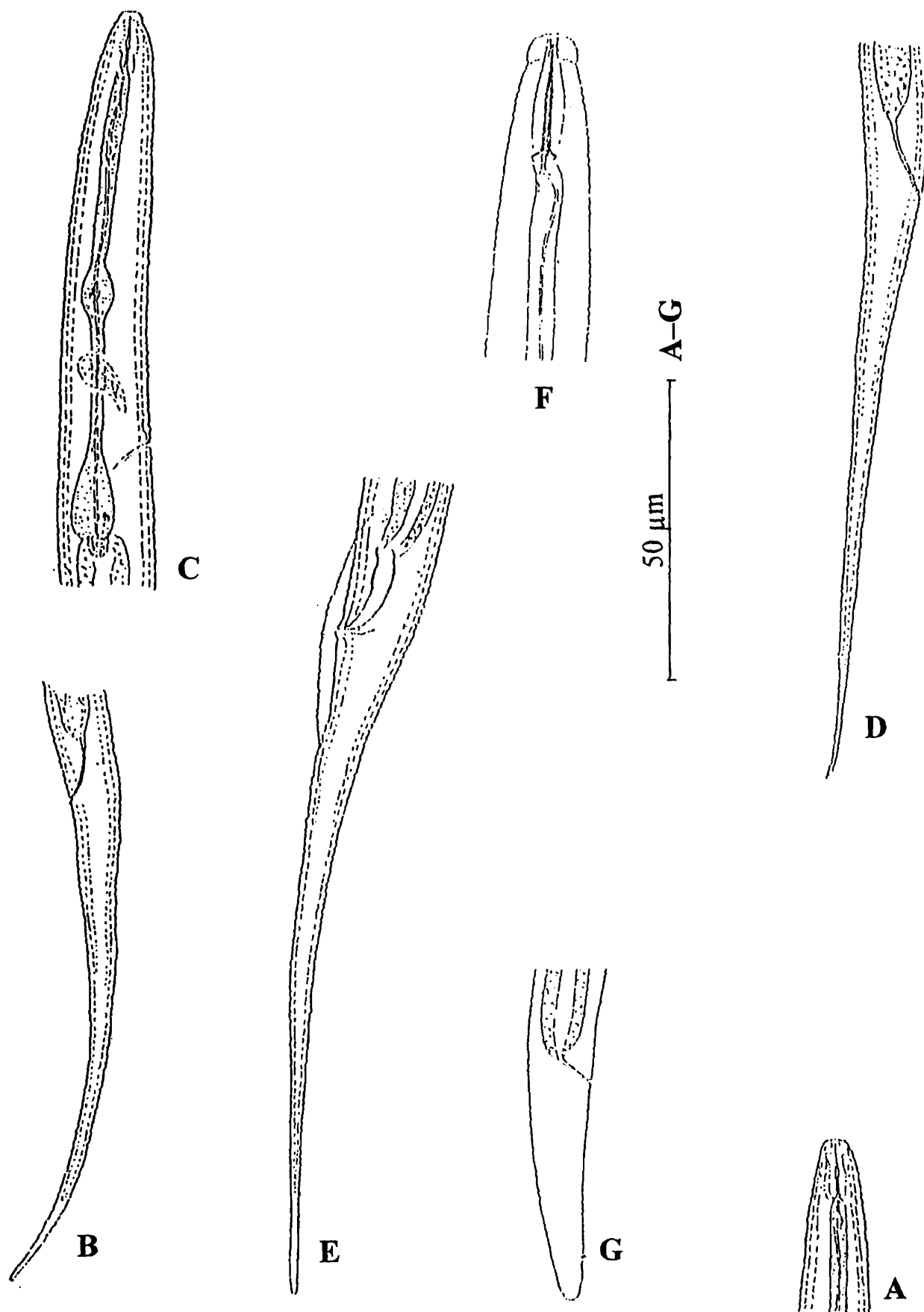


Fig. 1. A-B : *Filenchus vulgaris* (Brezeski, 1963) Lownsbery & Lownsbery, 1985 A-Female anterior end; B-Female tail.
 C-E : *Basiria graminophila* Siddiqi, 1959. C-Oesophageal region; D-Female tail; E-Male tail.
 F-G : *Telotylenchus aerolatus* Baqri & Jairajpuri, 1969. F-Female anterior end; G-Female tail.

Family PSILENCHIDAE Paramonov, 1967 (Khan, 1969)

4. *Psilenchus hilarulus* de Man, 1921

(Fig. 2, D-E)

Measurements : Females (2) : L = 1.25–1.30 mm; a = 28–30; b = 7; c = 11.5–11.8; c' = 4.9–5.0; V = $6.747-54^{8-9}$

Description : *Female* : Body more or less straight upon fixation. Cuticle finely striated, striae 1 μ m apart. Lip region elevated, dome-shaped, smooth, continuous. Amphidial apertures transverse, slit-like. Stylet cylindrical, 18–20 μ m long, without basal knobs. Dorsal oesophageal gland opening 6–7 μ m posterior to stylet base. Median oesophageal bulb prominent, oval. Basal bulb small pyriform. Cardia conoid, obscure. Female reproductive system amphidelphic. Ovaries outstretched. Tail elongate with clavate terminus, 108–110 μ m long or 4.9–5.0 anal body-width long. Phasmids less than one anal body-width posterior to anus.

Male : Not found.

Habitat and Locality : Collected from soil around roots of wheat (*Triticum aestivum*) at Pipali Ki Dhani, district Jaipur.

Order DORYLAIMIDA Pearse, 1942

Family DORYLAIMIDAE de Man, 1876

5. *Mesodorylaimus mesonyctius* (Kreis, 1930) Andrassy, 1959

(Fig. 2, A-C)

Syn. *Dorylaimus mesonyctius* Kreis, 1930. II. *Zool. Ans. Leipzig*; 87(3-6); 67–87

Dorylaimus subulatus Thorne & Swanger, 1936. *Capita zool.* 6, 223p.

Measurements Females (4) L = 1.09–1.42 mm; a = 36–40; b = 4.1–5.0; c = 17–18; V = $11-1350-51^{11-13}$

Males (2) : L = 1.23–1.25 mm; a = 27–28; b = 4.4–5.0; c = 44–45; T = 45–50.

Description : *Female* : Body almost straight upon fixation. Cuticle finely striated, 2–4 μ m thick (thickest at tail). Lips separate, head region marked by a constriction. Odontostyle 12–14 μ m or as long as lip region-width; aperture 3–4 μ m or 25–28% of odontostyle length. Odontophore 16–18 μ m long. Guiding ring single, situated at 7–8 μ m from anterior end. Oesophagus expands gradually to form the basal extended portion which occupies 39–45% of total oesophageal length. Vulva a transverse slit. Vagina 17–21 μ m long or 1/3rd of corresponding body-width. Female reproductive system amphidelphic; ovaries reflexed. Prerectum 80–105 μ m or 4.0–4.3 anal body-width long. Rectum 40–42 μ m or 1.5–1.6 anal body-width long. Tail 60–75 μ m or 3.0–3.5 anal body-width long, conoid then spicate, with two caudal pores on each side.

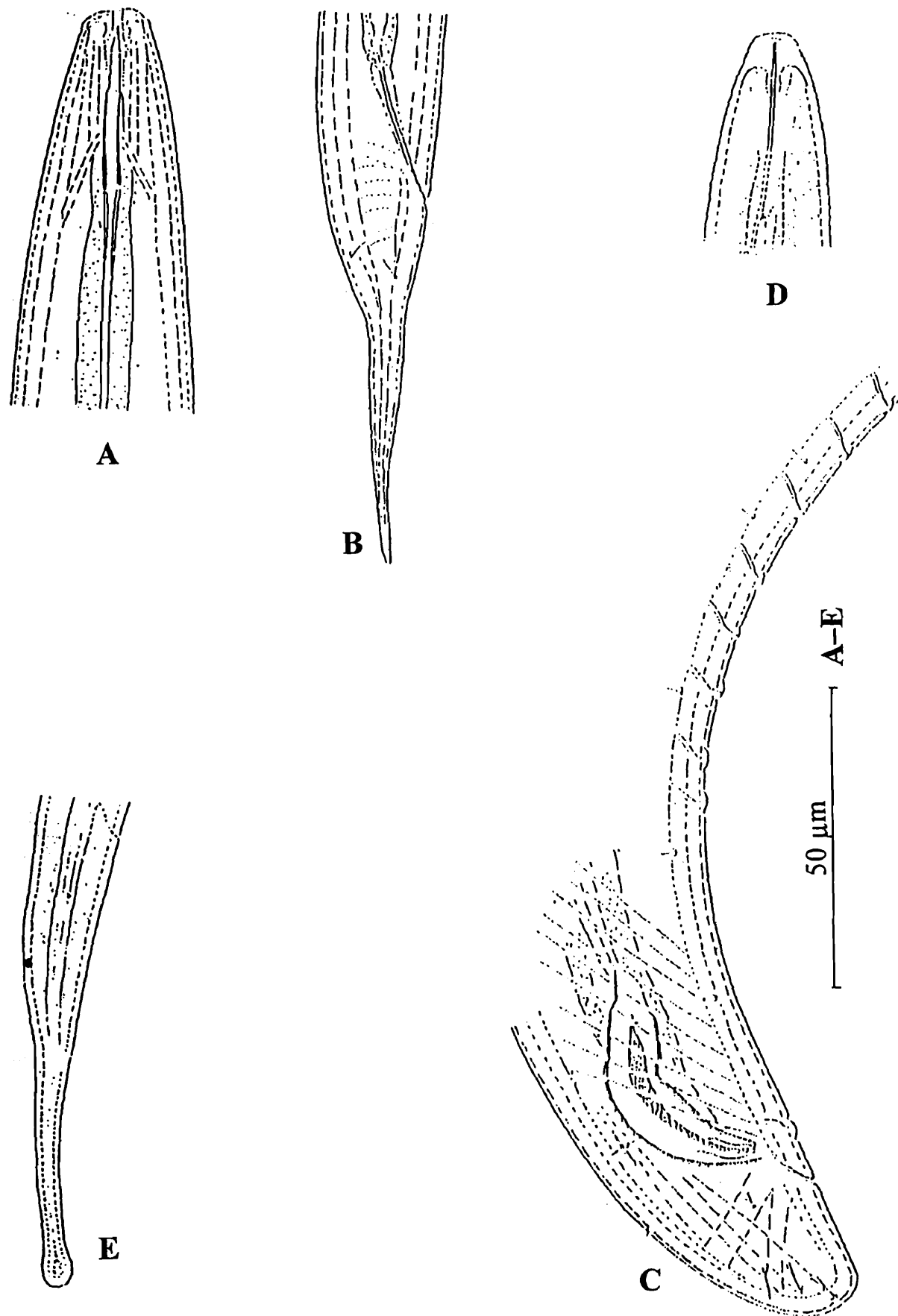


Fig. 2. A-C : *Mesodorylaimus mesonyctius* (Kreis, 1930) Andrassy, 1959. A-Female anterior end; B-Female tail; C-Male tail.
D-E : *Psilenchus hilarulus* de Man, 1921. D-Female anterior end; E-Female tail.

Male : Similar to female in general morphology except in tail shape and reproductive system. Spicules 38–40 μm long. Ventromedian supplements nine, spaced irregularly. Submedian papillae seven, irregularly spaced. Tail short, rounded conoid 27–28 μm long or 0.9–1.2 anal body-width.

Habitat and Locality : Collected from soil around roots of wheat (*Triticum aestivum*) at Darrah, district Kota.

Family QUDSIANEMATIDAE Jairajpuri, 1965

6. *Discolaimium mukhtarpuriense* Baqri & Jairajpuri, 1969

(Fig. 3, A-B)

Measurements : Females (4) : L = 0.80–0.87 mm; a = 25–32, b = 3.8–4.2; c = 28–29; V = 10^{-11} 53–55 $^{10-11}$.

Description : Female : Body slender, slightly tapering in posterior third of its length upon fixation. Cuticle smooth. Lateral chords 1/5th–1/4th of the body-width- with well developed 60–70 glandular bodies. Lip region set off. Odontostyle 14–16 μm long; its aperture 5–6 μm . Guiding ring single. Odontophore 15–17 μm long. Basal expanded part of oesophagus occupies 33–36% of total neck region. Vulva transverse. Vagina 9–10 μm or about one third of corresponding body-width. Female reproductive system amphidelphic. Ovaries reflexed. Prerectum 72–102 μm or about 3–5 anal body-width long. Rectum 30–32 or about one anal body width long. Tail 28–30 μm or 1.2 anal body-width long, convex-conoid, with a rounded terminus.

Male : Not found.

Habitat and Locality : Collected from soil around roots of maize (*Zea mays*) at Gogunda, district Udaipur and five females were also collected around roots of millet (*Pennisetum typhoides*) at Peeh, district Nagaur and Nasirabad Road, district Ajmer.

7. *Latocephalus smithi* (Heyns, 1963) Patil & Khan, 1982

(Fig. 3, C-D)

Syn. *Discolaimoides smithi* Heyns, 1963. *South Africa J. Agr. Sci.* 6 : 289–302.

Discolaimium smithi (Heyns, 1963) Das, Khan & Loof, 1969. *Nematologica*, 15 : 473–491.

Measurements : Female (1) : L = 1.60 mm; a = 51.7; b = 4.5; c = 32; V = 40⁸.

Description : Female : Body slightly tapering in neck region. Cuticle finely striated transversely. Lip region expanded. Lateral chords about 1/4th of body-width having 65 glandular organs. Stylet 12 μm long; aperture 5 μm or 41% of odontostyle length. Odontophore 20 μm . Basal expanded part of oesophagus occupies 51% of total oesophageal length. Vulva a transverse slit. Vagina 11 μm or

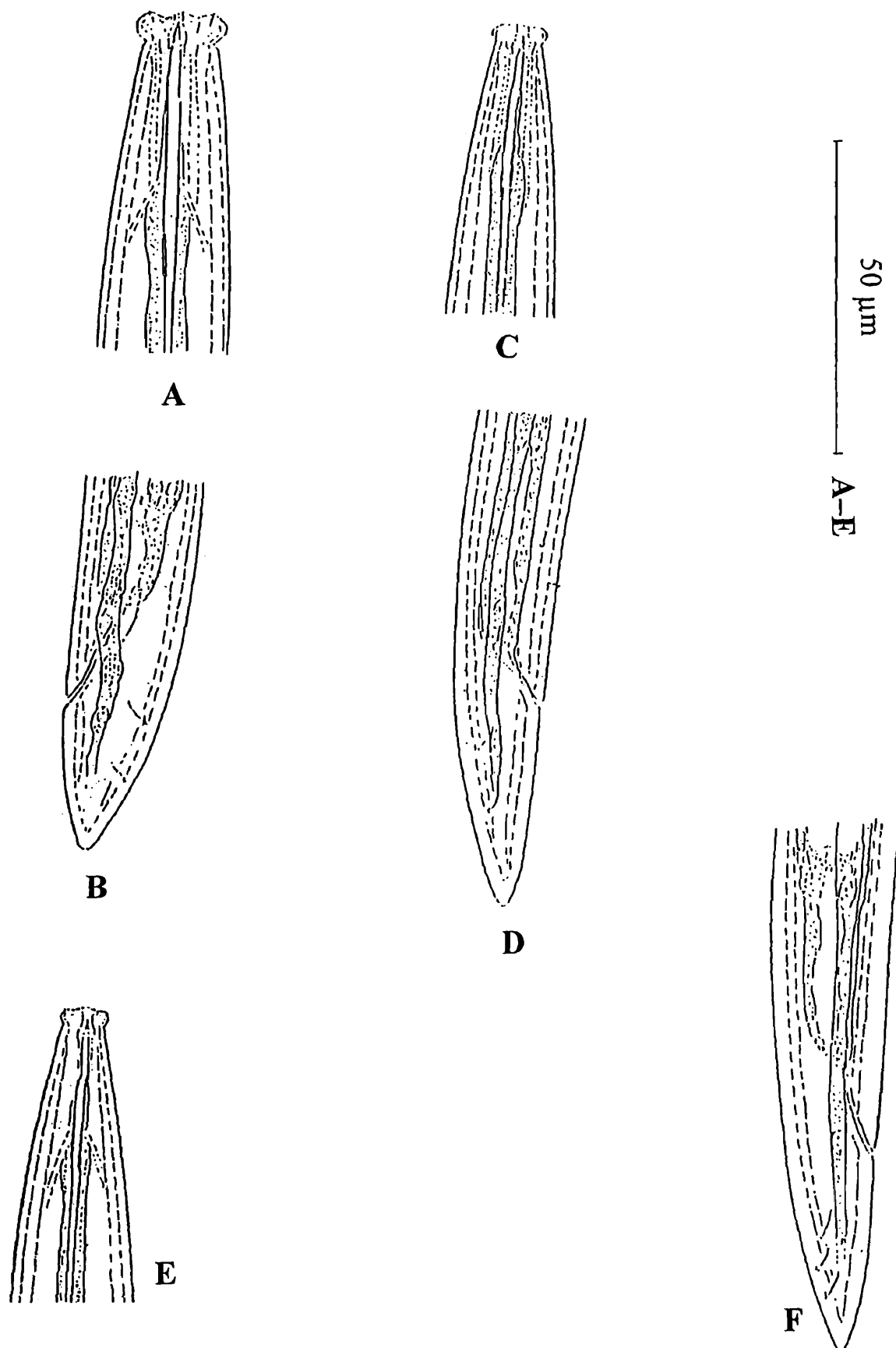


Fig. 3. A-B : *Discolaimium mukhtarpuriense* Baqri & Jairajpuri, 1969. A-Female anterior end; B-Female tail.
 C-D : *Latocephalus smithi* (Heyns, 1963) Patil & Khan, 1982. C-Female anterior end; D-Female tail.
 E-F : *Latocephalus ooetenbrinki* (Ali, Suryawanshi & Prabha, 1973) Patil & Khan, 1982. E-Female anterior end;
 F-Female tail.

about 1/3rd of corresponding body width. Female reproductive system mono-opisthodelphic. Ovary reflexed. Prerectum 55 μm or 2.7 anal body-width long. Rectum 30 μm or 1.6 anal body-width long. Tail 50 μm or 2.5 anal body-width, long, convex-conoid with rounded terminus.

Male : Not found.

Habitat and Locality Collected from soil around roots of millet (*Pennisetum typhoides*) at Dikwala, district Jalore.

8. *Latocephalus oostenbrinki*

(Ali, Suryawanshi & Prabha, 1973) Patil & Khan, 1982

(Fig. 3, E-F)

Syn. *Discolaimium oostenbrinki* Ali, Suryawanshi & Prabha, 1973 *Nematologica* **19** : 190–194.

Measurements : Female (1) L = 1.77 mm; a = 53; b = 5.4; c = 42; V = 38⁸.

Description : Female : Body slender, slightly ventrally curved in posterior third region. Cuticle transversely striated. Lateral chords about 1/4th of body-width near middle, with 30 glandular organs on each side. Lip region set off from body by a deep constriction; lips separate. Odontostyle 12 μm long; aperture 4 μm or about 1/3rd of odontostyle length. Odontophore 15 μm long. Basal expanded part of oesophagus occupies 50% of neck region. Vulva a transverse slit. Vagina slightly posteriorly directed and about 1/3rd of corresponding body-width. Female reproductive system mono-opisthodelphic. Anterior uterine sac absent. Prerectum 50 μm or 2.5 anal body-width long. Rectum 20 μm or one anal body-width long. Tail elongate conoid, 42 μm long or 2.1 anal body-width long, with rounded terminus.

Male Not found.

Habitat and Locality Collected from soil around roots of millet (*Pennisetum typhoides*) around Bijawal, district Jodhpur.

Family CARCHAROLAIMIDAE Thorne, 1967

9. *Carcharolaimus masoodi*, Jairajpuri, 1968

(Fig. 4)

Measurements : Females (2) : L = 1.59–1.60 mm; a = 48–49; b = 4.2–4.5; c = 64–72; V = ⁵⁻⁶50–51⁴⁻⁵

Description : Female : Body tapering slightly towards extremities. Outer cuticle 2–4 μm thick (thickest at tail). Lateral chords about 1/4th of body-width at mid-body. Lateral glandular organs vary from 102–130, more conspicuous on tail. Of these, 20–27 are in oesophageal region. Lips large, angular, labial papillae visible 21–22 μm wide or as wide as about 2/3rd of body-width at the base of

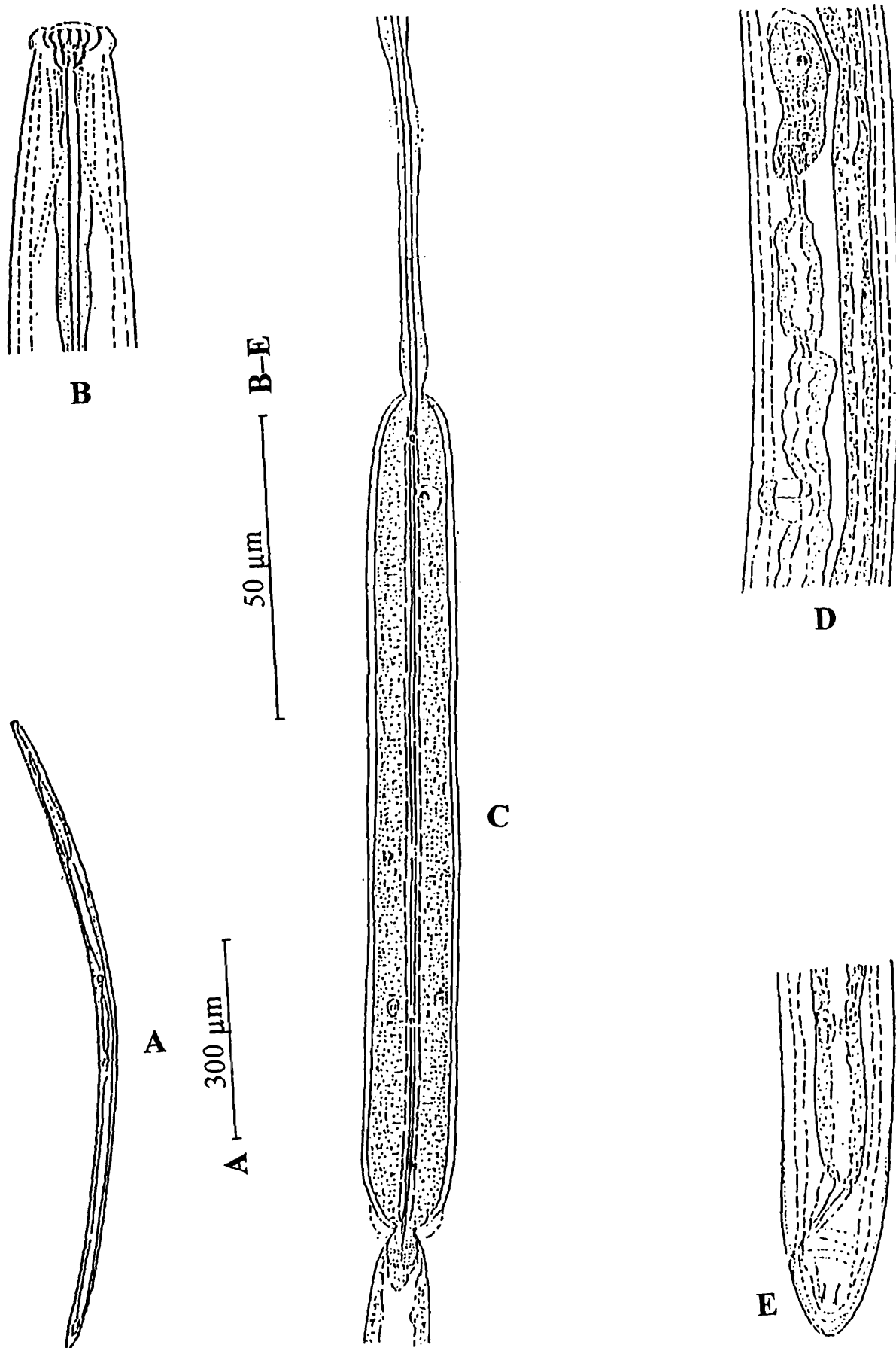


Fig. 4. A-E : *Carcharolaimus masoodi* Jairajpuri, 1968. A-Entire female; B-Anterior end; C-Oesophageal region; D-Anterior sexual branch; E-Female tail.

oesophagus. Amphids cup-shaped, situated 7–9 μm from anterior end, 6–7 μm wide. Odontostyle 11–13 μm long; aperture 5–6 μm or 45–46% of odontostyle length. Guiding ring 9–11 μm from anterior end. Odontophore 20–24 μm long. Nerve ring encircles oesophagus at about 93–102 μm from anterior end. Basal expanded part of oesophagus occupies 55–60% of total neck region. Oesophageal lumen sclerotized, 2–4 μm wide. The location of oesophageal gland nuclei and their orifices are as follows : $\text{DO} = 42.43\text{--}43.24$; $\text{DN} = 44.20\text{--}45.50$; $\text{DO-DN} = 1.77\text{--}2.26$; $\text{S}_1\text{N}_1 = 60.00\text{--}62.16$; $\text{S}_2\text{N} = 81.62\text{--}82.43$; $\text{S}_2\text{O} = 82.78\text{--}83.32$. Cardia hemispheroid. Prerectum 35–50 μm long or 1.5–1.6 anal body-width long. Rectum 19–23 μm or 0.9–1.1 anal body-width long.

Female reproductive system amphidelphic. Vulva a transverse slit. Vagina 13–15 μm or 1/3rd of to 1/4th of corresponding body-width long. Both genital branches are equally developed. Ovaries reflexed. Tail rounded conoid, 22–25 μm long or 1.1–1.2 anal body-width long, with two caudal pores on each side.

Male : Not found.

Habitat and Locality : Collected from soil around roots of millet (*Pennisetum typhoides*) and wheat (*Triticum aestivum*) at Dikwala, district Jalore and Jhunjhunu respectively.

Remark : The information about the position of Oesophageal gland nuclei and their orifices in *C. masoodi* has been added for the first time.

Family BELONDIRIDAE Thorne, 1939

10. *Dorylaimellus (Belondorylaimellus) discocephalus* Siddiqi, 1964

(Fig. 5, A-B)

Measurements Females (3) : $\text{L} = 1.03\text{--}1.31\text{ mm}$; $\text{a} = 37\text{--}38$; $\text{b} = 4.2\text{--}4.5$; $\text{c} = 39\text{--}46$; $\text{V} = {}^{8-9}50\text{--}52^{7-8}$.

Description : Female Body ventrally curved upon fixation. Lateral hypodermal chords 1/4th–1/3rd of body-width in mid-body. Lateral glandular organs conspicuous, 70–72 in number, variable in size and irregular in arrangements. Lip region well set off. Amphidial apertures 4–5 μm wide or about 3/4th of corresponding body-width. Odontostyle 6–7 μm , its aperture 2–3 μm or 33–42% of odontostyle length. Odontophore 9–11 μm long. Basal expanded part of oesophagus occupies 55–57% of neck region.

Vulva longitudinal. Vagina 10–12 μm or extending less than 1/2 of corresponding body-width. Female reproductive system amphidelphic. Ovaries reflexed. Prerectum 50–60 μm about 2–3 anal body-width long. Rectum 22–25 μm or 0.7–0.8 anal body-width long. Tail 26–28 μm , cylindrical with bluntly rounded terminus, about 1.4 anal body-width long.

Male : Not found.

Habitat and Locality : Collected from soil around roots of millet (*Pennisetum typhoides*) at Nagaur.

Family LEPTONCHIDAE Thorne, 1935

11. *Leptonchus granulatus* Cobb, 1920

(Fig. 5, C-D)

Measurements : Females (5) : L = 0.98–1.14 mm; *a* = 24–30; *b* = 5–6; *c* = 57; *V* = $7.959-60^{6-9}$

Description : Female : Body almost straight upon fixation. Cuticle finely striated, inner cuticle coarsely striated, usually loose and folded. Radial refractive elements present. Lip region set off by constriction. Lips and papillae distinct. Labial framework prominent. Amphids duplex. Odontostyle 9–10 μ m long; with narrow lumen and small aperture. Odontophore 10–12 μ m long, arcuate. Oesophagus typical of the genus. Basal pyriform bulb occupies 18–25% of neck region. Vulva a transverse slit. Vagina 12–15 μ m, extending inwards about 1/4th of corresponding body-width. Female reproductive system amphidelphic; ovaries reflexed. Intestine-prerectum junction located anterior to vulva; prerectum 420–450 μ m or 16–21 anal body-width long. Rectum 20–24 μ m or 0.8–1.0 anal body-width long. Tail bluntly conoid, 17–20 μ m or about one anal body-width long.

Male : Not found.

Habitat and Locality : Collected from soil around roots of sorghum (*Sorghum vulgare*) and millet (*Pennisetum typhoides*) at Jas Nagar, district Nagaur.

Family MYDONOMIDAE Thorne, 1964

12. *Dorylaimoides (Digidorylaimoides) pakistanensis* Siddiqi, 1964

(Fig. 5, E-F)

Measurements : Females (4) : L = 0.79–1.00 mm; *a* = 40–43; *b* = 5.2–5.5; *c* = 4.7–5.8; *V* = $14.1538-41^{15-17}$.

Description : Female : Body ventrally arcuate upon fixation. Cuticle with fine transverse striations. Lip region rounded, set off from body by a constriction. Odontostyle 7–8 μ m or 1/3rd of odontostyle length. Odontophore 14–15 μ m long. Guiding ring, 6–7 μ m from anterior end. Oesophagus typical to the genus. Basal expanded part of oesophagus occupies 40–42% of neck region. Vulva a transverse slit. Vagina 20–22 μ m or extending inwards about 2/5th of corresponding body-width. Female reproductive system amphidelphic. Ovaries reflexed. Prerectum 95–98 μ m or 3.8–4.1 anal body-width long. Rectum 25–26 μ m or one anal body-width long. Tail elongate, regularly conoid to rounded terminus, 165–170 μ m or 7.0–7.1 anal body-width long.

Male : Not found.

Habitat and Locality : Collected from soil around roots of wheat (*Triticum aestivum*) at Kota.

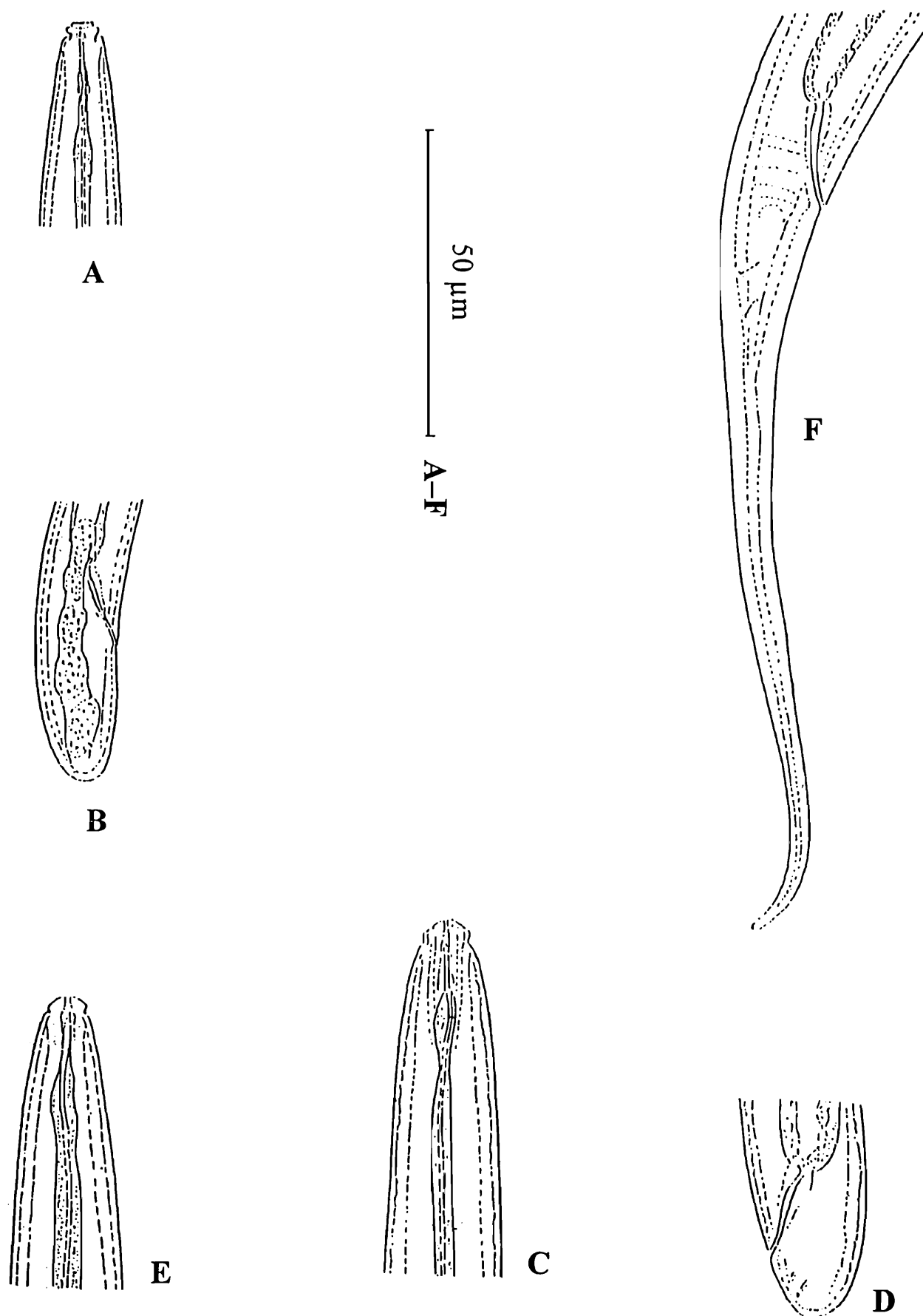


Fig. 5. A-B : *Dorylaimullus* (*Belondorylaimellus*) *discocephalus* Siddiqi, 1964. A-Female anterior end; B-Female tail.
 C-D : *Leptonchus granulatus* Cobb, 1920. C-Female anterior end; D-Female tail.
 E-F : *Dorylaimoides* (*Digidorylaimoides*) *pakistanensis* Siddiqi, 1964. E-Female anterior end; F-Female tail.

Suborder NYGOLAIMINA Ahmad & Jairajpuri, 1935

Family NYGOLAIMIDAE Thorne, 1935

13. *Nygolaimus harishi* Ahmad & Jairajpuri, 1980

(Fig. 6, A-E)

Measurements : Females (6) : L = 1.25–1.30 mm; *a* = 3.0–3.5; *b* = 3.9–4.2; *c* = 65–69; *V* = ⁴⁻⁵42–45⁶⁻⁷

Description : Female : Body almost straight upon fixation. Cuticle finely striated. Lip region set off from body by constriction. Tooth deltoid, 6–7 µm long. Odontophore rod-like. Basal expanded part of oesophagus occupies 52–53% of neck region. Sheath surrounding basal expanded part of oesophagus inconspicuous. Vulva a transverse slit. Vagina 12–13 µm, extending inwards about half of corresponding body-width. Female reproductive system amphidelphic. Anterior reproductive branch reduced. Prerectum 30–34 µm or 1.5–1.7 anal body-width long. Rectum 18–20 µm or about one anal body-width long. Tail straight conoid with blunt terminus, 18–20 µm or 1.0–1.2 anal body-width long, with two caudal pores on each side.

Male : Not found.

Habitat and Locality : Collected from soil around roots of wheat (*Triticum aestivum*) and millet (*Pennisetum typhoides*) at Sambhar, district Jaipur and Jhunjhunu.

Order MONONCHIDA Jairajpuri, 1969

Family MYLONCHULIDAE Jairajpuri, 1969

14. *Mylonchulus minor* (Cobb, 1893) Andrassy, 1958

(Fig. 7, A-B)

Measurements : Females (2) : L = 0.95–0.98 mm; *a* = 21–25; *b* = 3.4–3.7; *c* = 30–31; *V* = ⁸⁻⁹54–55⁷⁻⁸

Description : Female : Body ventrally curved in posterior third upon fixation, tapering gradually anterior to base of oesophagus but more behind vulva. Cuticle 2–3 µm thick (thickest on tail). Lip region 22–25 µm wide, 7–8 µm high. Buccal cavity 21–22 × 14–15 µm. Apex of dorsal tooth at 17–18 µm from base of stoma. Transverse rows of denticles 5 to 6; submedian tooth present. Rectum 18–25 µm or less than one anal body-width long. Female reproductive system amphidelphic. Tail 30–32 µm long, arcuate conoid with rounded terminus. Spinneret terminal.

Male : Not found.

Habitat and Locality : Collected from soil around roots of maize (*Zea mays*) at Gogunda, district Udaipur.

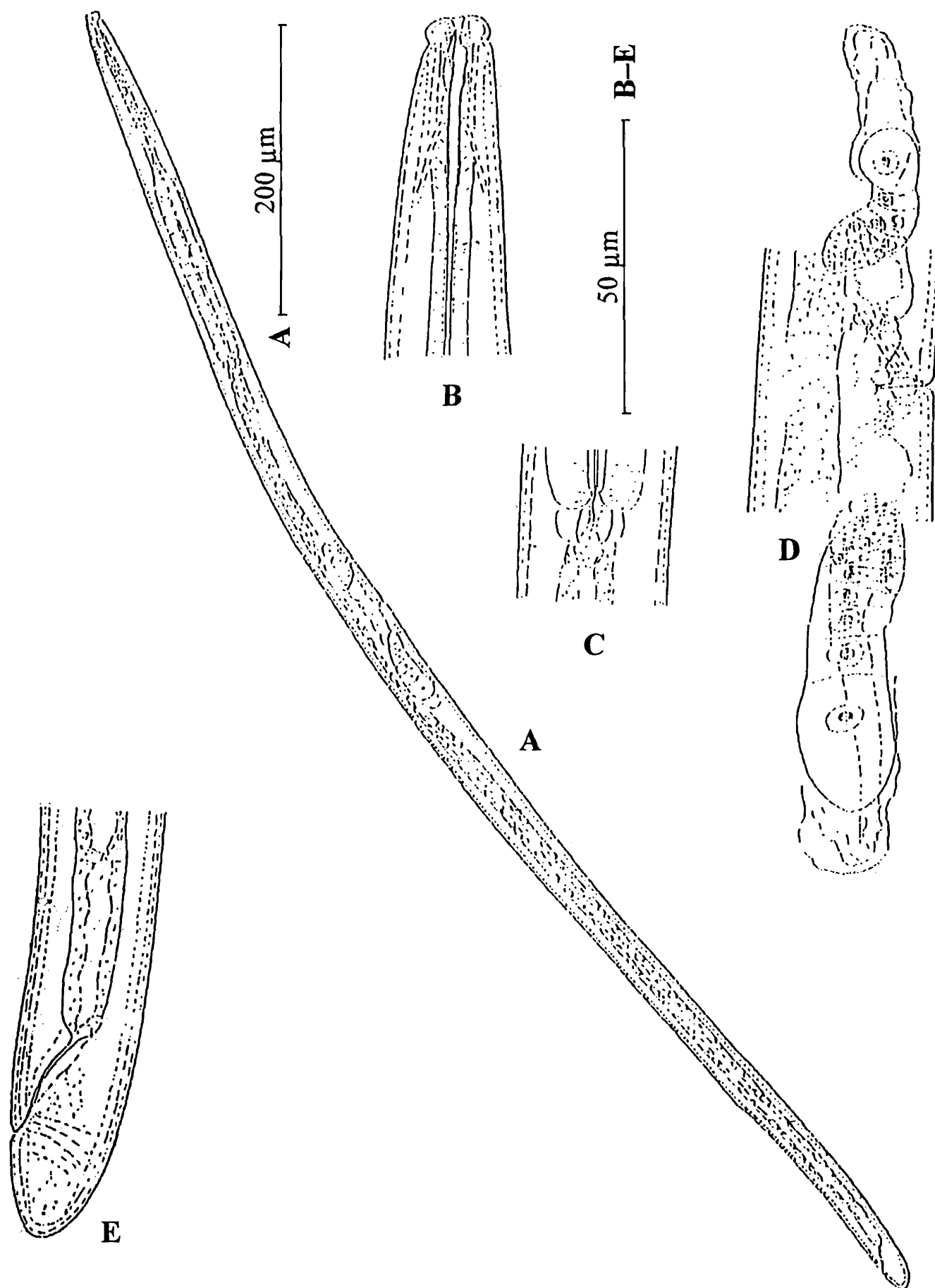


Fig. 6. A-E : *Nygolaimus harishi* Ahmad & Jairajpuri, 1980. A-Entire female; B-Anterior end; C-Oesophago intestinal junction; D-Female reproductive organ. E-Female tail.

15. *Mylonchulus branchyuris* (Butschli, 1873) Andrassy, 1958

(Fig. 7, C-D)

Measurements : Females (2) : L = 0.74–0.98 mm; a = 25–30; b = 2.3–3.4; c = 29–32; V = 8.9^{60-65} .

Description : Female : Body ventrally arcuate upon fixation, tapering towards both extremities. Cuticle 2–3 μ m thick. Lip region 20–24 μ m wide, 5–6 μ m high. Buccal cavity 21–23 $\times$ 12–15 μ m. Apex of dorsal tooth 15–18 μ m from base of stoma. Transverse rows of denticles 6–7. Submedian teeth present. Rectum 18–23 μ m or about one anal body-width long. Female reproductive system amphidelphic. Tail 25–30 μ m or 1.0–1.5 anal body-width long conoid, ventrally arcuate, terminus blunt. Spinneret subdorsal.

Male : Not found.

Habitat and Locality : Collected from soil around roots of rice (*Oryza sativa*) at Gogunda, district Udaipur.

16. *Mylonchulus lacustris* (N. A. Cobb in M. V. Cobb, 1915) Andrassy, 1958

(Fig. 7, E-F)

Measurements : Female (1) : L = 0.92 mm; a = 25; b = 3.2; c = 18.4; V = 655^6 .

Description : Female : Body ventrally curved upon fixation; tapering towards slightly both ends. Cuticle 2 μ m thick. Lip region 20 μ m wide, 7 μ m high. Buccal cavity 25 $\times$ 14 μ m. Apex of dorsal tooth 20 μ m from base of stoma. Six transverse rows of denticles, submedian teeth present. Rectum 30 μ m; less than one anal body-width long. Female reproductive system amphidelphic. Tail 50 μ m long, arcuate, conoid. Caudal glands tandem. Spinneret terminal.

Male : Not found.

Habitat and Locality : Collected from soil around roots of rice (*Oryza sativa*) at Gogunda, district Udaipur.

17. *Mylonchulus contractus* Jairajpuri, 1970

(Fig. 7, G-H)

Measurements : Female (1) : L = 0.95 mm; a = 29; b = 3.5; c = 25; V = 756^7 .

Description : Female : Body ventrally arcuate upon fixation, tapering towards both extremities. Cuticle 2 μ m thick. Lip region 20 μ m wide and 2 μ m high. Buccal cavity 21 $\times$ 12 μ m. Apex of dorsal tooth 15 μ m from the base of stoma. Five transverse rows of denticles. Submedian teeth small. Rectum 20 μ m long or less than one anal body-width long. Female reproductive system amphidelphic; ovaries reflexed, intestine contracted dorsally in the region of gonads. Uterus small. Cuticularised pieces present at vulva-vagina junction. Tail 37 μ m or one and half anal body-width long, arcuate-conoid with blunt terminus. Caudal glands grouped. Spinneret subdorsal.

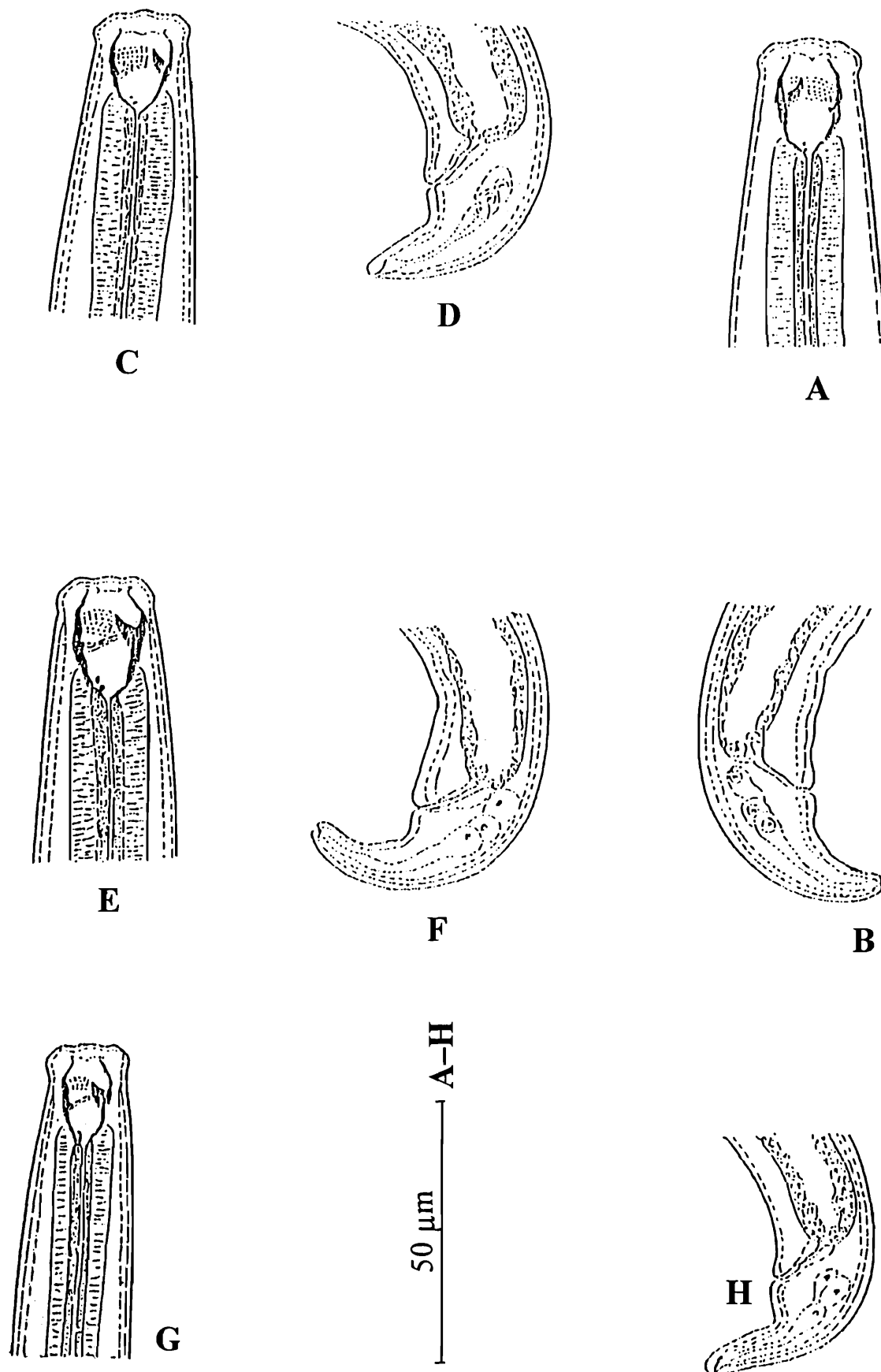


Fig. 7. A-B : *Mylonchulus minor* (Cobb, 1893) Andrassy, 1958. A-Female anterior end; B-Female tail.

C-D : *Mylonchulus brachyuris* (Biitschli, 1873) Andrassy, 1958. C-Female anterior end; B-Female tail.

E-F : *Mylonchulus lacustris* (N. A. Cobb in M. V. Cobb, 1915) Andrassy, 1958. E-Female anterior end; F-Female tail.

G-H : *Mylonchulus contractus* Jairajpuri, 1970. G-Female anterior end; H-Female tail.

Male : Not found.

Habitat and Locality : Collected from soil around roots of rice (*Oryza sativa*) at Dholaghati, district Udaipur.

RESULTS AND DISCUSSION

The following Seventeen species of plant and soil nematodes belonging to the orders Tylenchida, Dorylaimida and Mononchida have been reported :

Tylenchida : *Filenchus vulgaris* (Brezeski, 1963) Lownsbery & Lownsbery, 1985; *Basira graminophila* Siddiqi, 1959; *Telotylenchus aerolatus* Baqri & Jairajpuri, 1969; *Psilenchus hilarulus* de Man, 1921.

Dorylaimida : *Mesodorylaimus mesonyctius* (Kreis, 1930) Andrassy, 1959; *Discolaimium mukhtarpuriense* Baqri & Jairajpuri, 1969; *Latocephalus simithi* (Heyns, 1963) Patel & Khan, 1982; *Latocephalus oostenbrinki* (Ali, Suryawanshi & Prabha, 1937) Patil & Khan, 1982; *Carcharolaimus masoodi* Jairajpuri, 1968; *Dorylaimellus* (*Belondorylaimellus*) *discocephalus* Siddiqi, 1964; *Leptonchus granulatus* Cobb, 1920; *Dorylaimoides* (*Digidorylaimoides*) *pakistanensis* Siddiqi, 1964; *Nygolaimus harishi* Ahmad & Jairaipuri, 1980.

Monochida : *Mylonchulus minor* (Cobb, 1893) Andrassy, 1958; *Mylonchulus brachyuris* (Biitschli, 1873) Andrassy, 1958; *Mylonchulus lacustris* (N. A. Cobb in M. V. Cobb, 1915) Andrassy, 1958; *Mylonchulus contractus* Jairajpuri, 1970.

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REFERENCES

- Baqri, Q. H. 2000. Diversity in Plant and Soil Nematodes (Neamtoda) of Rajasthan (India) : Gaps in Research. In *Plant Diseases* (Edited by P. C. Trivedi) : Pointer Publishers, Jaipur-302003, India : 286-304 pp.
- Baqri, Q. H. and Bohra, P. 2001. Nematodes from Rajasthan, India. I. Six New species of Dorylaimida. *Nematology*, 3 : 113-127.
- Bohra, P. and Baqri, Q. H. 2000. Nematodes from Rajasthan, India. II. Six New Records from India. *Rec. zool. Surv. India*, Calcutta, 98(4) : 117-122.
- Bohra, P. and Baqri, Q. H. 2000. Abnormal Vulva Position in *Nygolaimus harishi* Ahmad & Jairajpuri, 1980. *Rec. zool. Surv. India*, Calcutta, 98(4) : 123-124.

PHYLOGENETIC SIGNIFICANCE OF ROBERTSONIAN FUSIONS IN *CHORTHIPPUS INDUS* UVAROV (ORTHOPTERA : ACRIDIDAE : GOMPHOCERINAE)

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INTRODUCTION

The grasshopper species *Chorthippus indus* Uvarov, has been investigated for the first time. Subfamily Gomphocerinae is an assemblage of large number of genera. *Chorthippus* comprises of six sub-genera of which sub-genus *Chorthippus* is an enormous one with not less than 65 species (Jago 1971). So far 23 species under this genus are known chromosomally, each having $2n \sigma = 17$ (XO), instead of 23 acrocentrics. Their three meta/submetacentric pairs had originated by Robertsonian fusions. Several species under different genera have also been reported for their Robertsonian fusions. Had these species obtained their three fusions independently? or they form a natural phylogenetic group pleading their origin monophyletic (i.e., fusions truly homologous). The findings on the submetacentric chromosomes of *C. indus* carries unique phylogenetic significance. This species had obtained its fusions independently, so can not be placed with so called natural phylogenetic group. The present investigations also include morphometric analysis of the published karyotype of several species which support polyphyletism in the Gomphocerinae.

MATERIAL AND METHODS

Six males collected from Saproon and Renuka lake in Himachal Pradesh were injected with 0.03 to 0.04 ml of 0.05% colchicine prior to dissection to arrest metaphases. After 4–6 hours of injection, the testes and hepatic caecae were dissected-out and cleaned in 0.67% solution of insect saline. The tissues were then transferred for a hypotonic treatment in a solution of 0.9% sodium citrate for 45–60 minutes then were fixed for a minimum of 40 minutes. In the field, tissues were transferred to small tubes and brought to laboratory and stored preferably at 4°C in refrigerators. The slides were prepared by the air-dry technique. The fixed tissues were transferred to 50% acetic acid till it became soft. Squashed this material in a few drops of 50% acetic acid, and stored in vapours of 50% acetic acid in refrigerator for overnight. Next morning the slides were brought at room temperature and immersed in 1 : 3 acetic acid methanol mixture for an hour. The coverslips were removed with the sharp edge of a blade in the immersed condition and dried at room temperature in a dust proof chamber. After a preliminary scanning of the unstained slides, the

selected ones were stained in 2-3% solution of Giemsa [E. Merck (India) Pvt. Ltd.] in phosphate buffer at pH 6.8 to 6.9. Staining was continued till appropriate contrast was obtained; they were then rinsed in distilled water (two changes) and rapidly air dried under lamp. Selected slides were soaked in xylene and mounted in DPX.

The cells with good chromosome spreads were photomicrographed with the help of Leitz Ortholux microscope. Black and white negative film viz., NP22, 120 ASA (35 mm) were mostly used. The negatives so obtained were printed on photosensitive Agfa bromide papers of normal and hard grades. Fine grain film and paper developers of Agfa-Gevaert (A901 and A902) and Kodak (D76 and D163) were used in developing negatives and positive prints.

The diploid number ($2n$) was determined by basic or most predominant number observed. The cut-out of individual chromosomes which appeared similar in morphology and staining intensity were paired to construct karyotypes. Morphometric measurements of each chromosome was taken from several karyotypes. Their mean values were used calculating the relative length of the chromosome in percent of the total haploid length. The measurements were used in constructing idiogram i.e. a diagrammatic karyotype of the species. The nomenclature of Levan *et al.* (1964) has been followed. The individually numbered specimens of the species with locality details are preserved and maintained in the Cytotaxonomy Research Laboratory, Zoological Survey of India, Kolkata.

OBSERVATIONS

KARYOLOGICAL DETAILS :

Diploid Number, Chromosome Morphology and Sex Chromosome Constitution

17 chromosomes were present in the males. This consisted of 6 metacentric and 10 acrocentric autosomes and 1 acrocentric X chromosome. Smaller arms of the metacentrics were larger than the last four chromosomes. The 1st, 2nd and 3rd largest metacentric elements were the fusion products of the 2nd and 4th, 1st and 8th and 3rd and 7th acrocentric chromosomes of the parental complement (Pl. refer table I & RL in percent). The X was the 4th largest in the complement with its centromeric region negatively heteropycnotic at late prophase I and metaphase I stages (Figs. A-D arrow).

Karyotype :

Study of 66 cells—2 zygotene, 50 diakinesis/metaphase I and metaphase plates of 5 males confirmed the morphological feature of the complement. Chiasma localization of the bivalents was also studied.

Gaps/Constrictions :

Gaps/constrictions were not present. Centromeric region of the bivalents appeared as uncoiled constrictions at diakinesis (Figs. A, B & D arrow).

Relative length (RL) in percent :

1	2	3	4	5	6	7	8	9
22.52	20.65	16.60	8.53	8.20	6.82	5.29	5.12	4.27
(X)								

Idiogram :

The X or the 4th largest in the complement, was half the size of the 3rd pair.

Chiasma Distribution :

For study of chiasma distribution, each bivalent was arbitrarily divided into 3 equal segments as proximal (P), interstitial (I) and distal (D). The chiasmata were randomly distributed in all the bivalents except the last one which appeared to have distally located chiasma.

Bivalents	1	2	3	4	5	6	7	8
Chiasma	2I, 1D 1	I, D 2	2D 1	P, D 1	D 3	D 3	D 3	D 4
	2I, 2D 1	I, 2D 1	2I 1	I 2	I 1	P.D 1	I 1	
Location	3I 2	2I 1	2I, 2D 1	D 1				
& number			D, I 1					
Total	I = 10 D = 3	I = 5 D = 4	I = 5 D = 5	P = 1 I = 2	I = 1 D = 3	P = 1 D = 4	I = 1 D = 3	D = 4
				D = 2				
	13	9	10	5	4	5	4	4

The 54 chiasmata scored for 32 bivalents were 2(P), 24(I) and 28(D). Small arm of the submetacentric pairs was found to form chiasma in every cell (Figs. A-D).

DISCUSSION

Jago (1971) arranged species under genus *Chorthippus* into six subgenera, and of which subgenus *Chorthippus* was an enormous one with not less than 65 species. The large complex of *Chorthippus* is distributed in all zoogeographical regions except Australia (Dirsh 1975). Bhowmik (1985) recorded 3 species from India and adjoining regions viz., *Chorthippus* (*Chorthippus*) *almorani* Uvarov (from Almora in Uttar Pradesh), *C. (Glyptobothrus) hammarstroemi* (Miram) (India (H.P.), Siberia and China) and *C. (Chorthippus) indus* Uvarov (from Kashmir; Simla (H.P.); Kumaon Hills (U.P.) and N.W.F. Province, Pakistan). *C. hammarstroemi* had $2n = 21$ in males ($20 + X$) (Kiknadze and Vysotskaya 1970). *Chorthippus schmidtii* from Russia had $2n = 23$, all acrocentrics in males (Bugrov 1996). Karyologically twenty three *Chorthippus* species known so far had $2n = 17$ ♂ with 6 meta/

Table-1. Chromosome measurements of species under subfamily Gomphocerinae.

Species & References	Chromosome number n : 2n									Constituents of metacentrics		
	1	2	3	4	5	6	7	8	9			
<i>Chorthippus biguttulus</i>	5	9	8							1	2	3
Santos J.L. and Giraldez	8.5	7.2	7.4	10.6(X)	7.8	7.5	6.9	6.2	4.2	(1 + 5)	(2 + 9)	(4 + 8)
R. (1978) (C-band)	13.5	11.9	10.3									
	1	2	4	3	6	7	10	11	12			
<i>Chorthippus brunneus</i>	6	5	8							1	2	3
John, B. and Hewitt,	14.1	14.1	11.0	15.3(X)	12.9	10.6	7.7	6.3	5	(1 + 6)	(2 + 5)	(3 + 8)
G. M. (1966)	21.3	19.5	16.2									
	1	2	3	4	7	9	10	11	12			
<i>Chorthippus brunneus</i>	8.8	6.5	6.6	7.5	4.8	5.2						
Jones G. H., Stamford	16	14.3	10.6	10.2	10.1	7.5						
W. K. and Perry P. E.	5	6	9							1	2	3
(1975) (C-band)	7.65	7.05	5	7.9(X)	7.05	6	4.85	3.9	3.05	(1 + 5)	(2 + 6)	(3 + 9)
	15.15	10.4	8.8									
	1	2	3	4	7	8	10	11	12			
<i>Chorthippus brunneus</i>	9.8	9.7	8.3	10	9	10						
John B. and Hewitt	15.5	15	13.2	13.1	11.9	10.7						
G. M. (1963)	5	7	6							1	2	3
(C-band)	9.75	9.15	9.5	10.3(X)	8.8	8	7.15	5.05	3.7	(1 + 5)	(2 + 7)	(3 + 6)
	15.25	13.15	11.3									
	1	2	3	4	8	9	10	11	12			
<i>Chorthippus brunneus</i>	8.7	9.4	10.5	9.1	8.5	8.7						
John B., Lewis K. R. and	15.1	15.0	14.5	13.7	11	10.5						
Henderson S. A. (1960)	7	6	8							1	2	3
	9.05	9.8	8.6	11.4(X)	9.95	7.85	7.15	4.1	3.1	(1 + 7)	(2 + 6)	(4 + 8)
	15.05	14.1	10.75									
	1	2	4	3	5	9	10	11	12			
<i>Chorthippus indus</i>	8	4	7							2	1	3
Present observation	4.3/8	5.8/7.5	4.7/6.6	5.3(X)	5.2	4.2	3.5	3.5	2.1	(1 + 8)	(2 + 4)	(3 + 7)
	1	2	3	5	6	9	10	11	12			

Table-1. (Contd.).

Species & References	Chromosome number n : 2n									Constituents of metacentrics			
	1	2	3	4	5	6	7	8	9				
<i>Chorthippus jucundus</i> John B. (1973)	6 13.2 21.6 1	9 11.0 20.7 2	7 12.2 18.0 4	18.7(X) 3	15 5	11.4 8	8.0 10	6.0 11	5.0 12	1 (1 + 6)	2 (2 + 9)	3 (4 + 7)	
<i>Chorthippus parallelus</i> John B. and Hewitt G. M. (1966)	7 11.5 19.5 1	5 13.1 17.3 2	10 9.3 14.3 3	13.1(X) 4	12.2 6	10.9 8	10 9	7.2 11	4.12 12	1 (1 + 7)	2 (2 + 5)	3 (3 + 10)	
<i>Chorthippus parallelus</i> John B. and Hewitt G. M. (1966)	8 14.9 7 8.6 14.8 1	9.2 14.7 6 9.05 14.15 2	8.6 14.4 9 7.7 11.9 3	9.5 13.9 11.2(X) 4	7.6 12.5 9.25 5	7.8 11.3 8.1 8		10 : 8.5 4.6 6.35 10	8.2 : 8 3.15 11	6.6 : 6.1 1 (1 + 7)	4.7 : 4.5 2 (2 + 6)	3.3 : 3 3 (3 + 9)	
<i>Chorthippus parallelus</i> Hewitt G.M. and John B. (1968)	9.2 15.3 6 8.4 15.2 1	7.6 15.1 7 8.3 14.1 2	8.6 14.5 9 7.05 10.95 4	8 13.7 12.3(X) 3	6.6 11.4 8.4 5	7.5 10.5 7.3 8		8.2 : 8.6 4.7 6.45 10	7.7 : 6.9 3 11	6.5 : 6.4 1 (1 + 6)	5 : 4.4 2 (2 + 7)	3.8 : 2.2 3 (4 + 9)	
<i>Euchorthippus pulvinatus</i> Arana P. Santos J.L. and Giraldez R. (1980) (C-band)	7 6 11 1	6 6.1 10.2 2	9 5.0 9.2 3	7.6(X) 4	7.0 5	5.5 8	5.0 10	2.8 11	2.0	1 (1 + 7)	2 (2 + 6)	3 (3 + 9)	
<i>Euchorthippus pulvinatus</i> Santos J.L. and Giraldez R. (1982) (C-band)	11.6 20.5 7 11.45 20.45 1	11.3 20.4 9 10.95 18.4 2	11.2 18.8 10 9.75 16.1 4	10.7 18 16.5(X) 3	10.5 15.8 14.35 5	9 16.4 12.3 6	17 : 16(X) 14.1 11.25 8	14.6 : 12.5 : 11.4 : 5.5 : 5.4 : 5.3	12.5 : 12.1 11.1 5.5 5.35 12	11.4 : 11.1 5.5 5.35 The last two pairs are quite distinct as short pairs in <i>E. pulvinatus</i>	1 (1 + 7)	2 (2 + 9)	3 (4 + 10)

Table-1. (Contd.).

Species & References	Chromosome number n : 2n									Constituents of metacentrics		
	1	2	3	4	5	6	7	8	9			
<i>Gomphocerus sibiricus</i>	6	4	8							1	2	3
Gosalvez J. and Lopez-	3.5	3.7	3.3	3.5(X)	3.3	2.3	2.2	1.6	1.6	(1 + 6)	(2 + 4)	(3 + 8)
Fernandez C. (1981)	6.1	5.3	5.2									
	1	2	3	5	7	9	10	11	12			
<i>Myrmeleotettix maculatus</i>	8	5	7							1	2	3
John B. and Hewitt G.M.	11.4	13.5	11.5	16.7(X)	13.0	10.1	8.1	5.1	4.5	(1 + 8)	(2 + 5)	(4 + 7)
(1965)	21	18.2	15.7									
	1	2	4	3	6	9	10	11	12			
<i>Myrmeleotettix maculatus</i>	7	5	8							1	2	3
John, B. and Hewitt,	12.5	14.2	10.6	16.5(X)	13.2	10.5	7.4	5.6	4.5	(1 + 7)	(2 + 5)	(3 + 8)
G. M. (1966)	23.5	19.5	16.5									
	1	2	3	4	6	9	10	11	12			
<i>Myrmeleotettix maculatus</i>	10	9.5	8.2	7.5	6.9	7.2		9 : 8.2	6.9 : 6.6	4.8 : 4.7	4 : 3.6	3.5 : 3.1
Gallagher A. Hewitt G. M.	14	13.8	13.6	13.1	10.5	10.4						
and Gibson I. (1973)	5	7	8							1	2	3
	9.75	7.85	7.05	10(X)	8.6	6.75	4.75	3.8	3.3	(1 + 5)	(2 + 7)	(3 + 8)
	13.9	13.35	10.45									
	1	2	3	4	6	9	10	11	12			
<i>Omocestus viridulus</i>	6	5	8							1	2	3
John B. and Hewitt	14	14.6	11.6	15.6(X)	12.5	10.6	9.8	5	4.4	(1 + 6)	(2 + 5)	(3 + 8)
G.M. (1966)	24	20.7	17.2									
	1	2	3	4	7	9	10	11	12			
<i>Omocestus viridulus</i>	5	6	8							1	2	3
Santos J.L. and Fox D. P.	7.12	6.3	5.7	7.4(X)	6.3	5.6	4.5	2.5	2.5	(1 + 5)	(2 + 6)	(3 + 8)
(1988) (N-band)	10.7	10	8									
	1	2	3	4	7	9	10	11	12			

submetacentric chromosomes. The species being *C. albomarginatus* (Santos and Fox 1988), *C. apicalis* (Santos and Fox 1988), *C. apricarius* (del Cerro and Santos 1995; Santos and Fox 1988), *C. biguttulus* Santos and Giraldez 1978 and Santos and Fox 1988), *C. binotatus* (Santos and Fox 1988), *C. brunneus* (Camacho et al. 1984; Hewitt 1964; 1965; John and Hewitt 1963, 1966b; John et al., 1960; Jones et al. 1975; Lewis and John 1963; Santos and Fox 1988; Southern 1967), *C. dorsatus* (Santos and Fox 1988), *C. hammarstroemi* (Kiknadze and Visotskaya 1970), *C. jucundus* (Cano and Santos 1990; John 1973; Santos and Fox 1988), *C. longicornis* (Coleman 1947), *C. parallelus* (Camacho et al. 1984; Cano and Santos 1990; Fox et al. 1974; Hewitt 1964, 1965; Hewitt and John 1968, 1970; John and Hewitt 1966a, 1966b, 1968, 1969; Santos and Fox 1988; Westerman 1969, 1970) and *C. vagans* (Cano and Santos 1990; del Cerro and Santos 1995 : Santos and Fox 1988). Bugrov (1996) reported another 11 species of *Chorthippus* of the Russian sub-continent with 17 chromosomes viz., *C. angulatus*, *C. dichrous*, *C. fallax*, *C. montanus*, *C. intermedius*, *C. jacobsoni*, *C. loratus*, *C. macrocerus*, *C. ferganensis*, *C. saxatilis* and *C. vicinus*. Hewitt (1979) reported Robertsonian fusion in another 12 genera of Gomphocerinae viz., *Chloealtis*, *Chrysochraon*, *Euchorthippus*, *Euthystira*, *Gomphocerus*, *Mongolotettix*, *Myrmeleotettix*, *Napaia*, *Omocestus*, *Podismopsis*, *Stauroderus* and *Stenobothrus*. He had suggested their monophyletic origin, and thus had formed a natural phylogenetic group.

It was found worth while in tracing the validity of this natural phylogenetic grouping, because cytogenetic studies carried out mostly on individual species had not been summarized in this regard. And, phylogenetic grouping on morphological features by Jago (1971) had no correlation with this natural phylogenetic group suggested by Hewitt (1979). In the present study, published metaphase complements of 8 species of 5 different genera were measured. The species were *C. biguttulus*, *C. brunneus*, *C. jucundus*, *C. parallelus*, *C. indus*, *Euchorthippus pulvinatus*, *Myrmeleotettix maculatus*, *Omocestus viridulus* and *Gomphocerus sibiricus*. All the arms were measured and numbered serially according to their length (Table 1) which indicated their position in the parental complements (i.e. $2n \sigma = 23$). The 1st, 2nd and 3rd largest chromosomes of parental complement always fused with other elements but they retained their positions in the complements after fusions. In *C. indus* (present observation) the 2nd largest parental chromosome after undergoing fusion with the 4th chromosome has become the biggest chromosome in the complement. In *Euchorthippus pulvinatus* (Santos and Giraldez 1982, collected from Spain), 2nd and 4th chromosomes had fused with 9th and 10th respectively. This feature was not noticeable in any of the species measured for the size of the chromosomes involved in Robertsonian fusions. *Chorthippus hammarstromi* with $2n \sigma = 21$ ($20 + X$) with 1 fusion and *Chloealtis abdominalis* $2n \sigma = 19$ ($18 + X$) with two fusions (Hewitt 1979) were also suggestive of their separate fusion events. Bugrov (1996) has reported $2n \sigma = 19$ with 2 submetacentric pairs in *Erepippus mistschenkoi* and *E. sobolevi* belonging to Gomphocerini. It appears that the biarmed chromosomes in the 6 species, belonging to 4 different genera viz., *C. indus*, *C. hammarstroemi*, *E. pulvinatus*, *C. abdominalis*, *E. mistschenkoi* and *E. sobolevi*, did not originate monophyletically. Multivalents were not formed in any meiotic cell of *C. indus* studied, which apparently indicated that fusions had not shared any monobrachial homology.

SUMMARY

Karyological investigations carried-out on male individuals of an Acridid species viz., *Chorthippus indus* Uvarov (Subfamily : Gomphocerini) showed $2n \sigma^7 = 17$ (XO), comprising three submetacentric pairs. These pairs were found to be the fusion products of 1st (2 + 4), 2nd (1 + 8) and 3rd (3 + 7) of parental complement i.e. its 23 chromosome karyotype, as the result of Robertsonian translocation. The X showed understained centromeric region, designated as nucleolus organiser. Submetacentric bivalents revealed non-localized chiasmata pattern. On comparative study of published metaphase complements of several species of *Chorthippus* and of other Gomphocerine genera, it was found that *C. indus* of Himachal Pradesh (India) had obtained its three fusions independently (i.e. not monophyletic).

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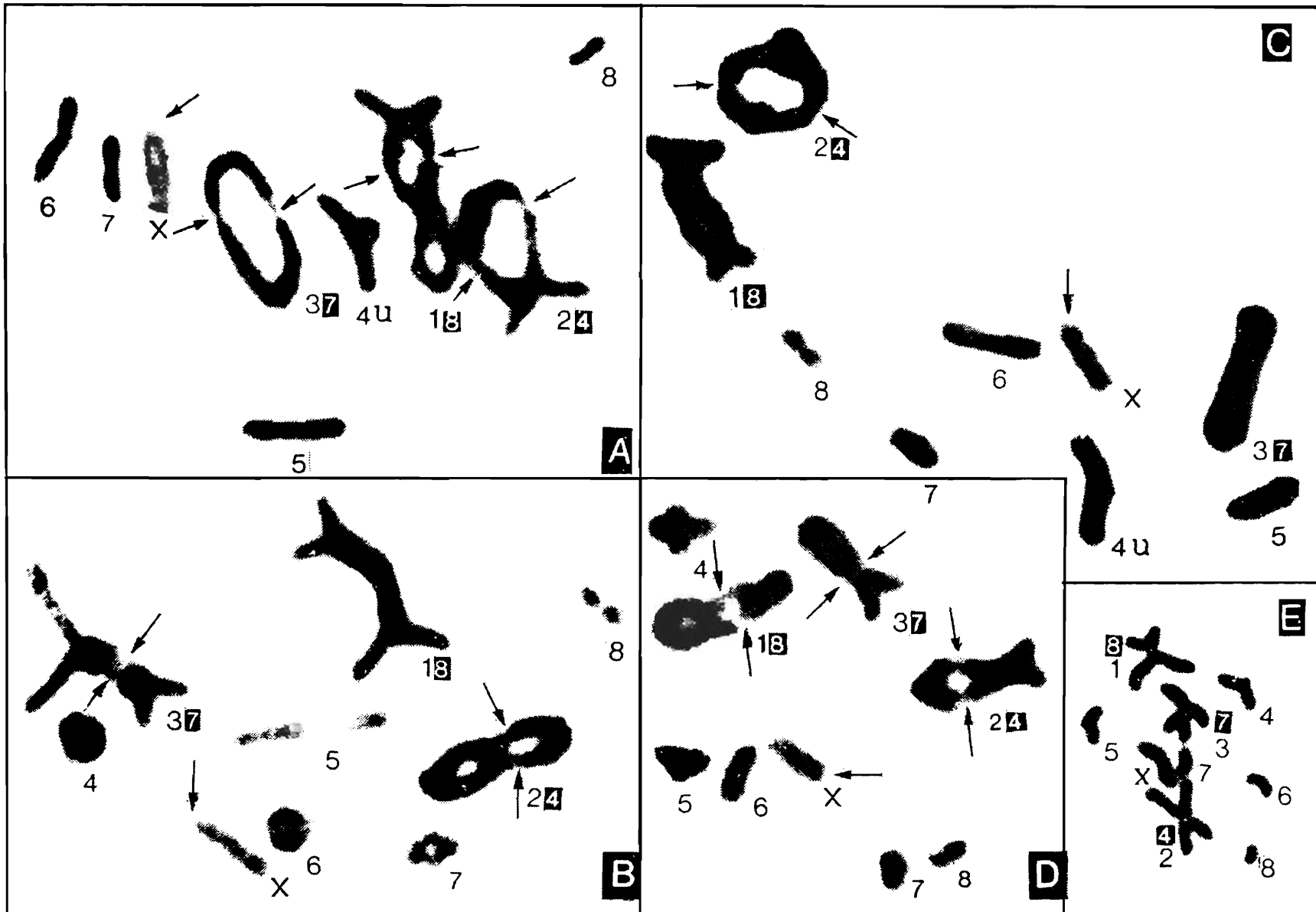
REFERENCES

- Arana, P. Santos, J. L. and Giraldez, R. 1980. Chiasma interference and centromere co-orientation in a spontaneous translocation heterozygote of *Euchorthippus pulvinatus gallicus* (Acrididae; Orthoptera). *Chromosoma* **78** : 327-340.
- Bhowmik, H. K. 1985. Outline of distribution with an index-catalogue of Indian grasshoppers (Orthoptera Acrididae). *Rec. zool. Surv. India*, Occ. Paper No. 78 : 51 pp, table 1.
- Bugrov, A. G. 1996. Karyotypes of the short-horned orthopteran insects (Orthoptera, Caelifera) from Russia, Kazakhstan, Central Asia, and the Caucasus. *Folia biologica* (Krakow) **44** : 15-25.
- Camacho, J. P. M., Viseras, E., Navas, J. and Cabrero, J. 1984. C-heterochromatin content of supernumerary chromosome segments of grasshoppers : detection of an euchromatic extra segment. *Heredity* **53** : 167-175.
- Cano, M. I. and Santos, J. L. 1990. Chiasma frequencies and distributions in gomphocerine grasshoppers : a comparative study between sexes. *Heredity* **64** : 17-23.
- Coleman, L. C. 1947. Chromosome abnormalities in an individual of *Chorthippus longicornis* (Acrididae). *Genetics* **32** : 435-447.
- del Cerro, A. L. and Santos, J. L. 1995. Synapsis in grasshopper bivalents heterozygous for centric shifts. *Genome* **38** : 616-622.
- Dirsh, V. M. 1975. Classification of the Acridomorphoid Insects. E. W. Classey Ltd. Faringdon, Oxon.

- Fox, D. P. Hewitt, G. M. and Hall, D. J. 1974. DNA replication and RNA transcription of euchromatic and heterochromatic chromosome regions during grasshopper meiosis. *Chromosoma* **45** : 43-62.
- Gallagher, A., Hewitt, G. M. and Gibson, I. 1973. Differential Giemsa staining of heterochromatic B-Chromosomes in *Myrmeleotettix maculatus* (Thunb.) (Orthoptera : Acrididae). *Chromosoma* **40** : 167-172.
- Gosalvez, J. and Lopez-Fernandez, C. 1981. Extra heterochromatin in natural populations of *Gomphocerus sibiricus* (Orthoptera : Acrididae). *Genetica* **56** : 197-204.
- Hewitt, G. M. 1964. Population cytology of British grasshoppers I. Chiasma variation in *Chorthippus brunneus*, *Chorthippus parallelus* and *Omocestus viridulus*. *Chromosoma* **15** : 212-230.
- Hewitt, G. M. 1965. Population cytology of British grasshoppers II. Annual variation in chiasma frequency. *Chromosoma* **16** : 579-600.
- Hewitt, G. M. 1979. Orthoptera; Grasshoppers and Crickets. Animal Cytogenetics, 3 Insecta 1. Gebruder Borntraeger Berlin. Stuttgart 1979.
- Hewitt, G. M. and John, B. 1968. Parallel polymorphism for supernumerary segments in *Chorthippus parallelus* (Zetterstedt) I. British populations. *Chromosoma* **25** : 319-342.
- Hewitt, G. M. and John, B. 1970. Parallel polymorphism for supernumerary segments in *Chorthippus parallelus* (Zetterstedt) IV. Ashurst revisited. *Chromosoma* **31** : 198-206.
- Jago, N. D. 1971. A review of the Gomphocerinae of the world with a key to the genera (Orthoptera Acrididae). *Proc. Acad. nat. Sci. Philad.* **123** : 205-343.
- John, B. 1973. The cytogenetic systems of grasshoppers and locusts II. The origin and evolution of supernumerary segments. *Chromosoma* **44** : 123-146.
- John, B. and Hewitt, G. M. 1963. A spontaneous interchange in *Chorthippus brunneus* with extensive chiasma formation in an interstitial segment. *Chromosoma* **14** : 638-650.
- John, B. and Hewitt, G. M. 1965. The B-chromosome system of *Myrmeleotettix maculatus* (Thunb.) I. The mechanics. *Chromosoma* **16** : 548-578.
- John, B. and Hewitt, G. M. 1966a. Karyotype stability and DNA variability in the Acrididae. *Chromosoma* **20** : 155-172.
- John, B. and Hewitt, G. M. 1966b. A polymorphism for heterochromatic supernumerary segments in *Chorthippus parallelus*. *Chromosoma* **18** : 254-271.
- John, B. and Hewitt, G. M. 1968. Patterns and pathways of chromosome evolution within the Orthoptera. *Chromosoma* **25** : 40-74.
- John, B. and Hewitt, G. M. 1969. Parallel polymorphism for supernumerary segments in *Chorthippus parallelus* (Zetterstedt) III. The Ashurst population. *Chromosoma* **28** : 73-84.
- John, B., Lewis, K. R. and Henderson, S. A. 1960. Chromosome abnormalities in a wild population of *Chorthippus brunneus*. *Chromosoma* **11** : 1-20.

- Jones, G. H., Stamford, W. K. and Perry, P. E. 1975. Male and female meiosis in grasshoppers II. *Chorthippus brunneus*. *Chromosoma* **51** : 381-389.
- Kiknadze, I. I. and Vysotskaya, L. V 1970. Measurement of DNA mass per nucleus in the grasshopper species with different numbers of chromosomes. *Tsitologia* **12** : 1100-1107.
- Levan, A., Fredga, K. and Sandberg, A. A. 1964. Nomenclature for centromeric position of chromosomes. *Hereditas* **52** : 201-220.
- Lewis, K. R. and John, B. 1963. Spontaneous interchange in *Chorthippus brunneus*. *Chromosoma* **14** : 618-637.
- Santos, J. L. and Fox, D. P. 1988. A study of nucleolus organiser regions (NORs) in the subfamily gomphocerinae (Acrididae : Orthoptera) by means of an acridine orange staining procedure. *Genet. (Life Sci. Adv.)* **7** : 27-32.
- Santos, J. L. and Giraldez, R. 1978. The effect of C-heterochromatin in chiasma terminalization in *Chorthippus biguttulus* L. (Acrididae : Orthoptera). *Chromosoma* **70** : 59-66.
- Santos, J. L. and Giraldez, R. 1982. C-heterochromatin polymorphism and variation in chiasma localization in *Euchorthippus pulvinatus gallicus* (Acrididae, Orthoptera). *Chromosoma* **85** : 507-518.
- Southern, D. I. 1967. Spontaneous chromosome mutations in Truxaline grasshoppers. *Chromosoma* **22** : 241-257.
- Westerman, M. 1969. Parallel polymorphism for supernumerary segments in *Chorthippus parallelus* (Zetterstedt) II. French populations. *Chromosoma* **26** : 7-21.
- Westerman, M. 1970. Parallel polymorphism for supernumerary segments in *Chorthippus parallelus* V. A new polymorphism in Europe. *Heredity* **25** : 662-667.

PLATE I



Figs. A-D. Late prophase I and metaphase I stages. Arrows on the submetacentric bivalents indicate relatively uncoiled centromeric constrictions. In figs. A and C the 4th bivalent appears to be unequal. Arrow on the X indicates understained centromeric region, considered to be the NOR in the complement. Also observe considerable variation in the meiotic configurations of the bivalents. **Fig. E :** A metaphase II stage showing three submetacentric chromosomes. They have been found to be the fusion products of 1st (2 + 4), 2nd (1 + 8) and 3rd (3 + 7) of the parental complement i.e. 23 acrocentrics. Each arm has been numbered according to length.

ON THE HIGHER CLASSIFICATION OF CHELISOCHIDAE (INSECTA : DERMAPTERA) WITH A CHECK LIST OF SPECIES

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INTRODUCTION

Family Chelisochidae is mainly characterised by the second tarsal segment narrowed apically, extending below the third approximately up to the middle.

Srivastava (1987) on the basis of the syntype Male of *Chelisoches doriae* Bormans, 1900, treated it as a synonym of *Lobophora superba* Dohrn, 1865. He pointed out that the costal fold is prominent but lacks costal carina. In the present paper, this species is placed under the genus *Chelisochella* Verhoeff, subfamily Chelisochellinae Steinmann, 1975. *Chelisochella* is the type genus of Chelisochellinae, and since it lacks costal carina of elytra, the Chelisochellinae is treated as a synonym of Chelisochinae. The genus *Chelisochella*, however, is retained in being distinct from others by having stout build, metallic sheen on body, elytra with humeral angles very prominent and hind tarsi not sulcate or deplanate at apex.

A new subfamily Kinellinae is proposed for the genus *Kinesis* Burr, 1907 which is characterised by the medium size (12.0 mm approx.), elytra abbreviated with a distinct ridge along the costal margin.

Amongst the genera included under Chelisochinae, the *Adiathus* Burr, 1907 now includes only the type species viz., *Chelisoches shelfordi* Burr, 1901, from Borneo & Sikkim and is different from other species (now transferred to the genus *Adiathella* Brindle, 1970) in having punctate elytra and densely pubescent body.

Sizochelisoches Steinmann, 1987 and *Schizoproneus* Steinmann, 1987 are treated as synonym of *Chelisoches* and *Proneus*, respectively. The above two synonymised genera were erected by splitting above two genera, on the basis of male parameres having vertical cleft or indentation, recognised earlier on morphological characters alone. The shape of paramere, as whole, in Forficulidae is not of much significance except in certain cases for separating closely related species along with other external features.

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Key to the various taxa of *Chelisochidae*

- 1(2). Elytra along the costal margin with a raised ridge; wings concealed
 *Kinellinae subfam. n.*
 Kinesis Burr, 1907
- 2(1). Elytra along the costal margin without any ridge; wings normally well developed.....
 *Chelisochinae* Burr, 1907 (= *Chelisochellinae* Steinmann, 1975—**Syn. n.**)
- 3(6). Hind tibiae neither flattened nor sulcate at extreme apex
- 4(5). Build robust, glabrous; elytra and wings smooth, former with humeral angle prominent
 *Chelisochella* Verhoeff, 1902
- 5(4). Build not so robust, hairy; elytra and wings punctulate, former with humeral angles not prominent *Adiathetus* Burr, 1907
- 6(3). Hind tibiae flattened or sulcate at extreme apex or in apical $\frac{1}{4}$ to $\frac{1}{2}$
- 7(14). Hind tibiae flattened or sulcate at extreme apex
 - 8(9). Elytra short, posterior margin obliquely truncate; wings absent; forceps, in males, undulate with three teeth internally, forceps, in females, with long, slender branches; Male parameres wide apically *Tauropygia* Brindle, 1970
 - 9(8). Elytra longer, posterior margin not obliquely truncate; wings visible; male forceps not as above
- 10(11). Pronotum transverse; hind tarsi with segments stout, less compressed.....
 *Euenkrates* Rehn, 1927
- 11(10). Pronotum longer than broad; hind tarsi with segments slender, compressed
- 12(13). Male and females forceps similar in shape and length, former with teeth internally; pygidium, in both sexes, posteriorly excised medially but in females narrower
 *Gressittolabis* Brindle, 1970
- 13(12). Male and female forceps dissimilar in shape and length; pygidium in both sexes normally sexually diamorphic *Adiathella* Brindle, 1970
- 14(7). Hind tibiae sulcate in apical $\frac{1}{4}$ to $\frac{1}{2}$
- 15(16). Hind tibiae sulcate in apical $\frac{1}{4}$; 1st tarsal segment longer than 3rd segment
 *Exypuus* Burr, 1907
- 16(15). Hind tibia sulcate in apical $\frac{1}{3}$ to $\frac{1}{2}$
- 17(18). Long and slender build; elytra abbreviated, wings wanting *Solenosoma* Burr, 1907
- 18(17). Build stout; elytra wing well developed
- 19(20). Body strongly depressed; tibiae depressed *Laprophorella* Mzöberg, 1924
- 20(19). Body not strongly depressed; tibiae compressed

- 21(22). Elytra and wings punctured, pubescent; male papameres deplanate or projecting externally *Hamaxas* Burr, 1907
- 22(21). Elytra and wings smooth, glabrous; male parameres feebly dilated in middle or narrow
- 23(24). Distal segments of antennae long and slender, elytra with yellow markings, wings yellow *Proreus* Burr, 1907 (= *Schizoproreus* Steinmann, 1987-Syn. n)
- 24(23). Distal segments of antennae broad and short; elytra and wings unicolourous, dark *Chelisoches* Scudder, 1876 (= *Schizochelisoches* Steinmann, 1987-Syn. n)

CHECKLIST OF TAXA

FORFICULOIDEA

CHEISOCHIDAE

KINELLINAE Subfam. n.

Type genus : *Kinesis* Burr, 1907.

Kinesis Burr, 1907

Type species : *Chelisoches punctulatus* Burr, 1897.

List of species :

- K. mounseyi* Burr, 1916—Philippine Isls : Mindanao
- K. punctulata* (Bur, 1897)—Indonesia : Java & Celebes
- K. significus* Steinmann, 1993—Indonesia : Sulawesi Is.
- K. wernerii* Srivastava, 1978—Philippine Isls, Mindanao.

CHELISOCHINAE Burr, 1907

(= CHLISOCHELLINAE Steinmann, 1987—Syn. n.)

Type genus : *Chelisoches* Scudder, 1876.

Chelisochella Verhoeff, 1902

Type species : *Lobophora superba* Dohrn, 1865.

Known by the type species distributed in the Oriental Region.

Adiathetus Burr, 1907

Type species : *Chelisoches shelfordi* Burr, 1901.

Now this genus contains only the type species in having the body hairy; elytra and wings punctulate and hind tarsi hardly sulcate apically. All other species included under this genus earlier are transferred to *Adiathella* Brindle, 1970.

***Tauropygia* Brindle, 1970**

Type species : *Tauropygia tridentata* Brindle, 1970.

Only type species, distributed in Solomon Islands : Bougainville, is included. The taxonomic position of this genus is doubtful according to Steinmann (1989).

***Euenkrates* Rehn, 1927**

Type species : *Sphingolabis variegata* Kirby, 1891.

List of Species :

E. boesmani Steinmann, 1981—Sumatra

E. simplex Ramamurthi, 1967—Bismark Isl : New Ireland.

***Gressitolabis* Brindle, 1970**

Type species : *Gressitolabis delicatulus* Brindle, 1970.

List of species :

G. delicatulus Brindle, 1970—Solomon Isls : Bougainville

G. gurneyi Brindle, 1970—Solomon Isls : Bougainville.

***Adiathella* Brindle, 1970**

Type species : *Adiathella lingua* Brindle, 1970.

List of species :

A. dravidius (Burr, 1910)—India

A. elegans (Bormans, 1900)—Sumatra and Java

A. glaucopterus (Bormans, 1888)—India, Myanmar, China (Yunnan) and Vietnam

A. incisa Brindle, 1970—Solomon Isls : Guadalcanal

A. lingua Brindle, 1970—Solomon Isls : Guadalcanal

A. metallicus (Srivastava, 1985)—India (Arunachal Pradesh)

A. nigrocastaneous (Burr, 1910)—India (south) and Malay Peninsula

A. philippinensis Srivastava, 1976—Philippine Isls : Mindanao

A. phoenix (Steinmann, 1993)—India (South)

A. proreoides (Ramamurthi, 1967)—Bismarck Isls : New Britain

A. spinosa Brindle, 1970—Solomon Isls : New Georgia Group

A. tenebrator (Kirby, 1891)—India (South) and Borneo

***Exypnus* Burr, 1907**

Type species : *Chelisoches pulchripennis* Bormans, 1883.

*List of species :**E. chinensis* Steinmann, 1974—China*E. koorgensis* Hebard, 1923—India and Malaysia*E. pulchripennis* (Bormans, 1883)—Oriental Region and New Guinea*E. nathani* Srivastava—in press—India : Karnataka, Coimbatore, 1400 ft.***Solenosoma* Burr, 1907**Type species : *Auchenomus birmanus* Bormans, 1888.

This genus is known by its type species only, originally described from Myanmar and subsequently reported from India (India : Assam) and China (Yunnan).

***Laprophorella* Mzöberg, 1924**Type species : *Mecomera kervillei* Burr, 1905.

This genus is known by its type species only distributed in India (Assam and West Bengal) and Java.

***Hamaxas* Burr, 1907**Type species : *Chelisoches feae* Bormans, 1894.*List of species :**H. bidentatus* Ramamurthi, 1965—South India*H. crassus* Borelli, 1926—Philippine Isls : Mindoro*H. delicatulus* (Burr, 1911)—Sri Lanka*H. dohertyi* (Burr, 1899)—Celebes*H. feae* (Bormans, 1894)—Oriental Region, New Guinea & New Zealand*H. fuscus* (Borelli, 1927)—Sumatra*H. kempfi* (Burr, 1913)—India (Arunachal Pradesh)*H. kozlovi* Semenov & Bey-Bienko—Myanmar, China (Yunnan) and Mangolia*H. melanocephalus* (Dohrn, 1865)—India, Myanmar, Vietnam and Java*H. nigrorufus* (Burr, 1902)—Philippine Isls, New Guinea and Micronesia*H. pusillus* (Borelli, 1918)—Philippine Isls.*H. semiluteus* (Bormans, 1899)—Java*H. singhi* Kapoor, 1966—India*H. tenebrosus* Brindle, 1968—Philippine Isls : Siargao*H. varicornis* (Bormans, 1903)—Celebes*H. versicolor* Borelli, 1923—Philippine Isls : Luzon*H. chandrai* Srivastava, 2001—India : Andaman Isls.

***Proreus* Burr, 1907**

(= *Schizoproreus* Steinmann, 1987—**Syn. n.**)

Type species : *Forficula simulans* Stål, 1860.

List of species :

- P. abdominalis* Ramamurthi, 1965—South India
- P. biratnagarensis* Kapoor, Malla & Shah, 1978—Nepal
- P. chatterjeei* Kapoor, Bharadwaj & Banerjee, 1978—India
- P. coalescens* (Borelli, 1927)—Philippine Isls and Sumatra
- P. coloratus* (Burr, 1906)—New Guinea
- P. corporaali* Boeseman, 1954—Sumatra
- P. cunctator* Burr, 1911—India
- P. dentatus* Srivastava, 1976—Philippine Isls.
- P. duroides* Hebard, 1933—Australia Queensland
- P. fletcheri* Hebard, 1923—India (NE)
- P. fuscipennis* (Haan, 1842)—Sumatra, Java, Malaysia and New Guinea
- P. horsfieldi* (Kirby, 1891)—Java
- P. inermis* Bey-Bienko, 1959—China : Yunnan
- P. laetior* (Dohrn, 1865)—Celebes, New Guinea, Bismarck Isls and Solomon Isls
- P. ledyardi* Srivastava, 1990—Philippine Isls Los Banos
- P. longiforceps* Ramamurthi, 1962—South India
- P. ludekingi* (Dohrn, 1865)—Oriental Region
- P. minor* (Caudell, 1904)—Philippine Isls : Luzon
- P. orpheus* Steinmann, 1993—Bismarck Isls : Chimbu
- P. persuasus* Steinmann, 1993—Borneo
- P. ramamuarthii* Kapoor, 1967—South India
- P. ritsemae* (Bormans, 1883)—Oriental Region
(= *P. shaffii* Bharadwaj and Kapoor, 1967)
- P. simulans* (Stål)—Oriental Region
- P. sobrius* (Bormans, 1985)—Sumatra and Borneo
- P. tezpurenensis* (Srivastava, 1969)—India : Assam
- P. torrevilasi* Srivastava, 1976—Philippine Isls : Mindanao
- P. unidentatus* Bey-Bienko, 1970—China : Yunnan
- P. variopictus* (Bormans, 1900)—Oriental Region
- P. weissi* (Burr, 1904)—Philippine Isls : Mindanao, Vietnam, China and India (Arunachal Pradesh)

***Chelisoches* Scudder, 1876**(= *Lobophora* Serville, 1839)(= *Enkrates* Burr, 1907)(= *Kleiduchus* Burr, 1911)(= *Schizochelisoches* Steinmann, 1987—**Syn. n.**)Type species : *Forficula morio* Fabricius, 1775.*List of species :**C. annulata* Burr, 1906—New Guinea and Celebes*C. ater* Bormans, 1879—North Australia*C. australicus* (Guillon, 1841)—New Guinea and North Australia*C. brevipennis* (Borelli, 1923)—Philippine Isls, Malaysia and Sumatra*C. calopteryx* Günther, 1929—New Guinea and Solomon Isls*C. cheesmanae* Hincks, 1952—New Hebrides*C. chopardi* Hincks, 1951—Madagascar*C. diadonatus* Ramamurthi, 1967—Bismarck Islands*C. flavipennis* (Fabricius, 1793)—West Africa*C. formosanus* (Burr, 1912)—Taiwan*C. handschini* Günther, 1934—North Australia*C. kimberleyensis* Mzöberg, 1913—Australia*C. malagachus* Bormans, 1903—Madagascar*C. morio* (Fabricius, 1775)—Oriental and Australian Regions*C. paravicinii* Günther, 1993—Solomon Isls*C. persimilis* Menozzi, 1938—Sumatra*C. semirufus* Borelli, 1926—Sumatra, Mentawai Isl, Java and Malaysia*C. variegatus* (Burr, 1917)—Vietnam**SUMMARY**

A taxonomic list of various taxa of Chelisochidae is provided besides giving a key to subfamilies and genera. Subfamily *Chelisochellinae* Steinmann, 1975 is synonymised under Chelisochinae Burr, 1907. A new subfamily Kinellinae with *Kinesis* Burr, 1907 as the type genus is proposed. *Chelisochella* Verhoeff, 1902, is transferred to Chelisochinae. The genus *Adiathetus* Burr, 1907 now contains only the type species and other species are transferred to *Adiathella* Brindle, 1970.

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REFERENCES

- Srivastava, G. K. 1987. Studies on some Bormans' material and Dermaptera. *Annali Mus. civ. Stor. nat. Giacomo Doria*, **86** : 481-508.
- Steinmann, H. 1987. A new classification of the family Chelisochidae (Dermaptera). *Annls hist. nat. Mus. natn. Hung.*, **79** 113-118.
- Steinmann, H. 1989. World Catalogue of Dermaptera 1-934 (Kluwer Academic Publishers, Dordrecht, The Neitherlands and Akadémiai Kiadó, Budapest, Hungary).

DERMAPTERA (INSECTA) OF ANDAMAN AND NICOBAR ISLANDS, INDIA

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INTRODUCTION

Through literature only four species, namely, *Echinosoma andamanensis* Srivastava, *E. nandii* Srivastava (Srivastava, 1988), *Forcipula leonardi* Steinmann (1981) and *Proreus shaffii* Bharadwaj and Kapoor (1967), treated as synonym of *Proreus ritsemae* (Bormans, 1884) from Andaman Islands are reported. Besides Srivastava (2001) has described three species new science, namely, *Circolabia bhatiai*, from Andaman Isls, *Chaetospania sahai* and *Chelisoches chandrai* from Great Nicobar Island, recording two other species, viz., *Cranopygia similis* (Zacher, 1910) from Andaman and *Nesogaster minusculs* Rehn, 1946 which were hitherto not recorded within the Indian limits.

The present study is based upon the specimens available in the Survey and deals with altogether 24 species belonging to seven genera. Of these 19 species occur in Anadaman and 11 in Nicobar Isls and have six species common to both which are distributed world wide The composition of former is essentially derived from the main land of Indian subcontinent including Myanmar whereas that of latter is mainly from the Indo-Malayan Sub-Region. This is further confirmed by the occurrence of Family Nesogastrinae with one species and four other species which are restricted to Nicobar Group exhibiting affinities with Malayan forms.

Family Nesogastrinae within the Oriental Region occurs in Sumatra, Java, Celebes and Philippine Isls only. The record from Nicobar group of Islands within Indian limits is of interest.

SYSTEMATIC ACCOUNT

PYGIDICRANOIDEA

PYGIDICRANIDAE

PYGIDICRANINAE

Cranopygia similis (Zacher)

(figs. 1–2)

Cranopygia similis Srivastava, 2001, Rec. zool. Surv. India, 99 (1-4) : 49, figs. 1-2.

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List of species with their distribution

Name of the taxa	Andaman Isls	Nicobar Isls	Oriental	Worldwide
PYGIDICRANOIDEA PYGIDICRANIDAE PYGIDICRANINAE				
<i>Cranopygia similis</i> (Zacher, 1910)	+	–	+	–
ECHINOSOMATINAE				
Parvulum – Group				
<i>Echinosoma andamensis</i> Srivastava, 1988	+	–	–	–
Sumatranum – Group				
<i>Echinosoma nandii</i> Srivastava, 1986				
ANISOLABOIDEA ANISOLABIDIDAE ANISOLABIDINAE				
<i>Euborellia annulipes</i> (Lucas, 1837)	+	–	+	+
<i>Euborellia annulata</i> (Fabricius, 1793)	+	+	+	+
LABIDURIDAE LABIDURINAE				
<i>Labidura riparia</i> (Pallas, 1773)	+	+	–	+
<i>Forcipula leonardi</i> Steinmann, 1981	Doubtful record			
FORFICULOIDEA SPONGIPHORIDAE SPONGIPHORINAE				
<i>Marava arachidis</i> (Yersin, 1860)	+	–	+	+
<i>Spongovostox semiflavus</i> (Bormans, 1894)	+	+	+	–
<i>Spongovostox mucronatus</i> (Stål, 1860)	+	–	+	–
IRDEXINAE				
<i>Irdex nitidipennis</i> (Bormans, 1894)	+	–	+	–
NESOGASTRINAE				
<i>Nesogaster minusculus</i> Rehn, 1946	–	+	+	–

Name of the taxa	Andaman Isls	Nicobar Isls	Oriental	Worldwide
LABIINAE				
<i>Circolabia dubronyi</i> (Hebard, 1922)	–	+	–	–
<i>Circolabia curvicauda</i> (Motschulsky, 1863)	+	+	+	+
<i>Circolabia pillicornis</i> (Motschulsky, 1863)	+	+	+	+
<i>Circolabia bhatiai</i> Srivastava, 2001	+	–	–	–
<i>Chaetospania nigriceps</i> (Kirby, 1891)	+	+	+	–
<i>Chaetolabia bihastata</i> (Börg, 1904)	+	–	–	–
<i>Chaetolabia sahai</i> Srivastava, 2001	–	+	–	–
CHELISOCHIDAE CHELISOCHINAE				
<i>Proreus ritsemae</i> (Bormans, 1894)	+	–	+	–
<i>Chelisoches morio</i> (Fabricius, 1775)	+	–	+	–
<i>Hemaxas chandrai</i> Srivastava, 2001	–	+	–	–
FORFICULIDAE OPISTHOCOSMIINAE				
<i>Eparchus insignis</i> (Haan, 1842)	–	+	+	–
<i>Hypergus humeralis</i> (Kirby, 1891)	+	–	–	–

Material examined : India : Andaman, South Andaman, Wandoor, 1 Male (genitalia mounted between two coverslips and pinned with the specimen), 15.vi.1982, at light (R. N. Sharma coll.)

Remarks : Distributed in Malay Peninsula, Sumatra, Java and India (South Andaman).

ECHINOSOMATINAE

Echinosoma andamanensis Srivastava

(Fig. 3)

Material examined : India : Andaman : Middle Andaman, 8 km W of Rangat, Holotype Male (genitalia mounted between two coverslips and pinned with the specimen), Paratype 1 Female, 7.xii.1979, ex decaying log (B. Nandi coll.).

Remarks : This species is known by its type specimens.

***Echinosoma nandii* Srivastava**

(Fig. 4)

Material examined : India : South Andaman, Port Blair, Junglighat, 1 Male (genitalia mounted between two coverslips and pinned with the specimen), 1 Female, 4.viii.1981, ex under bark of rain tree's dead log lying on the ground (*R. C. Sharma* coll.); Chidiatopu, 2 Males (genitalia mounted between two coverslips), 1 Female, ex under bark of dead log, 02.02.2000; Jully Buoy Island, 1 Male, 1 nymph, 22.i.2000, ex under bark of dead tree (*G. K. Srivastava* coll.); North Andaman, Lakshmipur, 7 km of Diglipur, 1 Female, 15.xii.1978 (*B. Nandi* coll.).

Remarks : So far known from Andaman Islands.

ANISOLABOIDEA

ANISOLABIDIDAE

ANISOLABIDINAE

***Euborellia annulipes* (Lucas)**

Material examined : India : Andaman Isls, S. Andaman, Port Blair, Corbyns Cove, 3 Males (2 specimens with genitalia mounted between two coverslips and attached to the pin of specimens), 1 Female, 6 nymphs, 1.iii.1975 (*G. K. Srivastava* coll.).

Remarks : One male represents teneral form since the carina on the sides of abdominal segments is obsolete and colour is lighter.

***Euborellia annulata* (F)**

Material examined : Great Nicobar, South Bay, 4 KM P on N S Road, 1 Male, 1 Female, 13.vii.1984 (*S. S. Saha* coll.); Nr. Galathea, 40 KM P on N. S. Road, 1 Male, ex under bark of rotten tree, 30.vii.1984 (*S. S. Saha* coll.); South Andaman, Chiriatapu, 1 Female, 9 nymphs, 19.iii.1975 (*G. K. Srivastava* coll.); Janglighat, Port Blair, 1 Male (subadult), 14.xii.1972 (*K. S. Pradhan* coll.); Middle Andaman, Mayabunder, 1 Male (genitalia mounted between two coverslips and attached to the pin of specimen), 1 Female, 9.iii.1975 (*G. K. Srivastava* coll.); Mayabunder, 1 Female, 2 nymphs, 10.iii.1973 (*K. S. Pradhan* coll.); North Andaman, Durgapur, 3 km S of Arial Bay Jetty, Diglipur, 1 Male (genitalia mounted between two coverslips and attached to the pin of specimen), 23.iv.1971 (*B. K. Tikader* coll.).

Remarks : The male specimens from Janglighat and Durgapur, Diglipur appear to be not fully mature since general body colouration is lighter and carina on the sides of abdominal segment is not discernible.

LABIDURIADE

LABIDURINAE

Labidura riparia (Pallas)

Material examined : Andaman : South Andman, Wright Myo, 150 m Mt. Harriet Range, 1 Male, 1 Female, 28.iii.1964 (*B. S. Lamba* coll.); Chiritapu, 1 nymph, 19.iii.1975 (*G. K. Srivastava* coll.), 1 Female, 17.iv.1982 (*R. M. Sharma* coll.); Horticulture Garden, 1 Female, 11.iii.1970 (*B. K. Tikader* coll.). Shadipur, 1 Male, at light, 24.ix.1992 (*Rajesh Kumar* coll.); 1 Female, 28.x.1992, at light; Delanipur, Port Blair, 1 Male, 24.vii.1982 (*V. Armugam* coll.); 3 Females, 30.x.1970 (*A. C. Shukla* coll.); Middle Andaman : 2 km W of Rangat, 2 nymphs, 6.iii.1975 (*G. K. Srivastava* coll.); Rangat, Panchwati, 1 Female, at light, 20.viii.1991 Shyamkund, 1 Male, on wings, 22.viii.1991 (*K. Chandra* coll.); Rutland Isl, 2 Males, 8 Female, 1 nymph, 23.ii.1995, at light (*G. C. Rao* coll.); Mayabandar, New Coast, 1 Male, 23.iii.1969 (*T. D. Soota* coll.).

Little Andaman : Hut Bay, 2 Males, 2 Females, at light, 14.xi.1993; 4 km LE Centre, 1 Female, at light, 14.x.1991 (*K. Chandra* coll.).

Great Nicobar Isls : Campbell Bay, 4 Females, 24.6.1984; South Bay, 45 KMP, N. S. Road, 1 Male, 6.vii.1998 (*S. S. Saha* coll.); Great Nicobar Biosphere Reserve, 16 Km E. W. Road, 1 nymph (*K. Chandra* coll.).

Car Nicobar : Chukuchucha, 5 Males, 3 Females, 1 nymph, ex under stones, 28.xii.1979 (*M. K. Dev Roy* coll.).

Remarks : It is widely distributed throughout the Globe.

Forcipula leonardi Steinmann

Remarks : This species was described on a Female (Steinmann, 1981) from Andaman Is., Port Blair. It is difficult to assess the taxonomic status of this species in the absence of a Male.

Generally females of genus *Forcipula* Bolivar have slender forceps with a preapical tooth. The figure of ultimate tergite and forceps (Steinmann, 1. c.) lack preapical tooth and are stout. Perhaps it may be female of *Labidura riparia* (Pallas).

FORFICULOIDEA

FORFICULIDAE

SPONGIPHORIDAE

Marava araichidis (Yersin)

Material examined : Andaman, 1 Male, 1 Female, 1 nymph, 12.iv.1939, c. Forest Officer, ex white Chuglam (ex F.R.I., Dehra Dun coll.).

Remarks : World wide in distribution.

Spongovostox semiflavus (Bormans)

Material examined India Andaman Is, North Andaman, Kalighat, 2 Females, 7.viii.1994, at light; Kalpang HEPA, 1 Female, 24.vi.1994, 2 Males, 20.vi.1994; Subhashgram, ca 3 km from Diglipur, 1 Male, 1 Female, 20.xii.1979 (*B. Nandi* coll.); Great Nicobar Is, Navy Dera, 1 Male (left branch of forceps missing), 22.xi.1993, at light (*K. Chandra* coll.).

Remarks This species is widely distributed in the Oriental Region and Bismark Is.

Spongovostox mucronatus (Stål)

Material examined South Andaman, Port Blair, Phoenix Bay, 1 Male, 1 nymph, 24.xii.1978 (*B. Nandi* coll.).

Remarks : Widely distributed in the Oriental and Indo-Australian regions.

IRDEXINAE

Irdex nitidipennis (Bormans)

Material examined : India : Andaman Isl, South Andaman, Ferrargunj, 1 Male (genitalia mounted between two coverslips and attached to the pin of specimen), 17.iii.1975 (*G. K. Srivastava* coll.); North Andaman, Lakshmipur, 7 km NW of Diglipur, 1 ex (hind portion missing), 14.xii.1979, ex gargum log; Little Andaman, Hut Bay, 1 Female, 21.xi.1978, ex decaying log (*B. Nandi* coll.).

Remarks : In the present material great variation in body size were observed. Length of body 7.0–11.0 mm and forceps 2.5–3.0 mm.

Widely distributed in the Oriental Region.

NESOGASTRINAE

Nesogaster minusculus Rehn

(Figs. 5-7)

Nesogaster minusculus; Srivastava, 2001, *Rec. zool. Surv. India*, **99** (1-4) 49, figs. 3-7. (India : Nicobar Isls)

Material examined : India Great Nicobar Isl, Near Galathea, 40 kmp on N S Road, 1 Male, 2 Females, 4 nymphs, 30.vii.1994; South Bay, 4 km form N S Road, 2 Males (1 brachylabic and 1 macrolabic), 1 Female, 1 nymph, 6.viii.1984; South Bay, 45 km of N S Road, 1 Male (macrolabic), 10.viii.1984; Pygmalian Point, 1 Female, 1 nymph, 18.viii.1984, all under bark of rotten logs (*S. S. Saha* coll.); Paulo Baha Coast, 1 Male (macrolabic), 5 Females, 21.viii.1984, Cambell Bay, 24 kmp from Cambell Bay, 1 Female, 1.xii.1978, ex bark of log; Cambell Bay, near Lakshman Beach, 2 Males, 1 nymph, 4.xii.1978 (*B. Nandi* coll.); Rajendra Nagar, 1 Female, 30.xii.1975 (*P. K. Maiti* coll.), Campbell Bay, 2 nymphs, 4.xii.1966 (*A. Daniel* coll.).

Remarks : This species was recorded within the Indian limits (Nicobar Islands) on the basis of above specimens by Srivastava (2001).

LABIINAE

Circolabia dubronyi (Hebard)

(Fig. 8)

Material examined : India : Great Nicobar Island, Pygmalion Point, 2 Males, 4 Females, 18.vii.1984, under the bark of a dead giant tree rotting; Near Galathea, 40 kmp on N S Road, 3 Males, 1 Female, 1 nymph, under bark of dead rotten tree, 30.vii.1984 (S.S. Saha coll.).

Remarks Srivastava (2001) recorded this species within Indian limits on the above specimens. It is reported from Hawaii and Micronesia also.

Circolaabia curvicauda (Motschulsky)

(Fig. 9)

Material examined : S. Anadaman : Ferrargung, 12 Males, 20 Females, 4 nymphs, 17.iii.1975; 4 Males, 6 Females, 2 nymphs, 16.iii.1975; Manglutan, 6 Females, 14.iii.1975; Corbyns Cove, 5 Male, 16 Females, 4 nymphs, 1.iii.1975; Bambooflat, 2 Males, 5 Females, 2.iii.1975 (G. K. Srivastava coll.); Janglighthat, 12 exs (Males, Females & nymphs), 14.xii.1972 (K. S. Pradhan coll.); M. Andaman : Webi, 2 Males, 4 Females, 8.iii.1975; Rangat, 9 Males, 8 Females, 4-5.iii.1975 (G. K. Srivastava coll.); Mayabunder, 2 nymphs, 10.i.1973 (K. S. Pradhan coll.).

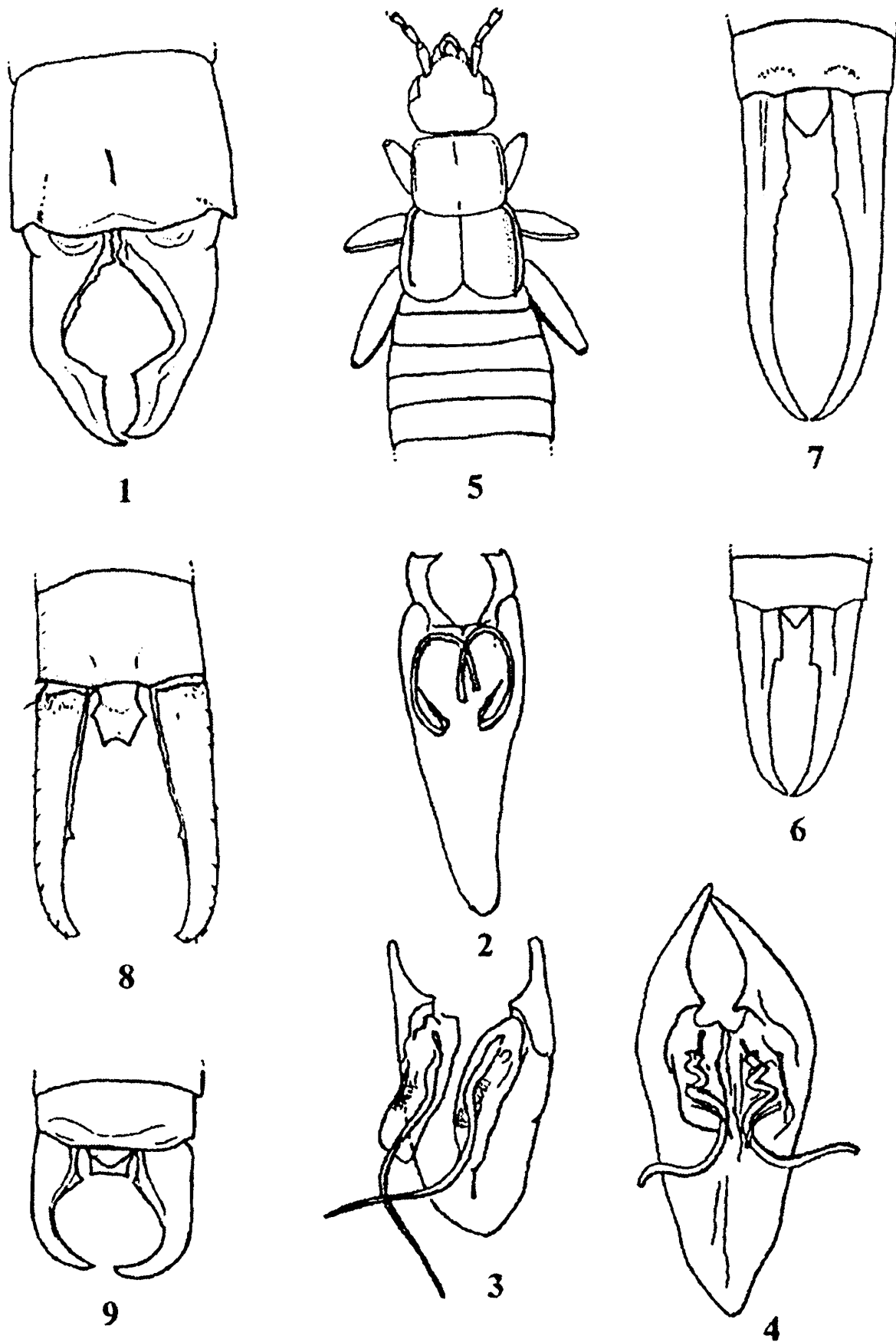
Nicobar Isls, Kakana, 1 Male, 1 Female, 1 nymph, 27.xii.1973 (K. S. Pradhan coll.); Rajendra Nagar, 1 Female, 30.xii.1975 (P. K. Maiti coll.).

Remarks : World wide in distribution.

Circolabia pilicornis (Motschulsky)

(Fig. 10-12)

Material examined : Andaman : South Andaman, Astinabad, 2 Males, 1 Female, ex. Tomping Log, 27.viii.1978 (P. K. Maiti coll.); Guptapara, 2 Male, ex Papaya tree log, 21.xii.1978 (B. Nandi coll.); Chidiyatapu, 2 Females ex under bark of log, 2.ii.2000, 1 Female, at light, 1.ii.2000 (G. K. Srivastava coll.); M. Andaman, Bakultala, 1 Male, ex under bark of Jaroa Jhinka stump, 6.xii.1978 (B. Nandi coll.); South Andaman, Ferrargunj, 2 nymphs, 16.iii.1975; 3 Males (1 Male with genitalia mounted between two coverslips and pinned with the specimen), 3 Females, 12 nymphs, 12.iii.1975 (G. K. Srivastava coll.); Andaman Is, 1 Female, 1930 (Beeson coll. ex F.R.I. Dehradun coll.); Middle Andaman, Rangat, 1 Female, 4.iii.1975, ex rotten banana stem; Webi, 1 Male, 5 nymphs, 8.iii.1975 (G. K. Srivastava coll.).



Figs. 1-9. *Cranopygia similis* (Zacher), Male; 1. Ultimate tergite and forceps; 2. Genitalia; *Echinostoma andamanensis* Srivastava, Holotype Male; 3. Genitalia; *Echinostoma nandii* Srivastava, Holotype Male; 4. Genitalia; *Nesogaster minusculus* Rehn, Male; 5. Anterior portion of body; 6. Ultimate tergite and forceps (microbalic form); 7. Ultimate tergite and forceps (macrolabic form); *Circolabia dubronyi* (Hebard), Male; 8. Ultimate tergite and forceps; *Circolabia curvicauda* (Motschulsky), male; 9. Ultimate tergite and forceps.

Andaman Isls : Ross Isl., Male, 1 nymph, ex under bark of log, 24.i.2000 (*G. K. Srivastava* coll.).

Little Andaman : Hut Bay, Ramakrishnapur, 1 Female, ex log, 21.xi.1978 (*B. Nandi* coll.).

Nancowry Isls : Champin Bay, 2 Females, 1 nymph, ex coconut tree, 16.xi.1978 (*B. Nandi* coll.).

Great Nicobar Isls, Pygmalion Point, 4 Males, 2 Female, 14 nymph, under bark of dead rotting giant tree, 18.vii.1984; Near Galathea, 40 km KMP on NS Rd., 1 Male, ex under bark of rotten tree, 30.vii.1984; South Bay 45 KMP NS Rd., 5 Females, 4 nymphs, 6.iii.1984 (*S. S. Saha* coll.); Great Nicobar Biosphere Reserve, 10 km EW Road, 1 Male, 11.xi.1993, 1 Female, 14.xi.1993; Navy Dera, 1 male, 1 Female, 22.xi.1993, 1 Female, 23.xi.1993, all at light (*K. Chandra* coll.).

Remarks : This is a widely distributed species all over the world in tropical and subtropical parts.

Measurements : (in mm) : Male : Length : body 5.5–6.0, forceps 1.4–1.75; Female : Length : body 3.65–5.5, forceps 0.75–1.5.

Circolabia bhatiai Srivastava

(Fig. 13)

Circolabia bhatiai Srivastava, 2001, *Rec. zool. Surv. India*, **99** (1-4) : 50, figs. 11-17 (Male, Female; India : Andaman Isls).

Material examined : India : North Andaman, Holotype Male (genitalia mounted between two coverslips and attached to the pin of specimen; penultimate sternite mounted on the card with the specimen), *canarium euphlym*, RRD 917, BCR 334; Cage 511, 18.i.1929; Andaman Islands, Paratype, RRD 88, BCR 44, Cage GX, Ex unknown wood bark, 29.iii.1930; Paratype 1 Male (genitalia mounted between two cover slips and attached to the pin of specimen and penultimate sternite mounted on the card with the specimen), RRD 88 & BCR 42, Cage GZ, Ex *Rhizophora mucronata* bark, 24.iv.1930; Paratype 1 Male, 1 Female, RRD 88, BCR 37, Cage 716, Ex *Sideroxylon longipetiolatum*, 17.viii.1930; Paratype 1 Female, 12.ix.1930, Paratype 1 Female 14.ix.1930, Paratype 1 Female, 21.xi.1930 and Paratype 1 Female, 3.i.1931, all RRD 88, BCR 37, Cage 716, Ex *Sideroxylon longipetiolatum*, ex FRI, Dehra Dun coll. (all *C. F. C. Beeson* coll.); South Andaman, Burmanala; Paratype 1 Female, ex under bark of dead decaying tree trunk, 22.i.2000 (*G. K. Srivastava* coll.).

All material is ex F.R.I., Dehradun coll. excepting 1 Female collected by *Dr. G. K. Srivastava*.

Remarks : This species is so far known by its above mentioned Type specimens from Andaman Isls.

Chaetospania nigriceps (Kirby)

(Figs. 14-16)

Material examined : Andaman Isls, South Andaman, Bambooflat, 2 Males, (1 male with genitalia mounted between two coverslips and pinned with the specimen), 3 Females, 2.iii.1975,

ex rotten banana stem; Humphrygunj, 1 Male, 13.iii.1975, ex rotten banana stem (*G. K. Srivastava* coll.).

Great Nicobar, Pygmalion Point, 4 Males, 5 Females, 3 nymphs, ex under bark of giant rotting tree, 18.vii.1984 (*S. S. Saha* coll.).

Remarks : The tooth on the inner margin of male forceps may be single or double.

This species is distributed in Papua New Guinea, Solomon Isls, India (Andaman & Nicobar Islands; Lakshadweep (Minicoy Isl), Myanmar and Celebes.

Chaetolabia bihastata (Börg)

Material examined India Andaman Isl, Middle Andaman, Mayabunder, 3 Males (1 male with genitalia mounted between two coverslips and attached to the pin of specimen), 1 Female, 2 nymphs, 9.iii.1975, ex rotten banana stem; South Andaman, Burmanala, 1 Male, 1 nymph, 22.i.2000, ex under bark of decaying tree stem (*G. K. Srivastava* coll.); Cowright, 1 Male, 1 Female, 11.iv.1964 (*B. S. Lamba* coll.).

Remarks : West and Central Africa; India (West Bengal, Darjeeling dist. and above record).

Chaetolabia sahai Srivastava

(Fig. 17)

Chaetolabia sahai Srivastava, 2001, *Rec. zool. Surv. India*, **99** (1-4) : 53, figs. 18-23 (Male, Female; India : Great Nicobar Isls).

Material examined : India : Great Nicobar Island, Paulo Baha, West Coast, Holotype Male, 21.viii.1984 (*S. S. Saha* coll.).

Remarks : Known by its type Male from Nicobar Isls.

CHELISOCHIDAE

CHELISOCHINAE

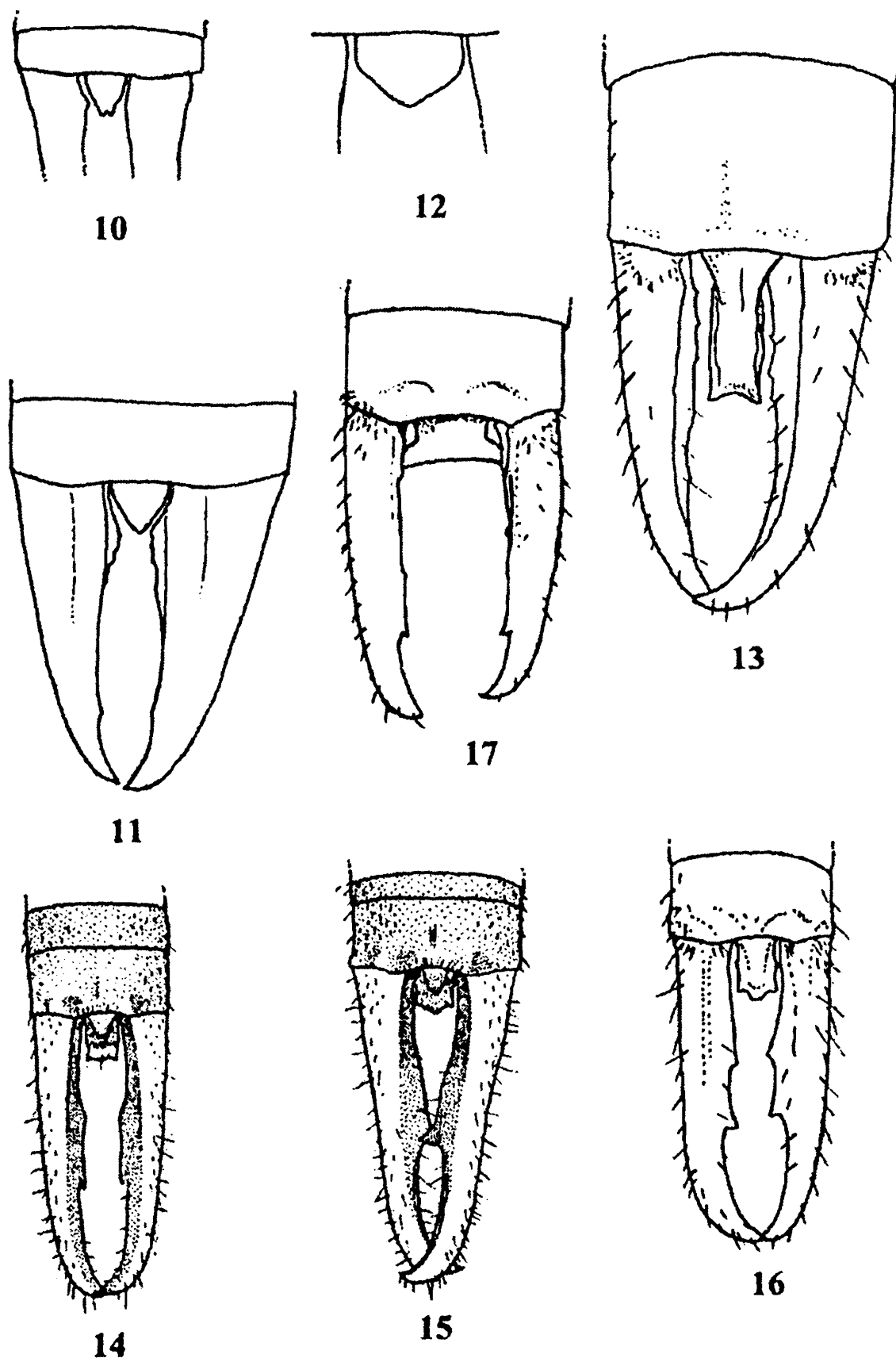
Proreus ritsemae (Bormans)

(Figs. 18-23)

Chelisoche ritsemae Bormans, 1884, *Notes Leyden Mus.*, **6** : 185 (1 Male, Moeara Laboe, Sumatra Expedition Scientific, Néderland; Type deposited in Rajksmuseum van Natuurlijke Historie, Lieden).

Proreus ritsemae; Srivastava, 1987, *Bull. zool. Surv. India*, **8** (1-3) : 49, figs. 5-7 (Male genitalia of the type figured).

Proreus shaffii Bharadwaj and Kapoor, 1967, *Bull Ent.*, New Delhi, **8** (2) : 4 (Male; Port Blair, Andaman Isls, Holotype Male deposited at the Indian Agricultural Research Institute, New Delhi); Srivastava, 1987, *Bull. zool. Surv. India*, **8** (1-3) : 49 (treated as a synonym).



Figs. 10-17. *Circolabia pillicornis* (Motschulsky), Male; 10. Ultimate tergite, pygidium and basal portion of forceps; 11. Ultimate tergite, pygidium and forceps; 12. Pygidium, enlarged; *Circolabia bhatiai* Srivastava, Holotype Male; 13. Ultimate tergite and forceps; *Chaetospania nigriceps* (Kirby), Male; 14-16, Ultimate tergite and forceps showing variations in inner armature; *Chaetospania sahai* Srivastava, Holotype Male; 17. Ultimate tergite and forceps.

Remarks : Occurrence of this species from the area is based upon the Holotype Male of *Proreus shaffii* Bharadwaj and Kapoor.

***Chelisothes morio* (Fabricius)**

Material examined : India : South Andaman, Port Blair, Dilanipur, 1 Male (head missing; genitalia mounted between two coverslips and pinned with the specimen), 4.ii.1982 (*V. Arumugam* coll.); Wimberlygung, 1 Female, 10.vii.1997, at light (*P. T. Rajan* coll.); Corbyns cove, Port Blair, 2 nymphs, 01.iii.1975 (*G. K. Srivastava* coll.).

Remarks : It is distributed in Oriental, Australian and Africotropical regions.

***Hamaxas chandrai* Srivastava**

(Figs. 24-25)

Hamaxas chandrai, Srivastava, 2001, *Rec. zool. Surv. India*, **99** (1-4) : 55, figs. 24-30 (Male; India : Great Nicobar Is.).

Material examined : India : Great Nicobar Is., Great Nicobar Biosphere Reserve, 41 Km, Galathea National Park, Holotype Male, 18.xi.1993, on wings (*K. Chandra* coll.).

Remarks : It is known by its Holotype Male only.

FORFICULIDAE

OPISTHCOSMIINAE

***Eparchus insignis* (Haan)**

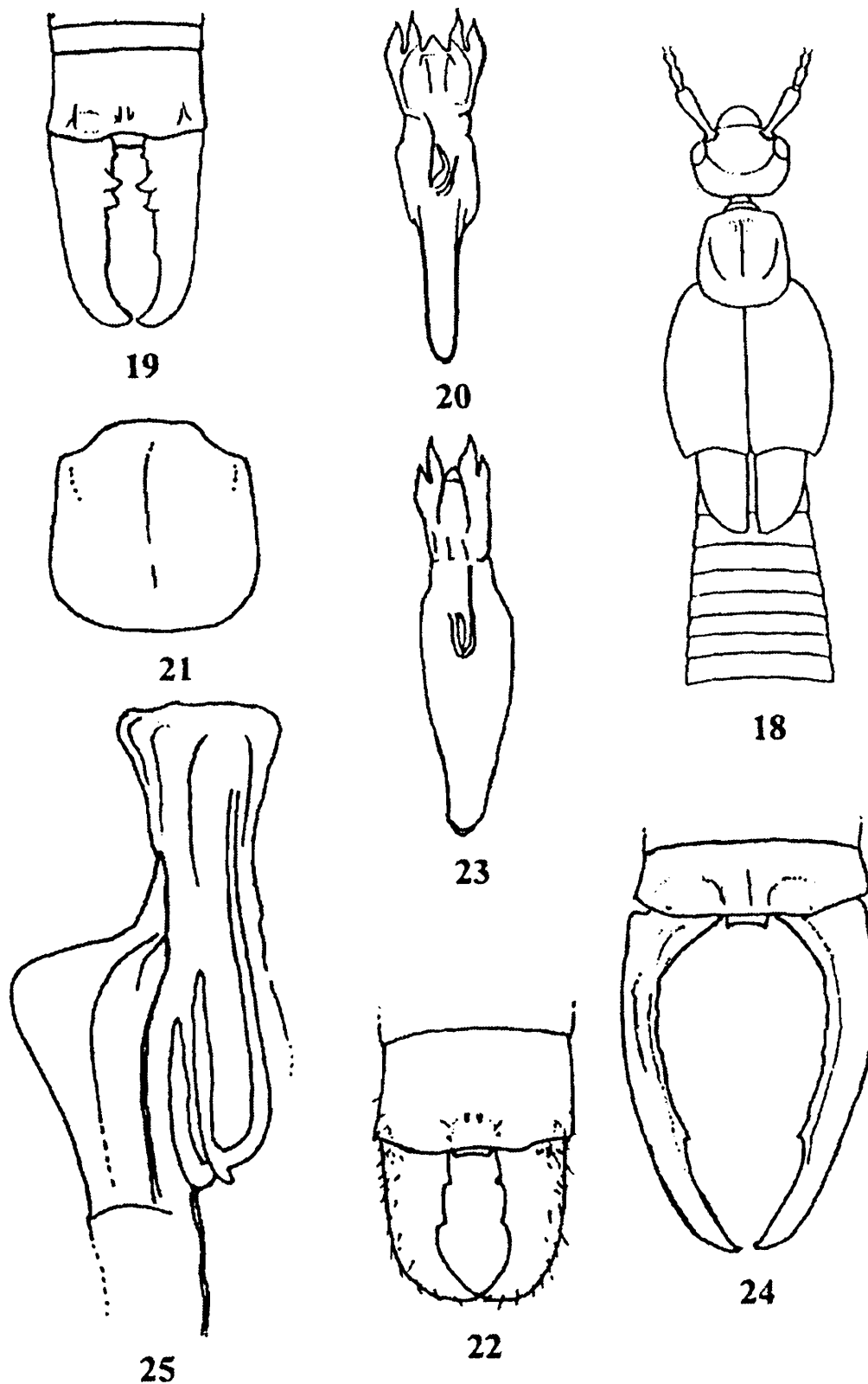
Material examined : India : Great Nicobar Is, 16 km EW Road, Great Nicobar Biosphere Reserve, 1 Male, 10.xi.1993, 4 Female, 12.xi.1993, 1 Male, 13.xi.1993, 2 Males, 1 Female, 14.xi.1993, 1 Male, 15.xi.1993, 1 Male, 3 Females, 16.xi.1993, all at light (*K. Chandra* coll.).

Remarks : Known to occur in the Oriental Region only.

***Hypergus humeralis* (Kirby)**

Material examined : India : Andaman, South Andaman, Mount Harriet, 1 Male, 16.xii.1994, 1 Male, 1 Female, 23.ix.1994 at light; Port Blair, Yatri Niwas, 1 Male, 25.viii.1992, at light (*K. Chandra* coll.); Pawaji Camp, 1 Male, 17.xii.1985, at light (*M. Mitra* coll.); Wandoor, 1 Male, 16.iv.1982, 1 male, 23.ix.1983, 1 Female, 22.ix.1983, all at light (*R. M. Sharma* coll.); North Andaman, Kalpang HEPA, 1 Male, 19.vi.1994, 1 Male, 1 Female, 20.vi.1994, 3 Males, 2 Females, 21.vi.1994, all at light; Kalighat, 1 Female, 7.vi.1994, at light (*K. Chandra* coll.).

Remarks : Known from the Oriental Region.



Figs. 18-25. *Proreus ritsemae* (Bormans), 18. Anterior portion of body; 19. Ultimate tergite and forceps; 20. Genitalia; 21. Pronotum; 22. Ultimate tergite and forceps; 23. Genitalia; *Hamaxas chandrai* Srivastava, Holotype Male; 24. Ultimate tergite and forceps; 25. Left paramere and distal lobe, enlarged.

(Figs. 18-20 are from the Type Male of *Proreus ritsemae*, after Srivastava (1987) and figs. 21-23 from *Proreus shaffii* after Bharadwaj and Kapoor (1967).

SUMMARY

A total of 24 species belonging to 7 genera are reported, of which 19 are recorded from Andaman Isls and 11 from Nicobar Isls, including six species common to both islands which have world wide distribution.

ACKNOWLEDGEMENTS

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REFERENCES

- Bharadwaj, R. K. and Kapoor, V. C. 1967. Dermaptera in the National Pusa collection, *Bull. Ent.*, New Delhi, 8(2) : 1-7.
- Srivastava, G. K. 1987. Notes and illustrations on some Dermaptera (Insecta) preserved in the "Rijksmuseum van Natuurlijke Historie, Leiden", *Bull. zool. Surv. India*, 8(1-3) : 47-56.
- Srivastava, G. K. 1988. Fauna of India Dermaptera Pt. I, Superfamily Pygidicranoidea (Zool. Surv. India), pp i-xii + 1-268.
- Srivastava, G. K. 2001. New species and new records of Dermaptera (Insecta) from Andaman & Nicobar Isls., India, *Rec. zool. Surv. India*, 99 : 49-50.
- Steinmann, H. 1981. The Dermaptera of the Museo Civico de Storia Naturale di Milano with the description of *Forcipula leonardi* n.sp., *Atti Soc. Ital. Sci. nat. Museo civ. Stor. Nat. Milano*, 122 : 157-170.

BIODIVERSITY OF MACROBENTHOS ON THE INTERTIDAL FLATS OF SUNDERBAN ESTUARINE REGION, INDIA

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INTRODUCTION

Estuaries are highly dynamic and interesting ecosystem where strong transition between sea and freshwater exists (Mclusky, 1971). The mixing of fresh and marine water produces complex effects on the entire abiotic and biotic conditions of the ecosystem including sedimentation, salinity, nutrients-level, productivity and diversity and abundance of fauna. The tidal nature of estuaries exposes periodically vast areas of intertidal flats, during low tides, which harbour a specialised community of macrobenthic invertebrates. Because of their great importance, both in trophic dynamics of the ecosystem and as indicator of the quality of environment, these communities have gained considerable attention both in India (Panikker and Aiyer, 1937; Balssubramaniam, 1960; McIntyre, 1964; Maclachlan, 1971; Ansel *et al.*, 1972, 1978; Ajmal Khan *et al.*, 1975; Parulekar *et al.*, 1975; Dwivedi *et al.*, 1975; Bhunia and Choudhury, 1981; Govindan *et al.*, 1983; Choudhury *et al.*, 1984 and Fernando, 1987) and elsewhere (Spooner and Moore, 1940; Brady, 1943; Holme, 1949; Carriker, 1967; Dawn, 1971; Wolff, 1973; Sasekumar, 1974; Khayrulla and Jones, 1975; Wildish and Kristmanson, 1979; Maurer and Lathern, 1979; Andrew *et al.*, 1980; Alongi, 1987 and Elliot and Kingston, 1987). However, barring a few, most of the studies were mainly carried out from the viewpoint of density or productivity, without making much efforts to analyse the specific structure of the community. It is only during the last few years that serious attempts have been made in this direction in different parts of the world (Elliot and Kingston, 1987; Barr *et al.*, 1990; Attrill *et al.*, 1996). However, from the Indian estuaries not many reports are yet available, more so from the most important and largest estuarine complex—the Hugly-Matla, which is formed by the major Indian river, Ganga. The lower zone of this system on the delta forms Sunderban estuarine and mangrove region.

Therefore, the present investigations were undertaken to study the benthic macroinvertebrates-occurrence, abundance and diversity on intertidal flats of Sunderban estuarine region, specially from the view point of assessing the spatial variations in biodiversity patterns between different areas and zones associated with major contributing estuaries. In order to make proper comparison, areas situated in mid-estuarine zone of the Major River Hugly have also been included.

DESCRIPTION OF THE STUDY AREA

Indian Sunderban estuarine region, which is only one third of total Sunderban delta (two-third in Bangladesh), covers the lower portion of Hugly-Matla estuarine system and is mainly formed by an offshoot of major river Ganga in the districts of North and South 24 Parganas of West Bengal State, near Bay of Bengal, between latitudes $21^{\circ}31' \text{ N}$ and $23^{\circ}30' \text{ N}$ and longitudes $87^{\circ}45' \text{ E}$ and $88^{\circ}45' \text{ E}$. Several other smaller tributaries like Roopnarayan and Haldi also join the system. The main estuary Hugly is highly tidal and this limit extends to 295 km from the mouth. Estuarine complex in lower zone, forming main Sunderban region, is criss-crossed with a large number of smaller distributaries and their creeks and channels (Khals), forming a number of islands where dense luxuriant mangrove forests grow. Vast areas of mud flats and a few patches of sand flats (near sea face) appear around these islands during low tides which occur twice a day. The important estuaries contributing to the system are Hugly, Muriganga, Saptamukhi, Thakuran (Jamira), Matla, Harinbanga-Raimangal etc. (Fig. 1). Details of the physiography has already been described (Khan, 1995a, 1995b).

MATERIALS AND METHODS

A. Study Zones and Stations

For the purpose of present study, the entire area was divided into four major zones, and samples were collected from different stations, numbering one to three in each zone. These zones and stations were :

ZONE-1, HUGLY MIDDLE ZONE

This zone was demarcated in almost middle region of 295 Km tidal stretch of main feeding river and samples were drawn from following stations.

Station 1, Achipur : Approximately 135 Km from the mouth. The river at this point passes through Calcutta Metropolitan District with large human settlements along both the banks. The intertidal flats were small and the substrate muddy but not very soft.

Station II, Nurpur. Approximately 115 Km from the mouth. The river in this region passes through comparatively thinly populated area. The sizes of the exposed flats were comparatively larger than station 1.

ZONE-2, HUGLY LOWER ZONE MUDFLATS

This zone was located in lower region of the estuarine system in Sunderban proper on the western side. This included areas west of the River Saptamukhi to the western boundary of Sunderban. Most the intertidal flats in upper and middle portions of this zone were muddy but at the mouth these were replaced by sand flats. Sampling was done from the following stations :

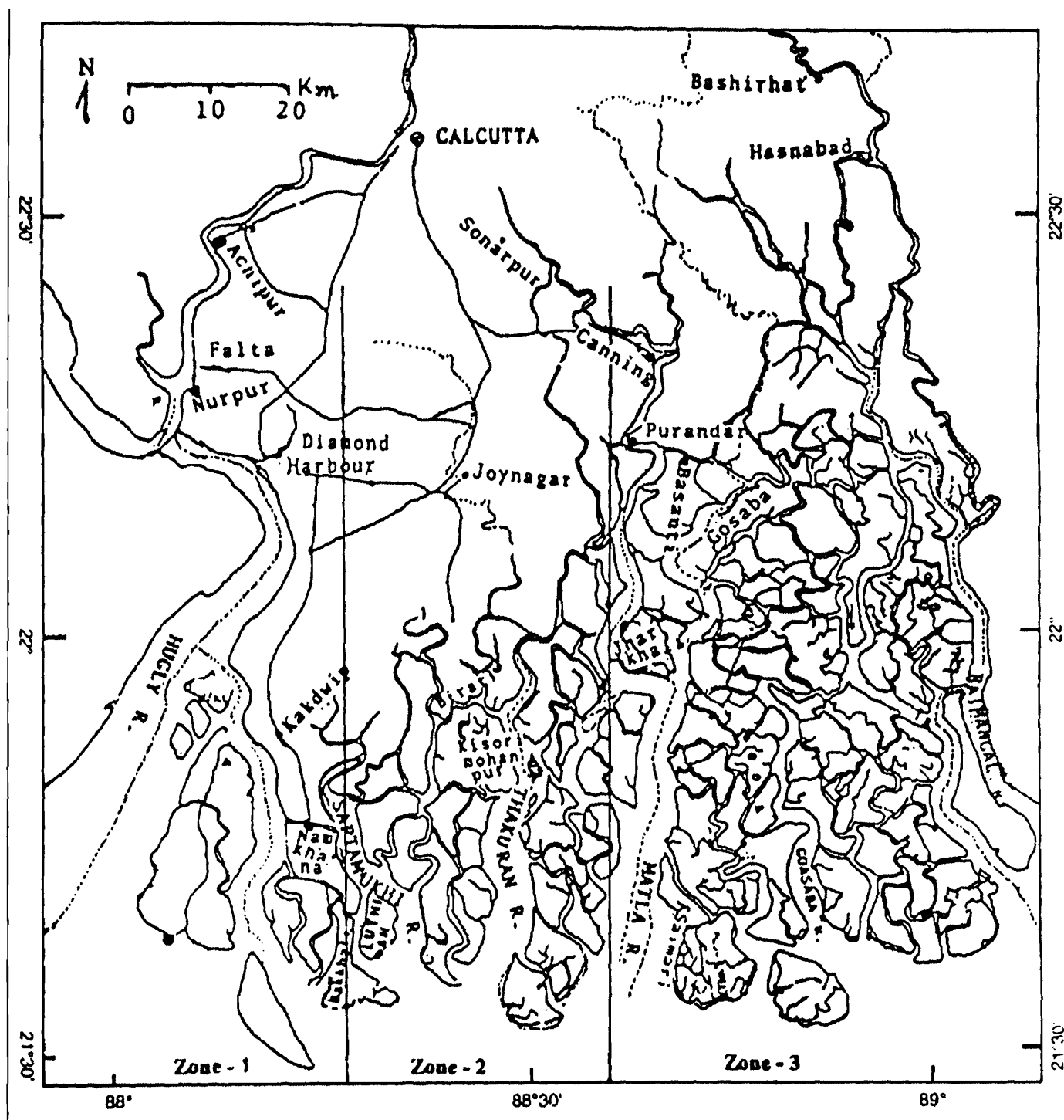


Fig. 1. Sunderban Estuarine Zone of Hugly-Matla System.

Station III, Kakdwip : This station was situated nearly 25 Km from the mouth, with muddy flats.

Station IV, Namkhana : This station was located about 19 Km from the mouth, with considerably larger exposure of soft muddy flats.

Station V, Printice island : This station was nearly 10 Km from sea face. The island was uninhabited and full of mangrove forest. The mudflats were formed by very soft mud.

ZONE-3, THAKURAN-MATLA ZONE MUD FLATS

This zone covered the areas situated east of River Saptamukhi to west of river Goasaba covering major distributaries, namely Thakuran and Matla. This was the biggest zone, covering main area of the system. The entire zone was characterized by extremely soft muddy substrate near low tide marks and not very hard substrate at highest of high tide marks during any time of lunar month. It included almost virgin areas of mangrove forests. Most of the area is under Tiger Reserve where the entry is extremely restricted. This zone was covered from the following stations.

Station VI, Kishori Mohanpur : This station was situated on a small island, most of which gets submerged during high tide. The intertidal flats were mainly comprised of extremely soft muddy substrate. It was situated nearly 45 km from the mouth in Thakuran estuarine area.

Station VII. Jharkhali : This station was almost in the middle of Matla estuary, nearly 60 Km from the mouth. The island has a small population of mainly fisherfolk. The substrate around the island was muddy and soft.

Station VIII, Purandar (Canning) : This was situated in the upper portion of Matla River. This river has lost its freshwater connection due to reclamation in upper reaches and resembles almost backwater. Except during monsoon period, this river does not receive any freshwater discharge.

ZONE-4, MATLA SAND FLATS

Almost all areas near the sea face contain sandy flats that are located around certain islands. Only one sand flat was surveyed :

Station IX, Saimari : This station was situated about 8 km from sea-face on the western side of the island and was comprised of vast beach of sand flats.

Survey and Collection

Macrobenthic fauna were collected from different stations during the years 1989-92. As monsoon plays an important role in the dynamics of seasons of this region of the country, the annual cycle was divided into three major seasons viz. Premonsoon (March-June), Monsoon (July-October) and Postmonsoon (November-February). Each season was subdivided into two parts, the early (I), covering first two months, and late (II) comprising of last two months.

From each station a set of 4 samples along a transect, from low water mark to high water mark, were collected by placing a wooden quadrat of 0.5 X 0.5 m to a depth of 15 cm. The epifauna from the demarcated area were first picked up or trapped quickly (crabs) and then entire soil was taken and washed through a sieve of 0.5 mm mesh-size. Macro fauna retained on the sieve were picked up with the help of a magnifying glass and the remaining contents were washed in small amount of water. The smaller animals were gently picked up with the help of a sable hairbrush or a wide-mouth pipett. All macrobenthos were sorted live. Samples were first narcotized by adding a few drops of menthol in water containing the animals and then preserved after sometime in 8%

formalin. Special care was taken for polychaetes for narcotisation and whenever possible they were fixed in 70% alcohol. The identification of taxa, counting, measurement and biomass-determination were carried out in laboratory. The dry weight biomass was determined by keeping the animals in an oven at 65°C for a few days.

Species diversity and similarity indices

In order to assess the diversity, several indices of diversity were applied to macro-benthic community which are :

1. Menthinik Index (Menhinik, 1964) $S/\ln$
2. Index of Diversity (Margalef, 1951) $\frac{S - 1}{\log_e N}$
3. Shannon-Weiner Index of diversity (Wilhm, 1972) $H = -\sum ni/N \log_e ni/N$
4. Simpson/s index $D = 1 - \sum \frac{nj(nj - 1)}{N(N - 1)}$
5. Evenness (Pielow 1959) $J = H/H_{\max}$ where $H_{\max}$ is equal to $\log_2 S$

Where S = No. of species in the sample

N = total number (density) of all individuals of all groups in the sample

N_i, n_j = number of individuals (density) of species i or j in the sample.

Similarity Analysis

Similarity between different zones were determined based on percentage similarity index, which chiefly represented the qualitative structure of fauna (Greig-Smith, 1964) as :

$$S = (c \times 100) / a + b - c$$

Where a is the number of species present in first sample, b is the number of species in second sample and c is the number of species present in both samples.

The similarities between zones with respect to quantitative structure of fauna were determined as per the formula of Romaniszyn (1970)

$$S = \frac{W}{a + b + c}$$

Where W is the sum of densities minima of different taxa occurring at site A or B, irrespective of sites, and a and b are sum of densities of all taxa occurring at site A or B.

Soil samples were analysed for the grain size as per the methods of Krumbein and Pettijhon (1938). Organic carbon was estimated as per the methods of El-Wakeel and Riley (1956). Dissolved oxygen of interstitial water was determined by Winkler's modified method. Temperature was measured with the help of a soil thermometer. Salinity was measured argimetrically.

RESULTS

A. Physico-chemical nature of soil

The general features of physico-chemical nature of soil of all zones during different seasons are given in Table 1. Salinity increased steadily from Zone-1 (Hugly middle zone) to Zones 2, 3 and 4. In Zone-1, drastic reduction in salinity occurred during monsoon months when the surface runoff and river discharges were highest. The impact of huge dilution was also evident during post-monsoon months when salinity was not very high. However, during premonsoon season the salinity increased considerably to nearly 15 times of the lowest value observed during monsoon period. In Zones 2 (Hugly mudflats) and 3 (Matla mudflats) the salinity as a whole was considerably high throughout the year, though the seasonal variations were of the same order as in Zone-1, lowest in monsoon and highest in premonsoon. Mean salinity values in Zone-3 were always slightly higher than in Zone-2. The values varied between 10.0 and 27.0 ppt in Zone-2 and 16.0 to 29.0 ppt in Zone-3. Mean soil temperature did not vary much in different zones. The seasonal variations were also not very pronounced during major part of the year when mean monthly temperature fluctuated around 30°C. A moderate drop in temperature was noted during the latter part of postmonsoon season but that was for a brief period. Dissolved oxygen contents of interstitial water were also moderate in all zones during all seasons, which varied between 3.01 mg/l (Zone-1, PRM-1) and 5.2 mg/l (Zone-4, POM-11). Organic carbon values were also quite moderate in all the zones during all seasons, except in Zone-1 during premonsoon.

Sediment composition was dominated by silt followed by clay in Zones 1, 2 and 3. Sand particles contributed very little during all seasons. The case was reverse in Zone-4 where, sand particles formed nearly 88% of the sediment particles.

Table 1. Physico-chemical nature of the soil of mud and sand flats at different zones.

Parameters	Zone 1			Zone 2			Zone 3			Zone 4		
	PRM	MON	POM	PRM	MON	POM	PRM	MON	POM	PRM	MON	POM
Salinity (ppt)	15.0	1.0	5.2	27.0	10.0	14.0	29.0	16.0	18.0	32.0	18.0	26.6
Organic carbon (mgC/g)	3.57	1.2	1.0	1.2	2.9	1.7	1.3	2.6	1.5	1.1	1.5	1.0
Temperature (°C)	30.5	30.5	22.5	30.0	29.6	22.0	30.5	29.8	21.9	30.5	30.5	21.2
Dissolved oxygen (mg/l)	3.01	3.0	4.0	4.0	4.1	4.9	4.1	4.4	4.9	4.6	4.8	5.2
Sediment Composition (%)												
Sand	20.7	16.6	18.3	5.6	4.0	5.5	4.3	6.2	5.1	92.6	84.3	88.5
Caly	22.3	20.9	20.2	21.5	26.0	22.2	22.2	25.5	24.9	4.2	8.5	6.8
Silt	57.9	62.5	61.5	73.5	70.0	72.3	73.3	68.3	70.0	3.8	7.2	4.7

PRM–Premonsoon, MON–Monsoon, POM–Postmonsoon.

B. Total recorded species

Altogether 83 taxa were recorded during quantitative sampling from different zones of the estuarine system over the length of survey (Fig 2). Macrobenthic fauna of both mud and sand flats belonged mainly to Gastropoda (24 taxa), Bivalvia (12 taxa), Polychaeta (14 taxa), Brachyura (17 taxa) Anomura (3 taxa) and Asteroidea (3 taxa). Other groups like Actinaria, Nemartina, Bryozoa, Oligochaeta, Echiura, Sipuncula, Macrura (Crustacea), Ophiuroidea and Chironomidae were represented by one or two taxa each (Table 2).

Most of the taxa were common to two or more zones. Maximum number of taxa was recorded from Zone-3 (Thakuran-Matla mud flats), comprising Stations 6, 7 and 8. This zone was represented by 58 taxa. This was followed by Zone 2 from where a total of 48 taxa were recorded. Minimum number of taxa was found in Zone-1 (Hugly middle zone) where only 22 taxa occurred over the entire duration of survey. The sand flats of Zone-4 (Takuan-Matla sand flats) contained altogether 39 species. These species were recorded from the quantitative samples only (Fig. 2). Not many differences were noticed between different stations in each zone (Fig 3, Table 2).

Groupwise analysis revealed the dominance of gastropods in all zones which were represented by 12, 14, 18 and 9 taxa, constituting 54%, 34%, 31% and 25% of the total macro-invertebrate fauna in Zones 1, 2, 3 and 4 respectively (Fig 4, Table 3). Polychaetes contributed between 13% and 18% of the total taxa in different zones, with number of species varying between 3 and 9. Bivalves were represented by maximum number of species in Zone-4. While only few species of brachyuran crabs were recorded from Zone-1 (3 species, 13%), their strength reached to the maximum in Zone-3 (12 species, 20%). The oligochaetes were the inhabitants of Zone-1 only and were not able to tolerate higher salinity values. Contrary to this, taxa belonging to most of the other groups were only confined to higher salinity zones.

C. Numerically abundant species

Out of these only 9-12 taxa were abundant in different zones and formed the major portion of benthic macroinvertebrate density (Table 4). Among the gastropods, *Assiminea brevicola*, *Cerithidea (C) cingulata* and *Telescopium (T) telescopium* were very common on the mud flats and these together contributed more than 30% of total macrobenthos in Zones 2 and 3. Next in importance were hermit crabs of the species *Clibanarius padaensis* in Zones 2 and 3. In Zone-4, gastropod, *Septaria lineata*, bivalve, *Macoma birmanica* and *Solen brevis*, anomura, *Coenobita cavipes* and brachyuran *Ocypoda macrocera* were most abundant species. In Zone-1, gastropod, *Stenothyra deltae*, *Assiminea francesiae*, polychaete, *Neanthes cihingrigattensis* etc. were most abundant species.

D. Density (abundance)

The numerical density of major groups as individuals/m² and their relative composition in different zones are shown in Fig. 5 and stationwise listing is done in Table 5. The mean density

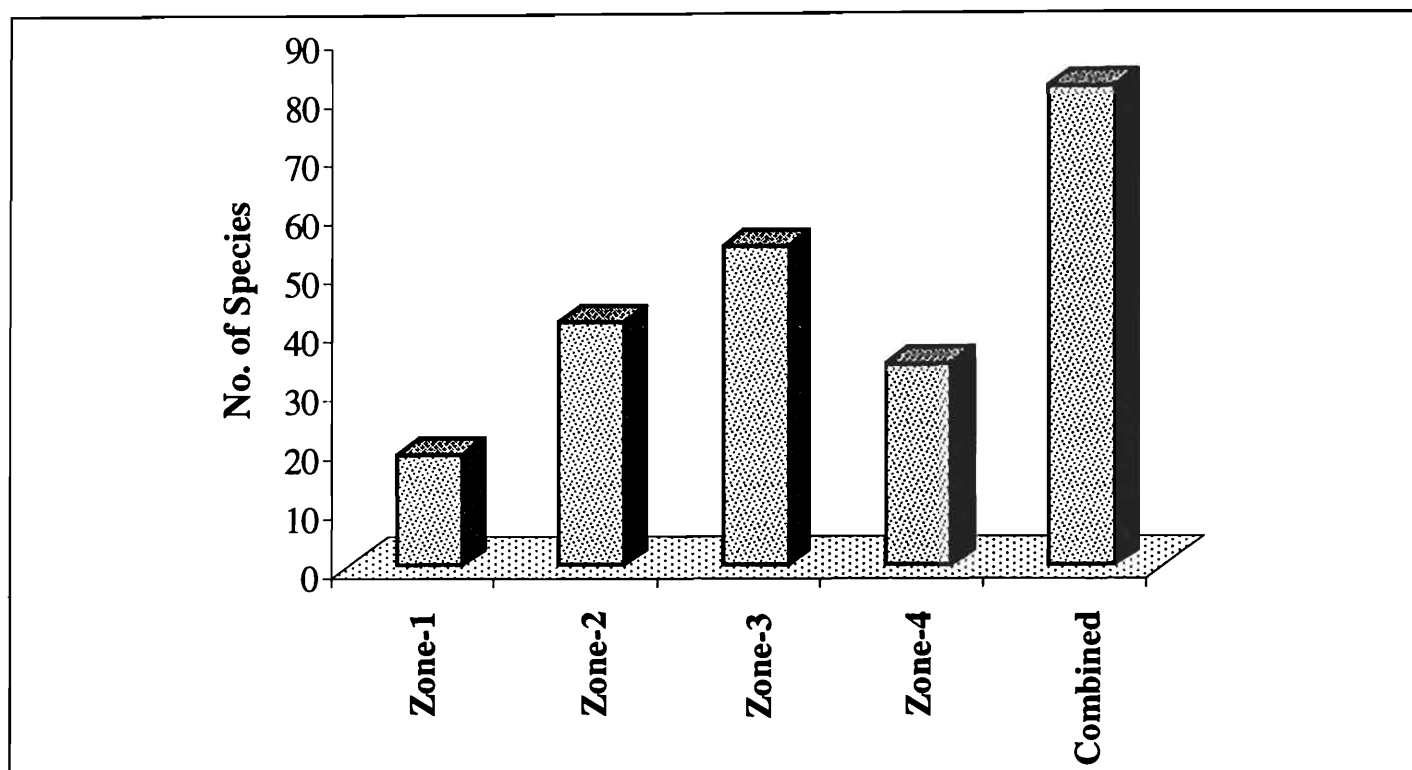


Fig. 2. Number of species recorded from each zone and all zones combined.

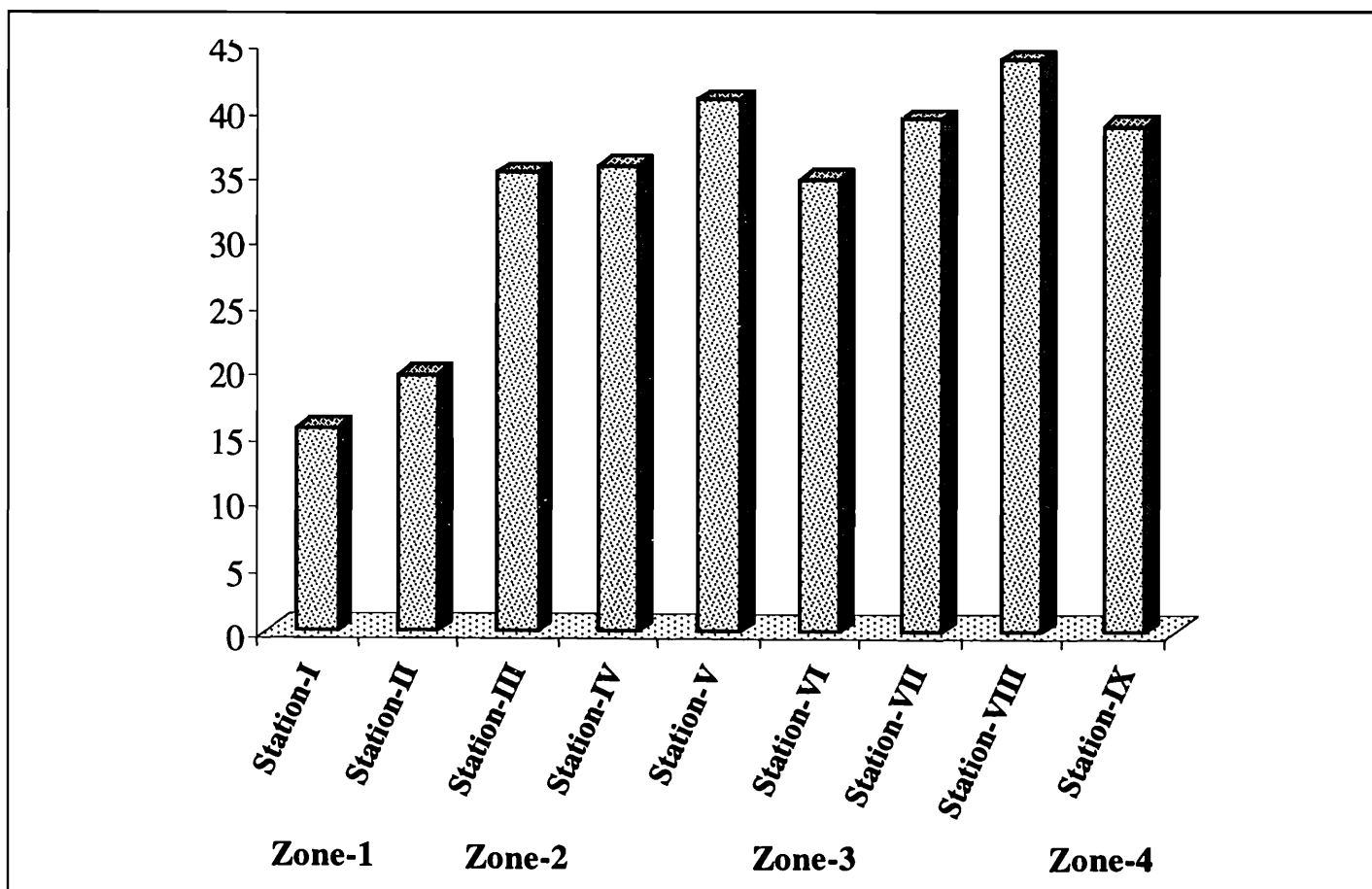


Fig. 3. Number of species recorded from each station.

Table 2. The occurrence of macrobenthic invertebrates in different zones.

Taxa	Zone 1	Zone 2	Zone 3	Zone 4
CNIDARIA – ACTINARIA				
1. <i>Edwardsia jonesii</i> Sheshya & Cuttress	–	+	+	–
2. <i>Pelocoetes exul</i> (Annandale)		–	+	–
BRYOZOA				
3. <i>Victorella</i> sp	–	+	+	–
MOLLUSCA-GASTROPODA				
4. <i>Potamacmaea fluviatilis</i> (Blandford)	–	–	+	–
5. <i>Tubiola microscopia</i> Adams	–	–	+	–
6. <i>Nerita articulata</i> (Gould)		+	+	–
7. <i>Neritina</i> (<i>Dostia</i>) <i>violacea</i> (Gmelin)	+	–	–	–
8. <i>Pseudonerita sulculosa</i> (Von Martens)	+	+	+	–
9. <i>Septaria lineata</i> (Lamarck)	+	+	–	+
10. <i>Littorina</i> (<i>Palustorina</i>) <i>melanostoma</i> Gray	–	–	+	–
11. <i>Littorina</i> (<i>Littorinopsis</i>) <i>scabra</i> (Linnaeus)	+	+	–	–
12. <i>Stenothyra deltae</i> (Bensen)	+	+	+	+
13. <i>Stenothyra blanfordiana</i> Nevil	–	+	+	+
14. <i>Assiminea beddomeana</i> Nevil	–	+	+	+
15. <i>Assiminea brevicola</i> (Pfeiffer)	–	+	+	+
16. <i>Assiminea francesiae</i> (Wood)	+	–	–	–
17. <i>Thiara</i> (<i>Thiara</i>) <i>scabra</i> (Muller)	+	–	–	–
18. <i>Telescopium</i> (<i>T</i>) <i>telescopium</i> (Linnaeus)	+	+	+	+
19. <i>Cerithidea</i> (<i>Cerithideopsis</i>) <i>cingulata</i> (Gmelin)	+	+	+	+
20. <i>Natica tigrina</i> (Roeding)	–	–	+	+
21. <i>Nassarius stolatus</i> (Gmelin)	–	+	+	–
22. <i>Pugilina cochlidium</i> (Linnaeus)	–	–	+	+
23. <i>Ellobium</i> (<i>Auricula</i>) <i>gangeticum</i> (Pfeiffer)	–	+	+	+
24. <i>Ellobium aurisjudae</i> (Linnaeus)	+	+	–	–
25. <i>Melampus pulchella</i> Petit	+	–	+	–
26. <i>Pythia plicata</i> (Gray)	+	+	+	–
27. <i>Onchidium tigrinum</i> Stoliczka	–	+	+	–
MOLLUSCA-BIVALVIA				
28. <i>Scaphula deltae</i> Blandford	–	+	–	–
29. <i>Anadora granosa</i> (Linnaeus)	–	–	+	–
30. <i>Modiolus striatulus</i> (Hanley)	–	–	+	–

Table 2. (Contd.)

Taxa	Zone 1	Zone 2	Zone 3	Zone 4
31. <i>Crassostrea gryphoides</i> Newton & Smith	—	—	+	+
32. <i>Meretrix meretrix</i> Lennaeus	+	+	+	+
33. <i>Pelcyora trigona</i> (Reeve)	—	+	—	—
34. <i>Donax incarnatus</i> Schroter	—	—	+	+
35. <i>Macoma birmanica</i> (Philippi)	—	—	+	+
36. <i>Solen brevis</i> Gray	—	+	+	+
37. <i>Silqua albida</i> Dunker	—	+	—	+
38. <i>Corbicula striatella</i> Deshayes	+	—	—	—
39. <i>Tellina</i> sp.	—	+	+	+
ANNELIDA-POLYCHAETA				
40. <i>Lepidonotus tenuisetosus</i> (Gravier)	—	—	—	+
41. <i>Anaitides madeirensis</i> (Langerhans)	—	+	—	—
42. <i>Sigambra constricta</i> (Southern)	—	—	—	+
43. <i>Talehsapia annandalei</i> Fauvel	—	+	+	—
44. <i>Dendronereides heteropoda</i> Southern	+	+	+	+
45. <i>Namalycastis indica</i> (Southern)	—	+	—	—
46. <i>Neanthes chingrighattensis</i> (Fauvel)	+	+	—	—
47. <i>Glycera</i> sp.	—	—	+	—
48. <i>Eunice aphroditois</i> (Pallas)	—	—	+	—
49. <i>Diopatra cuprea</i> (Bosc)	—	—	+	+
50. <i>Lumbrineris polydesma</i> (Southern)	—	+	+	
51. <i>Polydora</i> sp.	—	—	+	—
52. <i>Poletamilla leptochaeta</i> Southern	+	—	—	—
53. <i>Nepthys polybranchia</i> Southern	—	+	+	+
ANNELIDA-OLOGOCHAETA				
54. <i>Limnodrillus</i> sp.	+	—	—	—
ECHIURA				
55. <i>Anelassorhynchus microrhynchus</i> (Prashad)	—	+	+	+
56. <i>Anelassorhynchus branchiorhynchus</i> (Annadale & Kemp)	—	+	+	+
SIPUNCULA				
57. <i>Phascolosoma arcuatum</i> (Gray)	—	+	+	+
MACRURA-ALPHEIDAE				
58. <i>Alpheus paludicola</i> Kemp	—	+	+	+

Table 2. (Contd.)

Taxa	Zone 1	Zone 2	Zone 3	Zone 4
ANOMURA				
59. <i>Clibanarius padavensis</i> de Man	—	+	+	—
60. <i>Diogenes</i> sp.	—	—	—	+
61. <i>Coenobita cavipes</i> Stimpson	—	—	—	+
BRACHYURA				
62. <i>Euricarcinus</i> sp.	—	+	+	+
63. <i>Sesarma biddens</i> (De Haan)	—	+	+	—
64. <i>Sesarma tetragona</i> (Fabricius)	—	—	+	+
65. <i>Sesarma edwardsi</i> de Man	+	—	—	—
66. <i>Metapograpsus messor</i> (Forsk.)	—	+	+	+
67. <i>Metapograpsus maculatus</i> H. M. Edwards	—	—	+	+
68. <i>Metaplax intermedia</i> de Man	+	—	—	—
69. <i>Metaplax dentipes</i> (Heller)	—	+	+	—
70. <i>Scylla serrata</i> (Forsk.)	+	—	—	—
71. <i>Ocypoda macrocera</i> H. Milne-Edwards	—	—	—	+
72. <i>Uca (Deltuca) dussumieiri</i> Spinata	—	—	+	—
73. <i>Uca (Deltuca) rosea</i> (Tweedie)	—	—	+	+
74. <i>Uca (Celuca) triangularis</i> Crane	—	—	+	+
75. <i>Dotilopsis brevitarsis</i> (de Man)	—	—	+	—
76. <i>Dotilla blanfordi</i> Alcock	—	+	—	—
77. <i>Tympanomerus gangeticus</i> Kemp	—	—	+	—
78. <i>Macrophthalmus</i> sp.	—	—	+	—
ASTEROIDEA				
79. <i>Astropecten indicus</i> Doederlein	—	+	+	+
OPHIUROIDEA				
80. <i>Amphioplus tenuis</i> (H. L. Clark)	—	+	—	+
81. <i>Ophiactis delagoa</i> Balinsky	—	—	—	+
INSECTA; DIPTERA; CHIRONOMIDAE				
82. <i>Chironomus</i> sp.	+	+	+	—
NEMERTINA				
83. <i>sp. n. det</i>	—	—	+	+
TOTAL NUMBER OF TAXA	22	44	58	39

Table 3. Number of macrobenthic taxa of major groups recorded from different Stations and Zones (Combined).
Figures in parentheses indicate approximate percentage composition.

Macrobenthic groups	Number of species											
	Zone-1			Zone-2				Zone-3				Zone-4
	Station-I	Station-II	Combined	Station-III	Station-IV	Station-V	Combined	Station-VI	Station-VII	Station-VIII	Combined	Station-IX
Actinaria	—	—	—	—	1(2.8)	1(2.4)	1(2.3)	2(5.7)	1(2.5)	1(2.2)	2(3.4)	—
Nemertina	—	—	—	—	—	—	—	1(2.8)	1(2.5)	—	1(1.7)	1(2.5)
Bryozoa	—	—	—	1 (2.8)	—	1(2.4)	1(2.3)	—	1(2.5)	1(2.2)	1(1.7)	—
Gastropoda	8(50)	10(50)	12(54)	12(34.3)	14(39)	14(34.1)	15(34)	14(40)	10(26)	15(34)	18(31)	10(25)
Bivalvia	1(6.2)	2(10)	2(11)	4(11.4)	4(11.1)	5(12.2)	6(14)	3(8)	4(10)	5(11)	8(14)	6(15.4)
Polychaeta	3(18.7)	2(10)	3(13.6)	7(20)	6(16.6)	7(17.1)	7(15.9)	4(11.4)	6(15.4)	8(18.2)	9(15.5)	7(17.9)
Oligochaeta	1((6.2)	1(5)	1(5.5)	—	—	—	—	—	—	—	—	—
Echiura	—	—	—	2(5.7)	1(2.7)	2(20.5)	2(4.5)	1(2.8)	1(2.6)	2(4.5)	2(3.4)	1(2.5)
Sipuncula	—	—	—	1 (2.8)	1(2.8)	1(2.4)	1(2.3)	—	1(2.5)	1(2.2)	1(1.7)	1(2.5)
Macrura	—	—	—	—	1(2.8)	1(2.4)	1(2.3)	1(2.8)	1(2.5)	1(2.2)	1(1.7)	1(2.5)
Anomura	—	—	—	1 (2.8)	1(2.8)	1(2.4)	1(2.3)	1(2.8)	1(2.5)	1(2.2)	1(1.7)	2(5)
Brachyura	2(12.4)	3(15)	3(13.6)	6(17.1)	5(13.9)	6(13.6)	6(13.6)	7(20)	11(28.2)	6(13.6)	12(20)	7(18)
Astroidea-Ophiuroidea	—	—	—	—	1(2.8)	2(4.9)	2(4.5)	1(2.8)	1(2.5)	2(4.5)	1(1.7)	3(7.7)
Chironomidae	1(6.2)	1(5)	1(5.5)	1 (2.8)	1(2.8)	—	1(2.3)	—	—	1(2.2)	1(1.7)	—
TOTAL	16	20	22	35	36	41	44	35	39	44	58	39

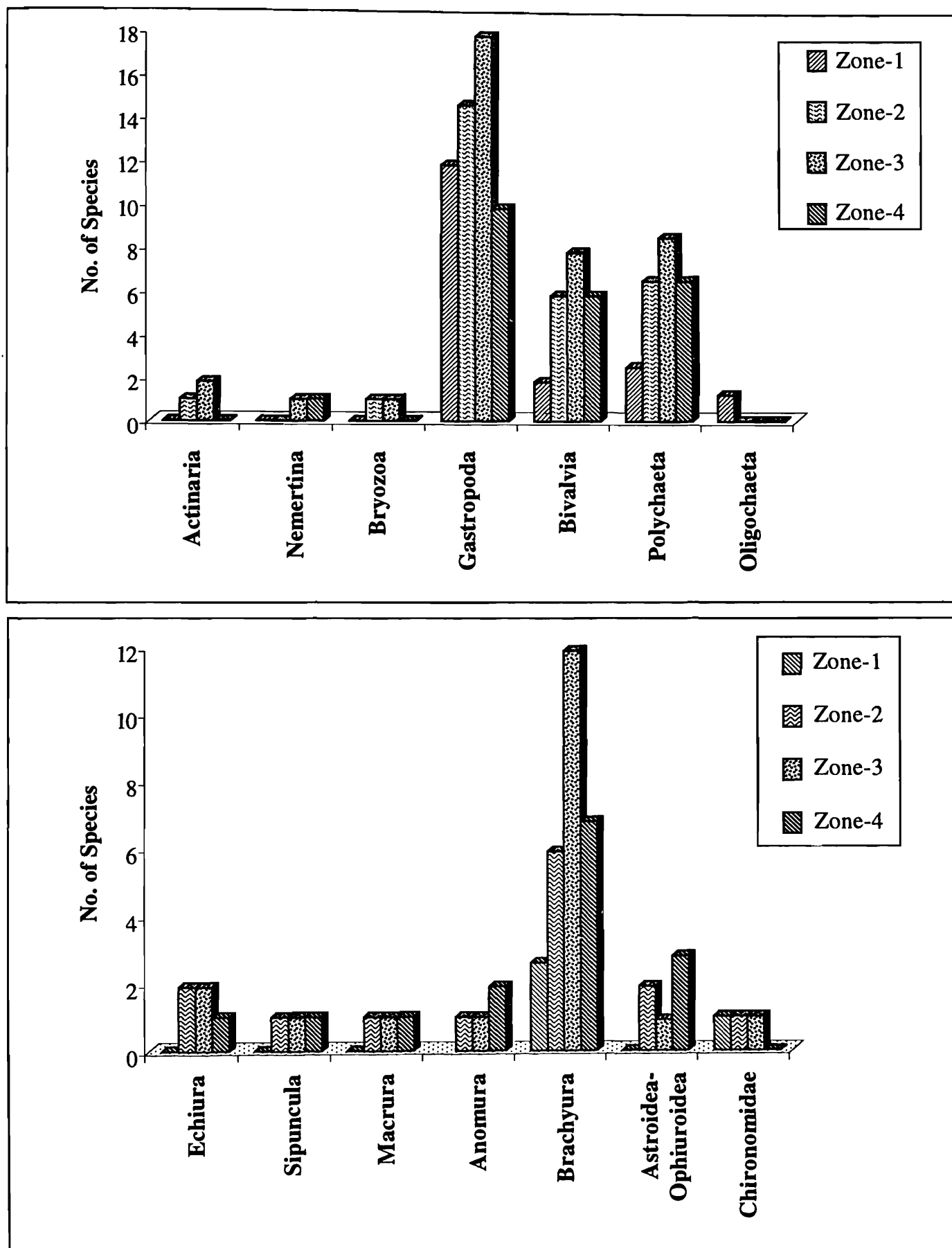


Fig. 4. Number of Species of different macrobenthic groups recorded from different zones.

Table 4. Numerically abundant taxa in different zones.

ZONE-1	ZONE-3
<i>Littorina (Littorinopsis) scabra</i> (Linnaeus)	<i>Assiminea brevicola</i> (Pfeiffer)
<i>Stenothyra deltae</i> (Bensen)	<i>Telescopium (T) telescopium</i> (Linnaeus)
<i>Assiminea francesiae</i> (Wood)	<i>Cerithidea (Cerithideopsisilla) cingulata</i> (Gmelin)
<i>Thiara (Thiara) Scabra</i> (Muller)	<i>Pythia plicata</i> (Gray)
<i>Telescopium (T) telescopium</i> (Linnaeus)	<i>Anadora granosa</i> (Linnaeus)
<i>Cerithidea (Cerithideopsisilla) cingulata</i> (Gmelin)	<i>Meretrix meretrix</i> Linnaeus
<i>Neanthes chingrighattensis</i> Fauvel	<i>Talehsapia annandalei</i> Fauvel
<i>Tubifex</i> sp	<i>Glycera</i> sp
<i>Metaplax intermedia</i> de Man	<i>Diopatra cuprea</i> (Bosc)
	<i>Clibanarius padvensis</i> de Man
	<i>Sesarma tetragona</i> Fabricius
	<i>Metapograpsus messor</i> (Forskal)

ZONE-2	ZONE-4
<i>Assiminea brevicola</i> (Pfeiffer)	<i>Assiminea brevicola</i> (Pfeiffer)
<i>Telescopium (T) telescopium</i> (Linnaeus)	<i>Anadora granosa</i> (Linnaeus)
<i>Cerithidea (Cerithideopsisilla) cingulata</i> (Gmelin)	<i>Meretrix meretrix</i> Linnaeus
<i>Meretrix meretrix</i> Linnaeus	<i>Donax incarnatus</i> Schroter
<i>Silqua albida</i> Dunker	<i>Solen brevis</i> Gray
<i>Talehsapia annandalei</i> Fauvel	<i>Coenobita cavipes</i> Stimpson
<i>Dendronereides heteropoda</i> Southern	<i>Diogenes</i> sp
<i>Euricarcinus</i> sp	<i>Metapograpsus messor</i> (Forskal)
<i>Sesarma biddens</i> (De Haan)	<i>Ocypoda macrocera</i> H. Milne-Edwards

varied between 65/m² in Zone-1 and 126/m² in Zone 3. The density in Zones 2 and 4 were also moderate, with values as 94/m² and 74/m² respectively. Density-wise too, the most abundant macrofaunal group was gastropod in all zones, contributing 41% to 67.0% in Zones 1, 2 and 3. Their contribution in Zone-4 was comparatively lesser (34%) due to considerable increase in the abundance of bivalves, which contributed nearly 19.46% as against their contribution of approximately 6%, 5.3% and 5.5% in Zones 1, 2 and 3 respectively. Polychaetes were almost

Table 5. Variation in density (No/m²) of major macrobenthic groups at different stations and Zones (Combined).
Figures in parentheses indicate approximate percentage composition.

Macrobenthic groups	Number of species											
	Zone-1			Zone-2				Zone-3				Zone-4
	Station-I	Station-II	Combined	Station-III	Station-IV	Station-V	Combined	Station-VI	Station-VII	Station-VIII	Combined	Station-IX
Actinaria	—	—	—	—	2.5	6.5	4.5(4.8)	3	6.5	4	4.5(3.5)	—
Nemertina	—	—	—	—	—	—	—	1	0.5	—	0.5(.4)	1(1.3)
Bryozoa	—	—	—	0.5	0.5	0.5	0.5(.5)	—	1.5	—	0.5(.4)	—
Gastropoda	32	50	41((63)	38.5	48.5	65.4	50.8(54)	70.5	65	67	67.5(53)	26(34)
Bivalvia	3.5	4.5	4(6.1)	6.2	5.3	3.5	5(5.3)	4.8	10.7	5.5	7(5.5)	14.5(19)
Polychaeta	8.5	9.5	9(13.8)	13.5	9.8	18.5	13.9(15)	14.5	12.7	26.8	18(14.3)	6.5(8.5)
Oligochaeta	6	2	4(6.1)	—	—	—	—	—	—	—	—	—
Echiura	—	—	—	0.5	0.5	0.5	0.5(.5)	1	1	—	0.7(.55)	0.5(.65)
Sipuncula	—	—	—	—	1	0.5	0.5(.5)	—	1	0.5	0.5(.4)	0.5(.65)
Macrura	—	—	—	—	2.4	1	0.9(.9)	0.5	1.2	0.8	0.8(.63)	0.5(.65)
Anomura	—	—	—	2.2	6.5	9.3	6(6.4)	5.5	7	14.5	9(7.1)	9(11.7)
Brachyura	3.5	6.5	5(7.7)	7.7	8.2	14.5	10.1(10)	9	18	10.5	12.5(9.9)	13(17)
Astroidea-Ophiuroidea	—	—	—	—	—	1.5	0.5(.5)	7	5	—	4(3.1)	5(6.5)
Chironomidae	3	1	2(3.1)	1	0.5	—	0.5(.5)	—	—	1.5	0.6(.48)	—
TOTAL	56.5	73.5	65	70.1	85.7	121.7	93.7	116.8	130.1	131.1	126.1	76.5

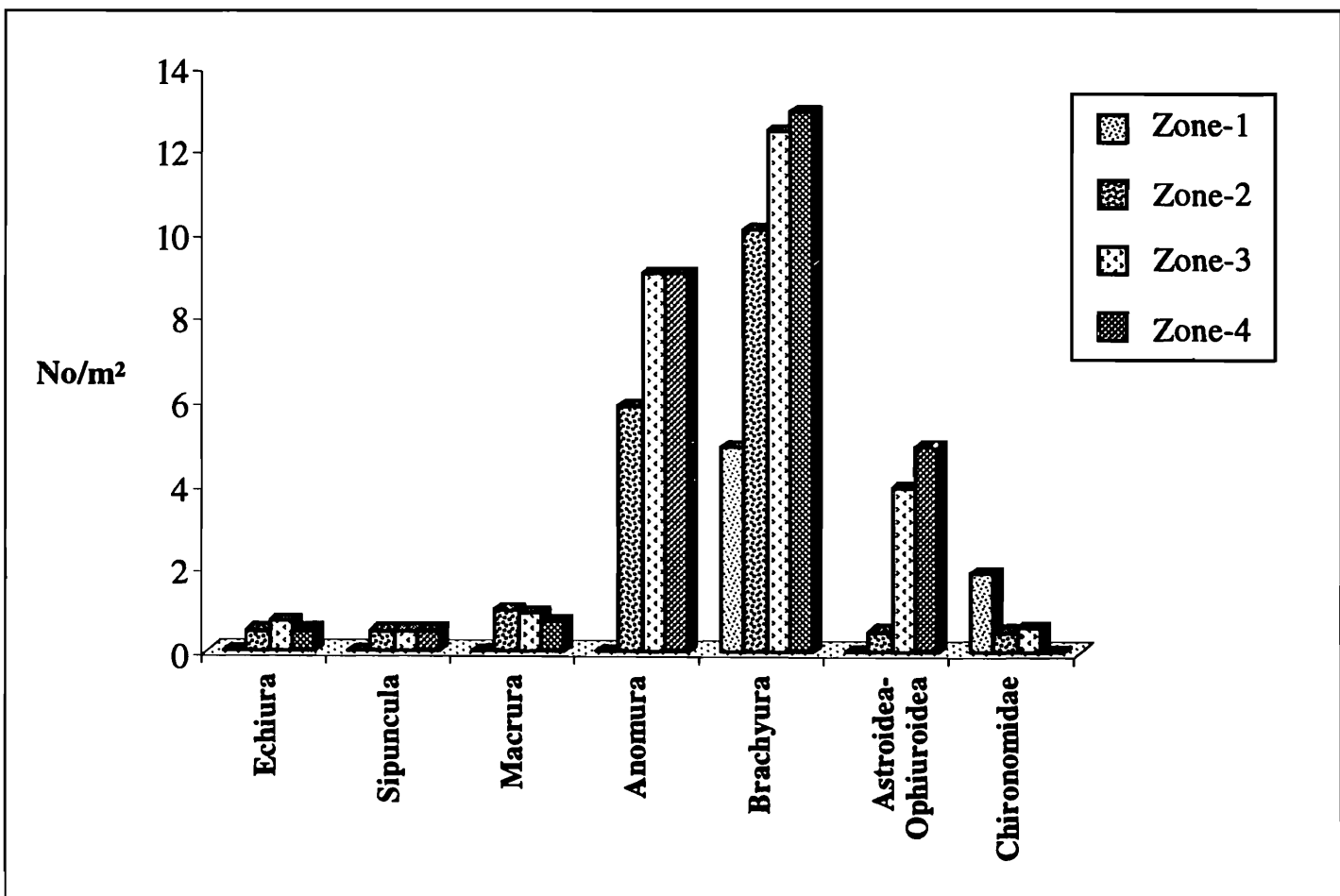
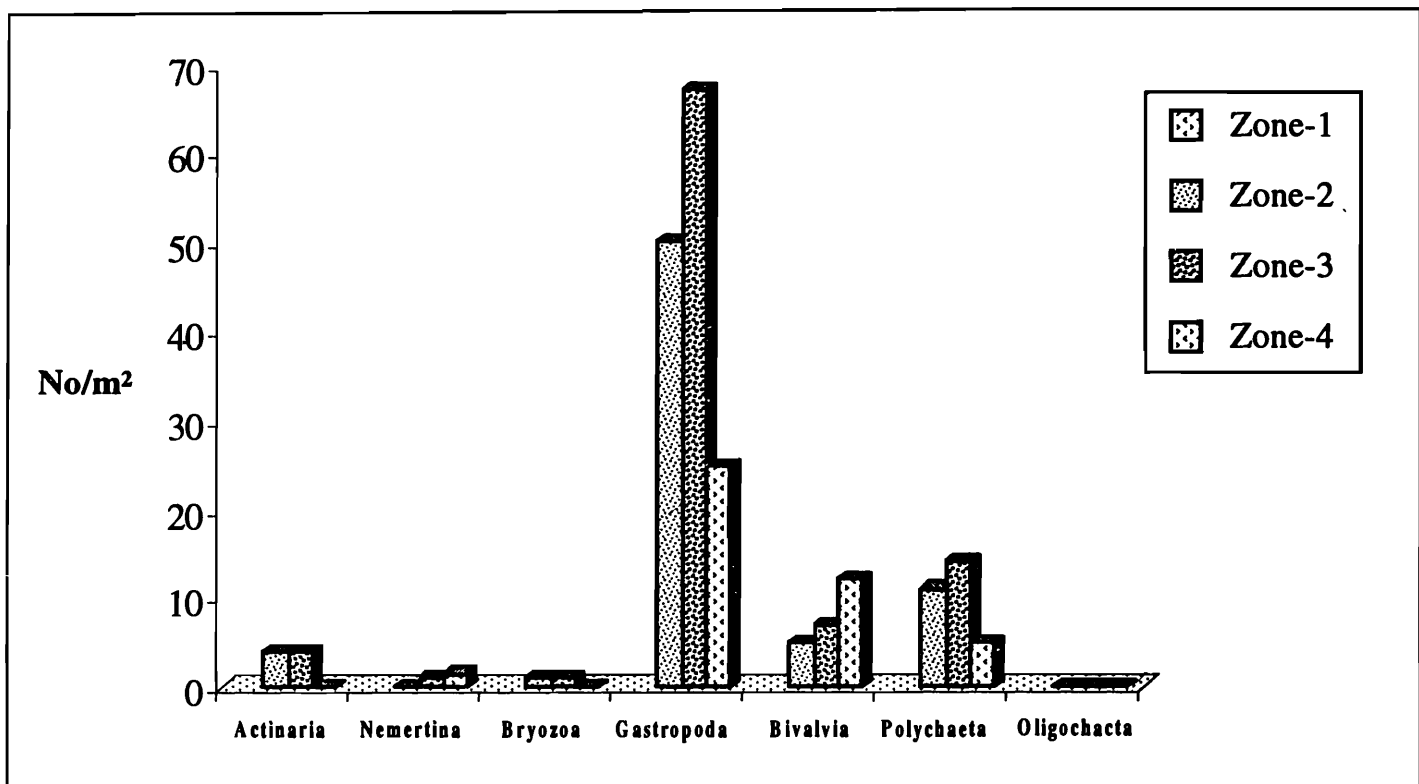


Fig. 5. Variations in mean density of major macrobenthic groups in different zones.

uniformly distributed in Zones 1 to 3, contributing between 14 to 18%. In Zone 4, their contribution was only 8.5%. Because of the occurrence of ocy pod crabs in comparatively higher numbers, the contribution of total brachyuran crabs in Zone-4 was slightly higher (17%), as compared to other zones. The hermit crabs contributed significantly in Zones 2, 3, and 4 and the densities varied between 6.4–11.7%, highest in Zone-4 where two species of sand flat replaced the mud flat species *Clibanarius padvensis*. The contribution of all other groups, except Echinoderms–Asteroidea and Ophiuroidea, were very low.

Biomass

Biomass values of some important groups of macrobenthos are shown zonewise in Figs. 6 and detailed stationwise data are given in Table 6. Like abundance, highest biomass values were recorded from Zone-3 (29.2 g/m²). While gastropods contributed maximum to biomass in Zones 1 to 3, the biomass contribution of bivalves was higher in Zone-3 (6.9 g/m²), as compared to gastropods (2.9 g/m²), which was mainly due to occurrence of large-sized bivalves on sand flats. Polychaetes and brachyuran crabs contributed almost equally in Zones 1 to 3 but the contribution of the latter in Zone 4 was comparatively higher. The ocy pod crabs were responsible for the higher biomass in Zone-4.

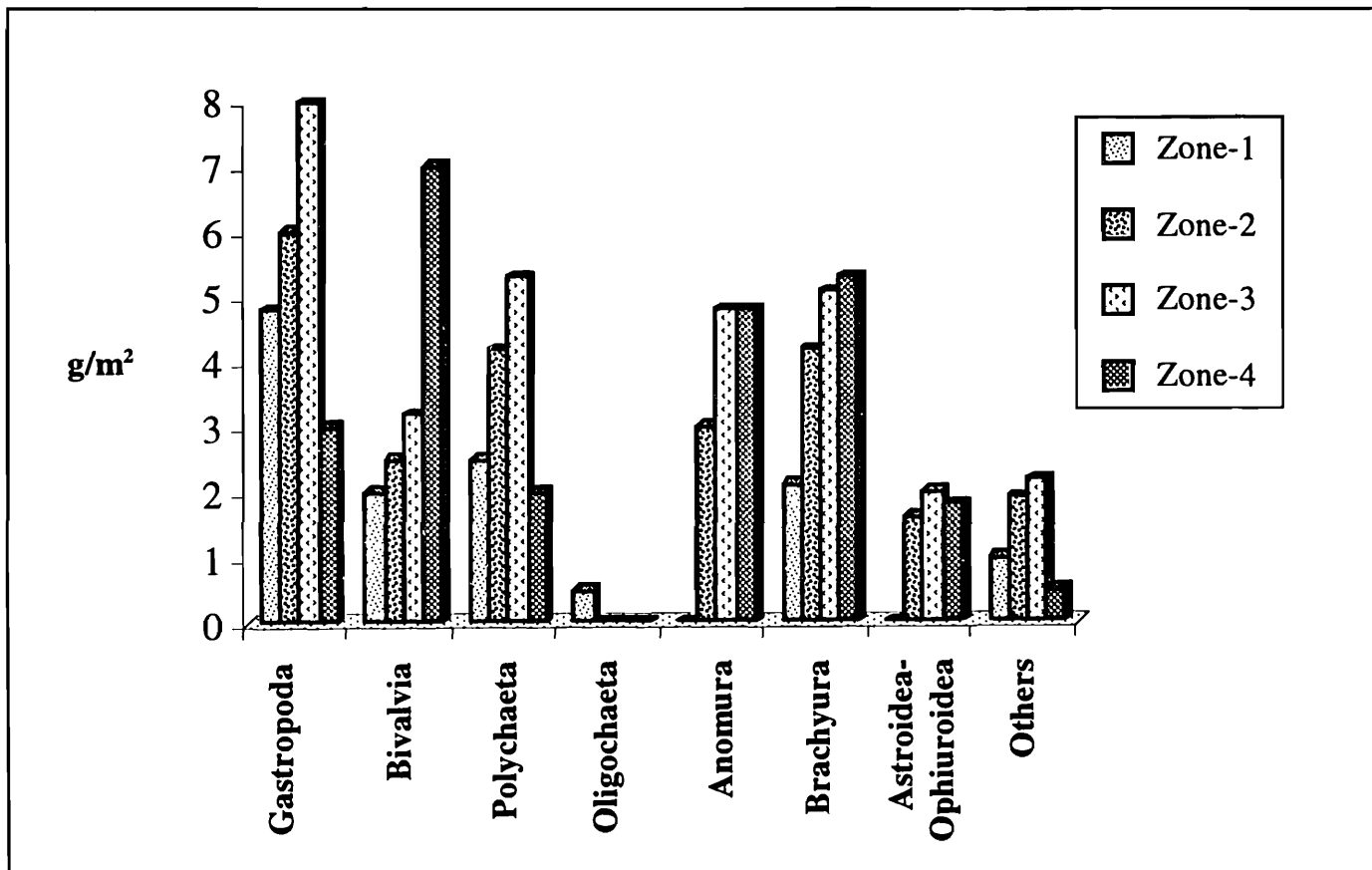


Fig. 6. Variation in mean biomass (g/m²) of some important groups.

Table 6. Variation in biomass (g/m²) of some important macrobenthic groups at different stations and Zones (combined).
Figures in parentheses indicate approximate percentage composition.

Macrobenthic groups	Number of species											
	Zone-1			Zone-2				Zone-3				Zone-4
	Station-I	Station-II	Combined	Station-III	Station-IV	Station-V	Combined	Station-VI	Station-VII	Station-VIII	Combined	Station-IX
Gastropoda	4	5.2	4.6(37)	4.1	5.8	7.2	5.7(26)	8.4	6.7	7.6	7.6(26)	2.9(12)
Bivalvia	1.6	2.2	1.9(15)	3.1	2.8	1.3	2.4(11)	2.3	5.1	2.7	3.4(11)	7(30)
Polychaeta	2.2	3	2.6(21)	2.7	3.6	6.2	4.2(19)	4.4	3.3	8.2	5.2(18)	1.9(8)
Oligochaeta	0.6	0.2	0.4(3.2)	—	—	—	—	—	—	—	—	—
Anomura	—	—	—	1	3	4.2	2.7(12)	2.8	4.6	5.8	4.4(15)	4.4(19)
Brachyura	1	3	2(16)	3.4	2.2	6.4	4(18)	3	7.5	4.5	5(17)	5.2(22)
Astroidea-Ophiuroidea	—	—	—	—	—	3.3	1.1(5)	3	1.8	—	1.6(5)	1.3(5)
Others	1.3	0.6	0.9(7.2)	1.6	1.8	1.5	1.6(7)	2.1	1.7	2.2	2(7)	0.5(2)
TOTAL	10.7	14.2	12.4	15.9	19.2	30.1	21.7	26	30.7	31	29.2	23.2

E. Species diversity and Evenness

Almost all the indices applied (Table 7) revealed high diversity in Zones 2 to 4 and Zone 1 was characterised by lowest diversity. The Menhinick index values ranged between 2.728 and 5.167, Margalef's, between 5.031 and 11.785, Simpson's, between 0.4206 and 0.8958, and Shannon-Weiner's, between 2.118 and 4.560, highest in Zone 3 and lowest in Zone 1. The order of ranking was Zone 3, Zone 2, Zone 4 and Zone 1 in descending order, excepting Simpson's, which interchanged the position of Zones 4 and 3. The evenness values were 0.47, 0.61, 0.71 and 0.58 in Zones 1, 2, 3 and 4 respectively following the same ranking order. The values of Shannon-Wiener index was above three in all zones excepting Zone-1.

F. Similarity

Table 8 gives the values of similarity analysis of both indices, the qualitative of Greig-Smith and quantitative of Romaniszyn between the pairs of different zones. While qualitative index revealed higher similarity between Zones 2 and 3; 3 and 4 and 2 and 4, the quantitative index placed only Zones 2 and 3 close together. However, both indices gave almost similar highest values of similarity between Zones 2 and 3.

Table 7. Species diversity values.

Indices	Zone 1	Zone 2	Zone 3	Zone 4
Species richness (s)	22	44	58	39
Meenhinick Index of Diversity	2.728	4.538	5.176	4.518
Simpson's Diverity Index (D)	0.4206	0.7228	0.8958	0.8330
Shannon-Weeiner Diversity Index (H)	2.118	3.346	4.560	3.086
Pielow Evenness Index (J)	0.470	0.610	0.710	0.580

Table 8. Index of Similarity between Zones.

Pair of zones	Similarity indices	
	Qualitative (Grieg-Smith)	Quantitative (Romaniszyn)
Zone-1 and 2	15.8	18.2
Zones 1 and 3	11.1	12.2
Zones 1 and 4	12.9	10.7
Zones 2 and 3	41.6	41.2
Zones 2 and 4	33.8	12.0
Zone 3 and 4	39.9	16.7

DISCUSSION

The total number of macrobenthic invertebrate taxa recorded during present investigations from Sunderban region of Hugly-Matla estuarine system is very low as compared to number of species recorded by taxonomists. A recent report (Subba Rao, 1995) summarises the number of species recorded from the estuarine system till date. This includes more than 300 species of only those macrobenthic groups that are considered during present study. Although this cumulative figure is based on detailed taxonomic surveys and collections spanning over a century, the currently recorded number of species are also considerably high (Anon, 1995). Such a large discrepancy could be related to two factors. Firstly, the present report is based on quantitative samples collected from very specific measured areas of few randomly selected spots at fixed depth without getting biased to animals occurring outside the demarcated area. Contrary to this, taxonomist made a thorough search of all possible habitats repeatedly including those available in water or attached to mangrove plants and even macrovegetations, over a very large space and for quite a long time, and also collecting those species which are important from taxonomic viewpoints like rare species etc. Further each worker was specialist of a particular group. Such efforts by a very large number of taxonomists are bound to yield considerably higher number of species. Secondly, during the present investigation too, not many efforts were made to take into consideration rarely occurring species, which were not important from general ecological viewpoints.

Even 83 species are taken into consideration, the number is sufficiently large as compared to several earlier reports on this estuary and also on many others. The earlier report from one part of the estuarine system (Bhunja and Choudhury, 1981; Choudhury *et al.*, 1984) lists less than 30 species. A general faunistic survey carried out by Misra and Barua (1987) revealed the existence of 70 species. It appears that many of the species reported earlier (Subba Rao, 1995) are either rare or do not occur in the areas surveyed during present investigations.

Comparatively high species richness and diversity of Sunderban estuarine system is exceptional, as estuaries in general have been reported to be low biodiversity areas because of their quickly changing nature and physically stressful conditions (Mclusky, 1971; Wildish and Kristmanson, 1979; Warwick and Uncle, 1980). However, there are several other estuaries where species richness was considerably high. Elliot and Kingston (1987) reported very high macrobenthic faunal species richness from Fourth estuary (East U.K. Coasts) with 87 species from just two grabs, and Barr *et al.*, (1990) found a total of 78 species from Humber estuary. Recently, Attrill *et al.*, (1996) recorded 200 species of benthic invertebrates (93 macrobenthic and 107 micobenthic) from Chapman Buoy area of Thames Estuary. All these figures are very close to the number of macrobenthic species recorded from Sunderban estuarine system.

The species richness on the mud flats increased progressively from Zone-1 to Zone-3. The lowest number of species was recorded from upper zone of the estuary which was expected, as

environmental stress was comparatively greater in this zone as compared to nearly stable conditions of other zones. As a general rule, species richness increases progressively from upper zone towards the mouths as conditions become more suitable, specially salinity.

Among the factors directly governing such increase in species richness and density, salinity and substrate have been reported to be of utmost importance (Carriker, 1967; Wildish, 1977; Paruleker and Dwivedi, 1977; Warwick and Uncle, 1980). It is clear from the physical composition of benthic sediments of mud-flats that composition changed considerably from Zone-1 to Zones 3 and 4. The high composition of silt in the sediments of lower zone was almost constant during different parts of the year but such changes in the composition of sediments in Zone-2 were quite pronounced. The high species richness in Zones 2 and 3. The high species richness in Zones 2 & 3, where the sediment composition was not very heterogeneous, is also a feature of this estuarine system, as high species richness of benthic fauna is generally associated with sediments of heterogeneous composition. However, the richness of sand flat could be related to such sediment heterogeneity. Increase in faunal diversity and abundance with increasing level of salinity was quite evident and such relationships in estuaries are well known.

Groupwise analysis revealed the dominance of gastropods both in terms of species richness and abundance followed by polychaetes. This important characteristic of Sunderban estuaries is not observed in most of other Indian estuaries. Generally macrobenthos of the estuaries are either dominated by polychaetes followed by bivalves (Purulekar *et al.*, 1975) or vice-versa (Paruleker and Dwivedi, 1974) or polychaetes followed by crustaceans (Untawale and Paruleker, 1976). In Vellar estuary, McIntyre (1967) reported the dominance of crustaceans. The dominance of polychaetes over gastropods have also been reported from other countries too (Atrill *et al.*, 1996). Similar dominance of gastropods on the intertidal flats of this estuarine system has also been observed by earlier workers (Choudhury *et al.*, 1984), Nandi and Choudhury, 1985).

Biotic indices based on quantitative diversity have been widely used in communities of benthic macroinvertebrates in order to assess the biodiversity patterns (Abele and Walters 1974, Clarke and Warwick, 1984). All the indices applied to benthic macroinvertebrates of Sunderban intertidal flats revealed comparatively very high diversity except in Zone-1. Highest diversity was observed in Zone-3. This result tallied well with all other biotic parameters that separated Zone 3.

The similarity analyses very clearly separated Zone-1 from rest of the zones, as the values were lowest in all sets where Zone-1 was involved. Secondly, it showed very high similarity between Zones 3 and 4. Considering the similarity of physico-chemical and biological conditions of these two zones, it was quite expected. The differences in the results obtained by the two types of indices were also evident. While qualitative index of Gerig-Smith gave higher values in several pairs, the quantitative one showed closeness of only one pair. It was probably due to the fact that the latter index also takes into consideration the density, besides species number. There were many species that were common to different zones but their densities differed considerably.

SUMMARY

Benthic macroinvertebrate biodiversity on intertidal flats of Sunderban estuarine region of Hugly-Matla estuarine system was studied between the period 1989 and 1993. Species composition, density and biomass of different groups were determined based on quantitative sampling.

For the purpose of spatial comparison, entire region was divided into four ecologically different zones viz. Mid-estuarine zone of main river Hugly (Zone-1), Hugly lower zone and flats (Zone-2), Thakuran-Matla mud flats (Zone-3) and Matla sand flats (Zone-4).

Quantitative collection over the length of survey revealed the occurrence of 83 taxa from all zones belonging mainly to four major groups, Gastropoda, Bivalvia, Polychaeta and Brachyura. Other groups were represented by a few taxa only. The maximum species richness was recorded from Zone-3 followed by Zone-2, both mud flats in lower zone, and minimum from Zone-1. However, maximum abundance and biomass was contributed by a few numerically abundant species in each zone.

Both abundance and biomass were high on mud flats and least values were obtained from mid estuary. Sand flats reflected a slightly different picture where biomass was higher in comparison to their numerical density. Gastropods dominated both in species richness and abundance in all zones.

To assess the macrobenthic species diversity, several quantitative and qualitative biotic indices were applied. All these indices pointed to high species diversity in all zones except Zone-1. The lower diversity of Zone-1 was related to great environmental stress due to continuously fluctuating tides and lower salinity level and higher diversity of mud flats in lower zone was due to stability of benthic sediments and higher salinity levels.

Both qualitative and quantitative indices of similarities were applied to find out the affinities between different zones. The indices separated clearly Zone-1 from others as most dissimilar. Highest similarity was recorded in case of Zones 2 and 3, both mud flats in lower estuarine zone.

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REFERENCES

- Abele, L. G. and Walters, K. 1979. Marine benthic diversity : a critique and alternative explanation. *Journal of Biogeography*, **6** : 115-126.
- Ajmal Khan, S., Venkatnaidu, E. and Balasubramanyam, K. 1975. Bottom fauna in two regions of vellar estuary In : *Recent Researches in Estuarine Biology* (Ed. R. Natrajan). Hindustan Publishing Corporation (I), Delhi : 255-272.

- Alongi, D. M. 1987. Intertidal zonation and seasonality of meiobenthos in tropical mangrove estuaries. *Marine Biology*, **95** : 447-458.
- Andrews M. J., Aston, K. F. A. and Richard, D. G. 1980. Rehabilitation of inner Thames estuary. *The London naturalist*, **51**. 30-61.
- Anon. 1995. *Hugly-Matla Estuary, West Bengal*. Zool. Surv. India Estuarine Ecosystem Series, Part 2.
- Ansell, A. P., Sivadas, P., Narayan, B. Sankaranarayan, V. N. and Trevallion, A. 1972. The ecology of two sandy beaches in South West India. 1. Seasonal changes in physical and chemical factors and macrofauna. *Mar. Biol.*, **17** : 38-62.
- Attril, M. J., Ramsay, P. M., Myles Thompson, R. and Trett, M. W. 1996. An estuarine biodiversity hot-spot. *J. mar. biol. Ass. U.K.*, **76** : 1161-1175.
- Balasubramaniam, K. 1960. Studies on the ecology of Vellar estuary. 3. Littoral and estuarine polychaetes. *J. Annamalai Univ., Sc.*, **29** : 199-207.
- Barr, R., Watson, P. G., Ascroft, C. R., Barnett, B. E. and Hilton, C. 1990. Humber estuary – a case study, *Hydrobiologia*, **195** : 127-143.
- Bhunja, A. B. and Choudhury, A. 1981. Observation on the hydrology and quantitative studies on benthic macrofauna in a tidal creek of Sagar Island. *Proc. Nat. Acad. Sci.*, **B 47** : 398-407.
- Brady, F. 1993. The distribution of the fauna of some intertidal sand and mud on the Northumberland coast. *J. Anim. Ecol.*, **12** : 27-41.
- Carriker, M. R. 1967. Ecology of estuarine benthic invertebrates, a perspective. In : *Estuaries* (Ed. G. F. Luff) pp. 442-487. American Association for the Advancement of Science, Washington, D.C.
- Choudhury, A., Bhunia, A. B. and Nandi, S. 1984. Preliminary survey on Macrobenthos of Printice Island, Sunderbans, West Bengal. *Rec. zool. Surv. India*, **81** : 81-92.
- Clarke, K. R. and Warwick, R. M. 1994. *Changes in Marine Communities : An Approach to Statistical Analysis and Interpretation*. Plymouth Marine Laboratory.
- Dawn, W. F. 1971. A preliminary list of macrofauna from a mangrove forest and adjacent biotops at Swin Island, Western Peninsular Thailand. Phuket marine Biological Centre, Phuket. *Thailand Research Bulletin* No. 17.
- Dwivedi, S. N., Rahim, A. and Ayappan Nair 1975. Ecology and Production of intertidal sand fauna during south west monsoon along Mondovi Estuary (Goa). In : *Recent Researches in Estuarine Biology* (ed. R. Natrajan). Hindustan Publishing Co. (I), New Delhi : 1-76.
- Elliot, M. and Kingston, P. F. 1987. The sublittoral benthic fauna of the estuary and Firth and Forth, Scotland. *Proceedings Royal Soc. Edin.* **B**, **93** : 449-465.
- El Wakeel, S. K. and Riley, J. P. 1956. The determination of organic carbon in marine mud. *J. du Consell.*, **22** : 180-183.

- Fernando, O. J. 1987. Studies on intertidal fauna of Vellar estuary, Port Novo. *Mahasagar-Bulletin of National Institute of Oceanography*, **16** : 341-348.
- Govindan, K., Varshney, P. K. and Desai, B. 1983. Benthic studies in south Gujarat estuaries. *Mahasagar-Bulletin of National Institute of oceanography*, **16** : 349-356.
- Greig-Smith, P. 1964. *Quantitative Plant Ecology*. Butterworth.
- Holme, N. A. 1949. The fauna of sand and mud bank near the mouth of the Eye estuary, *J. mar. biol. Ass. U.K.*, **28** : 189-237.
- Khan, R. A. 1995. Ecology of Hugly-Matla estuarine system. In : *Zool. Surv. India, Estuarine Ecosystem Series, Part 2, Hugly Matla Estuary, West Bengal* : 417-465.
- Khan, R. A. 1995. Ecology of Kulti estuary with reference to discharge of Calcutta Metropolitan sewage. *Ibid* : 465-496.
- Khayralla, N. and Jones, A. M. 1975. A survey of the benthos of Tay estuary. *Proceedings Royal Soc. Edinburgh*, **B 75** : 113-135.
- Krumbein, W. C. and Pettijhon, E. B. (eds.) 1938. *Manual of sedimentary petrography*. Appleton Century-Craft, New York : 549 pp.
- Margalef, R. 1951. Diversidad de especies en las comunidades naturales. *Publnes Inst. Biol. Appl. Barcelona*, **9** : 5-27.
- Maurer, D. W., Leathern, W., Kinner, P. and Tinsman, J. 1979. Seasonal fluctuations in coastal benthic invertebrate assemblage. *Estuarine and Coastal Marine Science*, **8** : 181-193.
- McLachlan, A. 1971. Composition, distribution, abundance and biomass of the macrofauna of four sandy beaches. *Zool. Afr.* **12** : 279-306.
- McIntyre, A. B. 1964. Meiofauna and macrofauna of some tropical beaches. *J. Zoo. London*, **156** : 377-392.
- McLusky, D. S. 1971. *Ecology of Estuaries*, London : Heinemann Educational.
- Menhinick, E. F. 1964. A comparison of some species diversity indices applied to the samples of filed insects. *Ecology*, **45** : 859-861.
- Misra, A. and Barua, S. 1987. The intertidal distribution of macro-fauna on the muddy shore of Matla river, Canning, West Bengal. *J. Indian Soc. Coastal agric. Res.*, **51** : 339-346.
- Nandi, S. and Choudhury, A. 1993. Quantitative studies on benthic macrofauna. *Mahasagar-Bulletin of National Institute of oceanography*, **16** : 409-414.
- Panikker, N. K. and Aiyer, R. G. 1977. The brackishwater fauna of Madras. *Proc. Indian Acad. Sci.*, **B 6** : 284-337.
- Parulekar, A. H., Rajanikan, V. and Dwivedi, S. N. 1975. Benthic studies on Goa estuaries : *Indian J.mar. Sci.*, **4** : 202-205.
- Pielow, E. C. 1969. *An Introduction to Mathematical Ecology*. Weily, New York. 286 pp.

- Romaniszyn, W. 1970. An attempt at interpreting agglomerative tendencies of animals based on definition of similarity and distance. *Wiskad. Ekol*, **14** : 306-327.
- Spooner, G. M. and Moore, H. B. 1940. The ecology of Tamer estuary. VI. An account of macrofauna of intertidal mud. *J. mar. biol. Ass. U.K.*, **24** : 283-330.
- Sasekumar, A. 1974. Distribution of macrofauna on a Malayan mangrove shore. *J. Anim. Ecol.*, **34** : 51-69.
- Subba Rao, N. V. 1995. A faunal appraisal of Hugly-Matla estuarine complex. In : *Zool. Surv. India, Estuarine Ecosystem Series, part 2, Hugly Matla Estuary, West Bengal* : 1-8.
- Untawale, A. G. and Puruleker, A. H. 1976. Some observation on the ecology of estuarine mangrove of Goa. *Mahasagar-Bulletin of National Institute of Oceanography*, **9** : 57-62.
- Warwick, R. M. and Uncle, R. J. 1980. The distribution of benthic macrofauna associations in Bristol Channel in relation to tidal stress. *Marine Ecology Progress Series*, **3** : 97-103.
- Wildish, D. J. and Kristmanson, D. D. 1979. The energy and sublittoral macrobenthic animals in estuaries. *J. Fish. Res. Bd. Canada*, **36** : 1197-1206.
- Wolff, W. J. 1973. The estuary, as a habitat. An analysis of the data on the soft bottom macrofauna of estuarine area of Rivers Rhine, Meuse and Scheldt. *Zoologische verhandelingen*, **126** : 1-242.

PLATE - I



Exposed mud flats at Sunderban

DIVERSITY OF SCOLOPENDRID CENTIPEDES (CHILOPODA : SCOLOPENDROMORPHA) IN HIMALAYAN ECOSYSTEM AND ADJACENT AREAS—A REVIEW

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INTRODUCTION

The present paper deals with the species diversity represented by the Scolopendrid centipedes in the Himalayan ecosystem from Northwest to Northeastern Himalaya through Central Himalaya, Myanmar, Bhutan, Tibet to Bangladesh, in the east and Kashmir, Pakistan, Afghanistan and China in the north and Northwest (Map-1).

The majority of the species listed is, either based on the collection actually studied by the author or from the records of the distribution of the species available through literature. Barring a few recent collections from Northwestern Himalaya and Western Himalaya the majority of the old collection (studied by the author) dates back to the late 19th century or early 20th century (specially from NE States). Therefore, it cannot be said with a reasonable certainty if those species still exist in nature or not, owing to large-scale destruction of their natural habitat over the period of time. At the same time a large invasion of foreign elements cannot also be ruled out.

According to a latest report of the Center International De Myriapodologie, France (CIM Web, 2002) the Scolopendrid centipedes are known globally by 620 species referable to 34 genera and 3 families, of which India alone supports precisely 102 species, as check listed by Khanna (2001), roughly comprising 16.5% of the global diversity. These 102 species are spread over 8 genera of the family Scolopendridae and 3 genera of the family Cryptopidae, thus representing approximately 33% of the genera and 66% of the families.

While reviewing the literature the present author arranged the distribution of the species occurring in the Himalayan region, in the tabular form appended. The table includes not only the Indian species occurring in the Himalayan belt but also the species that occur in other South Asian Himalayan countries around, such as Pakistan, Afghanistan, China, Tibet, Bhutan, Myanmar, Nepal and Bangladesh, whose external boundaries either touch or lie in the mountain chain. The results of the tabulation of the distribution of the species are quite encouraging and interesting, so far, as the zoo-geographical pattern of the distribution of the species are concerned.

Out of a total of 75 species that found their distribution in the area, the **Indian Himalayan belt represents 53 species**, some of which extend to China, Myanmar, Bhutan, Nepal, Bangladesh or Pakistan, in the Himalayan belt. Some of the species are restricted in their distribution to Western Himalaya or Northwestern Himalaya, Central Himalaya or Eastern Himalaya. While some species have overlapping range of their distribution in the Himalayan belt, extending down to Deccan Plateau.

While Myanmar represents 25 species, Bhutan represents 3; Bangladesh and Pakistan one each; Nepal and China represents 11 and 15 species.

As can be seen from the table there are 6 species each exclusively representing Myanmar and China, 4 to Nepal and one each to Bhutan and Bangladesh. Distribution of some of the species which are exclusive to such countries in the Himalayan belt have, however, been recorded in the Indian subregion in Indo-gangetic plains or further south in Deccan Plateau, but not found distributed in the Indian chain of mountains.

Out of the 53 species that occur in the Indian chain of Himalaya, 29 species represents Western Himalaya; 27 species represents Northwestern Himalaya, 13 to Central Himalaya and 26 species represents North Eastern Himalaya.

It is further interesting that out of the 75 species, 31 species have their homes in Himalayas as their type localities. The author invites the discussions from the colleagues and scientific fraternity on the pattern of distribution, restricted patchiness or endemism within Scolopendromorpha.

HIMALAYAN ECOSYSTEM AND ITS PHYSIOGRAPHY

The Himalaya is the highest and the youngest chain of mountains containing most of the world's highest eight thousander peaks. It extends un-interrupted from Pamir Knots in the extreme northwest in a smooth curve of about 2500 km to Arunachal Pradesh in the east covering around 500,000 km². The width of these mountains decreases from about 400 km in the west to about 150 km in the east. The traditional limits being Indus valley in the west to Brahmaputra valley in the east. The entire system consists of sedimentary rocks. The Himalaya took about 6 or 7 million years to rise and erosion continued to lower the surface. It was after a substantial uplift that the mountains have attained the tremendous height while the climate has established in the Himalaya. In the eastern Himalaya, where the rise of mountains is abrupt and has more rainfall, the occurrence of humid fauna of the tropical areas has increased. On the western Himalaya even at a lesser altitude the fauna of sub-humid area is present. However, at greater heights in the eastern Himalaya the temperate fauna is prevalent.

GEOGRAPHICAL AND BIOGEOGRAPHICAL DIVISIONS OF THE HIMALAYA

Geographically the Himalaya is divided into :

1. **The Punjab (Or the Northwestern Himalaya)** (560 km) lying between river Sutlej to Mt. Nanga Parbat, west of which River Indus curves round south-westwards and includes the whole of the state of Himachal and Jammu and Kashmir.
2. **The Kumaon (or the Western Himalaya)** (320 km) lying between river Kali and the great defile of R. Sutlej and comprises Garhwal and Kumaon Himalaya.
3. **The Nepal (or the Central Himalaya)** (900 km) lying between River Kali in the west to river Tista in the east. The southern boundary of these Himalaya lies in the Terai while the spurs from the main Himalaya occupy the north. The division includes a part of Sikkim. In the Sikkim where the Assam Himalaya passes into Nepal Himalaya there is also a change of alignment, with the ranges on the west extending from east – a little north of west.
4. **The Assam (or the Eastern Himalaya)** (720 km) comprises a portion between Namcha Barua Peak (7750 m), east of which R. Brahmaputra curves southwards and R. Tista to the west. In this division there is a very little sub Himalayan tract so that Himalaya rises abruptly from the plains.

(Note : Collection made from the NE States like Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura and West Bengal (hills) have been included under Eastern Himalaya).

PATTERN OF DISTRIBUTION OF SPECIES

Ecology of nearly the whole of India, perhaps with the exception of higher Himalaya, above timberline particularly to the west of Nepal, is dominated by the rhythm of monsoon rainfall climate. The ecology of only high altitude is characteristically temperature dominated. The whole of the Indian sub-continent is not rich only in biological or ecological diversity but because it lies at the confluence of African, European and Indo-Malayan realms, the biota, therefore, includes, African, European, Eurasian and Mediterranean elements. The Palaearctic, Ethiopian, Indo-Chinese or Indo-Malayan and endemic fauna and flora meet and intermingle here giving rise to a characteristic distribution patterns, contributing to the outstanding peculiarities of the biogeographical evolution.

The very idea for the above concept also came from the theory of continental drift that the continents of south and north America, Africa, Peninsular India, Australia and Antarctica once united in one land mass (Gondwanaland) are now widely separated by southern Ocean and bear striking similarity of geological history and distribution of ancient and modern organisms.

SPECIES DIVERSITY IN HIMALAYAN ECOSYSTEM AND ADJACENT AREAS

(Chilopoda : Scolopendromorpha)

Sl. no	Name of the species	Status	Type Locality	Western Himalaya	NW Himalaya	Central Himalaya	Eastern Himalaya	Adjacent areas of Himalaya	Elsewhere, in India OUTSIDE INDIA	References
1	2	3	4	5	6	7		9	10	11
Family : SCOLOPENDRIDAE Subfamily : SCOLOPENDRINAE Tribe 1 : SCOLOPENDRINI										
1.	<i>SCOLOPENDRA morsitans</i> Linn.	Cosmopolitan	India	+	+	+	+	+	Throughout	Khanna, 2001
2.	<i>Scolopendra amazonica</i> Bucherl	Circumtropical	Amazona	+	-	-	-	-	Delhi, Goa, Gujarat, Kerala, Karnataka, MP, Rajasthan, and UP : BRAZIL, NORTH AND SOUTH AMERICA, AUSTRALIA AND SUDAN, BULGARIA, CROATIA, GENEVA, TURKEY, THAILAND, ROMANIA, ENTIRE MEDITERRANEAN REGION	
3.	<i>Scolopendra indica</i>	Indian	Kulu (HP)	-	+	-	-	-	-	Meinert 1886, Attems, 1930

4.	<i>S. mazbii</i> Gravely	Indian	Upper Rohtang (HP)	-	+	-	-	-	-	Gravely, 1912
5.	<i>S. pinguis</i> Pocock	Indo-Malayan	Karenberg (Myanmar)	-	-	-	-	Myanmar	JAVA	Pocock, 1895
6.	<i>S. subspinipes de haani</i> Brandt	Indo-Malayan	?	+	-	-	+	Myanmar, Bangladesh, China	A & N Isls; MALAYA, SUMATRA, JAVA, THAILAND	Gravely 1910; Ahmed, 1980 & Khanna, 2001
7.	<i>Scolopendra subspinipes subspinipes</i> Leach			-	-	-	-	Myanmar, China		
8.	<i>S.s.multidens</i> Newport	Oriental	?	-	-	-	-	China	-	Attems, 1930
9.	<i>S.septumspinosa</i> Brandt	Oriental	?	-	-	-	-	China	-	Attems, 1930
10.	<i>Scolopendra subspinipes mutilans</i> Koch			-	-	-	-	China	-	-
11.	<i>S. calcarata</i> Porath	Oriental	?	-	-	-	-	China	-	Attems, 1930
12.	<i>Scolopendra afer</i> (Meinert)	Ethiopian	?	-	-	-	+	-	ZANZIBAR, AFRICA AND KILMANDZARO	Attems, 1930; Khanna (Unpublished record)
13.	<i>Psiloscolopendra feae</i> (Pocock)	?	Karenberg (Myanmar)	-	-	-	-	Myanmar	-	Attems, 1930
14.	CORMOCEPHALUS <i>dentipes</i> Pocock	Indian	Bengal ?	+	+	-	+	-	A & N Isls., Bihar, Delhi, Madhya Pradesh, Orissa, West Bengal, Uttar Pradesh.	Khanna, 1987, 1995a,b,c, 2001, Khanna and Kumar, 1984; Khanna & Tripathi, 1985 and Jangi & Dass, 1984
15.	<i>Cormocephalus pygmaeus</i> Pocock	Indian	Madras (T. N.)	+	+	+	+	Nepal, Myanmar	A&N Isls., Bihar, Maharashtra, Rajasthan, Uttar Pradesh, Tamilnadu, and West Bengal.	Khanna, 1994a, 1995; Khanna and Kumar, 1984, Khanna and Tripathi, 1984; Lewis, 1992; Vazirani and Khanna, 1976.

Tribe 2 : Asanadini										
16.	<i>ASANADA indica</i> Jangi and Dass	India	Pune : Maharashtra	+	+	-	-	-	Delhi, Haryana, HP, Kerala, Maharashtra, Rajasthan, Uttar Pradesh	Jangi & Dass, 1984, Khanna, 1987, 1995, 1997 & 2001
17.	<i>Asanada brevicornis</i> Meinert	Palearctic, Oriental, Ethiopian and Indo-Malayan extending to Australia	Kulu (HP)	-	+	-	-	Myanmar	A & N Isl., Delhi, Haryana, Gujarat, Rajasthan and Maharashtra; Australia, MYANMAR, REEF ISLAND, NEW GUINEA (MOROCCO)	Attems, 1930; Ahmed, 1980 : Jangi & Dass, 1984; Khanna, 2001
Subfamily : OTOSTIGMINAE										
Tribe 3 : OTOSTIGMINI										
18.	<i>OTOSTIGMUS</i> <i>amballae</i> Chamberlin	Indian	Ambala (Haryana)	+	+	+	-	Nepal UP	Haryana, HP and	Chamberlin, 1913, Khanna, 1987, 1994, 1995, 2001 and Lewis, 1992
19.	<i>Otostigmus burn-</i> <i>murdochi</i> Gravely	Indian	Kulu (H.P.)	-	+	-	-	-	-	Gravely, 1912
20.	<i>Otostigmus ceylonicus</i> Haase	Oriental	Paradeniya, Sri Lanka	+	+	-	+	Myanmar, Bhutan	Maharashtra, Uttar Pradesh, SRI LANKA, SEYCHELLES	Attems, 1930; Khanna, 1994c and Khanna and Tripathi, 1986.
21.	<i>Otostigmus feae</i> Pocock	-	Myanmar	-	-	-	-	Myanmar	-	Attems, 1930
22.	<i>Otostigmus glaber</i> Chamberlin	Oriental	?	-	-	+	-	Nepal	INDONESIA, FIJI	Attems, 1930
23.	<i>Otostigmus geophilinus</i> Haase	Indo-Malayan	Java	-	+	-	+	Mergui Archipe- lago (Myanmar)	OWENS ISLAND, JAVA, TIMOR	Khanna (in press, 2001) and Khanna and Tripathi, 1986

24.	<i>Otostigmus kashmirensis</i> Lewis	Palearctic	Pahalgam (J & K)	-	+	-	-	-	-	Lewis, 1992; Khanna, 2001
25.	<i>Otostigmus insularis</i> Haase	Oriental	Sri Lanka	-	+	-	+	Bhutan	A & N Isl., West Bengal. SRI LANKA and SEYCHELLES	Gravely, 1910, 1912b : Khanna, 1994c and Khanna and Tripathi, 1986
26.	<i>Otostigmus martensi</i> Lewis	-	Nepal	-	-	+	-	-	-	Lewis, 1992
27.	<i>Otostigmus metallicus</i> Haase		Sangir Island, Sri Lanka	-	-	+	+	Sikkim	West Bengal, BORNEO, SRI LANKA	Khanna, unpublished record
28.	<i>Otostigmus morsitans</i> Haase	Indian	Madras (TN)	+	+	-	-	Myanmar	Uttar Pradesh, Tamilnadu; SRI LANMKA;	Attems, 1930; Khanna, in press, 1998 and 2001
29.	<i>Otostigmus nudus</i> Pocock	Indian	Madras (TN)	+	+	-	+	-	Tamilnadu and Uttar Pradesh	Khanna, 1987, 1994, 1995 and Khanna and Kumar, 1984
30.	<i>Otostigmus oatesi</i> Kraepelin	Indo- australian	"British Burma"	-	-	-	+	Myanmar	-	Khanna, 1994
31.	<i>Otostigmus oweni</i> Pocock	Indian	Mergui Archipelago (Myanmar)	-	-	-	+	Myanmar	-	Attems, 1930; Khanna, 1991
32.	<i>Otostigmus p. politus</i> Karsch	Indo- australian	Tienstein, Tsingtau, China	+	+	+	+	China, Myanmar	Delhi, Kerala, Maharashtra, Orissa, and West Bengal; SUMA- TRA, CHINA, NEW GUINEA, AUSTRALIA	Attems, 1930, Khanna, 1994c, 1997 and 2001
33.	<i>Otostigmus p. quadrispinosus</i> Khanna	Indian	Almora (Uttaranchal)	+	+	-	-	-	-	Khanna, 1987
34.	<i>Otostigmus poonamae</i> Khanna and Tripathi	Indian	Chamba (HP)	+	+	-	-	-	-	Khanna, 1985, 1987, 2001
35.	<i>Otostigmus proponens</i> Chamberlin	Indo-Malayan	Fulakowa, Solomon Isls.	-	-	-	+	-	-	Khanna, 1994c

36.	<i>Otostigmus ruficeps</i> Pocock	Oriental	Madras (Tamilnadu)	+	-	-	+	Uttar Pradesh, Tamilnadu	Tamilnadu; VIETNAM, JAVA, SUMATRA KAKATAU, BORNEO, SULAWESI, NEW GUINEA	Pocock, 1890; Attems, 1930; Khanna, 1994 and 2001
37.	<i>Otostigmus rugulosus</i> Porath	Oriental	Madras (Tamilnadu)	-	+	-	+	Myanmar	A & N Isls., MAURITIUS, SEYCHELLES, THAILAND	Gravely, 1910, 1912b; Attems, 1930 and Khanna, 1994c
38.	<i>Otostigmus scaber</i>	Indo- Australian	China	-	+	+	-	China, Myanmar, Nepal	A & N Isls., Kerala (Cochin) and Uttar Pradesh JAPAN, FORMOSA, THAILAND, MALAYA, SUMATRA, COCOS ISLAND	Gravely, 1910; Attems, 1930; Lewis, 1992
39.	<i>Otostigmus spinosus</i> Porath	Indo-Malayan extending to Australia	Borneo	-	-	+	-	-	West Bengal; JAVA, SUMA- TRA, BORNEO, NEW GUINEA	Attems, 1930; Khanna, 1994c
40.	<i>Otostigmus sumatranus</i> <i>kraepelini</i> Attems	Palearctic	Chitral "NW Kashmir"	-	+	-	-	-	-	Attems, 1930; Khanna, in press; Khanna and Tripathi, 1986
41.	<i>Otostigmus splendens</i> Pocock	Indo-Malayan extending to Australia	Madras, Tamil- nadu	-	-	-	+	Myanmar	JAVA, SUMA- TRA, SULAWESI, NEW GUINEA	Attems, 1930; Khanna, 1994c
42.	<i>RHYSIDA afra cuprea</i> Kraepelin	Indian	Bhutan	+	+	+	+	Bhutan, Bangladesh, China	Delhi and West Bengal.	Gravely, 1910, Khanna, 1987 and 2001; Khanna and Tripathi, 1985
43.	<i>Rhysida afra petersi</i> Porath	Ethiopian	Bhutan	-	-	-	-	Bhutan	SOUTH AFRICA	Gravely, 1910; Attems, 1930

44.	<i>Rhysida carinulata</i> Haase	Indo- Australian	Australia	+	-	-	-	-	SUMATRA, CELEBES, NEW GUNINEA AND THURSDAY ISLANDS	Attems, 1930; Khanna and Kumar, 1984
45.	<i>Rhysida ceylonicus</i> Gravely	Oriental	Paradeniya (Sri Lanka)	-	+	-	-	-	SRI LANKA	Attems, 1930; Khanna and Tripathi, 1985
46.	<i>Rhysida corbetti</i> Khanna	Indian	Pauri (Uttaranchal)	+	-	-	-	-	-	Khanna, 1987, 1994c and 2001
47.	<i>Rhysida crassispina</i> Kraepelin	Indian	Matheran (Maharashtra)	+	-	-	+	-	Maharashtra, Tamilnadu, Uttar Pradesh	Attems, 1930; Jangi and Dass, 1984; Khanna, 1994c, 1998 and 2001
48.	<i>Rhysida lithobioiodes</i> <i>lithobioiodes</i> (Newport)	Oriental	China	-	-	-	-	China, Myanmar	Bihar, Haryana, Tamilnadu and Uttar Pradesh	Attems, 1930
49.	<i>Rhysida lithobioiodes</i> <i>kumaonensis</i> Khanna	Indian	Nainital (Uttaranchal)	+	-	-	-	-	-	Khanna, 1994b and 2001
50.	<i>Rhysida lithobioiodes</i> <i>shivalikensis</i> Khanna	Indian	Dehra Dun (Uttaranchal)	+	-	-	-	-	-	Khanna, 1995b
51.	<i>Rhysida longicarinulata</i> Khanna and Tripathi	Indian	Sirmaur (Himachal Pradesh)	+	+	-	-	-	-	Khanna, 1995a, 2001 and Khanna and Tripathi, 1985
52.	<i>Rhysida longipes</i> <i>longipes</i> (Newport)	Cosmopolitan	?	-	-	+	+	Myanmar, Nepal, Pakistan	West Bengal, Gujarat, Delhi, Goa, Karnataka, Maharashtra, Madhya Pradesh, Uttar Pradesh, AUSTRALIA, EAST AND WEST AFRICA, MADAGASKAR, SEYCHELLES, MAXICO, CENTRAL AND SOUTH AMERICA PAKISTAN, SRI LANKA	Attems,1930 : Khanna,1994b, 1997 and 2001

53.	<i>Rhysida longipes simplicior</i> Chamberlin	Indian	Coonoor (Tamilnadu)	+	-	-	-	-	Delhi, Tamil Nadu	Chamberlin, 1920; Attems, 1930; Khanna, 1997, 2001
54.	<i>Rhysida longipes punctata</i> Khanna	Indian	Nainital (Uttaranchal)	+	-	-	-	-	Uttar Pradesh	Khanna, 2001
55.	<i>Rhysida monalii</i> Khanna and Kumar	Indian	Almora (Uttaranchal)	+	+	-	+	-	Maharashtra and Uttar Pradesh	Khanna, 2001 and Khanna and Kumar, 1984
56.	<i>Rhysida nuda nuda</i> (Newport)	Cosmopolitan	Paramata, NS Wales, Australia	+	-	-	+	Myanmar	Andhra Pradesh, Haryana, Karnataka, Maharashtra, MP, Orissa, Tamil Nadu, Uttar Pradesh; AUSTRALIA, SRI LANKA, NORTH AMERICA, PARAGUAY	Attems, 1930, Khanna, 1995a, b and 2001
57.	<i>Rhysida nuda immarginata</i> (Porath)	Cosmopolitan	Philippines	+	+	+	+	Myanmar	A & N Isls., Delhi, Gujarat, MP, Maharashtra, Rajasthan and West Bengal; WEST AFRICA; MALAYA, SOUTH AMERICA, PHILIPPINES, VENEZUELA, GUATEMALA	Khanna, 1987, 1995a, b and 2001
58.	<i>Rhysida stuhlmanni stuhlmanni</i> Kreapelin	Ethiopian	Bogamoyo, Rio Quaqua, Ethiopia	-	-	-	+	-	KAPLAND, CAPE PROVINCE, EAST AFRICA, SOUTH AFRICA	Attems, 1930, Khanna, 1994b, 2001
59.	<i>Rhysida stuhlmanni himalayanus</i> Khanna	Indian	Kaladungi, Nainital (Uttaranchal)	+	-	-	-	-	-	Khanna, 1994b and 2001

60.	ETHMOSTIGMUS <i>Platycephalus</i> <i>platycephalus</i> (Newport)	Oriental, Palearctic and Ethiopian	?	-	-	-	-	Myanmar	Kerala, Maharashtra; NEW GUINEA, NEW POMMERN, YORKLAND, SOLOMON ISLANDS, MOLUCAS, JAVA	Gravely, 1910; Attems, 1930, Jangi and Dass, 1984; Khanna, 2001
61.	<i>Ethmostigmus</i> <i>platycephalus spinosus</i> (Newport)	Oriental	?	-	-	-	-	Myanmar	Karnataka, Maharashtra, Tamilnadu; SRI LANKA	Gravely, 1910; Attems, 1930; Jangi and Dass, 1984 and Khanna, 2001
62.	<i>Ethmostigmus</i> <i>pygomegas</i> (Kohlrausch)	Indian	Sylhet (Bangladesh)	+	+	-	-	Bhutan, Bangladesh, Myanmar	A & N Isls. and West Bengal	Attems, 1930, Ahmed, 1980, Khanna, 1998 and 2001
63.	<i>Ethmostigmus</i> <i>trigonopodus pygmanosoides</i> Lewis		Myadugi, Nepal	-	-	-	-	Nepal	-	Lewis, 1992
64.	<i>Ethmostigmus sulcidens</i> (Kohlrausch)			-	-	-	-	China	-	-
Family 2 : CRYPTOPIDAE										
Subfamily 1 : CRYPTOPIDAE										
65.	CRYPTOPS <i>doriae</i> Pocock	Indo-Malayan extending to Australia	Schwegoo (Myanmar)	+	-	+	-	Myanmar, Nepal, China	Maharashtra; VIETNAM JAVA, NEW GUINEA	Gravely, 1910; Attems, 1930; Khanna, 1997, 2001; Lewis, 1999
66.	<i>Cryptops feae</i> Pocock	Indian	Myanmar	-	-	-	-	Myanmar	-	Gravely, 1910; Attems, 1930
67.	<i>Cryptops sitosior</i> Chamberlin	India	Molta, Himalaya ?	?	-	?	?	?	-	Chamberlin, 1959

68.	<i>Cryptops inermipes</i> Pocock	Myanmar	?	-	-	-	-	Myanmar	-	Gravely, 1910
69.	<i>Cryptops kemp</i> Gravely	Indian	Siju Caves, Assam	-	-	-	+	-	-	Gravely, 1912
70.	<i>Cryptops nepalensis</i> Lewis		Nepal	-	-	-	-	Nepal	-	Lewis, 1999
71.	PARACRYPTOPS <i>indicus</i> Silvestri	Indian	Siju Caves, Assam	-	-	-	+	-	Rajasthan	Silvestri, 1924; Khanna, 1994c and 2001
72.	<i>Paracryptops feae</i> Pocock	Indian	Myanmar	-	-	-	-	Myanmar	-	Gravely, 1910
73.	<i>MIMOPS orientalis</i> Kraepelin	Oriental	China	-	-	-	-	China	-	Attems, 1930
Subfamily 2 : SCOLOPOCRYPTOPINAE										
74.	OTOCRYPTOPS <i>rubiginosus</i> Koch	Oriental	China	-	-	-	-	China	JAPAN, BRAZIL, KOREA	Attems, 1930
75.	SCOLOPOCRYPTOPS <i>brolemanni</i> Kraepelin			-	-	-	-	China	-	Attems, 1930
				29	27	13	26			

*Distribution of species in India : 53; Myanmar : 25; China : 15; Bhutan : 3; Nepal : 13; Bangladesh : 1 and Pakistan : 1.

In early tertiary, the breakaway Gondwanaland in a northward drift first hit the Asian landmass at what is presently northeast India, served as the biogeographic gateway, "the Assam Gate", for dispersal and migration of much of the fauna and flora. The Northeast Zone is richest of biological resources, and has affinities with Indo-Chinese and Indo-Malayan regions in the east and southeast and many species are shared. From west came the Palaearctic and Ethiopian elements. Relatively young Himalayan mountain ranges opened up new southwards route of migration and acted as a two-way link between West Africa to South Asia. In peninsula there may be some cross over points between southern-Western Ghats and Eastern Hills. While Andamans have a biogeographic affinity with Myanmar, the Nicobar (with Great Nicobar, only 90 Kms of Sumatra) have more Indonesian and South Asian Elements.

The pattern of distribution tabulated for the Scolopendrid centipedes conforms to the above theory.

SUMMARY

The paper deals with the pattern of distribution of 75 species of Scolopendrid centipedes, recorded from the Himalayan ecosystem, including the bordering countries like Afghanistan, Pakistan, China, Myanmar, Bhutan, Nepal and Bangladesh. 53 species represents Indian Himalaya, comprising 29 from Western Himalaya, 27 from Northwestern Himalaya, 13 from Central Himalaya and 26 from Eastern Himalaya. Table depicts 6 species each exclusively representing Myanmar and China, 4 to Nepal and one each to Bhutan and Bangladesh. 31 species have their homes in Himalayas as their type localities. The table also contains the known distribution of the species in India, other than Himalayan belt or outside India beyond Himalayan countries. Efforts have been made to provide the type localities of the species, as far as possible, with status of zoogeographical distribution of the species.

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REFERENCES

- Ahmed, S. 1980. On a collection of centipedes (Scolopendromorpha : Scolopendridae and Cryptopidae) from Andaman and Nicobar Islands. *Rec. zool. Surv. India*, **77** : 25-30.
- Attems, C. 1930. Scolopendromorpha, *Das Tierr.*, **54**(2) : 1-308.
- Chamberlin, R. V. 1913. Two new Otostigmini from India. *Ent. News.*, Philad., **24** : 73-76.
- Chamberlin, R. V. 1920a. On some Myriapods collected in India in 1916 by C. A. Kefold. *Univ. Calif. Pub.*, Berkley, **19** : 189-403.
- Chamberlin, R. V. 1920b. The Myriapoda of the Australian Museum. *Bull. Mus. Comp. Zool.*, **64**(1) : 1-269.
- Chamberlin, R. V. 1944. On a collection of centipedes from Indo-Australian Archipelago. *Notulae naturae.*, Philad., **147** : 1-14
- Chamberlin, R. V. 1959. On some Chilopods from India. *Ent. Mitt. Zool. Staatsinstt. Mus.*, **19** : 1-4.
- Gravely, F. H. 1910. The distribution of Oriental Scolopendridae. *Rec. Indian Mus.*, **5**(1) : 161-172.
- Gravely, F. H. 1912a. Two new species of Scolopendridae. *Rec. Indian Mus.*, **7**(4) : 415-417.
- Gravely, F.H. 1912b. Zoological results of Abhor expedition 1911-12. *Rec. Indian Mus.*, **8**(1) : 69-73.
- Haase, E. 1886. Die Indisch-australischen Myriapoden, I. Chilopoden, *Abh. Ber K. zool. Anthr.-ethnogr. Mus.*, Dresden, **5** : 1-118 (1887).
- Jangi, B. S. and Dass, C. M. S. 1978. A new species of the genus *Paracryptops* from India, with remarks on the generic and specific characters (Chilopoda : Scolopendromorpha : Cryptopidae). *Zool. J. Linn.Soc.*, **64** : 327-330.
- Jangi, B. S. and Dass, C. M. S. 1979. Redescription of the Indian centipede *Scolopendra mazbii* Gravely (Chilopoda : Scolopendromorpha : Scolopendridae). *Ent. Mon. Mag.*, **115** : 161-164
- Jangi, B. S. and Dass, C. M. S. 1984. Scolopendridae of Deccan. *J. Scient. Indl. Res.*, **43**(2) : 27-54
- Khanna, V 1987. Taxonomic and ecological studies on the centipedes (Chilopoda : Scolopendromorpha : Scolopendridae) from Western Himalaya, Uttar Pradesh. *D. Phil Thesis*, University of Garhwal, Srinagar, U.P., pp. 1-243
- Khanna, V. 1991. Chilopoda : Scolopendridae. In : State of-the-Art Report, Zoology; from Protozoa to Mammalia, *Zool.Surv.India*, pp. 461-465.

- Khanna, V. 1993. Myriapods in relation to soil : Their identification, Collection and Preservation. *Earthworm Res. and vermiculture, Zool. Surv. India*, pp. 123-128.
- Khanna, V. 1994a. Chilopoda : Scolopendridae. In : *Fauna of Conservation Area Series 5 : Fauna of Rajaji National Park, Zool. surv. India*, pp. 309-316.
- Khanna, V. 1994b. Chilopoda : Some ecological observations on the centipede *Cormocephalus* Pocock, with comments on "sexual dimorphism" in the species and on the status of *Cormocephalus pseudonudipes* Jangi and Dass, 1984. In : *Fauna of Conservation area Series 5 : Fauna of Rajaji National Park, Zool. Surv. India*, pp. 237-243.
- Khanna, V. 1994c. Chilopoda : Scolopendromorpha : Scolopendridae). In : Himalayan Ecosystem series. Pt. 1 : Uttar Pradesh. *Zool. Surv. India*, 111-113.
- Khanna, V. 1994d. Centipede Fauna of Corbett National Park, Uttar Pradesh, India (Chilopoda : Scolopendromorpha : Scolopendridae). *Rec. zool. Surv. India*, 94(2-4) : 329-350.
- Khanna, V. 1994e. Centipede Fauna of NE States, India (Chilopoda : Scolopendromorpha). *Rec. Zool. Surv. India*, 94(2-4) : 459-472.
- Khanna, V. 1997a. Chilopoda. In : *Fauna of Conservation Area Series : Fauna of Nanda Devi Biosphere Reserve, Zool. Surv. India*, 105-106.
- Khanna, V. 1997b. Chilopoda. In : *State Fauna Series 6 : Fauna of Delhi, Zool. Surv. India*, 467-475
- Khanna, V. 1997c. Chilopoda : Scolopendromorpha. In : *Fauna of Conservation area Series, Fauna of Dudhwa National Park, UP. Zool. Surv. India*, mss 1-7 with 2 pls.
- Khanna, V. 1997e. Chilopoda : Scolopendromorpha. In : *Fauna of Himalayan Ecosystem, Pt. II : Fauna of Himachal Pradesh, India. Zool. Surv. India*, mss 1-9.
- Khanna, V. 1998a. Faunal diversity in India : Myriapoda. In : Alfred *et. al.*, 1998. Faunal Diversity in India, I-viii, 1-495. *ENVIS Center, Zoological Survey of India, Calcutta*, pp. 434-349.
- Khanna, V. 1998b. Centipedes. In : **Report on Scientific and Ecological research. Panchchuli Multi-dimensional Expedition-1998**, by Sapper Adventure Foundation, The Corps of Engineers, Indian Army, pp. 79-80.
- Khanna, V. 2000. Centipedes (Chilopoda : Scolopendromorpha). In : *Fauna of Conservation area Series : Fauna of Gobind Pashu Vihar, Uttaranchal, Zool. Surv. India*, mss pp. 1-4.
- Khanna, V. 2001. A Checklist of the Indian Centipedes (Chilopoda : Scolopendromorpha). *Ann. For.*, 9(2) : 199-219.
- Khanna, V. and Kumar, A. 1984. Scolopendrid centipedes of Western Himalaya, U.P., with an annotated list of Indian species (Chilopoda : Scolopendromorpha : Scolopendridae). *Uttar Pradesh J. Zool.*, 4(1) : 83-98.

- Khanna, V. and Tripathi, J. C. 1985. On a new species of the centipede genus *Rhysida* Wood from Himachal Pradesh, India (Chilopoda : Scolopendridae : Otostigmini). *Annals entomol.*, 3(1) : 19-24.
- Khanna, V. and Tripathi, J. C. 1986. On a new species of the centipede genus *Otostigmus* Porath from Himachal Pradesh, India (Chilopoda : Scolopendridae : Otostigmini). *Annals entomol.*, 4(1) : 35-39
- Kraepelin, K. 1903. Revision der Scolopendriden (Scolopendromorpha). *Mitt. Mus.*, Hamburg, 20 : 1-276.
- Lewis, J. G. E. 1992. Scolopendrid centipedes from Nepal and Kashmir (Chilopoda : Scolopendromorpha). *Senckenbergiana biol.* 72(4/6) : 435-456.
- Lewis, J. G. E. 1999. On the genus *Cryptops* Leach in Nepal with redescrptions of *Cryptops australis* Newport and *C. doriae* Pocock (Chilopoda : Scolopendromorpha : Cryptopidae). *Senckenbergiana biol.* 79 : (1) : 19-38.
- Pocock, R. I. 1890. Report upon a small collection of Scorpions and Centipedes sent from Madras by Mr. Edgar Thurston of Government Central Museum. *Ann. nat. Hist.*, ser.6, 5 : 244-249.
- Pocock, R. I. 1891. Notes on the synonymy of some species of Scolopendridae with descriptions of new genera and species of the group. *Ann. nat. Hist.*, ser.6, 7 : 51-68 and 221-231, 2 pls.
- Silvestri, F. 1924. Myriapoda from Siju Caves, Garo Hills, Assam. *Rec. Indian Mus.*, 31 : 263-267.

STUDIES ON *INCERTELLA* SABROSKY (DIPTERA : CHLOROPIDAE) FROM THE ORIENTAL REGION

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INTRODUCTION

Incertella Sabrosky is a relatively small genus hitherto reported only from the Holarctic Region. Species of this genus were earlier described by Duda (1933), Collin (1946), Nartshuk (1970), Andersson (1977) and others under *Tropidoscinis* Enderlein. However, Sabrosky (1980), based on his study of the syntypes of *luederwaldi* Enderlein, the type species of *Tropidoscinis*, redefined the genus which according to him is limited in its distribution to the Neotropical Region. He separated species possessing yellow halteres, dull and grey to brownish grey tomentose frontal triangle and scutum and 1 + 1 *npl*, earlier described under *Tropidoscinis*, and included them in his new genus *Incertella*.

No species has been described under *Incertella* from the Oriental Region. One new species, *Incertella luteifrons* from India is described here and *sulcata* from Sumatra and *indica* from India are transferred to *Incertella*.

The type specimens are deposited in the collections of Southern Regional Station, Zoological Survey of India, Chennai.

Key words : New Species, *Incertella* Sabrosky, Chloropidae, Oriental Region.

Incertella Sabrosky

1980. *Incertella* Sabrosky, *Proc. Entomol. Soc. Wash.*, **82**(3) : 420-422. Type species : *Incertella incerta* (Becker) 1912 (= *Oscinella incerta* Backer). By original designation.

1911. *Tropidoscinis* acutt. nec Enderlein.

Small, slender species with heavily tomentose frontal triangle and usually 1 + 1 *npl*.

Head : As high as or higher than long; frons broader than and slightly projecting in advance of eye; frontal triangle broad at base, reaching from middle to anterior margin of frons, heavily tomentose; facial profile receding, deeply concave; vibrissal corner a right angle or slightly obtuse; gena linear to one-third or a trifle more as wide as ant 3; antennae of moderate size; arista short

pubescent; proboscis and palpi short. Head bristles with distinct *ivt* and *ovt*, erect *pvt*, subparallel reclinate and slightly converging *oc* and hair-like *orb* of which upper 2-4 may be stouter.

Thorax : Dull, densely tomentose except for shining lower half of pleura; hairs on scutum arranged mostly in rows; scutellum broad and short, broadly rounded apically; thoracic bristles with 1 weak *h*, 1 + 1 or 1 + 2 *npl*, 1 *pa*, 1 *dc*, *as* and 1-2 *ss* bristles.

Legs : Short with narrowly oval tibial organ and femoral organ of 2 rows of closely placed warts bearing short, stout spines. Wings usual for Oscinellinae; costa reaching M 1 + 2 and ending at apex of wing; second costal sector longer than the third; r-m cross-vein nearly in the middle of discal cell or slightly beyond; anal area usually well developed.

Abdomen : Oval, tomentose, with dark hairs. Female cerci slender; male genitalia with distinct cerci, flat and simple surstylus, incurved postgonites and well developed phallus.

Distribution : Holarctic and Oriental Regions.

Remarks : Sabrosky (1980) included under *Incertella* only species possessing 1 + 1 *npl* which according to him is a distinctive character of the genus. Though Andersson (1977) considered *zurcheri* (Duda), a palaearctic species possessing 1 + 2 *npl*, congeneric with *albipalpis* (Meigen) and *kerteszi* (Backer) which have 1 + 1 *npl* typical of *Incertella*, yet Sabrosky (1980) stated that *zurcheri* "seems to me to belong to *Oscinella*" Later, based on his studies, *zurcheri* along with *exigua* described from the Oriental Region by Duda (1934) under *Tropidoscinis* were transferred to *Oscinella* in the list of species in the holdings of the United State's National Museum.

I have 3 species belonging to *Incertella* before me which include *sulcata* (Duda) and *indica* (Cherian), the two remaining species from the Oriental Region described earlier under *Tropidoscinis*. Both these species have 1 + 2 *npl* while in one new species, *luteifrons* from India described here, there are only 1 + 1 *npl*, typical of *Incertella*. However *indica* and *sulcata* show marked similarities to *luteifrons*, a typical species of *Incertella*, in the general body characters and the development of male genitalia and it is apparent that all the three are congeners. Hence it is felt that generic limits of *Incertella* should be redefined to include species possessing either 1 + 1 or 1 + 2 *npl*.

Key to the species from the Oriental Region

1. Notopleural bristles 1 + 2; gena at most one-third as wide as ant 3; scutum black or brownish black 2
- Notopleural bristles 1 + 1; gena half as wide as ant 3; scutum laterally yellowish brown
..... *luteifrons*, sp. n.

2. Gena atleast one third as wide as ant 3; frons, antennae and scutellum black; legs partly black; discal cell more of *Oscinella*-type *indica* (Cherian)
3. Gena sublinear; frons and scutellum partly and antennae almost entirely yellow or brownish yellow; legs wholly yellow; discal cell conspicuously narrowing basally *sulcata* (Duda)

***Incertella indica* (Cherian) N. Comb.**

(Figs. 1-2)

1973. *Tropidoscinis indicus* Cherian, *Oriental Insects*, 7(4) : 507-509. Type localities : India : UP : Agra; Kerala : Thumpamon; Assam : Bhoilymbong.

I have examined 5 more specimens collected from Tamil Nadu which agree entirely with the types. As in the original diagram some of the male genitalic features were not clearly depicted, male genitalia (Figs. 1 & 2) are redrawn here.

Specimens examined : Apart from the holotype and paratypes, the following specimens were examined : 2 males, 2 females, Tamil Nadu : Kodayar, 30.iii.1989, Coll. Koshy Mathew; 1 female, Tamil Nadu : Palani Hills, 29.iv.1989, Coll. P. T. Cherian.

Remarks : In the development of general body characters and genitalia *indica* markedly resembles other species of *Incertella*, including the new species *luteifrons* described in this paper. As mentioned earlier, generic limits of *Incertella* are redefined to include species possessing 1 + 1 or 1 + 2 *npl*. Hence *indica* and its congeners having 2 posterior *npl* are transferred to *Incertella*.

***Incertella sulcata* (Duda) N. Comb.**

(Figs. 3-4)

1934. *Tropidoscinis sulcata* Duda, *Tijdschr. Ent.* 77 : 110. Type locality : Sumatra : Fort de Kock.

This species is hitherto known by the 8 type specimens from Sumatra. I have 9 more specimens from India which agree with the original description. Some of the body characters not described earlier are given here.

Eye large, with very minute, sparse pubescence; gena nearly linear; *pvt* equal to *ovt*. Scutellum 0.62 x as long as wide, dark brown at base, brownish yellow distally at margin and below, with flattened disk. Wing 2.5 x as long as wide, proportions of costal sectors 2 to 4 in the ratio 14 : 16 : 7; r-m cross-vein distad of middle of discal cell, opposite 0.6 of its length; discal cell narrowing towards wing base; anal angle slightly reduced and hence wing widest in the middle.

Specimens examined : 1 female, Tripura : Paratia, 10.x.1997, Coll. N. Muraleedharan; 2 males (abdomen damaged), E. Tripura : Amarpur, 12.x.1977, Coll. N. Muraleedharan; 2 females,

W. Tripura : Telimura, 20.x.1977, Coll. N. Muraleedharan; 1 male, 1 female (both partly damaged), Tripura : Ambasa, 26.x.1977, Coll. N. Muraleedharan; 1 female, Assam : Garampani, 11.ix.1977, Coll. P. T Cherian; 1 female, Tamil Nadu : Yercad, 27.xii.1989, Coll. P. T Cherian.

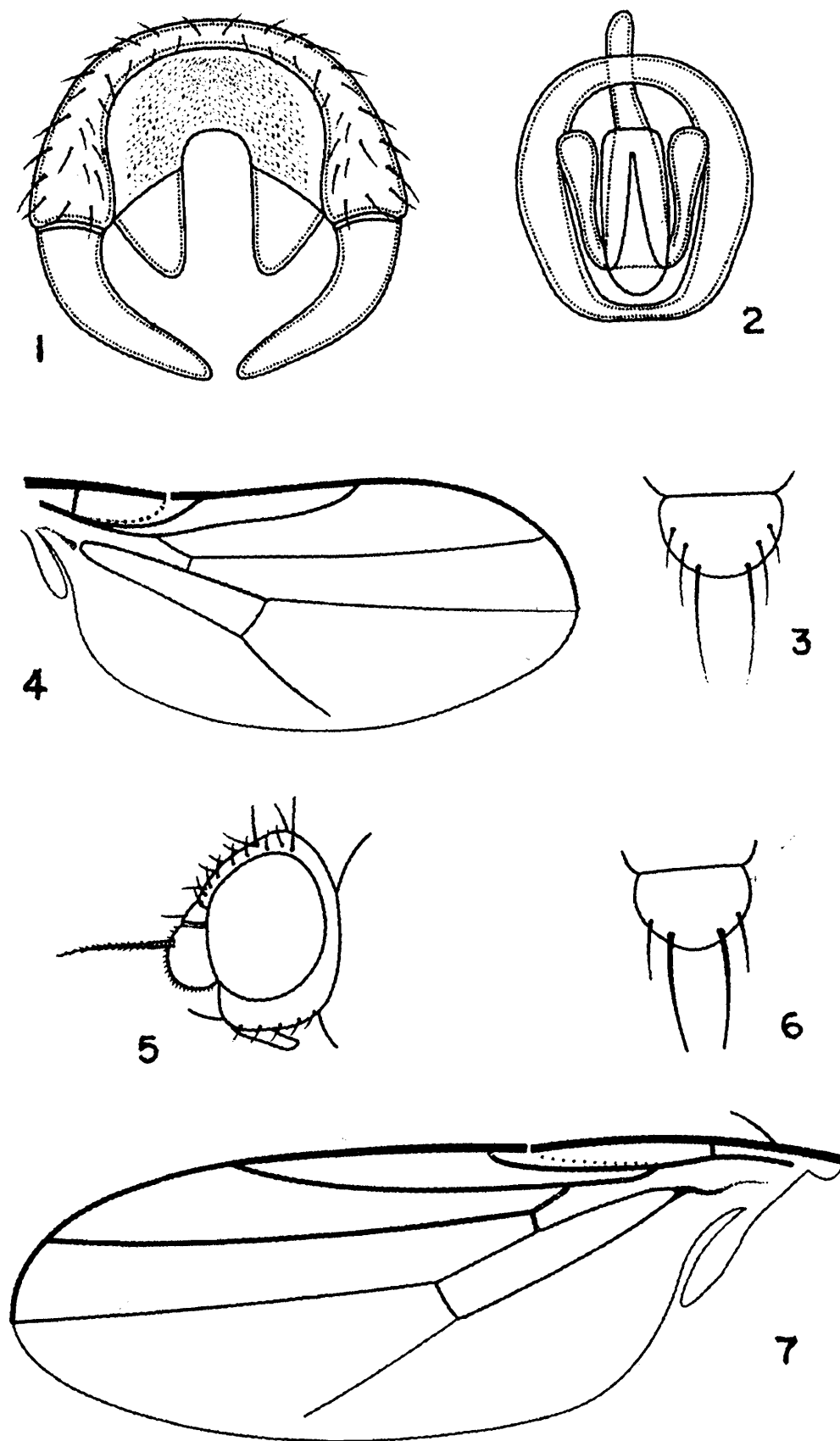
Remarks : This species which shows similarities to other members of *Incertella*, inspite of possessing 2 posterior *npl* as in *indica* (Cherian), is transferred to this genus from *Tropidoscinis*. With it's slightly reduced anal angle, basally markedly narrowed discal cell and prominent *pvt*, which is more developed than *oc*, *sulcata* differs from other species of the genus. This species is being reported for the first time from India and after it was originally described from Sumatra in 1934.

***Incertella luteifrons*, sp. n.**

(Figs. 5-7)

Female : *Head* : (Fig. 6) Wider than high, length, height and width ratio 11 : 15 : 21; frons nearly parallel sided, width at vertex 1.2 x its length, grey tomentose, projecting above but not beyond anterior margin of eyes, dark brown around vertex margin and gradually turning brownish yellow anteriorly and ending with concave anterior margin; frontal triangle large, dull brownish black, densely dark grey tomentose, reaching anterior margin of frons and ending with slightly pale obtuse apex. Eye elongated oval, densely pubescent, with slightly oblique long axis. Face deeply concave, dark brown and grey tomentose; facial carina distinct, triangular between antennae and reaching nearly middle of face; epistomal margin raised up. Antennae rather erect, mostly brownish black but ant 2 and basal part of ant 3, especially in one specimen, with light brown tinge; ant 3 about three-fourths as long as wide; arista short, brownish black, with short, fairly dense, concolourous pubescence. Gena nearly half as wide as ant 3, pale yellow with a few hairs; postgena well developed, concolorous with gena; vibrissal corner rather obtuse. Palpi brownish yellow; proboscis rather slender, basally shiny brownish black, distally yellowish brown, bearing slender, erect hairs. Head bristles brownish black; *ovt* longer and stouter than other head bristles; *ivt* about half as long as *ovt* but very slender; *pvt* convergent, about two-thirds the *ovt*; *oc* almost subparallel, recumbent, longer than *pvt*; *if* 7, turned inwards and slightly proclinate; a few short *fr* present between *if* and *orb* mostly in the anterior part of frons; vibrissal bristle distinct; oral margin with a row of pale, slender setae.

Thorax : Scutum nearly as wide as long, predominantly dull brownish black but humeral callus and the area behind it upto the wing base and below covering anterior part and upper half of pleural region yellowish brown, especially in one specimen, wholly dark grey tomentose with well developed dark brown hairs arranged in longitudinal rows; scutellum (Fig. 7) about two-thirds as long as wide, disk only slightly convex, blackish brown with yellowish brown tinge around apex, pubescent and tomentose like scutum; *h* 1, subequal to *ovt*; *npl* 1 + 1, subequal and a trifle longer and stouter than *h*; *pa* 1 equal to and 1 *dc* a trifle longer than *npl*; *pa* 2 hardly



Figs. 1-2. : *Incertella indica* (Cherian) : 1-2, Male genitalia.

Figs. 3-4. : *Incertella sulcata* (Duda) : 3, scutellum; 4, wing.

Figs. 5-7. : *Incertella luteifrons*, sp. n. 5, head; 6, scutellum; 7, wing.

distinguishable from thoracic hairs; *as* 1.25 x as long as scutellum, distally convergent; *ss* 1 half the *as*.

Wing : (Fig. 8) Longer than body, 2.7 x as long as wide, hyaline with brown veins; proportions of costal sectors 2 to 4 in the ratio 5 : 5 : 2; r-m cross-vein proximad of middle of discal cell, opposite 0.55 of its length; r 4 + 5 and m 1 + 2 nearly parallel in the distal part of wing; wing wider in the middle, anal angle rather reduced; knob of haltere yellowish brown, stalk brownish yellow.

Legs : Long, rather slender, almost wholly brownish yellow; tibial organ distinct.

Abdomen : Longer than wide, suboval, subshiny brownish black with slender hairs. Female cerci of medium size.

Length : Female 2 mm; wing 1.8 mm.

Holotype : Female, India : Meghalaya : Naya Bungalow, 10.i.1979, Coll. P. T. Cherian.

Paratype : 1 female, collection data same as of holotype.

Gender and derivation : Feminine, referring to the yellow colour of frons.

Incertella luteifrons is a typical species of the genus as defined and understood by Sabrosky (1980). It shows affinities to *sulcata* (Duba) but while in the former antennae are predominantly brownish black, gena is half as wide as ant 3, there is only one posterior *npl* and scutum is dull not subshiny, in the latter antennae are yellow, gena is linear, there are two posterior *npl* and scutum is partly subshiny.

SUMMARY

Incertella Sabrosky is reported for the first time from the Oriental Region. One new species viz. *luteifrons* from India is described and *indica* (Cherian) from India and *sulcata* (Duda) from Sumatra are transferred to this genus from *Tropidoscinis* Enderlein.

ACKNOWLEDGEMENTS

I am thankful to the Director, Zoological Survey of India, Calcutta for encouragement.

ABBREVIATIONS

ant 2, second antennal segment; *ant* 3, third antennal segment; *as*, apical scutellar bristle; 1 *dc*, first dorsocentral bristle; *h*, humeral bristle; *if*, inter frontal bristle; *ivt*, inner vertical bristle; *npl*, notopleural bristle; *oc*, ocellar bristle; *orb*, fronto-orbital bristle; *ovt*, outer vertical bristle; *pa*, post alar bristle; *pvt*, post ventral bristle; *ss*, subapical scutellar bristle.

REFERENCES

- Andersson, H. 1977. Taxonomic and phylogenetic studies on Chloropidae (Diptera) with special reference to Old World Genera. *Ent. Scand. Suppl.*, **8** : 1-200.
- Cherian, P. T. 1973. Description of a few new species of Chloropidae from India. *Oriental Insects*, **7**(4) : 507-509.
- Collin, J. E. 1946. The British genera and species of Oscinellinae (Diptera : Chloropidae). *Trans. Ent. Soc. London*, **97** : 117-148.
- Duda, O. 1932-1933. Fam. 61. Chloropidae. In Lindner, E. Die Fliegen der palaearktischen Region **6**(1) : 1-248.
- Duda, O. 1934. Fauna sumatrensis. Bijdrage No. 74. Chloropidae (Dipt.). *Tijdschr. Ent.*, **77** : 55-161.
- Nartshuk, E. P. 1970. Revision of type-specimens of Chloropidae (Diptera) described by Th. Becker and O. Duda from the collection of the Zoological Institute, Academy of Sciences of the USSR. *Ent. Oboz. Moscow*, **49** : 459-470.
- Sabrosky, C. W. 1980. New genera and new combinations in Nearctic Chloropidae (Diptera). *Proc. Entomol. Soc. Wash.*, **82**(3) : 412-49.

LENGTH-WEIGHT RELATIONSHIP AND RELATIVE CONDITION INDEX OF *NOTOPTERUS NOTOPTERUS* (PALLAS) OF TILAIYA RESEARVOIR, BIHAR

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INTRODUCTION

Family Notopteridae is widely distributed in Southeast Asia and Africa. In India, genus *Notopterus* is represented by two species viz., *Notopterus chitala* (Hamilton) and *N. notopterus* (Pallas). The former is very large fish (>1500 mm) and latter is a medium sized fish (>600 mm). *Notopterus notopterus* forms lucrative fisheries in rivers reservoirs beels and ponds in Indian sub-continent. The information on length-weight relationship and condition index of *Notopterus notopterus* (Pallas) is very scanty in the literature, barring the preliminary work of Sinha and Parameswaran (1966) from the ponds of Cuttack, Orissa. Therefore, the paucity of scientific data on these aspects has necessitated to undertake such studies.

MATERIALS AND METHODS

Fishes were collected randomly bi-weekly through out the year from Barhi Fish landing centre, district Hazaribagh, Jharkhand. A total of 300 species ranging from 81 mm to 360 mm in total length and grouped at 10 mm were utilized for the computation of length-weight relationship and condition index. The measurements were taken on a conventional fish measuring board upto the nearest millimeters and corresponding weights on a monopan balance to the nearest gram.

The length-weight relationship was derived separately for males and females by well-known equation ($W = a L^n$) where W = Weight of the fish, L = length of the fish, a is a constant and n an exponent, usually ranging between 2.5 and 4.5 (Hiles, 1936). Relative Condition Index (K_n) was also derived separately for the two sexes as per Le Cren (1951) by using, the equation : $K_n = W/W^{\wedge}$ where W is observed weight of the fish and $W^{\wedge}$ is mean weight calculated for each group of fish.

RESULTS

Length-weight relationship

The equations describing the length-weight relationship for males & female are given below :

Males : $\text{Log } W = 0.00001464 L^{2.8951}$ or expressed logarithmically as :

$$\text{Log } W = -4.7835 + 2.8951 \text{ Log } L \quad (r = 0.9450).$$

Females : Low $W = 0.00001546 L^{2.9052}$ or expressed logarithmically :

$$\text{Log } W = -4.8152 + 2.9052 \text{ Log } L \ (r = 0.93901).$$

Since, the difference between the above equations for the two sexes appeared to be non-significant the data for males and females were pooled together into a single equation. The general length-weight equation for *N. notopterus* was calculated to be :

$$W = -4.7988 L^{2.9015} \text{ or expressed logarithmically as :}$$

$$\text{Log } W = 0.000015892 L^{2.9015} \text{ (both sexes combined).}$$

The length-weight relationship of *N. notopterus* is depicted in Fig. 1. The curve represents the calculated weight derived by the general length-weight relationship and the dots the empirical weights. The agreement between the calculated values and observed values of weights is generally quite close, except for the fishes between the size range 300 to 340 mm. In this group, the observed values are slightly higher than the calculated ones. Similar trends are reflected in the relative condition of the fish that is also highest in this group. This further indicates that group gains more in weight than in length or in other words fishes are heavier for their lengths.

Seasonal fluctuation in relative condition

The monthly average of K_n values for males and females are plotted in Fig. 2. A perusal of the graph indicates that peak values of K_n of either sex were attained in the winter month of November. Thereafter, a gradual fall in the values of either sex was observed. Females attained minimum value in February and males in March. Subsequently, a general improvement in the condition of both sexes was observed in summer months (April–June). With the advent of monsoon in July, K_n values for males showed an abrupt fall. The same for females was observed in August. Thereafter, the K_n values for both the sexes shot up in October.

Fluctuation in K_n in relation to length and age of fish

The fishes were divided into 7 age groups for determining the condition index. First age group below 101 mm in length was scarce, in the catch, hence not taken into consideration for determining the relative condition index. Average value of K_n thus, obtained in relation to length and age of the fish of either sex is plotted in Fig. 3. It may be seen that the pooled k_n of the two sexes is lower in the case of smaller (II and III) and larger fishes (VI and VII) than medium group (IV and V).

DISCUSSION

A perusal of the length-weight equation derived for *N. notopterus* of Tilaiya Reservoir indicates that the values of n , the equilibrium constant were found to be less than 3 (2.8951 for males and 2.9052 for females) and so was the case with the general length-weight equation derived for either sex ($n = 2.9015$). Since the value of n is below 3, it may be inferred that the weight of *N. notopterus*

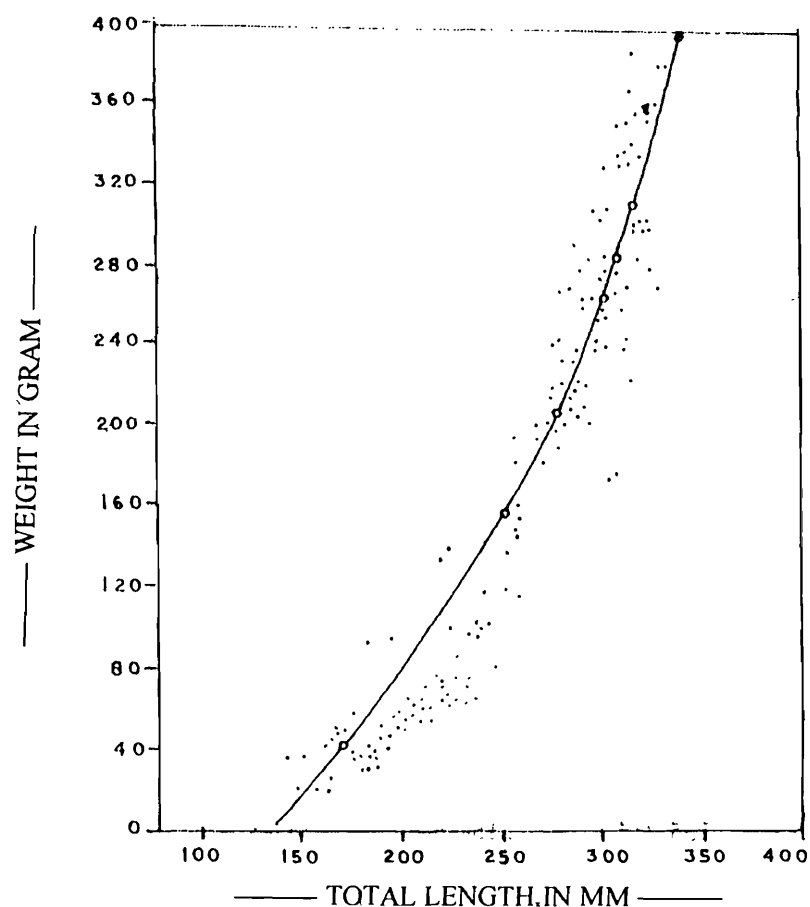


Fig. 1. Length-weight Relationship of *N. notopterus* (pallas).

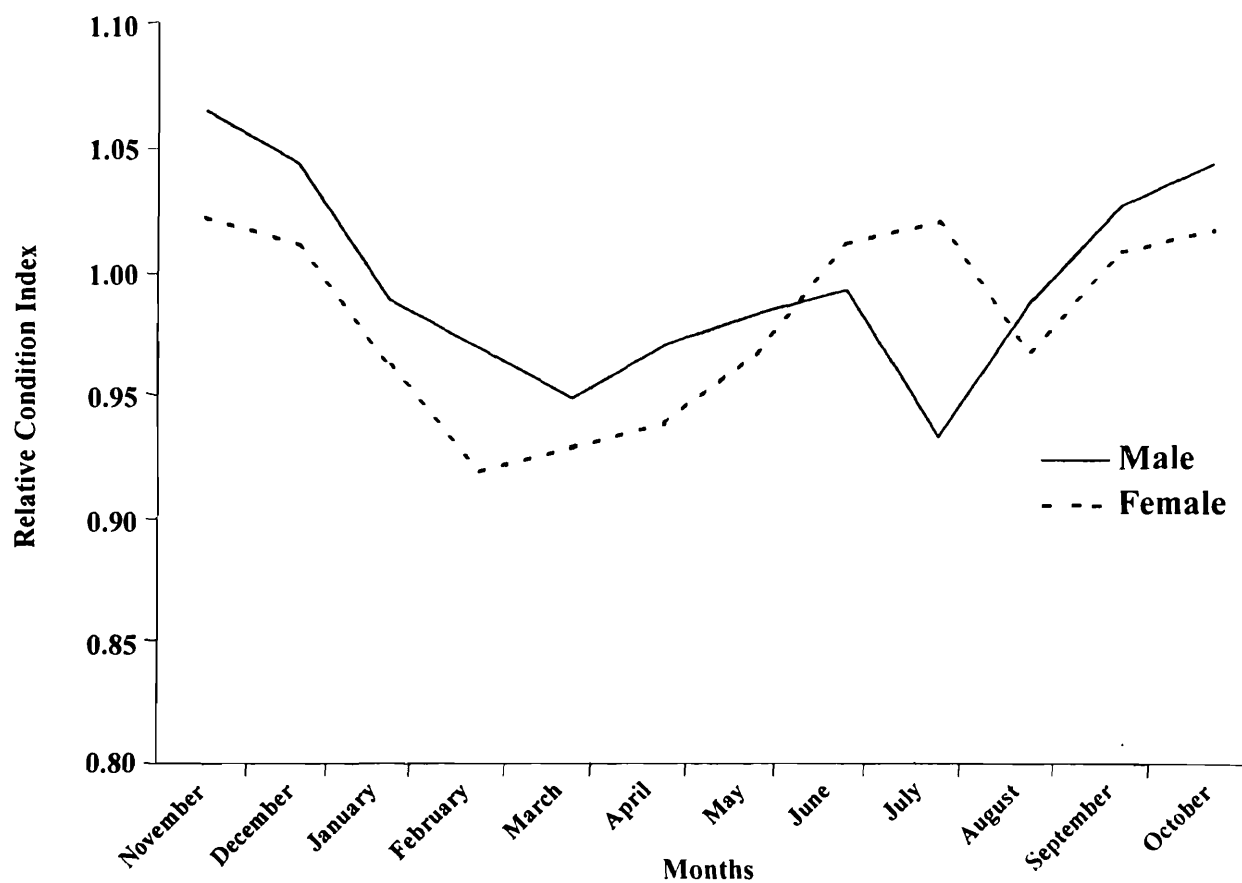


Fig. 2. Monthly fluctuation in the average Kn of *N. notopterus* of either sex.

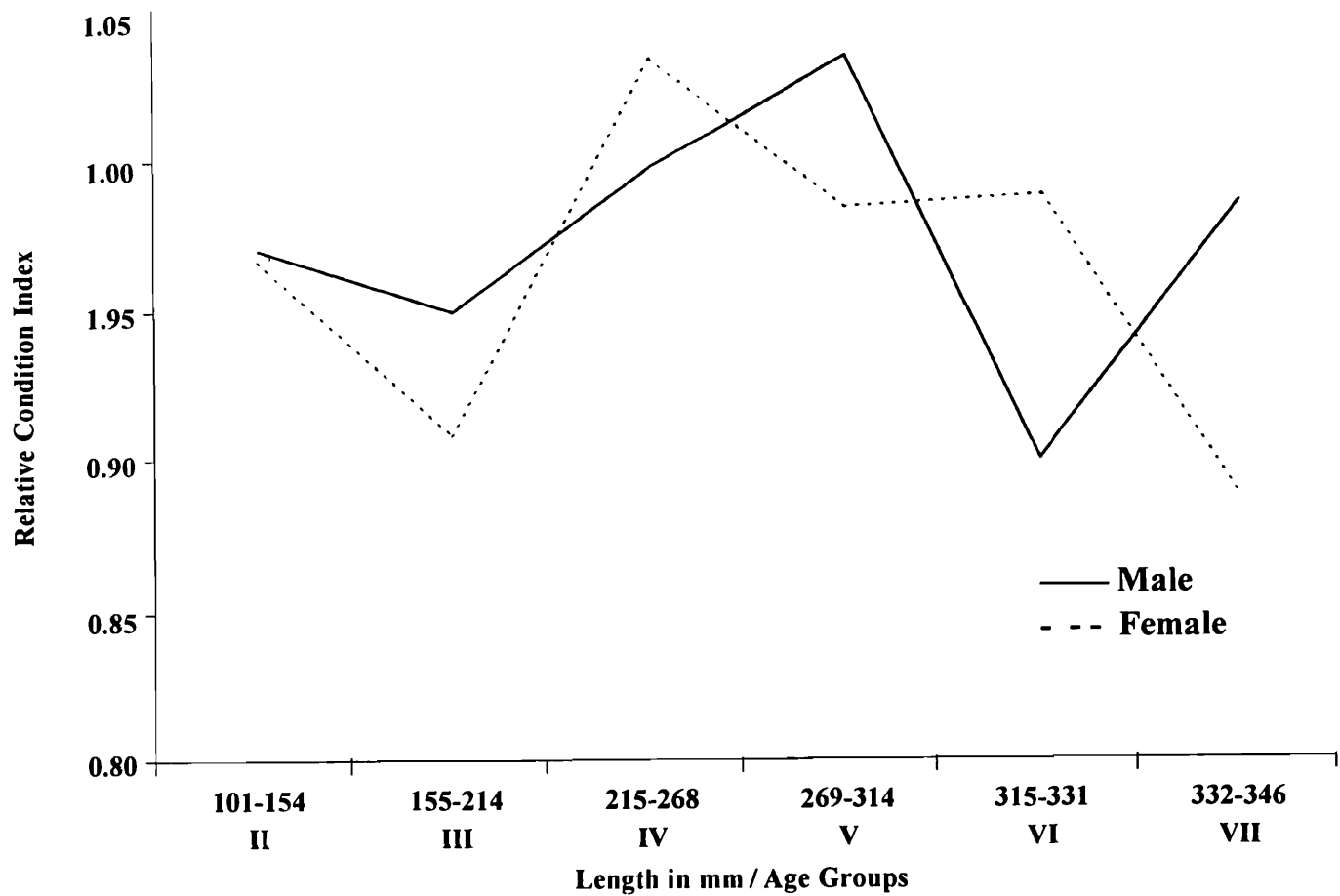


Fig. 3. Average Kn in relation to length and age of *N. notopterus* of either sex.

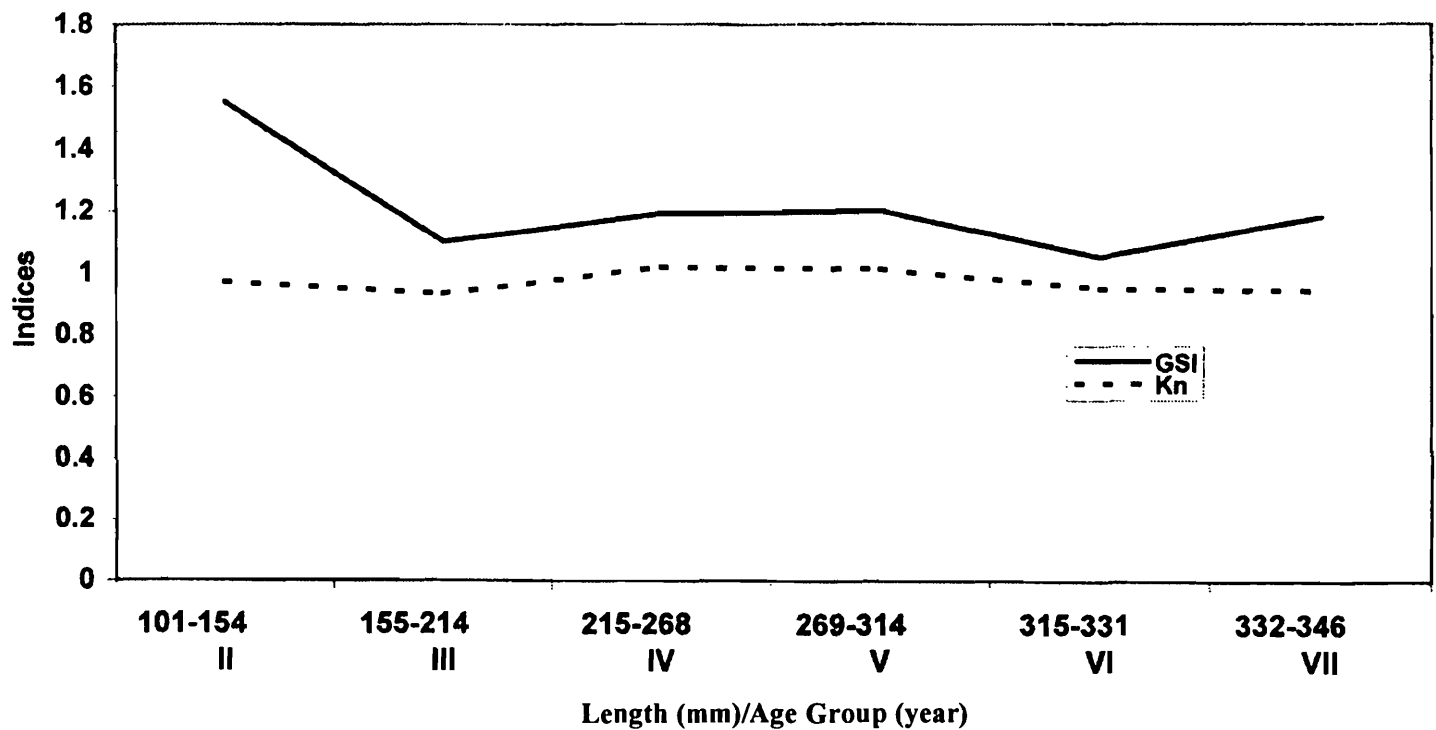


Fig. 4. Gastroscopic Index (GSI) and Relative condition index (Kn) of various age size groups of *N. notopterus*.

of Tilaiya Reservoir increases slightly lesser than the cube of its length, indicating that the individuals of either sex do not obey the cube law. Similar observations have been reported by a host of workers (Fulton, 1904; Hile, 1936; Le Cren, 1951). Parameswaran and Sinha (1966) derived the length-weight equation for *N. notopterus* of Cuttack ponds as $\text{Log } W = -4.9556 + 2.9677 \log L$. They too observed the value of n to be less than 3, though slightly more than that derived for *N. notopterus* of Tilaiya Reservoir.

The factors which influence n values are : dietary, topographic, taxonomic and selectivity of the gear (Le Cren, 1951). When the influence of above factors on n of this fish is critically examined, it is brought out that relatively colder climate, lower basic productivity level of Tilaiya Reservoir and selectivity of gill-nets might have contributed to lowering of n as compared to the well manured stocking ponds of Cuttack. The effect of taxonomic factor could not be assessed in the present study on account of non-availability of morphometric data of this fish from Cuttack ponds.

Fig. 2 indicates 3 Peaks in K_n , which are coinciding, with the 3 seasons viz., winter (November, December, January and February) summer (March, April, May and June) and monsoon (July, August, September and October). The highest peak in K_n was observed in June for male and July for females. These months represent peak breeding and low intensity in feeding (Khan, 1983). This suggests that high value of k_n be due to ripening of gonads alone and not to pertaining to feeding intensity. Comparison of pooled k_n and GSI values of this fish is given in Fig. 4 (after Khan, *op. cit.*). It is further corroborated by the fact that the period of breeding continues upto August as revealed by maturity. The same is reflected in low K_n of fishes of either sex in July and August thereafter values of K_n shows upward trend till December on account of high feeding intensity as after spawning fishes are in recovery stage and require more nourishment hence, resort to intensive feeding. Moderate water temperature also helped in increasing the appetite of the fishes. But, the severe winter condition in January and February had an adverse effect on its condition index due to subdued feeding, and it is reflected by gradual fall in condition index. The onset of summer months created better feeding conditions on account of improvement of food supply in the ecosystem caused by higher water temperature of summer months. This in turn induced emergence of insects and activated the weed fishes and prawns thus making them available aplenty as food for this fish. Thus, availability of preferred food in the ecosystem results in shooting up of the K_n values in summer months, reaching a peak in June.

Males registered relatively a higher K_n than females because the latter diverted most of the energy for development of the gonads (Le Cren, 1951; Sinha, 1972). Parameswaran and Sinha (1966) observed more or less similar trend in *N. notpterus* of Cuttack fishponds. Fig. 4 indicates a lower value of K_n in immature group 156–215 mm (shown in the Fig. 4 as 1st) of both sex and a higher value in older groups (5+ to 7+). The low value of K_n for the former may be accounted for by the faster linear growth in the early two years of fish life because at this stage the metabolic changes in fish tend more towards increase in linear dimension than towards building of weight.

The low value of K_n in 156–214 mm group is due to onset of sexual maturity. The fluctuations in K_n values related to increase in length of fish have been used by several workers (Hart, 1931; Verghese, 1973) as a sign of attainment of sexual maturity.

The point of inflexion on a curve shows the diminution of the length at which sexual maturity is attained, it was observed in this fish, on K_n curve between 155–214 mm for either sex *i.e.*, when fishes attain first sexual maturity. The intermediate groups (216–348 mm) of either sex showed generally, an upward trend in K_n values, thereby indicating that the subsequent spawning has not much adversely affected the K_n . However, low value of K_n observed in males at 315–331 mm and in females of the same group may be of cyclic nature. Pantulu (1961) and Verghese (1973) observed a similar trend in fluctuation of K_n values in *Mystus gulio* and *Coilia ramacarati* Gunthur respectively.

SUMMARY

A total of 300 fishes, ranging from 81 mm to 360 mm in total length were procured from Tilaiya Reservoir, Jharkhand for the study of length-weight relationship and relative condition index (K_n). The pooled length-weight relationship for the two sexes was found to be $W = -4.7988 + 2.9015 \log L$. The Relative Condition Index was estimated on monthly basis and well-marked seasonal fluctuations in its values were observed. In general, peak values of K_n were higher in male's (1.068) than female's (1.023) and were observed in November. Females attained minimum values in K_n in February and males in March. Subsequently, a general improvement in condition of fishes of the two sexes was observed in summer, while in peak monsoon months an abrupt fall in K_n was perceptible for the two sexes.

REFERENCES

- Fulton, T. W. 1904. The rate of growth of fishes. *Fish Bd. Scot, Rept.* **22**, Pt. 33 : 141-240.
- Hart, J. L. 1931. The growth of whitefish *Coregonus clupeaformis* (Mitchill), *Contr. Canad. Biol. & Fish N.S.*, **6**(20) : 429-444.
- Hile, Ralph 1936. Age and growth of the cisco, *Liucichthys artedi* (Lesueur), in the lakes of northeastern highlands, Wisconsin. *Fish. Bull. U.S.*, **48**(19) : 211-317.
- Jhingran, A. G. 1972. Fluctuations in the ponderal index of the Gangetic anchovy, *Setipinna phasa* (Hamilton), *J. Inland. Fish. Soc. India*, **4** : 1-9.
- Jobling Malcolm 1995. *Environmental Biology of Fishes*. Fish and Fisheries series, **16** : 1-445. Chapman & Hall publication.
- Khan, M. A. 1983. On some aspects of Biology of *Notopterus notopterus* (Pallas) of Tilaiya Reservoirs, Bihar. Ph.D. thesis submitted to Agra University : 1-197.

- Le Cren, A. H. 1951. The length weight relationship and seasonal cycle in gonad weight and condition in perch (*Perca fluviatilis*). *J. Anim. Ecol.*, **20** : 201-19.
- Natarajan, A. V. and A. G. Jhingran, 1963. On the biology of *Catla catla* (Ham.) from the river Jamuna. *Proc. Nat. Inst. Sci. India* (B), **29**(3) : 326-355.
- Pantulu, V. R. 1961. Determination of age and growth of *Mystus gulio* (Ham.) by the use of pectoral spines with observations on its biology and fishery in the Hooghly estuary. *Proc. Nat. Inst. Sci. India* (B), **27**(4) : 198-225.
- Parameswaran, S. and M. Sinha, 1966. Observations on the biology of feather-back. *N. notopterus* (pallas). *Indian J. Fish.* **11**(1) : 232-250.
- Sinha M. 1972. Observations on the biology of *Puntius sarana* (Hamilton) of Loni Reservoir (M.P.) 1. Length-weight relationship food and condition factors. *J. Inland Fish. Soc. India.* **1** : 122-133.
- Verghese, T. J. 1973. Estimation of the age and growth of *Coilia ramacarati* Gunther. *J. Inland Fish. Soc. India*, **5** : 115-125.

TAXONOMIC STUDIES ON THE INDIAN SPECIES OF *PALMON* DALMON (HYMENOPTERA : CHALCIDOIDEA : TORYMIDAE) WITH THE DESCRIPTION OF A NEW SPECIES

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INTRODUCTION

Palmon Dalmon is an uncommon genus of Torymidae, members of which are parasitoids in the oothecae of mantids. The genus has long been considered as a synonym of *Podagrion* Spinola till Grissell (1995) attributed an independent status to the genus. He has provided the phylogeny, synonymy and diagnosis of the genus and also synonymised *Pachytomoides* Girault under *Palmon*. Eighteen species are known under *Palmon* in the world out of which four are represented in the Oriental region viz. *greeni* (Crawford) from Sri Lanka, Taiwan and India; *ashmeadi* (Crawford) from Philippine islands; *megarhopalus* (Masi) from Taiwan; *orchesticus* (Masi) from Taiwan, Sri Lanka and India (Grissell, 1995, Noyes, 2001). Narendran (1994) reported *P. greeni* (= *Pachytomoides greeni*) and *P. orchesticus* (= *Pachytomoides orchesticus*) from India and provided a key to Oriental species of *Pachytomoides*. Here, a new species of *Palmon* is described from India and *P. orchesticus* again reported from Kerala. A key to separate the Indian species of *Palmon* is also provided.

The type specimens of the new species described are deposited in Zoological Survey of India, Western Ghats Field Research Station, Calicut, Kerala, India. The following abbreviations are used in the text :

IPAL – Institut für Pflanzenschutzforschung der Akademie der Landwirtschaftswissenschaften, Eberswalde, Germany; MCSN – Museo Civico di Storia Naturale “G.Doria,” Genoa, Italy; MV – Marginal vein; OD – ocellar diameter; OOL – Ocellocular distance; PMV – Postmarginal vein; POL – Postocellar distance; SMV – Submarginal vein; STV – Stigmal vein; T1 – Gastral tergite 1; UC – University of Ceylon, Colombo, Sri Lanka; USNM – National Museum Natural History, Washington D.C., USA.

Key to the Indian species of *Palmon* Dalmon, females

1. Ovipositor short, 2.92x as long as gaster and 1.4x as long as rest of the body; length of antennal clava 1.3x preceding funicular segments and ring segment together (Fig. 1)
..... *P. alfredi* sp. nov.

- Ovipositor long, 4–4.5x as long as gaster and 2.1x as long as rest of the body; length of clava never exceeds preceding 7 funicular segments 2
- 2. Forewing with an infuscated area attached to STV; gaster with T1 joining petiole at condyle away from its insertion at foramen *P. greeni* (Crawford)
- Forewing without an infuscated area attached to STV; gaster with T1 joining petiole at condyle near its insertion at foramen *P. orchesticus* (Masi)

1. *Palmon alfredi* sp.nov.

(Figs. 1-4)

Female : Body length 2.8 mm, ovipositor, 3.9 mm. Color metallic blue, bright green on face and gena; antennae testaceous except on clava brown; gaster brown, paler on ventral part and a narrow sub median band dorsally; ovipositor sheaths dark brown; fore and mid legs uniformly yellow; hind legs brown except basal half of coxae blackish on dorsal part; wings sub hyaline, veins and pubescence brown.

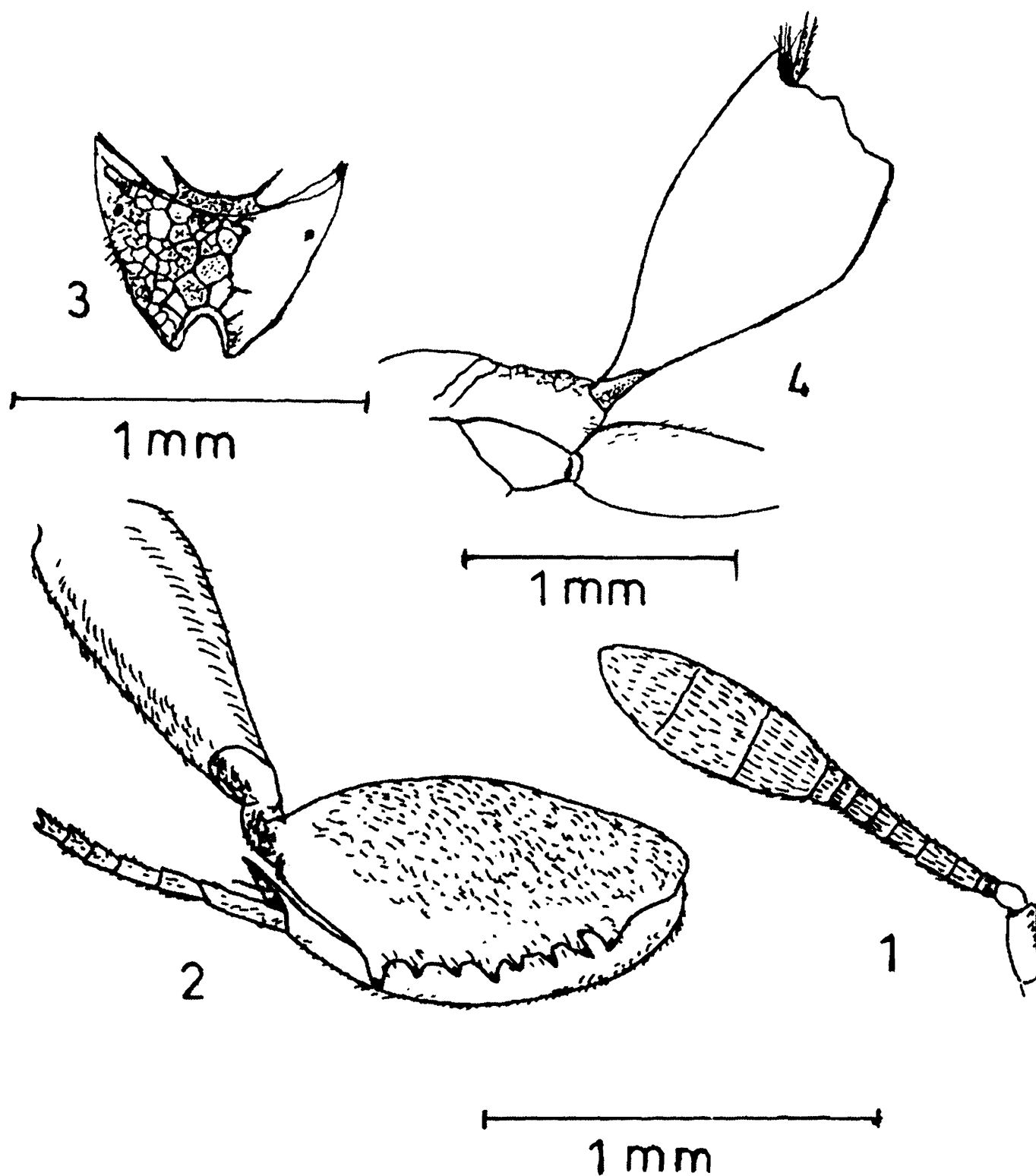
Head : 1.2x as broad as pronotum; reticulation finer and closer. POL : OOL : OD = 6.5 : 2 : 3; occiput with a fine carina. Head width : length in dorsal view 26.5 : 17; eyes separated by a distance equal to their length; eye length : width 17.5 : 13; malar space length in profile 5; malar grooves distinct; gena with fine posterior carina; antenna (Fig. 1) with scape length 8.55, pedicel plus flagellum 52, clava 1.3x as long as funicular segments and ring segment together.

Mesosoma : 1.8x as long as broad, closely and moderately reticulate. Pronotum anteriorly rounded. Mesoscutum, 1.7x as wide as long; notauli shallow, complete. Scutellum with reticulation finer towards the tip, only slightly convex, medially as long as mesoscutum. Propodeum (Fig. 3) almost level with scutellum, slightly curved in profile, uniformly with irregular aerolae, interior of which finely granulated in the middle, but polished laterally, medially propodeum shorter than scutellum, (12 : 17.5). Prepectus almost polished. Mesopleuron almost polished except on mesepimeron finely reticulate; lower mesepimeron with a deep pit anteriorly. Metapleuron very finely aciculate. Hind coxae (Fig. 2) with moderate reticulation on basal part. Relative lengths of hind coxa length : width 34 : 22.5, femur 44 : 20; tibia 43 : 5; tarsus length 26.5. Forewing length 3.2x width, pubescence almost complete except on a narrow posterobasal strip. Relative lengths SMV 42, MV 31, PMV 9, STV 5.

Gaster : (Fig. 4) shiny, 0.9x as long as rest of the body (without ovipositor), ovipositor 1.4x as long as rest of the body, 2.92x gaster and 3.9x as long as hind tibia

Host : Not known, biology in moist deciduous forests.

Holotype : Female : INDIA : Kerala, Wynad district, Muthanga, moist deciduous forest, 7.x.95, Coil. P. M. Sureshan.



Figs. 1-4. *Palmon alfredi* sp. nov. Female : 1. antenna; 2. hind leg; 3. propodeum dorsal view; 4. attachment of gaster on propodeum in profile.

Etymology : The species is named after Dr. J. R. B. Alfred, Director, Zoological Survey of India in honour of his contributions towards Indian Zoology.

Remarks : In general morphology this species closely resembles *P. orchesticus* (Masi) but can be readily distinguished from it and other Indian species *P. greeni* by the characters given in the key.

2. *Palmon orchesticus* (Masi)

Pachytomoides orchesticus Masi 1926 : 264-266, Female, Male, syntypes, Anping, Formosa (IPAL and/or MCSN), synonymy by Grissell, 1995.

Podagrion idgo Femando 1957 : 16-17, Female, syntypes, Habarana, Ceylon (UC) synonymy by Narendran, 1994.

Material examined : I Female, INDIA : Kerala : Calicut district, Anakampoyil, scrub jungle, 17.x.1995, Coil. P. M. Sureshan.

Remarks : Mani (1989) redescribed the female of *orchesticus* and Narendran (1994) the female and male. The present record forms the subsequent report of the species from Kerala after 1994.

SUMMARY

A new species of *Palmon* Dalmon viz, *P. wynadensis* is described from India and a key to the Indian species of *Palmon* is provided. *Palmon orchesticus* (Masi) is reported from Kerala after 1994.

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REFERENCES

- Grissell, E. E. 1995. Toryminae (Hymenoptera : Chalcidoidea : Torymidae) A redefinition, generic classification and annotated world catalog of species. *Mem. Ent. Int.* 2 : pp 470.
- Mani, M. S. 1989. The fauna of India and adjacent countries. Chalcidoidea (Hymenoptera). part. I and II, Zoological Survey of India, 1633 pp.
- Masi, L. H. 1926. Sauter's Formosa-Ausbeute. Chalcididae (Hym.). *Konowia* 5 : 1-20, 170-178, 264-279.

- Femando, W. 1957. New species of insects from Ceylon (1). *Ceylon J. Science (Biol Sci.)*. **1** : 7-18.
- Noyes, J. S. 2001. Interactive catalogue of world Chalcidoidea. Electronic publication (CD-Rom). Dicky S. Yu. Vancouver, Canada.
- Narendran, T. C. 1994. Torymidae and Eurytomidae of Indian subcontinent. *Zool Mon. Uni. of Calicut*. pp. 500.

CONTRIBUTION TO THE KNOWLEDGE OF CHALCIDIDAE OF INDIA

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INTRODUCTION

The family Chalcididae include one of the most important group of insects; most of them being natural enemies of agricultural pests, used as biological control agents. Many species are primary parasites of several insect pests of agricultural importance. Adults are usually free living, but the larvae are usually entomophagous parasites. Hyperparasitism, super parasitism and multiple parasitism are common among chalcids.

Chalcididae can be easily distinguished by its swollen hind femora. Other distinguishing features are geniculate antenna, presence of prepectus, biarticulate trochanter, fore wings with single vein, without closed cells etc. They are the largest insects among chalcidoidea, with a length ranging from 1.5 mm to 20 mm.

Major contributions to our knowledge on Indian chalcididae are provided by Masi (1916-1947), Boucek (1949-1988), Joseph, Narendran & Joy (1973), Boucek and Narendran (1981). Narendran (1989) published a complete monograph on Oriental chalcididae. This work comprises the systematic revision of Oriental fauna of Chalcididae, with dichotomous keys and descriptions (with illustrations) for identification of taxa. Narendran (1989) reported 190 species of chalcididae from 31 genera from India and 330 species from 41 genera from Oriental Region.

Present study deals with 45 species under 11 genera. Out of these, 11 species are reported for the first time from the state of Tripura and 1 species (*Epitranus crassicornis*) is new record from India. The material of study are mainly from Tripura but it also contains a few rare species from different parts of India.

Abbreviations used

BMNH : British Museum (Natural History) London, U.K.

BSRI : Biosystematic Research Institute, Ottawa, Ontario, Canada.

DEI : Institute for Pflanzenschutzforschung, Eberswalde, Germany (GDR).

DZCU : Department of Zoology, Calicut University, India.

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- ELKU : Entomological laboratory, Kyushu University, Fukuoka, Japan.
 FRI : Forest Research Institute, Dehra Dun, India.
 HDEO : Hope Department of Entomology, University Museum, Oxford, England.
 IARI : Division of Entomology, Indian Agricultural Research Institute, New Delhi, India.
 MCSG : Museo Civico di Storia Naturel, Genove, Italy.
 MNHN : Museum National de Histoire Naturelle, Paris, France.
 NM : Entomologicke oddeleni; Narodni, Museum, Praha, CSSR.
 NRS : Naturhistoriska Riksmuseet, Stockholm, Sweeden.
 QMB : Queensland Museum, Brisbane, Australia.
 USNM : United States National Museum of Natural History, Washington D.C., U.S.A.
 UZM : Universitets Zoologiska Museum, Copenhagen, Denmark.
 ZMHU : Zoologisches Museum Der Humboldt Universitat Berlin, FDR.
 ZSI : Zoological Survey of India.
 F : Female.

Genus 1. *Antrocephalus* Kirby

1883. *Antrocephalus* Kirby. Type species : *Halticella fascicornis* Walker by original designation, 54 : 63.

The known synonyms of this genus are : *Coelochalcis* Cameron 1904, *Dilla* Strand 1911, *Stomatoceroides* Girault 1913, *Metarretocera* Girault 1927, *Tainania* Masi 1929, *Sabatiella* Masi 1929, *Stomatocerella* Girault 1930, *Uxa* Girault 1930, *Dellisca* Ghesquire 1946 and *Uda* Girault 1930.

1. *Antrocephalus brevidentata* Roy and Farooqi

1984. *Antrocephalus brevidentata* Roy and Farooqui : 7. F., INDIA : Delhi (IARI)

Materials examined : 6F. INDIA : no locality and date of clection, M. S. Mani and Party; 1M. INDIA, Kerala, Kottoor, M. S. Mani and Party, 29-iv-1980.

Distribution : India, Delhi, Tamil Nadu, Kerala.

2. *Antrocephalus brevigaster* Masi

1926. *Antrocephalus brevigaster* Masi : Lectotype F., TAIWAN : Taiharin (DEI)

1982. *Antrocephalus hyalopennis* Husain and Agarwal, (synonymy by Narendran 1989)

Materials examined : 2F. INDIA : Kerala, Palode, M.S. Mani and Party, 16-iv-1980.

Distribution : India, Taiwan, Philippines, Malaya.

3. *Antrocephalus decipiens* (Masi)

1929. *Haltichella decipiens* Masi : 176, Lectotype F., PHILIPPINES (USNM).

Materials examined : 1F. INDIA : Kerala, Kottoor, M. S. Mani and Party, 3-iv-1980.

Distribution : All over Oriental Region.

4. *Antrocephalus dividens* (Walker)

1860. *Chalcis dividens* Walker : 357, F., SRI LANKA (BMNH)

1846. *Haltichella sepyra* Walker, (synonymy by Narendran 1989)

1874. *Halticella apicalis* Walker, (synonymy by Narendran 1989)

1904. *Coelochalcis carinifrons* Cameron, (synonymy by Narendran 1989)

1907. *Antrocephalus varipilosus* Cameron, (synonymy by Narendran 1989)

1911. *Antrocephalus longicornutus* Strand, (synonymy by Narendran 1989)

1974. *Sabatiella nepalensis* Mani and Dubey, (synonymy by Narendran 1989)

1984. *Antrocephalus delhiatus* Roy and Farooqui, (synonymy by Narendran 1989)

Materials examined : 21 F. INDIA : Tripura, Kailashar, 28-30-v-1978; 12F. Teliamura, 18-20-v-1978; 6F. Ambassa, 24-26-v-1978; 1F. Belonia 15-18-v-1978; 2F. Udaipur, 14-v-1978; 1F. Dharmanagar 1-vi-1978, J. K. Jonathan and party; 2F. Orissa, Narayanpur, Gopalpur, 7-x-72, Y. Chaturvedi; 1F. Maharashtra, Jog Shimogo, 9-i-1977, K. S. Pradhan; 1F. West Bengal, Jalpaigury, Jaigaon, 25-viii-1986; T K. Pal and Party; 3F. without any data.

Distribution : All over Oriental Region.

5. *Antrocephalus fascicornis* (Walker)

1871. *Halticella fascicornis* Walker : 43, F., INDIA : Bombay (BMNH).

Materials examined : 1M. INDIA : Kerala, Kottoor, M. S. Mani and Party, 29-iv-1980, 2F. INDIA : Tripura, Ambassa, J. K. Jonathan and Party, 24-26-v-1978.

Distribution : Indian subcontinent, China, Java, Philippines, Malaya.

6. *Antrocephalus japonicus* (Masi)

1936. *Sabatiella japonica* Masi : 48, F., JAPAN (DEI)

1982. *Antrocephalus brevicorpus* Husain and Agarwal, (synonymy by Narendran 1989)

Materials examined : 1F. INDIA : Tripura, Ambassa, J. K. Jonathan and Party, 28-30-v-1978.

Distribution : India, Malaysia, Taiwan and Japan.

Remarks : This is the first report of this species from Tripura.

7. *Antrocephalus hakonensis* (Ashmead)

1904. *Stomatocerus hakonensis* Ashmead : 148, F., JAPAN (USNM).
 1917. *Stomatocerus sulcatiscutellum* Girault (synonymy by Narendran 1989)
 1933. *Tainania dispar* Masi (Synonymy by Narendran 1989)
Antrocephalus renalis Waterston (Synonymy by Narendran 1985)

Material examined : 1F. INDIA : Arunachal Pradesh, Namdhapa, S. Biswas, 27-iv-1981.

Distribution : Indian subcontinent, Taiwan & Japan.

Host : *Opisina arenosella* Walker (Oecophoridae), *Conthyla rotunda* Habu.

8. *Antrocephalus mitys* (Walker)

1860. *Halticella mitys* Walker : 81, F., MAURITIUS (BMNH)
 1926. *Antrocephalus aethiopicus* Masi (Synonymy by Boucek 1976)
 1922. *Antrocephalus humilis* Waterston (Synonymy by Narendran 1989)
 1917. *Antrocephalus mahensis* Masi (Synonymy by Boucek 1976)
 1982. *Antrocephalus vitatus* Husain & Agarwal (Synonymy by Narendran 1989)
 1860. *Chalcis pandens* Walker (Synonymy by Narendran 1989)
 1871. *Halticella divicicornis* Walker (Synonymy by Boucek 1976)
 1862. *Halticella simplex* Walker (Synonymy by Boucek 1976)
 1921. *Stomatocera bergeraci* Girault (Synonymy by Boucek 1988)
 1900. *Stomatocera sulcata* Ashmead (Synonymy by Narendran 1989)

Material examined : 1F. INDIA : Tripura, Kailashar, J. K. Jonathan and Party, 28-30-v-1978.

Distribution : Africa, Asia and Australia.

Host : *Corcyra cephalonica* (Stainton) (Pyralidae), *Lamida moncusalis* Wlk. (Pyralidae)

Remarks : This is the first report of this species from Tripura.

Genus 2. *Brachymeria* Westwood

1829. *Brachymeria* Westwood, in Stephens : 36. Type species : *Chalcis minuta* Fabricius, designated by Westwood 1839.

The known synonyms of this genus are : *Tumidicoxa* Girault (1911), *Pseudepitelia* Girault (1913), *Brachepitelia* Girault (1913), *Tumidicoxoides* Girault (1913) *Tumidicoxella* Girault (1913), *Meyeriella* Krausse (1916), *Onchochalcis* Cameron (1904), *Ceyxia* Cameron (1911) and *Holochalcis* Kieffer (1904).

1. *Brachymeria albotibialis* (Ashmead)

1904. *Chalcis albotibialis* Ashmead : 12, F., PHILIPPINES (USNM)

1982. *Brachymeria(B) rufogastri* Husain and Agarwal, (synonymy by Narendran 1989)

Material examined : 1F. INDIA : Tripura, Teliamura, J. K. Jonathan and Party, 18-20-v-1978.

Distribution : Philippines, Singapore, India (Tamil Nadu, Delhi, Kerala, Karnataka).

Host : *Erionota thrax* L. *Pelopidas mathias* F., *Pericyma crugeri* B. and *Pieris brassica* L.

Remarks : This is the first report of this species from Tripura.

2. *Brachymeria alternipes* Walker

1871. *Chalcis alternipes* Walker : 49, M., HONKONG (BMNH)

Material examined : 1F. INDIA : Arunachal Pradesh, Tippi, K. Mondal. 1-ix-2001.

Distribution : South China and India.

Remarks : This is the first report of this species from Arunachal Pradesh.

3. *Brachymeria apicicornis* (Cameron)

1911. *Onchophalcis apicicornis* Cameron : 3, F., (BMNH)

1973. *Brachymeria apicornis* Joseph Narendran & Joy : 174 (misspelling for *apicicornis*)

Material examined : 1F. INDIA : no locality data or date, collected by M. S. Mani and Party.

Distribution : Jawa, Borneo, India, Sulawesi.

4. *Brachymeria bengalensis* (Cameron)

1897. *Chalcis bengalensis* Cameron : 39 F., INDIA (BMNH)

1936. *Stypiura variabilis* Mani (synonymy by Narendran 1986)

1963. *Brachymeria yasumatsui* Habu (synonymy by Joseph et al. 1973)

1970. *Brachymeria scrobatae* Joseph et al., (synonymy by Joseph et al. 1973)

Material examined : 1F. INDIA : West Bengal, Datta pukur, A.N.T Joseph, 6-xii-1986, 1F. Rajasthan, Nowa, T. G. Vazirani, 10-v-1988, 1F. Rajasthan, Jodhpur, A. K. Datta, 28-vi-1961.

Distribution : All over Oriental region and Japan.

5. *Brachymeria burksi* Chottani

1966. *Brachymeria burksi* Chottani : 89, F., INDIA : West Bengal (ZSI)

Material examined : 1F. INDIA : Calcutta, Botanical Garden, 27-x-1965, K.R.R. & Party; 1F. West Bengal, Barrackpore, viii-1965, Chottani.

Distribution : India.

Host : *Aspidomorpha miliaris* Fabricius (Chrysomelidae)

6. *Brachymeria calopeplae* Joseph, Narendran & Joy

1972. *Brachymeria calopeplae* Joseph, Narendran & Joy : 554, F., INDIA : Dehra Dun (FRI)

Material examined : 1F. INDIA : West Bengal, Calcutta, Eden Gardens, 17-iv-1965, S. N. Saha.

Distribution : India (Dehra Dun, West Bengal)

Host : *Calopepla leayana*.

7. *Brachymeria euploae* (Westwood)

1837. *Chalcis euploae* Westwood : 6? F., INDIA (HDEO)

1982. *Brachymeria(B) flavotibialis* Husain & Agarwal (synonymy by Narendran 1989)

1922. *Brachymeria hearseyi* var. *xanthotenus* Waterson (synonymy by Narendran 1986)

Material examined : 1F. INDIA : West Bengal, Dhangara, A. K. Sanyal & Party, 29-xi-1983; 1F. West Bengal, Jalpaiguri, S. K. Tandon & Party, 14-x-1987; 1F. Tripura, Udaipur, J. K. Jonathan & Party, 18-20-v-1978; 1F. West Bengal, Jhargram, Rajbari, A. K. Hazra & Party, 3-x-1983; 21F. INDIA : Andamans, Burmahnala, 14-iv-1964, B. S. Lamba; 1F. NEFA, Daphabum Expedition, 3-xii-1969, J. M. Julka; 1F. South Andamans, Shoal Bay, 29-iii-1964, B. S. Lamba; 2F. Barkuda Id, Chilka Lake, Ganjam Dist. 11-16-xii-1919; 4F. Bangalore, Cameron; 2F. Darjeeling.

Distribution : India, N. Borneo, Sumatra Java and Philippines.

Host : Several Dipteran hosts.

Remarks : This is the first report of this species from Andamans And Tripura.

8. *Brachymeria hearseyi* (Kirby)

1883. *Chalcis hearseyi* Kirby : 76, F., INDIA : Barrackpore (BMNH)

Material examined : 1F. INDIA : Gt. Nicobar, Dogmar, Daniel and Bhowmik, 18-iv-1966.

Distribution : India.

Host : Pupa of Nymphalidae.

Remarks : This is the first report of this species from Nicobar.

9. *Brachymeria lasus* (Walker)

1841. *Chalcis lasus* Walker : 219. Lectotype F., INDIA : Calcutta (BMNH)

1904. *Onchochalcis marginata* Cameron : 267

1874. *Chalcis obscurata* Walker : 399
 1862. *Chalcis inclinator* Walker : 345
 1911. *Chalcis punctiventris* Cameron
 1862. *Chalcis nitator* Walker : 356 (synonymy by Boucek 1988)
 1913. *Chalcis papuana* Cameron : 85-86 (synonymy by Boucek 1988)
 1913. *Tumidicoxa regina* Girault : 103 (synonymy by Boucek 1988)
 1915. *Chalcis regina* var. *dentata* Girault : 318 (synonymy by Boucek 1988)
 1936. *Chalcis regina* var. *copernaci* Girault : 3 (synonymy by Boucek 1988)

Material examined : 1F. INDIA : Tripura, Kailashar, J. K. Jonathan & Party, 28-29-v-1978; 3F. Tripura Udaipur, J. K. Jonathan & Party, 14-v-1978; 1F. Uttar Pradesh, Gaziabad, Shishodia & Party, 11-vi-1989; 1F. INDIA : Darjeeling, jalpaiguri, 20-iv-1975, B. C. Nandy : 1F. Assam. Shillong, Polo ground, 20-x-1974, S. K. Gupta, 1F. NEFA, Kameng division, Bomdila, 22-iv-1966, A. N. T Joseph; 1F. Madhya Pradesh, Sehore, 19-x-1964, B. N. Modi (ex pupa of *Sylepta derogara*); 1F. West Bengal, Bankura, 9-iv-1951, N. C. Chatterje; 1F. Jammu, Gandhrashnagkishtwar, 15-vii-1965, Raj Tilak.

Distribution : World wide.

Hosts : Several Lepidopterans.

10. *Brachymeria lugubris* (Walker)

1871. *Chalcis lugubris* Walker : 49, F. HONG KONG (BMNH)
 1883. *Chalcis atrata* Kirby

Material examined : 1F. INDIA : South Andamans, Burmahnala, 14-iv-1964, B. S. Lamba.

Distribution : India, South China, Australia.

Host : *Atteva fabriciella* (Swederus) (Yponomeutidae) and Tachinid pupa.

Remarks : This is the first report of this species from Andamans.

11. *Brachymeria marmonti* (Girault)

1924. *Chalcis marmonti* Girault : 175, F., Australia (QMB)
 1946. *Chalcis wittei* Schmitz
 1973. *Brachymeria koduvalliensis* Joseph et al.

Material examined : 1F. INDIA Coimbatore, 4-ii-1928, T.K.V.; 1F. Punjab, Ludhiana, 1974, Jaswant Singh.

Distribution : Africa, South Asia and Eastern Australia.

Host : Hyperparasite of Lepidoptera through Braconidae and Ichneumonidae.

12. *Brachymeria megaspila* (Cameron)

1907. *Chalcis megaspila* Cameron : F., INDIA : Abu (BMNH)
 1910. *Chalcis koebeleri* Crawford : (synonymy by Boucek 1988)
 1927. *Chalcis poema* Girault : (synonymy by Boucek 1988)

Material examined : 1F. INDIA : Pandava falls, M.S. Mani & Party, 7-8-ix-1979).

Distribution : India, Vietnam, Java, Japan, Australia.

Host : *Delias* sp. (Noctuidae), *Eurema blanda silhetana* Wall. Pieridae), *Eurema hecabe* Linn. (Pieridae).

13. *Brachymeria minuta* (Linnaeus)

1767. *Vespa minuta* Linnaeus : 952, F.,? South Europe (?UZM)
 1790. *Chalcis pusilla* Rossi : 348
 1834. *Chalcis brevicornis* Klug
 1859. *Chalcis scrobiculata* For : 93
 1859. *Chalcis tricolor* Forster : 98
 1875. *Chalcis fumata* Thompson : 18
 1910. *Chalcis paraplesia* Crawford : 19 (synonymy by Habu 1960)
 1912. *Chalcis jezoensis* Matsumura : 166 (synonymy by Habu 1960)
 1971. *Brachymeria putturensis* Joseph et al. : 229 (synonymy by Joseph et al. 1971)

Material examined : 1F. INDIA : Sikkim, Jerthang, G. C. Sen and Party 5-xi-1994; 1F. West Bengal, Darjeeling, A.N.T. Joseph & Party, 3-x-1978, 1F. Karnataka, Western Ghats, P. T. Cherian & Party, 10-iii-1977, 1F. Tamil Nadu, Tirupati, M. S. Mani & Party, 25-26-i-1967; 8F. without data.

Distribution : World wide.

Host : Several Dipterans.

14. *Brachymeria podagrica* (Fabrecius)

1787. *Chalcis podagrica* Fabrecius : 48, M., INDIA, Tamil Nadu (UZM)
 1841. *Chalcis fonscolombi* Dufour : (synonymy by Boucek 1972)
 1846. *Chalcis alphius* Walker : (synonymy by Boucek 1972)
 1846. *Chalcis xerxena* Walker : (synonymy by Boucek 1972)
 1846. *Chalcis amenocles* Walker : (synonymy by Boucek 1972)
 1929. *Chalcis beccari* Masi : (synonymy by Narendran 1989)
 1868. *Brachymeria pulchripes* Holmgren : (synonymy by Boucek 1972)
 1871. *Chalcis manseuta* Walker : (synonymy by Boucek 1972)
 1883. *Chalcis callipus* Kirby : (synonymy by Boucek 1972)

1897. *Chalcis eccentrica* Cameron : (synonymy by Boucek 1972)
 1905. *Chalcis borneanus* Cameron : (synonymy by Boucek 1972)
 1936. *Chalcis garutianus* Gunther : (synonymy by Boucek 1972)
 1929. *Brachymeria becarii* Masi : (synonymy by Narendran 1989)
 1916. *Chalcis neglecta* Masi : (synonymy by Boucek 1972)
 1888. *Chalcis mikado* Cameron : (synonymy by Boucek 1972)
 1915. *Chalcis depterophaga* Girault & Dodd (synonymy by Boucek 1988)
 1913. *Tumidicoxoides kurandaensis* Girault : (synonymy by Boucek 1988)
 1915. *Tumidicoxoides paucipunctatus* Girault : (synonymy by Boucek 1988)
 1982. *Brachymeria (Matsumuraria) aligarhensis* Husain & Agarwal : (synonymy by Narendran 1989)
 1862. *Chalcis restituta* Walker (synonymy by Boucek 1992)
 1924. *Chalcis vegai* Girault (synonymy by Boucek 1988)

Material examined : 1F. INDIA : Tripura, Kailashar, J. K. Jonathan & Party, 28-30-v-1978; 1F. Tripura, Teliamura, J. K. Jonathan & Party 18-20-v-1978; 2F. Tripura, Ambassa, J. K. Jonathan & Party, 24-26-v-1978; 1F. Bakchur, M. S. Mani & Party, 7-9-1979; 1F. Tripura, Udaipur, J. K. Jonathan & Party 14-v-1978; 1F. Sikkim, Jorhang, G. C. Sen & Party, 10-vi-1994.

Distribution : World wide.

Host : Sarcophagidae, Calliphoridae, Synanthropic Diptera, secondarily parasitic on Lepidoptera through Diptera.

15. *Brachymeria ryukyuensis* Habu

1963. *Brachymeria (Matsumuraria) ryukyuensis* Habu : 115, F., JAPAN : Ryukyu Is. (ELKU)

Material examined : 3F. INDIA : Tripura, Ambassa, J. K. Jonathan & Party, 24-26-v-1978.

Distribution : Japan, Philippines, India (Andaman & Nicobar Is.)

Remarks : This is the first report of this species from Tripura.

Genus 3. *Dirhinus* Dalman

1818. *Dirhinus* Dalman : 75-76, Pl. 2. Type species : *Dirhinus excavatus* Dalman by monotypy.

The known synonyms of this genus are *Eniaca* Kirby (1883), *Dirhinoidea* Girault (1912), *Pareniaca* Crawford (1914), *Eniacella* Girault (1914), *Eniacomorpha* Girault (1915), *Dirhinoides* Masi (1947).

1. *Dirhinus anthracia* Walker

1846. *Dirhinus anthracia* Walker : 7, 85, M., PHILIPPINES (BMNH)
 1981. *Dirhinus aligarhensis* Husain & Agarwal : 183, F., INDIA : Aligarh (ZDAMU) (synonymy by Narendran 1989)
 1981. *Dirhinus ignobilicornis* Husain & Agarwal : 187, F. INDIA : Aligarh (ZDAMU) (synonymy by Narendran 1989)

1957. ?*Dirhinus sinon* Fernando W. : 214 syntypes, 2M. Eastern Province, Puanui (?lost)

1913. *Eniacellularia ruficornis* Girault (synonymy by Boucek & Narendran 1981)

1915. *Eniacellularia bicornutipes* Girault (synonymy by Boucek & Narendran 1981)

1919. *Dirhinus sacrophagae* Froggat (synonymy by Boucek & Narendran 1981)

1933. *Dirhinus frequens* Masi (synonymy by Boucek & Narendran 1981)

1972. *Dirhinus intermedius* Mani & Dubey (synonymy by Boucek & Narendran 1981)

1974. *Dirhinus georgei* Mani & Dubey (synonymy by Boucek & Narendran 1981)

Dirhinus excavatus Auctorum Nec. Dalman as misidentification (synonymy by Boucek & Narendran 1981)

Materials examined : 7F. INDIA : Tripura, Kailashar, J. K. Jonathan & Party, 28-30-v-1978; 2F, Tripura Teliamura, J. K. Jonathan & Party, 18-20-v-1978; 2F. Harsa, M. S. Mani & Party, 9.x.1979; 1F. Pandava falls, M. S. Mani & Party, 7-8-ix-1979; 1F. no locality name, M. S. Mani & Party; 1F. Bakchur, M. S. Mani & Party, 7-ix-1979.

Distribution : Oriental Region, Australian Region, Mediterranean Region & Africa.

Host : *Calliphora villosa* (Calliphoridae), *Dacus cucurbitae* Coq (Tephritidae), *Dacus ferrugineus* F., *Sarcophaga aurifrons* Mac. (Sarcophagidae), *Brachartona catoxantha* Hampson (Zygaenidae), *Plecoptera reflexa* G. (Noctuidae), *Pyrausta machaeralis* W. (Pylalidae).

2. *Dirhinus auratus* Ashmead

1905. *Dirhinus auratus* Ashmead : 402, Lectotype F. PHILIPPINES : Manila (USNM)

1981. *Dirhinus circinus* Husain and Agarwal : 182, F. INDIA : Aligarh (ZDAMU) (synonymy by Narendran 1989).

1974. *Dirhinus pambaeus* Mani & Dubey (synonymy by Boucek & Narendran 1981)

Material examined : 1F. INDIA : Mopping Survey, Jhargram Rajbari, A. K. Hazra & Party, 3-x-1983; 3F. Vindhya Survey, Harsa, 9-10-ix-1979, M. S. Mani & Party.

Distribution : India, Sri Lanka, Thailand, Laos, Vietnam, Taiwan, Philippines, and Pakistan.

Host : *Dacus* sp.

3. *Dirhinus bakeri* (Crawford)

1914. *Parenia bakeri* Crawford : 459, F., PHILIPPINES : Manila (USNM)

1927. *Parenia tricophthalma* Masi

Material examined : 3F. INDIA : Harsa, M. S. Mani & Party, 9-10-ix-1979; 1F. Pandava falls, M. S. Mani & Party, 7-8-ix-1979; 1F. Panna Satna Rd. 9-10-1979, M. S. Mani & Party; 2F. Tripura, Kailashar, J. K. Jonathan & Party, 28-30-v. 1978.

Distribution : India, Sri Lanka, Malaysia, Philippines & Japan.

Hosts : *Sargus metallinus* (F.) (Stratiomyidae), *Musca domestica*, (Muscidae), *Ptychomyia remota* Ald. (Tachinidae) and *Dacus incisus*.

Remarks : This is the first report of this species from Harsa, Pandava falls, Panna Satna & Tripura.

4. *Dirhinus himalayanus* Westwood

1836. *Dirhinus himalayanus* Westwood : 840, F., INDIA : Uttar Pradesh
 1981. *Dirhinus lakhimpuriensis* Husin & Agarwal (synonymy by Narendran 1989)
 1906. *Dirhinus crythroceras* Cameron (synonymy by Boucek & Narendran 1981)
 1923. *Dirhinus luzonensis* Rohwer (synonymy by Boucek & Narendran 1981)
 1923. *Dirhinus luciliae* Rohwer (synonymy by Boucek & Narendran 1981)
 1927. *Dirhinus pachycerus* Masi (synonymy by Boucek & Narendran 1981)
 1952. *Dirhinus vlasovi* Nikolskaya (synonymy by Boucek & Narendran 1981)
 1972. *Dirhinoides mathuri* Mani & Dubey (synonymy by Boucek & Narendran 1981)

Materials examined : 2F. INDIA : Calcutta, Presidency College, 15-viii-1974, B. D. Gupta; 1F. Calcutta, Bansdroni, 12-iii-2001, Sheela, S.

Distribution : India, Saudi Arabia, Iraq, Turkmenia, Pakistan, Malaysia, China, Philippines, Japan, Cocos Is., Sumatra & Hawaii.

Hosts : *Chrysomya megacephala* (Fab) (Calliphoridae), *Hypantiria cunea* Drury (Lep.), *Lucilia* sp. (Calliphoridae), *Musca domestica* Linn (Muscidae).

5. *Dirhinus madagascariensis* (Masi)

1947. *Pareniaca madagascariensis* Masi : 74, Lectotype F., MADAGASCAR (MNHN)
 1974. *Pareniaca coromandelica* Mani and Dubey

Material examined : 1F. INDIA : West Bengal, Taki, Haripur, 24 Parganas District. 10-ix-1965, H. K. B. and Party.

Distribution : India, Thailand, Africa, Japan, Senegal.

Host : *Sylepta derogatga* (Fab.) (Pyralidae)

Remarks : This is the first report of this species from West Bengal.

Genus 4. *Epitranus* Walker

1834. *Epitranus* Walker : 21, 26. Types species : *Epitranus fulviscens* Walker by monotypy.

The known synonyms of this genus are : *Chalcitella* Westwood 1835, *Anacryptus* Kirby 1883, *Arretocera* Kirby 1883, *Neoanacryptus* Girault 1913, *Chalcitelloides* Girault 1914, *Paranacryptus* Girault 1915 and *Pararretoceroides* Mani 1938.

1. *Epitranus crassicornis* Boucek

1982. *Epitranus crassicornis* Boucek : 608, F., LAOS (BMNH)

Materials examined : 1F. INDIA : Tripura, Kailashar, J. K. Jonathan & Party, 28-30-v-1978.

Distribution : Laos, Malaysia & Vietnam.

Remarks : This is the first report of this species from India.

2. *Epitranus erythrogaster* Cameron

1888. *Epitranus erythrogaster* Cameron : 119, Lectotype, F., JAPAN : Nagasaki (BMNH)
1982. *Epitranus acuminatus* Husain & Agarwal (synonymy by Narendran 1989)
1910. *Anacryptus sculpturatus* Crawford (synonymy by Boucek 1982)
1933. *Anacryptus kankanensis* Masi (synonymy by Boucek 1982)
1936. *Arretoceroides ceylonensis* Mani (synonymy by Boucek 1982)
1953. *Anacryptus raoi* Mani & Kurian (synonymy by Boucek 1982)
1957. *Chalcitelloides devadatta* W. Fernando (synonymy by Boucek 1982)
1957. *Chalcitelloides ajatasattu* Fernando (synonymy by Boucek 1982)
1958. *Chalcitella cinca* W. Fernando (synonymy by Boucek 1982)
1959. *Pararretoceroides austini* Fernando (synonymy by Boucek 1982)
1973. *Arretocera ambadevia* Mani & Dubey (synonymy by Boucek 1982)
1973. *Arretocera nilamburensis* (!) Mani & Dubey (synonymy by Boucek 1982)
1973. *Arretocera pallava* Mani & Dubey (synonymy by Boucek 1982)
1973. *Arretocera tanjorensis* Mani & Dubey (synonymy by Boucek 1982)
1974. *Chalcitella nilamburensis* Mani & Dubey (synonymy by Boucek 1982)
1974. *Arretocera malabarensis* Mani & Dubey (synonymy by Boucek 1982)

Materials examined : 6F. INDIA : Western Ghats, Kidu, M. S. Mani & Party, 23-iii-1975; 1F. West Bengal, Ballarpur forest, S. B. Roy & Party, 29-i-1986.

Distribution : All over Oriental Region & Japan.

Host : *Corcyra cephalonica* (Stainton) (Pyralidae), *Chilo simplex* But.

3. *Epitranus observator* Walker

1862. *Epitranus observator* Walker : 349-350, Lectotype F., UGANDA : Sierra Leon (BMNH)
1936. *Anacryptus bayoni* Masi (synonymy by Boucek 1982)
1942. *Anacryptus megacerus* Schmitz (synonymy by Boucek 1982)
1953. *Anacryptus muzafferu* Mani & Kurian (synonymy by Boucek 1982)
1953. *Anacryptus shaffii* Mani & Kurian (synonymy by Boucek 1982)
1960. *Pararretoceroides coomaraswamyi* W. Fernando (synonymy by Boucek 1982)

Materials examined : 1F. INDIA : Tripura, Kailashar, J. K. Jonathan & Party, 28-30-v-1978; 1F. Tripura Teliamura, J. K. Jonathan & Party, 18-20-v-1978; 1F. Sikkim, Jorhang, G. C. Sen & Party, 6-ix-1994.

Distribution : Africa, Sri Lanka, Thailand, Malaysia.

Remarks : This is the first report of this species from Tripura and Sikkim.

Genus 5. *Hockeria* Walker

1834. *Hockeria* Walker : 21, 34. Type species : "*Chalcis bispinosa*" Fabricius sensu Kirby (= *Hockeria bifasciata* Walker) designated by Kirby 1883.

1960. *Nipponohockeria* Habu (synonymy by Narendran 1989)

The known synonyms of this genus are : *Stomatoceras* Kirby (1883), *Temnata* Cameron (1897), *Centrochalcis* Cameron (1905), *Hypochochalcis* Girault (1915), *Orthochochalcis* Silvestri (1943), *Afrochalcis* Schmitz (1946), *Hockerella* Girault (1930) and *Afrhockeria* Steffan (1955).

1. *Hockeria anupama* Narendran

1989. *Hockeria anupama* Narendran : 96, F., INDIA : Kerala (DZCU)

Materials examined : 1F. INDIA : Kerala, Palode, M. S. Mani & Party, 1-iv-1980.

Distribution : India (Kerala).

Remarks : Narendran (1989) described this species based on a single specimen obtained from Malampuzha. This is the second time this species is being reported.

2. *Hockeria argentigera* Holmgren

1869. *Hockeria argentigera* Holmgren (misspelling for *Hockeria*) : 436, F., Lectotype, JAVA, (NRS)

Materials examined : 1F. INDIA : North Bengal, Cooch Behar, M. Prasad & Party, 28-iii-1984.

Distribution : India, Java, Singapore, Sarawak.

Remarks : This is the first report of this species from Bengal.

3. *Hockeria fronta* Narendran

1989. *Hockeria fronta* Narendran : 104, F., M., INDIA : Kerala (DZCU)

Materials examined : 1F. INDIA : Kerala, Palode, M. S. Mani & Party, 25-iii-1980.

Distribution : India.

4. *Hockeria guptai* Narendran

1989. *Hockeria guptai* Narendran : 108, F., M., INDIA : Tamil Nadu (DZCU)

Materials examined : 3F. INDIA : Tripura, Ambassa, J. K. Jonathan & Party, 24-26-v-1978; 2F. Kailashar, J. K. Jonathan, 28-30-v-1978; 1F. West Bengal, Bankura, Sonamukhi. M. Dutta & Party, 30-x-1985.

Distribution : India, Nepal, Malaya.

5. *Hockeria tristis* (Strand)

1911. *Antrocephalus tristis* Strand : 8, Lectotype, F., SRI LANKA (ZMHU)
 1897. *Temnata maculipennis* Cameron : 42 (synonymy by Narendran 1989)
 1973. *Trichoxenia zigonensis* Mani & Dubey : 35, (synonymy by Narendran 1989)
 1974. *Hockeria nilgiriensis* Mani & Dubey : 11, (synonymy by Narendran 1989)

Materials examined : 1F. INDIA : Tripura, Kailashar, J. K. Jonathan & Party, 28-30-v-1978.

Distribution : All over Indian subcontinent.

Host : *Pyrausta machaeralis* (Walker) (Pyralidae).

Genus 6. *Kreichbaumerella* Dalla Torre

1894. *Coelops* Kreichbaumer : 316-317, Type species : *Coelops palpebrator* Kreichbaumer by monotypy.
 Pre occupied by *Coelops* Blyth 1849
 1897. *Kreichbaumerella* Dalla Torre : 84 Replacement name for *Coelops* Kreichbaumer.

1. *Kreichbaumerella javensis* Narendran

1989. *Kreichbaumerella javensis* Narendran : 73, F., NEPAL : Kathmandu (BSRI)

Materials examined : INDIA : Tripura, Kailashar, J. K. Jonathan & Party, 28-30-v-1978.

Distribution : India, Nepal.

Remarks : This is the first report of this species from Tripura and second report from elsewhere India.

2. *Kreichbaumerella kraussi* Narendran

1989. *Kreichbaumerella kraussi* Narendran : 78, F., CAMBODIA : Siem Resp. (USNM)

Materials examined : INDIA : Vindhya Survey, Panna Satna, M. S. Mani & Party, 9-10-ix-1979.

Distribution : India, Cambodia, Philippines.

Remarks : This is the first report of this species from Vindhya and second report from elsewhere India, formerly being the paratypes reported from Kerala.

3. *Kreichbaumerella pulvinatus* (Masi)

1932. *Kreichbaumerella pulvinatus* Masi : 232, Lectotype, F., FORMOSA : Kankau (MCSG)

Materials examined : 1F. INDIA : Ghasiabad, Dhaulana, Shishodia & Party, 11-vi-1989; 1F. Tripura, Teliamura, J. K. Jonathan & Party, 18-20-v-1978; 2F. Tripura, Kailashar, J. K. Jonathan & Party, 28-30-v-1978.

Distribution : India, Malaya, Java, Philippines, Sri Lanka, Nepal, Singapore, Cochin China, Hainan Island.

Remarks : This is the first report of this species from Tripura and Ghaziabad.

Genus 7. *Neochalcis* Kirby

1883. *Neochalcis* Kirby : 54, 63. Type species : *Halticella osmicida* Saunders by original designation.

The known synonyms of this genus are : *Orthochalcis* Kieffer 1904 and *Eugastrochalcis* Masi 1929.

1. *Neochalcis breviceps* (Masi)

1929. *Eugastrochalcis breviceps* Masi : 182, Lectotype F., PHILIPPINES : Basilan Is. (USNM).

1929. *Hockeria maetai* Habu (synonymy by Narendran 1989)

1964. *Eugastrochalcis secundus* Mani & Dubey (synonymy by Narendran 1989)

Materials examined : 1F. INDIA : Harsa, M. S. Mani & Party, 9-10-ix-1979.

Distribution : Oriental Region, Japan.

Genus 8. *Psilochalcis* Kieffer

1904. *Psilochalcis* Kieffer : 250, Type species : *Psilochalcis longigena* Kieffer

1951. *Hyperchalcidia* Steffan : 67 (synonymy by Narendran 1989)

1. *Psilochalcis carinigena* (Cameron)

1907. *Coelochalcis carinigena* Cameron : 579, Lectotype M., INDIA : Gujarat (BMNH)

1985. *Invreia opisinae* Narendran (synonymy by Narendran 1989)

Materials examined : 1F. INDIA : Karnataka, Appangala, M. S. Mani & Party, 19-24-v, 3-vi-1978; 1F. Vindhya Survey, M. S. Mani & Party, 9-10-ix-1979; 1F. West Bengal, Sagar Islands Survey, Mandir Tala, R. C. Basu & Party, 16-vi-1977; 1F. Tripura, Udaipur, J. K. Jonathan & Party, 14-v-1978.

Distribution : All over Indian subcontinent.

Host : *Opisina arenosella* Walker (Oecophoridae).

2. *Psilochalcis keralensis* Narendran

1989. *Psilochalcis keralensis* Narendran : 183, F., INDIA : Kerala (DZCU)

Materials examined : 2F. INDIA : Tripura, Kailashar, J. K. Jonathan & Party, 28-30-v-1978.

Distribution : India.

Remarks : This is the first report of this species from Tripura and the second report from India.

Genus 9. *Steninvreia* Boucek

1988. *Steninvreia* Boucek : 58. Type species : *Xenarretocera tricarinata* Girault, by original designation.

1. *Steninvreia noyesi* Narendran

1989. *Steninvreia noyesi* Narendran : 165, F., INDIA : Kerala (DZCU)

Materials examined : 1F. INDIA : Andamans, Port Blair (Hadda), 30-iv-1970, B. K. Tikader.

Distribution : India (Kerala, Andamans).

Remarks : Narendran (1989) erected this species based on a single female from Kerala. After that this is the first time this specimen is being reported.

Genus 10. *Tropimeris* Steffan

1948. *Tropimeris* Steffan : 118, Type species : *Tropimeris excavata* Steffan by original designation.

1. *Tropimeris monodon* Boucek

1958. *Tropimeris monodon* Boucek : 481, F., INDIA : Bombay (NM)

Materials examined : 36F. & 1M. INDIA : Kerala, Palode, M. S. Mani & Party, 25-iii-16-iv-1980; 14F. Kerala, Kottur, M. S. Mani & Party, 27-iii-29-iv-1980; 1F. Kerala, Neyyar Dam, M. S. Mani & Party 20-iii-1980; 13F. Kerala, Aryankavu, M. S. Mani & Party, 18-iv-1980; 1F. Anchal, M. S. Mani & Party, 16-iv-1980.

Distribution : South and South East Asia.

Host : *Exealtis atomosa* Walshm. (Lep. Pterophoridae).

Genus 11. *Uga* Girault

1933. *Uga* Girault : 4, Type species : *Stomatoceras colliscutellum* Girault by original designation.

1982. *Neotainania* Husain & Agarwal.

1. *Uga menoni* Kerrich

1960. *Uga menoni* Kerrich : 115, F., INDIA : Orissa (BMNH)

1982. *Neotainania brevicorpis* Husain & Agarwal

Materials examined : 11F. INDIA : Bihar, Patna, A. P., Kanpur, 1964.

Distribution : India, Taiwan.

Host : *Epilachna* sp. (Coccinellidae).

Remarks : This is the first report of this species from Harsa. Previous reports from India include, Kerala, Karnataka and Tamil Nadu.

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REFERENCES

- Ashmead, W. H. 1900. New genera and species of Hymenoptera from the Philippines. *Proc. U. S. natn. Mus.* **23** : 397-413.
- Ashmead, W. H. 1904. Description of new Hymenoptera from Japan-2. *Jl. N. Y. ent. Soc.* **12** : 11-20, 65-83, 146-165.
- Ashmead, W. H. 1905. Additions to the recorded Hymenopterous fauna of the Phillippine Islands, with description of new species. *Proc. U. S. natn. Mus.* **28** (No. 1413) 3 : 957-971.
- Boucek, Z. 1958. Descriptions of new *Tropimeris* and a new *Tanycoryphus* (Chalcididae : Hymenoptera). *Acta. ent. natn. Pragae.* **32** : 481-485.
- Boucek, Z. 1976. Changes in the classification of some African chalcidoidea (Hymenoptera). *J. ent. Soc. South. Afr.* **31** : 345-355.
- Boucek, Z. 1988. Australian Chalcidoidea—Published C A B International. U. K. 832 pp.
- Boucek, Z. and Narendran, T C. 1981. Indian Chalcid wasps (Hymenoptera) of the genus *Dirhinus* parasitic on synanthropic and other Diptera. *Syst. Ent.* **6** : 229-251.
- Cameron, P. 1888. Descriptions of one new genus and some new species of parasitic Hymenoptera. *Proc. Manchester phil. Soc.* **26** : 1-120.
- Cameron, P. 1897. *Hymenoptera Orientalia* or Contribution to a knowledge of the Hymenoptera of the Oriental Zoological Region, Part-V. *Mem. Manchester Soc.* **XLI**(4) : 40-144.
- Cameron, P. 1904. Description of new genera and species of Hymenoptera from Mexico. *Trans. Am. ent. Soc.* **30** : 251-267.
- Cameron, P. 1905. A third contribution to the knowledge of Hymenoptera of Sarawak. *J. Straits. Brch. R. Asiat. Soc.* **42** : 1-98.
- Cameron, P. 1907. On the parasitic Hymenoptera collected by C. G. Nurse in the Bombay Presidency. *J. Bombay nat. Hist. Soc.* **27** : 580-581.

- Cameron, P. 1911. Descriptions of new genera and species of Chalcididae, collected by Mr. John Hewitt, B. A. in Borneo. *Societas ent.* **26** : 7-8, 11-12, 14, 19, 23-24, 28.
- Dalla Torre, C. G. 1897. Zur Nomenclatur der Chalcididen genera. *Wien ent. Ztg.* **16** : 84.
- Dalman, J. W. 1818. Nagra nya genera och species of insekter. *K. Vetensk. Akad. Handl.* **41** : 1-143.
- Fabricius, J. C. 1787. Mantissa Insectorum sistens species nuper detectas. 1, 20 + 348 pp. Copenhagen.
- Girault, A. A. 1913. On several new genera and species of Australian Hymenoptera, Chalcidoidea. *Can. Ent.* **45** : 101-106, 138-145.
- Girault, A. A. 1915. Australian Hymenoptera Chalcidoidea I-XIV. The family chalcididae with description of new genera & species. *Mem. Qd. Mus.* **3-4** : 142-365.
- Girault, A. A. 1917. *Description Hymenopterorum Chalcidoidicarum Variorum cum observationibus.* Privately Printed Paper **5** : 1-16.
- Girault, A. A. 1924. Homo perniciosus and New Hymenoptera. Privately printed paper. 4 pages Brisbane.
- Habu, A. 1963. Chalcididae from the Ryukyu Islands preserved in the Entomological laboratory of Kyushu University (Hymenoptera). *Mushi.* **37** : 111-112.
- Holmgren, A. E. 1869. Hymenoptera species novas descripsit pp. 391-442, pl. 8 (Haft. 12, no. 1). In Kongliga svenska fregartan Eugenics resa omkring jorden. *Vet. lakk. 2. Zoologie. I, Insecta.* 617 pp.
- Husain, T and Agarwal, M. M. 1981. Systematic studies on Indian Dirhininae (Hymenoptera : Chalcididae). *Oriental Ins.* **15** : 179-193.
- Husain, T and Agarwal, M. M. 1982. Indian species of *Brachymeria* Westwood (Hymenoptera : Chalcididae). *Oriental Ins.* **16** : 491-509.
- Joseph, K. J., Narendran, T C. and Joy, P. J. 1973. *Oriental Brachymeria* A monograph on the Oriental species of *Brachymeria* (Hymenoptera : Chalcididae). *Zoological Monograph* No. 1. pp. 215. Dept. of Zoology, University of Calicut.
- Kerrich, G. J. 1960. A systematic study of the Chalcid genus *Uga* Girault (Hymenoptera : Chalcididae) parasites of Epilachninae beetles. *Proc. R. ent. Soc. Lond., Ser. B.* **29** : 113-119.
- Kieffer, J. J. 1904. New Eucharinae and Chalcidinae. *Berl. ent. z.* **49** : 244-265.
- Kirby, W. F. 1883. Remarks on the genera of the subfamily Chalcidinae, with synonymic notes and description of new species of Leucospidinae and Chalcidinae. *J. Linn. Soc. (Zool.)* **17** : 17, 68, 76.

- Linnaeus, C. 1767. *Systema naturae* **12**(1) : 952.
- Mani, M. S. 1936. Some new and little known Parasitic Hymenoptera from India. *Rec. Ind. Mus.* **38**(2) : 333-340.
- Mani, M. S. and Dubey, O. P. 1972. On some Dirhinini (Hymenoptera : Chalcididae) from India *Oriental Ins.* **6** : 401-407.
- Mani, M. S., Dubey, O. P., Kaul, B. K. and Saraswat, G. G. 1973. On some chalcidoidea from India. *Mem. Sch. Ent. St. John's Coll.* **2** : 1-128.
- Mani, M. S. *et. al.*, 1974. Descriptions of some new and records of some known Chalcidoidea (Hymenoptera) from India. *Mem. Sch. Ent. St. John's Coll.* **3** : 1-108.
- Mani, M. S. and Kurian, C. 1953. Descriptions and records of chalcids (Parasitic : Hymenoptera) from India. *Indian J. Ent.* **15** : 1-21.
- Masi, L. 1926. H. Sauters Formosa-Ausbeute. Chalcididae (Hymenoptera). *Konowia* **5** : 8-20., 170-178, 264-268.
- Masi, L. 1927. Sopra un nuovo genera di Haltichellini e sulle diverse forme attribuite al genera Euchalcis Duf. (Hymenoptera : Chalcididae). *Mem. Soc. Natn. Ital.*, **6** : 208-222.
- Masi, L. 1929. Contributo alla conoscenza dei chalcididi Orientali della Sottofamiglia Chalcidinae. *Boll. Lab. Ent. R. Ist. Sup. agr. Bologna.* **2** : 155-188.
- Masi, L. 1932. H Sauters Formosa-Ausbeute. Chalcididae (Hymenoptera) II. *Konowia* **11** : 38-47, 228-240.
- Masi, L. 1933. H. Sauters Formosa-Ausbeute. Chalcididae (Hymenoptera) II. *Konowia*, **12** : 1-15.
- Masi, L. 1936. On some Chalcidinae from Japan (Hymenoptera : Chalcididae). *Mushi.* **9** : 48-51.
- Masi, L. 1947. Nuovo contributo alla conoscenza dei Dirhinini (Hymenoptera : Chalcididae) Eos. **23** : 39-78.
- Narendran, T. C. 1986. Chalcididae : *Oriental Ins.*, **20** : 11-41.
- Narendran, T. C. 1989. Oriental Chalcididae (Hymenoptera : Chalcidoidea) 440 pp.
- Rossius, P. 1790. Fauna Etrusca, sistens, Insecta, quac, In. provinciis, Florentina et, Pisana, praesertim, Collegit, Petrus, Rossius, **2** : 348 pp. Livorno.
- Roy, C. S. and Farooqui, S. I. 1984. Taxonomy of Indian Haltichellinae (Chalcididae : Hymenoptera) At National Pusa collection, IARI, New Delhi, *Mem. Ent. Soc. India.* **10** : 1-59.
- Schmitz, G. 1946. Explorative van het national Albert Park Chalcididae. *Inst. Parcs. Nat. Congo Belg. Bruxelles.* **48** : 3-191.
- Steffan, J. R. 1948. Deux nouveaux genres d'Haltichellinae (Hym. : Chalci.). *Bull. Soc. ent. France.* **53** : 118-123.
- Stephens, J. F. 1929. The nomenclature of British Insects. **1** : 36.

- Strand, E. 1911. Neue Exotische Chalcididen der Gattungen *Phasgonophora* Westw., *Heptasmicra* Ashm., *Anacryptus* Kby., *Antrocephalus* Kby., *Aperilampus* Wlk. and *Chryseda* Spin. *Fauna Exotica*. 1 : 6-10.
- Thomson, C. G. 1875. Hymenoptera scandinavicae. 4 : 1-259; 5 : 1-307.
- Walker, F. 1834. Monographia Chalciditum (cont.). *Ent. Mag.* 2 : 13-39.
- Walker, F. 1841. Descriptions of Chalcidites. *Entomologist.*, 1 : 217-220.
- Walker, F. 1846. *List of the specimens of Hymenopterous insects in the collections of the British Museum*. Part I Chalcidites VI + 100 pp. London.
- Walker, F. 1860. Characters of some apparently undescribed Ceylon insects. *Ann. Mag. nat. Hist.* 6 : 357.
- Walker, F. 1862. Notes on Chalcidites and characters of undescribed species. *Trans. Ent. Soc. Lond.* (3)1 : 345-397.
- Walker, F. 1871. Notes on Chalcididae. Part IV. Chalcididae, Leucospidae, Eucharidae, Perilampidae, Ormyridae, Eurytomidae London; pp. 20-70.
- Walker, F. 1874. In Smith, Description of new species of Tenthredinidae. Ichneumonidae, Chrysididae, Formicidae & Chalcididae of Japan. *Trans. ent. Soc. London.* 899-401.
- Waterson, J. 1922. On Chalcidoidea (Mainly bred at Dehra Dun, U.P., for Sal, Toon, Chi and Sundri). *Ind. For. Rec.* 9 : 1-44.
- Westwood, J. O. 1836. Descriptions of insects figures in plates 9 and 10; pp. III-IV, in Royle, J. F. 1933-40. *Illustrations of the Botany and other branches of the Natural History of the Himalayan Mountains and of the flora of Cashmere*. J. London. Parts I-IX, pp. 1-IXXX, 1-472.
- Westwood, J. O. 1837. Exhibition memories etc. *Proc. Ent. Soc. Lond.* V-VL. *Cin Trans. ent. Soc. London.* 2 : 1837-40.
- Westwood, J. O. 1839. Die Hymenopteran-Gattung *Leucospis* Monographisch behandelt. *Z. Ent.* (Germar) 1 : 237-266, pls. 3-4.

REPORT ON A COLLECTION OF PARASITIC NEMATODES FROM THE KAIMUR WILD LIFE SANCTUARY, ROHTAS AND BHABUA DISTRICTS, BIHAR, INDIA, ALONGWITH THE DESCRIPTIONS OF FIVE NEW SPECIES

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INTRODUCTION

A faunistic survey was undertaken by Shri A. K. Poddar of this survey to the conservation areas of the Kaimur Wild Life Sanctuary (Rohtas and Bhabua districts), Bihar in November, 1997. The present author was also included in the party, in the course of which a small collection of nematode alongwith some other helminth parasites were recovered from the collected hosts. The other groups of helminth parasite are not dealt here. The collection though small, has produced a number of properly authenticated records of nematode parasites of vertebrate hosts from the Kaimur Wild Life Sanctuary, Bihar.

It includes 21 species contained in 20 genera belonging to 17 families and 4 orders. Sixteen among these are fairly well known and the remaining five species are new. Detailed description of the species excepting a few is avoided.

All measurements are in millimeters.

LIST OF NEMATODES RECORDED FROM VERTIBRATE HOSTS OF KAIMUR WILD LIFE SANSTUARY, BIHAR

I. Order ENOPLIDA

Superfamily TRICHINELLOIDEA

1. Family TRICHURIDAE (Ransom, 1911) Railliet, 1915

Genus 1. *Trichuris* Roederer, 1761

1. *Trichuris globulosa* (V. Linstow, 1901) Ransom, 1911

Host : Goat.

II. Order ASCARIDIDA

Superfamily 1. COSMOCERCOIDEA

2. Family COSMOCERCIDAE (Railliet, 1916) Travassos, 1925

Subfamily COSMOCERCINAE Railliet, 1916

Genus 2. *Oxysomatium* Railliet & Henry, 19162. *Oxysomatium macintoshii* (Stewart, 1914) Karve, 1927*Host* : Toad (*Bufo melanostictus*).

Superfamily 2. HETERAKOIDEA

3. Family HETERAKIDAE Railliet & Henry, 1912

Subfamily HETERAKINAE Inglis, 1967

Genus 3. *Heterakis* Dujardin, 18453. *Heterakis spumosa* Schneider, 1866*Host* : *Rattus rattus*.

4. Family ASCARIDIIDAE Travassos, 1919

Genus 4. *Ascaridida* Dujardin, 18454. *Ascaridia galli* (Schrunk, 1788) Freeborn, 1923*Host* : Fowl.

Superfamily 3. SUBULUROIDEA

5. Family SUBULURIDAE (Travassos, 1914) Yorke &
Maplestone, 1926

Subfamily SUBULURINAE Travassos, 1914

Genus 5. *Subulura* Molin, 1860Subgenus *Subulura* Molin, 18605. *Subulura (Subulura) turdoideae* Soota & Dey Sarkar, 1981*Host* : Indian Rollar (*Coracias benghalensis*).6. *Subulura (Subulura)* sp.*Host* : Night Jar (*Caprimulgus* sp.).

Superfamily 4. SEURATOIDEA

6. Family SEURATIDAE (Hall, 1916) Railliet, 1916

Subfamily SEURATINAE Hall, 1916

Genus 6. *Seuratum* Hall, 19167. *Seuratum indicum* sp. n.*Host* : Greater Yellow Bat (*Scotophilus heathi heathi*).

7. Family QUIMPERIIDAE Baylis, 1930

Subfamily QUIMPERIINAE Gendre, 1928

Genus 7. *Paragendria* Baylis, 1939

8. *Paragendria* sp.

Host : *Wallago attu*.

III. Order SPIRURIDA

Superfamily 1. SPIRUROIDEA

8. Family SPIROCERCIDAE (Chitwood & Wehr, 1932 subfam.)
Chabaud, 1975

Subfamily SPIROCERCINAE Chitwood & Wehr, 1932

Genus 8. *Cylicospirura* Vevers, 1922

Subgenus *Gastronodus* (Singh, 1934 gen.) Chabaud, 1975

9. *Cylicospirura (Gastornodus) stresseni* (Singh, 1934)

Host : House Shrew (*Suncus murinus caerulescens*).

Superfamily 2. PHYSALOPTEROIDEA

9. Family PHYSALOPTERIDAE (Railliet, 1893) Leiper, 1908

Subfamily PHYSALOPTERINAE Railliet, 1893

Genus 9. *Pseudophysloptera* Baylis, 1934

10. *Pseudophysloptera scotophili* sp. n.

Host : Greater Yellow Bat (*Scotophilus heathi heathi*).

Superfamily 3. HABRONEMATODEA

10. Family HABRONEMATIDAE (Chitwood & Wehr, 1932)
Ivaschkin, 1961

Subfamily (1) HABRONEMATINAE Chitwood & Wehr, 1932

Genus 10. *Habronema* Diesing, 1861

11. *Habronema imbricatum* Maplestone, 1930

Host : Spotted Owlet (*Athene brama*).

Subfamily (2) HISTOCEPHALINAE Gendre, 1922

Genus 11. *Hadjelia* Seurat, 1916

12. *Hadjelia* sp.

Host : Indian Rollar (*Coracias bengalensis*).

Superfamily 4. THELAZIOIDEA

11. Family THELAZIIDAE Skrjabin, 1915

Subfamily THELAZIINAE (Skrjabin, 1915 fam.) Baylis &
Daubney, 1926Genus 12. *Thelazia* Bosc, 1819Subgenus *Thelaziella* Travassos, 191813. *Thelazia (Thelaziella) kaimurensis* sp. n.*Host* : Night Jar (*Caprimulgus* sp.).

Superfamily 5. ACUARIOIDEA

12. Family ACUARIIDAE Seurat, 1913

Subfamily ACUARIINAE Railliet, Henry & Sissoff, 1912

Genus 13. *Acuaria* Bremser, 181114. *Acuaria anthuris* (Rudolphi, 1819) Railliet, Henry & Sissoff, 1912*Host* : Tree Pie (*Dendrocitta vagabonda*).Genus 14. *Echinuria* Soloviev, 191215. *Echinuria* sp.*Host* : Brown Shrike (*Lanius cristatus*).

Superfamily 6. DRACUNCULOIDEA

13. Family MICROPLEURIDAE

(Baylis & Daubney, 1926 subfam.) Travassos, 1960

Genus 15. *Micropleura* Linstow, 190616. *Micropleura helicospicula* sp. n.*Host* : Marsh Crocodile (*Crocodylus palustris*).

Superfamily 7. DILOTRIAENOIDEA

14. Family DILOTRIAENIDAE

(Skrjabin, 1916 subfam.) Anderson, 1958

Subfamily DILOTRIAENINAE Skrjabin, 1916

Genus 16. *Dilotriaena* Railliet & Henry, 190917. *Dilotriaena tricuspis* (Fedchenko, 1874) Seurat, 1915*Host* : *Acridotheres tristis*.

Superfamily 8. APROCTOIDEA

15. Family APROCTIDAE (Yorke & Maplestone, 1926)
Skrjabin & Schikhobalova, 1945

Subfamily APROCTINAE Yorke & Maplestone, 1926

Genus 17. *Pseudaprocta* Schikhobalova, 1930

18. *Pseuaprocta kaimurensis* sp. n.

Host : Indian Rollar (*Coracias benghalensis*).

IV. Order STRONGYLIDA

Superfamily STRONGYLOIDEA

16. Family CHABERTIIDAE (Popova, 1952 subfam.)
Lichtenfels, 1980

Subfamily OESOPHAGOSTOMINAE Railliet, 1916

Genus 18. *Oesophagostomum* Molin, 1861

Subgenus (1) *Oesophagostomum* Molin, 1861

19. *Oesophagostomum (O.) dentatum* (Rudophi, 1803) Molin, 1861

Host : Pig.

Subgenus (2). *Poteracrum* Railliet & Henry, 1913

20. *Oesophagostomum (P.) columbianum* (Curtice, 1890) Stossich, 1899

Host : Goat.

Superfamily 2. TRICHOSTRONGYLOIDEA

17. Family MOLINEIDAE (Skrjabin & Schulz, 1937 Subfam.)
Durette-Desset & Chabaud, 1977

Subfamily MOLINEINAE Skrjanbin & Schulz, 1937

Genus 19. *Oswaldocruzia* Travassos, 1917

21. *Oswaldocruzia goezei* Skrjabin & Schulz, 1952

Host : Toad (*Bufo melanostictus*).

SYSTEMATIC ACCOUNT

I. Order ENOPLIDA

Superfamily TRICHINELLOIDEA

1. Family TRICHURIDAE (Ransom, 1911) Railliet, 1915

Genus 1. *Trichuris* Roederer, 1761

Trichuris globulosa (V. Linstow, 1901) Ransom, 1911

Material : One male; host—domestic goat; location—intestine; locality—Adhaura, Bhabua district, Bihar; 13.xi.1997; coll. S. R. Dey Sarkar.

Remarks : This species is widely distributed in India as a common parasite of goat.

II. Order ASCARIDIDA

Superfamily (1) COSMOCERCOIDEA

2. Family COSMOCERCIDAE (Railliet, 1916) Travassos, 1925

Subfamily COSMOCERCINAE Railliet, 1916

Genus 2. *Oxysomatium* Railliet & Henry, 1916

Oxysomatium macintoshii (Stewart, 1914) Karve, 1927

Material : 2 males, 6 females; host—Toad (*Bufo melanostictus*); location—rectum; locality—Adhaura and Mundeswari Bhagwanpur, Bhabua district, Bihar; 20.xi.1997 and 23.xi.1997; coll. S. R. Dey Sarkar.

Remarks : This species is a common parasite of *Bufo*, *Rana*, *Hyla*, *Pelobates* etc. and widely distributed in India.

Superfamily (2) HETERAKOIDEA

3. Family HETERAKIDAE (Railliet & Henry, 1912)

Subfamily HETERAKINAE Inglis, 1967

Genus 3. *Heterakis* Dujardin, 1845

Heterakis spumosa Schneider, 1866

Material : 1 male, 2 females; host—*Rattus rattus*; location—rectum; locality—Adhaura, Bhabua district, Bihar; 16.xi.1997; coll. S. R. Dey Sarkar.

Remarks : This species has world-wide occurrence and has been reported from rats, mice and bandicoots, only excepting a stray record by Gupta (1960) from a cat which had probably just ingested a rodent infected by the parasite.

4. Family ASCARIDIIDAE Travassos, 1919

Genus 4. *Ascaridea* Dujardin, 1845

Ascaridia galli (Schrank, 1788) Freeborn, 1923

Material : One male, one female; host—domestic fowl; location—intestine; locality—Adhaura, Bhabua district, Bihar; 13.xi.1997; coll. S. R. Dey Sarkar.

Remarks : This species is widely distributed in India and abroad and has been reported from ducks, hens and rarely from cat.

Superfamily (3) SUBULUROIDEA

5. Family SUBULURIDAE (Travassos, 1914) Yorke and
Maplestone, 1926

Subfamily SUBULURINAE Travassos, 1914

Genus *Subulura* Molin, 1860

Subgenus *Subulura* Molin, 1860

Subulura (Subulura) turdoideae Soota and Dey Sarkar, 1981

Material : 2 males; Z.S.I. Reg. No. WN 814; host—Indian Rollar (*Coracias benghalensis*); location—caecum; locality—Adhaura, Bhabua district, Bihar; 13.xi.1997; coll. S. R. Dey Sarkar.

Description : Body slender, posterior end curved in the form of hook. Head small, buccal cavity minute, thick walled, three small teeth present at the base of the cavity. Cervical alae well developed, extending from the cephalic extremity to beyond the oesophageal bulb. Caudal alae narrow.

Male : Body 12.0–13.04 long, 0.26–0.29 wide; buccal capsule (0.032×0.024) in diameter; nerve ring 0.19–0.24 from the head end; oesophagus including bulb 1.17–1.20 long, bulb (0.176×0.144) in diameter; cervical alae broad, 1.84–1.92 long, 0.048 wide; sucker fan shaped, 0.43 from the cloaca; tail curved, ending in a long fine point, 0.32–0.34 long; spicules equal, similar, non-alate, pointed 0.80–0.83 long, gubernaculum 0.144 long, with a spur; caudal alae narrow; caudal papillae 9 pairs, 3 pairs preanal, one pair adanal and 5 pairs postanal in position, of the preanal papillae one pair in the sucker.

Female : Unknown.

Remarks : Soota and Dey Sarkar (1981) created *Subulura turdoideae* from the single male specimen obtained from *Turdoides striatus* from Monar, Patna district, Bihar. The present specimens agree in all the details with the earlier description of the species given by Soota and Dey Sarkar (1981) excepting the size of lateral cervical alae. The specimens, however, form a new host record.

2. *Subulura (Subulura)* sp.

Material : One female; Z.S.I. Reg. No. WN 815; host—Night Jar (*Caprimulgus* sp.); location—caeca; locality—Mundeswari Bhagwanpur, Bhabua district, Bihar; 24.xi.1997; coll. S. R. Dey Sarkar.

Description : Head small, without lips. Buccal cavity with three teeth at the base. Cervical alae narrow. Vulva Prominent, pre-equatorial in position.

Male : Absent.

Female : Body 26.6 long, 0.048 wide; buccal capsule (0.048×0.032) in diameter; nerve ring 0.4 from the head end; oesophagus including bulb 2.16 long; bulb (0.32×0.32) in diameter; narrow cervical alae extended upto 1.12 from the head; tail short, pointed, 0.32 long; valva at 3.8 from the anterior end, dividing the body length in ratio of 1 : 7; vagina short transverse, with ovijectors running anteriorly from it; eggs spherical (0.032×0.032) in diameter.

Remarks : In the absence of a male specimen, specific identification is not possible.

Superfamily (4) SEURATOIDEA

6. Family SEURATIDAE (Hall, 1916) Railliet, 1906

Subfamily SEURATINAE Hall, 1916

Genus 6. *Seuratum* Hall, 1916*Seuratum indicum* sp. n.

(Fig. 1. a, b, c and d)

Material : Holotype, one male, Z.S.I. Reg. No. WN 816; host—Greater Yellow Bat (*Scotophilus heathi heathi*); location—intestine; locality—Rohtas, Rohtas district, Bihar; 8.xi.1997; coll. S. R. Dey Sarkar.

Paratypes 2 mature females and 4 immature females; Z.S.I. Reg. No. WN 817; other particulars same as for the holotype.

Description : The worms are stout and coarse. The female is as much as 4.5 times longer than the male. Cuticle with longitudinal rows of spines. The body transversely striated; mouth with two lateral lips, each lip bearing a pair of large papillae. Buccal capsule short. Oesophagus short, undivided, slightly swollen at its anterior end, rest of the Oesophagus being club shaped. Tail conical in both sexes and terminating in cuticular spine. Caudal alae in male narrow.

Male : Body 4.8 long, 0.18 wide; nerve ring 0.16 from the head end; oesophagus 0.35 long, about 1/13-th of the entire body length; tail 0.11 long; caudal alae narrow; caudal papillae 11 pairs, 4 pairs preanal and 7 pairs postanal, of the postanal papillae one pair ventral in position; spiculs subequal 0.144 and 0.160 long, slightly curved; gubernaculum small, 0.032 long.

Female : Body 20.64–21.20 long, 0.32–0.37 wide; nerve ring 0.24–0.26 from the head; Oesophagus 1.30–1.44 long, about 1/15-th to 1/16-th of the entire length of the female body; tail 0.37–0.43 long, with a terminal spike; vulva prominent, 8.64–8.8 from the anterior end; uteri divergent, eggs thin shelled and subspherical.

The measurements given above are for the mature females only.

Remarks : The present species agrees with *Seuratum congolense* Sandground, 1937, an African species, in almost every respect excepting in the number and arrangement of caudal papillae, size of spicules and gubernaculum.

7. Family QUIMPERIIDAE Baylis, 1930

Subfamily QUIMPERIINAE Gendre, 1928

Genus 7. *Paragendria* Baylis, 1939*Paragendria* sp.

Material : One female; host—*Wallago attu*; location—intestine; locality—Rohtas, Rohtas district, Bihar; 8.xi.1997; coll. S. R. Dey Sarkar.

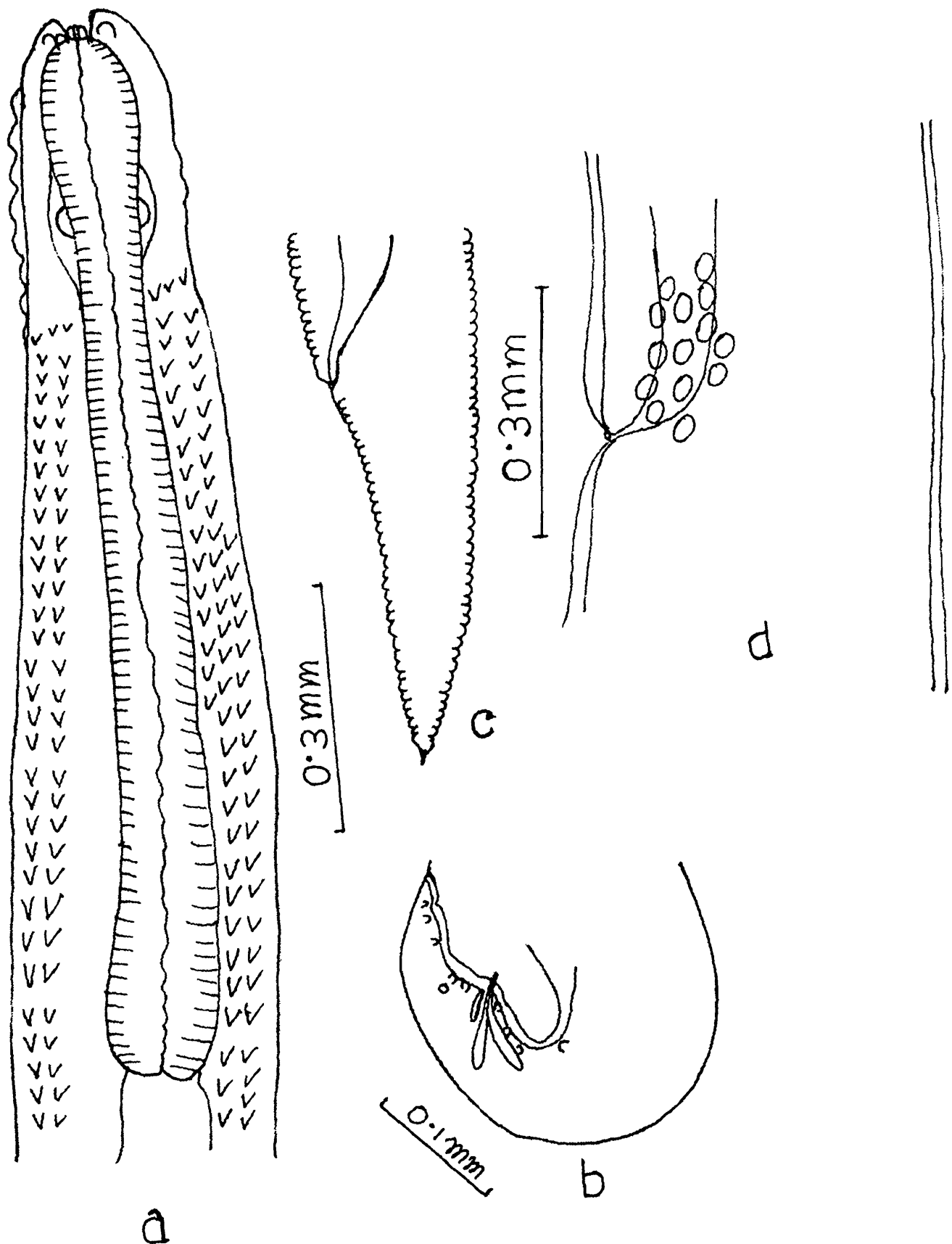


Fig. 1. *Seuratium indicum* sp. n. : (a) Anterior end of female. (b) Posterior end of male. (c) Posterior end of female. (d) Vulva of female.

Female : Body 10.2 long; cervical papillae 0.6 from the anterior end; tail tapering, 0.28 long; vulve postequatorial, 6.2 from the anterior end.

Remarks : In the absence of males specific identification is not possible.

III. Order SPIRURIDA

Superfamily 1. SPIRUROIDEA

8. Family SPIROCERCIDAE (Chitwood & Wehr, 1932 subfam.)
Chabaud, 1975

Subfamily SPIROCERCINAE Chitwood & Wehr, 1932

Genus 8. *Cylicospirura* Vevers, 1922

Subgenus *Gastronodus* (Singh, 1934 gen.) Chabaud, 1975

Cylicospirura (Gastronodus) stresseni (Singh, 1934)

Material : One male, one female; host—House shrew (*Suncus murinus caerulescens*); location—stomach nodule; locality—Adhaura, Bhabua district, Bihar; 16.xi.1997; coll. S. R. Dey Sarkar.

Description : Male body 25.6 long, 0.56 wide; tail spiral; caudal alae well developed; caudal papillae 10 pairs pedunculated, 6 pairs preanal, 4 pairs postanal and an unpaired median preanal papilla, in addition 2 pairs minute sessile papillae near the tip of the tail; spicules unequal, dissimilar, longer 2.56 and shorter 0.64 long; gubernaculum 0.064 long.

Female : Body 26.5 long; vulva in the oesophageal region, 0.8 away from the head; tail subterminal.

Remarks : The specimens show slight differences from the earlier description of the species by Singh (1934), which however, are considered here as intraspecific variations. Earlier, the species has been reported from Hyderabad (Andhra Pradesh) (Singh, 1934) and West Champaran, Bihar (Dey Sarkar, 1998).

Superfamily 2. PHYSALOPTEROIDEA

9. Family PHYSALOPTERIDAE (Railliet, 1893) Leiper, 1908

Subfamily PHYSALOPTERINAE Railliet, 1893

Genus 9. *Pseudophysaloptera* Baylis, 1934

Pseudophysaloptera scotophili sp. n.

(Fig. 2. a, b, c and d)

Material : Holotype, one male; Z.S.I. Reg. No. WN 818; host—Greater Yellow Bat (*Scotophilus heathi heathi*); location—stomach; locality—Rohtas, Rohtas district, Bihar; 8.xi.1997; coll. S. R. Dey Sarkar.

Paratypes 3 males and 7 females; Z.S.I. Reg. No. WN 819; other details as for the holotype.

Description : Body stout, cuticle thick, wrinkled here and there. A less distinct cephalic collarete present. Mouth with two lateral lips, each lip provided with three teeth in the inner margin.

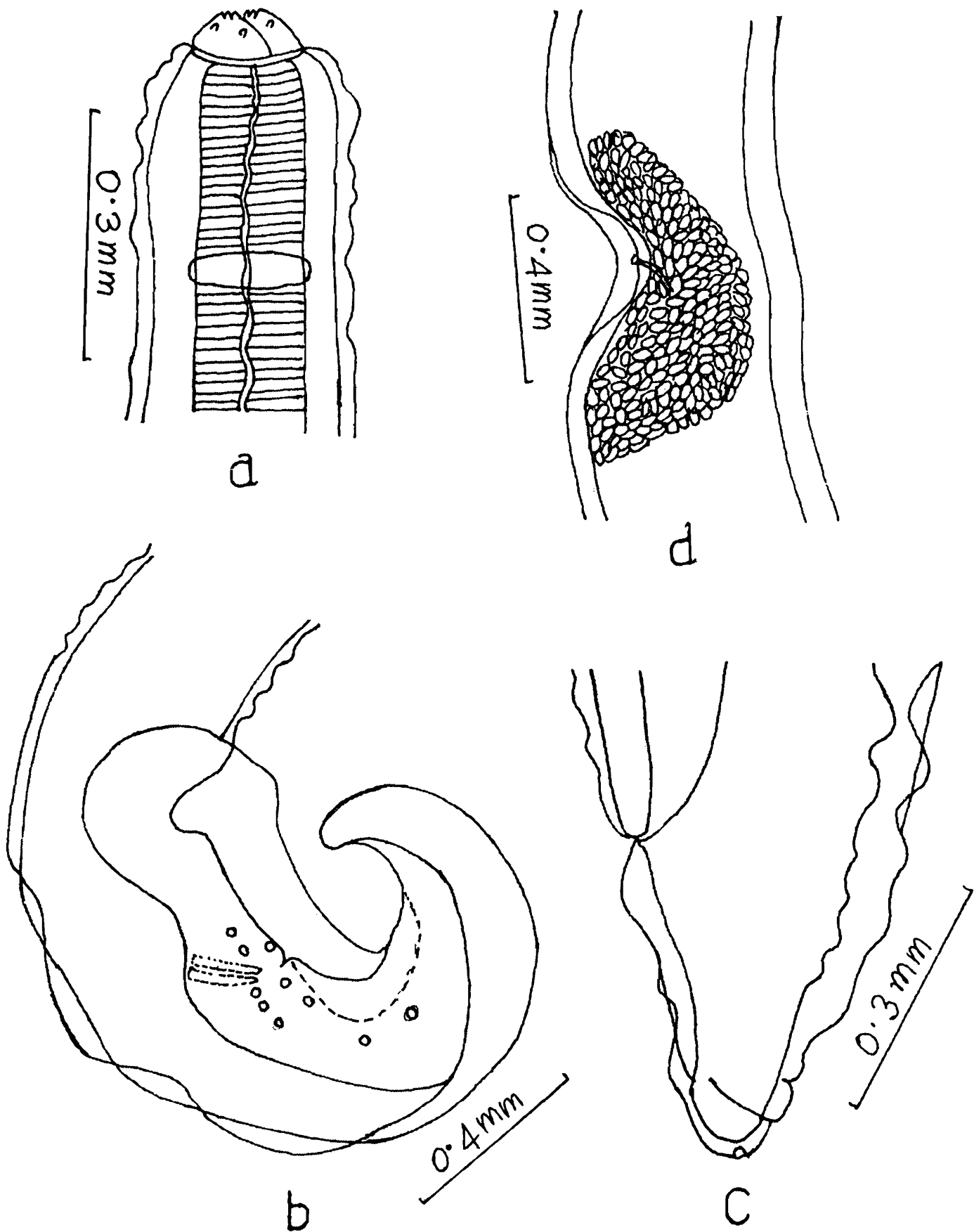


Fig. 2. *Pseudophysaloptera scotophili* sp. n. : (a) Anterior end of male. (b) Posterior end of male. (c) Posterior end of female. (d) Vulva of female.

Oesophagus indistinctly divided into two parts, anterior muscular and posterior glandular. Male tail coiled towards ventral side. Caudal alae wide, large, united together in front of the cloaca. Caudal papillae minute, sessile. Gubernaculum absent. Female body characteristically constricted venterolaterally where the vulva is located. Tail bluntly conical.

Male : Body 10.4–11.6 long, 0.4–0.48 wide; nerve ring 0.29–0.32 from the anterior end; oesophagus divided into two parts, anterior muscular and posterior glandular, entire oesophagus 2.96–3.44 long; tail ventrally bent 0.64–0.72 long, tip rounded; caudal alae well developed, caudal papillae minute, sessile, two pairs and a median preanal and four pairs postanal papillae clearly discernible; near the cloaca, a paired structure, somewhat resembling spicules present.

Female : Body 18.72–19.12 long, 0.72 wide; nerve ring 0.48–0.51 from the anterior end; oesophagus as in male, 3.76–4.08 long; tail conical, 0.35–0.40 long, tip blunt; with a knob like structure; vulve prequatorial, 8.0–9.2 from the anterior end; eggs small.

Remarks : Baylis (1934) established the genus *Pseudophysaloptera* with *P. sorisina* as its type species. Since then only two valid species viz. *P. formosana* (Yokogawa, 1922) Lincicome, 1948 and *P. riukiuana* Lincicome and McConnaughey, 1948, have been added under it from Insectivora : Soricidae.

The present specimens do not agree with any member of the genus *Pseudophysaloptera* in various body measurements and in the number and arrangement of caudal papillae. Therefore, it is regarded as a new species and incidentally *Scotophilus heathi heathi*, an aggressive Insectivorous bat (Chiroptera) forms the new host record.

Superfamily 3. HABRONEMATOIDEA

10. Family HABRONEMATIDAE (Chitwood & Wehr, 1932) Ivaschkin, 1961

Subfamily (1) HABRONEMATINAE Chitwood & Wehr, 1932

Genus 10. *Habronema* Diesing, 1861

Habronema imbricatum Maplestone, 1930

Material : One male; host–Spotted Owlet (*Athene brama*); location–under horny layer of gizzard; locality–Adhaura, Bhabua district, Bihar; 13.xi.1997; coll. S. R. Dey Sarkar.

Remarks : Widely distributed in India.

Subfamily (2) HISTOCEPHALINAE Gendre, 1922

Genus 11. *Hadjelia* Seurat, 1916

Hadjelia sp.

Material : 2 immature females; host–Indian Rollar (*Coracias benghalensis*); location–under horny layer of gizzard; locality–Adhaura, Bhabua district, Bihar; 13.xi.1997; coll. S. R. Dey Sarkar.

Remarks : In the absence of a male specimen, specific identification is not possible.

Superfamily 4. THELAZIOIDEA

11. Family THELAZIIDAE Skrjabin, 1915

Subfamily THELAZIINAE (Skrjabin, 1915 fam.) Baylis and Daubney, 1926

Genus 12. *Thelazia* Bosc, 1819

Subgenus *Thelaziella* Travassos, 1918

Thelazia (Thelaziella) kaimurensis sp. n.

(Fig. 3. a, b and c)

Material : One female; Z.S.I. Reg. No. WN 820; host–Night Jar (*Caprimulgus* sp.); location–under nictitating membrane; locality–Mundeswari Bhagwanpur, Bhabua district, Bihar; 24.xi.1997; coll. S. R. Dey Sarkar.

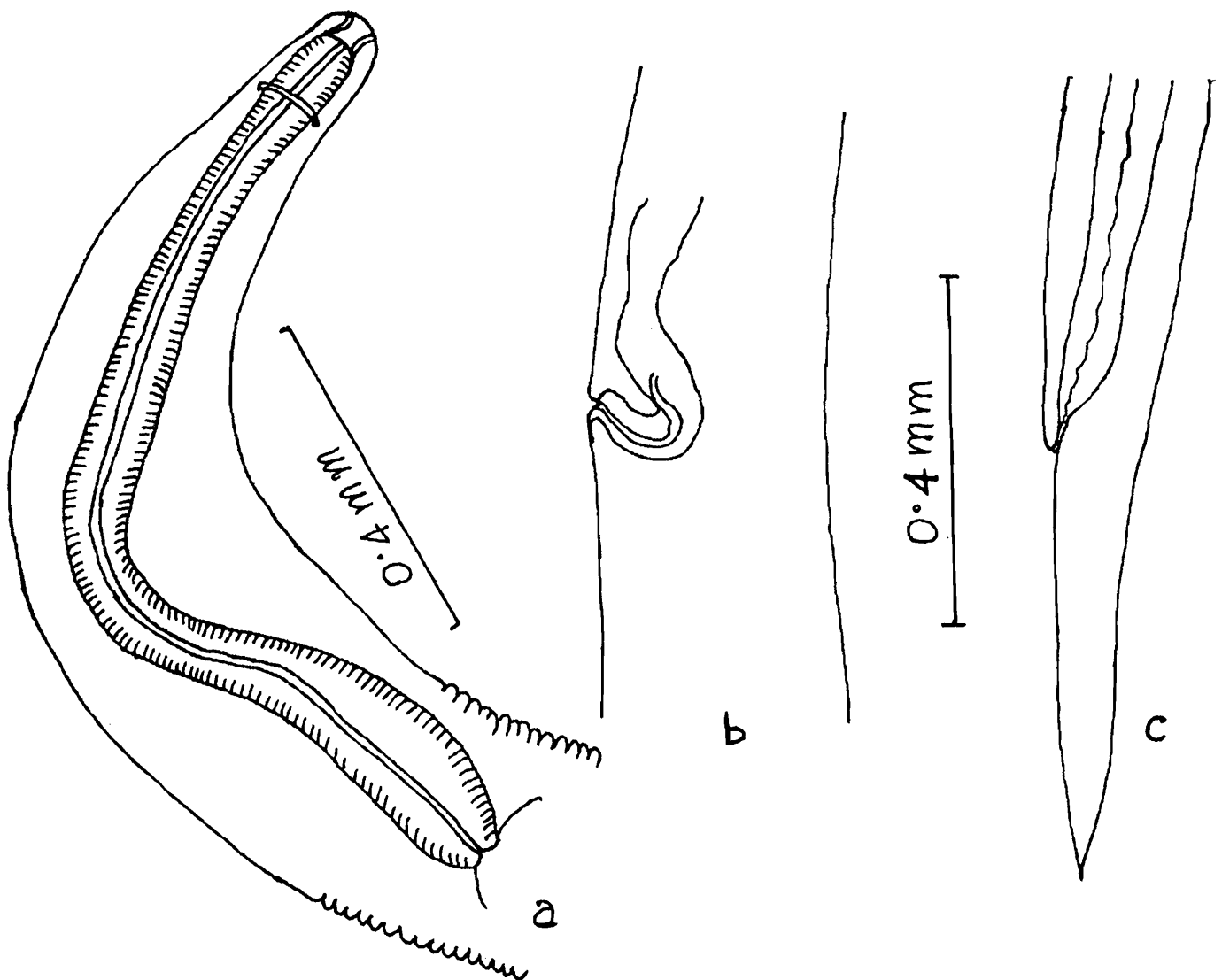


Fig. 3. *Thelazia (Thelaziella) kaimurensis* sp. n. : (a) Anterior end of female. (b) Vulva of female. (c) Posterior end of female.

Description : (Based on a single female) Mouth without lips, buccal capsule short with thin chitinized walls. Cervical alae absent. Body transversely striated, striations less prominent in the oesophageal region. Oesophagus undivided, cylindrical. Valva prominent, preequatorial in position. Ovijector short. Tail straight, relatively long, pointed.

Female : Body 8.2 long, 0.27 wide; buccal capsule 0.032 deep; nerve ring 0.19 from the head; oesophagus 1.2 long; vulva 3.7 away from the head, vagina anteriorly directed; tail straight, pointed, 0.48 long; eggs not found.

Remarks : The present parasite belongs to the genus *Thelazia* (*Thelaziella*) Travassos, 1918. It does not agree with any other species so far described under the genus *Thelazia* (*Thelaziella*) in the position of vulva and nature of the tail. Therefore, without a male specimen, the present author with the greatest hesitation treats his single female specimen as a new species.

Superfamily 5. ACUARIOIDEA

12. Family ACUARIIDAE Seurat, 1913

Subfamily ACUARIINAE Railliet, Henry & Sissoff, 1912

Genus 13. *Acuaria* Bremser, 1811

Acuaria anthuris (Rudolphi, 1819) Railliet, Henry & Sissoff, 1912

Material : One male, one female; Z.S.I. Reg. No. WN 821; host—Tree Pie (*Dendrocitta vagabonda*); location—under horny layer of gizzard; locality—Adhaura, Bhabua district, Bihar; 20.xi.1997; coll. S. R. Dey Sarkar.

Description : Body slender. Mouth with two simple lateral lips. Four cordons which are long, non-recurrent or anastomosing, originate from the margin of the mouth and extend posteriorly about 0.8 in male and 1.44 in female.

Male : Body 7.12 long, 0.144 wide, nerve ring 0.192 from the head; pharynx 0.016 long; cervical papilla at 0.27 from the anterior end; oesophagus divided into two parts, anterior glandular and posterior muscular, entire oesophagus 2.11 long; tail spirally coiled, caudal alae about 0.51 long and relatively broad; tail 0.27 long; caudal papillae 11 pairs, 4 pairs preanal and 7 pairs postanal in position; spicules subequal, similar, short and stout, 0.21 and 0.24 long.

Female : Body 17.28 long, 0.016 wide; nerve ring 0.27 from the head; pharynx 0.224 long; cervical papilla at 0.35 from anterior end; oesophagus as in male, 2.51 long; tail 0.21 long, tip rounded, tail papillae not observed; vulva at 7.57 from posterior end; eggs (0.016 × 0.112) in diameter.

Remarks : The present specimens show slight differences from the earlier descriptions of the species which, however, are considered here as intraspecific variations. Its occurrence in Tree Pie (*Dendrocitta vagabounda*) from Adhaura, Bihar, forms the first host and locality records.

Genus 14. *Echinuria* Soloviev, 1912

Echinuria sp.

Material : One female; host–Brown Shrike (*Lanius cristatus*); location–under horny layer of gizzard; locality–Adhaura, Bhabua district, Bihar; 14.xi.1997; coll. S. R. Dey Sarkar.

Remarks : In the absence of males specific identification is not possible.

Superfamily 6. DRACUNCULOIDEA

13. Family MICROPLEURIDAE (Baylis & Daubney, 1926 subfam.)
Travassos, 1960

Genus 15. *Micropleura* Linstow, 1906

Micropleura helicospicula sp. n.

(Fig. 4. a and b)

Material : Holotype one male, Z.S.I. Reg. No. WN 822; host–a juvenile Marsh Crocodile (*Crocodylus palustis*); location–intestine; locality–Mundeswari Bhagwanpur, Bhabua district, Bihar; 24.xi.1997; coll. S. R. Dey Sarkar.

Paratype one male, Z.S.I. Reg. No. WN 823; other particulars same as for the holotype.

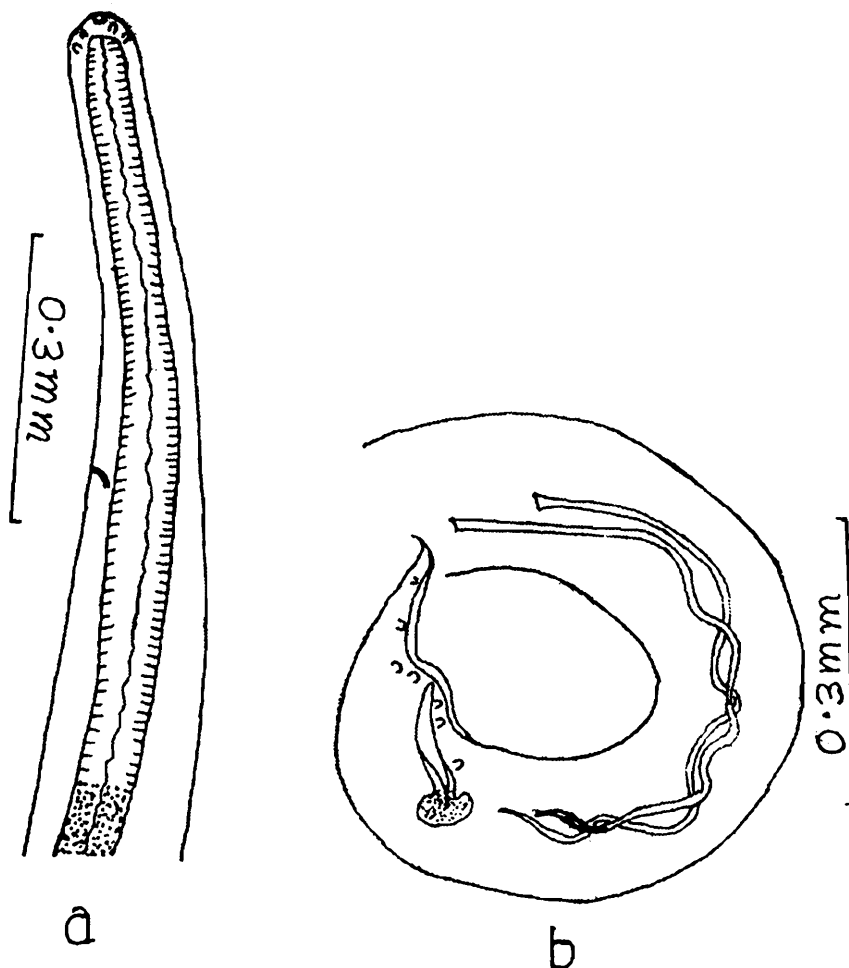


Fig. 4. *Micropleura helicospicula* sp. n. : (a) Anterior end of male. (b) Posterior end of male.

Description : Body filiform, cuticle smooth. Anterior end tapering. Two lateral and four submedian head papillae present. Oral opening minute. Oesophagus clearly divided into two parts of same width.

Female : Absent.

Male : Body 7.04–9.84 long, 0.13–0.19 wide; oesophagus clearly divided into anterior muscular and posterior glandular portion, muscular oesophagus 0.8–1.12 and glandular portion 1.12–1.28 long, entire oesophagus 2.08–2.24 long; nerve ring not clear; excretory pore 0.48 from the head; caudal end spirally coiled; tail tapering, ending in a sharp point, measuring 0.14–0.16 long; caudal alae narrow, present on both sides; caudal papillae 7 pairs, 3 pre-anal and 4 postanal in position; spicules similar, equal, very slender, twisted throughout their distal halves and ending in fine points, 0.74–0.80 long; gubernaculum well chitinized, measuring 0.128–0.144 long.

Remarks : The present species comes closer to *Micropleura vivipara* V. Linstow, 1906 in body length and in number and arrangement of caudal papillae, but differ from it in having longer spicules, which are helical throughout their distal halves, longer gubernaculum and also in possessing caudal alae on both sides which is single in *M. vivipara*.

Superfamily 7. DILOTRIAENOIDEA

14. Family DILOTRIAENIDAE (Skrjabin, 1916 subfam.)
Anderson, 1958

Subfamily DILOTRIAENINAE Skrjabin, 1916

Genus 16. *Dilotriaena* Railliet & Henry, 1909

Dilotriaena tricuspis (Fedchenko, 1874) Seurat, 1915

Material : 2 females; host–*Acridotheres tristis*; location–body cavity; locality–Adhaura, Bhabua district, Bihar; 20.xi.1997; coll. S. R. Dey Sarkar.

Remarks : This species has already been dealt with in detail by Baylis, (1939) and several other workers; hence detailed description is avoided. Widely distributed in India.

Superfamily 8. APROCTOIDEA

15. Family APROCTOIDAE (Yorke & Maplestone, 1926)
Skrjabin & Schikhobalova, 1945

Subfamily APROCTINAE Yorke & Maplestone, 1926

Genus 17. *Pseudaprocta* Schikhobalova, 1930

Pseudaprocta kaimurensis sp. n.

(Fig. 5. a, b and c)

Material : Holotype, one male, Z.S.I. Reg. No. WN 824; host–Indian Rollar (*Coracias benghalensis*); location–Body cavity; locality–Adhaura, Bhabua district, Bihar; 13.xi.1997; coll. S. R. Dey Sarkar.

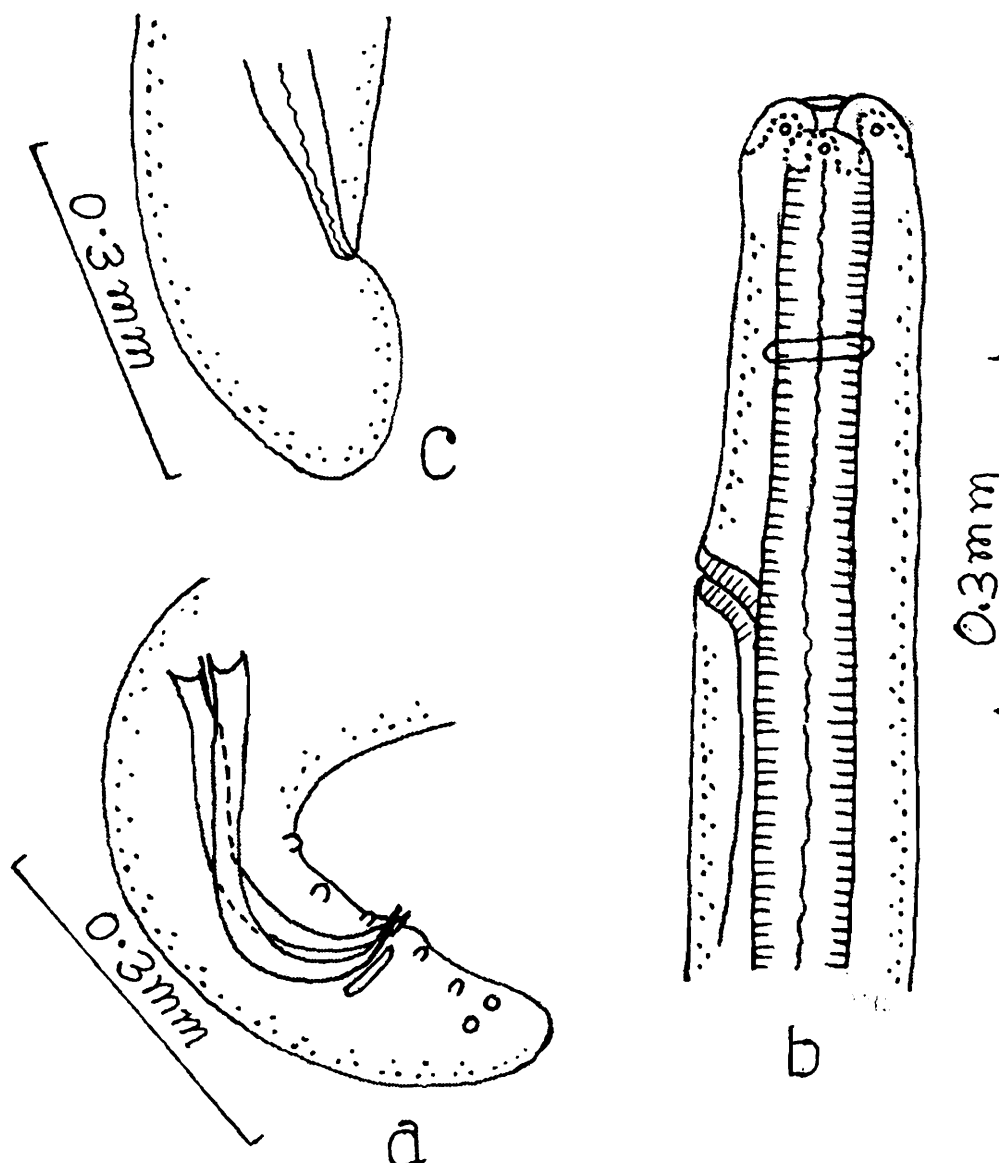


Fig. 5. *Pseudaprocta kaimurensis* sp. n. : (a) Posterior end of male. (b) Anterior end of female, showing vulva. (c) Posterior end of female.

Paratype, one female, Z.S.I. Reg. No. WN 825; other particulars same as for the holotype.

Description : Body stout, slightly tapering towards extremities. Head round, with delicate lobed cordons between cephalic papillae. Buccal cavity minute. Cuticle smooth, without bosses in both sexes. Oesophagus short and undivided. Spicules of male similar and subequal, gubernaculum present.

Male : Body 14.4 long, 0.4 wide; nerve ring 0.144 from the anterior end; oesophagus undivided, 0.56 long; tail spirally rolled, 0.144 long, with rounded tip; spicules similar, subequal, stout, curved in the form of a hook, measuring 0.30 and 0.32 in length; gubernaculum 0.056 long; caudal alae absent; caudal papillae 7 pairs, 3 pairs preanal and 4 pairs postanal in position.

Female : Body 28.08 long, 0.51 wide; nerve ring 0.24 from the head; oesophagus as in male, 0.64 long, vulva prominent, at 0.4 from the head; tail tip rounded, without any papilla near the tip, 0.18 long; eggs (0.016 × 0.032) in diameter.

Remarks : The present species comes closer to *Pseudaprocta gubernacularia* Schikhobalova, 1930, in the presence of subequal spicules and gubernaculum in the male. But differs from it in relative body measurements, size of spiculi, number and arrangement of caudal papillae and in the absence of subterminal tail papilla in the female.

Therefore, the present species is regarded as different from all known forms under the genus *Pseudaprocta* Schikhobalova, 1930 and is named *Pseudaprocta kaimurensis* sp. n.

IV. Order STRONGYLIDA

Superfamily STRONGYLOIDEA

16. Family CHABERTIIDAE (Popova, 1952 subfam.) Lichtenfels, 1980

Subfamily OESOPHAGOSTOMINAE Railliet, 1916

Genus 18. *Oesophagostomum* Molin, 1861

Subgenus (1) *Oesophagostomum* Molin, 1861

Oesophagostomum (Oesophagostomum) dentatum (Rudolphi, 1803) Molin, 1861

Material : 2 males, 2 females; host—domestic pig; location—intestine; locality—Adhaura, Bhabua district, Bihar; 15.xi.1997; coll. S. R. Dey Sarkar.

Remarks : Widely distributed in India. Cosmopolitan.

Subgenus (2) *Proteracrum* Railliet & Henry, 1913

Oesophagostomum (Proteracrum) columbianum (Curtice, 1890) Stossich, 1899

Material : One male; host—domestic goat; location—intestine; locality—Adhaura, Bhabua district, Bihar; 16.xi.1997; coll. S. R. Dey Sarkar.

Remarks : Widely distributed in India. Cosmopolitan.

Superfamily 2 TRICHOSTRONGYLOIDEA

17. Family MOLINEIDAE (Skrjabin & Schulz, 1937 subfam.) Durette-Desset and Chabaud, 1977

Subfamily MOLINEINAE Skrjabin and Schulz, 1937

Genus 19. *Oswaldocruzia* Travassos, 1917

Oswaldocruzia goezei Skrjabin & Schulz, 1952

Material : One male, 3 females; host—Toad (*Bufo melanostictus*); location—intestine; locality—Mundeswari Bhagwanpur, Bhabua district, Bihar; 23.xi.1997; coll. S. R. Dey Sarkar.

Remarks : Widely distributed in India, Asia and Europe.

SUMMARY

This report deals with the parasitic nematodes collected from vertebrate hosts in the Kaimur Wild Life Sanctuaru (Rohtas and Bhabua districts), Bihar. It includes 21 species belonging to 19 genera and 17 families of which 5 species are new to science and the remaining 16 species are fairly well known.

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REFERENCES

- Baylis, H. A. 1934. On a collection of Cestodes and Nematodes from small mammals in Tanganyika Territory. *Ann. Mag. nat. Hist.* (10), **13** : 539-554.
- Baylis, H. A. 1936. Nematoda. I (Ascaroidea and Strongyloidea). *Fauna of British India including Ceylon and Burma*. Taylor and Francis, London : 408 pp.
- Baylis, H. A. 1939. Nematoda. II (Filarioidea, Dictophymoidea and Trichinelloidea). *Fauna of British India including Ceylon and Burma*. Taylor and Francis, London : 274 pp.
- Baylis, H. A. 1944. Notes on some parasitic nematodes. *Ann. Mag. nat. Hist.* (11), **11** : 793-804.
- Cram, E. B. 1927. Bird parasites of the nematode Suborder Strongylata, Ascaridata and Spirurata. *Bull. U.S. nat. Mus.* (140) : 465 pp.
- Dey Sarkar, S. R. 1998. Fauna of Valmiki Tiger Reserve. Parasitic Nematodes. Fauna of Conservation Areas. No. **10**. *zool. Surv. India* : 79-84.
- Hall, M. C. 1916. Nematode parasites of mammals of the orders Rodentia, Lagomorpha and Hyracoidea. *Proc. U.S. nat. Mus.*, Washigton. **50** : 258 pp.
- Lincicome, D. R. 1948. A note on the nematode genus *Pseudophysaloptera*. *J. Paraset.*, **43**(5) : 452 p.
- Lincicome, D. R. and McConnaughey, B. H. 1948. A new nematode of the genus *Pseudophysaloptera* from an Okinawan Shrew. *Pacific Science*, **2**(4) : 239-242.
- Sandground, J. H. 1937. Three new parasitic nematodes from Belgian Congo. *Rev. zool. e Bot. Afric.* **29**(3) : 230-236.

- Shikhobalova, N. P. 1930. Sur une nouvelle filaire d'oiseaux *Pseudaprocta gubernacularia* n.g., n. sp. *Annls Parasit. him comp.*, **8**(6) : 624-627.
- Skrjabin, K. I., Shikhobalova, N. P. and Schulz, R. S. 1954. Essential of Nematology. III. Trichostrongylids of Animals and Man. *Academy of Sciences of the USSR*, Moscow.
- Soota, T. D. and Dey Sarkar, S. R. 1981. On some nematodes parasitic in vertebrate hosts from Bihar, India. *Rec. zool. Surv. India*, **78** : 121-127.
- Yamaguti, S. 1961. *Systema Helminthum*. III. The nematodes of vertebrates Pt. I & II : 1261 pp. Interscience Publishers Inc. New York.

A REPORT ON MITES OCCURRING ON MEDICINAL PLANTS IN WEST BENGAL

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INTRODUCTION

West Bengal is rich with agroclimatic variation and has high natural resources of medicinal plants. Of the 2500 plant species under about 1000 genera which are commercially used by different companies for pharmaceutical purpose and are widely used by medical practitioners under Indian System of Medicine (ISM), many of those are available in West Bengal. Because of the rich diversity of medicinal plants and for their large scale use for medicinal purpose, attention of Govt. of India has been focussed to promote the culture of many of those medicinal plants and extract the useful and beneficial alkaloids from those plants for human welfare.

Like many other plants, the medicinal plants are also prone to a large number of pests including mite pests which cause retardation of growth of the plants and that ultimately affect the yield. So far as mites occurring on medicinal plants are concerned, practically nothing has been done from West Bengal and barring Lal & Mukherji (1977) no efforts were made to explore the mite fauna on medicinal plants from India. Since many of the mites on medicinal plants have importance either as pests or as predators, it was thought desirable to explore the mite fauna on medicinal plants and find out their importance, if any, either as pests or as predators. The present paper is the first attempt in that direction and reports 54 species belonging to 27 genera under 14 families and 3 orders from West Bengal, of those, 23 species are phytophagous. 2 are fungivorous and the remaining 29 species are predatory in habit. This report is made partly basing on survey of literature and partly on the basis of collection made by the senior author.

The plants which have been considered here as medicinal plants are as per Chopra *et al.* (1956) and Satyavati *et al.* (1976, 1987).

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SYSTEMATIC ACCOUNT

Phytophagous mites

Family 1. TETRANYCHIDAE

1. *Aponychus corpuzae* Rimando

1966. *Aponychus corpuzae* Rimando, *Philip. Agric.*, **50** : 105.

Medicinal plant : *Feronia elephantum*.

Distribution : India : Assam, Meghalaya, West Bengal, Orissa, Andaman & Nicobar Island. Elsewhere : Philippines; Thailand; Japan.

2. *Eutetranychus orientalis* (Klein)

1936. *Aponychus orientalis* Klein, *Bull. Agric. Res. Stn., Rehovoth*, **21** : 3.

Medicinal plants : *Azadirachta indica*, *Cocos nuciferae*, *Datura alba*.

Distribution : India : Assam, West Bengal, Delhi, Uttar Pradesh, Punjab, Haryana, Jammu & Kashmir, Karnataka. Elsewhere : Pakistan; Taiwan; Israel; Turkey; Jordan; Iran; Afghanistan; Cyprus; South Africa; Sudan; Egypt.

Remarks : This species was found to cause severe damage specially to citrus and papaya plants. The infested leaves became fully enveloped by web formed by the mites where dust particles got adhered causing retardation of physiological activities of plants. This ultimately made the leaves brownish, unhealthy and ultimately such leaves fell off.

3. *Oligonychus indicus* (Hirst)

1923. *Paratetranychus indicus* Hirst, *Proc. Zool. Soc. London*. p. 990.

Medicinal plant : *Musa paradisica*.

Distribution : India : West Bengal, Orissa, Bihar, Delhi, Haryana, Punjab, Andhra Pradesh, Karnataka, Tamil Nadu. Elsewhere : Pakistan.

Remarks : The feeding of this mite caused the appearance of white stipplings on the under surface of leaves.

4. *Oligonychus mangiferus* (Rahman & Sapro)

1940. *Paratetranychus mangiferus* Rahman & Sapro, *Proc. Indian. Acad. Sci.*, **11B** : 102.

Medicinal plants : *Mangifera indica*, *Syzygium cumini*.

Distribution : India : West Bengal, Orissa, Bihar, Delhi, Haryana, Punjab, Himachal Pradesh, Karnataka, Kerala.

Remarks : It caused yellowing on upper surface of mango leaves.

5. *Oligonychus punicae* (Hirst)

1926. *Paratetranychus punicae* Hirst, *Proc. Zool. Soc. London*, p. 830.

Medicinal plant : *Cocos nucifera*.

Distribution : India : West Bengal, Tamil Nadu. Elsewhere : Central and South America.

6. *Oligonychus* sp.

Medicinal plant : Guava.

Distribution : India : West Bengal.

7. *Schizotetranychus baltazari* Rimando

1962. *Schizotetranychus baltazari* Rimando, *Philipp. Agric.*, **45** : 534-535.

Medicinal plant : *Azadirachta indica*.

Distribution : India : Assam, West Bengal, Karnataka. Elsewhere : Myanmar; Thailand; Taiwan; Hong Kong.

8. *Schizotetranychus hindustanicus* (Hirst)

1924. *Tetranychus* (*Schizotetranychus*) *hindustanicus* Hirst, *Ann. Mag. nat. Hist.* (9) **14** : 525.

Medicinal plants : *Azadirachta indica*, *Citrus* sp.

Distribution : India : Tamil Nadu, Kerala.

Remarks : On citrus and neem, this mite caused the appearance of yellowish stipplings on leaves. Recently, it has been seen attacking citrus in southern part of West Bengal.

9. *Panonychus citri* (McGregor)

1916. *Tetranychus citri* McGregor, *Ann. ent. Soc. Amer.*, **9** : 284.

Medicinal plants : *Melia azadirachta*, papaya, citrus.

Distribution : India : West Bengal, Assam, Meghalaya, Punjab, Jammu & Kashmir, Andaman & Nicobar Island. Elsewhere : Argentina; Bermuda; U.S.A.; China; Cuba; Japan; Mexico; New Zealand; South Africa; Thailand.

Remarks : This mite was seen as pest of citrus and papaya in West Bengal causing yellowing and later drying of leaves.

10. *Panonychus* sp.

Medicinal plant : Banana.

Distribution : India : West Bengal.

11. *Tetranychus urticae* Koch

1836. *Tetranychus urticae* Koch, *Deu. Crust. Hyr. Arach. Fasc.*, 1 : 10.

Medicinal plants : *Solanum melongena*, *Mangifera indica*, *Psidium guajava*, *Ricinus communis*.

Distribution : India : Meghalaya, West Bengal, Orissa, Bihar, Gujarat, Haryana, Punjab, Rajasthan, Karnataka, Kerala. Elsewhere : Cosmopolitan.

Remarks : It was seen severely infesting brinjal and castor in West Bengal enveloping the leaves with webs. The infested leaves became yellow which dried up and fell off.

12. *Tetranychus neocaledonicus* Andre

1933. *Tetranychus neocaledonicus* Andre, *Bull. Mus. Nat. Hist. nat. Paris*, (2) 5 : 302.

Medicinal plant : *Solanum melongena*.

Distribution : India : Assam, Meghalaya, West Bengal, Orissa, Bihar, Uttar Pradesh, Delhi, Punjab, Haryana, Rajasthan, Gujarat, Maharashtra, Karnataka, Kerala. Elsewhere : Africa; Fiji; Bahamas; Hawaii; Venezuela; Puerto Rico; U.S.A.

Remarks : The affected plants suffered defoliation.

Family 2. TENUIPALPIDAE

13. *Brevipalpus obovatus* Donnadieu

1875. *Brevipalpus obovatus* Donnadieu, *Recherches pour Service Historie des Tetranyques* : 116.

Medicinal plant *Syzygium cumini*.

Distribution : India : West Bengal, Delhi, Himachal Pradesh, Punjab. Elsewhere : Pakistan; Sri Lanka; Egypt; Japan; Israel; France; Spain; Cyprus; Australia; Canada; U.S.A.; Venezuela; Argentina.

Remarks : The infested leaves became brittle.

14. *Brevipalpus phoenicis* (Geij.)

1939. *Brevipalpus phoenicis* Geij., *Meded. Landb. Hooges. Wageningen*, 42 : 230.

Medicinal plant : *Cocos nucifera*.

Distribution : India : Assam, Meghalaya, West Bengal, Orissa, Bihar, Delhi, Punjab, Himachal Pradesh, Maharashtra, Karnataka, Tamil Nadu. Elsewhere : Kenya; Tanganyika; Okinawa Isl.; Australia; Holland; Spain; Portugal; Syria; Sicily; Italy; U.S.A.; Trinidad; Argentina; Brazil; Venezuela.

Remarks : The infested leaves first developed yellowish patches. Such leaves dried up and the infested trees suffered defoliation.

15. *Brevipalpus rugulosus* Chaudhri, Akbar & Rasool

1974. *Brevipalpus rugulosus* Chaudhri, Akbar & Rasool, p. 45.

Medicinal plants : *Hibiscus rosa-sinensis*, *Adhatoda vasica*.

Distribution : India : West Bengal, Punjab. Elsewhere : Pakistan.

16. *Raoiella indica* Hirst

1924. *Raoiella indica* Hirst, *Ann. Mag. nat. Hist.*, (9) **14** : 522.

Medicinal plant : *Cocos nucifera*.

Distribution : India : West Bengal, Punjab, Karnataka, Tamil Nadu. Elsewhere : Mauritius.

Remarks : The infestation of this mite caused the appearance of reddish patches on leaves.

Family 3. ERIOPHYIDAE

17. *Aceria lycopersici* (Wolff.)

1879. *Phytoptus lycopersici* Wolff., *Monatschr. Gartenb.*, **22** : 424.

Medicinal plant : Brinjal.

Distribution : India : West Bengal, Punjab, Delhi, Karnataka, Tamil Nadu. Elsewhere : Cosmopolitan.

Remarks : The infested leaves became greyish white.

18. *Aceria mangiferae* Sayed

1946. *Aceria mangiferae* Sayed, *Bull. Soc. Fouad Ber. Ent. Egypte*, **30** : 7-10.

Medicinal plant : *Mangifera indica*.

Distribution : India : West Bengal, Bihar, Punjab, Haryana, Delhi, Karnataka, Tamil Nadu. Elsewhere : Egypt; Southern Asia; Brazil.

Remarks : This mite has been incriminated to causing vegetative and floral mango malformation.

19. *Tegonotus jambolensis* Mondal, Ghosh & Chakraborti

1982. *Tegonotus jambolensis* Mondal, Ghosh & Chakraborti, *Oriental Ins.*, **16** : 310-312.

Medicinal plant : *Eugenia jambolana*.

Distribution : India : West Bengal.

Remarks : The infested leaves developed russeting symptoms.

20. *Tegonotus mangiferae* (Keifer)

1946. *Oxypleurites mangiferae* Keifer, *Bull. Calif. Dep. Agr.* **35** 43.

Medicinal plant : *Mangifera indica*.

Distribution : India : West Bengal. Elsewhere : Hawaii.

Remarks : The infested leaves developed rusty symptoms.

21. *Phyllopoptruta oleivora* (Ashmead)

1879. *Typhlodromus oleivora* Ashmead, *Can. Ent.*, **11** : 160.

Medicinal plant : Citrus.

Distribution : India : West Bengal, Tamil Nadu. Elsewhere : U.S.A.; South Africa; Israel; Mauritius.

Remarks : The infested leaves developed russetting symptoms. Infested fruits got shrivelled, dried up and fell off prematurely.

22. *Bakeriella ocimis* Chakrabarti & Mondal

1982. *Bakeriella ocimis* Chakrabarti & Mondal, *Oriental Ins.*, **16** : 521-522.

Medicinal plant : *Ocimum basilicum*.

Distribution : India : West Bengal.

Family 4. TARSONEMIDAE

23. *Polyphagotarsonemus latus* (Banks)

1904. *Tarsonemus latus* Banks, *Proc. U. S. Nat. Mus.*, **32** : (1553) : 615.

Medicinal plants : *Datura alba*, *Solanum melongena*, *Amaranthus* sp., Citrus.

Distribution : India : West Bengal, Bihar, Uttar Pradesh, Punjab, Maharashtra, Karnataka. Elsewhere : Cosmopolitan.

Remarks : It was seen causing crinkling and curling of leaves.

Predatory mites

Family 5. STIGMAEIDAE

24. *Agistemus simplex* Gonzalez-Rodriguez

1965. *Agistemus simplex* Gonzalez-Rodriguez, *Univ. Calif. Pub. Ent.*, **41** : 33-34.

Medicinal plant : *Azadirachta indica*.

Distribution : India : West Bengal.

25. *Zetzellia languida* Gonzalez-Rodriguez

1965. *Zetzellia languida* Gonzalez-Rodriguez, *Univ. Calif. Pub. Ent.*, **41** : 21.

Medicinal plant : *Mangifera indica*.

Distribution : India : West Bengal.

Family 6. TYDEIDAE**26. *Tydeus cumini* Gupta**

1992. *Tydeus cumini* Gupta, In : *State Fauna Ser. 3, Fauna of West Bengal, Part 3*, p. 134.

Medicinal plant : *Eugenia jambolana*.

Distribution : India : West Bengal.

Family 7. RAPHIGNATHIDAE**27. *Raphignathus guajavae* (Gupta)**

1992. *Acheles guajavae* Gupta, In : *State Fauna Ser. 3, Fauna of West Bengal, Part 3*, p. 134-135.

Medicinal plant : *Psidium guajava*.

Distribution : India : West Bengal.

Remarks : This appears to be an important predatory mite upon *Tetranychus urticae* infesting guava.

Family 8. CUNAXIDAE**28. *Cunaxa mangiferae* Gupta**

1992. *Cunaxa mangiferae* Gupta, In : *State Fauna Ser. 3, Fauna of West Bengal, Part 3*, p. 136-138.

Medicinal plant : *Mangifera indica*.

Distribution : India : West Bengal.

Remarks : This mite was noticed feeding upon *Oligonychus mangiferus* on mango.

29. *Cunaxa setirostris* (Hermann)

1804. *Scirus setirostris* Hermann, *Mem. Aptelologie*. **1** : 60-62.

Medicinal plant : *Mangifera indica*.

Distribution : India : West Bengal, Arunachal Pradesh, Meghalaya, Tripura, Sikkim, Uttar Pradesh, Punjab, Himachal Pradesh, Andaman & Nicobar Isls., Lakshadwip Isls. Elsewhere : Cosmopolitan.

Family 9. ANYSTIDAE

30. *Tencateia kanthiensis* Gupta

1992. *Tencateia kanthiensis* Gupta, In : *State Fauna Ser. 3, Fauna of West Bengal, Part 3*, p. 146-148.

Medicinal plant : Betel vine.

Distribution : India : West Bengal.

Family 10. CHEYLETIDAE

31. *Cheletogenes ornatus* (Canestrini & Fanzago)

1876. *Cheyletus ornatus* Canestrini & Fanzago, *Atti. Soc. Vent. Trentina*, **1** : 106.

Medicinal plant : *Mangifera indica*.

Distribution : India : West Bengal, Punjab, Rajasthan. Elsewhere : China; Italy; Australia; Hawaii; U.S.A.; Galapagos Isls.; West Indies.

Remarks : It was seen amidst *Aceria mangiferae* infesting axillary buds in mango.

Family 11. PHYTOSEIIDAE

32. *Amblyseius (Amblyseius) channabasavannai* Gupta & Daniel

1978. *Amblyseius channabasavanni* Gupta & Daniel, *Oriental Ins.*, **12** : 328-329.

Medicinal plant *Mangifera indica*.

Distribution : India : West Bengal, Kerala, Tamil Nadu.

33. *Amblyseius (Amblyseius) herbicolus* (Chant)

1959. *Typhlodromus (Amblyseius) herbicolus* Chant, *Can. Ent.*, **91** : 84-85.

Medicinal plants : Guava, papaya, wood apple, *Hibiscus rosa-sinensis*.

Distribution : India : Arunachal Pradesh, Tripura, West Bengal. Elsewhere : Philippines; Taiwan; Thailand; Japan; Madagascar; U.S.A.; South America; Mexico; Brazil; British West Indies.

Remarks : This is an effective predator of tetranychid mites and is abundantly available in the field.

34. *Amblyseius (Amblyseius) largoensis* (Muma)

1955. *Amblyseiopsis largoensis* Muma, *Ann. Ent. Soc. Amer.*, **48** : 266.

Medicinal plants : *Mangifera indica*, *Psidium guajava*, *Adhatoda vasica*, wood apple. *Hibiscus rosa-sinensis*.

Distribution : India : Assam, Arunachal Pradesh, Manipur, West Bengal, Bihar, Himachal Pradesh, Andhra Pradesh, Karnataka, Kerala, Andaman & Nicobar Isls., Gujarat. Elsewhere : Phillippines; Taiwan; Thailand; Hong Kong; Israel; Iran; Japan; New Zealand; South Africa; Brazil; U.S.A.

Remarks : Like *A. (A.) herbicolus*, it is also a good predator of a number of tetranychid mites and is abundantly available in nature.

35. *Amblyseius (Amblyseius) neorykei* Gupta

1977. *Amblyseius neorykei* Gupta, *Entomologists' mon. Mag.*, **112** : 56-57.

Medicinal plant : *Azadirachta indica*.

Distribution : India : West Bengal, Arunachal Pradesh.

36. *Amblyseius (Euseius) alstoniae* Gupta

1975. *Amblyseius alstoniae* Gupta, *Internat. J. Acarol.*, **1**(2) : 31-32.

Medicinal plants : *Psidium guajava*, bitter gourd.

Distribution : India : West Bengal, Orissa, Bihar, Uttar Pradesh, Punjab, Jammu & Kashmir, Rajasthan, Gujarat, Madhya Pradesh.

37. *Amblyseius (Euseius) coccineae* Gupta

1975. *Amblyseius coccineae* Gupta, *Internat. J. Acarol.*, **1**(2) : 33.

Medicinal plants : *Mangifera indica*, *Cocos nucifera*.

Distribution : India : Meghalaya, West Bengal, Bihar, Orissa, Uttar Pradesh, Jammu & Kashmir, Gujarat, Madhya Pradesh, Andhra Pradesh, Tamil Nadu.

38. *Amblyseius (Euseius) finlandicus* (Oudemans)

1915. *Seiulus finlandicus* Oudemans, *Ent. Ber.*, **4** : 183.

Medicinal plants : *Mangifera indica*, citrus.

Distribution : India : West Bengal, Bihar, Uttar Pradesh, Himachal Pradesh, Jammu & Kashmir, Karnataka. Elsewhere : Pakistan; Japan; Greece; Netherlands; Scandinavian countries; U.S.S.R.; Africa; Mexico; South America; North America.

39. *Amblyseius (Euseius) pruni* Gupta

1975. *Amblyseius pruni* Gupta, *Internat. J. Acarol.*, **1**(2) : 40-42.

Medicinal plants : *Psidium guajava*, *Glycosmis pentaphylla*.

Distribution : India : Assam, Meghalaya, Tripura, West Bengal, Himachal Pradesh, Jammu & Kashmir.

40. *Amblyseius (Neoseiulus) paspalivorus* (DeLeon)

1957. *Typhlodromus paspalivorus* DeLeon, *Fla. Ent.*, **40** : 143-144.

Medicinal plant : *Ocimum sanctum*.

Distribution : India : West Bengal, Rajasthan, Andhra Pradesh. Elsewhere : Jamaica; Philippines.

41. *Amblyseius (Paraphytoseius) multidentatus* (Swirski & Shechter)

1961. *Paraphytoseius multidentatus* Swirski & Shechter, *Israel J. agric. Res.*, **11** : 114-116.

Medicinal plant : *Solanum melongena*.

Distribution : India : Assam, Tripura, West Bengal, Bihar, Uttar Pradesh, Maharashtra, Andhra Pradesh, Karnataka, Andaman & Nicobar Isls. Elsewhere : Pakistan; Thailand; Philippines; Malaya; Nigeria; Madagascar; Hong Kong.

42. *Amblyseius (Typhlodromalus) kalimpongensis* Gupta

1969. *Amblyseius kalimpongensis* Gupta, *Bull. Ent. Ent. Soc. India*, **10** : 128-129.

Medicinal plants : *Mangifera indica*, *Datura alba*, *Eugenia jambolana*.

Distribution : India : Assam, West Bengal, Andaman & Nicobar Isls., Kerala.

43. *Amblyseius (Typhlodromips) suknaensis* Gupta

1978. *Amblyseius suknaensis* Gupta, *Oriental Ins.*, **4** : 185-186.

Medicinal plants : *Glycosmis pentaphylla*, citrus, *Azadirachta indica*.

Distribution : India : Assam, West Bengal, Andaman & Nicobar Isls., Kerala.

44. *Amblyseius (Typhlodromips) syzygii* Gupta

1975. *Amblyseius syzygii* Gupta, *Internat. J. Acarol.*, **1**(2) : 44-45.

Medicinal plants : *Azadirachta indica*, *Tagetes erecta*.

Distribution : India : West Bengal. Elsewhere : Thailand.

45. *Amblyseius* sp.

Medicinal plants : *Musa paradisica*, *Solanum melongena*, *Ocimum sanctum*, *Tagetes erecta*.

Distribution : India : West Bengal.

46. *Iphiseius (Iphiseius) andamanicus* Gupta

1980. *Iphiseius andamanicus* Gupta, *Entomologists' mon. Mag.*, **115** : 213-214.

Medicinal plant : *Eugenia jambolana*.

Distribution : India : West Bengal, Karnataka, Andaman & Nicobar Isls.

47. *Phytoseius (Pennaseius) kapuri* Gupta

1969. *Phytoseius (Phytoseius) kapuri* Gupta, *Israel J. agric. Res.*, **19** : 115-117.

Medicinal plants : *Ocimum sanctum*, *Mangifera indica*, Citrus.

Distribution : India : West Bengal, Bihar, Uttar Pradesh, Punjab, Rajasthan, Gujarat, Madhya Pradesh, Jammu & Kashmir, Kerala, Tamil Nadu, Andaman & Nicobar Isls., Pondicherry.

48. *Phytoseius (Phytoseius)* sp.

Medicinal plants : *Ocimum sanctum*, *Solanum melongena*.

Distribution : India : West Bengal.

49. *Typhlodromus (Amblydromella) darjeelingensis* Gupta

1986. *Typhlodromus (Amblydromella) darjeelingensis* Gupta, *Fauna of India (Acari : Mesostigmata) Family Phytoseiidae*. p. 270-272.

Medicinal plants : *Mangifera indica*, *Psidium guajava*.

Distribution : India : Tripura, West Bengal, Punjab, Uttar Pradesh, Karnataka, Tamil Nadu.

50. *Typhlodromus (Orientiseius) hadii* Chaudhri

1965. *Typhlodromus hadii* Chaudhri, *Acarologia*, **7** : 632-633.

Medicinal plant : Brinjal.

Distribution : India : West Bengal.

51. *Typhlodromus (Typhlodromus) communis* Gupta

1980. *Typhlodromus communis* Gupta, *Entomologists' mon. Mag.*, **115** : 209.

Medicinal plant : *Mangifera indica*.

Distribution : India : West Bengal, Arunachal Pradesh, Karnataka, Tamil Nadu.

Family 12. ASCIDAE

52. *Lasioseius* sp.

Medicinal plants : *Tagetes erecta*, *Musa paradisiaca*.

Distribution : India : West Bengal.

Fungivorous mites

Family 13. EUPODIDAE

53. *Eupodes sigmoidensis* Strandtmann & Goff

1978. *Eupodes sigmoidensis* Strandtmann & Goff, *Pacific Insects*, 19 : 123-124.

Medicinal plants *Mangifera indica*, *Musa paradisiaca*.

Distribution : India : West Bengal, Mizoram, Lakshadwip Isls., Sikkim. Elsewhere : Hawaii; Ivory Coast; Africa.

Family 14. ACARIDAE

54. *Acarus* sp.

Medicinal plant : *Tagetes erecta*.

Distribution : India : West Bengal.

SUMMARY

This paper lists for the first time from West Bengal a total of 54 species of mites belonging to 27 genera under 14 families and 3 Orders occurring on various medicinal plants along with giving the names of medicinal plants on which they occur, their distribution and importance, if any, either as pests or predators.

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REFERENCES

- Chopra, R. N., Nagar, S. L. and Chopra, I. C. (Eds.). 1956. *Glossary of Indian Medicinal plants*. Council of Scientific and Industrial Research, New Delhi, 330 pp.
- Lal, L. and Mukherji, S. P. 1977. A contribution to the knowledge of phytophagous mites infesting medicinal plants. *Sci. & Cult.*, 43 : 313-316.
- Satyavati, G. V., Raina, M. K. and Sharma, M. (Eds.). 1976. *Medicinal plants of India*. Vol. 1. Indian Council of Medical Research New Delhi, 438 pp.
- Satyavati, G. V., Gupta, A. K. and Tandon, N. (Eds.). 1987. *Medicinal plants of India*. Vol. 2. Indian Council of Medical Research New Delhi, 545 pp.