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MANGROVE ECOSYSTEMS

A MANUAL FOR THE ASSESSMENT OF BIODIVERSITY

A follow up of the
National Agricultural Technology Project
(NATP.), ICAR.

Mangrove Ecosystem Biodiversity :
Its Influence on the Natural Recruitment of
Selected Commercially Important Finfish and Shellfish
Species in Fisheries

Edited by :
Dr. George J. Parayannilam

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(Indian Council of Agricultural Research)
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Published by :

Prof. Dr. Mohan Joseph Modayil
Director
Central Marine Fisheries Research Institute, Cochin - 18, Kerala, India
Telephone : + 91-484-2394798
Fax : + 91-484-2394909
E-mail : mdcmfri@md2.vsnl.net.in
Website : http://www.cmfri.com

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Edited by :
Dr. George J. Parayannilam

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Mr. P. K. Jayasurya
Dr. Ansy Mathew

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Benthos - Polychaetes

G. P. Kumaraswamy Achary, Gurudas Chakravarty, S. K. Chakraborty, P. K. Jaya Surya and K. Sarala Devi

Introduction

Polychaetes are one of the major benthic group of animals just like molluscs and crustaceans. Globally 12,620 species of Polychaetes are supposed to be occurring and in India around, 1,093 species representing 8.66% of the total number of polychaete species are known. Polychaetes are very important in the marine and brackish water ecosystems extending from the abyssal depths to the inter-tidal regions. Its major role is through the biomass formation in the benthic as well as in the pelagic aquatic systems as sedentary and pelagic polychaetes and through the different larval forms released by them. It also forms the major food for crustaceans, molluscs as well as for fishes. Because of the special adaptive nature of this group, Polychaetes are distributed in almost all ecological conditions, both in the macro and micro environments having different ranges of salinities and dissolved oxygen. Certain species survive in the anaerobic conditions also.

In the open sea as well as in the brackish water environments of the mangroves also species are widely distributed and almost all families of the benthic polychaetes occur in the mangroves depending upon the substratum, salinity, dissolved oxygen and the tidal influence.

Polychaetes of the mangrove eco-systems.

Polychaete species belonging to the families of Aphroditidae, Amphinomidae, Hesionidae, Phyllodocidae, Syllidae, Nereidae, Eunicidae, Onuphidae, Glyceridae, Spionidae Cirratulidae, Capitellidae, Sabellariidae, Amphectenidae, Terebellidae, Chaetopteridae, Sabellidae and Serpulidae are commonly occurring in the mangrove ecosystems. Among these, members of the families of Nereidae, Onuphidae, Eunicidae, Sabellariidae, Spionidae and Serpulidae aggregate colonies and develop parallel community systems in different localities. The species composition is repeated from one mangrove to another irrespective of the distance and depending upon the uniformity and parallelism of the environment.

Earlier studies on polychaete taxonomy

The study of polychaetes in India dates back to the early 1920 (Southern 1921, Gravely 1927). A comprehensive account on this group is given by Fauvel (1953) in which he has described 34 families and 450 species and is a classical reference on this subject even though he had described 300 species of polychaetes of the Indian Museum – Culcutta (Fauvel, 1932). Day's work on the South Afrcian polychaetes (1967) have given a detailed key for the identification of majority of families and species even though some of the later workers have increased the number of families and genera through revisions. In India Ganapathy & Radhakrishan (1958), Thampi & Rangrajan (1964) Cherian (1966), Achari (1969 & 1972) are some of the later authors dealt with this subject. Recently Hartman (1974) has presented a Bibliography of the polychaetes from India giving 59 families, 315 genera and 860 species as per the later revisions of this group.

The list of polychaete families presented by Hartman and the pictorial key for the identification given by Day are presented here for new researchers for identification up to the family level.

List of Polychaete families reported from Indian region

Errantia	**Sedentaria**
Aphroditidae	Orbinidae
Polynoidae	Paraonidae
Polyodontidae	Spionidae
Peisidicidae	Magelonidae
Sigalionidae	Disomidae
Pisionidae	Poecilochaetidae

Chrysopetalidae
Amphinomidae
Euphrosinidae
Spintheridae
Phyllodocidae
Alciopidae
Lapadorrhynchidae
Lacydonidae
Tomopteridae
Hesionidae
Pilargidae
Syllidae
Nereidae
Nephthydae
Sphaerodoridae
Glyceridae
Goniadidae
Onuphidae
Eunicidae
Lumbrineridae
Arabellidae
Lysaretidae
Dorvilleidae
Heterospionidae
Chaetopteridae
Cirratulidae
Acrocirridae
Cossuridae
Flabelligeridae
Scalibregmidae
Sternaspidae
Capitellidae
Arenicolidae
Maldanidae
Oweniidae
Sabellariidae
Pectinariidae
Ambaretidae
Terebellidae
Trichobranchidae
Sabellidae
Serpulidae
Spirorbidae
Archiannelida

Biologically polychaetes are highly adapted compared with other groups. Because of the peculiar reproductive adaptability of polychaetes they are widely distributed and majority of them are cosmpolitain in distribution. Though sexes are separate and fertilization is external, some hermaphrodites, show protandric hermaphroditism also. The protracted larval phase of some of the species also help them for their wide distribution. The polychaete faunal diversity of the Indian region is very much comparable with the South African and North Australian region since there are close similarities of the faunal structure of these regions. In mangroves also such similarities can be observed as parallel community patterns.

Polychaetes

Several studies on polychaetes have been conducted in India by different workers like Willey (1908), Southern (1921), Fauvel (1932 & 1953) Misra et al (1984), Misra (1995) etc. Fauvel (1953) recorded 283 species of marine and estuarine polychaetes from different parts of India, of which only 47 species were esturine. Misra (1998) reported the occurance of 167 species of polychaetes belonging to 38 families from different brackish water bodies in India.

Class Polychaeta

(Main Diagnostic characters):

i. Annulated worms with numerous chitinous bristles on parapodia and lateral processes of the segment's body-wall.

ii. Various appendages like antennae, palps, cirri and gills are present.

iii. Exclusively marine animals, very exceptionally they are encountered in fresh water.

iv. Sexes separate

Special Morphological Charaters (General Scientific Terms)

Prostomium, Metastomium and Pygidium:

The elongated body divided into numerous segments, consist of the anterior cephalic lobe or *Prostomium; a Metastomium* including all the following segments and a *Pygidium*, the last segment.

Styles and statodes:

These are epidermic solid projection (appendages) of polychaetes.

Phore:

When the antennae, palps and cirri are borne on a hollow base, is termed as *phore*. Such an antenna is then divided into a solid distal part or *ceratostyle* and a basilar hollow part or *ceratophore;* a palp is divided into a *palpostyle* and a *palpophore*, a cirrus into a *cirrostyle* and a *cirrophore.*

Parapodia:

Parapodia or feet are complicated lateral processes, provide the most important features for the identification of the species. Typically, each segment carries one pair of parapodia divided into two *rami*; a dorsal one, called *notopodium* and a ventral one, called *neuropodium.*

When both rami are borne on a common base the biramous foot is said to be *monostichous*; when both rami are quite distinct and more or less apart, it is termed as *distichous.* In biramous parapodium of *Nereis* there are:1) two setigerous lobes (or chaetigerous suckers) carrying the setae and supported by a stout, enclosed, bodkin-like bristle or *aciculum*. 2) parapodial lobes, lips or fillets 3) a dorsal and ventral *cirrus*.

Biramous parapodia: When both rami are nearly equally developed.

Sub- biramous parapodia- with a dorsal cirrus but the dorsal setal sack and setae more or less reduced.

Sesquiramous parapodia – when the dorsal lobe is reduced to a few bristles or acicula.

Uniramous parapodia – when the dorsal ramus is practically wanting, being reduced to the dorsal cirrus.

Tori and uncini –in the Sedentaria, the neuropodia or ventral rami, are often reduced to mere transverse ridges, called *uncinigerous* tori, with out a cirrus and carrying short hooks, known as *uncini.*

Pleae – when the setae are short, stout, bodkin shaped or flattened, paddle or oar-shaped, they are called paleae.

Homogomph and Heterogomph – when both side of the articulation of the setae are the same length, it is termed as homogomph and when they are unequal, termed heterogomph.

Sub–class-Errantia (Diagnostic characters).

i. Long vermiform body with numerous uniform segments, except the first near to the mouth.

ii. Cephalic appendages like-antennae, palps and tentacular cirri are present; feet uniramous or biramous, with both rami hardly different; acicula present; gills are present frequently above the feet.

Sub-class-Sedentaria (Diagnostic characters).

i. Body divided into distinct regions.

ii. Head small, hardly distinct or greatly modified.

iii. Parapodia generally simple, the ventral rami are often with tori, pinnules, hooks or uncini; gills usually limited to a part of the body.

iv. Usually tubiform

Key to the families of polychaetes under

Sub-class-Errantia.

1. Pharyngeal armature complex ……. **Eunicidae.**

   Pharyngeal armature simple or absent …… 2

2. Tentacles not more than three…..3

   Tentacles more than three….4

3. Dorsal cirri short or of moderate length, not moniliform; pharynx armed with a single pair of strong toothed jaws; tentacles two; parapodia almost biramous…….**Nereidae.**

   Dorsal cirri long and more or less distinctly moniliform; pharynx cylindrical, armed with a small pair of jaws, usually only with stylets or unarmed; Tentacles two or three; Parapodia sesquiramous or biramous ……. **Hesionidae.**

4. Palps small; prostomium conical, slender, annulate, terminated by four small tentacles arranged in the form of a cross; pharynx large, covered with papillae armed with at least four teeth; parapodia biramous…….. **Glyceridae.**

Palps absent; prostomium more or less normal; parapodia with foliaceous cirri; without sickle shaped, gill generally uniramous; general appearance including the single pair of eyes normal; tentacles four or five …….. **Phyllodocidae**.

Polychaeta – Sedentaria.

1. Body clearly divided into regions……..4

   Body not clearly divided into regions…….2

2. Palps present, elongated, tentacle-like, two in number, not retractile into the mouth, without suckers; parapodial lamellae erect, dorsal branchiae cirriform; hooded hooked setae …….**Spionidae.**

   Without tentacle-like palp …… 3

3. Prostomium blunt, without appendages or with a crown of lacinated lobes; without branchiae; ventral tori with many rows of very small uncini; Sandy tube……**Owenidae.**

   Prostomium with a keel, or a rimmed cephalic plate; An anal plate or an anal funnel with cirri; without branchiae; ventral tori with elongated sigmoid hooks……..**Maldanidae.**

4. Terminal branchial tuft absent; without opercular setae; prostomium conical, without process; branchiae on many segments; with uncinigerous tori; anterior region abranchiate; posterior region with branchiae simple rudimentary or wanting. In the abdominal region dorsal and ventral tori with sigmoid hooded hooks …….**Capitellidae.**

   Genus – *Talehsapia* Fauvel, 1932

The characters of the genus are those of the only one species

1. *Talehsapia annandalei* Fauvel, 1932

   Body filiform, cylindrical; teguments smooth and

shining; first five segments slightly swollen; the prostomium is a blunt cone; proboscis soft, cylindrical, transparent, without any papillae; pharynx extending to the middle of the 5th setigerous segment; the setae are all simple, straight or slightly curved; two short anal cirri.

Genus – *Eteone* Savingny, 1818

Body linear, with numerous segments; prostomium triangular, with four small tentacles; generally two small eyes; two pairs of tentacular cirri; dorsal cirrus absent on the second setigerous segment; proboscis smooth, or with soft papillae and small chitinous tubercles; dorsal and ventral cirri foliaceous; setae compound.

2. *Eteone barantollae* Fauvel, 1932.

Body filiform, sub-cylindrical, with segments; prostomium broader than long and notched on each side; two very small black eyes; four small, short, knob-like tentacles; proboscis smooth and transparent at the base, and with five longitudinal rows of large, soft, depressed, rounded or squarish papillae anteriorly; two pairs of tentacular cirri subulate, somewhat lanceolate and flattened; ventral cirri conical or oval, setae are short.

3. *Eteone* (mysta) *ornata* Grube, 1877.

Body elongated, with three striking longitudinal rows of violet pigmented spots upon a pale-yellowish colour; towards the middle part of the body the pigmented spots become gradually smaller and blend into a single streak, while in the posterior region of the body they entirely disapper; dorsal cirri comparatively small and borne on a distinct stalk; prostomium; two eyes, small and dot-like.

Genus – *Neanthes* Kinberg, 1866

Vermiform body with numerous segments; two tentacles; two ovoid palps; four eyes; four pairs of tentacular cirri; proboscis with two horny, curved jaws and conical horny paragnaths; parapodia usually biramous with an exception for the first two setigerous segments, which are uniramous; dorsal and ventral cirri present; spinigerous and falcigerous compound setae.

4. Neanthes chingrighattensis (Fauvel, 1932)

About 5-10 cm in length; prostomium without any frontal groove; pharynx eversible with paragnaths on both rings; biramous parapodia with 3 notopodial ligules; neuropodium with 3 lobes; spinigers setae; chitinous paragnaths are present in oral ring but absent in basal ring; posterior feet elongated and lamellate with dorsal cirri.

Genus – *Perinereis* Kinberg, 1866

Parapodia biramous; horny paragnaths on both rings of the proboscis; paragnaths, transverse, ridge-shaped, or a transverse row of more or less flattened denticles.

5. *Perinereis cultrifera* Grube, 1878

Prostomium sub-pyriform with dark longitudinal bands of pigments between anterior pair of eyes; pharynx eversible with paragnaths on both rings; parapodia biramous; notopodia with 2 blunt finger like subequal ligules and a small anterior acicular lobe; neuropodia with a bluntly conical setigerous lobe and a blunt inferior ligule.

6. P. nigropunctata Horst, 1889

Pharynx eversible with paragnaths on both rings; notopodia with 2 ligules and a small anterior acicular lobe, superior notopodial ligules enlarged bearing dorsal cirri on upper distal margin; neuropodia with a bluntly conical setigerous process and a blunt club shaped inferior ligule.

Genus – *Dendronereides* Southern, 1921

Pharynx eversible with soft papillae on both rings; tentacular cirri 4 pairs; parapodia biramous; branchiae present as subdivisions of notopodial superior lobes; neuropodia inferior; ligule absent.

7. *Dendronereides gangetica* Misra, 1995

Prostomium deeply indented with 2 short tapered antennae; tentacular cirri 4 pairs; pharynx eversible with soft papillae on both rings; biramous parapodia with 3 conical notopodial ligules and a short anterior acicular lobe; neuropodium with bluntly bifid presetal lobe and short rounded postsetal lobe; branchial filaments arranged in whorl.

8. *D. heteropoda* Southern, 1921

Prostomium broad, slightly indented in front, with 2 small antennae; tentacular cirri 4 pairs, longest pair reaching setiger 4-6; pharynx eversible with soft papillae on both rings; biramous parapodia with 2-3 notopodial ligules; neuropodium with 2 anterior and a posterior digitiform lobes; branchiae arising below dorsal cirrus, in the form of branched bunches of filaments, starting from setiger 7-8 and extending up to setiger 20-22.

Genus- *Dendronereis* Peters, 1854.

Proboscis with only soft papillae; prostomium deeply indented in front; dorsal cirrus of a number of anterior segments bearing numerous branchial filaments; setae all homogomph spinigerous.

9. Dendronereis aesturaina Southern, 1921

Anterior 10-12 segments light green with brown pigments, while posterior segments are light coloured; prostomium; deeply cleft anterodorsally; pharynx eversible with a pair of jaws; maxillary ring smooth and oral ring with soft papillae; parapodia biramous from third setiger with 3 notopodial ligules, 10-12 neuropodial lobes and inferior ligule; number of ligules and lobes gradually decreasing posteriorly; branchiae as bipinnate divisions of dorsal cirri commencing from setiger 15 and extending up to 21-22; setae all homogomph spinigerous with slender, minutely serrated blades.

Genus – *Namalycastis* Hartman, 1959.

Notopodia without branchiae; parapodia sub-biramous throughout, without ligules.

10. Namalycastis indica (Southern, 1921.)

Prostomium wider than long, with a short anteromedian groove; antennae short and slender; tentacular cirri long and slender; parapodia sub-biramous; notosetae 1 or 2 per setiger; dorsal cirri gradually increasing in size, broad and flattened in middle and posterior setigers.

11. Namalycastis fauveli Rao, 1981

Prostomium wider than long, without anteromedian groove; antennae very small and indistinct; tentacular cirri short. parapodia sub-biramous, with reduced notopodia; neuropodial falcigers usually heterogomph.

Genus – *Glycera* Savigny, 1818.

Body rounded, tapering at both extremities; segments two or three-ringed. prostomium acutely conical, ringed, with four small terminal tentacles; proboscis club-like, with four hooked horny jaws; parapodia biramous, with a stumpy dorsal cirrus; branchiae present or absent, simple or branched, permanent or retractile into the foot; ventral setae compound, spinigerous; dorsal setae simple.

12. Glycera tesselata Grube, 1863.

Branchiae absent. parapodia with two anterior equal elongated lobes and two posterior lobes much shorter, rounded and equal to each other; papillae of the proboscis long and slender; support of the jaws with two long dagger-like processes.

13. *Glycera alba* Rathke, 1843.

Branchiae simple; parapodia with two anterior, subequal, triangular or cirriform lobes and two posterior lobes; papillae of the proboscis obliquely truncated with a transparent nail-like appendage; supports of the jaws triangular, with a single process.

Genus – *Diopatra* Audouin and Milne-Edwards.

Head rounded; two pad-like palps; two small oval frontal tentacles; five long occipital tentacles; an achaetous segment bearing two small tentacular cirri; dorsal cirri subulate while ventral cirri subulate in a few anterior parapodia; pseudo-compound bristles in the anterior parapodia, succeeded by simple setae, comb-setae and acicular setae; gills large; lower jaw with two pieces; upper jaw with a pair of mandibles, three pairs of toothed plated and an unpaired one; tube membranous, sticking in the sand or mud.

14. Diopatra cuprea cuprea Bose 1802.

Prostomium with a pair of oval cushion-like palps, and 5 occipital antennae; tentacular cirri slender; anterior parapodia well developed, supported by 2-3 acicula, each with a long, conical postsetal lobe and a short, rounded presetal lobe; first 4 or 5 setigers with presetal lobes having larger superior and smaller inferior processes.

Genus – *Lumbriconereis* Blaninville, 1828

Body long and cylindrical; prostomium conical or globular, devoid of palps and tentacles; eye absent; dorsal cirri absent or reduced to a small knob; ventral cirri absent; gills absent; parapodia with two unequal ligules; simple winged setae and simple or compound hooks; lower jaw (labrum); upper jaw with a pair of mandibles and three pairs of toothed plates.

15. *Lumbriconereis heteropoda* Marenzeller, 1879.

Prostomium conical; parapodia increase in length posteriorly, with posterior cirriform ligule long and often erect; only simple capillary setae in the anterior feet followed by winged capillaries and unjointed hooks with small denticles above the main fang.

16. *L. Polydesma* Southern, 1921

Very slender elongated body; prostomium rounded; feet uniform in the middle and posterior parts, with an anterior short rounded lobe and a

posterior longer, conical or cirriform one; only capillary winged setae in the 28 anterior parapodia, which do not disappear in the middle and posterior parapodia; the hooks, from the 29th parapodium are all unjointed, with 6-10 small denticles above the main fang; acicula colourless.

Genus – *Polydora* Bose

Prostomium blunt or notched in front, ending posteriorly in a crest, gills begin beyond the 6th, 9th parapodium, rarely on the 2nd , fifth setigerous segment highly modified, with peculiar stout dorsal bristles; simple or lobed anal cup.

17. *Polydora normalis* Day 1963

Prostomium deeply notched anteriorly; eyes absent; branchia commencing from setiger 7-9 as slender filaments, continuing nearly to the posterior end; parapodia of first setiger each with reduced notopodium in the form of a papilla and a well developed neuropodial lamella; parapodia of succeeding setigers each with notopodium protecting as a broad acicular lobe; neuropodium having superior and inferior presetal lamellae and a median rounded postsetal lobe.

Genus – *Mastobranchus* Eisig.

Thorax of eleven setigerous segments with only dorsal and ventral capillary setae; abdomen with capillary setae and hooks on the dorsal ramus and hooks only on the ventral ramus; thoracic feet claviform; anterior abdominal segments long, cylindrical, the posterior ones strobileform or campanulate. parapodial gills simple, next compound and retractile.

18. *Mastobranchus indicus* Southern, 1921

Prostomium small, rounded; no eyes; skin of the anterior region tessellated; 4 pairs of genital pores behind the segments 8-11; tori in segments 2-4 very short, loger on the subsequent segments; the right ventral bundles of the 11th parapodium contain two very elongate hooks; the dorsal bundles on 13th and 14th segments contain only capillary setae, the ventral bundles contain hooks that are much larger and shorter than those of the right 11th foot; In the dorsal bundle of the 15th segment there are only hooks.

Genus – *Capitella* Blainville.

Thorax with 9 segments; anterior setigerous segment absent; either first 4 segment with capillary setae only, then next 3 segments with mixed hook and capillary setae in both rami and then genital spines in segments 8-9; branchiae absent.

19. *Capitella capitata* Fabricius, 1780

Body very small, generally varies from 30 to 40 mm in length; prostomium conical with a pair of ventral eyes; thorax of 9 segments, with capillaries in both rami from segments 1-6; segment 7 variable, with capillaries only or hooks only or both; in females, segments 8-9 with hooks in both rami, bust in males, genital hooks replace notosetae; abdominal segments with long-shafted hooks in both rami.

Genus – *Parheteromastus* Manro.

Thorax with 12 segments; capillary setae only in first 4 thoracic setigers; hooks only in succeeding setigers; branchiae absent.

20. Parheteromastus tenuis Manro, 1937.

Worms thread like; prostomium bluntly conical; thorax with 12 segments, first segment achaetous; setigers 1-4 with short capillaries in both rami; setigers 5-11 with long-handled hooked hooks in both rami; abdominal hooded hooks with shorter shafts than in thorax; branchiae absent; pygidium with a short, median anal cirrus.

Genus – *Maldane* Grube.

Characters of the genus are same to those of the species mentioned bellow.

21. *Maldane sarsi* Malmgren, 1867.

Cephalic keel convex, arched; rim divided into three parts by two deep lateral notches. nuchal grooves short, anal plate oval, slanting, with the rim notched on each side; anus dorsal; ante-anal segments achaetous. anterior segments without collar. ventral setae absent on the first segment. dorsal setae of three kinds; uncini from the second setigerous segment; glandular belts; Tube coated with mud.

Genus – *Axiothella* Verrilli.

The characters of the genus are same to those of the species mentioned bellow.

22. *Axiothella obockensis* Gravier, 1906.

A cephalic rimmed plate; pygidium funnel shaped, fringed with cirri; without collar; denticulated uncini from the first setigerous segment; tube membranous coated with sand.

Genus – *Owenia* Chiaje, 1814.

Prostomium bearing a branchial laciniate

membranous; buccal segment achaetous; the first three setigerous segments long and without uncini; dorsal setae slender, spinous; uncini bidentate; pygidium bilobed; glandular belts and spinning glands present.

23. Owenia fusiformis Chiaje, 1814

Uncini with an elongated manubrium and a curved hook with two parallel teeth; the two ante-anal segments without dorsal setae; tube membranous, open and tapering at both ends, coated with overlapping sand grains and flat bits of shells, imbricated.

ROLE OF BENTHOS OF MANGROVES IN BIOMASS INCREASE, FISH PRODUCTION AND ITS COMMERCIAL IMPORTANCE

It is well known that the floral and faunal biomass production has its direct relation with the fishery resource of any aquatic system. It is not only that the biomass has a direct link with the fishery as an important source of food for fishes; but it has also an indirect contribution in the form of the major source of inorganic nutrients for the production of phytoplankton and zoo- plankton. Just like the benthic faunal impact on the major biomass increase in specific areas, the epiphytic algae also forms a major source of feed for fishes and other animals as well as their larval forms. Some of the recent findings have also shown that the gametes and spores released by major algae form an important food for bivalves, fishes, crustaceans and almost all larval forms of animals just like the nano plankton and other types of phytoplankton in the aquatic environment. Because of this the mangrove ecosystems and its associated benthic and epiphytic fauna and flora serve as a nursery area for the larvae and juveniles of fishes, crustaceans, bivalves etc.

As mentioned earlier, mangroves have their own complexity of floral and faunal groups but there are parallelism in the structural configuration of the mangrove locality. In spite of this, it is possible to make generalizations based on the earlier observations on the benthic faunal and floral distributions in this peculiar environment.

Potential groups contributing the benthic biomass

Among the potential groups, Coelenterates, Annelids (Polychaetes) Molluscs especially the bivalves, gastropods and Crustaceans are the major biomass producers. Similarly the epiphytic algae also contribute to the biomass production. Some of the polychaete species under the families like *Nereidae, Nephthydae, Onuphidae, Eunicidae, Spionidae, Maladanidae, Sabellariidae* etc are the major biomass producers among Annelids and these form an important food for different species of prawns and fishes. Similarly Bivalves like Mussels, Clams, Rock oysters, Edible oysters etc contribute a major share in the benthos of mangrove ecosystems.

Algae like *Ulva, Spp., Chaetomorpha Spp, Hypnea Spp, Enteromorpha Spp, Gracilaria Spp*. etc are some of the dominent biomass producer in this system.

The enormous quantities of larvae released by the animals and the reproductive bodies released by the algae enrich the system as a productive nursery area with sufficient sources of food for the young ones of commercially important Fishes, Crustaceans and Mollucs of export value.

Recycling of Nutrients from the benthic habitat

The burrowing bivalves and gastropod molluscs, polychaetes, coelenterates etc have a ploughing effect on the bottom substratum and it helps in the release of nutrients from the sub soil.

In addition to this the organic decay of these animals also enriches the nutrient potential of the aquatic environment for increased production of phytoplankton and zooplankton and they in turn increases the productions of Ichthyofauna.

Above findings are some of the areas in which further investigations are to be conducted and as a result it can be established that mangrove and its benthos function as a very useful recycling system for increased production of resources of commercial value in the aquatic environment.

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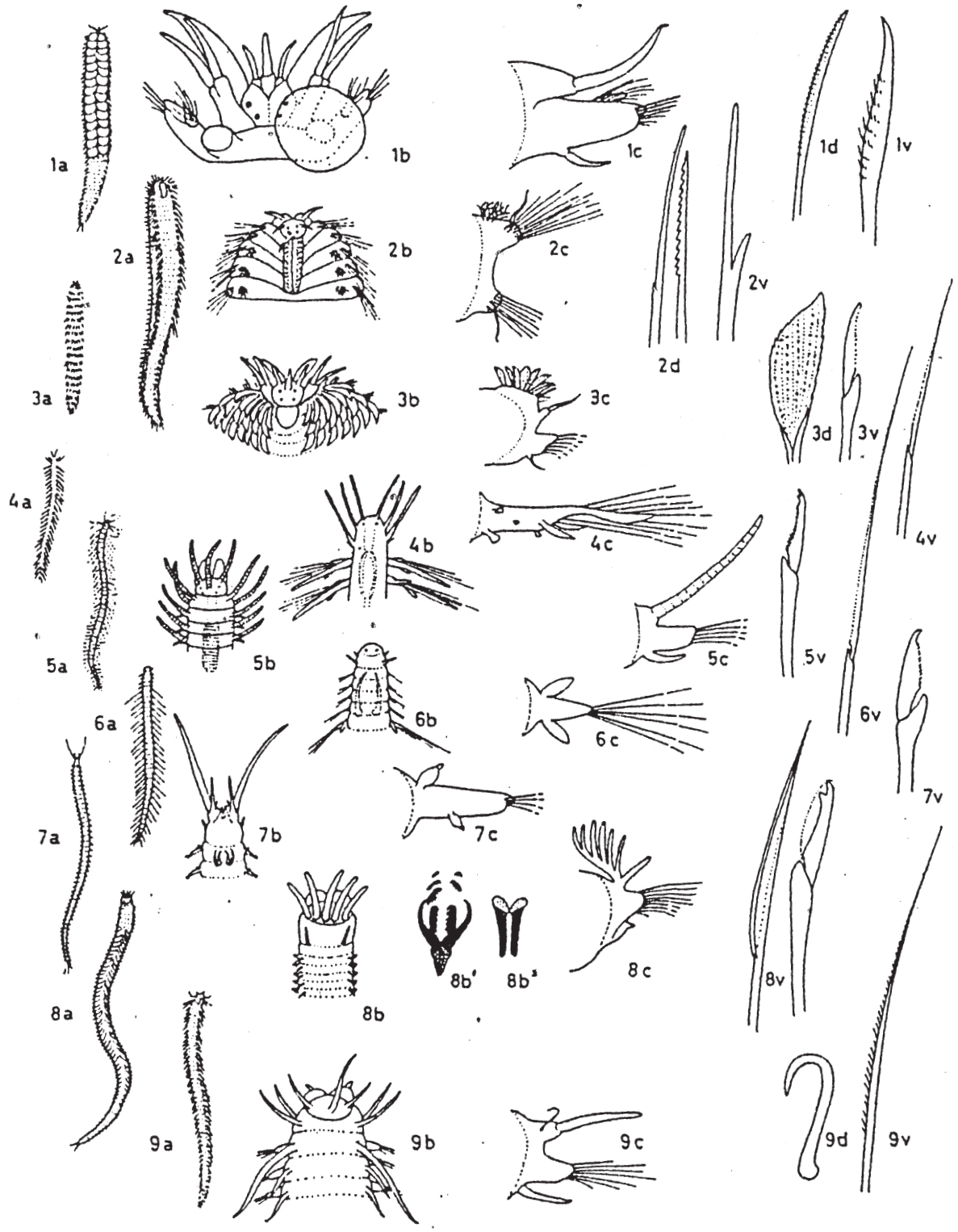


Fig. 1. Illustrations of Family Characters (After Day, 1967) 1a to 9a Entire worm. (1a) Aphroditidae. (2a) Amphinomidae. (3a) Palymridae. (4a) Pontodoridae. (5a) Syllidae. (6a) Iospilidae. (7a) Pisionidae. (8a) Eunicidae. (9a) Pilargidae.

1b to 9b Head of the above mentioned families

1c to 9c Foot of the above mentioned families

1d, 2d, 3d & 9d Notoseta of the above mentioned families

1v, 9v Neuroseta or seta of uniramous parapodium of the above mentioned families

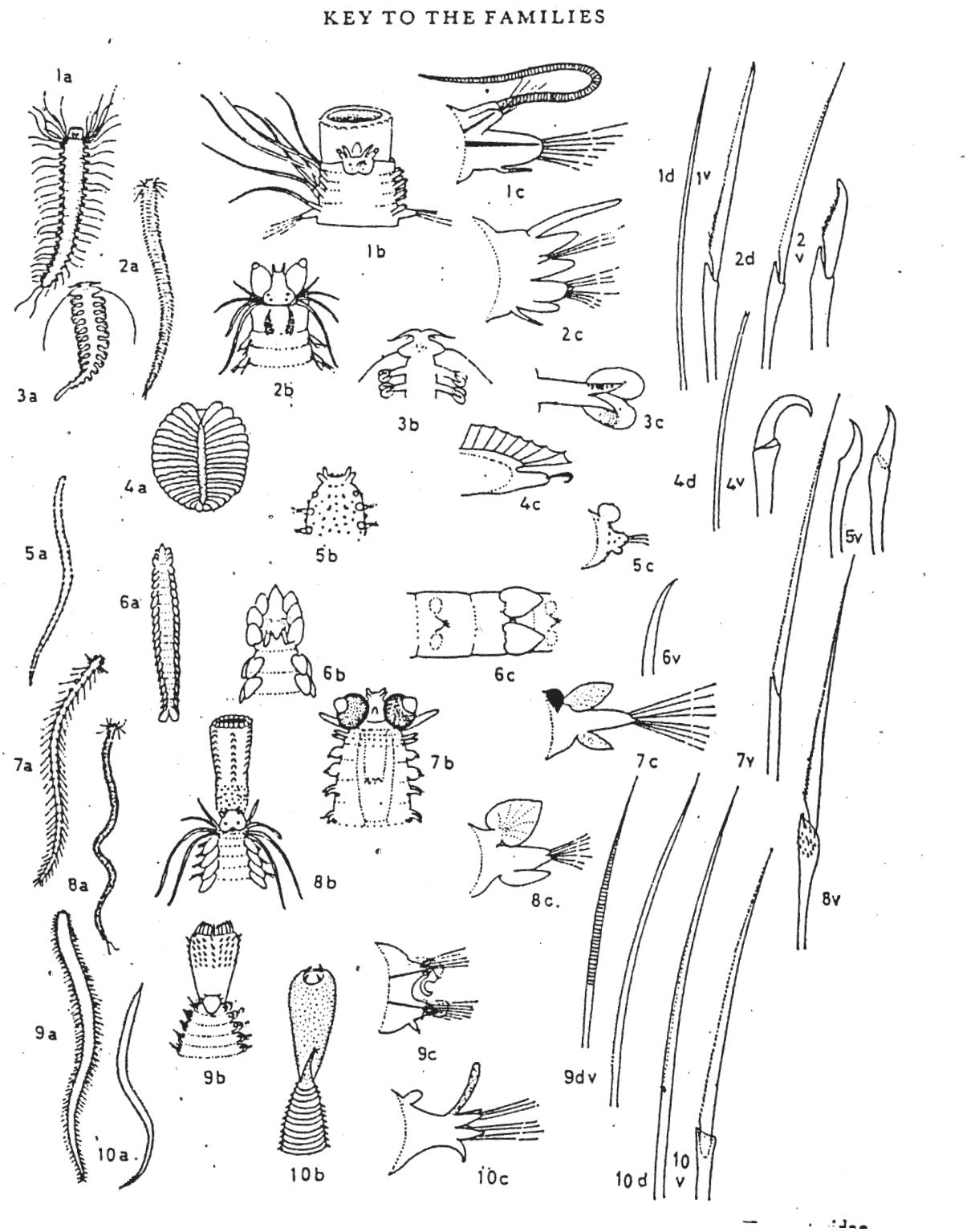


Fig. 2. Illustrations of Family Characters (After Day, 1967) 1a to 10a Entire worm. (1a) Hesionidae. (2a) Nereidae. (3a) Tomopteridae. (4a) Sphintheridae. (5a) Sphaerodoridae. (6a) Typhloscolecidae. (7a) Alciopidae. (8a) Phyllodocidae. (9a) Nephtyidae. (10a) Glyceridae.

1b to 3b & 5b to 10b Head of the above mentioned families

1c to 10c Foot of the above mentioned families

1d, 2d, 4d, 9d & 10d Notoseta of the above mentioned families

1v, 2v & 4v to 10v Neuroseta or seta of uniramous parapodium of the above mentioned families

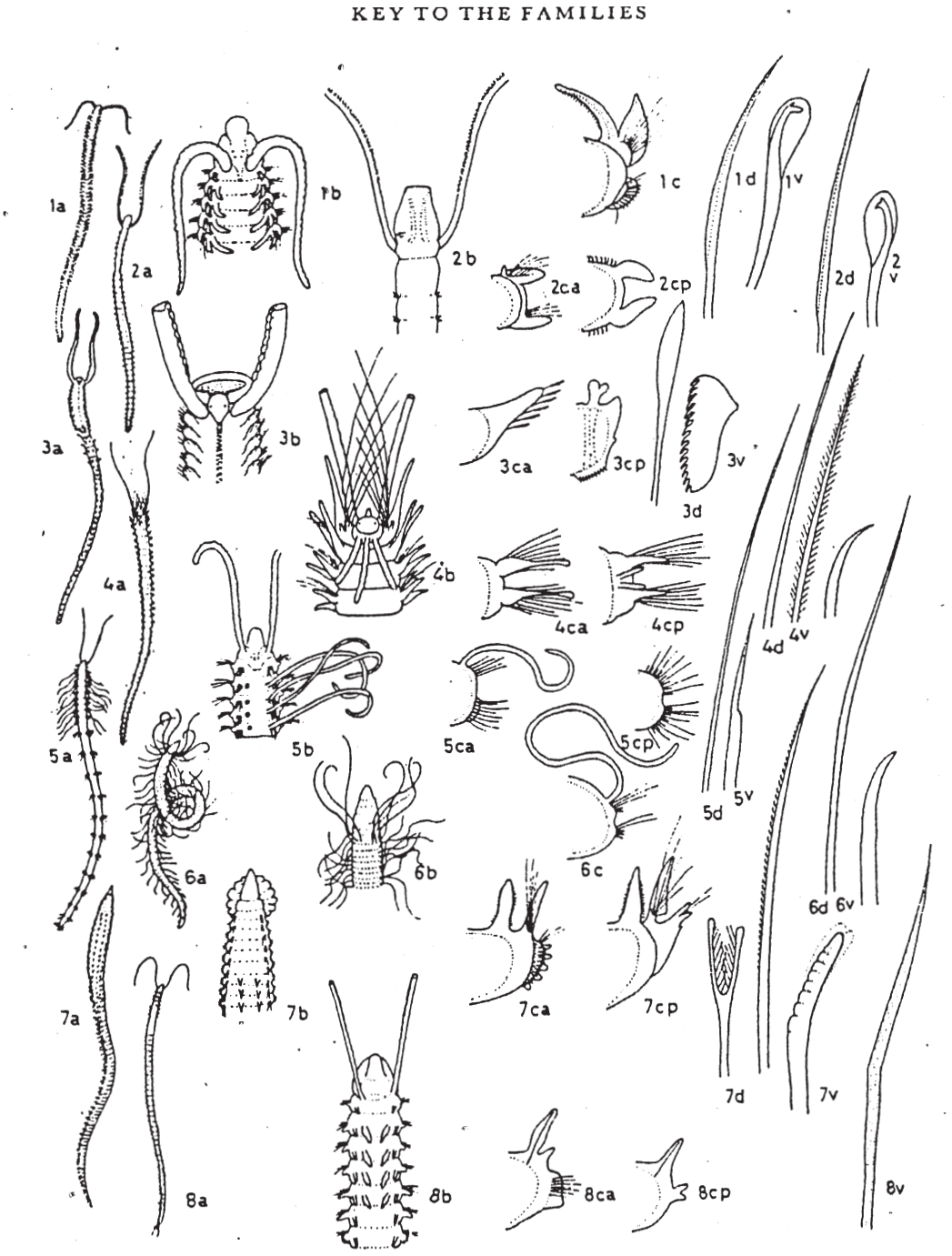


Fig. 3. Illustrations of Family Characters (After Day, 1967) 1a to 8a Entire worm. (1a) Spionidae. (2a) Magelonidae. (3a) Chactopteridae. (4a) Trochochaetidae. (5a) Heterospionidae. (6a) Cirratulidae. (7a) Orbiniidae. (8a) Aspitobranchidae.

1b to 8b Head of the above mentioned families

2ca to 5ca, 7ca & 8ca Anterior Foot of the above mentioned families

2cp to 5cp, 7cp & 8cp Posterior Foot of the above mentioned families

1c & 6c Foot of the above mentioned families

1d, to 7d Notoseta of the above mentioned families

1v to 8v Neuroseta of the above mentioned families

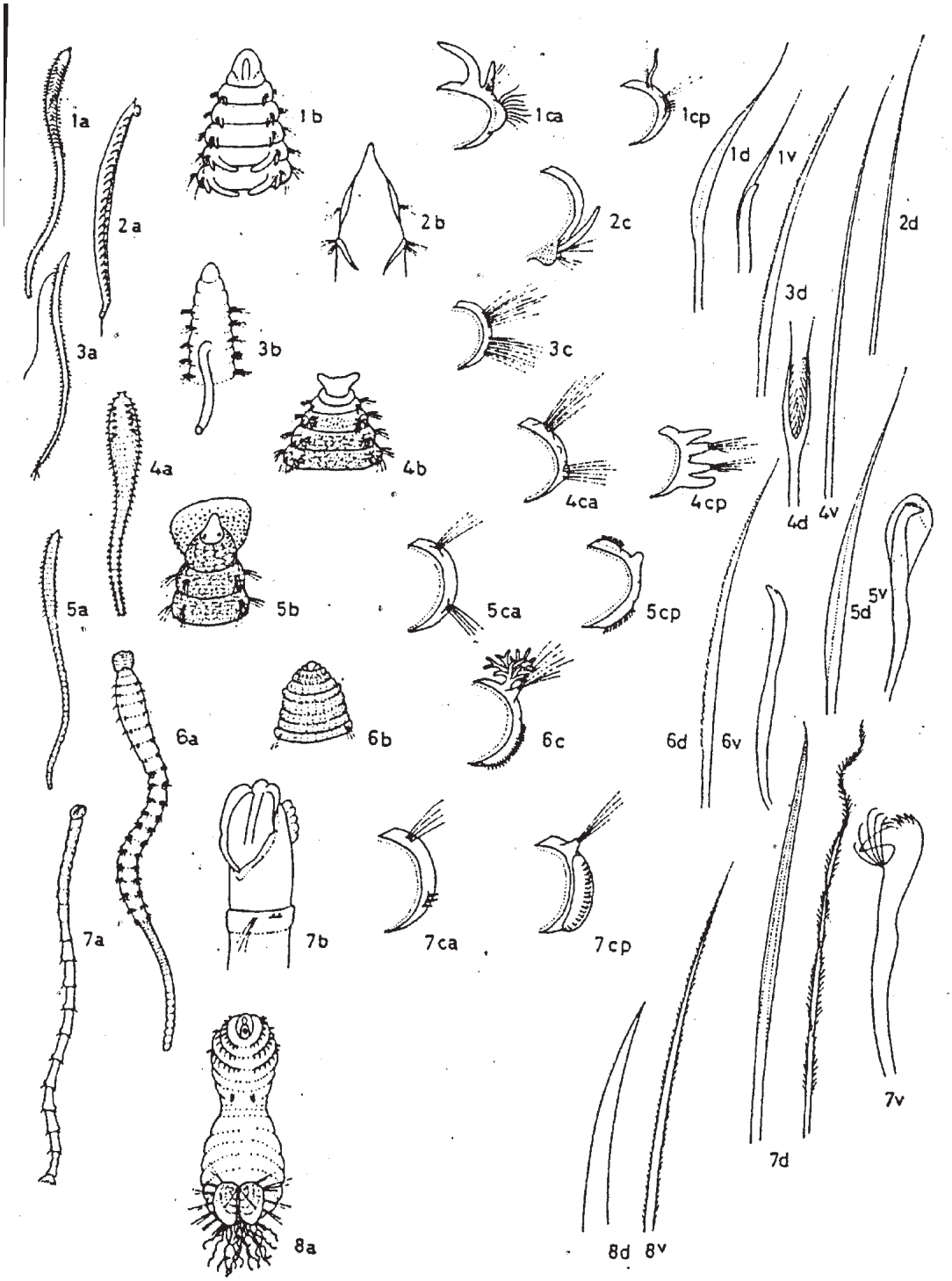


Fig. 4. Illustrations of Family Characters (After Day, 1967) 1a to 8a Entire worm. (1a) Paraonidae. (2a) Opheliidae. (3a) Cossuridae. (4a) Scalibregmidae. (5a) Capitellidae. (6a) Arenicolidae. (7a) Maldanidae. (8a) Sternaspidae.

1b to 7b Head of the above mentioned families

1ca, 4ca, 5ca & 7ca Anterior Foot of the above mentioned families

1cp, 4cp, 5cp, 7cp Posterior Foot of the above mentioned families

2c, 3c & 6c Foot of the above mentioned families

1d, to 8d Notoseta of the above mentioned families

1v & 4V to 8v Neuroseta of the above mentioned families

Fig. 5. Illustrations of Family Characters (After Day, 1967) 1a to 8a Entire worm. (1a) Oweniidae. (2a) Flabelligeridae. (3a) Sabellaridae. (4a) Pectinariidae. (5a) Ampharetidae. (6a) Teribellidae. (7a) Sabellidae. (8a) Serpulidae.

1b to 6b Head of the above mentioned families

1c to 4c Foot of the above mentioned families

5ca to 8ca Anterior Foot of the above mentioned families

5cp, 7cp & 8cp Posterior Foot of the above mentioned families

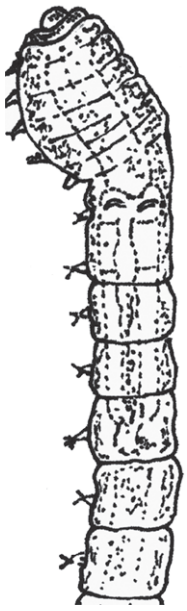
1d, to 8d Notoseta of the above mentioned families

3h Palea from operculum

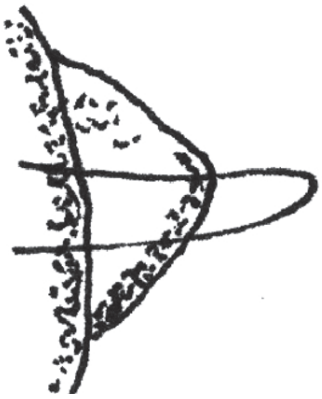
1t, 3t, 4t & 8t Tube

1v to 8v Neuroseta of the above mentioned families

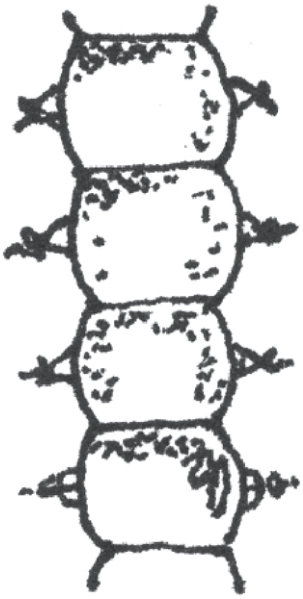
Talehsapia annandalei (After Day, 1967)



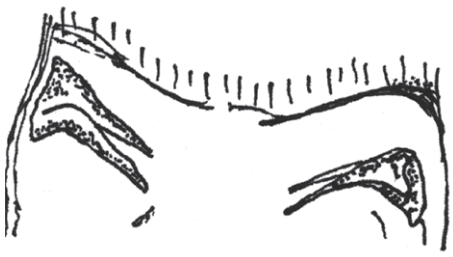
Anterior end compressed
Showing the jaw



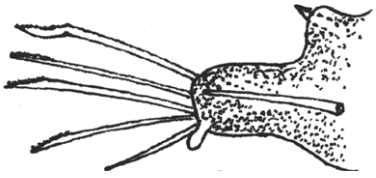
Dorsal ramus and stout
Acicular bristle



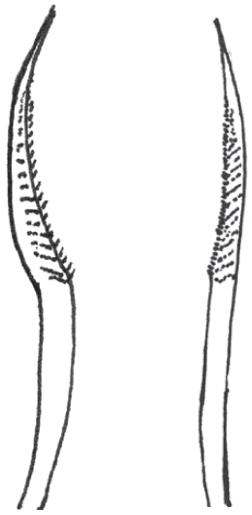
Segments of posterior end



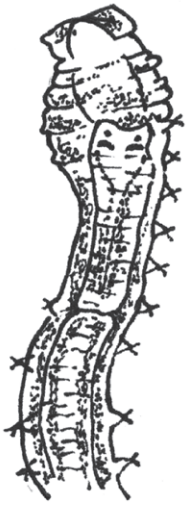
Jaws, dorsal view



Foot



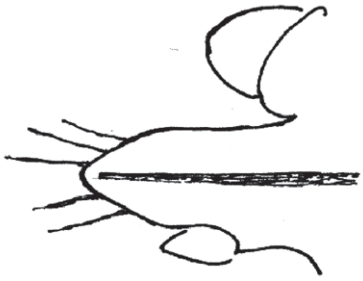
Hidpid setae

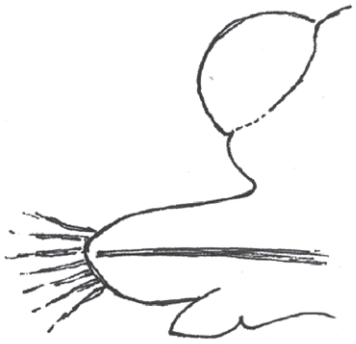


Anterior end

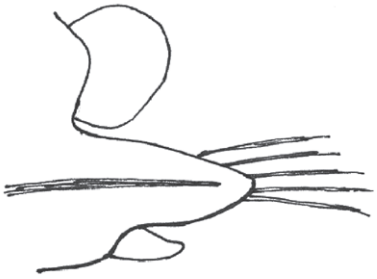
Fig. 6.

Eteone barantollae (After Day, 1967)





Anterior foot front and back view



Foot from mid-body

Posterior dorsal cirrus

Lumbriconereis heteropoda

Hook

Hind foot

Mastobranchus indicus

Tip of a long hook
from the ventral division
of the 11th foot

Tip of the dorsal hook
from the 14th foot

Fig. 7.

Lumbriconereis polydesma (After Day, 1967)

Anterior end

Hook

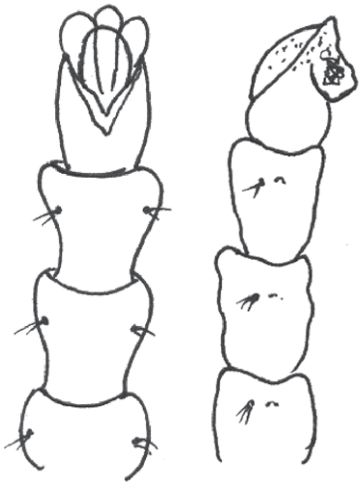
80th foot

10th foot

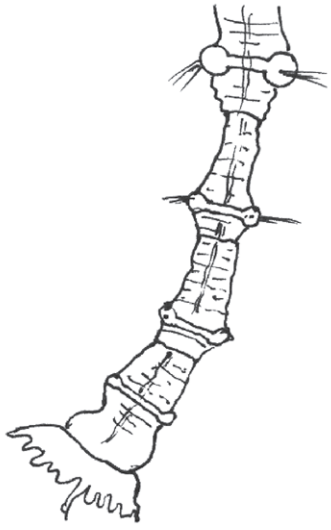
3rd and 4th pairs of jaws

300th foot

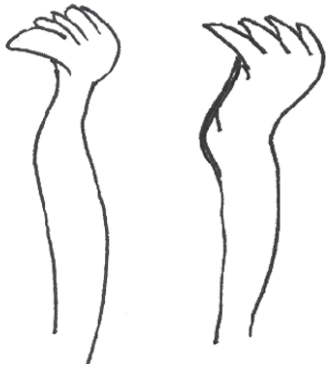
Axiothella obockensis



Anterior region



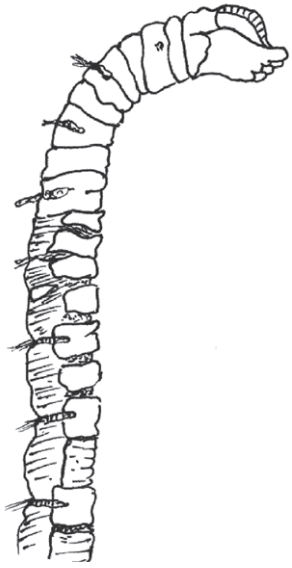
Posterior region



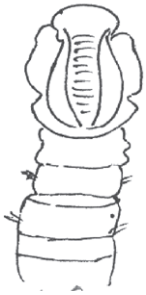
Hooks from the first setigerous segments

Fig. 8.

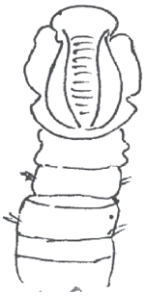
***Maldane sarsi* (After Day, 1967)**

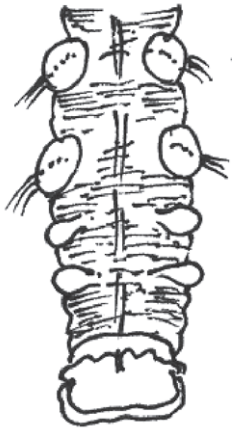


Anterior part



Head





Posterior part (side and ventral)

Part of a spinous

Hook, side and front view

Winged kneed seta

Straight winged seta

Fig. 9.

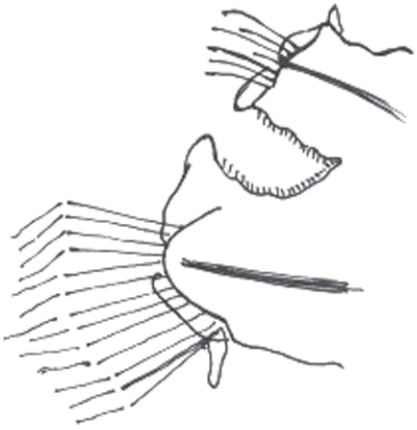
***Eteone ornata* (After Day, 1967)**

Head

Foot from mid body

15th foot

Compound seta



Foot from mid body

Anterior part

Dendronereides aestuarina

Foot

Dendronereides heteropoda

4th foot

8th foot

11th foot

Glycera alba

Papillae

Jaws

Hind foot

Foot from mid body

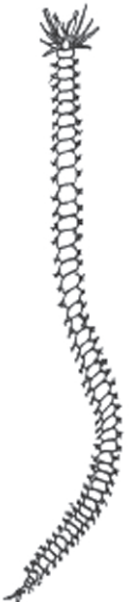
18th foot

25th foot

34th foot

Fig. 10.

Perinereis cultrifera (After Day, 1967)



Natural size

Female, Heteronereis stage

Male, Heteronereis stage

Pygidium

Heterogomph falciger

Head and proboscis (dorsal and ventral view)

Anterior, midbody and posterior feet

Glycera tesselata

Proboscis papillae

Jaw

Foot from midbody

Neanthas chingrighanttensis

Proboscis (ventral and dorsal view)

66th foot

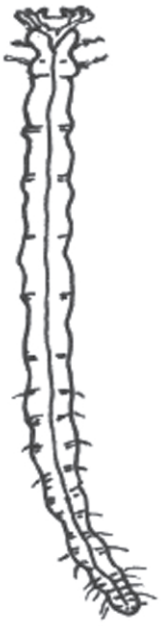
10th foot

Lower ventral spiniger

Ventral hemigomph spinigers

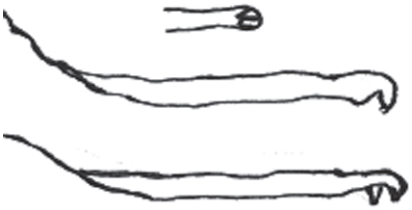
Fig. 11.

Owenia fusiformes **(After Day, 1967)**



Natural size

Tube, natural size



Unicini, front and side view

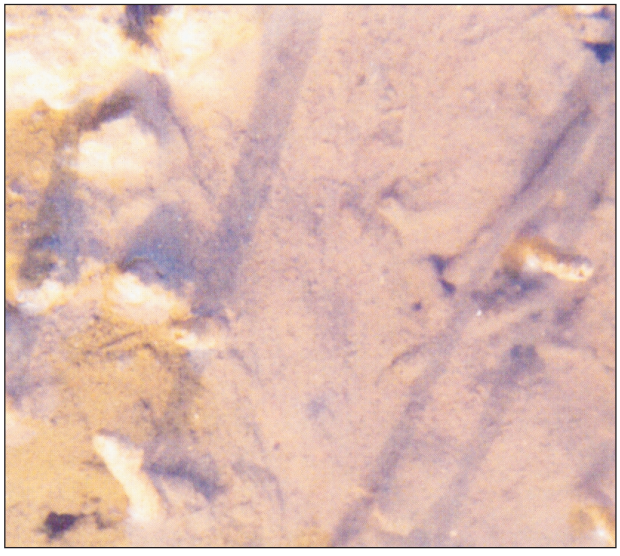
Dorsal bristle

Head with mouth

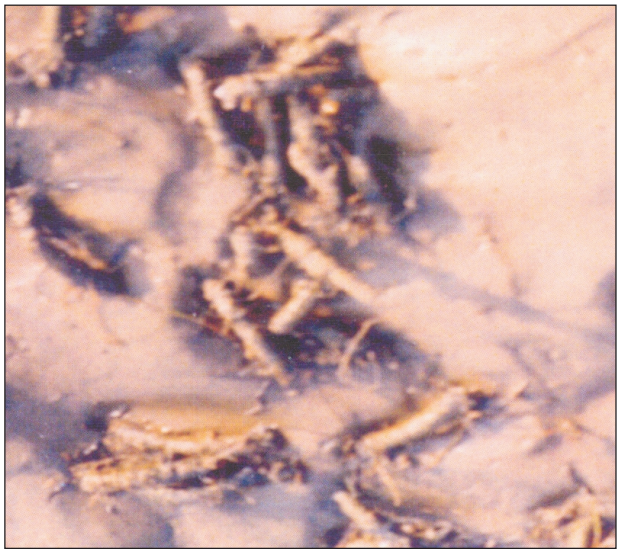
Fig. 12.

(After Day, 1967)

Bioturbation structure of the polychaete *Diopatra cuprea*



Bioturbation structure of the polychaete *Maldane sarsi*



Bioturbation structure of the polychaete *Owenia sp.*

Fig. 13.