

Pictorial Handbook on
INDIAN COLLEMBOLA
(Part-1)

A. K. HAZRA
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ZOOLOGICAL SURVEY OF INDIA

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(Part - 1)

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FOREWORD

Collembola popularly known as "Springtail" dominate micro faunal insect biomass in the soil and their significant effects on the soil structure, aeration and fertility are well documented. Collembolans are primitive, small (0.25 to 6 mm in length) wingless insects, occurring in all possible habitats (except seas and oceans) even in Antarctica up to 83° south latitude where no other insects are found.

First pioneer taxonomic work on Indian springtails was done by A.D. Imms (1912). Thereafter, contributions of Prof. D.K. Choudhuri, Late Prof. N.R. Prabhoo and Dr. S.K. Mitra are worth mentioning. Dr. Hazra has been actively working on taxonomy and ecology of Collembola for the last 30 years, with his expertise in this field it is expected that he shall bring out more such works on the remaining Collembolan families with shri G.P. Mandal.

I am sure that the present handbook will help the student researchers, agricultural and soil scientists in the country, as no such publication so far available for the beginners to identify this little studied insect order.

May, 2007
Place : Kolkata

Dr. RAMAKRISHNA
Director-in-Charge
Zoological Survey of India

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INTRODUCTION

Collembola—popularly known, as “springtails” are small and permanently wingless insects. The English entomologist Sir John Lubbock in the year 1870 gave the name Collembola to this group of insects. The small to minute insects with a range from 0.25 mm to 6 mm in length. Antennae with 4 to 6 segments. These are minor pests in agriculture but its importance as biological agent in the soil forming process are immense. Many species of collembolan are now established bio-indicator of soil pollution as well as soil fertility. The collembola have a very wide distribution, occurring in all parts of the world and in any atmospheric habitat. They occur to the vicinity of both south and north poles (up to 83° south latitude in Antarctica). Few species are living of permanently on glaciers or snow fields. The diversity as well as the greatest number is found in rich organic matter content soil. Some species live freely on the surface of the water (viz. *Podura aquatica*). They are less abundant in the dry habitat. The Collembola are divided into two suborders, each characterized by a distinct body form. The Collembolans, which have elongated body, come under suborder Arthropleona. In the Symphypleona the body is compacted and globular.

There are approximately 7500 described species worldwide (Frans Janssens, 2005). From India about 230 species under 86 genera, 8 families and 2 sub-orders are known. The present hand book provides pictorial key to 8 families, 11 subfamilies and 82 genera. The classification followed here after Christiansen & Bellinger (1980).

GENERAL MORPHOLOGY OF COLLEMBOLA

(Figs. 1 and 2)

The Head : It is more or less oval shaped in dorsal view, which varies considerably in different species, depending upon whether the jaws are directed, anteriorly or ventrally said to prognathous or hypognathous. In Sminthuridae the long axis of the head is typically vertical and the antennae arise dorsally.

The Antennae : These are normally consisting of four basic segments. In many Sminthuridae the last segment or last two segments are divided into a few or many sub-segments.

The post antennal organ (PAO) : This organ is found in some families between the antennal base and the eye region. This organ has got immense taxonomic value.

The eyes : The eye patch behind each antenna, which consists of from 1 to 8 in more or rectangular arrangement, usually located on a heavily pigmented area.

The Thorax and the legs : In each segments of the thorax there is a pair of six segmented legs. Some times there are one or more sub apical hairs on the tibiotarsus, these are called tenent hairs and have considerable taxonomic important. The leg terminates in one or two claws, the larger is known as unguis, the smaller one is known as unguiculus.

The abdomen : Unlike other insects the abdomen of collembola is six segmented. In

most of the species of Arthropleona the abdominal segments are distinct where as the Symphypleona the first four segments of the abdomen are fused with thorax to form a globular-mass. In majority species of Symphypleona the females bear chitinous structures on each side of the anus. The anal appendages are important in the separation of species.

The ventral tube (Collophore) : In the abdominal segment a circular or cylindrical bilobed appendages is present which is known as the ventral tube. Because of the presence of this peculiar structure by all the known species the name of this order was given as Collembola. It secretes glue like substances, which helps in adhesion process.

The furcula : The common name of this group is spring tail insect has been originated for the presence of this organ. It is appended to the ventral surface of the fourth segment of the abdomen. It is present in the majority of species, in some it is lacking or poorly developed. The structure is composed of a pair of appendages fused in their basal portion to form the manubrium. From this basal segment a pair of separate elongate structures known as dentes, which attached distally with small hook like structure which is called as mucrones (Fig. 1).

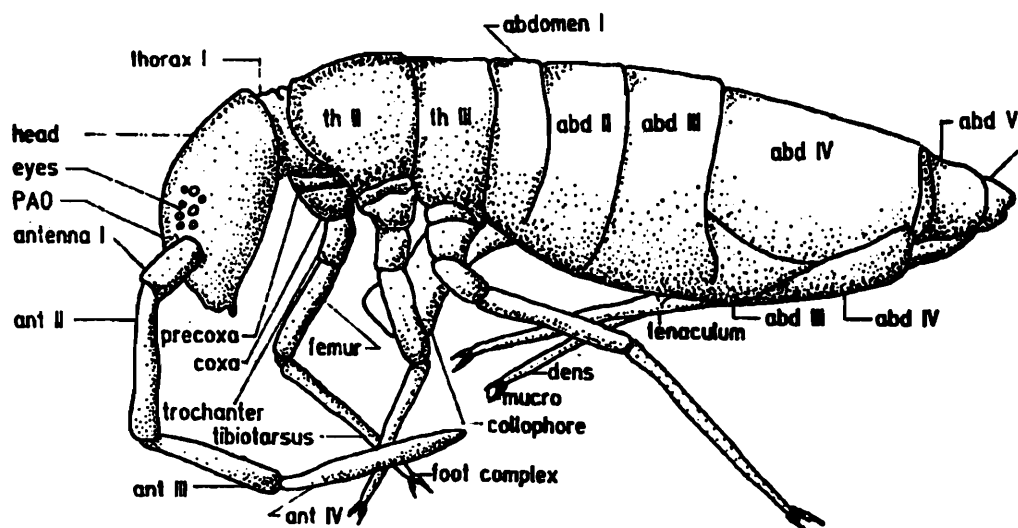


Fig. 1. Showing schematic diagram of a typical Arthropleonid Collembola

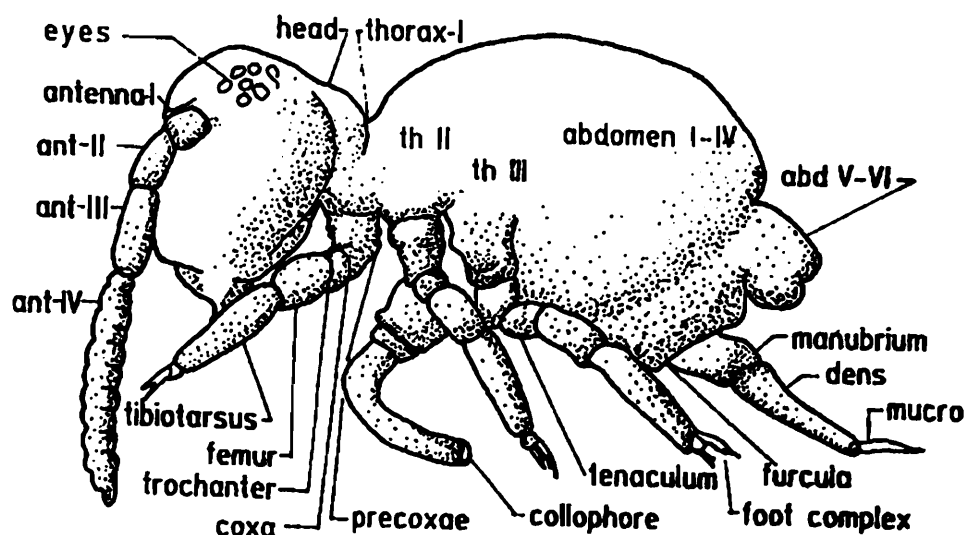


Fig. 2. Showing schematic diagram of a typical Symphypleonid Collembola

Body clothing : The body of the Collembolans is clothed with different types of hairs arranged in patterns, which gives the identity of different species. There are some sensory hairs arising from cup like pits in the integument is called bothriotricha.

COLLECTION AND PRESERVATION OF COLLEMBOLA

These small tiny insects may be collected from most of the habitat. But the collection techniques are different for taxonomical study and for the ecological study. A white enamel tray and aspirator are most use full tools for the collection of collembola to be used for taxonomic studies. Sometime alcohol may be given in the tray or on a large Petridis and then by beating the bushes or mosses or forest litters the Collembolans may be collected by inducing them to jump on these objects. They are then picked up in the end of a fine brush and transferred to fixative. But large numbers and greater varieties of collembola can be obtained by employing stainless steel corers (Fig. 2a) for collecting known quantity of soil samples. The cores are then placed on Tullgren funnel or High gradient extraction apparatus (Macfadyen, 1953) (Fig. 2b). The Tullgren funnel is simply a funnel, or rows of funnels with a wire net on which soil, litter, mosses etc are placed. An electric bulb above the funnel is hanging to provide temperature. A tube with alcohol below the funnel is kept for the collection of soil insects. But the Tullgren funnel technique is unsatisfactory for fine-grained materials and mineral soil as these materials is passed through the wire-net easily. Therefore, for which things the soil sample is immersed in water or salt solution and stirred, and collembolans float to the surface of solution and collected by picking up with brush. This method is known as flotation technique.

Preservatives : The Collembolans can be preserved in Von-Torne's medium. It consists of 1000 cc. Isopropyl alcohol, 30 cc glacial acetic acid and 3 cc. 40% formaldehyde.

Mounting media : For studying the collembolans the media which permit mounting directly from alcohol or clearing agents are useful. Hoyer's mounting medium perhaps would be best. It consists of 50 cc. Distilled water, 200g. Chloral hydrate, 40cc. Glycerin, 20 gm. gum arabic, these mixture should be filtered through glass wool.

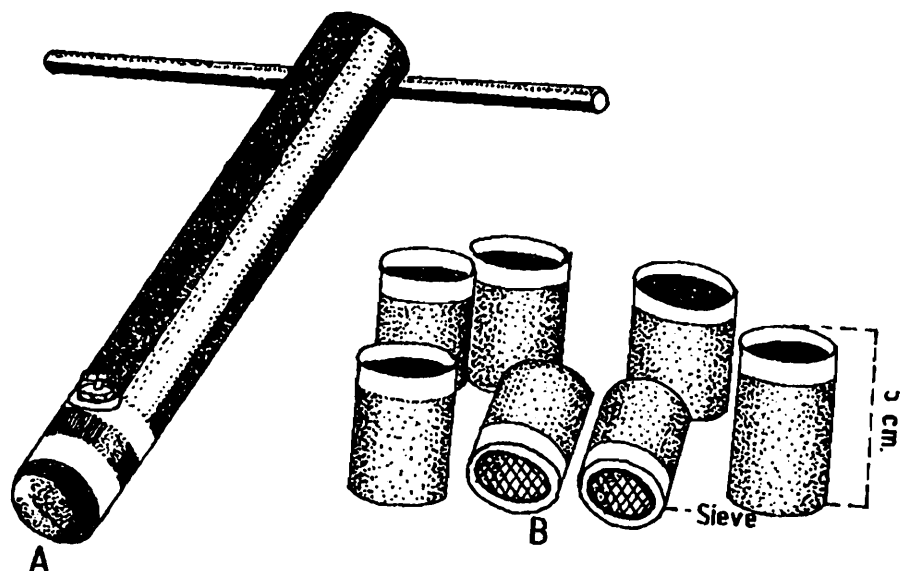


Fig. 2a. Stainless steel soil sampler : A. sample holder B. Stainless steel corer.

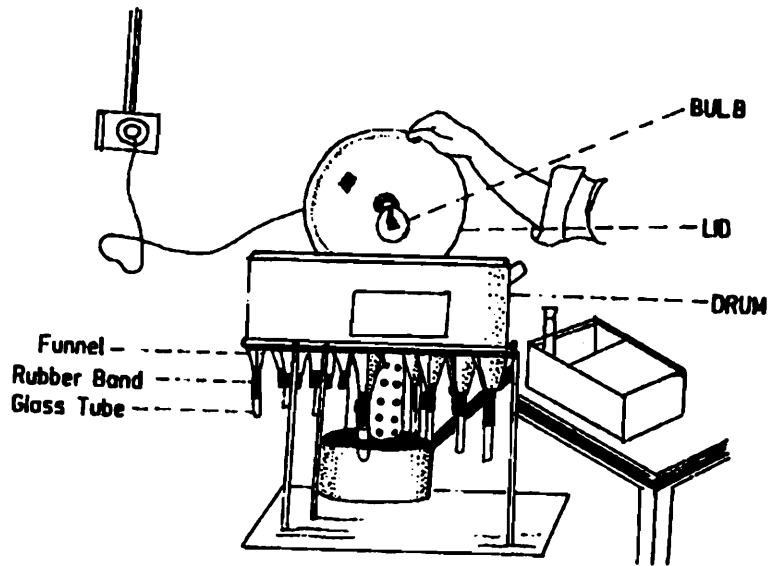
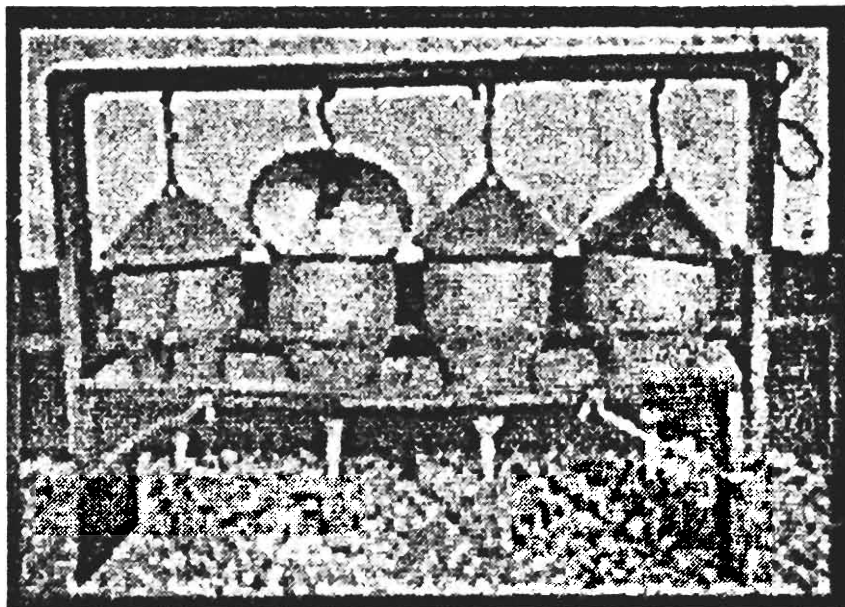


Fig. 2b. Soil sample extraction apparatus (modified)



Tulgren funnel extraction apparatus for soil fauna

SYSTEMATIC ACCOUNT

Phylum ARTHROPODA

Class INSECTA

Subclass APTERYGOTA

Order COLLEMBOLA

Suborder ARTHROPLEONA

Key to Families of COLLEMBOLA

1. Body linear (Fig. 3A, B); at least anterior 4 abdominal segments dorsally separated by membranes lacking setae, or furcula rudimentary or absent (Suborder-Arthropleona)..... 2

- 1' Body globular (Fig. 3C); anterior 4 abdominal segments fused dorsally; furcula always well developed (Suborder Symphypleona)..... 10.

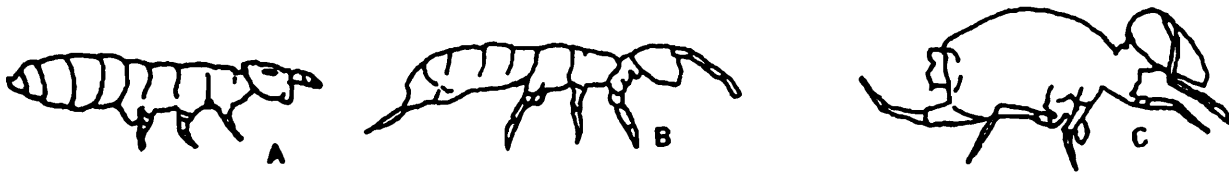


Fig. 3

2. First thoracic segment dorsally distinct and with dorsal setae (Fig. 4A) (Section Poduromorpha) 3

- 2' First thoracic segment without dorsal setae and frequently not visible dorsally (Fig. 4B) (Section Entomobryomorpha)..... 6

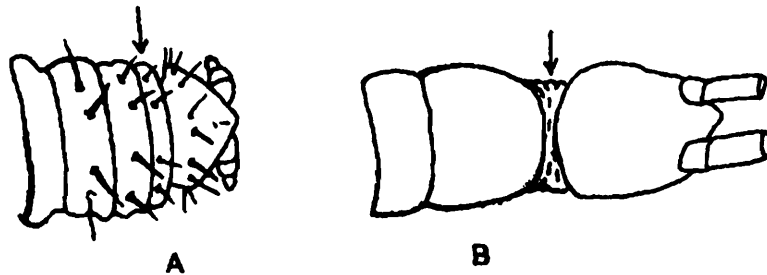


Fig. 4

3. Dentes more than 3 times as long as manubrium with distal rings of granules (Fig. 5A) PODURIDAE

- 3' Dentes absent or relatively shorter and not ringed (Fig. 5B) 4



Fig. 5

4. Pseudocelli present, at least on antennal base (Figure 6) or dorsum of fifth abdominal segment ONYCHIURIDAE

- 4' Pseudocelli absent HYPOGASTRURIDAE

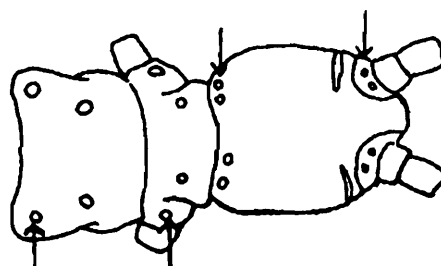


Fig. 6

- 5. Mucro hairy (Fig. 7A) : fourth antennal segment shorter than third : body scaled ENTOMOBRYIDAE (Subfamily TOMOCERINAE)
- 5' Mucro with at most 1-2 setae (Fig. 7B) : fourth antennal segment at least as long as third: scales present or absent..... 6



Fig. 7

- 6. Dentes with dentate spines (Fig 8A) : mucro sub equal in length to dens or longer ENTOMOBRYIDAE (Subfamily ONCOPODURINAE)
- 6' Dental spines simple (rarely) (Fig 8B) or absent : mucro usually much shorter than dens..... 7



Fig. 8

- 7. P.A.O present (Fig. 9A) or (2 species) absent and setae at most unilaterally ciliate ISOTOMIDAE
- 7' P.A.O absent (Fig. 9B) : some setae multilaterally ciliate 8

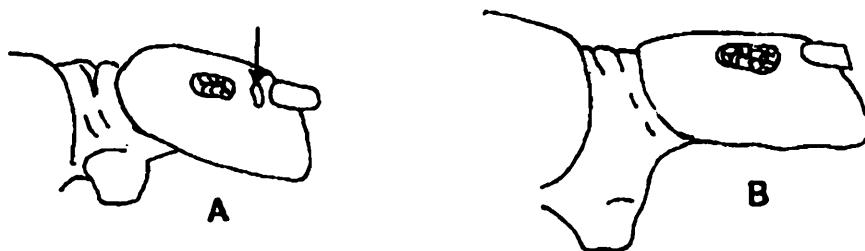


Fig. 9

- 8. Dens dorsally crenulate and curving upward, basally in line with manubrium (Fig.10A) ENTOMOBRYIDAE
- 8' Dens not crenulate, straight and usually forming a basal angle with manubrium (Fig. 10B)..... 9

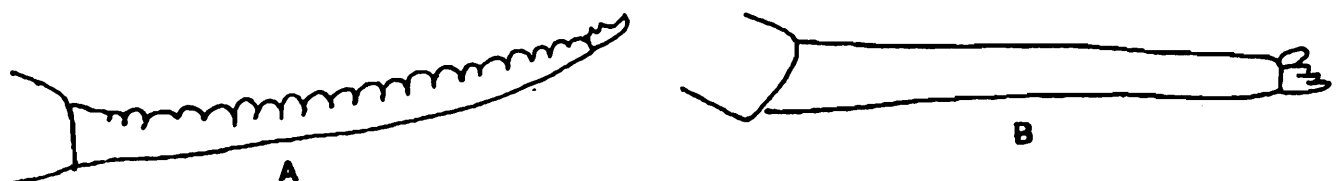


Fig. 10

9. Eyes and pigment absent; dens with large dorsal scales and without apical lobe ENTOMOBRYIDAE (Subfamily CYPHODERINAE)
- 9' Eyes and pigment present; dens without dorsal scales and with apical lobe (Figure 3B) ENTOMOBRYIDAE (Subfamily Paronellinae)
10. Antenna shorter than head; eyes absent NEELIDAE
- 10'. Antenna longer than head, or at least 1+1 eyes (Sometimes unpigmented) SMINTHURIDAE

Section PODUROMORPHA

This includes Arthropleona with setae on the first thoracic tergite. Only this character will surely distinguish all species from some superficially similar Isotomidae. However, any Arthropleona with the last two antennal segments more or less fused, or with the postantennal organ made up of separate lobes, or without a molar plate on the mandible, belongs here. In general, the species have a weakly sclerotized, granulate or tuberculate integument without clear distinction between sclerites and membranes; relatively sparse chaetotaxy of simple setae (weakly serrate, knobbed, or spin-like setae occur); relatively short appendages, with the furcula and tenaculum often rudimentary or absent. The color is usually brown, blue, or white, without striking pattern. The majority of species are found in litter, soil, or caves.

Of the three families recognized here, the Poduridae are very distinct in structure and habitat. The Onychiuridae are similar in many respects to the Hypogastrurinae, but may almost always be distinguished by the pseudocelli and sense organ of the third antennal segment.



Fig. 11

Family PODURIDAE

Poduromorph Collembola with a mandibular molar plate and eyes, and a very long furcula, which reaches the ventral tube when at rest. The head is hypognathous; P.A.O and unguiculi are absent. A single genus and species are known (Fig. 11).

Genus *Podura* Linnaeus, 1758

Type species : *P. aquatica* Linnaeus, 1758

Family HYPOGASTRURIDAE

Poduroid Collembola with the furcula short or absent, the third antennal segment

sense organ simple and typical pseudocelli lacking. The mouthparts vary in structure in this family more than in any other Collembola; see Fig. 14. The furcula, when extended posteriorly, never reaches beyond the end of the abdomen; this character distinguishes the family from all other Collembola except Onychiuridae and some Isotomidae. In addition to pseudocelli and a complex third antennal segment sense organ, almost all Onychiurids have a long, parallel-sided P.A.O. with many tubercles in a groove, whereas the P.A.O. in Hypogastruridae, if present, is rounded or oval and usually has few tubercles. All isotomids with a short furcula may be distinguished from any similar hypogastrurid by the absence of setae on the prothoracic tergum, and from almost all hypogastrurids by the P.A.O. in the form of a single vesicle.

There are 2 subfamilies of Hypogastruridae, which may be distinguished as follows :

Mandible with a basal molar plate (Fig. 12A, C) HYPOGASTRURINAE

Mandible absent or without a molar plate (Fig. 12B) NEANURINAE

The molar plate (see figures in key to genera of Hypogastrurinae) is easily seen in well cleared specimens of most genera; the two genera in which it is weakly sclerotized differ from all Neanurinae in having conspicuous, lamellate unguiculi.

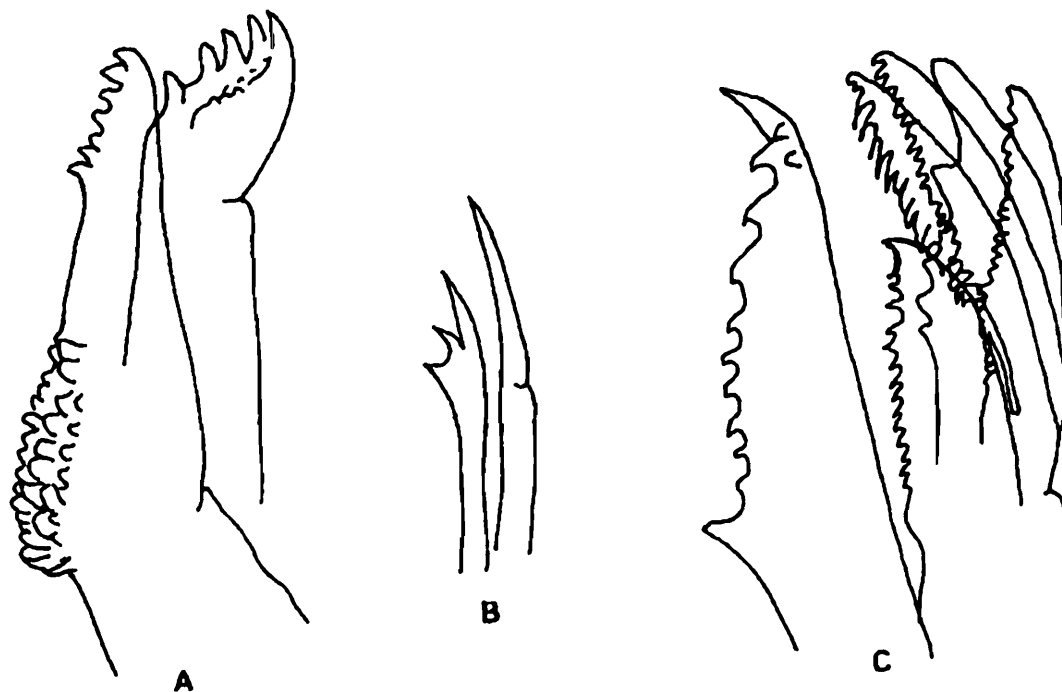


Fig. 12

Mouthparts of Hypogastruridae. In each figure the mandible is on the right and the maxilla on the left.

A. *Anuridae amorita* Folsom

B. *Neanura muscorum* (Templeton) after Massoud

C. *Hypogastrura oregonensis* Yosii

Key to Genera of HYPOGASTRURINAE

- 1. P.A.O absent 2
- 1' P.A.O present 3
- 2. 4-5 eyes per side *Xenylla*
- 2' Eyes absent *Acherontiella*
- 3. Anal spines 3 (Fig. 13A); 9 or more dorsal dental setae *Triacanthella**
- 3'. Anal spines 0 or 2 (Fig. 13B); or fewer dorsal dental setae 4
- 4. Eyes 8 + 8 5
- 4' Eyes 6+ 6 or fewer 7
- 5. Furcula absent *Knowltonella**
- 5' Furcula present 6

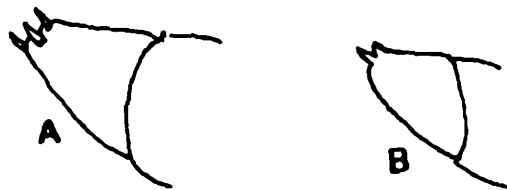


Fig. 13

- 6. Mandible with apical teeth (Fig. 14A); P.A.O. lobed
..... *Hypogastrura* (Plate I, fig. 1)
- 6' Mandible without apical teeth (Fig. 14 B); P.A.O. simple *Stenogastrura**



Fig. 14

- 7. Furcula absent 8
- 7' Furcula present 10
- 8. P.A.O. elongate with 2 rows of oblong tubercles (Fig. 15A)
..... *Sensiphorura* (Onychiuridae)
- 8' P.A.O. circular with triangular tubercles (Fig. 15B) 9
- 9. Unguis strongly toothed; clavate tenent hairs *Tafallia**
- 9' Unguis without tooth; at most 1 clavate tenent hairs *Willemia*



Fig. 15

- 10. More than 1 clavate tenent hair per foot..... *Mesachorutes**
- 10' 1 acuminate or clavate tenent hair per foot 10
- 11. Mandible with strong molar plate and several apical teeth (Fig. 14)... *Schaefferia**
- 11' Mandible with weak molar plate and at most 1 apical tooth (Fig. 16)
..... *Microgastrura**



Fig. 16

Key to genera of subfamily NEANURINAE

- 1. Mucro trilamellate (Fig. 17) *Odontella (Odontella)*
- 1' Mucro not trilamellate; frequently reduced or absent 2

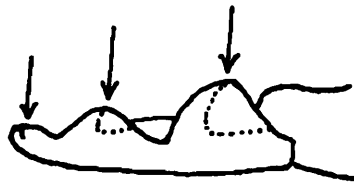


Fig. 17

- 2. Unguiculus present (Fig. 18); P.A.O. triradiate (Fig. 19A) *Odonetella (Xenyllodes)*
- 2' Unguiculus absent; P.A.O. when present lobed (Fig. 19) 3

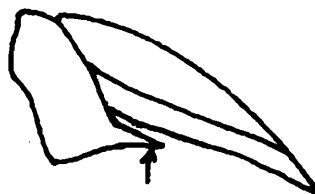


Fig. 18

- 3. Maxilla sickled- shaped (Fig. 20A); 3 or more anal spines or spine -like setae, or 2 such setae and mucro fused to dens *Friesea*

- 3' Maxilla quadrate (Fig. 20B), narrow and lamellate (Fig. 20C), or needle-like (Fig. 20 D); anal spines absent, or 2 anal spines and mucro separate from dens 4

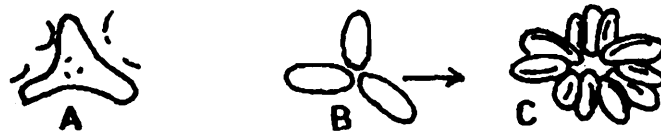


Fig. 19

- 4. Furcula present with all segments distinct 5
- 4' Furcula reduced or absent; mucro always absent 7
- 5. Head of maxilla quadrate (Fig. 20B)..... *Brachystomella*
- 5' Maxilla otherwise (Fig. 20D) 6
- 6. P.A.O present; anal spines absent *Pseudachorutes*
- 6'. P.A.O absent; 2 anal spines *Oudemansia*
- 7. Last abdominal segment bilobed; body usually with conspicuous tubercles (Fig. 19A) 8
- 7'. last abdominal segment rounded; body without conspicuous tubercles (Fig. 19 B) 9

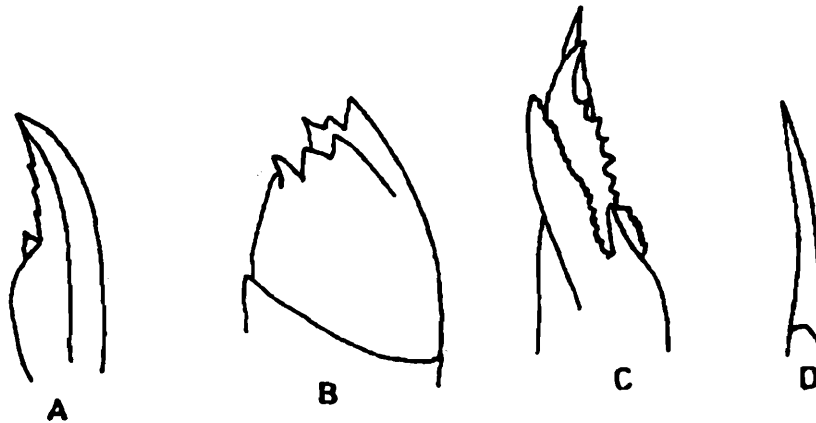


Fig. 20

- 8. P.A.O. present *Morulina**
- 8' P.A.O absent *Neanura* (Plate I, fig. 2)
- 9. P.A.O present *Anurida*
- 9' P.A.O absent *Paranura*

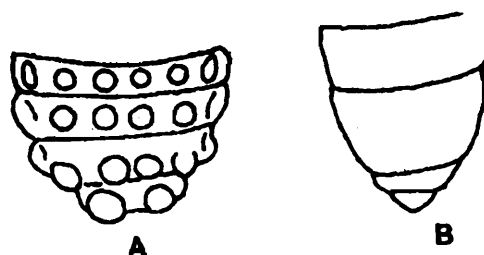


Fig. 21

Family ONYCHIURIDAE

This family is characterized by the presence of pseudocelli (occasionally hard to see) on the head and body and by the distinctive and usually complex apical organ of the third antennal segment. All species lack eyes and, except for *Lophognathella*, dark pigment and a functional furcula. They resemble Hypogastrurinae in mouthpart structure and general body form; all except *Onychiurus* (*Archaphorura*) spp. differ from the most similar Hypogastrurinae such as *Willemia* in having more numerous P.AO tubercles.

There are 4 genera, easily separated by a number of characters.

Key to genera of Onychiuridae

1. Furcula with dens and mucro present; tenaculam present *Lophognathella**
- 1' Furcula of paired knobs, single fold, or absent; mucro and tenaculum absent 2
2. Last 2 antennal segments completely fused *Sensiphorura*
- 2' Last 2 antennal segments distinctly separated 3
3. Apical sense organ of third antennal segment with 2 sense clubs behind 4-6 integumentary papillae (Fig. 22A) *Onychiurus*
- 3' Apical sense organ of third antennal segment with 1-3 exposed sense clubs (Fig. 22B) *Tullbergia*



Fig. 22

Section ENTOMOBRYOMORPHA

This includes Arthropleona with the first thoracic tergite reduced and membranous or fused with the second tergite, and always lacking setae. Any linear springtail with the furcula reaching the ventral tube at rest and a post antennal organ or scales or multilaterally ciliate setae belongs here. Forms with the furcula shorter or absent may be distinguished from almost all poduromorpha by the distinct sclerites which are clearly set off from the much weaker intersegmental membranes; abundant setae, usually with a clear differentiation of types; relatively long appendages, with the antennal segments all distinct. While many species are colorless or uniformly colored, bright and striking patterns, usually of blue markings on a white or yellow ground, are common. Species are found in all habitats where any Collembola occur.

Of the two families recognized here, the isotomids have simple to bilaterally ciliate setae and (almost always) a postantennal organ; the entomobryides have multilaterally

ciliate setae and/or scales, and the few species with a postantennal organ are scaled. Very young specimens of *Tomocerus* resemble Isotomids in these respects.

Family ISOTOMIDAE

This family includes *Arthropleona* with all antennal segments distinct, well developed mouthparts with a mandibular molar plate, pronotum reduced and lacking setae, unguis with a single inner margin, third and fourth abdominal segments comparable in length, dentes without multidentate spines, and without scales or "flexed" setae. With 2 exceptions, both of which lack eyes and pigment, all species have a P.A.O; this is in the form of a single tubercle, which varies from round to elongate and parallel-sided. In all other respects the characteristics of the family are extremely variable. The following features may be present or absent; pigment, the apical retractile antennal papilla, antennal blunt setae, eyes, unguiculli, tenaculum, furcula, anal spines, and bothriotracha. The integument ranges from smooth to reticulata or coarsely rugose. Setae may be uniform or differentiated in form and length, and smooth or serrate. All species are plurichaetotic, at least beyond the first instar.

The classification of this family is in a very unsatisfactory state. Attempts to divide it into subfamilies have not been successful because of the existence of intermediate forms, and many "genera" also intergrade. We follow Gisin's classification for the most part; this system, already somewhat arbitrary, becomes more so with the addition of species falling on the borderline of genera whose definition has been based on European species. A more "natural" classification may be possible, but would require systematic study of additional characters such as chaetotaxy, and should be based on a study of the world fauna. Fortunately, most species whose generic assignment is in question are not difficult on the basis of specific characters.

Key to the genera Isotomidae

- 1. Anal spines 2-4, terminal at end of abdomen, on projecting papillae (Fig. 23C); furcula never reaching end of abdomen; eyes 8 + 8 2
- 1' Abdominal spines absent, or sub terminal (Fig. 23 B), or not on papillae (Fig. 23C); or furcula extending beyond end of abdomen; eyes 8+8 or fewer 3



Fig. 23

- 2. 4 anal spines *Tetracanthella**
- 2'. 2 anal spines *Uzelia**

- 3. Abdominal segments 4-6 fused (no clear non-setaceous band separating these segments) (Fig. 24B) **Folsomia**
- 3' At least fourth and fifth abdominal segments separated by a clear non-setaceous band or structure (Fig. 24A) 4

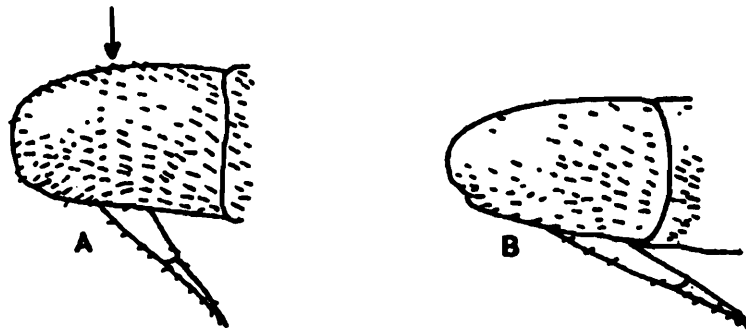


Fig. 24

- 4. Furcula well- developed; mucro with 2 (Fig. 25A) or more teeth; or lamellate (25B) 10
- 4' Furcula reduced or absent; mucro absent or unidentate and hooklike (Fig. 25C) 5

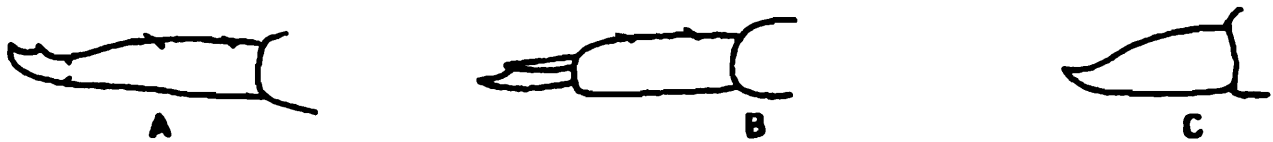


Fig. 25

- 5. Furcula bifurcate (Fig. 26A); tenaculum present 6
- 5' Furcula without paired distal projections (Fig. 26B) or; tenaculam absent 7

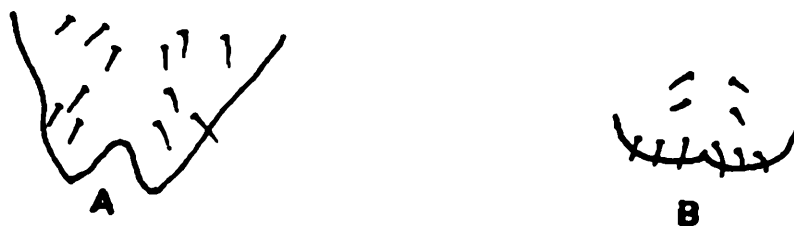


Fig. 26

- 6. Integument coarsely granulate (Fig. 27) **Coloburella (Coloburella)***
- 6' Coarse integumentary granulations absent **Stachanorema***
- 7. Eyes 2+2 or more; antenna with apical retractile papilla **Anurophorus (Anurophorus)***
- 7' Eyes 1+1 or absent; no apical retractile antennal papilla 8

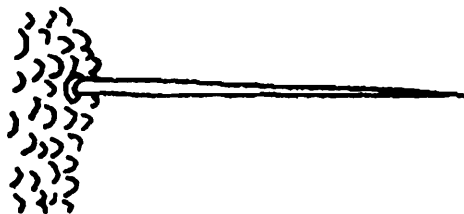


Fig. 27

- 8. Rudimentary furcula present (Fig. 26B); integument coarsely granulate (Fig. 27) *Coloburella (Paranurophorus)*
- 8'. Furcula completely absent; integument finely granulate 9
- 9. Fifth and sixth abdominal segments fused *Micranurophorus*
- 9'. Fifth and sixth abdominal segments separate *Anurophorus (Pseudanurophorus)*
- 10. Abdomen subterminally with 2-6 spines set in strongly rugose surface... " Spinisotoma" ecomorphs of *Isotoma* spp
- 10'. Abdominal spines absent or not set on rugose surface 11 *Proisotoma (P)*
- 11. Head wider than second thoracic segment; antennae shorter than head (Fig. 28A) *Metisotoma*
- 11'. Head subequal to or narrower than second thoracic segment; antennae longer than head (Fig. 28B) 12



Fig. 28

- 12. P.A.O absent ; eyes and pigment absent *Isotomiella*
- 12'. P.A.O present; eyes and pigment present or not 13
- 13. Ventral manubrial setae 10 or more (usually 14 or more) 14
- 13'. Ventral manubrial setae 9 or fewer (usually 6 or fewer) 20
- 14. Sense organ of third antennal segment with more than 10 blunt setae (Fig. 29A) *Axelosonia*
- 14'. Sense organ of third antennal segment with 2 (Usually) to 4 or 5 blunt setae (Fig. 29B) 15
- 15. Dentes dorsally smooth *Isotomurus (Hydroisotoma)*
- 15'. Dentes dorsally crenulate or tuberculate 16

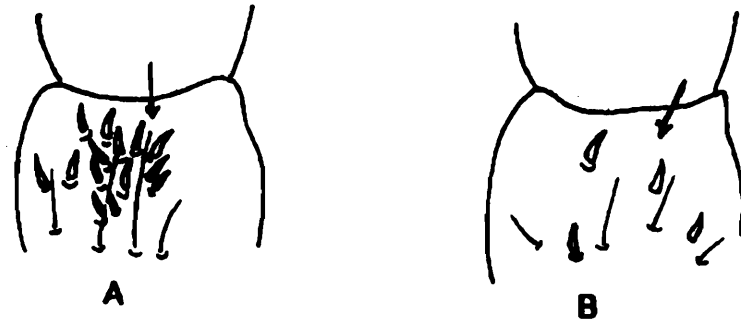


Fig. 29

- 16. Abdominal macrochaetae coarsely, multilaterally ciliate (Fig. 30A) second to fourth abdominal segments with bothriotracha ... *Isotomurus (Isotomurus)* (Plate I, fig. 3)
- 16' All setae smooth or unilaterally ciliate (Fig. 30B); bothriotracha absent 17

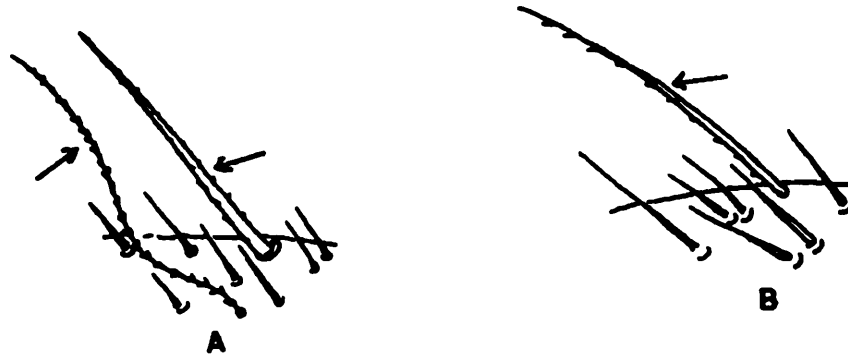


Fig. 30

- 17. Dentes with dorsal papillate spines (Fig. 31) *Semicerura**
- 17' Dentes without spines 18

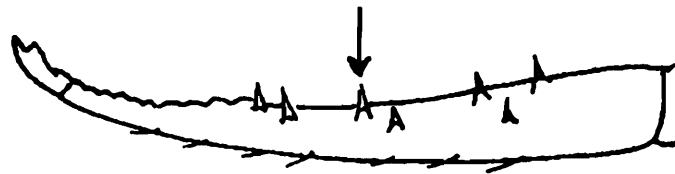


Fig. 31

- 18. Dentes dorsally tuberculate (Fig. 32A) 19
- 18' Dentes dorsally crenulate (Fig. 32B) *Isotoma* (Plate I, fig. 4)

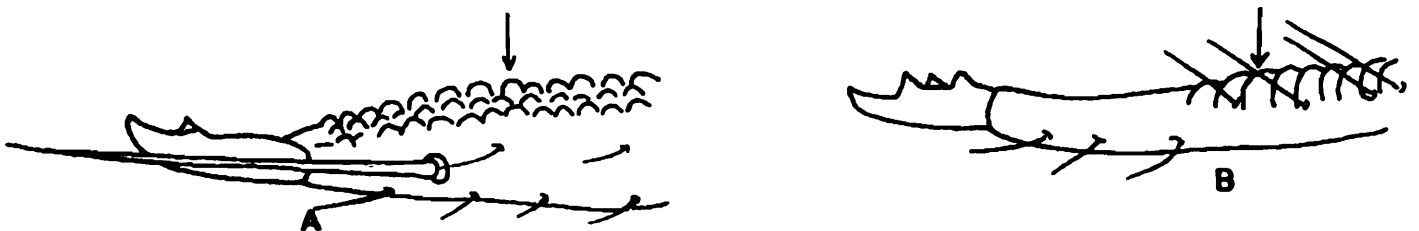


Fig. 32

- 19. Subapical dental seta greatly exceeding apex of mucro *Agrenia**
- 19' No dental setae exceed apex of mucro (Fig. 33) *Isotoma (Panchaetoma)*

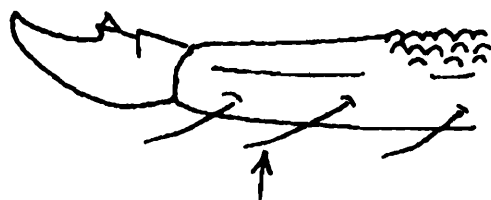


Fig. 33

- 20. Cephalic integument reticulate (Fig. 34 A); 8 anal spines present on papillae
..... *Weberacantha**
- 20' Cephalic integument granulate (Fig. 34C), tuberculate (Fig. 34B), or smooth; anal spines present or absent, rarely on papillae 21

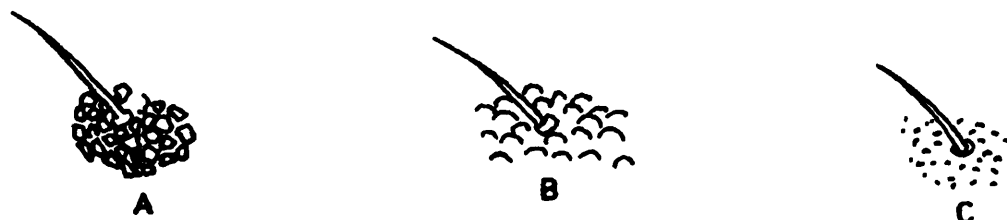


Fig. 34

- 21. Manubrium ventrally without setae 22
- 21' Manubrium ventrally with setae 26
- 22. Mucro with 2 basal flaps (Fig. 35) *Archisotoma*
- 22' Mucro without basal flaps 23



Fig. 35

- 23. Dorsal dental setae 7 or more 24
- 23' Dorsal dental setae 3 or fewer 25
- 24. Dentes without ventrolateral setae (Fig. 36A) *Bonetrura**
- 24'. Dentes with 1 or more ventrolateral setae (Fig. 36B) *Proisotoma*
- 25. Abdomen with spine-like setae on sixth segment; dens with 2 setae in ventral half
..... *Isotomodes*



Fig. 36

- 25' Abdomen without posterior spine-like setae; dens with 1 or no setae in ventral half *Folsomides*
26. P.A.O with margin divided into 4 quadrants (Fig. 37A); some macrochaetae conspicuously ciliate *Micrisotoma*
- 26' P.A.O margin not divided into quadrants; (Fig. 37B) no clearly ciliate setae 27



Fig. 37

27. Mucro with 3 or more teeth *Proisotoma*
- 27' Mucro bidentate 28
28. Fifth and sixth abdominal segments separated by clear non-setaceous band or suture *Proisotoma*
- 28' Fifth and sixth abdominal segments fused 29
29. Dens with 6 or fewer setae in ventral half *Dagamaea*
- 29' Dens with 7 or more setae in ventral half *Cryptopygus*

Family ENTOMOBRYIDAE

This family includes all members of Arthropleona having the prothorax reduced and without setae, and with scales and/or with the fourth abdominal segment much longer than the third. The clothing is generally of a wide variety of setae, including large, multilaterally ciliate or striate macrochaetae whose distribution is of great importance in the taxonomy of the group; except where otherwise clearly indicated, we have followed the system of Szeptycki (1969, 1972) in describing this distribution. Scales, when present, are diagnostic, since they are found only in this family. Most species lack a postantennal organ and Unguiculus are always well developed. The Furcula is always well developed; the form of the dens and mucro are characteristic in the different subfamilies. There are 5 subfamilies of Entomobryidae.

Characteristics of subfamilies of ENTOMOBRYIDAE

Key to genera of Entomobryidae

- 1. Dentes smooth (Fig. 38B) 2
- 1' Dentes crenulate (Fig. 38A) (Sub family Entomobryinae) 6

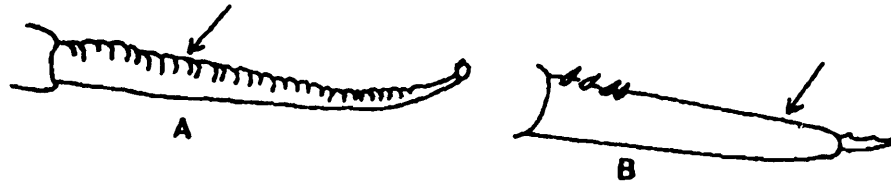


Fig. 38

- 2. Dental spines absent 3
- 2' Dental spines present (Fig. 39) 4



Fig. 39

- 3. Mucro at least 1/3 as long as dens (Subfamily Cyphoderinae) *Cyphoderus*
- 3' Mucro less than 1/4 as long as dens (Subfamily Paronellinae) *Salina*
- 4. Dental spines relatively small, on basal portion of dens only (Fig. 40A) (Subfamily Tomocerinae) *Tomocerus*
- 4' Dental spines relatively large, most conspicuous toward apex of dens (Fig 40B) (Subfamily Oncopodurinae) 5



Fig. 40

- 5. Eyes and pigment present *Harlomillsia*
- 5' Eyes and pigment absent *Oncopodura**
- 6. Body with scales 7
- 6' Body without scales 12
- 7. Mucro falcate (Fig. 41A) *Seira*
- 7' Mucro bidentate (Fig 41B) 8



Fig. 41

- 8. Dentes with scales on ventral surface 9
- 8' Dentes without scales 11
- 9. Forth abdominal segment at midline more than twice as long as third 10
- 9' Forth abdominal segment at midline less twice as third *Heteromurus*
- 10. Eyes 8 + 8 *Lepidocyrtus*
- 10' Eyes 6 + 6 or less *Pseudosinella*
- 11. Scales narrow, without clear marking (Fig. 42A) *Anetschekbrya**
- 11' Scales broad, and clearly striate (Fig. 42B) *Willowsia*

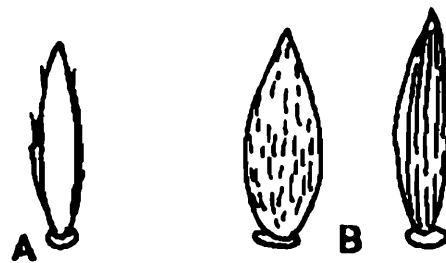


Fig. 42

- 12. Eyes 4+4 or fewer *Sinella*
- 12' Eyes 8+8 13
- 13. Forth abdominal segment at midline less than 3 times as long as third 14
- 13' Forth abdominal segment at midline more than 3 times as long as third
..... *Entomobrya*
- 14. Unguis with 2 unpaired and 2 paired inner teeth (Fig. 43A); first and second antennal segments subsegmented *Orchesella*
- 14' Unguis with 3 unpaired inner teeth (Fig. 43B); antennal segments not subsegmented
..... *Corynothrix*

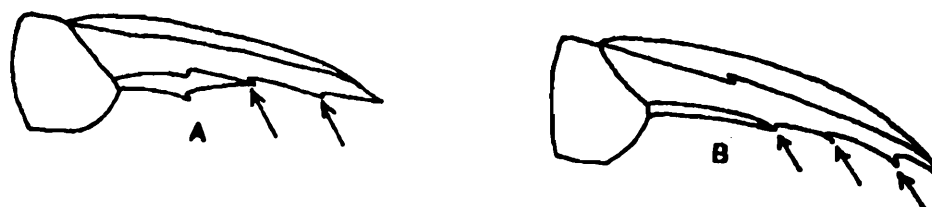


Fig. 43

Key to the Indian genera of subfamily Paronellinae

1. Body covered with scales 2
 - Body not covered with scales 3
2. Dental scale appendage and 4 + 4 frontal spines present, antennal segments without thick outstanding brush setae *Callyntrura* Börner
 - Dental scale appendage and 4 + 4 frontal spines absent, antennal segments with thick outstanding brush setae *Dicranocentroides* Schott
3. Mucro well developed, stout, bidantate or tridentate, dental scale appendage equal or subequal to mucronal length 4
 - Mucro vestigial in the form of a hook; dental scale appendage highly enlarged ..
..... *Yosia* Mitra
4. Mucro with 2 apical teeth; ventral tube anteriorly on anterior face with 5+5 macrochaetae; 1+1 frontal spines reduced *Pseudosalina* Mitra
 - Mucro with 3 apical teeth; ventral tube anteriorly on anterior face with 4 + 4 macrochaetae; 1 + 1 frontal spines well developed *Salina* MacGillivray

Key to the species and subspecies of *Salina*

1. Mucro long, narrow, superficially lobed into teeth, dental scale appendage relatively small, tergites with many macrochaetae (Fig. 44A, B, C, E, F, and G)
..... The Indica Group 2
 - Mucro short broad, deeply lobed into teeth, dental scale appendage relatively large, tergites with less number of macrochaetae (Fig. 44. D,H)
..... The Celebensis Group 4
2. Body always with patches of blue-black or orange pigments 3
 - Body without any pigment, thoracic tergites II, III and abdominal tergites I, II margins darker and II sometimes with faint violet pigment *indica* (Imms)
3. Thoracic tergite II with transverse orange bands or patches, abdominal tergites I-IV with median orange patches or pigments and V-VI with caudal patches
..... *biformis* Mitra
 - Thoracic tergites II, III with dark blue-black pigment or orange suffusion extending abdominal tergites I., II; I-VI sometimes without patches *bengalensis* Mitra
4. Body devoid of dark pigment, tergal margins seldom with faint violet pigment; chaetotaxic formula of Ths. II, III/Abds.I, II = 7, 5/2, 3 *celebensis* (Schaffer)
 - Body mostly with dark or variable or without pigment 5
5. Pigment usually in the form of violet streaks or small patches 6
 - Pigment in the form distinct of longitudinal or transverse bands with various combination of pigments 7

6. Lateral margins of thoracic segments. II, III and abdominal tergites I, II, darker with darker pigment including into abdominal tergite II; thoracic segments II, III and abdominal I-IV with inconsistent violet patches *montana* (Imms)
- Lateral margins of thoracic segments. II, III and abdominal I, II, III with purple pigment; abdominal segment IV with two characteristic median and caudal patches on each having violet lateral streaks *yosii* Salmon
7. Pigment usually tends to form longitudinal bands 8
- Pigment usually tends to form transverse bands at least on thorax 9
8. Two longitudinal usually interrupted bands on each side of thoracic segments II, III and abdominal I, II and IV with an additional median and caudal band or patch *striata* (Handschin)



Fig. 44. A, Typical Chaetotaxy of ventral tube; B, C, mucronal structures of *indica* group (B, from *S. indica*; C, from *S. bengalensis*); D, mucronal structures of *celebensis* group from *S. javana*; E, F, G, apices of flexed macrochaetae from thorax *indica* group; H, apices of flexed macrochaetae from thorax of *celebensis* group); I, a microchaeta from the general surface of the body in *celebensis* group; J, a lasiotrichium.

- Two longitudinal bands forming more or less characteristic quadrangle ones on each side of body, lateral bands darkest; abdominal segments II-IV with an additional median streaks *tricolor* (Handschin)
- A. Pigment does not cover entire surface of any segment
 *tricolor tricolor* (Handschin)
- B. Dark blue-black pigment totally covers Th. III, Abds. I, II, Th.II entirely with pigment or non pigmented; half of Abd.IV posterodorsally with dark blue black pigment or with irregular blotches or spots; *sikkimensis* Mitra
9. Thoracic segments III with transverse blue-black bands; abdominal segments I, II, V and VI with a continuous lateral band from head to segment III and IV with paired medial patch *javana* (Handschin)
- A dark blue-black band surrounds the entire body through lateral margins of the Head, thorax and abdomen with two dark blue-black narrow transverse bands which on abdominal segment II and IV connecting the lateral bands
 *choudhurii* Mitra

Key to the species of *Dicranocentroides*

1. Body generally without dark pigmented patches (Fig. 45A) 2
 Body with distinct dark pigmented patches (Fig. 45B) 3
2. Body dark brown to pale yellow, lateral edges of thorax and abdomen faintly pigmented at times; antennae not pigmented *flavescens* Yosii
 Body brown with faint purple blue pigment: Antennal segments. I, II, III each with a pigmented distal ring, segment. IV pigmented *indica* (Handschin)
3. Abdominal segments I, II and VI without pigment; III with a middle quadrangular dark patch, IV also with a posterior transverse band *gisini* Mitra

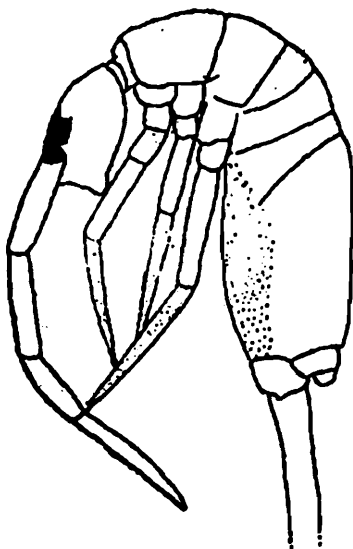


Fig. 45A. Lighter form

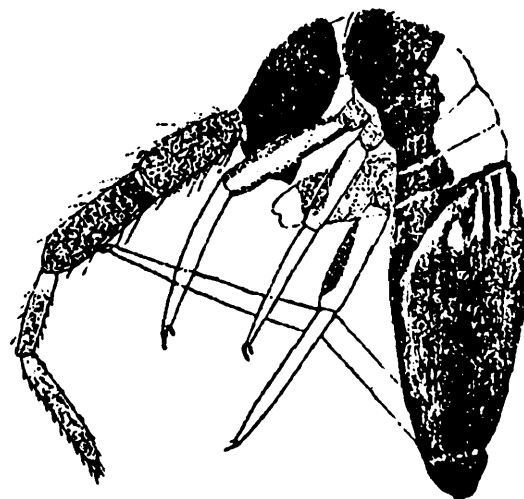


Fig. 45B. Pigmented form

- Abds. III, IV dorsally and/or laterally always pigmented patches 4
4. Sexually dimorphic in colour pattern; thoracic segment II totally pigmented with reddish blue pigment; thoracic III and abdominal segments I, II with lateral dark pigment and IV of both sexes with violet or metallic pigment in each laterally ...
 *fasciculatus* Imms
- Sexually not dimorphic in colour pattern; males and females pigmented with equal intensity; thoracic. III and abdominal segments. I, II mostly with dark pigmented patches *salmoni* Mitra

Key to the species of *Callyntrura*

1. Dental scale appendage present (*Handschinphysa*) 2
 Dental scale appendage absent (Fig. 46) (*Callyntrura*) 5
2. Head, thoracic. II, III and abdominal segments I-II with deep blue-black pigment, IV with or without median dark blue-black pigment, 3
 Pigmentation variable or without pigment, thoracic. II, III and abdominal segments I-III pigmented, IV-VI at least with a pair of pigmented spots or patches
 *lineata* (Parona)

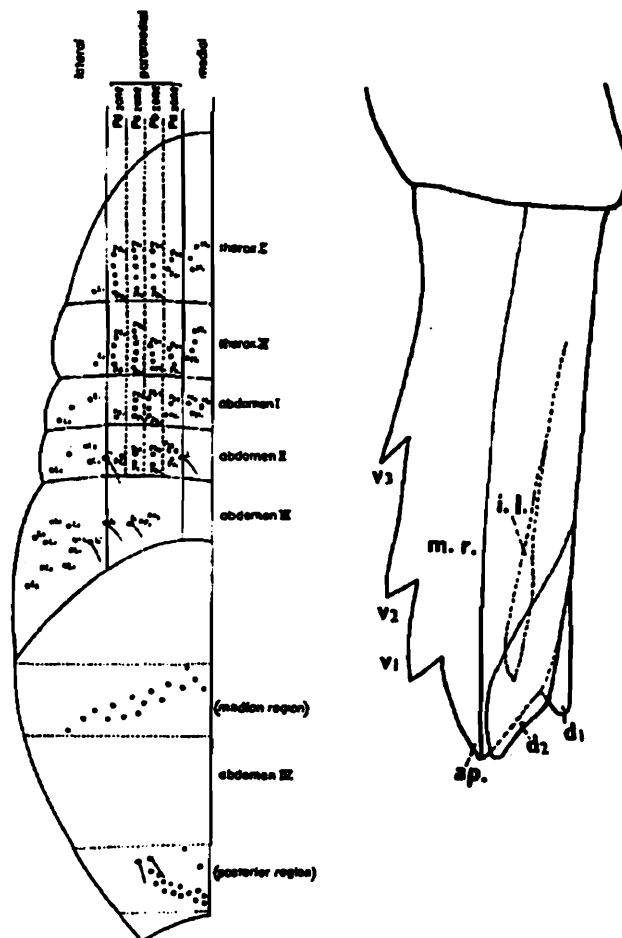


Fig. 46. Left. General plan for zonations of segments of *Callyntrura*. Right. Mucronal pattern of *Callyntrura* (after Mitra, 1994).

3. Abdominal segments. IV-VI with or without transverse pigmented bands or spots *vestita* (Handschin)
Abdominal segments. IV-VI with either median transverse pigmented bands or patches; legs without bands 4
4. Abdominal segment III with lateral purple patches extending to the body; legs with bands *borneri* (Imms)
Abdominal segment III with a lateral conspicuous pigmented spot, IV with a narrow transverse patch, others with darker pigmented streaks
..... *delamarei* Mitra
5. Ventral side of mucro with many serrations; thoracic II, III and abdominal tergites III, IV with dark blue-black pigment *serrata* (Salmon)
Ventral side of mucro with distinct teeth; thoracic and abdominal tergites without pigments 6
6. Lateral margins of heads, thoracic. II, III, abdominal segments. I, II, III with purple Pigment *semiviolacea* (Handschin)
Abdominal segment. IV with dorsal pigmented patches 7
7. Body with faint purple to blue pigment with a narrow lateral stripe extending to abdominal segment IV *zaheri* Mitra
Body with variable pattered rings 8
8. Thorax dusky; abdominal segment IV with transverse patch ... *japonica* (Kinoshita)
Thorax with blue-black pigment; abdominal segments. III and IV with lateral blue black pigment blotches *longicornis* (Oudemans)

Suborder SYMPHYPLEONA

Globular Collembola, without clear indication of trunk segmentation at least between the thorax and last two abdominal segments; Furcula always well developed. Probably a composite group, including two families that are not closely related.

Family NEELIDAE

Members of this family have the thorax and abdomen fused into a spherical or ovoid mass with the thoracic and abdominal portions sub equal (Unlike Sminthuridae); they lack eyes and have antennae shorter than the head and a dens subdivided into two parts.

The thorax is relatively large; the posterior trunk segments form a single mass, with only the prothorax and sometimes the mesothorax set off by distinct sutures. The head and body have more or less clearly demarcated sensory fields bearing specialized setae. An apical ventral process on the manubrium and a basal dental process form a supplementary articulation (Fig. 47) between these segments. There is a single genus present in this family.

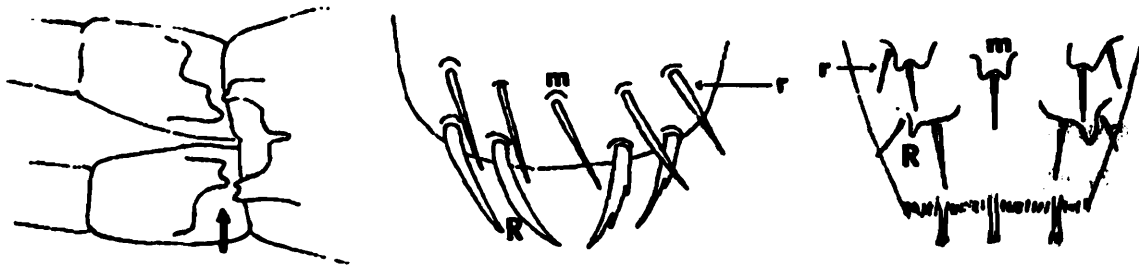


Fig 47. A. Manubrium of genus *Neelus*; B & C : Two (m & R) types labral structure in genus *Neelus*

Genus *Neelus* Folson, 1896

Family SMINTHURIDAE

This family includes all Symphypleona with eyes and members have the antennae longer than the head, which is hypognathous. A post antennal organ is absent and the first four abdominal segments are fused; the limits of the thoracic segments may be visible dorsally or not; the fifth abdominal segment may be distinct or fused to the fourth or sixth segment. The coxae and trochanters have characteristic shapes and bear setae and other organ of taxonomic value. The mucro is always elongated and commonly serrate along one or both margins. Sexual dimorphism occurs in many genera and may involve foot structure, supra anal structure, setal form, special organ of the head and body coloration, and size. The animals are usually brightly and strongly pigmented, and many have striking patterns.

Key to subfamilies of SMINTHURIDAE

1. Forth antennal segment less than half as long as third DICYRTOMINAE
- Forth antennal segment at least as long as third 2
- 2(1). Female without subanal appendages; male without clasping organ SMINTHURIDINAE
- Female with subanal appendages; male without clasping organ 3
- 3(2) Metathoracic trochanters with trochanteral organ KATIANNINAE
- Metathoracic trochanters without trochanteral organ SMINTHURINAE

Key to the genera of Sminthuridae

1. Forth antennal segment less than half as long as third *Dicyrtoma*
- Forth antennal segment more than half as long as third 2
- 2(1). With 2 or more clavate tenent hairs 3
- Without clavate tenent hairs 4
- 3(2). Tenent hairs 2 to 3, parallel to long axis of tibiotarsus, very strongly clavate (Fig 48A) *Bourletiella**

PLATE-I

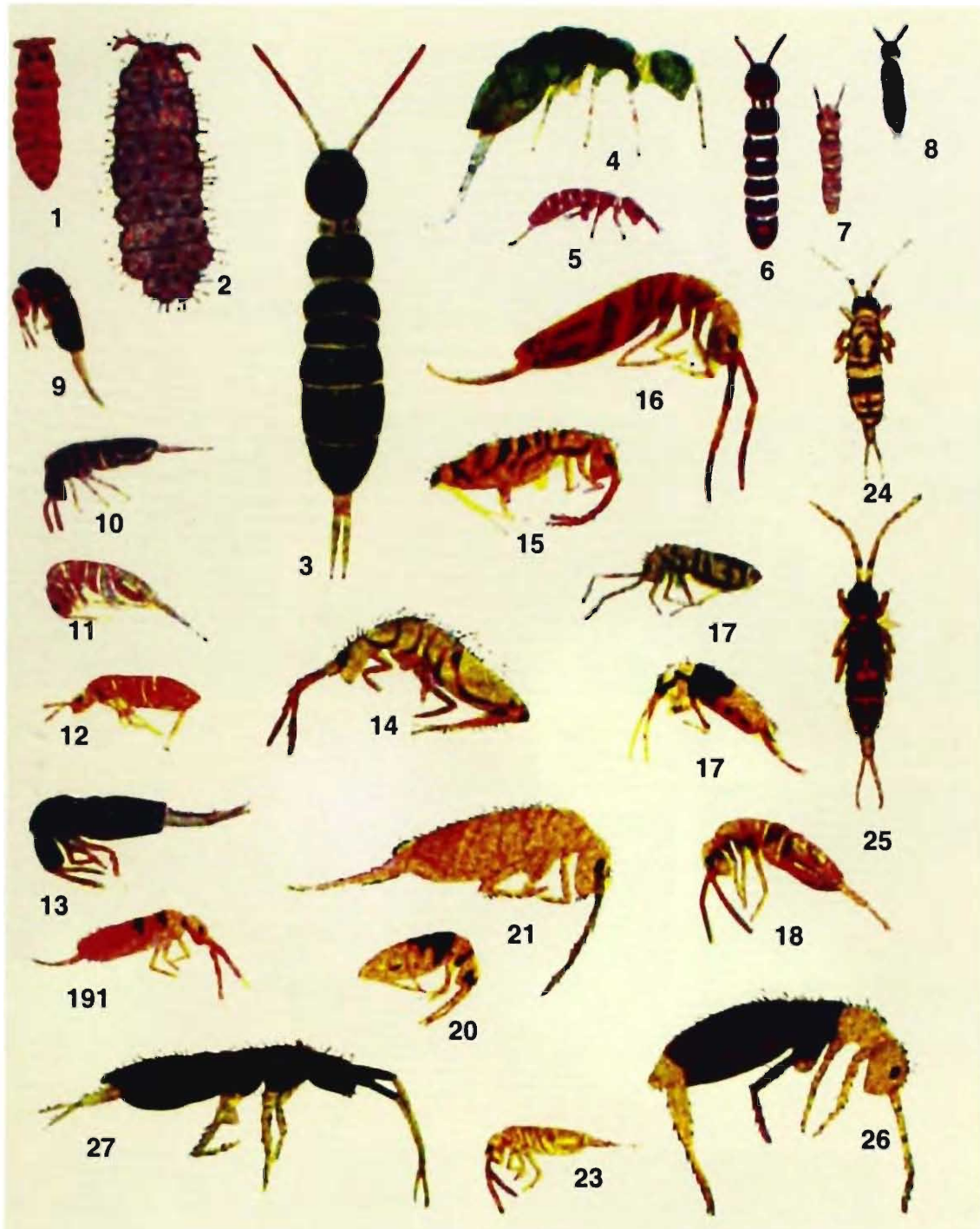


Plate 1. Arthroplenoid Collembolan genera : 1. *Hypogastrura*, 2. *Neanura*, 3. *Isotomurus*, 4 & 5. *Isotoma*, 6. *Anurophorus*, 7. *Metisotoma*, 8. *Isotoma*, 9-13. *Lepidocyrtus*, 14. *Willowsia*, 15-23. *Entomobrya*, 24-26. *Orchesella* and 27. *Tomocerus* (Modified after Maynard, 1951)

PLATE-II

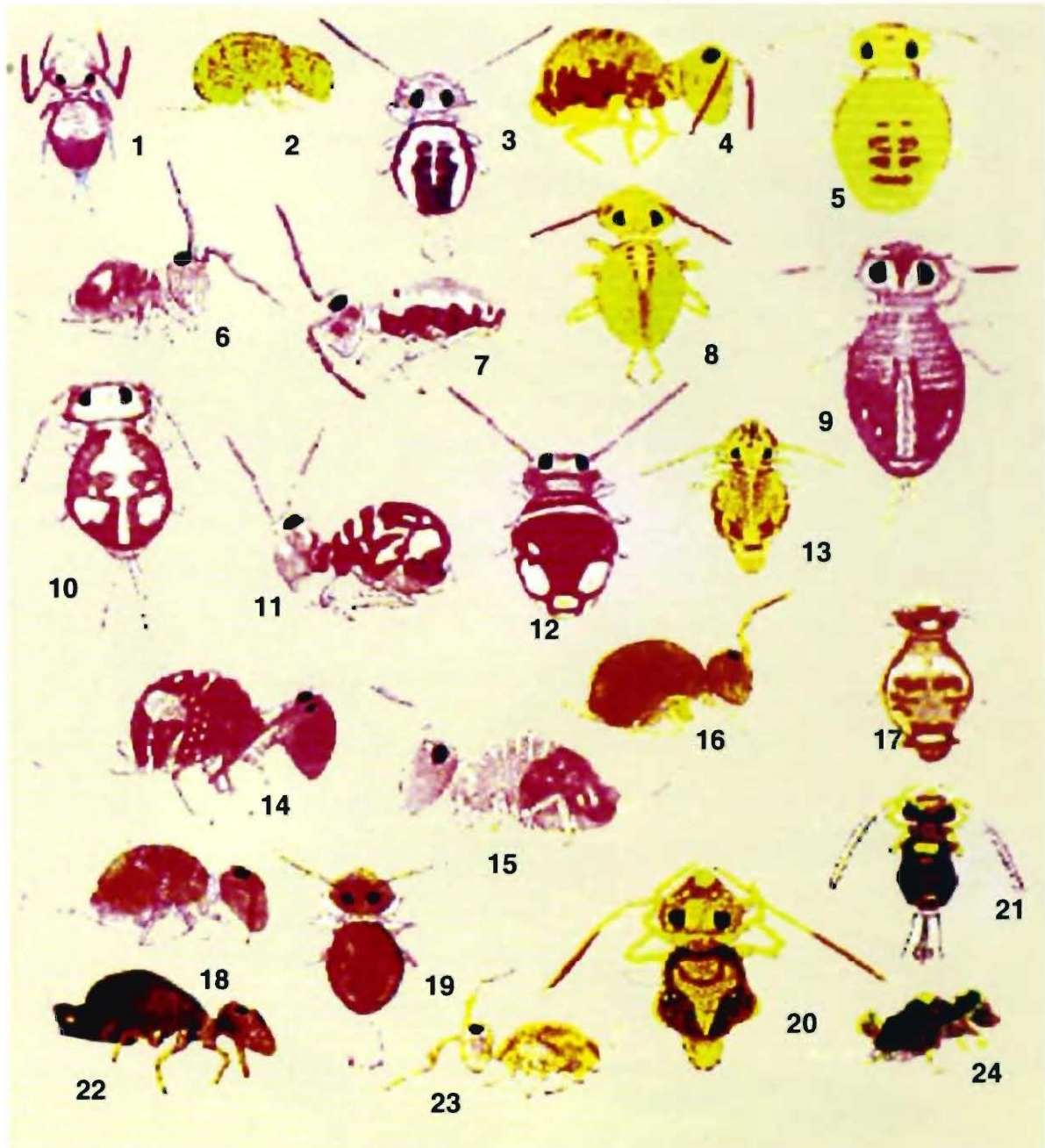


Plate 2. Symphylenoid Collembolan genera : 1. *Dicyrtoma*, 2. *Neelus*, 3-12, 14, 15, 16, 18, 19, 23. *Sminthurides*, 13, 20, 21, 24. *Bourletiella*, 22. *Sminthurinus*, 17. *Katiannina* (Modified after Maynard, 1951)

PLATE-III

SOME MAJOR COLLEMBOLA SPECIES

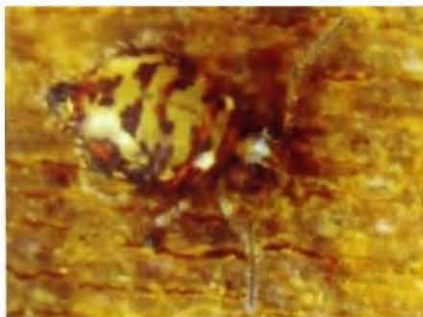
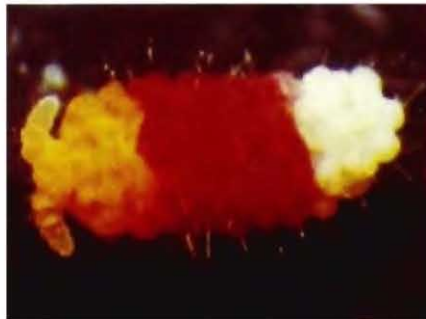


PLATE-IV

SOME MAJOR COLLEMBOLA SPECIES



Tenant hairs often more than 3, outstanding and not strongly clavate (Fig 48B) ..
 *Sminthurinus*



Fig. 46

- 4(2). Eyes 2 + 2 or fewer *Arrhopaliestes*
 Eyes 4 + 4 or more 5
- 5(4). Fourth antennal segment with 8 or more subsegments *Sphyrotheca*
 Fourth antennal segment with at most 6 subsegments. *Sminthurides*

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* So far not recorded from India

**Original not seen