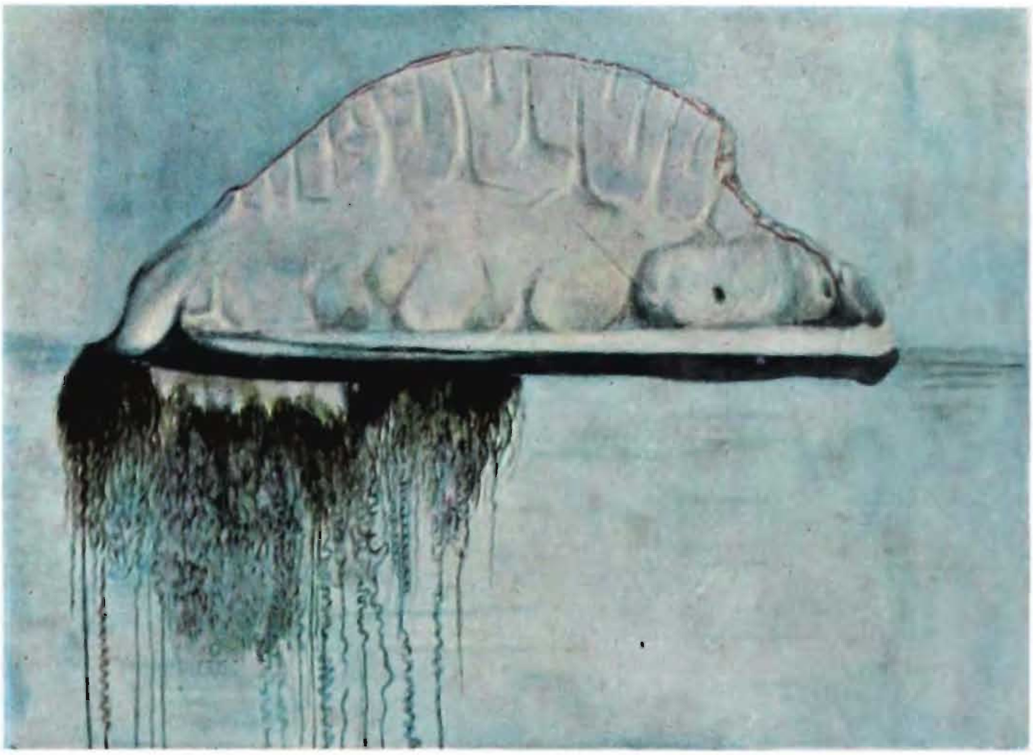

Fauna of India

COELENTERATA : HYDROZOA

SIPHONOPHORA

RUBY DANIEL

This volume on the Siphonophora gives account of species occurring in the Indian Ocean those not recorded so far from the Indian Ocean and details on terminology, general morphological characters internal structures of taxonomic importance, reproduction and development. It deals with ecological features and habitat of 120 species. The taxonomy is based on the extensive collections of Siphonophora present in the Zoological Survey of India and includes a section on the classification and keys to identify the suborders, families, genera and species. The systematic section is in two parts—the first deals with 89 species occurring in the Indian seas and the other 31 species occurring in the rest of the Indian Ocean (20°—120°E long. and 45°S lat). These sections give in detail synonymy, description, distribution and seasonal and night/day variations of the 120 species. It also contains a short discussion on the distribution of the Siphonophora and on the theories and phylogeny of Siphonophores.

THE FAUNA OF INDIA

AND

THE ADJACENT COUNTRIES

COELENTERATA : HYDROZOA

SIPHONOPHORA

By

RUBY DANIEL, M.Sc., Ph.D.

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EDITOR'S PREFACE

The "Fauna of India" volumes published by the Zoological Survey of India are authentic monographs on different animal groups written by experienced specialists of the concerned group. Since some years we have been laying stress to complete as many diverse groups as possible and I am happy to note that this tempo has been kept up. The present volume on Siphonophora by Dr. (Mrs) Ruby Daniel is one such monograph to appear in this series.

Siphonophora are marine animals which constitute an important part of the Marine Plankton. These are abundant in the tropical seas and are of a great value for the fisheries of our country. Dr. (Mrs) Ruby Daniel is an acknowledged authority on this group of animals and has a rieh experience of three decades of work on this group. The present volume gives in detail the taxonomy, morphology, ecology, distribution, abundance and seasonal fluctuations of the Siphonophores collected during the International Indian Ocean Expedition (1960, 1962-65). These were worked out by Dr. (Mrs) Daniel on the request of UNESCO. Further, the extensive collections present in the Zoological Survey of India, Calcutta, were also utilised by her.

Although as far as possible an uniform format is adopted in all the "Fauna of India" volumes but in a group as Siphonophora, it has not been possible to exclude some forms occurring outside the Indian limits of the Indian Ocean since as a group they are Holoplanktonic in habit. Moreover, these animals have a great capacity for adapting themselves to varying hydrographical conditions.

I am sure the present work will be useful to specialists and research students both in India and elsewhere.

B. K. TIKADER
Director

CALCUTTA
2nd September, 1985

AUTHOR'S PREFACE

The present work is based on the studies made by the author for the past three decades who had the unique opportunity to study the extensive siphonophore material from the Indian Ocean available in the collections of the Zoological Survey of India, Calcutta. This volume gives keys for identification, taxonomy and descriptions of 119 species and one variety including a new species belonging to 14 families and 45 genera. The distribution is based on the material examined by me and on authentic published records. The seasonal variations of these siphonophores occurring in the north-east/north-west and south-west/south-east monsoon regimes are based on the extensive collections of siphonophores made during the International Indian Ocean Expedition. In addition the preserved material of the Marine Biological Station, Z.S.I., Madras has also yielded valuable information.

A dietailed account of the morphology, internal structures of taxonomic importance, reproduction and development, habitat, classification used and review on phylogeny are included. The present account is divided into two parts, one dealing with the species occurring in the Indian seas and the other 29 species collected from the rest of the Indian Ocean down south as far as 45°S. Lat. and between 20° to 120°E. Long.

I wish to take this opportunity to express my sincere thanks to Dr. B. K. Tikader, Director, Zoological Survey of India, for constant encouragement, benefit of scientific advice in the preparation of this volume and providing facilities to complete this work, Dr. M. S. Mani, former Deputy Director; Dr. S. Khera, former Joint Director, Dr. T. N. Ananthakrishnan, and Dr. K. K. Tiwari, former Directors, Zoological Survey of India for their continuous help, encouragement and guidance; and to Dr. K. C. Jayaram, Joint Director for guidance and editorial advice. A special word of thanks is due to Dr. Augustine Daniel, Joint Director, Z.S.I., and my husband whose constant advice, support, encouragement and benefit of criticisms has made this work possible.

Grateful thanks are due to Dr. E. Leloup, Bruxelles; late Dr. W. J. Rees, and late Capt. A. K. Totton, British Museum, London; Dr. C. Carre, Ville Franche, Sur-Mer France; Dr. C. D. Stepanyants, Leningrad, USSR; Dr. R. Ja. Margulis, Moscow, USSR; and Mr. K. Rengarajan, CMFRI for the generous supply of their works on Siphonophora and to Dr. M. Sears and Dr. D. C. Pugh, U.S.A. for their valuable corrections of the manuscript.

I would also like to express my grateful thanks to the Department of Science and Technology and Department of Environment, Government of India for honouring me by assigning the writing of fauna volume on Siphonophora. M/s Amra Press, Madras, deserve deep appreciation for their untiring efforts to make the proofs ready without delay and complete the work within a short time.

MADRAS — RUBY DANIEL
2nd September, 1985

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SYSTEMATIC INDEX

INTRODUCTION

Siphonophora are abundant in the tropical seas and constitute an important part of the marine plankton. A considerable amount of published information is available on this group from the Atlantic Ocean and some from the Pacific and Indian Oceans. The monographs on this group are those of Eschscholtz (1829), Huxley (1859), Haeckel (1888), Lens & van Riemsdijk (1908), Bigelow (1911), Moser (1925) Bigelow & Sears (1937), Totton (1954, 1965), Stepanjants (1967), and Daniel (1974). The Siphonophora from the Indian Ocean have been studied by several workers — Browne (1926) from Seychelles, Mauritius and Chagos Archipelago; Sundara Raj (1927), Leloup (1934) and Daniel & Daniel (1963) from the Madras Coast; Patriti (1970) from off South East Coast of Africa and Madagascar; Totton (1954) from SE Coast of Africa, SE, NW & S. Indian Ocean, Gulf of Aden, Aqaba and Red Sea; Alvarino (1974) from the tropico – equatorial region; Rengarajan (1974) from the West Coast of India; and Daniel (1966, 1974) from the West and East Coasts of India and those collected by *R.V 'Vityaz'* along 90°–110° E longitude down 35° S latitude. In spite of these works there was still a definite paucity of knowledge on the systematics, distribution, abundance and seasonal fluctuations of Siphonophora in the Indian Ocean, sufficient to warrant the publication of a volume on the Siphonophora under the Fauna of India series.

There are 158 valid and 14 doubtful species of Siphonophora in the world's oceans. Of these, a grand total of 116 valid, one variety and 3 doubtful species are known from the Indian Ocean (Annotated list on page 2). Eighty nine species occur in the Indian Seas. The limits of this area are given in detail below:

On the west, the area bounded by the 60° E meridian as far north as Ras-al-Had and thus including the Gulf of Oman and the Persian Gulf; on the South by the latitude 1° S so as to include the whole of the Maldive Archipelago; on the east by the coast of Burma by a line drawn from Victoria Point to the northern tip of Sumatra and by the west coast of Sumatra as far south as lat. 1° S, (Cf. Editors Preface by R.B.S. Sewell – Fauvel, 1953 – Fauna of India – Annelida – Polychaeta; Misra, 1969 – Fauna of India. Pisces – Vol. I.)

The Siphonophora occurring in the other regions of the Indian Ocean not defined as belonging to the Indian seas, and deep-sea siphonophores also are included in a separate chapter because the Siphonophora are holoplanktonic in their habits with great capacity for adapting themselves to varying hydrographical conditions and therefore their presence in the Indian waters may confidently be expected.

Detailed informations on histology, biology, physiology, reproduction, embryological and early (larval) development of many species, genetics (chromosomes) and their bearing on taxonomy are still needed. It is hoped that future workers would take up such studies so as to get a complete knowledge of this beautiful group of animals.

AN ANNOTATED LIST OF SPECIES FROM THE INDIAN OCEAN AND ADJACENT SEAS

HYDROZOA — SIPHONOPHORA

Order SIPHONOPHORA Eschscholtz, 1829

Sub-Order I. CYSTONECTAE Haeckel, 1888

Fam. I. PHYSALIIDAE Brandt, 1835

Gen. 1. **Physalia** Lamarck, 1801
*1. *Physalia physalis* (Linné, 1758)

Fam. II. RHIZOPHYSIDAE Brandt, 1835

Gen. 2. **Rhizophysa** Peron & Lesueur, 1808
*2. *R. filiformis* (Forskål, 1775)
*3. *R. eysenhardti* Gegenbaur, 1859

Gen. 3. **Bathyphysa** Studer, 1878
4. *B. conifera* (Studer, 1878)

Sub-Order II. PHYSONECTAE Haeckel, 1888

Fam. III. APOLEMIIDAE Huxley, 1859

Gen. 4. **Apolemia** Eschscholtz, 1829
*5. *Apolemia uvaria* (Lesueur, 1811)

Fam. IV. AGALMIDAE Brandt, 1835

Gen. 5. **Agalma** Eschscholtz, 1825
*6. *A. okeni* Eschscholtz, 1825
*7. *A. elegans* (Sars, 1846)
*8. *A. haeckeli* Bigelow, 1911

Gen. 6. **Halistemma** Huxley, 1859
*9. *H. rubrum* (Vogt, 1852)
*10. *H. amphytridis* (Lesueur & Petit, 1807)

Gen. 7. **Cordagalma** Totton, 1932
*11. *C. cordiformis* Totton, 1932

Gen. 8. **Nanomia** A. Agassiz, 1865
*12. *N. bijuga* (Delle Chiaje, 1841)

Gen. 9. **Frillagalma** Daniel, 1966
*13. *F. vityazi* Daniel, 1966

Gen. 10. **Marrus** Totton, 1954
14. *M. orthocannoides* Totton, 1954

Gen. 11. **Lychnagalma** Haeckel, 1888
*15. *L. utricularia* (Claus, 1879)

Gen. 12. **Erenna** Bedot, 1904
*16. *E. richardi* Bedot, 1904

Fam. V. PYROSTEPHIDAE Moser, 1925

Gen. 13. **Bargmannia** Totton, 1954
*17. *B. elongata* Totton, 1954

Fam. VI. PHYSOPHORIDAE Eschscholtz, 1829 (*pro parte*)

Gen. 14. **Physophora** Forskal, 1775
*18. *P. hydrostatica* Forskal, 1775

Fam. VII. ATHORYBIIDAE Huxley, 1859

Gen. 15. **Athorybia** Eschscholtz, 1829
*19. *A. rosacea* (Forskal, 1775)

Gen. 16. **Melophysa** Haeckel, 1888
*20. *M. melo* (Quoy & Gaimard, 1827)

Fam. VIII. FORSKALIIDAE Haeckel, 1888

Gen. 17. **Forskalia** Kölliker, 1853
21. *F. edwardsi* Kölliker, 1853
*22. *F. leuckarti* Bedot, 1893
*23. *F. formosa* Keferstein & Ehlers, 1860
*24. *F. tholoides* Haeckel, 1888
25. *F. cuneata* Chun, 1888

Sub-Order III. CALYCOPHORAE Leukart, 1854

Fam. IX. PRAYIDAE Kölliker, 1853

Sub-fam. (*i*) AMPHICARYONINAE Chun, 1888

Gen. 18. **Amphicaryon** Chun, 1888
*26. *A. acaule* Chun, 1888
27. *A. peltifera* (Haeckel, 1888)
28. *A. ernesti* Totton, 1954
*29. *A. intermedia* Daniel, 1970

Gen. 19. **Maresearsia** Totton, 1954
*30. *M. praeclara* Totton, 1954

Sub-fam. (ii) PRAYINAE Chun, 1897

Gen. 20. **Rosacea** Quoy & Gaimard, 1827
*31. *R. plicata* Quoy & Gaimard, 1827
*32. *R. cymbiformis* (Delle Chiaje, 1841)

Gen. 21. **Praya** Quoy & Gaimard (in Blainville, 1834)
*33. *P. dubia* (Quoy & Gaimard, 1833)
*34. *P. reticulata* (Bigelow, 1911)

Gen. 22. **Prayoides** Leloup, 1934
*35. *P. intermedia* Leloup, 1934

Gen. 23. **Desmophyes** Haeckel, 1888
*36. *D. annectens* Haeckel, 1888

Sub-fam. (iii) NECTOPYRAMIDINAE Bigelow, 1911

Gen. 24. **Nectopyramis** Bigelow, 1911
37. *N diomedeae* Bigelow, 1911
38. *N. thetis* Bigelow, 1911
39. *N. natans* (Bigelow, 1911)
40. *N. spinosa* Sears, 1952

Fam. X. HIPPOPODIIDAE Kölliker, 1853

Gen. 25. **Hippopodius** Quoy & Gaimard, 1827
*41. *H. hippopus* (Forskal, 1776)

Gen. 26. **Vogtia** Kölliker, 1853
*42. *V. spinosa* Keferstein & Ehlers, 1861
*43. *V pentacantha* Kölliker, 1853
44. *V serrata* (Moser, 1925)
*45. *V. glabra* Bigelow, 1911

Fam. XI. DIPHYIDAE Quoy & Gaimard, 1827

Sub-fam. (i) SULCULEOLARIINAE Totton, 1954

Gen. 27 **Sulculeolaria** Blainville, 1834
*46. *S. quadrivalvis* Blainville, 1834
*47. *S. biloba* (Sars, 1846)
*48. *S. turgida* (Gegenbaur, 1853)
*49. *S. angusta* Totton, 1954
*50. *S. chuni* (Lens & van Riemsdijk, 1908)
*51. *S. monoica* (Chun, 1888)
*52. *S. bigelowi* (Sears, 1950)

Gen. 28. **Eudoxia** Eschscholtz, 1825
*53. *E. macra* Totton, 1954
*54. *E. indica* n.sp.

Sub-fam. (ii) DIPHYINAE Moser, 1925

Gen. 29. **Diphyes** Cuvier, 1817
*55. *D. dispar* Chamisso & Eysenhardt, 1821
*56. *D. bojani* (Eschscholtz, 1825)
*57. *D. chamissonis* Huxley, 1859

Gen. 30. **Lensia** Totton, 1932
*58. *L. subtiloides* (Lens & van Riemsdijk, 1908)
*59. *L. conoidea* (Keferstein & Ehlers, 1860)
*60. *L. hotspur* Totton, 1941
*61. *L. gnanamuthui* Daniel & Daniel, 1963
*62. *L. roonwali* Daniel, 1970
63. *L. minuta* Patriti, 1970
64. ?*L. peresi* Patriti, 1970
65. *L. hardy* Totton, 1941
*66. *L. fowleri* (Bigelow, 1911)
*67. *L. challengcri* Totton, 1954
68. *L. achilles* Totton, 1941
69. *L. cordata* Totton, 1965
*70. *L. leloupi* Totton, 1954
*71. *L. tottoni* Daniel & Daniel, 1963
*72. *L. panikkari* Daniel, 1970
*73. *L. nagabhushanami* Daniel, 1970
*74. *L. campanella* (Moser, 1925)
*75. *L. cossack* Totton, 1941
*76. *L. subtilis* (Chun, 1886)
L. subtilis var. *chuni* Totton, 1965
*77. *L. meteori* (Leloup, 1934)
78. *L. tiwarii* Daniel, 1970
*79. *L. multicristata* (Moser, 1925)
80. *L. hunter* Totton, 1941
81. *L. havock* Totton, 1941
*82. *L. lelouveteau* Totton, 1941
83. *L. exeter* Totton, 1941
84. *L. hostile* Totton, 1941
85. *L. grimaldi* Totton, 1941
*86. *L. ajax* Totton, 1941
87. *L. reticulata* Totton, 1954
*88. *L. multilobata* Rengarajan, 1973

Gen. 31. **Muggiaea** Busch, 1851
*89. *M. atlantica* Cunningham, 1892
*90. *M. delsmani* Totton, 1954

Gen. 32. **Dimophyes** Moser, 1925
*91. *D. arctica* (Chun, 1897)

Gen. 33. **Chelophyes** Totton, 1932
*92. *C. appendiculata* (Eschscholtz, 1829)
*93. *C. contorta* (Lens & van Riemsdijk, 1908)

Gen. 34. **Eudoxoides** Huxley, 1859
*94. *E. mitra* (Huxley, 1859)
*95. *E. spiralis* (Bigelow, 1911)

Fam. XII. CLAUSOPHYIDAE Totton, 1965
Gen. 35. **Clausophyes** Lens & van Riemsdijk, 1908
96. *C. ovata* (Keferstein & Ehlers, 1860)

Gen. 36. **Chuniphyes** Lens & van Riemsdijk, 1908
*97. *C. multidentata* Lens & van Riemsdijk, 1908
*98. *C. moserae* Totton, 1954

Gen. 37. **Crystallophyes** Moser, 1925
99. *C. amygdalina* Moser, 1925

Gen. 38. **Heteropyramis** Moser, 1925
*100. *H. maculata* Moser, 1925

Gen. 39. **Thalassophyes** Moser, 1925
101. *T crystallina* Moser, 1925

Fam. XIII. **Sphaeronectidae** Huxley, 1859
Gen. 40. **Sphaeronectes** Huxley, 1859
*102. *S. gracilis* (Claus, 1873)
*103. *S. irregularis* (Claus, 1873)
*104. ? *S. princeps* Haeckel, 1888

Fam. XIV. ABYLIDAE L. Agassiz, 1862

Sub-fam. (i) ABYLINAE L. Agassiz, 1862
Gen. 41. **Ceratocymba** Chun, 1888
*105. *C. leuckarti* (Huxley, 1859)
*106. *C. dentata* (Bigelow, 1918)
*107. *C. sagittata* (Quoy & Gaimard, 1827)
108. *C. indica* Daniel, 1970

Gen. 42. **Abyla** Quoy & Gaimard, 1827
*109. *A. trigona* Quoy & Gaimard, 1827
*110. *A. schmidti* Sears, 1853
*111. *A. haeckeli* Lens & van Riemsdijk, 1908
112. *A. ingeborgae* Sears, 1953
*113. *A. bicarinata* Moser, 1925 (=*A. brownia* Sears, 1953)
114. ? *A. carina* Haeckel, 1888

Sub-fam. (ii) ABYLOPSINAE Totton, 1954

Gen. 43. **Abylopsis** Chun, 1888

*115. *A. tetragona* (Otto, 1823)
*116. *A. eschscholtzi* (Huxley, 1859)

Gen. 44. **Bassia** L. Agassiz, 1862
*117. *B. bassensis* (Quoy & Gaimard, 1834)

Gen. 45. **Enneagonum** Quoy & Gaimard, 1827
*118. *E. hyalinum* Quoy & Gaimard, 1827
*119. *E. searsae* Alvarino, 1968.

MORPHOLOGY

Terminology for various Morphological structures:

The terminology used by Haeckel (1888b), Bigelow (1911b) and Totton (1954, 1960, 1965) is followed in the present study.

Suborder Cystonectae:

Aboral.—The float end of the oozooid, i.e. the end opposite to oral end.

Ampulla.—Is the hypertrophied basigaster of a gastrozooid containing innumerable nematoblasts. It has no mouth-opening. The tentacle arises from its base.

Apical pore (air-hole, stigma).—Is the opening situated at the tip of the pneumatophore or float.

Apical pigment.—Is the apically pigmented tip of the pneumatophore, varying from reddish-brown to black in colour.

Asexual nectophore (nectophore).—These are asexual medusoid nectophores developed in the gonodendra of *Physalia* and *Rhizophysa*. Previously regarded as female medusoids.

Basal internode.—Term used by Haeckel to describe the gap between the oral and the main zone of cormidia in *Physalia*.

Basigaster.—Is the base of the gastrozooid enlarged into a nematocyst producing area.

Beaked or bird-headed tentilla.—Is the third type of tentilla occurring in *Rhizophysa filiformis*, possessing a bunch of long processes with central enlargement and a long beak-like, bent structure at the tip (Totton, 1965, pl. IV, fig. 4).

Cnidoblasts (nematoblasts).—are "mother-cells", which produce nematocysts.

Cnidonodes (cnidocysts or nematocyst batteries, nematocyst head, or cnidospheres).—Are the sessile reniform nematocyst heads occurring at regular intervals along the dorsal side of the tentacle

* Species of Siphonophora collected between 25° N–1° S latitude and 60° E–100° E longitude in the Indian seas.

The species not marked with asterisks occur in the Indian Ocean but not recorded so far from the Indian seas.

of *Physalia* and in ? *Salacella* (=*Salacia*) possessing innumerable nematocysts.

Cormidium.—Is a group of appendages (gastrozooids, tentacles and gonodendra) occurring on the siphosome, which is highly reduced in *Physalia*.

Crest (sail).—Is a polythalamous sail on the dorsal side of the large pneumatophore of *Physalia*. It is held firm by a set of triangularly shaped septa dividing the crest into many chambers.

Cystonula.—Typical larva of Cystonectae.

Dendritic (or palmate) tentilla.—Is the second type of tentilla, found in *R. filiformis*. An expanded tentillum is a highly branched structure. At one side of the distal end of the enlarged body between the bases of the branches is a hemispherical pigmented boss, reddish-brown in colour and covered with hair-like processes (resembling those that cover the ectoderm of the whole tentacle and the pedicels of all the tentilla). At the other side is an extensive opaque area of the ectoderm (Totton, 1965, p. 41, pl. IV, figs. 5 & 6)

Female medusoids (gynophore).—Are the sessile female gonophores possessing a thin single layer of germ-cells which form a continuous, narrow, sinuous band, running over the surface.

Gas gland.—Is the spherical, opaque spot on the inner side near the main zone of cormidia in *Physalia*.

Gastrozooids (siphons, suctorial tubes. polypites, nutritive polyps, stomach sacs, gastral tubes, eating polyps, hydranths).—Are the feeding polyps possessing the enlarged basal region, the basigaster, stomach proper (stomachus), long flexible proboscis, a suctorial mouth, and tentacle at the base. They are either sessile or pedicellate.

Gonodendron (reproductive stalk, blastostyle, gonostyle).—Is a diffusely branched structure arising from the base of the gastrozooid or palpon, possessing gonophores, gonopalpons and asexual nectophores.

Gonopalpon (gonozooid).—A reduced gastrozooid associated with the gonodendron, but does not possess a tentacle.

Gonophore (reproductive person, sexual medusoid).—Is small ovoid male or female medusa, functional or reduced, without tentacles; codonid-like or styloid.

Gonozooids (gonopalpons).—Are reduced gastrozooids without any tentacles, from the base of which the gonodendra are budded off.

Hypocystic villi.—Are outgrowths containing giant ectodermal cells having a diameter of upto 2.0 mm, arising from the pneumadenia and often penetrating the septa that cross the pericystic cavity.

Jelly-polyps.—Are vestigial nectophores, found only in *Physalia.*

Left-handed specimens.—In *Physalia* the cormidia are borne on a bulge on the oral half of the animal, the tentacles streaming out on the windward side and acting as a drogue or sea-anchor; when the bulge is situated on the left-hand side of the float, the specimens are called left-handed specimens.

Main aboral zone.—The area or zone in which the highly developed cormidia occur. This zone is separated from the oral zone by the internode.

Male medusoids (androphores, male gonophores).—Are very similar to the female gonophores in being ovoid and sessile, possess a thick cap of germ-cells borne on a relatively less capacious endodermal spadix.

Nematoblasts.—Are 'mother-cells' which produce the nematocysts.

Nematocysts (stinging-cells, stinging-capsules, cnidocysts).—A nematocyst in most cases consists of a capsule with toxin, a whip-like thread coiled within the capsule, and a pointed minute trigger-spine or cnidocil. Depending on the structure of the capsule and armature on the whip-like thread, fourteen types of nematocyst are recognized.

Oozooid.—Is the early larval stage in which two parts: (i) the aboral invaginated pneumatophore or float, and (ii) the oral primary zooid, may be distinguished.

Oral end.—Is the part in which the primary zooid is situated.

Oral zone.—Area or zone in which the primary gastrozooid and a few cormidia are situated. This is separated from the main aboral zone of cormidia by the basal internode.

Palpons (feelers, tasters, arms, dactylozooids, hydrocysts, fluid receptacles).—Occur as gonopalpons without tentacles (in this sub-order), in the gonodendra of *Physalia*, *Rhizophysa* and *Bathyphysa.*

Pericystic cavity.—Is the space between the pneumatocodon and the pneumatocyst, often traversed by septa.

Pneumadenia (gas-gland).—Is the three-layered gas-gland of the invaginated pneumatocyst — a specialized part of the wall of the pneumatosaccus.

Pneumatocodon.—Is the outer three-layered wall of invaginated float.

Pneumatochone (air-funnel).—The basal cylindrical part of the chitinous lining of the pneumatosaccus, with the enclosed part of the pneumadenia.

Pneumatocyst (Pneumatosaccus).—Is the three-layered, invaginated gas-containing part of the float, lined above by chitin and below by secondary ectoderm that grows up from the gas-gland and lies over the chitinous lining.

Pneumatophore (float, swimming-bladder, air-chamber).—Is the aboral invaginated portion of the oozooid possessing the above-mentioned associated parts viz., pneumadenia, pneumatocodon, pneumatochone, pneumatocyst.

Pore.—Is the apical opening or stigma in the pneumatophore.

Protozooid (primary zooid, primary gastrozooid).—Is the primary, terminal gastrozooid situated at the oral end of the juvenile siphonophore, and in the mature cystonects.

Right-handed specimens.—Are specimens of *Physalia* in which the bulged region consisting of the cormidia is situated on the right hand side of the float.

Septa.—In *Physalia*, are the triangularly shaped partitions; the primary, secondary and tertiary septa divide the crest into many chambers.

Siphosome (nutritive body).—Is either reduced — brachystele or elongated — macrostele — from which the gastrozooids, palpons, and gonodendra are borne.

Spadix.—The central core on whose surface the sex cells ripen.

Sporosac.—Highly reduced gonophores — devoid of umbrella.

Stem (trunk, coenosome, coenosarc, axial body).—Is the central axial body on which the various zooids occur.

Styloid gonophores.—The gonophore has failed to develop beyond the original epidermal-gastrodermal protuberance. Vestigeal structures without umbrella or radial canals, often referred to as sporosacs.

Tentacle (capturing filament, stinging filament, nematozooid, tentacular filament).—Is long, thin, tubular and arises from the base of the gastrozooid.

Tentilla.—Are the lateral branches of the tentacle; these are either simple or end in tricornuate, dendritic, palmate or bird-headed sub-terminal batteries of nematocysts.

Tricornuate.—When a tentillum ends in the form of three-branched structure, it is called a tricornuate tentillum.

Tripartite group.—Consists of gastrozooid, tentacle and ampulla, and a gonodendron at the base of the gastrozooid; and further series of similar laterally placed tripartite groups grow from the base of its predecessor. This is the essential arrangement of budding in *Physalia*.

Ventral crest.—Thin fold or projection of the undifferentiated primary layers.

Suborder Physonectae:

The terms given below are other than those common names referred to under Suborder Cystonectae:

Angle-bands.—These are extensile structureless filaments connecting the basal mesoglea of the cnidosac with the base of the terminal filament. On activation, they cause the folded cnidoband to straighten and slap itself, with its larger flanking nematocysts, on to its prey.

Aurophore (or air-bell).—Lies below the pneumatophore; considered to be a gas-gland, and occurs only in the Family Rhodaliidae.

Blastostyle.—Reproductive stalk or bud, from which the gonophores are produced.

Bracts (covering pieces, hydrophyllia, protecta, covering scales, phyllozooids).—Are perhaps modified palpons with enlarged mesoglea, for protection and buoyancy. They are either thin and scale-like, or thick or facetted, and possess a thin thread-like canal-the bracteal canal which lies in the mid-region. They are attached to the siphosome by a peg-like structure or a large muscular sheath-the bracteal lamella.

Budding zone.—There are two budding zones on a physonect colony, viz., the area just under the pneumatophore, which buds off nectophores; and an apical area of the siphosome, from which are budded the gastrozooids, palpons, bracts and gonophores.

Canal system.—Occurs in nectophores and gonophores; pedicular canal-arises from the point of origin in the stem; radial canals-four meridionial canals run from the pedicular to the circular canal which unites the distal ends of the radial canals.

Cnidoband (cnidotaenia, utricating band).—Consists of rows of sabre-shaped nematocysts forming the chief part of most stinging organs. It is often flanked basally by two rows of larger, bean-shaped or sabre-shaped nematocysts. Usually the cnidoband occurs in the form of coils-the number of coils varies in different species.

Codonid gonophore.—Small in physonects, large in calycophores; medusoids with well developed umbrella and radial canals but without marginal tentacles. Mouthless manubrium bear sex cells.

Corm.—Is the reduced vesicular stem region in the family Rhodaliidae.

Cormidium.—Consists of group of gastrozooids, tentacle, palpons, palpacle, bracts and gonodendra.

Dissolved cormidia.—Many polymorphic zooids occurring all along the ventral crest line of the siphosome but in particular succession.

Entocodon (Glockenkern).—The terminal proliferation of ectoderm in a medusoid bud which eventually hollows out to form the bell cavity.

Gonostyle (reproductive stalks, blastostyle, gonoblastidia, gonodendra, klinozooid).—Stalks from which the gonophores are produced.

Nectophores (nectocalyces, swimming bells, nectozooids).—Are asexual medusoids used in locomotion.

Nectosac.—Sub-umbrellar cavity of a medusoid with well developed musculature and a canal system with four radial canals, of which the lateral radial canals are either short and simple or very long, forming a number of loops before joining the circular canal.

Nectosome.—That portion of the stem in which nectophores occur i.e., from the zone of budding or proliferation of nectophores down to the region of least growth situated just above budding zone of siphosome.

Nectostyle.—Is the area of attachment of larval type of bracts of Physonectae, e.g. in *Athorybia* and subsequent budding zone of siphosome.

Ordinate cormidium.—Free internode, without zooids between group of cormidia.

Ostium.—Mouth opening of nectosac nectophore or gonophore; opening of hydroecium.

Palpons (feelers, tasters, arms, fluid receptacles, hydrocysts, dactylozooids, cystons or anal vesicles).—Are reduced gastrozooids with a simple tentacle — the palpacle (tasting filament).

Pedicular canal (nectocalycine duct).—Duct or canal arising from the long tubular canal of the stem and entering the nectophores and ending in the nectosac; from this end arise the four radial canals found in the nectosac.

Physonula/Siphonula.—Typical larva of Physonectae.

Siphosome (nutritive body).—Is that portion of the stem, from the budding zone down to the protosiphon, on which the gastrozooids, palpons, bracts and gonophores are borne.

Tentillum.—Is a side branch of a tentacle, either simple or branched (as in Cystonectae). It consists of pedicle and a thick cnidoband. When it is spirally twisted, it is often partly or fully covered over by a theca-like covering — the involucrum, or naked non-involucrate (without involucrum), with a single terminal filament — the unicornuate type — or tricornuate filaments, i.e. a pair of lateral horns and a median ampulla or with many lateral horns (e.g. *Lychnagalma*), or without a median terminal ampulla or vesicle. It also occurs as a closed sacculus containing elastic bands, cnidoband and other nematocysts together with a terminal filament often provided with a disc-shaped sinker.

Suborder Calycophorae:

(In addition to those common ones given above):

Calyconula.—Typical larva of calycophorae.

Central organ.—Of uncertain origin. The central part of a larval nectophore of Hippopodiidae and Prayidae. Also the remains of a fragment of stem in an eudoxid, e.g. Prayidae.

Cnidosac (Cnidobattery, sacculus).—Pedicellate type of enclosed stinging organ by the tentilla.

Cormidium.—In Colycophorae consists of a single gastrozooid, tentacle, a single bract (absent in Hippopodiidae), with or without special nectophore; and gonophores, but no palpons.

Eudoxid phase (monogastric, sexual or second phase).—The oldest cormidia in the colony are set free as eudoxid-phases. The phase consists of a well-developed bract (except in Hippopodiidae), with or without special nectophore and a succession of gonophores, which are in turn set free as medusae (third phase). When a special nectophore is absent, the gonophore takes up the function of locomotion. The manubrium of the gonophore bears the germ-cells.

Hydroecium.—The hydroecial cavity (when present) in the nectophores of Calycophorae, is used for housing the retracted stem with its associated structures. It lies on the ventral side.

Mantle canal.—Is the upper and lower diverticula of the pedicular canal at the point of entry into a nectophore or gonophore (as in *Rosacea* spp.). The muscular pedicular lamella is attached to its proximal wall.

Nectosome.—Is very reduced in most of the Calycophorae (except in the Family Hippopodiidae). The colony lacks a pneumatophore or float.

Nectophore.—In Calycophorae is highly specialized, usually pyramidal in shape with well-marked ridges which are smooth or serrated, and facetted; or smooth, rounded and devoid of any ridges. It possesses a nectosac, hydroecium (may be absent) and somatocyst; ostium of nectosac often surrounded by ostial teeth and divided or undivided mouth-plates in Diphyidae.

Ordinate cormidia.—Various polymorphic zooids occurring in groups in the particular zones-nodes, the internodes being free devoid of bracts as in Physonect — *Apolemia* and all Calycophorae.

Pallial canal.—Sometimes used for mantle canal of a nectophore, sometimes for an apical part of it — thought to be homologous with the somatocyst.

Pedicular canal.—Duct or canal leading from the base of the somatocyst to the base of the nectosac where the four radial canals arise.

Phyllocyst (Bracteal canal).—Part of the common gastric cavity occluded in some mature bracts. It is either simple or branched.

Polygastric phase (asexual phase).—Asexual phase — first phase — from which cormidia are set free as eudoxid (or second) phase. The colony consists of the nectophores and many developing cormidia.

Siphosome.—In Calycophorae lacks palpons, except in *Stephanophyes* where vestigeal ones are found.

Somatocyst.—A caecal part of the common gastric cavity found only in Calycophoran nectophores. It is now thought to be a vestige of an original actinuloid tentacle (or bract), which has united with the nectophore. It may branch as in *Praya* spp. It is often vacuolated and possesses oil-globules.

General morphological characters of taxonomic significance:

A fully grown Siphonophora is defined by Totton as an overgrown oozooid polyp hat remains juvenile and asexual, but which carries with it large numbers of other unseparated, asexual, juvenile polyps (gastrozooids, palpons and bracts) as well as sexual adults (medusoid gonophores) and asexual adults (medusoid nectophores), all budded from the original and often much elongated oozooid or from other juveniles. Polygastric stage of Siphonophora are considered to be really larval "nurse - carriers" (paedophore) stage which do not become sexually mature (Totton, 1965).

The general pattern of organization of the 3 sub-orders Cystonectae, Physonectae, and Calycophorae can be understood clearly from an examination of the young growth stages. These young stages resemble each other in structure even though when fully grown they differ very much in their morphology.

Suborder Cystonectae:

In *Physalia* when the youngest larval stage comes to the surface after the development of the float (pneumatophore), it is a very small polyp the *oozooid* possessing a single *protozooid* and a highly contractile tentacle on one side of its float other buds of secondary polyps (gastrozooids) are developed. From the bases of these, secondary groups of gastrozooids and complexly branched gonodendra with adult medusoids are developed to form the complex cormidia seen in a fully grown *P. physalis*. All the cormidia are seen to occur on the underside of the elongated, large, horizontal, gas-filled pneumatophore, i.e. the primary oozooid polyp does not elongate as in the macrostele species of *Rhizophysa*, *Bathyphysa* and in most of the physonectae.

The three genera included under the sub order Cystonectae *Physalia*, *Rhizophysa* and *Bathyphysa* lack the efficient locomotor zooids — the adult asexual nectophores, but the rhizophysids and the bathyphysids are capable of vertical migration due to the possession of large, vertical pneumatophore with an apical pore and well developed conspicuous tufts of giant cells (gas-gland) protruding freely into the pericystic cavity as the hypocystic villi. This gas gland is capable of producing the required 'gas' (probably carbon monoxide) to enable the rising or sinking of the animal by regulating the gas volume through the apical pore. The gonodendra in all these three genera are complexly branched, with jelly-polps, gonopalpons, terminal asexual adult nectophores and sessile sac-like reduced gonophores of the styloid type. The tentacles of the gastrozooids may or may not have complexly formed tentilla Figure 1 gives morphology of a macrostele cystonect, *Rhizophysa filiformis*.

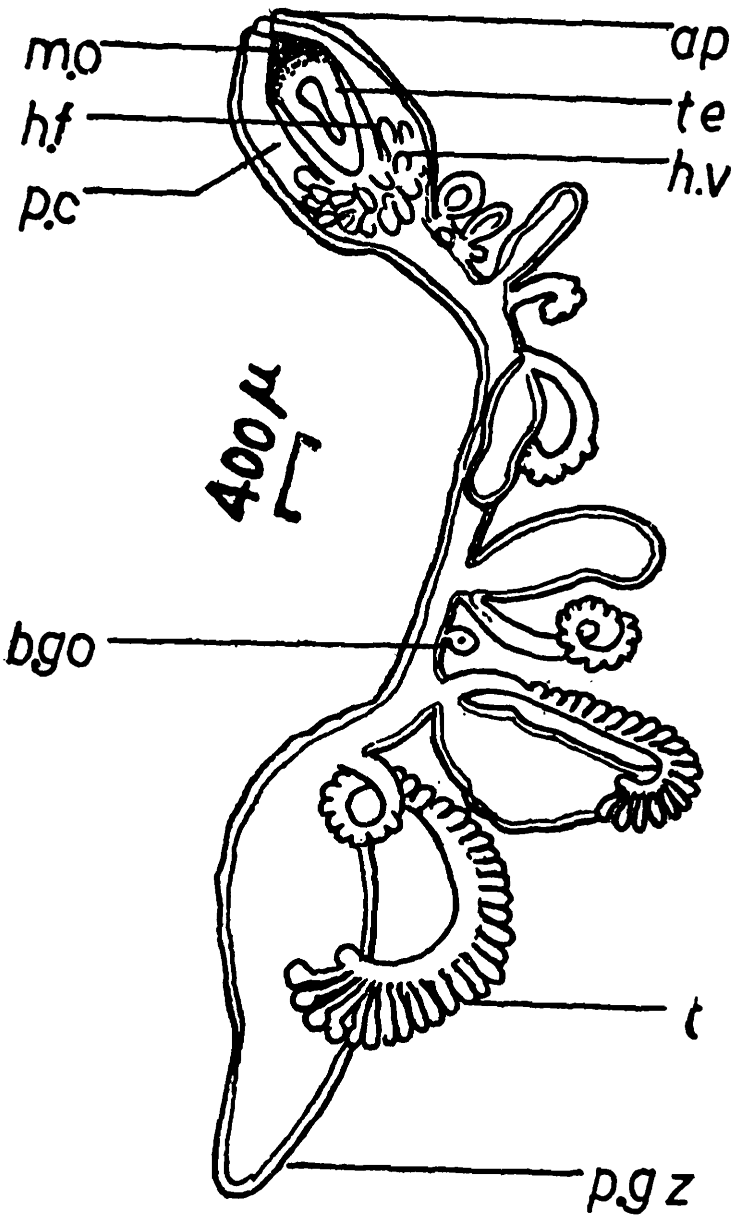


FIG. 1. *R. filiformis* (Forskal) — young specimen. ap – apical pore; bgo – bud of gonodendron; hf – hypocystic funnel; hv – hypocystic villi, mo – mitra ocellaris; pc – pericystic cavity; pgz – primary gastrozooid; t – tentacle.

Suborder Physonectae:

This suborder includes 7 families and 25 genera. The characteristic feature of this group is the possession of well developed nectophores (except in *Athorybia*) for locomotion and a small float. Their morphology is clearly understood when the developmental stages are compared to the larva of *P. Physalis*. These are very similar to the cystonects except that they have two proliferating zones — the siphosome, the budding zone of the larval polyps arising on one side of the float and the other budding zone *nectosome*, appearing on the opposite side of the float and give rise only to the adult asexual nectophores (medusoids). The course of the lateral radial canals in these nectophores are characteristic of the different species. In the siphosome other polyp structures such as palpons and protective, buoyant bracts and reduced blastostyles are budded to form the cormidia. The nectosome and siphosome are well developed in most of the physonects. The nectosome is nearly absent in *Athorybia* and highly reduced in *Melophysa*. The nectosome and siphosome form globular corm below the large saccular pneumatophore in *Rhodalia*, *Stephalia*, *Dromalia*, *Angelopsis* and *Archangelopsis*. The siphosome is saccular in both *Athorybia* and *Physophora*, (the latter has a well-developed nectosome) and reduced in *Melophysa*. Therefore, due to the macrostele or brachystele nature of the stem, the arrangement of the different zooids (gastrozooids, palpons, bracts and blastostyles) in the cormidia varies in different species. The gastrozooids possess either simple thick unbranched tentacles or with side branches called *tentilla* which may or may not end in complex coiled cnidoband with terminal filaments. The tentacles — *palpacles* — of the palpon are always small, thin and, simple (i.e. without side branches).

The protective buoyancy appendages, the bracts, exhibit a variety of shapes, sizes, structures and arrangements on the stem in the various genera. They form a corona beneath the float in *Athorybia* and *Melophysa;* a protective carapace to the siphosome, as in *Agalma okeni* and *A. clausi*; are present in hundreds along the stem of *A. elegans* and in many species of *Halistemma*, *Cordagalma*, *Forskalia* and *Nanomia* (with dissolved cormidium); or are arranged in an orderly manner, occurring only in the cormidia (ordinate cormidium), leaving free naked internodes as in *Apolemia* (and in suborder Calycophorae).

The adult sexual gonophores are borne on reduced blastostyles. *i.e.*, budded from the foot stalks of the secondary (juvenile) polypoids — the palpons. They are of the Codonid type. retaining the medusoid characters. The ova and sperms develop on the mouthless manubrium They do not have marginal tentacles.

Suborder Calycophorae:

In the Calycophorae the aboral part of the larva is atrophied and there is no aboral float, but in other respects they are similar to physonects. The larval, primary nectophore may be caducous or may be retained. The definitive nectophore becomes enlarged due to the development of much mesoglea and becomes sub-apical in position. As in physonects there are two budding zones — the short nectosome is formed of one (*Nectopyramis*, *Muggiaea*, *Spaeronectes*, *Enneagonum*) two or many nectophores which may be arranged as a single pair, opposite to each other as *Desmophyes*, *Rosacea* (Fig 2).

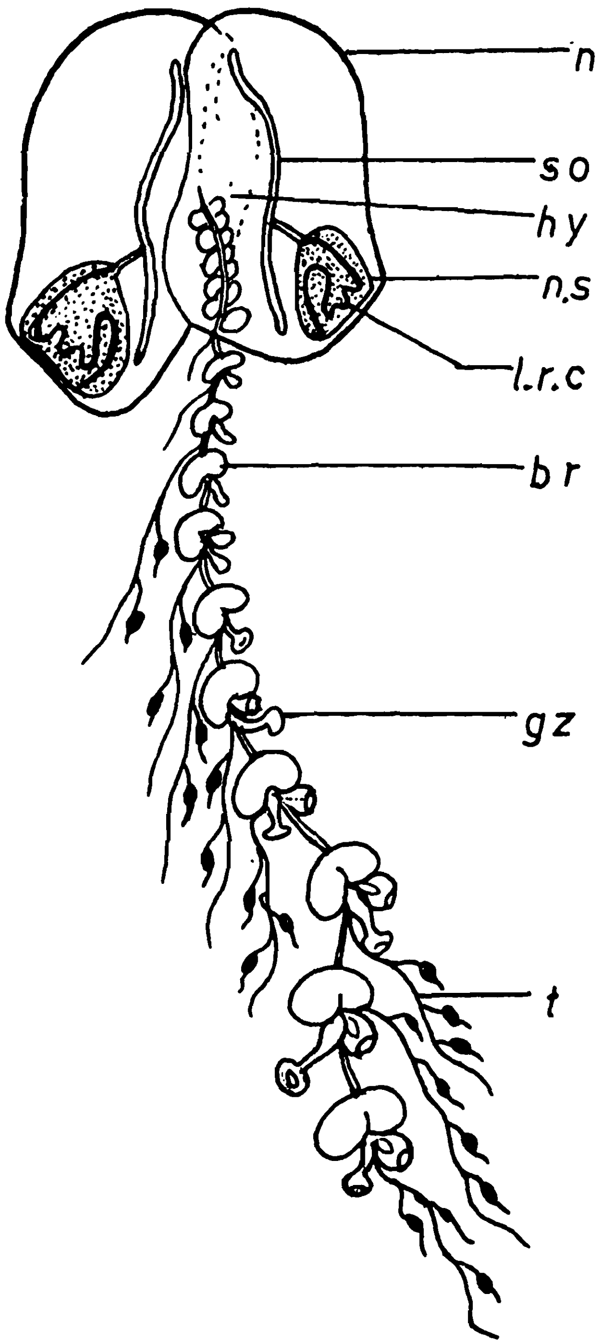


FIG. 2. *R. cymbiformis* (Delle chiaje), Entire. br – bract, gz – gastrozooid; hy – hydroecium; lcr – lateral radial canal; n – nectophore; ns – nectosac; so – somatocyst; t – tentacle. (From Kowamura, 1915, pl. 7, fig. 4)

Lilyopsis or in a corona as in *Stephanophyes* or form a complicated interlocking alternate arrangement of many similar nectophores as in *Hippopodius* and *Vogtia* or one behind the other as in the families Diphyidae (*Diphyes*, *Lensia*, *Sulculeolaria*, *Eudoxoides*, *Chelophyes*, *Dimophyes*, except *Muggiaea*) Clausophyidae (*Clausophyes*, *Chuniphyes*, *Crystallophyes*, *Heteropyramis* and *Thalassophyes* and Abylidae (*Ceratocymba*, *Abyla*, *Abylopsis* and *Bassia* except *Enneagonum*) and a well growing siphosome bearing cormidia in an orderly manner (ordinate cormidia) with free internodes. Figure 3 shows the comparative position of ridges in the anterior nectophores in the different genera of the families Diphyidae, Clausophyidae and Abylidae.

Palpons are absent except in a reduced form in *Stephanophyes*. The gastrozooids possess well developed tentacles with side branches — the tentilla with usually kindey shaped cnido-knobs and simple terminal filaments. The cormidium is covered over by a single bract (except in Hippopodiids), the shape and size varying in different species and made complex by the development of ridges, facets and prominences.

Internal structures of taxonomic importance:

Nematocyst:

Werner (1965) gives a good account of the different types and distribution of these remarkable organoids amongst the various cnidarian groups based on the nature of the tube or thread (open or closed at tip) and presence or absence of armature (Spines, bristles) along the butt or on tube (Weill, 1934; Hyman, 1940; Totton, 1954, 1960, 1965). Of these only the rhopalonemes are found exclusively in the Siphonophores, while the desmonemes. microbasic heterotrichous and the stenoteles are found in other coelenterates as well.

These occur in great abundance near the mouth of gastrozooids, palpons, bracts, and often aggregate together to form formidable "batteries" in the tentacles of all the species of Siphonophora. The nematoblasts occur in the basigaster region of the gastrozooids. The chemical nature of the toxin found within the capsules showed that there are various soluble substances present. The water soluble extract called *hypnotoxin* causes somnolence, anaesthesia and death in small experimental animals. The alcohol soluble substance called *thalassin* causes extreme itching and irritation. The glycerine soluble extract called *congestin* affects the digestive and respiratory systems of the prey.

Recently a number of research papers on nematocysts have been published, especially on the mechanism of its discharge, (Carre, 1980); two types of nematocysts based on function — one type with defensive function (receptor/effector) localised on pneumatophore, nectophores and bracts having no link with the nervous system and the other type with predatory function localised on the fishing tentacles and gastrozooids, connected with the nervous system (Carre & Carre, 1980); the cnidocil apparatus as a sensory

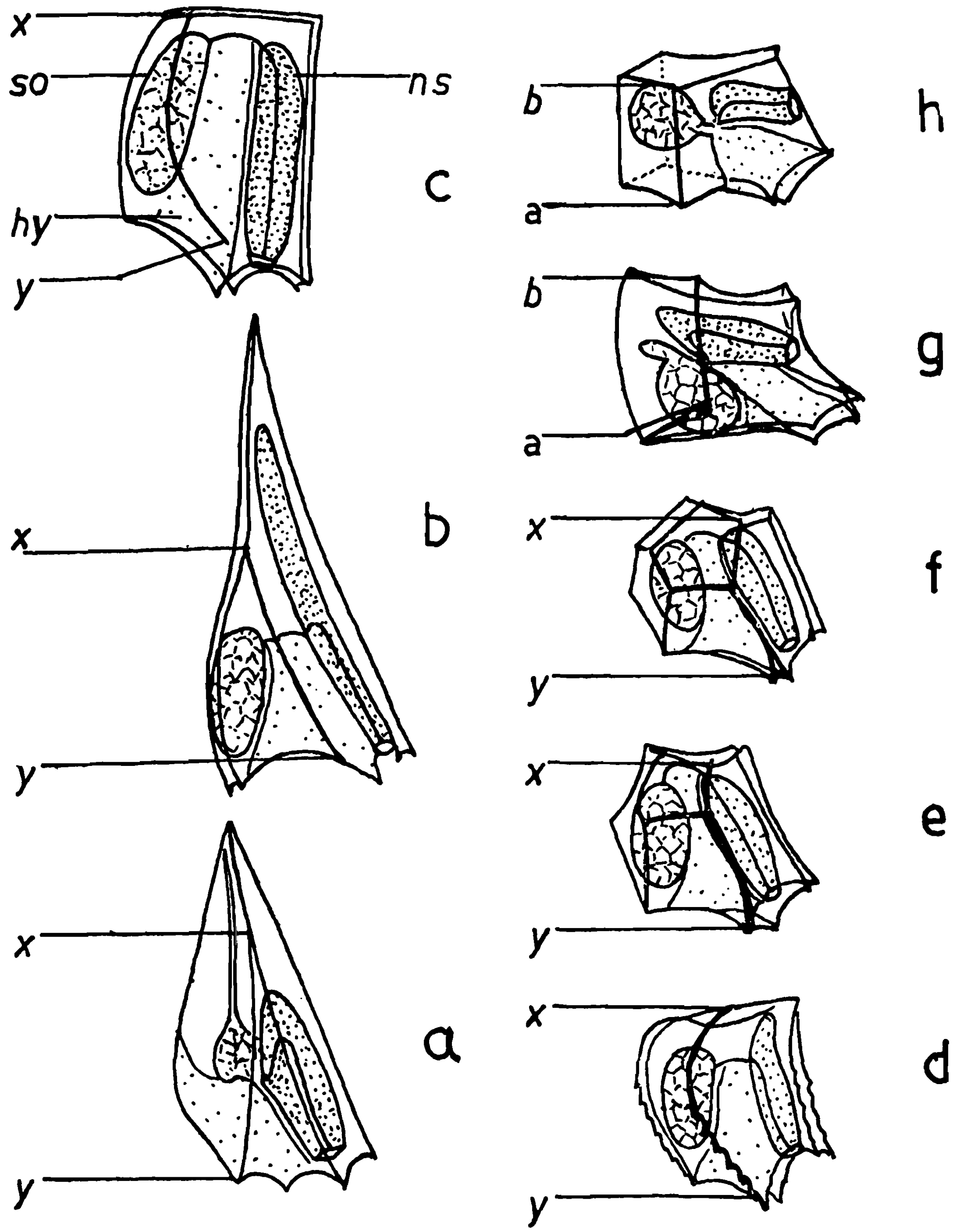


Fig. 3. Anterior nectophores of — a. *C. multidentata* Lens & van Riemsdijk; b. *C. sagittata* (Quoy & Gaimard); c. *C. leuckarti* (Huxley); d. *C. dentata* (Bigelow); e. *A. trigona* Quoy & Gaimard; f. *A. haeckeli* Lens & van Riemsdijk g. *A. tetragona* (Otto); h. *B. bassensis* (Quoy & Gaimard). Ridges ab & xy are homologous; hy – hydroecium; ns – nectosac; so – somatocyst. (From Totton, 1954).

receptor in *Physalia physalis* (Cormier & Hessinger, 1980); and purification and characterization of the endonuclease present in *P. physalis* venom (Ishak, Calton & Burnett, 1980).

Axial canal and arrangement of muscles in stem (Fig. 4):

Although the arrangement of the muscles in the mesoglea in the stem region appears to differ in the four species studied so far it is uncertain whether it is a good specific taxonomic character. It would be worthwhile to study transverse sections of stems of other siphonophores.

Transverse sections of the long stemmed Physonectae and Calycophorae showed the presence of narrow central canal (axial canal) lined by endoderm. Between the external ectoderm and the internal endoderm occurs a thick ring of longitudinal muscle fibres which are ectodermal in origin. These muscle fibres are arranged in close-set radial series on each side of the corresponding centrifugal bands of mesoglea (Fig. 2 a–d). These radial muscles differ in size from the dorsal side of the stem towards the ventral line, where it is replaced by a thin fold or projection of the undifferentiated primary layers called the '*Ventral crest*' Mesoglea is lacking in this region or is very thin. Budding of the various zooids take place only from this region.

The size, shape and position of the axial canal and the presence or absence of the ventral crest arrangement of longitudinal muscles in mesoglea characterises the different species of physonects and calycophores (stem structure is not known in the macrostele cystonects). Their taxonomic importance is seen in Fig. 4a. b, c & d of *Forskalia edwardsi*, *Agalma elegans*, *Apolemia uvaria* and *Rosacca cymbiformis* (studied by Korotneff, 1884; Claus, 1878).

Further, upon the structure of the ventral crest depends the budding and arrangement of various polyp and medusoid structures which characterises the different species. For example, *Forskalia edwardsi* and *Agalma elegans* (Physonects) the crest is continuous and, therefore, budding of the "*dissolved cormidia*" takes place in the siphosome. In species with "*ordinate cormidia*" no budding takes place along the internodes of the stem as in *Apolemia uvaria* (Physonectae) and in all Calycophorae due to the complete suppression of the ventral crest outside the segmental nodes (Garstang, 1946).

Mesoglea:

A characteristic structure or substance that is found in all coelenterates is the mesoglea. This non-cellular gelatinous substance is of great importance to floating coelenterates such as medusae and siphonophores. The amount and nature of the mesoglea varies in different species and in the different structures like the nectophores and bracts. The role of sulphate exclusion in buoyancy maintenance was studied by Bidigare & Biggs (1980).

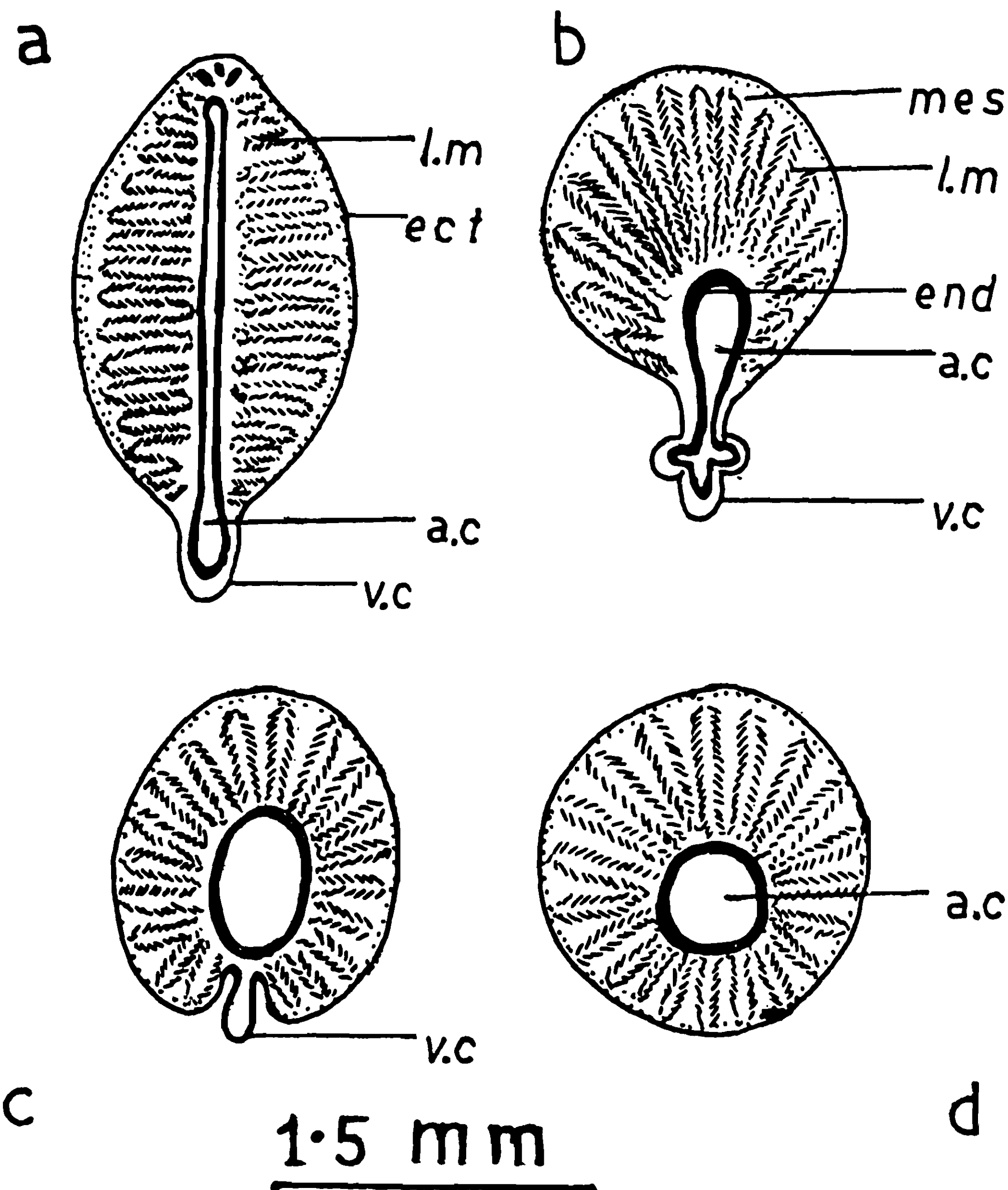


FIG. 4. Transverse sections of stem of — a. *F. leuckarti* Bedot; b. *A. elegans* (Sars); c. *A. uvaria* Lesueur; d. *Rosacea* sp. *Abbreviations used:* ac – axial canal; ect – ectoderm; end – endoderm; lm – longitudinal muscles; mes – mesaglea; vc – ventral crest. (From Garstang, 1946).

REPRODUCTION AND DEVELOPMENT

Studies on development of Siphonophora have been of great help in understanding the polypoid or medusoid origin of the different zooids and in the taxonomy of the group. The general pattern of organization of the three suborders, Cystonectae, Physonectae and Calycophorae can be understood clearly from an examination of their larval development and growth stages. These young stages resemble each other in structure even though when fully grown they differ very much in their morphology. However, nothing is known about the reproductive biology (reproductive cycle, oogenesis, spermiogenesis, sex-determination, hormones/ neurosecretions involved and genetics) or the early development of deep sea species of Siphonophora. Therefore, this study is of great importance not only from the stand point of the arrangement of taxa but also to check the validity of different species as seen in the case of species of *Sulculeolaria*. Morphological variations occurring in the successive anterior nectophores have lead to confusion and description of new species (Carre, 1979).

A review of the literature on reproduction, development and phylogeny of the Siphonophora was presented by the author at the Symposium on "Invertebrate Reproduction" (Daniel, 1980 in press). Usually the Siphonophores are hermaphroditic, each colony producing gonophores of both sexes except *Physalia physalis* which is unisexual. In the Cystonectae the gonophores are sessile highly reduced into sporosacs (styloid type). In the Physonectae and Calycophorae the gonophores are either very small or large but with well developed medusae (codonid type), the manubrium bearing a single ovum in the physonects and 4–16 ova in the calycophores. Fertilization (probably) and development takes place in the water after the germ cells are shed.

The larval development and growth stages of *P. physalis* and some Physonects (Fig. 5) (*A. elegans*, *A. okeni*, *N. cara*, *N. bijuga*, *A. rosacea*, *H. rubrum*) have been studied (Fewkes, 1880, 1885, 1886, 1888; Metschnikoff, 1874; Haeckel, 1888; Woltereck, 1905; Delage & Herouard, 1901; Okada, 1932; Totton, 1954, 1960, 1965). The embryological and larval development of Calycophorae are known in greater detail than the other two sub-orders (*Rosacea* sp. Delage & Herouard 1901; *Hippopodius hippopus* — Chun 1897a, Totton 1954; *Muggiaea kochi*-Chun, 1882; *M. atlantica* — Russel, 1938; *Sulculeolaria quadrivalvis* Metschnikoff, 1874; Lockman, 1914; *Sphaeronectes gracilis* — Metschnikoff, 1874; and on the laboratory reared species *S. quadrivalvis; S. chuni and S. turgida* and *Abylopsis tetragona* — Carre, 1967, 1979). Figs. 6 & 7.)

In all these species the fertilised egg, after segmentation and gastrulation, develops into the characteristic planula larva. The germ-layers are formed along a particular meridian — 'ventral' — and then extend to right and left, first the ectoderm, then the endoderm more slowly until gradually the whole surface of the yolk is covered. The region of the meridian is the site of precocious budding, while the rest of the body is solid with yolk. Further, the precocious budding takes place long before the larva exhibits the typical features of an actinula larva. Therefore, it appears that the slow bilateral course of gastrulation combined with the precocity of budding, is the main reason for the unilateral 'budding' line and the bilateral symmetry of the Siphonophora.

PLANULA LARVA (Figs. 5k; 7b): May be spherical or slightly oval in shape. It is solid, its interior being filled with yolk filled cells usually referred to as the primary endoderm. The end of the larva where the future float develops is the aboral pole and the opposite end where the future primary mouth opening of the

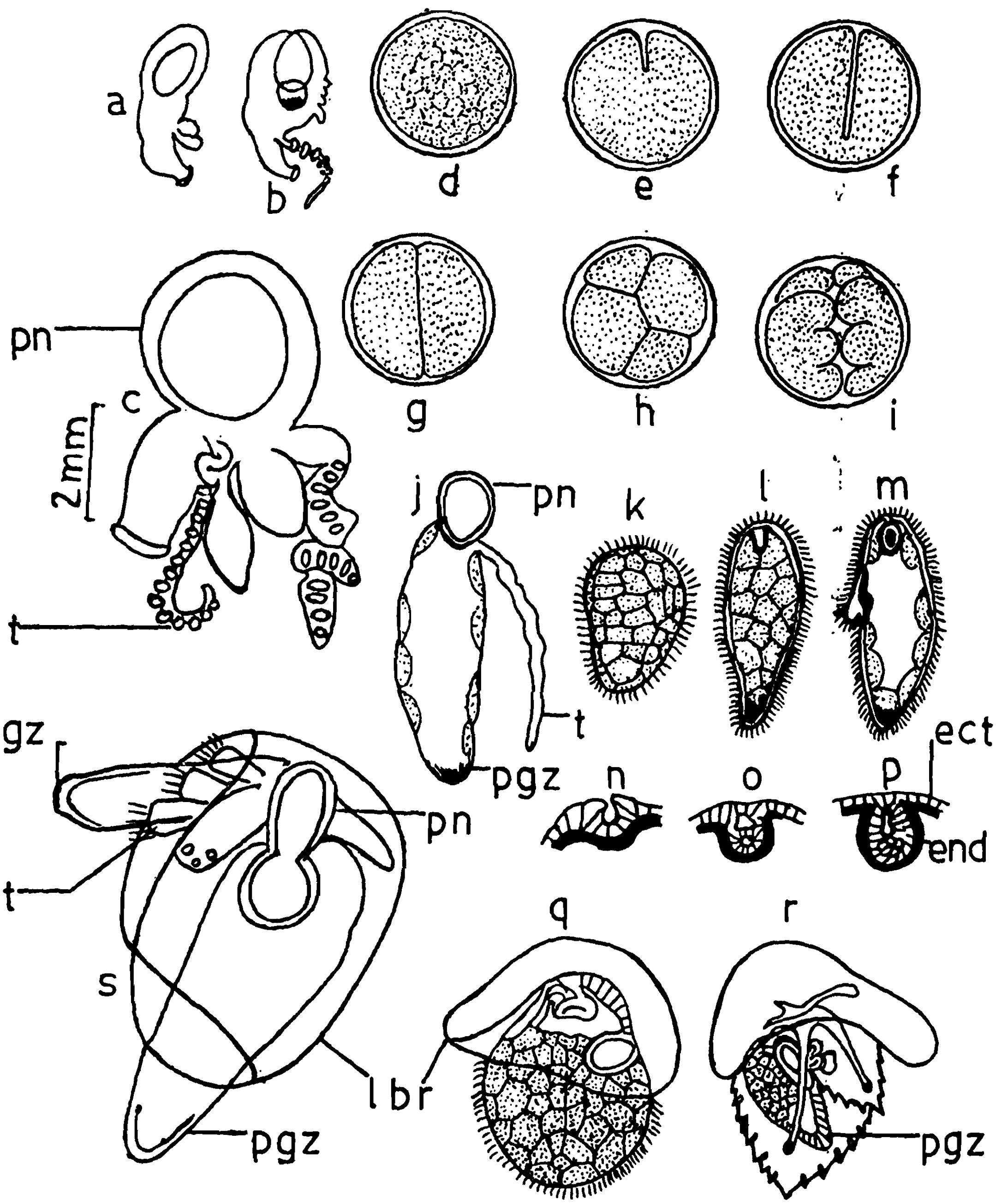


FIG. 5. Development of *P. physalis* (Linne): a–c. Young larval stages; *N. cara* A. Agassiz; d. egg; e & f. cleavage furrows; g.–2 cell stage; h.–4 cell stage; i.–beginning of 12 cell stage; j.–young larva with pneumatophore (pn); Primary gastrozooid (pgz) and tentacle (t); ect. – ectoderm; end – endoderm; *N. bijuga* (Delle Chiaje): k.–planula; l.–formation of pneumatophore; m.–formation of tentacle; n, o, p.–formation of pneumatophore by invagination. *A. elegans* (Sars) q & r.–development of larval bracts (l br); *P. hydrostatica* Forskal s.–young larva with larval bract (l br). (Figs. a, b, k, l, m, q, r — from Leloup, 1954, figs. 2, 4 & 5; d–j, n, o, p — from Fewkes, 1880, 1885; fig. s–from Totton, 1965, fig. 47).

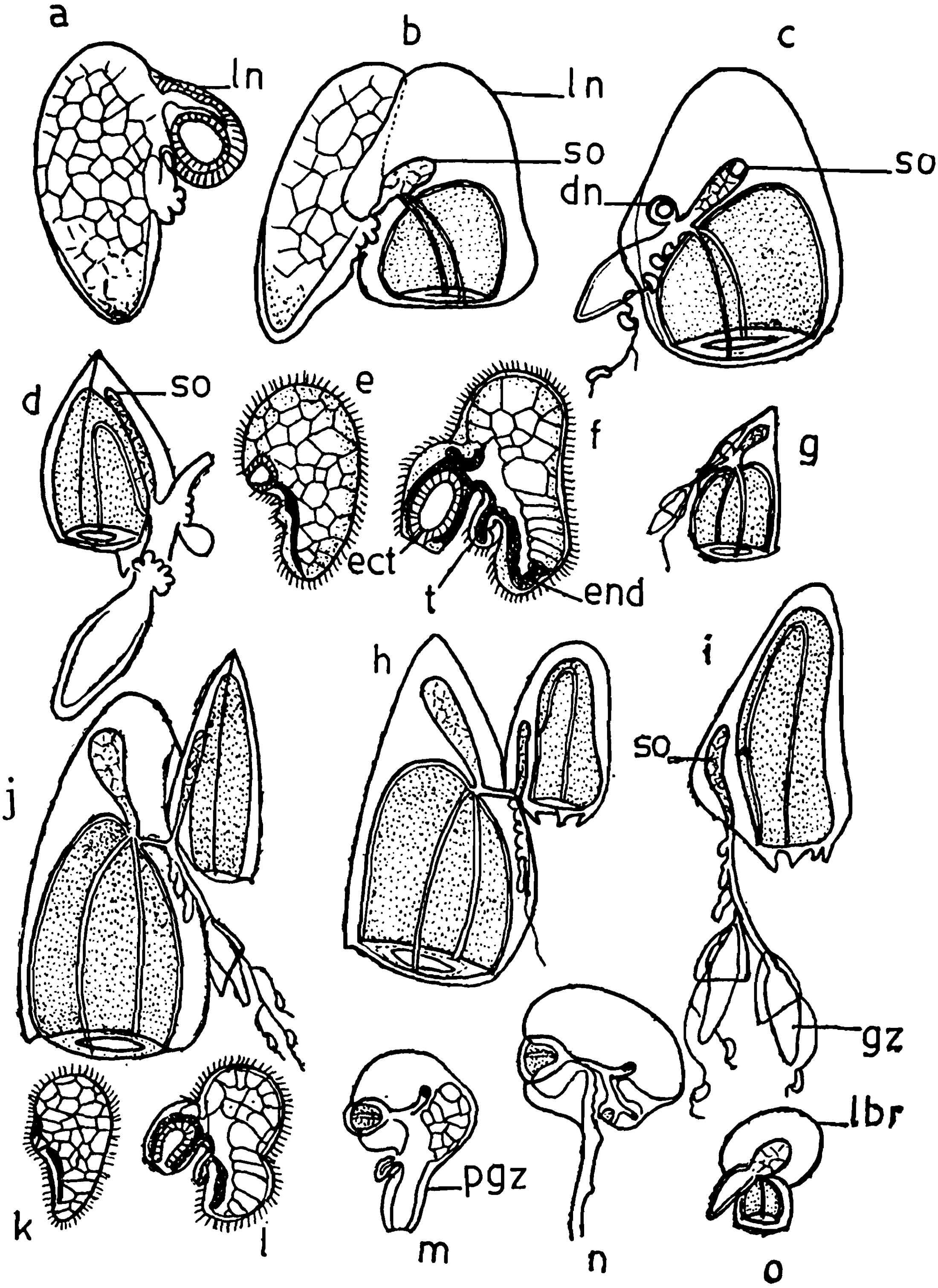


FIG. 6. Development of *M. atlantica* Cunningham: a. Planula with the bud of nectophore; b. larval Nectophore (l ne) and Somatocyst (So) well developed; c. later stage with a bud of definitive nectophore (dne); d. definitive nectophore. *S. quadrivalvis* Blainville: e & f. planula with bud of larval nectophore (l n); g. larval nectophore with bud of definitive nectophore (dn); h. larval and definitive nectophore attached; i. definitive nectophore *C. appendiculata* (Eschscholtz) j. larval and definitive mectophores attached. ect – ectoderm; end – endoderm; so – somatocyst; t – tentacle. *Sphaeronectes* sp. o – larval bract (l br) and nectophore. *Rosacea* sp. k, l & m. planula with bud of larval nectophore; m, n.–with primary gastrozooid (p gz); and – with bud of definitive nectophore. (Figs. a–d, j from Totton, 1965, figs. 3 & 4; e, f, h, i, k–n from Leloup, 1954, figs. 6 & 7).

protozooid is formed is the oral end. The larva is covered with cilia and is capable of locomotion. After the development of various buds on the ventral line, the larva is termed a *cystonula*, *siphonula* (*physonula*) and *calyconula*, characteristic to the three suborders (Haeckel, 1888, Totton, 1954, 1960, 1965; Carre, 1967, 1979).

Float or Pneumatophore (Fig. 5 l–p): For years the float was regarded as the homologue of a nectophore (Schneider, 1896; Chun, 1897; Moser, 1925). This was disproved when the development of the float and the nectophores in physonects and only nectophores in calycophores were studied. In the physonects the float is apical and is formed at first as a shallow open invagination of ectoderm which later closes as in *Nanomia* and *Halistemma* (Chun 1897a; Woltereck, 1905). Therefore, there is nothing in the early rudiment to point specifically to a medusoid origin (Garstang, 1946).

In the calycophores the aboral extremity of the planula larva atrophies so that the pneumatophore of the cystonects and physonects has no homologue in this group. The primary nectophore is developed as a ventral bud which secondarily assumes a sub-apical position. The aboral region of the larval body remains stuffed with yolk during the critical stages of development, and is finally absorbed as the larva grows large as in *Muggiaea kochi*, *M. atlantica*, *Chelophyes appendiculata* and *Abylopsis tetragona* (Figs. 6 & 7).

Gastrozooid and its tentacle (Figs. 5 b, j–pgz, t): The basal half of the planula after gastrulation by delamination, absorption of the yolk-filled cells and the formation of the endoderm along the 'ventral line', develops the primary gastral cavity. On the ventral side, the bud of the developing filament-tentacle is formed very early and elongates as it grows. The nematoblast or cnidoblasts develop at the basal end of this protozooid (primary gastrozooid).

Bract or hydrophyllum (Figs. 5 s, q, lbr): The origin and nature of the characteristic appendages—the bracts in Siphonophora has been under much dispute as to its polypoid or medusoid nature (Haeckel, 1888; Moser, 1925; Hyman, 1940; Garstang, 1946; Leloup, 1954; Totton, 1954, 1965).

The larval bract in *Physophora hydrostatica*, *Agalma elegans* and *Athorybia rosacea* arises very early even before the pneumatophore develops. It is smooth, dome shaped, gelatinous, subapical in position and covers the float. It grows larger due to the accumulation of mesoglea and serves to float the larva. This larval bract falls off after the nectophore becomes larger and functional. In *Halistemma rubrum* the nectophore develops earlier and the larval bract fails to appear (Metschnikoff, 1874) or has a very short existence (Woltereck, 1905).

In *Abylopsis tetragona* the bud of the larval bract is formed first and as it develops, the larval nectophore forms right in front of it.

A cavity lined by endoderm is formed within the bud of the nectophore (somatocyst) and a similar cavity or canal lined by endoderm extend into the rounded larval bract (Phyllocyst). These two structures grow large due to the formation of mesoglea. The mesoglea in the bract helps the larva to float. The yolk filled primary endoderm acts as the yolk-sac until all the yolk is used up by the developing larva. The primary endoderm encloses the cavity of the primary gastrozooid. This endoderm in the larval nectophore forms the somatocyst and the radial canals arising from its base run along the sub-umbrella of the nectophore and join the ring-canal around the ostium. To begin with, the larval nectophore has a rounded appearance and as it grows larger the adult, prismatic facets are formed. As the nectophore becomes functional with the development of the velum the larval bract drops off. The shrunken part of the yolk-filled endoderm covered with ectoderm comes to lie within the hydroecium of the nectophore and becomes the primary gastrozooid. This larval nectophore persists in the adult as the anterior nectophore and therefore it is not caducous as in those species of the families Prayidae and Diphyidae.

In the formation of the larval bract *Abylopsis tetragona* (Fig. 7g, lbr) resembles the species of physonects and *Sphaeronectes* spp. During the differentiation of the larval nectophore there appears a 'medusal nodule' which is typical during medusal budding of hydroid polyps (Carre, 1967 p. 192).

The primary nectophore (i.e. the larval nectophore) in the possession of a somatocyst (which is equivalent to the phyllocyst) and its gelatinous nature prove that it is really a compound structure formed by the fusion of bract and nectophore. It is further seen that the somatocyst develops from a small gastral cavity of the young planula close to the base of the larval nectophore, between the latter and the apical pole, exactly where the cap-shaped bract of a larval physonect takes its origin. The endodermal origin and the identity of the two structures were subsequently recognized by Woltereck (1905), Moser (1925), Garstang (1946), Totton (1965) and Carre (1967). In almost all the species of the families of Calycophorae except in Clausophyidae, Abylidae and Sphaeronectidae this primary nectophore is shed and a new definitive nectophore is developed from the stalk of the somatocyst. In the Abylidae the larval bract is caducous and does not fuse with the larval nectophore which persists as the anterior nectophore in the adult. While in *Sphaeronectes* the larval bract fuses with the larval nectophore and persists throughout life. Therefore, the family Sphaeronectidae which was considered to be the most primitive among the Calycophorae is transferred and put between families Clausophyidae and Abylidae after the significance of its development was understood more clearly (Totton, 1965).

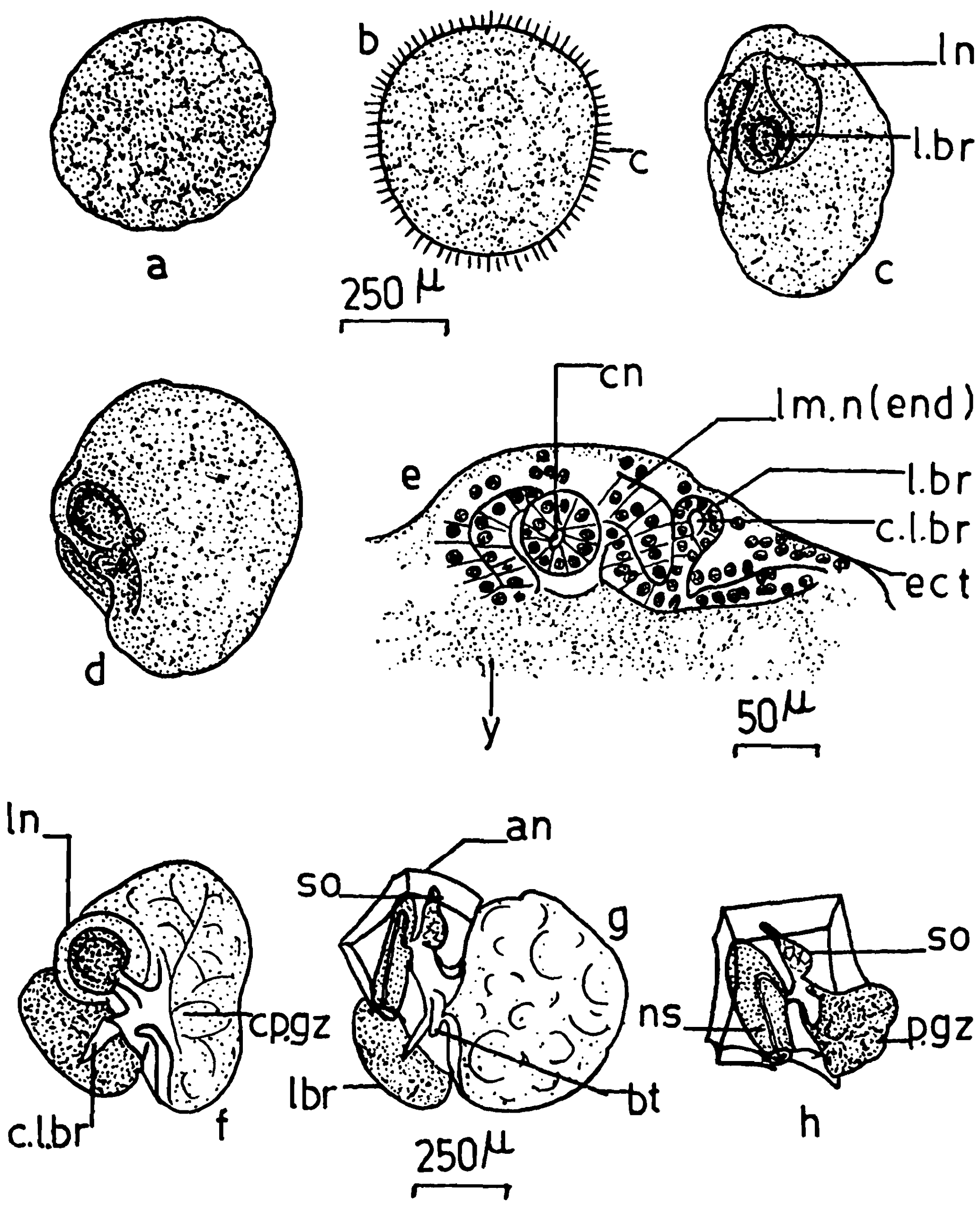


Fig. 7. Development of *A. tetragona* (Otto): a.–morula; b.–planula; c & d. Calyconula stage, with bud of anterior nectophore; e.–sagittal section of calyconula larva; f.–Calyconula 3½ days old, lateral view; g.–Calyconula 5 days old, lateral view; h.–young *Abylopsis*, 7 days old lateral view.—*Abbreviations used:* an – anterior nectophore; bt – bud of tentacle; c – cilia; c l br – canal of larval bract; cn – canal of nectophore; c p gz – cavity of primary gastrozooid; cn – cavity of nectophore; ect – ectoderm; l br – larval bract; lm n (end.) – lamella of nectophore (endoderm); l n – larval nectophore; n s – nectosac; p gz – primary gastrozooid; so – somatocyst; y – yolk granules. (From Carre, 1967, Fig. 1, and pls. I & II).

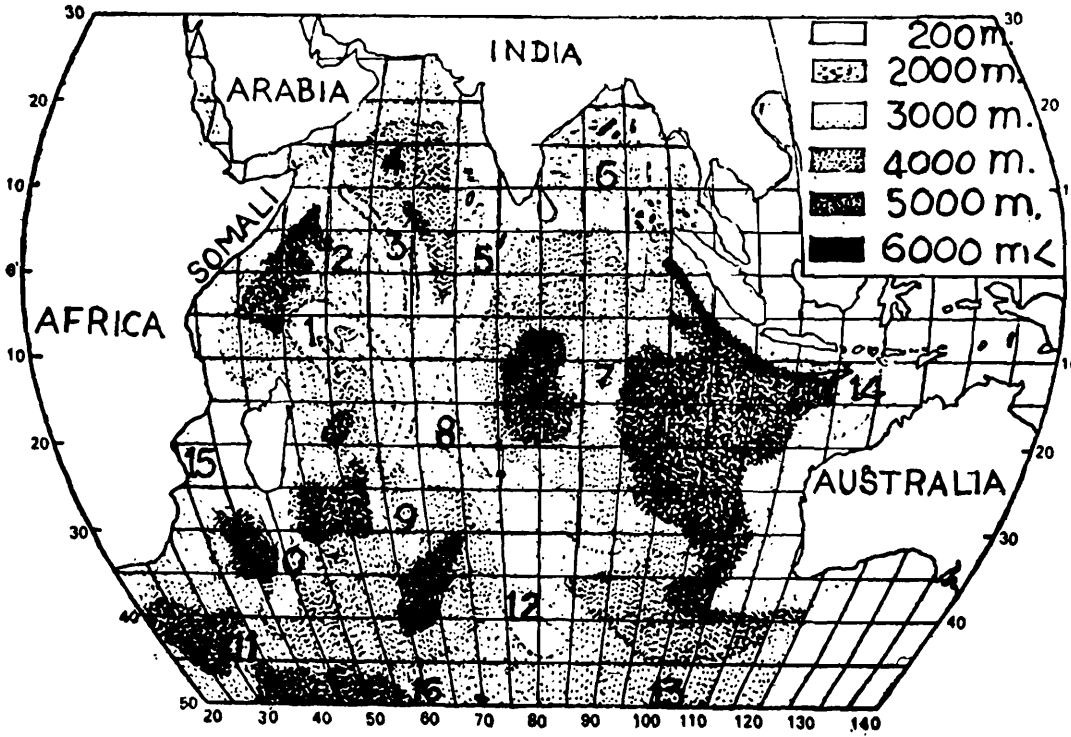
HABITAT

The Siphonophora are holoplanktonic throughout their lives. They do not pass through even a very short fixed larval polypoid stage as in the various hydroids, medusae, and Scyphozoa. Most siphonophores are stenohaline and cannot tolerate high or low salinities and differences in pressure due to depth and temperature. However, they have a wide distribution in the tropical regions of the oceans (Map 1).

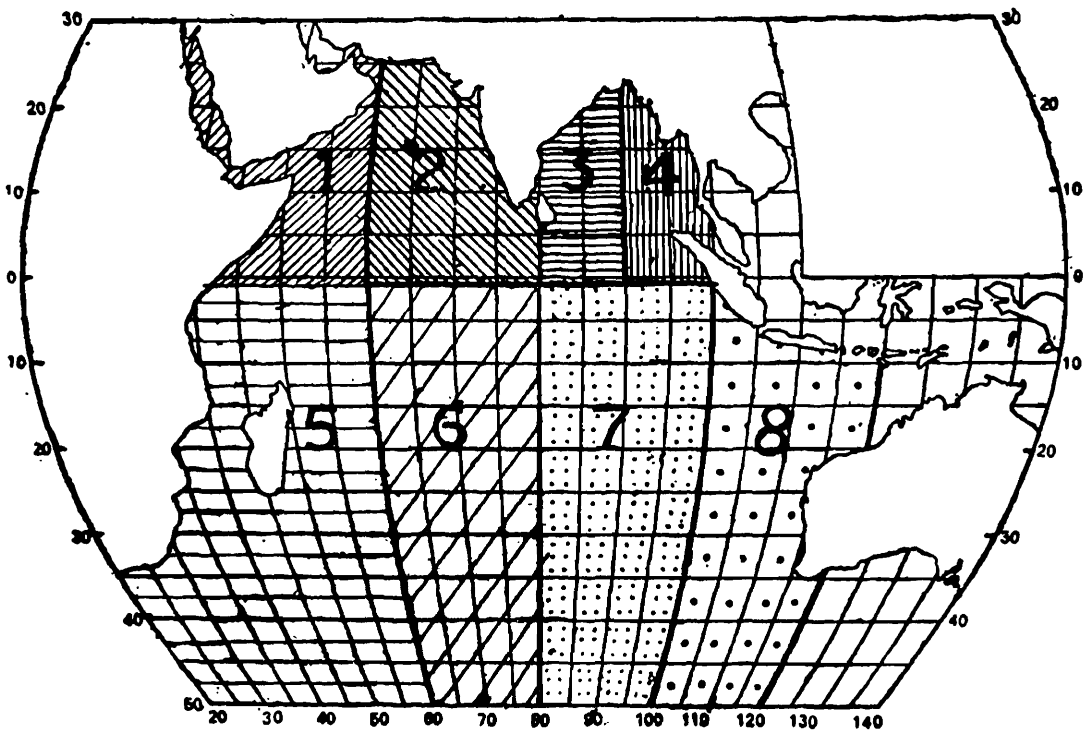
Even though all floating animals are referred to as being planktonic in their habit, many holoplanktonic animals like the Siphonophora are restricted to different zones in the Ocean. They are divided into five groups according to their distribution: Pleustonic species, Neritic species, Oceanic species, Bathypelagic species and Antarctic species.

Pleustonic (Surface) species: Only one species of Siphonophora is truly pleustonic in its habit — *Physalia physalis.* It occurs in dimorphic forms which are mirror — images of each other — i.e. the Siphosomal elements occur either on the right or left side of the crest. They drift passively on the surface of the tropical regions of the Oceans in shoals, being at the mercy of the winds and Ocean surface currents. Stranding of this species is observed along the eastern and western shores of India during particular seasons (Daniel & Daniel, 1963; Rengarajan, 1973). On the east coast they are stranded on the beaches during the months of November, December and January. The dimorphic nature of this species is of paramount importance because the position of the crest prevents a complete and total stranding of the entire population and thereby causing its extinction. When one population with left handed specimens is stranded, the other population with the right-handed specimens is driven away from the shore towards the sea at an angle of 45° right or left of the down wind direction. (A similar condition is noted in *Velella velella* — a pleustonic Chondrophora — where the dimorphic forms exhibit sails with two directions (SW and NW) on the pneumatophore — thereby preventing total stranding of the specimens (Totton, 1954; Daniel, 1979).

Neritic species: Of the 119 species of Siphonophora known from the Indian Ocean (as well as in the 172 world species) only four species, *Diphyes chamissonis*, *Lensia subtiloides*, *Muggiaea atlantica*, and *M. delsmani*, are considered to be neritic species (Bigelow, 1911b; Totton, 1954; Daniel, 1974). *M. delsmani* occurs along the coastal regions of India (along Kathiawar to Orissa Coast) and along the Burma and Malaya Coasts. The centre of distribution appears to be in the Pacific Ocean (Rees, 1966) and it enters the Indian Ocean along the coastal waters between Sumatra and Malaya. The distribution of *M. atlantica* is also noteworthy because it is restricted to the coastal waters of the Arabian Peninsula and to the south



MAP 1. Topography of the Indian Ocean: 1. Seychelles — Mauritius Ridge; 2. Somali Basin; 3. Socotra — Chagos Ridge; 4. Arabian Sea — Arabian Basin; 5. Laccadive — Chagos Ridge; 6. Bay of Bengal; 7. Cocos — Keeling basin; 8. Mid — Indian Rise; 9. South-Eastern Madagascar Basin; 10. Natal Basin; 11. Agulhas Basin; 12. Amsterdam — St. Paul Plateau; 13. Eastern Indian — Antarctic Basin; 14. Sunda Trench; 15. Mozambique Channel; 16. Atlantic-Indian — Antarctic Basin.



MAP 2. Divisions of the Indian Ocean: 1. Arabian Sea — Western part; 2. Arabian Sea — Eastern Part; 3. Bay of Bengal — Indian Region; 4. Bay of Bengal — Burma and Andaman Region; 5. South West Indian Ocean — African Region; 6. South West Indian Ocean — Oceanic Region; 7. South East Indian Ocean — Oceanic Region; 8. South East Indian Ocean — Australian Region.

eastern Africa. *Diphyes chamissonis* and *Lensia subtiloides*, though considered to be true neritic species, do not confine themselves to the coastal waters as seen from their distribution pattern in the Arabian sea and Bay of Bengal (Maps 61, 62, 63, 64). In the Arabian Sea a few examples of these species are observed in the Oceanic region connecting India *via* the Laccadive — Chagos ridge and across to the Seychelles — Mauritius ridge. In the Bay of Bengal, these two species occur in great abundance along the eastern coast of India and in the central region upto the Andaman Islands. This is probably due to the reduced salinity (29.50 o/oo) in the upper layer of water (0–75 m) in the Bay of Bengal due to the input of fresh water from the five major rivers of India *viz.*, Godavari, Krishna, Mahanadi, Ganges and Brahmaputra, monsoon rain and surface run off.

As pointed out by Raymont (1963) it is probable that many factors such as topography of the coast, depth of water, local currents, slightly warmer conditions and reduced salinity influence the distribution of neritic species.

Oceanic Species: The Oceanic species of Siphonophora are those that are not influenced by the proximity of the coast (continental shelf-neritic zone), occurring in the 200–0 m depth in the central regions of the ocean. The twenty-four species listed under the bathypelagic species are also oceanic forms that are usually restricted to the depths, rarely coming to the surface during the upwelling of cold deep waters. Therefore, out of 119 species (excluding 1 pleustonic, 4 neritic, 24 bathypelagic and 5 Antarctic species) 85 species occur all over the Indian Ocean, probably exhibiting a slight diel vertical migration depending upon the movement of thermocline within 50–200 m depth (Barham, 1963; Daniel, Nagabhushnam & Daniel 1968; Daniel & Premkumar, 1965).

In the Arabian Sea the high salinity (39.59 o/oo) water from the Red Sea which extends into the Indian Ocean at depths of about 500 m at latitude 8° N to depths of 1250 m at latitude 20° S. According to Sverdrup *et al.* (1946) the temperature of the surface layers are uniformly high during the greater part of the year, varying between 25°–29°C. During August the upwelling of cold water caused by the South-West monsoon occur along the East African and South-East Arabian coasts as far as the Equator and reduces the temperature. During February the north-west monsoon causes upwelling in the Bay of Bengal. Therefore, salinity also varies during the year, reaching a maximum of 34.4 o/oo. Further, they have noted three main water masses lying below the surface layers: (i) Indian Ocean Central Water — probably formed at the sub-tropical convergence (approximately at 40°S. lat.) by sinking, and having temperature of 8°–15° C and salinities of 34.6–35.5 o/oo; (2) Indian Ocean Equatorial water formed by sub-surface mixing with 4°–17°C temperature and 34.9–35.25 o/oo salinities; (3) Deep water mass below depths of 2000 m (approximately), formed by Antarctic intermediate water (temperature 2.2°C and salinity 33.8 o/oo) and partly by Antartic bottom water (temperature 2.0°C and Salinity 34.8 o/oo). Their mixing up produces deep water in the Indian Ocean of relatively high salinity 34.76 o/oo and temperature about 2.5°C. The maximum salinity recorded from the Red Sea was 39.59 o/oo at a depth of 200 m and 36.58 o/oo at 69 m depth, with corresponding temperature of 22.79°C and 27.10°C respectively on 4-12-64. The lowest salinity recorded from the Bay of Bengal on 19-1-65 was 29.50 o/oo at surface and 34.95 o/oo at 150 m depth with a temperature of 26.12°C at a depth of 30 m and 15.59°C at 150 m (I.I.O.E. - Hand book to the International Zooplankton Collections, Vol. II: Environmental data from I.O.B.C., Cochin; Totton, 1954).

Of the 119 species and one variety 59 have been collected only on one to four occasions from the Indian Ocean: (1) (200–0 m) *Agalma haeckeli*, *Cordagalma cordiformis*, *Lychnagalma utricularia*, *Bargmannia elongata*, *Forskalia formosa*, *F. tholoides*, *F. cuneata*, *Amphicaryon peltifera*, *A. ernesti*, *A. intermedia*, *Maresearsia praeclara*, *Prayoides intermedia*, *Desmophyes annectens*, *Praya reticulata*, *Lensia conoidea*, *L. challengeri*, *L. tottoni*, *L. gnanamuthui*, *L. roonwali*, *L. minuta*, *L. peresi*, *L. subtilis var. chuni*, *L. nagabhushanami*, *L. lelouveteau* ,*L. ajax*, *L. exeter*, *L. multilobata*, *L. grimaldi*, *Eudoxia indica n. sp.*, *Sphaeronectes gracilis*, *S. irregularis*, ? *S. princeps*, *Ceratocymba indica*, ? *Abyla carina* and *A. ingeborgae*.

(2) Deep sea forms *Bathyphysa conifera*, *Apolemia uvaria*, *Halistemma amphytridis*, *Marrus orthocannoides*, *Erenna richardi*, *Nectopyramis diomedeae*, *N. thetis*, *N. natans*, *N. spinosa*, *Vogtia serrata*, *Lensia achilles*, *L. cordata*, *L. tiwarii*, *L. hunter*, *L. havock*, *L. hostile*, *L. reticulata*, *Clausophyes ovata*, *Chuniphyes multidentata*, *C. moserae*, *Crystallophyes amygdalina*, *Heteropyramis maculata*, *Thalassophyes crystallina* and *Abyla bicarinata*.

The remaining 61 species have been recorded many times from the Indian Ocean (**Physalia physalis*, *Rhizophysa eysenhardti*, *R. filiformis*, *Agalma okeni*, *A. elegans*, *Halistemma rubrum*, *Nanomia bijuga*, *Athorybia rosacea*, *Melophysa melo*, *Frillagalma vityazi*, *Physophora hydrostatica*, *Forskalia leuckarti*, *F. edwardsi*, *Amphicaryon acaule*, *Rosacea cymbiformis*, *R. plicata*, *Praya. dubia*, *Hippopodius hippopus*, *Vogtia pentacantha*, *V. spinosa*, *V. glabra*, *Sulculeolaria quadrivalvis*, *S. biloba*, *S. chuni*, *S. turgida*, *S. monoica*, *S. angusta*, *S. bigelowi*, *Diphyes dispar*, *D. bojani*, **D. chamissonis*, *Eudoxia macra*, *Eudoxoides mitra*, *E. spiralis*, *Lensia hotspur*, **L. subtiloides*, *L. fowleri*, *L. leloupi*, *L. panikkari*, **L. hardy*, *L. campanella*, *L. cossack*, *L. subtilis*, *L. meteori*, *L. multicristata*, **Muggiaea atlantica*, **M. delsmani*, *Chelophycs appendiculata*, *C. contorta*, **D. arctica*, *Ceratocymba leuckarti*, *C. dentata*, *C. sagittata*, *Abyla haeckeli*, *A. schmidti*, *A. trigona*, *Abylopsis tetragona*, *A. eschscholtzi*, *Bassia bassensis*, *Enneagonum hyalinum*, and *E. searsae*.)

These species (except the pleustonic, neritic and cold water species — marked with asterisks) are able to adapt themselves to varying hydrographical factors, and eleven species (*A. okeni*, *D. dispar*, *D. bojani*, *S. chuni*, *L. hotspur*, *E. mitra*, *C. contorta*, *C. appendiculata*, *A. tetragona*, *A. eschscholtzi* and *B. bassensis*) contribute the bulk of the Siphonophore component of the zooplankton of the Indian Ocean, and also are not affected by the thermocline during their vertical migration, whereas *A. rosacea*, *V pentacantha*, *V. glabra*, *D. arctica*, *L. multicristata* and *L. fowleri* appear to be restricted by the thermocline during their upward migration (Daniel, 1977).

A study of the day/night variations in the occurrences of the different species shows that except the 17 species which did not show much day/night variation (*P. hydrostatica*, *R. plicata*, *R. cymbiformis*, *V. spinosa*, *V. pentacantha*, *A. acaule*, *P. dubia*, *S. quadrivalvis*, *S. turgida*, *S. monoica*, *S. bigelowi*, *L. meteori*, *L. multicristata*, *L. fowleri*, *D. arctica*, *C. dentata* and *A. haeckeli*) and the rarely recorded species (35 in number mentioned above) the others show distinct day/night variation. The species which occurred mainly during night time at a depth of 200–0 m are the Physonects (*A. okeni*, *H. rubrum*, *N. bijuga*, *F. vityazi*, and *A. rosacea*) and Calycophorids (*V spinosa*, *S. biloba* and *C. sagittata*). Most of the species of Siphonophora, however, occur more during day time at the same depth (these are: *R. filiformis*, *A. elegans*, *H. hippopus*, *V. glabra*, *S. chuni*, *E. macra*, *D. dispar*, *D. bojani*, *D. chamissonis*, *L. subtiloides*, *L. hotspur*, *L. campanella*, *L. cossack*, *L. subtilis*, *M. atlantica*, *C. appendiculata*, *C. contorta* *E. mitra*, *E. spiralis*, *A. tetragona*, *A. eschscholtzi*, *B. bassensis*, *E. hyalinum* and *E. searsae*). Certain other species show different day/night variations to the north and south of the equator (night captures being higher north of the equator for *M. melo* and *A. schmidti*; night captures being higher south of the equator for *F. leuckarti*, *S. angusta* and *C. leuckarti*). Certain other species though occurring in all the four zones, show that during the South West monsoon season their occurrence in the Arabian Sea differs from that in the Bay of Bengal *i.e.* when day captures are more in the Arabian Sea, night captures are more in the Bay of Bengal (*A. elegans*, *L. leloupi*, *C. contorta*, *E. mitra*, *A. tetragona*, *A. eschscholtzi* and *B. bassensis*). During the South East monsoon season in the South West Indian Ocean the night/day densities are invariably similar. The species occur in greater abundance during South West/South East monsoon season.

An interesting feature observed in the distribution of many species of Siphonophora is the aggregation of the species in the equatorial belt region, 5° N to 5° S latitudes, during South West/ South East monsoon season. Of the 89 species studied from the seas around the Indian Coast, 61 species occur in this narrow zone (equatorial belt) showing a greater concentration of species (75%) in this region. Excluding the rare species the percentage goes upto

94 (Daniel and Daniel 1969). During the North East/North West monsoon season, the species scatter from this region and move closer to land — masses and higher latitudes (Daniel, 1975 — Ph.D. Thesis).

The probable factors contributing to the concentration of the species in the narrow equatorial belt region are: (1) Occurrence of different currents converging on this zone — *i.e.* Sub-Antarctic water, Indian equatorial water and Indian central water (2) Circulation of water in this region in the form of a clock-wise gyral probably centred near 3° N mainly during south-west monsoon period, (3) Upwelling of deeper waters especially in the western sector (Panikkar, 1969; Chang — Tai Shih 1969; Gopalakrishnan and Brinton, 1969) and (4) Physical and chemical profiles along the equator showing the presence of relatively cool (26°C) water in the 0–100 m layer west of 55°E longitude and the high salinity, oxygen and inorganic phosphate content (Fisher, 1964; Taft, 1965).

It is felt that the Siphonophores brought into this zone through the agency of the different currents and the upwelling waters are prevented from being scattered into other areas during the South-West monsoon period by the clock-wise gyral circulation. During the North - East monsoon period, gyral circulation probably weakens and the Siphonophores (plankton) get scattered. Subsequently, the Somali current in the western sector and other zonal currents transport the Siphonophores to the Somali coast, Gulf of Aden, Arabian coast, and Gulf of Oman, on the western part of the Arabian sea and other areas on the west and east coasts of India. The occurrence of many common species of Siphonophores as a rich belt within 5° N to 10° N latitudes in the Bay of Bengal is probably caused by the formation of a barrier between (1) the water masses with reduced salinity emerging from the river systems and that with higher salinity occurring in the Oceanic region and (2) the extension of the clock-wise gyral circulation during South West monsoon period into the Bay of Bengal.

Thus the wide distribution enjoyed by the common species of siphonophores in the tropical regions of all the oceans can be attributed to the ocean currents, fairly high salinity (36–29°/$_{oo}$), temperature (25–30°C) and euryhaline depths (200–0 m).

Bathypelagic species: Except for two references on bathymetric range of Siphonophora from the Indian Ocean, nothing is known about the depth range of these mid-and deep-water species (Totton, 1954; Daniel, 1974).

During the International Indian Ocean Expedition plankton collections were made only from 200 m (or slightly deeper) to the surface except for collections made by the *R.V. Vityaz* and two samples each from 66 stations from the western sector of the Indian Ocean made by the *R.R.S. Discovery* which were taken from a depth of 200–0 m and the other from the thermocline to surface (Daniel, 1977).

Nothing is known about the mid-deep water species belonging to the family Rhodaliidae from the Indian Ocean. Further, our knowledge of the deep water physonects (sometimes measuring to several metres) is based on fragments of the species collected from fishing nets, trawls and from those sticking to the long wire ropes let down for deep hydrographical and topographical studies. Bathymetrical range for world species of Siphonophora is given by Daniel (1974).

The truly bathypelagic species sixteen in number which do not come up to the surface even during the upwelling of deep cold water mass are as follows: *Halistemma amphytridis* (1000–0 m); *Marius orthocannoides* (1400–700 m); *Erenna richardi* (1900–1500–100m); *Nectopyramis diomedeae* (1600–650 m); *N. thetis* (1250–800 m); *N. natans* (2580–2480; 1650–950 m); *N. spinosa* (1000–0 m); *Lensia hunter* (1000–0 m); *L. achilles* (1400–1000 m); *L. cordata* (950–650 m); *Clausophyes ovata* (1350–0 m); *Chuniphyes moserae* (1260–600 m); *C. multidentata* (1000–200 m); *Crystallophes amygdalina* (1650–950, –700 m); *Heteropyramis maculata* (1400–250 m); and ? *Thalassophyes crystallina* (1400–700, –200 m).

The following fourteen species though living at depth, come up (200–0 m) during upwelling of cold deep water mass: *Bathyphysa conifera* (4391–521 m in Pacific Ocean; fragments collected from 200–0 m from south of Java), *Apolemia uvaria* (collected from below 600 m in Mediterranean Sea, comes to surface during upwelling (Totton, 1954); exact depth range from Indian Ocean is not given by Haeckel, (1888). Other mid water species which also occur at 200–0 m are *Forskalia edwardsi*, *Lensia panikkari*, *L. tiwarii*, *L. hostile*, *L. havock*, *Dimophyes arctica*, *Ceratocymba dentata*, *C. sagittata*, *Abyla ingeborgae*, *A. bicarinata*, *A. trigona* and *Enneagonum searsae*. Most of these forms occur in the sonic scattering layer (Barham, 1963; Daniel, Nagabhushanam & Daniel, 1968; Daniel 1977). Of these the distribution of *D. arctica* is of great interest and importance because it is considered as a valuable "indicator" species of deep cold water masses (referred to among the Antarctic species).

Antarctic Species: The following eighteen species of Siphonophora are known from the Antarctic Ocean: *Moseria convoluta*, *Pyrostephos vanhoeffeni*, *Marrus antarcticus*, *Rosacea plicata*, *Vogtia serrata*, *Diphyes antarctica*, **Dimophyes arctica*, **Lensia hardy*, **L. achilles*, **L. havock*, **L. reticulata*, *Muggiaea bargmannae*, *Clausophyes galeata*, **Chuniphyes moserae*, **C. multidentata*, **Crystallophyes amygdalina*, **Heteropyramis maculata* and **Thallossophyes crystallina*. Of these *Moseria convoluta*, *Pyrostephos vanhoeffeni*, *Diphyes antarctica*, *Marrus*

* Mid to deep cold water species occurring in the Indian Ocean also.

antarcticus are restricted to the Antarctic Ocean. Distribution of *Muggiaea bargmannae* is of interest because of its occurrence near the two poles and probably it lives at depths where there is optimum temperature in the other oceans also connecting the Arctic and Antarctic Oceans. *M. bargmannae* does not come to the surface or even as far as the lower boundary of the thermocline like *Dimophyes arctica*. *D. arctica* also occurs in the Arctic and Antarctic Oceans but in the Indian Ocean it comes to the lower boundary of the thermocline as far north as 13° 12′ N latitude and longitudes 42° 04′ E–113° 20′ E. It is considered as a valuable "indicator species" of cold deep water mass (Totton, 1954; Daniel, 1974). During the International Indian Ocean Expedition it was found to occur in definite areas in the Indian Ocean during different months. Further, it is observed that this species which lives in great abundance in the Antarctic region is not present near the Sub-Antarctic Convergence or south of 12° 42′ S latitude, showing that in the Indian Ocean the upwelling of the deep, rich, cold water mass occurs within this area (13° 12′ N to 12° 42′ S latitudes) especially near Gulf of Aden (August), Somali Coast (January, August & December), off Cochin (November), off Sri Lanka (February), Andaman Islands (February, March, April, August & September), off Durban (January, August & December), South of Java (January &, December) and in the mid-oceanic region of the Equator (March, April, May, June, July, September, October & December). Furthermore, the absence of the eudoxid phase of *D. arctica* in the collections from 200–0 m depth and its presence at depth below 400 m indicates that the breeding takes place at the deeper regions and that the mid-water mass alone probably comes up during upwelling. This species prefers an optimum temperature of 3°–6°C and salinity of 34.20 ‰ to 34.94 ‰. It does not survive in the upper warm water regions (Totton, 1954; Daniel, 1974). I.I.O.E. material does not throw any light on the depth and temperature distribution for this species.

Our knowledge of the upwelling regions in the Indian Ocean is of great importance because these regions are enriched by the deeper waters, and become areas of high primary production. Upon such productive areas depend our fisheries.

Marrus antarcticus and *Vogtia serrata* occur mainly in this ocean but also are recorded in waters that have just left the zone. *V. serrata* and rest of the Antarctic species are collected from other oceans but from depths where the temperature is low. *Clausophyes galeata* is not recorded from the Indian Ocean but occurs in the Pacific Ocean. *Lensia hardy* is recorded for the first time from the Indian Ocean from the Sub-Antarctic Convergence areas between 35° S–45° S latitudes. Another interesting feature observed in the sub-Antarctic area is that, three species *Chelophyes contorta*, *Chelophyes appendiculata* and *Eudoxoides spiralis* — which do not normally occur in the Antarctic ocean — grow to large size — *i.e.* 1½ to 2 times the usual size. This phenomenon has been attributed to the cold temperature and abundant food supply available in the Sub-Antarctic Convergence regions (Raymont, 1963).

MATERIAL AND METHOD

The Siphonophora are very delicate holoplanktonic coelenterates occurring from the surface of the sea to great depths and measuring from a few millimetres to several metres. However, majority of them occur within 200–0 metre range, in the euphotic zone, and exhibit a slight diel migration (Barham, 1963). Many species are collected by using various plankton nets — Indian Ocean Standard Net, Organde net, Juday net, Pleuston net, Nansen's net, N 70 net; the huge bathyphysids and physonects and the deep sea forms need special nets and devices for capturing them — Isaac Kidd trawl, Ring trawl, Ichthyological net, Beam trawl, and sticking to wire ropes let down to great depths for hydrographical studies (Daniel 1974). Even in spite of careful collecting methods, many siphonophores loose all their polymorphic structures on collection and preservation. Therefore, in many cases, the descriptions are based not on whole individuals but on certain vital loose parts like nectophores.

Descriptions, distribution and seasonal variations included under each species have been based on ninety-seven species studied by the author. The remaining twenty-three species (*Apolemia uvaria*, *Agalma haeckeli*, *Marrus orthocannoides*, *Forskalia cuneata*, *Amphicaryon ernesti*, *Desmophyes annectens*, *Nectopyramis diomedeae*, *N. thetis*, *N. natans*, *Vogtia serrata*, *Lensia peresi*, *L. minuta*, *L. achilles*, *L. cordata*, *L. lelouveteau*, *L. exeter*, *L. grimaldi*, *L. multilobata*, *Clausophyes ovata*, *Crystallophyes amygdalina*, *Thalassophyes crystallina*, *Sphaeronectes princeps*, and *Abyla carina*) were not examined by the author but were compiled from the works of Huxley (1859), Haeckel (1888), Bigelow (1911b, 1931), Moser (1925), Browne (1926), Leloup (1933, 1934), Totton (1932, 1954, 1960, 1965), Carre (1968), Alvarino (1969–1971), Sears (1952, 1953) and Rengarajan (1973).

Collections Examined:

The extensive collections made during the International Indian Ocean Expedition (IIOE–1960, 1962–1965) by the nineteen research vessels from nine countries (participated) were deposited in the Indian Ocean Biological Centre (I.O.B.C.) Cochin, India, which maintained, sorted out various groups of plankton and processed the material for study by specialists. After the larger organisms, fish eggs and larvae were removed, the samples were sub-sampled either with a Lea's plankton fractioner or by a Folsom plankton splitter. The fractions varied from 10–90% depending upon the quantity of the plankton samples. The siphonophores made available to the author by the Consultative Committee of the UNESCO were sub-sorted, counted and identified down to species.

Condition of the International Indian Ocean Expedition material:

The entire Siphonophore material examined were not in a good state of preservation and almost all the nectophores had lost their musculature. Therefore, the canal system could not be studied. For example, the canal system of the nectophores of a rare species probably belonging to *Lychnagalma utricularia* could not be described in detail and the other parts of the colony were not present in the collections. Some rare and probably new species have not been included in this study.

Details of the IOBC material examined are tabulated below*:

No.	Name of ship	Country	No. of samples	No. of specimens
1.	"Anton Bruun"	United States	393	29,630
2.	"Argo Dodo"	United States	19	1,060
3.	"Argo Lusiad"	United States	109	2,790
4.	"Conch"	India	6	865
5.	"Diamantina"	Australia	230	13,379
6.	"Discovery"	United Kingdom	255	21,646
7.	"Gascoyne"	Australia	56	3,765
8.	"Kago Shima Maru"	Japan	40	2,307
9.	'Kistna"	India	402	38,374
10.	"Koyo Maru"	Japan	52	2,089
11.	"Meteor"	German Federal Republic	147	19,674
12.	"Gilchrist" (Natal)	South Africa	143	4,829
13.	"Oshoro Maru"	Japan	98	5,647
14.	"Patanela"	Australia	21	381
15.	"Pioneer"	United States	56	3,405
16.	"Umitaka Maru"	Japan	61	2,191
17.	"Varuna"	India	87	8,336
18.	"Vityaz"	Soviet Union	97	11,579
19.	"Zulun"	Pakistan	22	1,182
			2,294	1,73,129

1927 Zooplankton stations were established in the Indian Ocean (25° N to 45° S lat., 20° E to 120° E long.).

* Further details regarding the stations and hydrographical parameters are given in the Hand Book to the International Zooplankton Collections, Vol. I & II.

In addition the following material was examined:*

(1) Material collected from the 227 stations during the 4th cruise (1962), Ist cruise (1963) of *HMAS Gascoyne* and 2nd, 3rd and 4th cruises 1962, 1st, 2nd, 3rd & 5th cruises (1963) of *HMAS Diamantina* along the western coast of Australia (110° E longitude) provided 15,332 specimens belonging to 56 species, sent by CSIRO, Australia.

(2) The 35th cruise of *R. V. Vityaz* in 1962 collected 86 plankton samples from 48 stations for the Zoological Survey of India. The samples yielded 1,847 specimens of Siphonophora belonging to 61 species and contained three deep sea species *Chuniphyes multidentata*, *C. moserae* and *Heteropyramis maculata*.

(3) The *INS Kistna* cruises Nos. I, II & III (1962) and XV & XIX (1964) brought in 92 plankton samples for the Zoological Survey of India and 3,014 specimens belonging to 52 species were identified.

(4) Besides these, plankton hauls made from the following coastal regions Digha (West Bengal), Puri (Orissa) Waltair (Andhra Pradesh), Madras (Tamil Nadu), Cochin and Calicut (Kerala) and the Great Nicobar and Andaman group of Islands during 1965–'66 were also examined. A total of 4,131 examples belonging to 11 species were sorted from these collections.

(5) Further, the collections of Siphonophora, made from the in-shore and off-shore plankton samples and from the beach of Madras over a period of six years (1952–'54, 1956–'60) included 27 species.

Preservation: Siphonophores due to their floating habit possess a great deal of mesoglea which is composed of more than 95% sea water. Therefore, they are not an easy group to preserve well. Best results are obtained by preserving them with 5–10% formalin added to sea water or in saline water. For specialised detailed study they are narcotised in magnesium chloride, menthol crystals, or chloral hydrate. One draw back when narcotising reagents are used, is that the animals relax and extend to such an extent that they form too many knots and kinks on preservation.

Distribution Maps: The actual locality records for 112 species showing the number of examples per haul (especially for the 97 species mentioned above) have been presented for the two monsoon seasons (SW/SE monsoon season and NE/NW monsoon season) in the maps. For the eight species (*Diphyes dispar*, *D. bojani*, *Eudoxoides mitra*, *Chelophyes contorta*, *Lensia hotspur*, *Abylopsis tetragona*, *A. eschscholtzi* and *Bassia bassensis*) which occurred in more than

* Fuller details regarding the material and stations are given in several publications by the author (Daniel & Daniel, 1963 a, b, c; Daniel, 1966–1979.

75% of the stations established, the distribution and abundance have been presented as an average in each 5° square (Marsden square system) of the Indian Ocean for the two seasons, following the method adopted by earlier workers on other taxa for the I.I.O.E. samples. (Brinton & Gopalakrishnan, 1969). The year has been divided into two periods, April 16th–October 15th agreeing with the wind regime of the South West/South East monsoon (northern summer/southern winter) and October 16th–April 15th corresponding the North East/North West monsoon (northern winter/southern summer). These collections were further subdivided into night and day in the four main zones (Arabian Sea, Bay of Bengal, SW Indian Ocean and SE Indian Ocean) and monthly variations in the eight regions of the Indian Ocean.

INDIAN OCEAN: (Map 2)

1. *Arabian Sea:* (40°–80° E long & 22°–0° N lat.)

(a) Western Part (40° E–60° E long) — including Somali Coast, Gulf of Aden, Red Sea, Arabian Coast and Gulf of Oman;

(b) Eastern Part (60°–80° E long) — including west coast of India, Coast of West Pakistan.

2. *Bay of Bengal:* (80°–100° E long & 22°-0° N lat.)

(a) Indian Region (80°–90° E long) — east coast of India and Sri Lanka.

(b) Burma and Andaman Region (90°–100° E long.) — ncluding Andaman group of islands, coasts of Burma and Malaya;

3. *South-West Indian Ocean:* (20°–80° E long. & 0°-45° S lat.)

(a) African Region (20°–60° E long.) — including African coast south of Equator and Madagascar.

(b) Oceanic Region (60°–80° E long.) — including oceanic islands and mid-ocean.

4. *South East Indian Ocean:* (80°–120° E long. & 0°–45° S Lat.)

(a) Australian Region (100°–120° E long.) — south of equator off Indonesia and Australian coast.

(b) Oceanic Region (80°–100° E long.) — including mid-ocean area.

The distribution maps have been prepared on the basis of species studied and on previous published records, from the Indian Ocean.

The illustrations of the hundred and twenty species are based on the species studied (living and preserved) and on published works (referred to under each figure).

The details of the material of the ninety-seven species collected during the International Indian Ocean Expedition from the different zones and seasons are given under each species. For the other twenty-three species, locality records and the references are given.

Abbreviations used:

a.n.	—	anterior nectophore
br.	—	bract
col.	—	colony
eu (compl.)	—	eudoxid phase (complete with both bract and gonophore or special nectophore intact)
f.n.	—	functional nectophore
gz.	—	gastrozooid
go.	—	gonophore
l.br.	—	larval bract
l.st.	—	larval stage
n.	—	nectophore
p.	—	palpon
p.g. (compl.)	—	polygastric phase (complete with both anterior and posterior nectophores intact)
p.n.	—	posterior nectophore
sp.n.	—	special nectophore
te.	—	tentillum
v.n.	—	vestigeal nectophore

CLASSIFICATION

In accordance with the increase in our knowledge of the various groups of Siphonophora, their morphology and phylogenetic relationship (Garstang, 1946; Totton, 1954; Leloup, 1954) the Order Siphonophora which hitherto included the 'sub-order' Chondrophora (*Porpita, Porpema* & *Velella*) was separated from them, various taxa rearranged, nomenclatures and classification changed in many respects.

Keys for distinguishing the Sub-orders, families, Sub-families, genera and species are dealt with. The taxonomy of Siphonophora is based not only upon external morphological structures but also upon internal structures of specific importance.

There are 158 valid and 15 doubtful species of Siphonophora in the world oceans. Of these a grand total of 116 valid, one variety and 3 doubtful species are known from the Indian Ocean. Only one family, the Rhodaliidae, is not represented in the Indian Ocean. Forty-one valid and 12 doubtful species have not been collected so far from this region. These are:

1. *Bathyphysa sibogae* Lens & van Riemsdijk, 1908; 2. *Tottonia contorta* Margulis, 1980; 3. *Ramosia* sp. Stepanjants, 1967; (Family Apolemiidae); 4. *Agalma clausi* Bedot, 1886; 5. *Halistemma cupulifera* Lens & van Riemsdijk, 1908; 6. *H. striata* Totton, 1965; 7. *Nanomia cara* A. Agassiz, 1865; 8. *Marrus antarcticus* Totton, 1954; 9. *M. orthocanna* (Kramp, 1942); 10. *Moseria convoluta* (Moser, 1925); 11. *Moseria similis* Margulis, 1977; 12. *Rudjakovia plikata* Margulis, 1982; 13. *Stepanyantsia polymorpha* Margulis, 1982; 14. *Mica micula* Margulis, 1982; 15. *Pyrostephos vanhoeffeni* Moser, 1925; 16. *Athorybia lucida* Biggs, 1978; 17. *Angelopsis globosa* Fewkes, 1886; 18. *Angelopsis dilata* Bigelow, 1911; 19. *Stephalia corona* Haeckel, 1888; 20. *S. bathyphysa* Haeckel, 1888; 21. *Sagamalia hinomaru* Kawamura, 1954; 22. *Rhodalia miranda* Haeckel, 1888; 23. *Archangelopsis typica* Lens & van Riemsdijk; 24. *Dromalia alexandri* Bigelow, 1911; 25. *Prayola tottoni* Carre, 1969;. 26 *Rosacea flaccida* Biggs, Pugh & Carre, 1978; 27. *Lilyopsis rosea* Chun, 1885; 28. *Desmophyes villafranchae* Carre, 1969; 29. *Stephanophyes superba* Chun, 1888; 30. *Diphyes antarctica* Moser, 1925; 31. *Lensia baryi* Totton, 1965a; 32. *L. asymmetrica* Stepanjant, 1970; 33. *Lensia zenkevitchi*, Margulis, 1970; 34. *Lensia canupusi* S. tepanjant, 1977; 35. *Muggiaea kochi* (Will, 1884); 36. *M. bargmannae* Totton, 1954; 37. *Clausophyes galeata* Lens and van Riemsdujk, 1908; 38. *Sphaeroncctes gamulini* Carre, 1966; 39. *S. bougisi* Carre, 1968a; 40. *S. fragilis* Carre, 1968; 41. *Abyla tottoni* Sears, 1953. The 12 doubtful species of Siphonophora not represented in the Indian Ocean are as follows: 42. *Salacella polygastrica* Haeckel, 1888; 43. *Bathyphysa japonica* Kawamura, 1943; 44. *Epibulia chamissonis* (Eysenhardt, 1829); 45. *Epibulia ritteriana* Haeckel, 1888; 46. *Forskalia misakieniss* Kawamura, 1954; 47. *Athorybia lucida* Biggs, 1978; 48. *Maresearsia sphaera* Stepanjants, 1967; 49. *Lilyopsis gracilis* Fewkes, 1883 (=*L. rosea* Chun 1885); 50. *Sphaeronectes japonica* Stepanjants, 1967; 51. *Ceratocymba intermcdia* Sears, 1953; 52. *Abyla brownia* Sears, 1953 and 53. *Abyla peruana* Sears 1953.

Order SIPHONOPHORA (Eschscholtz, 1829 part)
= SIPHONANTHAE Haeckel, 1888

Suborder 1. CYSTONECTAE Haeckel, 1888
= 'PNEUMATOPHORIDEN' Chun, 1882
= RHIZOPHYSALIAE Chun, 1897b

Suborder 2. PHYSONECTAE Haeckel, 1888
= PHYSOPHORAE Eschscholtz, 1829 (part)

Suborder 3. CALYCOPHORAE Leuckart, 1854

Suborder CYSTONECTAE Haeckel, 1888

Family 1. PHYSALIIDAE Brandt, 1835

2. RHIZOPHYSIDAE Brandt, 1835

? EPIBULIIDAE Haeckel, 1888

Suborder PHYSONECTAE Haeckel, 1888

Family 3. APOLEMIIDAE Huxley, 1859

4. AGALMIDAE Brandt, 1835

5. PYROSTEPHIDAE Moser, 1925

6. PHYSOPHORIDAE Eschscholtz, 1829 (*pro parte*)

7. ATHORYBIIDAE Huxley, 1859

8. RHODALIIDAE Haeckel, 1888

9. FORSKALIIDAE Haeckel, 1888

Suborder CALYCOPHORAE Leuckart, 1854

Family 10. PRAYIDAE Kölliker, 1853

11. HIPPOPODIIDAE Kölliker, 1853

12. DIPHYIDAE Quoy & Gaimard, 1827

13. CLAUSOPHYIDAE Totton, 1965

14. SPHAERONECTIDAE Huxley, 1859

15. ABYLIDAE L. Agassiz, 1862

Key to Suborders of SIPHONOPHORA

1.	Nectophores and bracts absent; special nectophores present in gonodendra.	CYSTONECTAE
	Nectophores and bracts present.	2
2.	Pneumatophore present.	PHYSONECTAE
	Pneumatophore absent..	CALYCOPHORAE

Key to the families of SIPHONOPHORA

I. Suborder CYSTONECTAE:

Pneumatophore large, horizontal, siphosome reduced, occurring at surface of sea	PHYSALIIDAE
Pneumatophore, smaller, vertical, usually with hypocystic villi, siphosome well elongated, capable of vertical migration.	RHIZOPHYSIDAE

II. Suborder PHYSONECTAE:

1.	Nectosome and Siphosome well elongated.	2
	Nectosome and siphosome either or both reduced or one may be absent.	3

2.	Biserial nectophores.	4
	Multiserial nectophores.	FORSKALIIDAE
3.	Both nectosome and siphosome reduced with a corona of nectophores or bracts.	6
	Siphosome alone reduced and saccular.	PHYSOPHORIDAE
4.	With tufts of tentacles at base of nectophores	APOLEMIIDAE
	Without tufts of tentacles at base of nectophores	5
5.	Nectophores with well developed musculature on adaxial portion. .	AGALMIDAE
	Nectophores lacking musculature at adaxial portion.	PYROSTEPHIDAE
6.	With a corona of nectophores below large bulbous pneumatophore with an aurophore	RHODALIIDAE
	With a corona of bracts below pneumatophore..... ..	ATHORYBIIDAE

III. Suborder CALYCOPHORAE:

1.	Nectophores either only one, or two, smooth, similar or dissimilar, with or without ridges and facets...	2
	Nectophores many, similar, smooth or facetted with or without spines.. ..	HIPPOPODIIDAE
2.	Nectophore only one, rounded, small, smooth, devoid of ridges.	SPHAERONECTIDAE
	Nectophores two, large, smooth similar or dissimilar.	3
3.	Nectophores two usually similar, opposed, smooth usually devoid of ridges.	PRAYIDAE
	Nectophores two placed one behind the other, sub-equal or completely disproportionate in size, with ridges usually ending in teeth. ..... : ...	4
4.	Nectophores two, sub-equal in size with somatocyst in both anterior and posterior nectophores....	CLAUSOPHYIDAE
	Nectophores two, sub-equal or completely disproportionate in size with somatocyst in only anterior nectophore.	5
5.	Nectophores two, sub-equal in size, with 3, usually 5 or many ridges.	DIPHYIDAE
	Nectophores two, completely disproportionate in size, anterior nectophore with many facets and ridges. .	ABYLIDAE

SYSTEMATIC SECTION OF SIPHONOPHORA OF INDIAN SEAS

Keys to the sub-families, genera and species and the validity of species are dealt with at appropriate places. In the synonymies, the first is the original reference, the second is the reference wherein synonymies mostly upto 1911 (Bigelow, 1911b) are given in detail and the third lists all references from 1911 to 1974 (Daniel, 1974). Synonyms were checked from original references. Distribution and seasonal variations included under each species have been based on the material of the Indian Ocean Biological Centre, Cochin collected during the International Indian Ocean Expedition (1960, 1962–65) and the collections of the Zoological Survey of India.

Order SIPHONOPHORA Eschscholtz, 1829

Siphonophora are holoplanktonic overgrown hydrozoan, oozooid polyp that elongates and by giving rise to buds — the zooid becomes an asexual, juvenile or larval nurse carrier (paedophore) of other polyps (larvae) and the sexual/asexual medusoids (adults), the juvenile polyps being the *gastrozooids* (nutritive or feeding polyps) with single oral tentacles and *palpons* (feelers, tasters, or excretory?) and the adult medusoids being the sexual *gonophores* (reproductive zooids) and the asexual *nectophores* (locomotive zooids) and have protective buoyancy device the *bracts* which together with a group of other zooids (Cormidia) may separate and become free living and independent *eudoxids*.

The Order Siphonophora is divided into 3 suborders — Cystonectae Haeckel, 1887, Physonectae Haeckel, 1888 and Calycophorae Leuckart, 1854.

Suborder I. CYSTONECTAE Haeckel, 1887

Pneumatophoridae Chun, 1882.

Rhizophysaliae Chun, 1897; Bigelow 1911b.

Siphonophora with large horizontal or vertical pneumatophores with or without hypocystic villi, without nectophores or bracts; Siphosome either reduced or elongated having gastrozooids with simple or branched tentacles and gonodendron with either male or female gonophores, gonopalpons and asexual nectophores. One budding zone below float. Only two families Physaliidae and Rhizophysidae are recognized.

Family I. Physaliidae Brandt, 1835

Cystonectae with large horizontal pneumatophore, without hypocystic villi, siphosome highly reduced with numerous gastrozooids, simple unbranched tentacles and gonodendra in great bunches under float.

Monotypic family and genus.

Genus 1. **Physalia** Lamarck, 1801

Physaliidae with large, bladder-like horizontal pneumatophore.

The history of *Physalia* has been discussed in detail by Totton (1960). Although Schneider (1898) considered this genus to include only one species with varieties, Bigelow (1911b) supporting Chun's (1897b) view maintained that there were two valid species, *i.e.* *P. physalis* (Linnè, 1758) of the Atlantic Ocean and *P. utriculus* (La Martiniere, 1787) of the Indo-Pacific Ocean. The former was distinguished by many main tentacles and the latter with only a single main tentacle. Since later workers (Totton, 1960) have recorded intermediate forms, only one species *P. physalis* (L.) is considered as valid (Daniel & Daniel, 1963).

1. **Physalia physalis** (Linnè) 1758

(Fig. 8 a–e)

Holothuria physalis Linnè, 1758, p. 657.
Physalia utriculus Bigelow, 1911, p. 321.
Physalia physalis Daniel, 1974, p. 22 Text-fig. 1 A–G. (cf. for detailed synonymy)

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Bay of Bengal:* 3 col. *South West Indian Ocean:* 1 Larval stage. *South East Indian Ocean:* 81 col., swarming of *Physalia* in thousands; along 91° E long. and from 5° S to 12° S lat.

NORTH EAST/NORTH WEST MONSOON SEASON: *Bay of Bengal:* 36 col. *South West Indian Ocean:* 2 young col.

With two populations — Atlantic form larger, with many long tentacles and Indo-Pacific form smaller with single main and smaller tentacles; both populations with dimorphic forms — with crest lying on either left or right side of float *i.e.* mirror images of each other. Sexes separate.

Colour: Pneumatophore light blue; gastrozooids, gonopalpons, tentacles range from light sky-blue to deep valvety aquamarine blue; gonodendra pink to red.

Size: Grows upto 30.0 cm (Atlantic Ocean forms); Indian Ocean forms upto 15.0–17.5 cm float length.

Pneumatophore: Horizontal, bladder - like, transparent, with polythalamous crest on dorsal side. Outer coat thick, muscular — pneumatocodon; inner thin air-sac — pneumatocyst with finger-like processes fitting into crest. Crest divided by primary, secondary and tertiary, triangular septa. Gas gland circular, at base of float on one side, diameter varying with size of float.

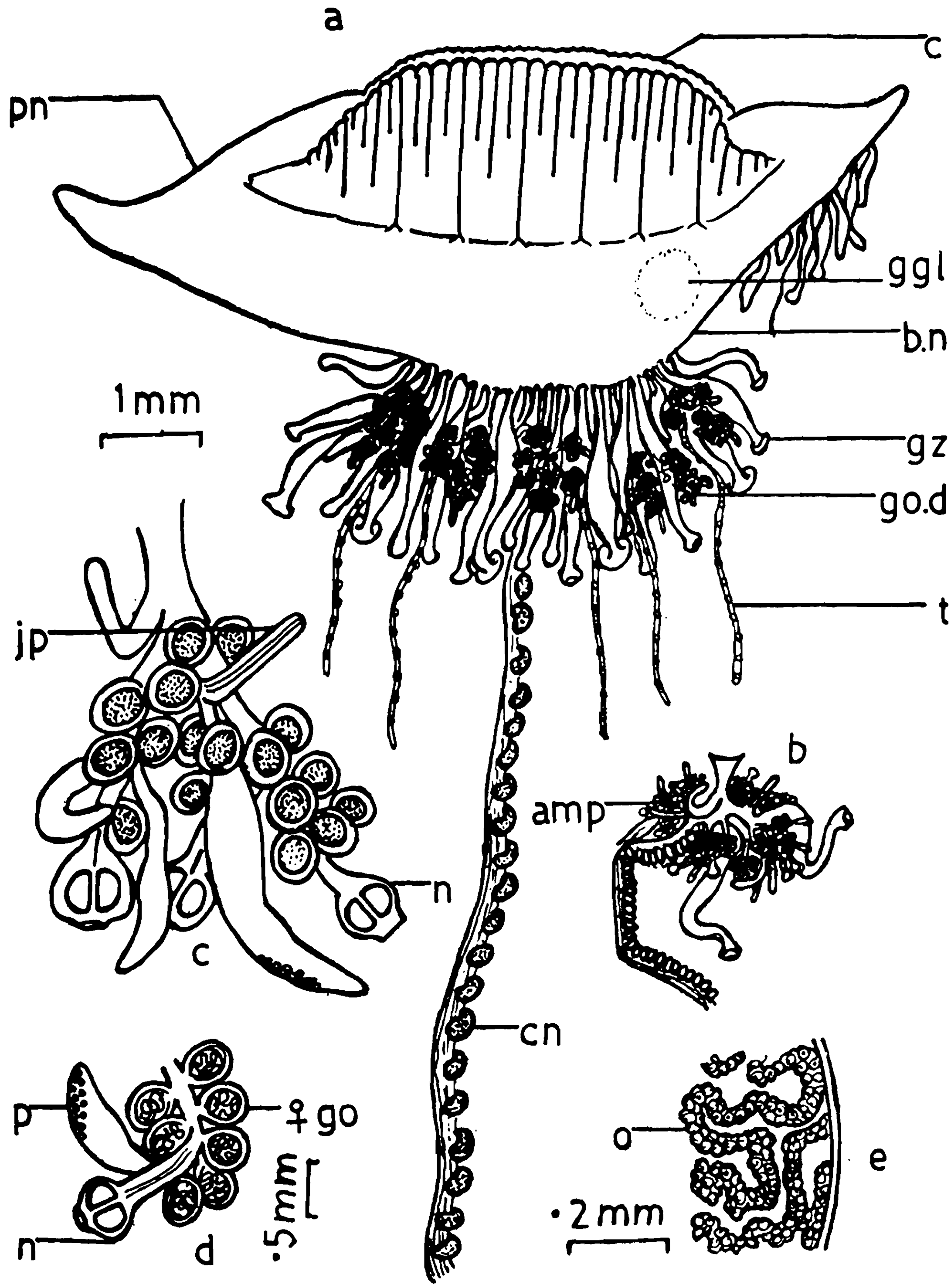
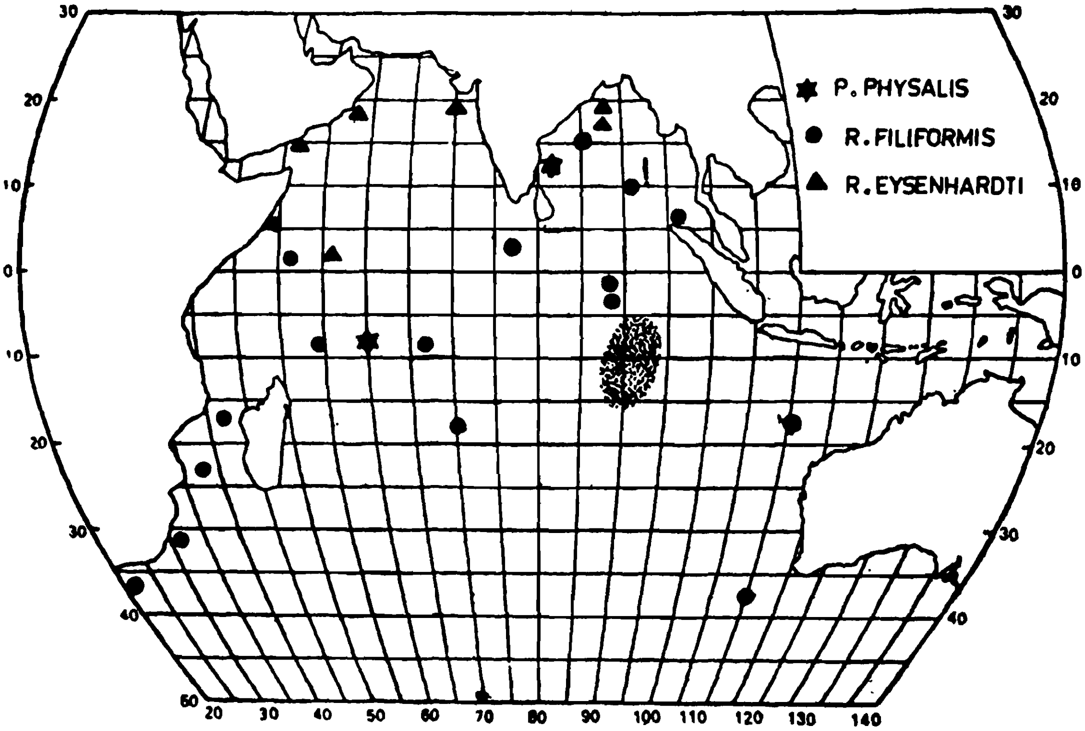
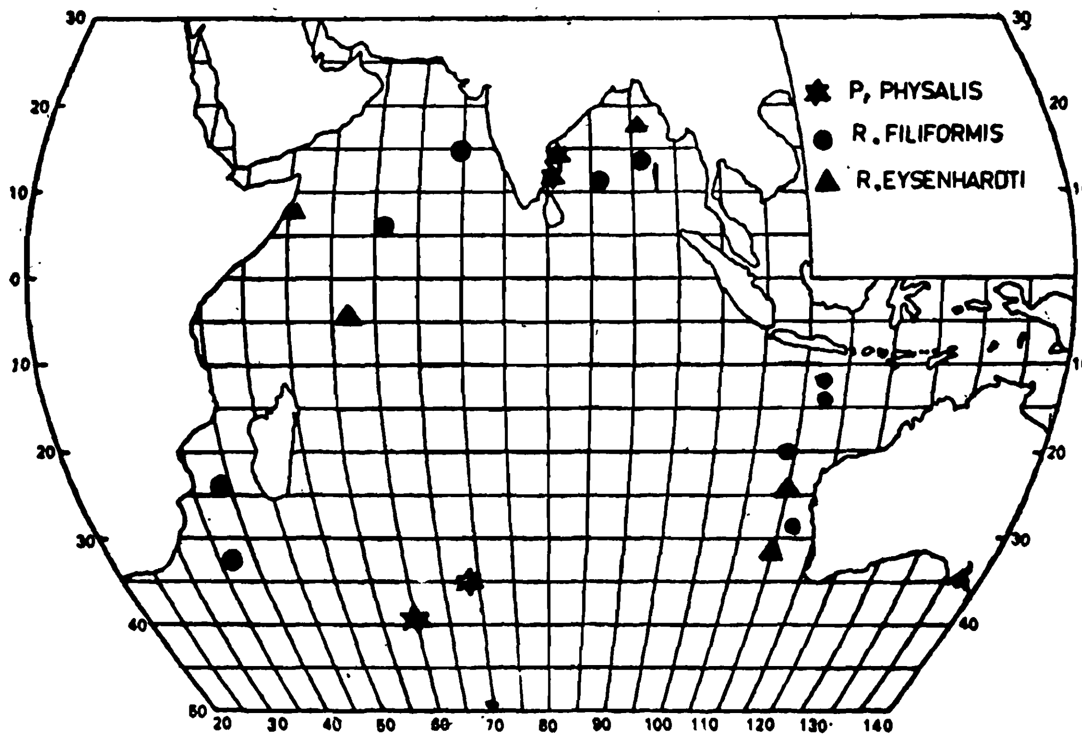


FIG. 8. *P. physalis* (Linn.) (a–e): a. entire; b. gonodendron; c. part of gonodendron enlarged; d. branchlet enlarged; e. female gonophore enlarged. (amp – ampula; b n – basal internode; c – crest; cn – cnidosphore f go – female gonophore; g gl – gas gland; go d – gonodendron; g z – gastrozooid; jp – jelly polyp; n – nectophore; o – ovum; p – gonopalpon; pn–pneumatophore, t – tentacle.)



MAP 3. Distribution of *P. physalis*, *R. filiformis* and *R. eysenhardti* during SW/SE monsoon season. 1–3 colonies/haul. Shaded area: swarming of *Physalia*.



MAP 4. Distribution of *P. physalis*, *R. filiformis* and *R. eysenhardti* during NE/NW monsoon season. 1–3 colonies/haul.

Cormidia: Number varies according to growth stages, crowded under extremely reduced siphosome — in two zones separated by 'basal internode' Each cormidium with numerous long gastrozooids, tentacles, ampulla and gonodendron.

Tentacle: Usually with single main thick, long tentacle and many small thin tentacles; with thick muscular suspensorium on one side and many sessile equidistantly placed kidney-shaped, cnido-knobs of nematocysts of stenotele type.

Gonodendron: Diffuse, complexly branched from bases of reduced mouthless gastrozooids — ampulla and branchlets from reduced gonopalpons. With gonophores, jelly-polyps and terminal asexual nectophores.

Androphore: Each branchlet with 3-4 pairs of sessile, reduced gonophores of styloid type, without umbrella or radial canals. Spadix bear sperms.

Gynophore: Similar to androphores, with many ova borne on continuous, sinuous band over surface of spadix.

Jelly-polyps: At bases of gonopalpons, stalked, with slightly enlarged tips resembling both a reduced medusa and a polyp.

Asexual Nectophore: At tips of each branchlet, stalked, ending in rounded medusoid structures with pedicular canal, radial canals, ring canal, umbrella and velum.

Type locality: Coast of Santa Catharine, Brazil.

Distribution: (Maps 3 & 4) occurs in swarms drifting along surface of sea at an angle of about 45° right or left of windward direction according to position of crest upon float. Thus, entire population never gets stranded on shore (when left handed specimens are stranded, right handed specimens drift away from the shore). Rarely taken by plankton nets. Collected from shores of south and south east coast of Africa, Arabian Sea, Bay of Bengal, Seychelles and Chagos Archipelago. Young larvae are collected during August and December. Along the east coast of India it is collected along the sea-shore during November, December and January.

Family II. RHIZOPHYSIDAE Brandt, 1835

Cystonectae with vertical pneumatophore with or without hypocystic villi; siphosome well elongated with well spaced gastrozooids and gonodendra.

Key to genera of RHIZOPHYSIDAE

Gastrozooids with no ptera (lateral expansion) in all growth stages. **Rhizophysa**

Gastrozooids with ptera in early growth stage. **Bathyphysa**

Genus 2. **Rhizophysa** Peron & Lesueur, 1808

Rhizophysidae with pneumatophore having hypocystic villi and gastrozooids without lateral wings or *ptera* in all growth stages. Tentilla either simple or tricornuate, and dendritic.

The genus *Linophysa* Haeckel 1888b, was included in the synonymy of *Rhizophysa* by Chun (1897b, p. 77) and Lens & van Riemsdijk (1908, p. 100), but it is not valid since the species *Rhizophysa conifera* Studer (1897) for which it was instituted, belongs to *Pterophysa* (= *Bathyphysa*) — Bigelow (1911b, p. 318).

Chun (1878b, p. 104) recognised five species of *Rhizophysa:* 1. *Rhizophysa filiformis* (Forskal, 1775); 2. *R. eysenhardti* Gegenbaur, 1859; 3. *R. clavigera* Chun, 1888 (=*Cannophysa filiformis* Mayer, 1894); 4. *R. gracilis* Fewkes 1882; and 5. *R. murrayana* (Haeckel, 1888).

The accounts given for *R. gracilis* and *R. murrayana* agree so well with *R. filiformis* especially in the form of the tentilla that these were united with the latter (Schneider, 1898; Lens & van Riemsdijk, 1908; Bigelow, 1911b). *R. clavigera* drawn from a mutilated specimen and its account and figures of the twisted siphons and tentacles given by Mayer (1894) were so unsatisfactory that Bigelow made it a synonym of *R. filiformis.*

For this reason recent workers (Lens & van Riemsdijk, 1908; Bigelow, 1911b; Totton, 1954, 1965; Leloup, 1955b; Daniel & Daniel, 1963) considered only two species: *R. filiformis* and *R. eysenhardti* as valid.

Type Species: *R. filiformis* (Forskål, 1775)

Key to species of **Rhizophysa**

1.	Tentilla simple and filiform.	*R. eysenhardti*
2.	Tentilla branched — tricornuate and dendritic.... ..	*R. filiformis*

2. **Rhizophysa filiformis** (Forskål) 1775
(Fig. 9 a–j)

Physophora filiformis Forskal, 1775, p. 120.

Rhizophysa filiformis Bigelow, 1911, p. 319.

Rhizophysa filiformis Daniel, 1974, p. 28, Text-fig. 1, H–N (cf. for detailed—synonymy)

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 4 col. *Bay of Bengal:* 6 col (young). *South West Indian Ocean:* 8 col. *South East Indian Ocean:* 4 col.

(young). NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 4 col. *Bay of Bengal:* 2 col. *South West Indian Ocean:* 2 col. *South East Indian Ocean:* 3 col. (mature); 5 col. (young).

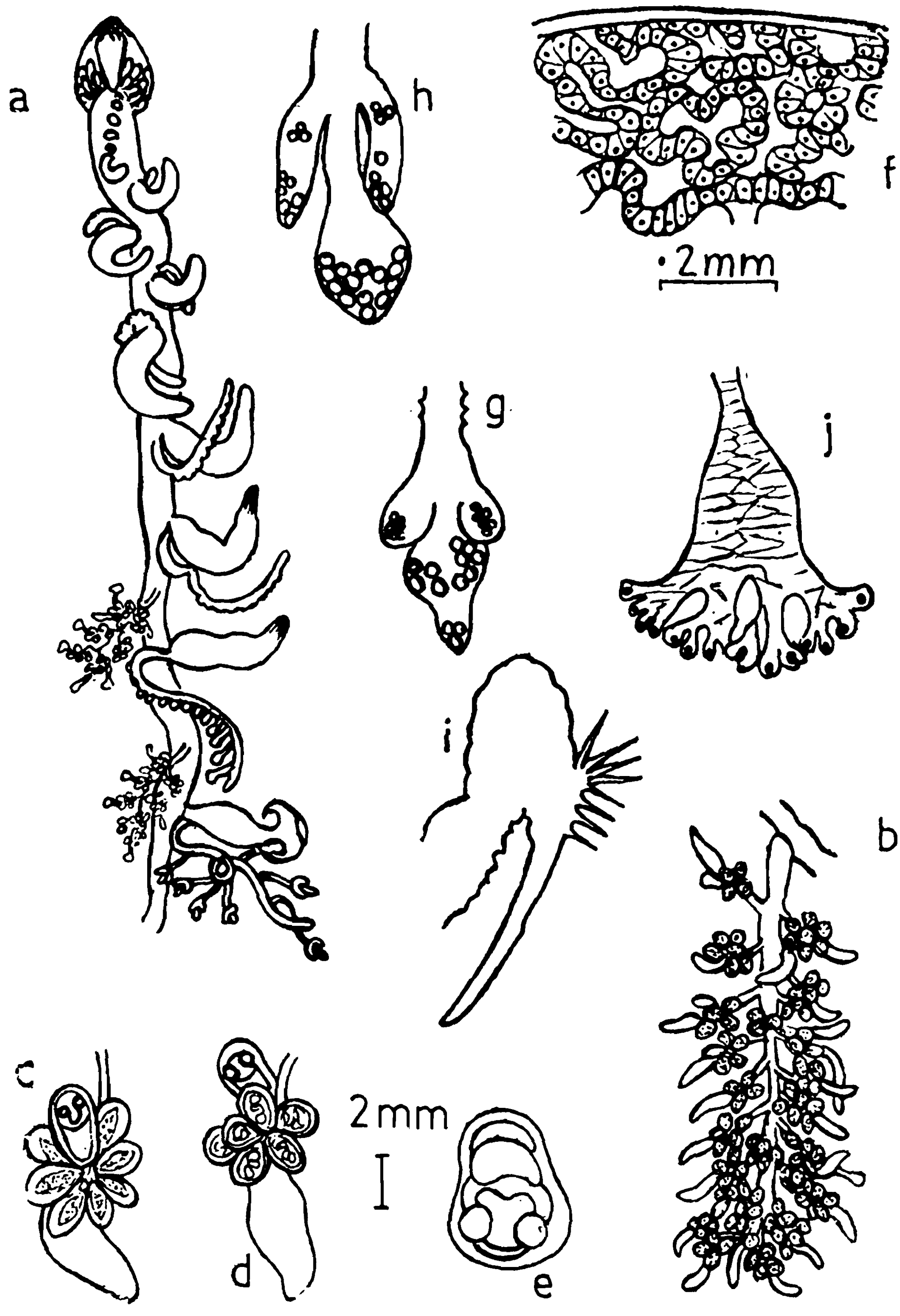


FIG. 9. *R. filiformis* (Forskal) (a–j): a. entire, b. gonodendron; c. branchlet of male gonodendron; d. branchlet of female gonodendron; e. nectophore f. female gonophore enlarged; g & h. tricornuate tentilla, i. bird-headed tentillum; j. dendritic tentillum. (Fig. i & j from Totton, 1965, pl. IV, figs 4 & 5).

Description: Size: 30–100 cm long.

Pneumatophore: 12 by 8 mm, cap of red pigment around apical pore. No septa, cavity filled with hypocystic villi containing giant gas-gland cells. (Fig. 1)

Siphosome: Thin, long, with numerous pale green coloured gastrozooids occurring on one side of stem only. Younger gastrozooids with undeveloped bud-like tentacle at base occur just below pneumatophore. Mature gastrozooids placed 2 to 3 cm apart, 8–10-mm long. Developmental stages of tentilla traceable in young gastrozooids.

Tentacle: Three types, depending on growth stages, distal tip knob-like in young tentilla (1) tricornuate-numerous, with median thicker lobe and two thinner and shorter or longer lateral lobes, nematocysts at tips, (2) 10 or 12 tricornuate, branches, with web connecting lateral to central branch, (3) 17 or more dendritic or palmate tentilla.

Gonodendron: Male or female, between two gastrozooids; with long stalk, 20–24 branchlets each with 3 or 4 pairs of sessile gonophores, sub-terminal gonopalpon and single asexual nectophore at side (not terminal as in *P. physalis*)

Gonophore: Androphore and gynophore alike in shape, size, position on branchlets and reduced into sporosacs. Androphore with spadix bearing sperms. Gynophore with oval-shaped ova borne on sinous band (as in *P. physalis*).

Remarks: It is not clear whether sexes are separate as in *P. physalis* or that the alternate gonodendron bear gonophores of one sex only.

Type locality: Mediterranean Sea.

Distribution: (Maps 3 & 4). *Arabian Sea:* During SW/SE monsoon season, *R. filiformis* occurred in two stations located in the equatorial region *i.e.* one at 53° E longitude (August) and the other at 4° N latitude and 77° E longitude (October). During NE/NW monsoon season it occurred near the equatorial region (December), in the central region of the Arabian Sea (January) and in the Gulf of Aden (February) (Map 3). *Bay of Bengal:* During SW/SE monsoon season it occurred at four stations *i.e.* one station each (i) in the central region, (ii) north east coast of Sumatra and (iii) at two stations near Andaman Islands (Map 3). During the NE/NW monsoon season it occurred at only two stations one located in the central region of the Bay of Bengal and the other on the West Coast of Sumatra (Map 4). *South West Indian Ocean:* During SW/SE monsoon season it has been recorded from seven stations *i.e.* 4 stations on the South-east coast of Africa (April, August and October) and three in the mid-oceanic regions (April, June and September). During NE/NW monsoon season it has been recorded at two stations, (i) near Chagos Archipelago (February) and (ii) near the equator (December) (Map 4). *South East Indian Ocean:* It has been recorded at two stations near the equator (between 0° and 5° S latitude) and at two stations along 110° E longitude during SW/SE monsoon season (August, September) (Map 3). During NE/NW monsoon season it has been collected south of Java (December) and off Western coast of Australia (January & February) (Map 4).

3. **Rhizophysa eysenhardti** Gegenbaur, 1860
(Fig. 10 a, b)

Rhizophysa eysenhardti Gegenbaur, 1860, p. 408 taf. 31, figs. 46-49.

Rhizophysa eysenhardti Bigelow, 1911, p. 320.

Rhizophysa eysenhardti Totton, 1965, p. 42, pl. I, figs. 3, 3a; pl. V, fig. 1; pl. VII (cf. for synonymy).

Type Specimen: Place of deposit not known.

Materials Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 4 col. *Bay of Bengal:* 2 col. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 1 col. *Bay of Bengal:* 2 col. *South East Indian Ocean:* 6 col.

Description: Size: Preserved material 30-50 cm long by 0.5-1.5 mm; well extended one 140 cm to several metres long.

Pneumatophore: 18 by 11 mm in preserved condition. Pale pink, with a deep patch of maroon around apical pore.

Gastrozooids: 10 to 15 mm long. Pedicellate. Tentacle slender and thread like, 50 to 80 mm long. Tentilla simple, unbranched, unilateral, claret coloured, 100 mm long. Nematocysts sphaeroidal 0.084 mm in diameter.

Gonodendron: Similar to *R. filiformis*, thread like pedicels, 15 mm long; pale reddish brown. Branchlets with a single palpon, asexual nectophore at tip and 3 to 4 pairs of sessile male or female gonophores.

Type locality: Mediterranean Sea.

Distribution: R. eysenhardti was recorded from less stations than *R. filiformis*. In the present collections it was observed only in the Arabian sea and Bay of Bengal (Maps 3 & 4). *Arabian Sea:* During SW/SE monsoon season it occurred along the Arabian coast (July), Indian coast (May) and Gulf of Aden (June - a young specimen). During NE/NW monsoon season it occurred along the Somali coast (December). *Bay of Bengal:* During both the monsoon seasons, this species was recorded in the central regions of the Bay of Bengal, during April and July.

Although this species was not collected from the South West and South East zones of the Indian Ocean it has previously been recorded from the Chagos Archipelago by Browne, 1926.

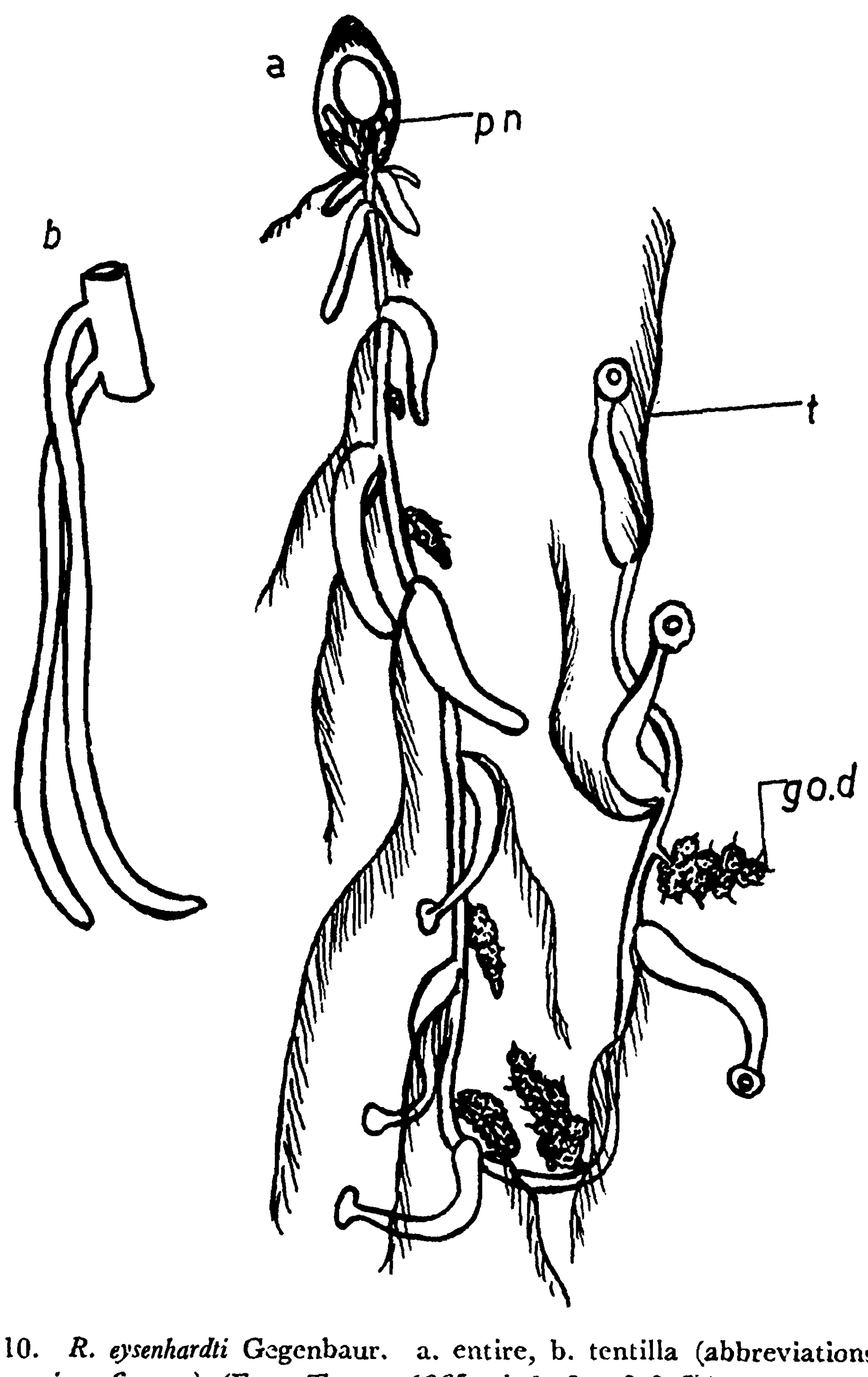


FIG. 10. *R. eysenhardti* Gegenbaur. a. entire, b. tentilla (abbreviations as in previous figures). (From Totton, 1965, pl. 1, figs. 3 & 3a)

Suborder II. PHYSONECTAE Haeckel, 1888

Siphonophora with small, apical, vertical pneumatophore and nectophores (except in Athorybia); Siphosome either well elongated or reduced bearing gastrozooids with simple or branched tentacles, palpons with simple tentacles (palpacles); with bracts and gonophores.

Larvae develop two budding zones on opposite sides of stem, one below apical float giving rise to nectophores which propel the whole animal and the other on siphosome budding various zooids (gastrozooids, palpons, bracts and gonophores). Nectosome and/or Siphosome may be reduced (brachystele) as in the families Athorybiidae and Rhodaliidae or well elongated (macrostele) in most of the physonects.

In Forskaliidae both the budding zones on nectosome and siphosome appear to be on the same side of the stem.

Suborder includes seven families, Apolemiidae, Agalmidae, Pyrostephidae, Physophoridae, Athorybiidae, Rhodaliidae and Forskaliidae. Key for identifying them is given on page—42—.

Family III. APOLEMIIDAE Huxley, 1859

Macrostele Physonectae with characteristic small tuft of tentacles (probably larval) below each muscular lamellae of nectophores; Siphosome with ordinate cormidia, gastrozooids and palpons having simple filiform tentacles.

Type Species: *Apolemia uvaria* Lesueur, 1811.

The family Apolemiidae hitherto considered as a monotypic family for the genus *Apolemia*, now has an addition of two more genera *Tottonia* Margulis, 1980 and *Ramosia* Stepanjants, 1967. *Tottonia contorta* Margulis, 1980, differs from *Apolemia uvaria* in the diversity of palpons and in the absence of tentacles in gastrozooids and palpons or when present very weakly developed. Diagnosis of the family, now comprising of three genera *Apolemia*, *Ramosia* and *Tottonia* is still to be confirmed.

The diagnostic features of the family Apolemiidae may have to be changed later.

Genus 3. **Apolemia** Eschscholtz, 1829

Physonectae with characteristic tuft of tentacles below each muscular lamella of nectophores.

Dicymba Haeckel, 1888, p. 209.

4. **Apolemia uvaria** (Lesueur, ? 1811)
(Fig. 11 a–e)

Stephanomia uvaria Lamarck, 1816, p. 462 (=*Stephanomia uviformis* Lesueur Ms.).
Dicymba diphyopsis Haeckel, 1888; p. 210, pl. 18, figs. 1–7.
Apolemia uvaria Bigelow, 1911; p. 342 (cf. for detailed synonymy).
Apolemia uvaria Totton, 1965; p. 45, pl. VIII, Text-figs. 13–17.

Type Specimen: Place of deposit not known.

Material: Recorded by Haeckel (1888) from the Arabian Sea.

Description: *Size:* Grows upto 20 or more metres.

Pneumatophore: Very small, usually hidden by nectophores.

Nectosome: Nectosome short, bearing about 2–6 pairs of nectophores.

Nectophore: 13–20 mm in diameter, biserially arranged. Axial side of nectophore deeply hollowed out, the lateral wings unite ventrally to form a keel and wide apart above embracing lower part of nectophore situated just above it. Youngest nectophore overlap immature ones above it and float. Muscular lamella broad. Pedicular canal short and obscure. Dorsal radial canal 'U' shaped, ventral canal short lying close to muscular lamella; lateral canals with 'S' shaped bends bearing short blind irregular branches. Unique tuft of 5 or 6 nectosomal tentacles at base of muscular lamellae of each nectophore (*Remarks:* "They in fact probably represent the aboral tentacles of the progenitors of Siphonophores"; and "comparable to somatocyst of Calycophorae", Totton, 1965; p. 47).

Siphosome: Huge — 20 or more metres long; contract spirally on preservation due to presence of longitudinal muscles on one side of stem only. With hundreds of cormidia, older ones detach, becoming free swimming.

Cormidia: Ordinate cormidia, about 5 cm apart; with one or two gastrozooids with filiform tentacles; some palpons long, vermiform, with simple tentacles; some palpons short, stiff, with red-brown pigmented granules.

Bracts: Numerous, scaphoid in shape, with convex dorsal surface. Bracteal canal lying close to concave ventral side.

Opaque patches of nematocysts on bracts, palpons, gastrozooids and nectophores.

Gonophores: In bunches at distal part of stem. Probably dioecious. Highly reduced, styloid. Female gynophore with laterally displaced manubrium, lying wholly within two layered ectoderm. Radial canals suppressed. Single ovum (monovon) with plenty of yolk.

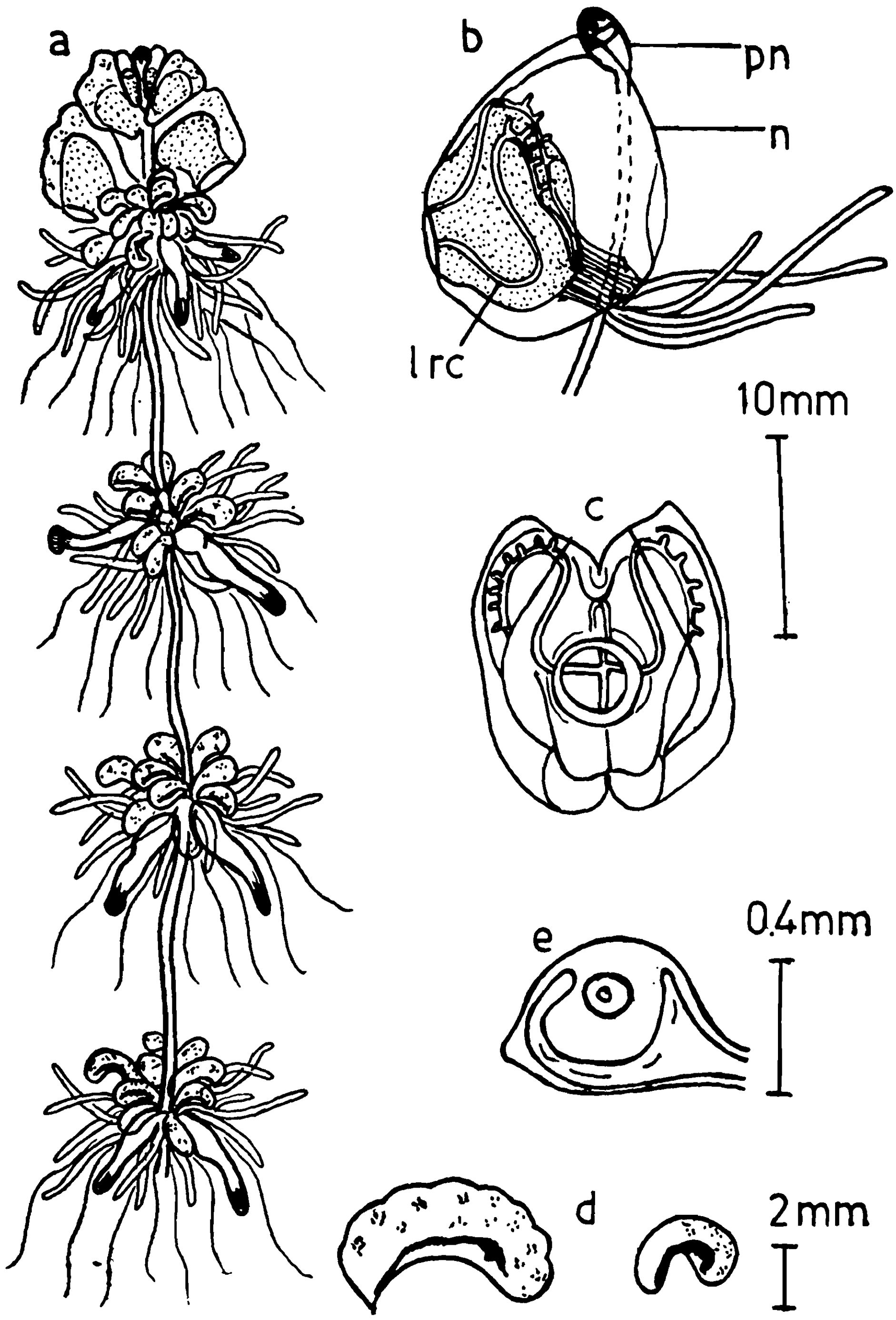


FIG. 11. *A. utaria* Lesueur (a–e). a. entire, b. nectophore showing tuft of tentacles (nt) at place of attachment to nectosome; c. ostila view of nectophore; d. bracts; e. monovon female gonophore (l r c – lateral radial canal). (From Totton, 1965, Text-fig. 13–16)

Type locality: Nice, Mediterranean Sea.

Distribution: In the Mediterranean Sea it occurs below a depth of 600 m coming to surface only during upwelling of deeper waters. During the International Indian Ocean Expedition it was not collected at the surface or even in the regions of upwelling of deeper water. Haeckel (1888) collected this species in the Arabian Sea during the month of November (Map 16).

Family IV. AGALMIDAE Brandt, 1835

Physonectae with elongated nectosome and siphosome; with long series of biserially arranged nectophores; tentacles of gastrozooids bearing tentilla ending in coiled or straight cnidoband with single (unicornuate) or three (tricornuate) terminal filaments and protozooids (oozooid) with larval type of tentilla.

The seventeen species recognized as valid are grouped under nine genera. Of these only eight are well known as complete colonies. (*Agalma okeni*, *A. elegans*, *Halistemma rubrum*, *Cordagalma cordiformis*, *Moseria convoluta*, *Nanomia bijuga*, *N. cara* and *Lychnagalma utricularia*); five (*H. amphytridis Marrus antarcticus*, *M. orthocannoides M. Orthocanna*, and *Erenna richardi*) are almost entirely known from fragments; two are known from their nectophores only (*H. striata* and *Frillagalma vityazi* and three (*A. haeckeli*, *A. Clausi* and *H. cupulifera*) are known for which the descriptions are inadequate.

The validity of the different genera and species are treated in detail by Bigelow (1911b), Totton (1965) and Daniel (1974).

Key to the genera of Agalmidae is based on two characteristics — nectophore and tentilla since some are known from fragments of material only.

Key to genera of AGALMIDAE

1.	Tentilla larval type uni or tricornuate.	2
	Tentilla multicornuate.	**Lychnagalma**
2.	Nectophores with simple, unlooped, lateral radial canals; tentilla larval type or unicornuate	3
	Nectophores with lateral radial canals either looped or simple with branches; tentilla uni or tricornuate.	4
3.	Nectophore small, heart-shaped with larval type of tentilla.	**Cordagalma**
	Nectophore with or without frilled ridges and lateral vertical ridges.	5
4.	Nectophores with horn canals from pigmented, simple, lateral radial canals; tentilla witn straight uncoiled, cnidoband; unicornuate.	**Erenna**
	Tentilla with few or many coils in cnidoband, with or without involucrum.	6
5.	Nectophore large, without lateral vertical ridges; tentilla unicornuate; without involucrum (cold water species).	**Marrus**
	Nectophore small, with frilled ridges.	**Frillagalma**

6.	Tentilla with few ($2\frac{1}{2}$) coils in cnidoband; unicornuate, with conspicuous incomplete involucrum. ...	**Nanomia**
	Tentilla with many coils in cnidoband; with conspicuous or inconspicuous involucrum	7
7.	Nectophore very flat; tentilla unicornuate with 7–8 coils in cnidoband; small inovlucrum covering 1 or 2 coils of cnidoband (Antarctic species)..	**Moseria**
	Tentilla completely covered with involucrum or involucrum inconspicuous; uni or tricornuate..	8
8.	Tentilla with 9–10 coils in matured cnidoband completely covered by involucrum; tricornuate	**Agalma**
	Tentilla with 4–8 coils in matured cnidoband, with very inconspicuous involucrum; unicornuate.	**Halistemma**

Genus 4. **Agalma** Eschscholtz, 1825

Agalmopsis Sars, 1846, p. 31.
Crystallomia Dana, 1858, p. 459.

Agalmidae with tricornuate tentilla consisting of involucıate coiled cnidoband, terminal ampulla and paired lateral horns.

Four species of *Agalma* are considered as valid by Bigelow (1911b) and Totton (1965): *A. okeni* Eschscholtz, 1825; *A. elegans* (Sars, 1846); *A. haeckeli* Bigelow, 1911b; *A. clausi* Bedot, 1888. The last species has been recently recorded by SCUBA divers from Woods Hole Oceanographic Institution (Biggs, 1977; Harbison Biggs & Madin, 1977).

Type Species: *A. okeni* Eschscholtz, 1825

Key to species of **Agalma**

	Nectophore dorsoventrally flat.	1
	Nectopnore not dorsoventrally flat.	2
1.	Bracts with very thick distal border, truncated and faceted.	*okeni*
	Bracts thick, oval, foliaceous with red spots, two teeth on each side.	*clausi*
2.	Bracts witn three unarmed, longitudinal ridges...	*elegans*
	Bracts with 3–5 armed longitudinal ridges and red pigment patches.	*haeckeli*

5. **Agalma okeni** Eschscholtz, 1825
(Fig. 12 a–h)

Agalma okeni Eschscholtz, 1825; p. 744, taf. 5, fig. 17.
Agalma okeni Bigelow, 1911; p. 277, pl. 17.
Agalma okeni Daniel, 1974; p. 37, Text-fig. 2. A–M (cf. for detailed synonymy)

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 54 col.; 149 'lr' n; 91 '2r' n; 300 br. *Bay of Bengal:* 70 col.; 148 '1r'; 67 '2r'; 276 br. *South West Indian Ocean:* 42 col.; 99 '1r' n; 22 '2r' n; 226 br., pieces of siphosome. *South East Indian Ocean:* 34 col.; 50 '1r' n., 76 '2r' n., 165 br., 6 bits of siphosome with gastrozooids, tentacles and gonodendra. NORTH EAST/NORTH WEST INDIAN OCEAN: *Arabian Sea:* 67 col.; 186 '1r' n., 96 '2r' n, 461 br. *Bay of Bengal:* 54 col.; 186 '1r' n., 40 '2r' n., 165 br. *South West Indian Ocean:* 31 col., 53 '1r' n., 68 '2r' n., 261 br. *South East Indian Ocean:* 41 col., 190 '1r' n., 68 '2r' n., 243 br.

Description: *Size:* 13 cm long and 2 cm wide at nectosome and Siphosome sub-equal in size.

Pneumatophore: Slender, elongated, with red-brown pigment at tip. 8 lamellae stretch from pneumatosaccus to pneumatocodon, with circular constriction at mid-level.

Nectosome: With 14 pairs of mature nectophores biserially and alternately arranged in a large specimen (excluding several very young immature ones).

Nectophores: 10–12 mm broad, characteristically dorso-ventrally flattened, prismatic, transparent. Lateral facet with one (1r forms) or two vertical ridges (2r forms). (Forms with one vertical ridges are considered to be immature specimens). In all other features these two nectophore types are alike. Upper lateral corners prolonged into wings or wedges. Dorso-lateral and ventro-lateral ridges occur at extreme lateral edges of nectophore. Nectosac characteristically 'Y' – shaped, not extending into lateral wings of mature nectophore but do so in immature nectophores. Muscular lamella broad, with short pedicular canal (Fig. 12, b). Dorsal and ventral radial canals short and simple, lateral radial canals long, forming loops at baso-lateral sides of nectophore. Ostium tetragonal in shape, with well developed velum.

Siphosome: Stiff, non-contractile. Number of cormidia 5–15 according to growth stages. Each cormidium with one gastrozooid, 8–12 palpons, their tentacles and bunches of male and female gonodendra. Succession of zooids regular and characteristic. Internode with only bracts.

Gastrozooid with prominent basigaster; its tentacle, thick, long with 12–15 tentilla; each tentillum ending in involucrate, much coiled (6–17 turns) maroon coloured cnidoband, tricornuate,

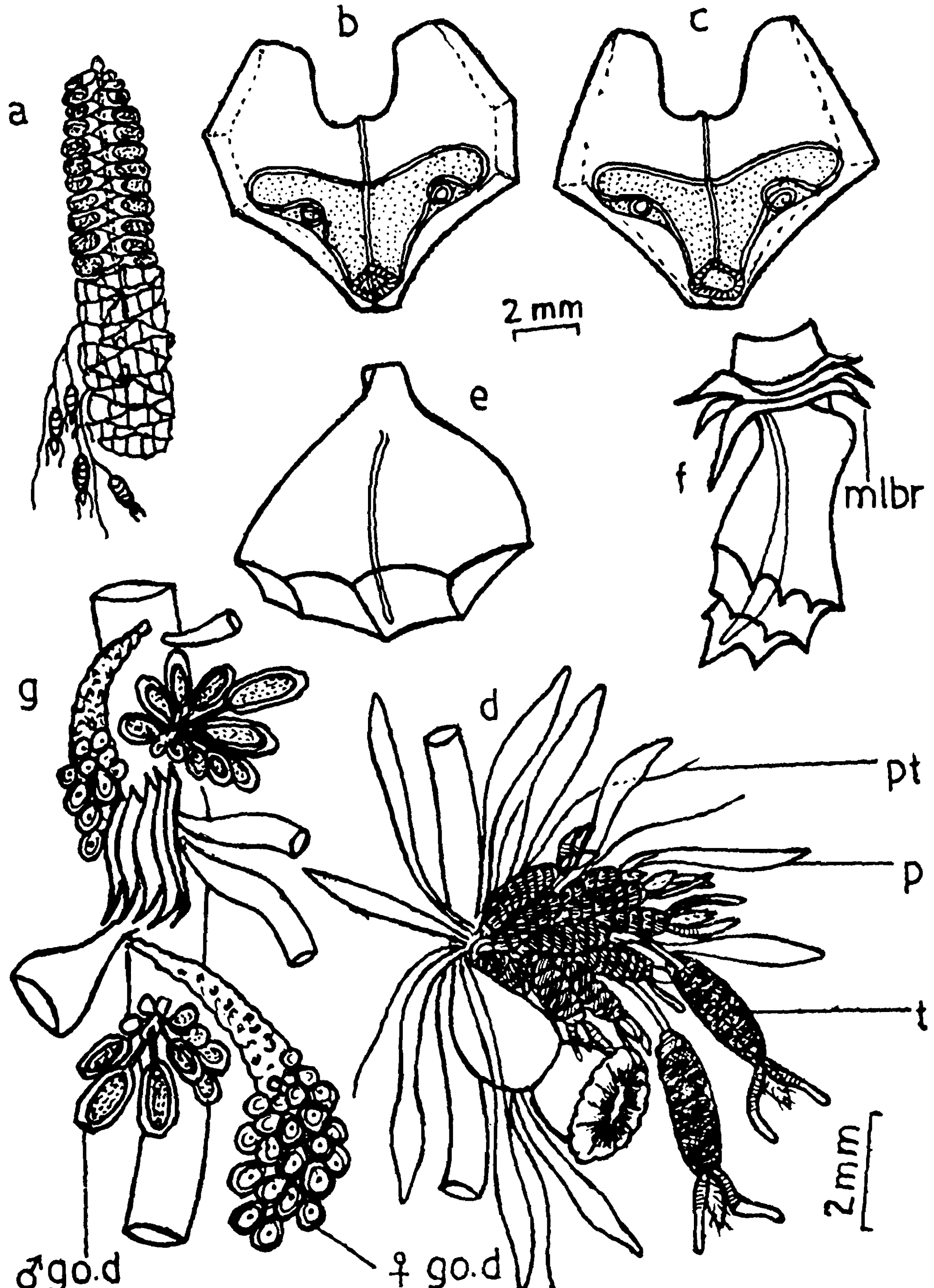


Fig. 12. *A. oeeni* Eschscholtz (a–g). a. entire, b. nectophore with 2 vertical lateral ridges (2r form); c. nectophore with 1 vertical lateral ridge (1r form); d. cormidium with gastrozooid (gz) palpons (p); tentacle (t) palpacle (pt); e mature bract; f immature bract and ends of muscular lamellae of bracts (m 1 br); g part of stem showing male and female gonodendra;

— median ampulla, spindle-shaped, thick, with vibratile sensory hairs and two long, thin, highly contractile lateral filaments.

Palpons long, about 10–12 mm, spindle shaped, transparent with brown nematocyst patches on surface. Palpacles simple, unbranched, thin, with beaded appearance.

Bracts: Occur in groups of 4 or 5 all budded from ventral side of stem; triangular in shape, transparent, prismatic, with thick, facetted distal ends. All bracts closely applied together to form a carapace around cormidia. Distal end divided into three to five concave facets by 2–3 vertical ridges. Younger bracts with sloping distal edges and thick bracteal canal.

Gonodendra: Male and female gonodendra with short stalk, occurring at bases of palpons, male and female gonodendra arranged in an alternating manner, separated by a group of bracts.

Androphore: 10–12 in number, with thin long pedicels, distinctly medusoid in structure with umbrella, radial canals, and ostium. Manubrium mouthless bearing germ cells.

Gynophore: Many, in various stages of development, smaller than male gonophores with short stalk, medusoids, with single large ovum in each.

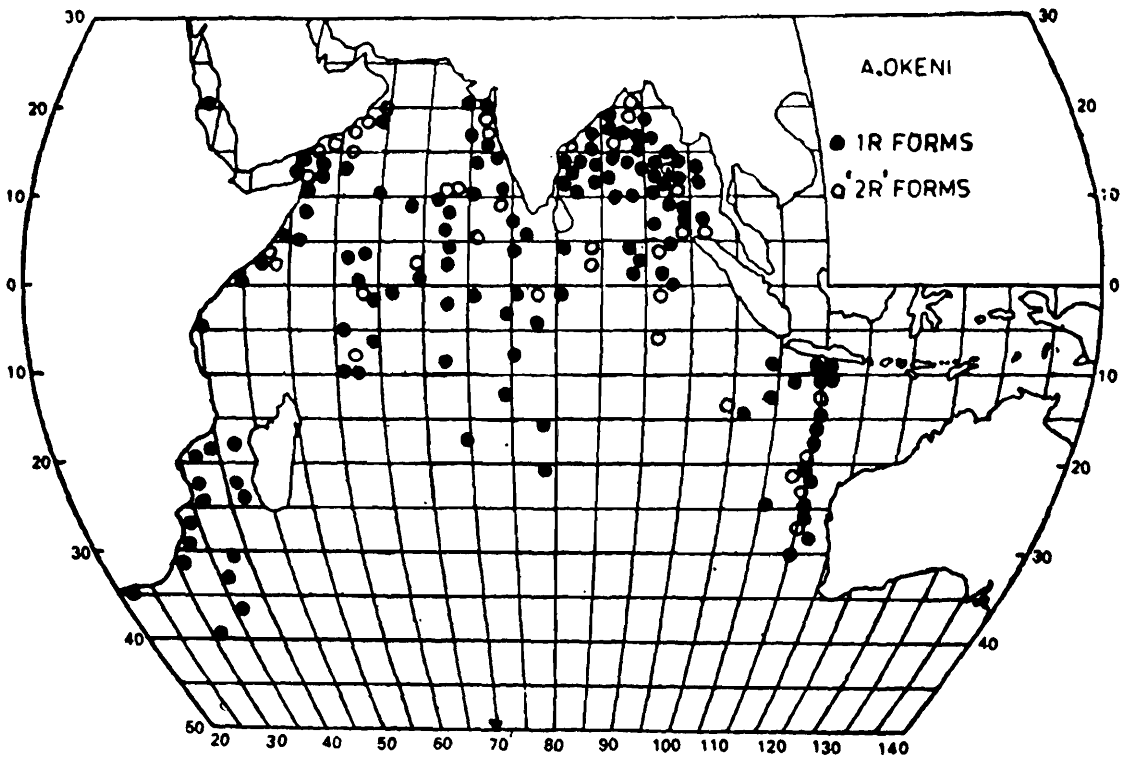
Remarks: According to Totton (1954, 1965) the nectopthores with only one vertical ridge on the lateral facets are produced in the early growth stages while the two ridge nectophores are associated with the mature colony. However, in the present collections it is observed that the single ridge (1r) nectophores persisted in most of the sexually matured colonies. Therefore, *Crystallomia polygonata* Dana (based on single ridge nectophores) is considered as a synonym of *A. okeni* and is probably a neotenous form.

Type locality: St. Peter and St. Paul Islands.

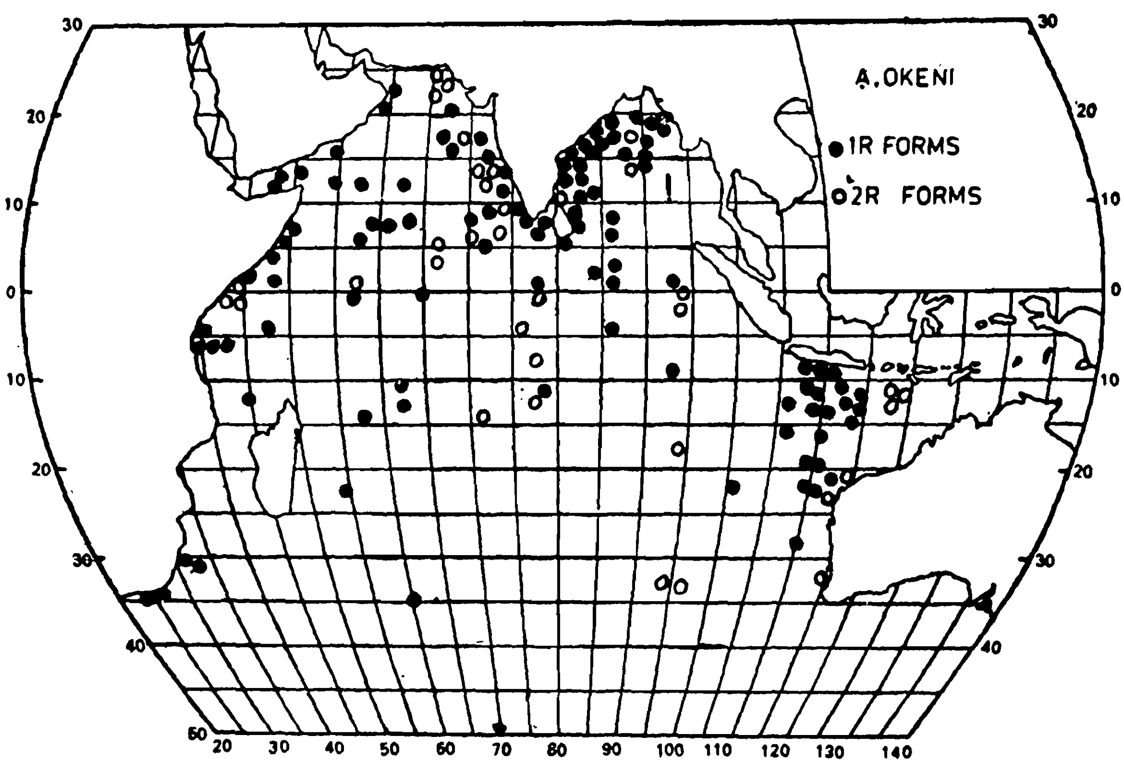
Distribution: (Maps 5 & 6). The records of both these forms and their distribution in the Indian Ocean are presented in maps 5 and 6. At each station only 1 or 2 or 3 colonies of *A. okeni* were collected per haul.

The colonies bearing nectophores with one vertical ridge ("1r" forms) occurred in wide areas throughout the Indian Ocean and the colonies having nectophores with two vertical ridges ("2r" forms) occurred in fewer stations during both the seasons. More were caught at night during both the seasons in all the zones except in the Bay of Bengal where the day captures were more during SW/SE monsoon season.

The "1r" forms of *A. okeni* occurred in a number of stations along the east and west coasts of India, Arabian and Somali coasts, along the equator, coasts of South Africa, along 110° E longitude especially south of Java and at few stations in the mid-oceanic region during both the seasons.



MAP 5. Distribution of *A. okeni* during SW/SE monsoon season. 1-3 colonies/haul.



MAP 6. Distribution of *A. okeni* during NE/NW monsoon season. 1-3 colonies/haul.

The "2r" forms of *A. okeni* occurred mainly along the Arabian and Somali coasts, west and east coasts of India, along the equator and 110°E longitude and at few stations in mid-ocean during SW/SE monsoon season. During NE/NW monsoon season it occurred along the west coast of India, at a few stations in Bay of Bengal, along the equator, south of Indonesia, west coast of Australia and in the mid-oceanic regions down to 35° S latitude.

Distribution of *A. okeni* extended from 25° N latitude to 40° S latitude along the African coast, 30° S latitude along the 110° E longitude and down to 20° S latitude in the mid-ocean during SW/SE monsoon season. During NE/NW monsoon season it occurred from 25°N latitude to 35° S latitude along the land mass and in the mid-oceanic regions.

Monthly variation: *A. okeni* is one of the most common species of Siphonophora and has a wide range of distribution in the Indian Ocean occurring almost throughout the year in the different regions. *Arabian Sea:* In the Western part *A. okeni* occurred throughout the year (except in September) along the Somali and Arabian coasts, Gulf of Aden and Red Sea especially from June to August and December. In the eastern part it occurred along the Indian coast and also near the equator during the months of February, March and November. It was not collected during June and October. *Bay of Bengal:* In the Indian region it occurred throughout the year especially during April. In the Andaman and Burma region it cocurred at a maximum number of stations during September and during April in the central Bay of Bengal. *South West Indian Ocean:* Along the African coast it was recorded during January, July and October. In the oceanic regions it occurred at a few stations almost throughout the year except in October and November. *South East Indian Ocean:* In the Australian region it was collected during January, August and December. It was rare during April, May and July. In the oceanic region it occurred mainly during December and it was very rare during January, July, September and November.

6. **Agalma elegans** (Sars, 1846)

(Fig. 13 a–h)

Agalmopsis elegans Sars, 1846, p. 32, taf. 5, 6 (in part).
Agalma elegans Bigelow, 1911, p. 281, pl. 18 figs. 9–13 pl. 19, figs. 1–4.
Agalma elegans Daniel, 1974, p. 41, Text-fig. 2, N–6; 3, A–D.

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 26 col., 79 n., 18 br., 3 lar. br., 29 '*athorybia*, stage larva. *Bay of Bengal:* 50 col., 106 n., 47 br., 6 lar. br., 16 '*athorybia*' stage larva. *South West Indian Ocean:* 36 col., 112 n., 14 br., 3 lar. br., 19 '*athorybia*' stage larva. *South East Indian Ocean:* 40 col., 126 n., 50 br., 85 lar. br., 46 '*athoryia*' stage larva. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 80 col., 183 n., 61 br., 10 lar. br., 58 '*athorybia*' stage larva. *Bay of Bengal:* 24 col., 64 nect., 23 br., 6 '*athorybia*' stage larva. *South West Indian*

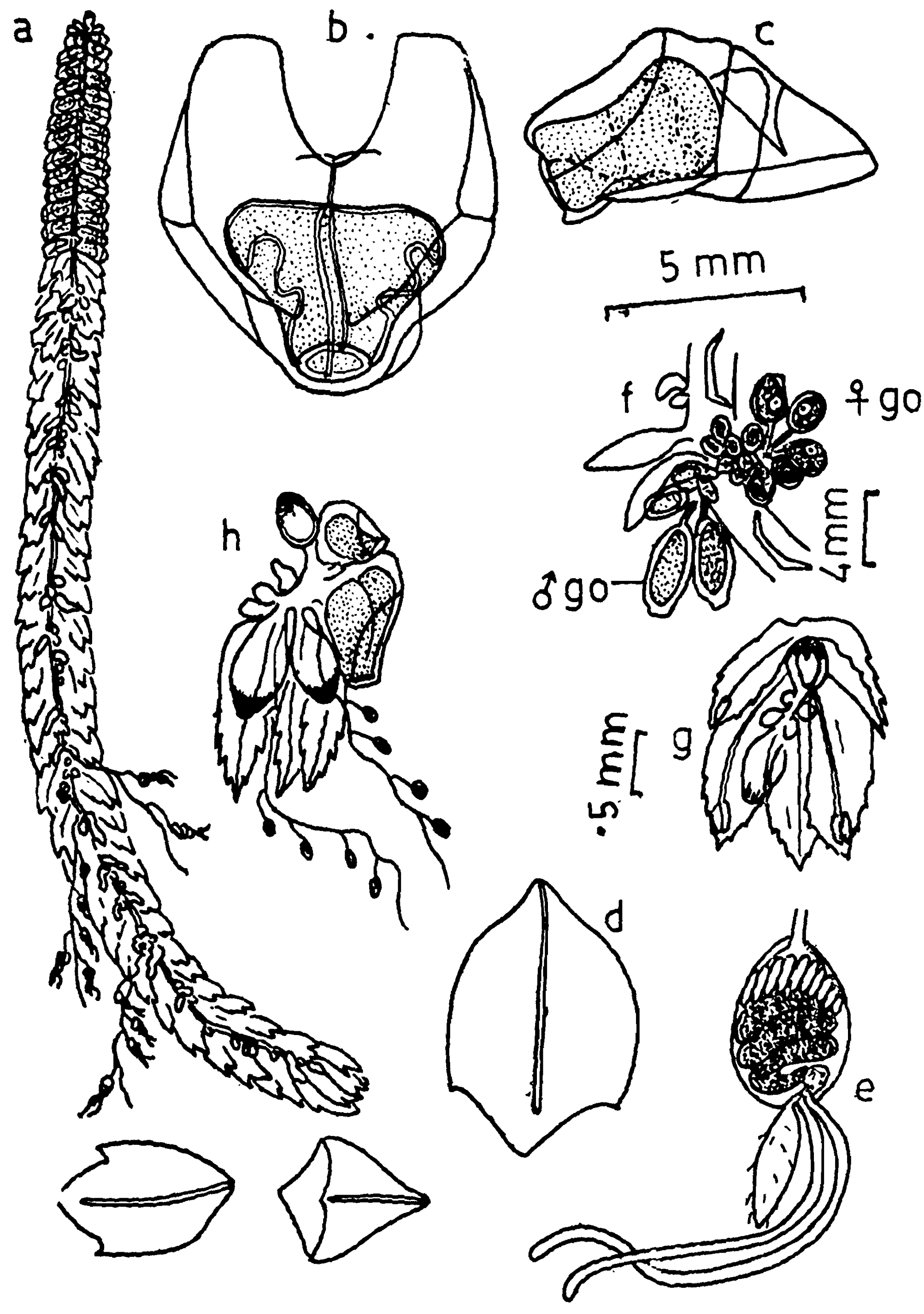


FIG. 13. *A. elegans* (Sars) (a–h). a. entire; b & c. upper and lateral views of nectophore; d. bracts; e. tentillum; f. female & male gonodendra; g. larval stage "athorybia" stage; h. later larval stage. (Fig. a from Sars, 1846, fig. 11).

Ocean: 26 col., 80 n., 16 br., 4 lar. br., 17 '*athorybia*' stage larva. *South East Indian Ocean:* 19 col., 34 n., 4 br., 8 '*athorybia*' larval stage.

Description: Size: 28 cm or more in length.

Pneumatophore: Small, oval shaped, with pigmented apex.

Nectosome: One third of total length, bearing 15–20 pairs of biserially and alternately arranged mature nectophores and several immature buds. Budding zone of nectophores dorsal.

Nectophore: 5.0 to 7.0 mm broad; 6.5 to 8.0 mm long. Not dorso-ventrally flattened as in *A. okeni*. Apico-lateral corners produced into extensions or wings. Dorso-lateral and ventro-lateral ridges connected by lateral vertical ridge. Dorso-lateral ridge bifurcate near ostium. Nectosac muscular, triangular in shape when viewed from above, not Y-shaped as in *A. okeni*. Dorsal and ventral radial canals short and straight; lateral radial canals longer and looped forming a semicircle at sides of nectosac before joining circular canal.

Siphosome: Nearly three-fourths total length, with 3–9 functional gastrozooids, placed 5 cm apart. Primary gastrozooid with larval type of tentilla-bearing kidney-shaped cnidiosacs. Other gastrozooids with typical adult type of tentacle, with 27 tentilla, 5.0 mm apart ending in tricornuate structure. Cnidoband with 4 or 5 coils completely covered by involucrum. Central thick ampulla short. Two lateral horns thin, 3.0 mm long. Cninoband with a row of elongated nematocysts. Siphosome with dissolved cormidia. Palpons slender with simple, unbranched threadlike palpacles.

Gonophores: Clusters of male and female gonophores, borne on short stalks arising from bases of palpons; female ones at proximal and male at distal end of each cormidium.

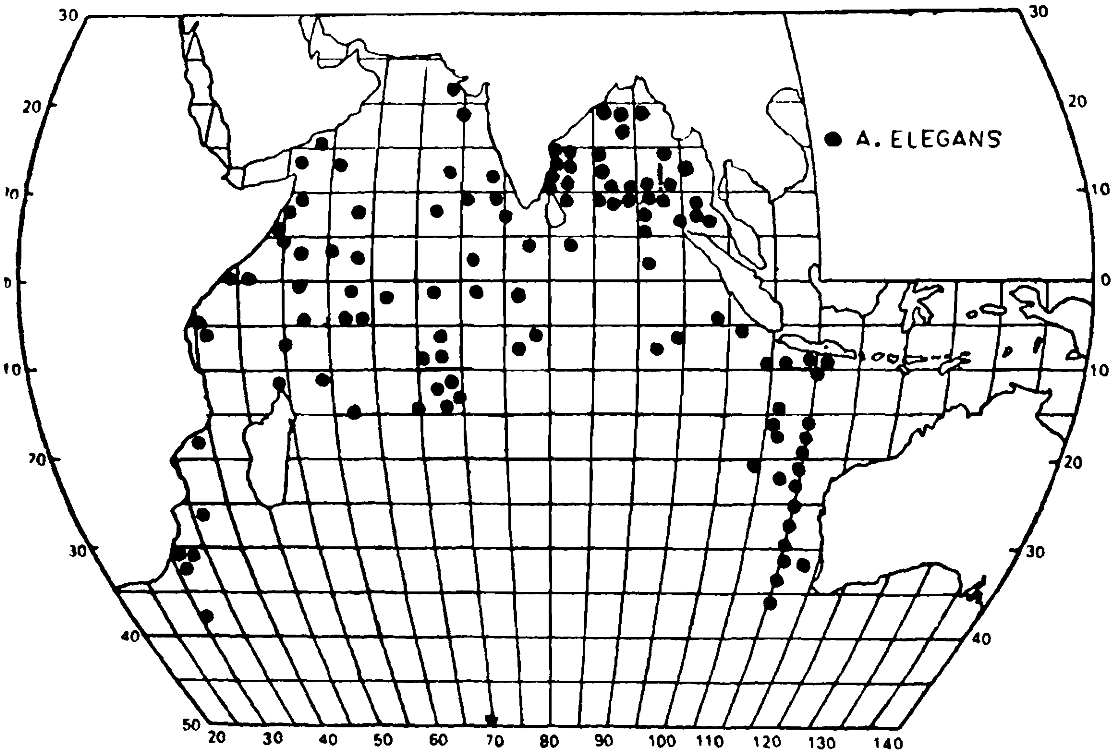
Gynophores: Round gynophores borne on long thin stalks, in various stages of growth; umbrella and radial canals well developed, with single large ovum in each.

Androphore: Fewer in number, in various stages of development, larger than gynophores, with thin, longer pedicels, and oval in shape with well developed umbrella and radial canals. Spadix fill entire space inside.

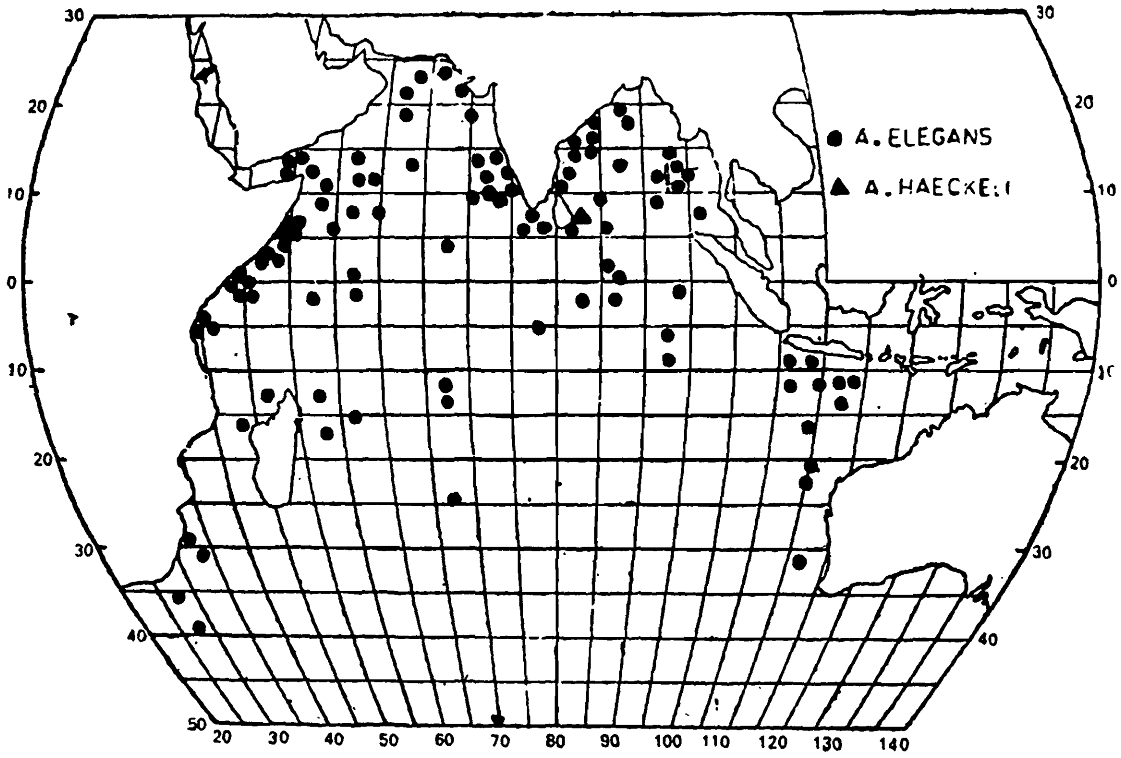
Bracts: Broad, trident, thick in middle and thin at lateral sides and distal ends. Smaller ones 1.33-10 mm long and 1.17–6.0 mm broad. Numberous brects cover entire stem. Some bracts with lateral edges folded to form cavities for retraction of cormidia.

Larvae occurring in the plankton: Two larval stages — "*Athorybia*" stage and "*Nectalia*" stage occur in plankton.

"*Athorybia Stage*": (Fig. 13 g) 1–1.5 mm long, pneumatophore round surrounded by a corona of 6–8 typical larval bracts



MAP 7. Distribution of *A. elegans* during SW/SE monsoon season. 1–3 colonies/haul.



MAP 8. Distribution of *A. elegans* and *A. haeckali* during NE/NW monsoon season. 1–3 colonies/haul.

4–6 of them thicker, 3 sided, with 3–4 finally serrated ribs or ridges on dorsal surface, and 2 large bannana-shaped nematocysts at tips. Other bracts thinner, broader and leaf-like. Nectosome and siphosome not yet elongated. Siphosome with one gastrozooid, larval type of tentacle and 4–6 palpons.

"Nectalia Stage": Nectosome and Siphosome slightly elongated, 3–8 mm long, with one or two pairs of nectophores, 2 or 3 cormidia and few long, trident bracts surrounding cormidia.

Type locality: North Sea.

Distribution: (Maps 7 & 8) At each station only 1 or 2 or 3 colonies and larval stages ("*Athorybia*" stage) of *A. elegans* were collected per haul. The number of records and distribution in the different zones of the Indian Ocean during the two seasons are presented in maps 7 and 8.

A perusal of the maps show that *A. elegans* occurred in greater number of stations during SW/SE monsoon season in the Bay of Bengal, South West and South East Indian Ocean while greater numbers occurred during NE/NW monsoon season in the Arabian Sea. It was also noticed that the day captures were more in the Arabian Sea during both the seasons and during SW/SE monsoon season in the Bay of Bengal. In the South West and South East Indian Ocean the night captures were more during both the seasons.

The distribution range of *A. elegans* extended from 25°N latitude to 38° S latitude along the African Coast and 45° S latitude along the 110° E longitude and down to 15° S latitude (except one station at 30° S latitude) in the mid-ocean, during SW/SE monsoon season. During NE/NW season its distribution extended south as far as 40° S latitude along the African coast and 31° S latitude along 110° E longitude and to 20° S latitude in the mid-ocean (except at one station at 36° S latitude).

Monthly variations: *A. elegans* occurred in abundance during definite months in the eight regions of the Indian Ocean. *Arabian Sea:* In the western part *A. elegans* occurred in maximum number of stations during December along the Somali coast and Gulf of Aden. In the Eastern part it occurred along the coast of Pakistan and India mainly during February and May. In the Arabian Sea it was not collected during September. *Bay of Bengal:* In the Indian region it was frequently recorded along the coast of India during June and at few stations in the rest of the months. It was not collected during September and October. In the Andaman and Burma region it was collected during September in greater number of stations than during March and August. In the Bay of Bengal it was not collected during October. *South West Indian Ocean:* Along the African coast *A. elegans* was collected at few stations during January, July and October. In the oceanic region it occurred at few stations throughout the year (absent in May and November) except during June when it was collected in greater number of stations. *South East Indian Ocean:* It occurred almost throughout the year (not present during March and November) especially May and August along the 110° E longitude. In the oceanic region it was recorded rarely during January, June, August, October and December.

7 **Agalma haeckeli** Bigelow, 1911

(Fig. 14 a-e)

Agalma eschscholtzii Haeckel, 1888, p. 226, pl. XVIII, figs. 8-17 (non *A. eschscholtzii* Lesson, 1843, p. 511).

Agalma haeckeli Bigelow, 1911, p. 277, 348.

Agalma haeckeli Totton, 1965, p. 53.

Type Specimen: Most of the species (except some Rhodalids) mentioned in the Challenger Report by Haeckel are not present in the British Museum (Totton, 1965, p. 92).

Material: Recorded only once by Haeckel (1888) off Sri Lanka, Bay of Bengal.

Pneumatophore: Ovate or pyriform, with purple pigment at apical half and yellow at lower half; with 8 equidistant longitudinal lines dividing pericystic cavity into 8 radial pouches.

Nectosome: With 4 pairs of nectophores.

Nectophores: (Fig. 14b) 30 $\times$ 20 mm in size, with two tril angularly shaped lateral wings; nectosac lying at basal half of nectophore (like *A. elegans*) .Ostium with 3 scarlet coloured pigment spots at velum at junction of dorsal and lateral radial canals.

Siphosome: Same size as nectosome, stiff densely covered with very thick large bulged bracts, giving a globular (50 mm in diameter) in appearance. Concave inner surfaces of bracts forming a hydroecium for retraction of cormidia.

Cormidia: Dissolved type, with 8 or more gastrozooids and several palpons. Gastrozooids with long pedicels, basigaster small, stomach with four double rows of red-brown liver glands.

Tentacle: With companulate, involucrate tentilla; 7-8 spira-turns in cnidoband, purple coloured; tricornuate with spindle shaped central ampulla and a pair of slender lateral horns. Tentacles of palpons simple.

Gonodendra: (Fig. 14, d, e) Occur at bases of palpons, gonophores well developed with umbrella and radial canals; female gonophores companulate with single ovum surrounded by a net work of spadicine canals. Male gonophore sub-cylindrical, purple in colour; with central spadix.

Bracts: Large, 3–5 lobed, with 3–5 prominent ribs on dorsal surface, forming a globular carapace around cormidia, with patch work of reddish pigment. Smaller irregular bracts occur inside.

Type locality: Off Sri Lanka, Bay of Bengal, Indian Ocean.

Distribution: Collected off Beligemma, Sri Lanka, in Bay of Bengal during December. It has not been collected since 1888 (Haeckel) (Map 8).

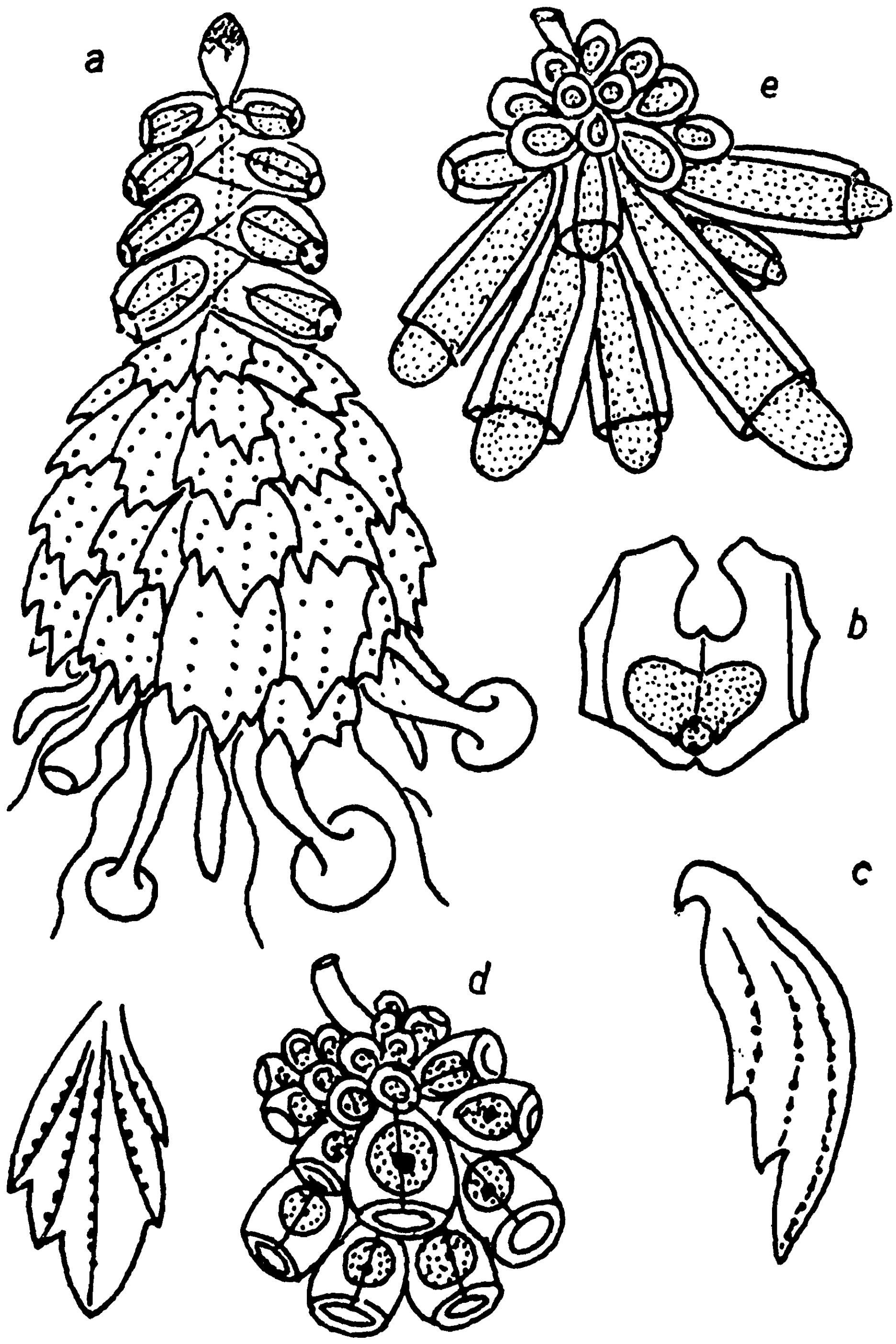


FIG. 14. *A. haeckeli* Bigelow (a—e). a. entire, b. nectophore; c. bracts; d. female gonodendron; e. male gonodendron. (From Haeckel, 1888 b, pl. XVIII, figs. 8-17)

Genus 5. **Halistemma** Huxley, 1859

Stephanomia Lesueur & Petit, 1807, p. 29.
Halistemma Huxley, 1859, p. 70.

Agalmidae with long, contractile stem, nectophores rigid, prismatic, not laterally winged, possessing a median lappet, dorso-lateral ridges and 1–4 lateral vertical ridges; gastrozooids with unicornuate tentilla whose cnidioband lacks a marked basal involucrum; bracts thin, foliaceous and trident.

Type Species: *H. rubrum* (Vogt, 1852).

Bigelow (1911b) included all the long stemmed agalmids with unicornuate tentilla under the genus *Stephanomia* Lesueur & Petit, 1807; (i.e., *S. amphytridis* Lesueur & Petit, 1807; *S. bijuga* Delle Chiaje, 1841; *S. rubrum* Vogt, 1852; *S. cara* Agassiz, 1865; and *S. cupulifera* Lens & van Riemsdijk, 1908). Later, an Antarctic species *S. convoluta* Moser, 1925 and an Arctic species *S. orthocanna* Kramp, 1942, were added to this list.

Totton (1954, 1965) while revising the family Agalmidae realized the necessity for the separation of the above mentioned species of *Stephanomia* into four genera, viz., *Halistemma* Huxley, 1859; *Nanomia* Agassiz, 1865; *Marrus* Totton, 1954 and *Moseria* Totton, 1965.

Further, he pointed out that *Stephanomia* is the name of a monotypic genus, the identity of whose only species *S. amphytridis* is exceedingly doubtful since only the siphosome is known. *Cupulita* (Quoy & Gaimard, 1824) is also monotypic and the identity of its only species *C. bowditchii* Quoy & Gaimard, is doubtful. *Agalmopsis* (Sars, 1846) was erected to include two species, *A. elegans* (Sars) and *A. cara* (Agassiz) but restricted by Kölliker (1853) and by Haeckel (1888b) for the species with tricornuate tentilla (*elegans*). Therefore, the next available name *Halistemma* Huxley, 1859 was revived by Totton, (1965). On the basis of the structure of the nectophore (except in *amphytridis*), bract and lack of marked basal involucrum in the cnidoband, the following species viz., *H. rubrum* (Vogt, 1852); *H. cupulifera* Lens & van Riemsdijk, 1908; *H. striata*, Totton, 1965; and *H. amphytridis* are recognized.

The next available name *Nanomia* Agassiz, 1865, was selected for the two closely allied species, *cara* and *bijuga*, on the basis of the shape and structure of the nectophore and involucrate tentilla.

The Arctic species *Stephanomia orthocanna* Kramp and two new species: *orthocannoides* and *antarcticus* were put under the genus *Marrus* Totton, 1954 as their nectophores bear the characteristic dorso-lateral ridges, simple unlooped latera radial canals and lack the usual vertical ridges. The only remaining species *Stepharomia convoluta* Moser, though bearing non-involucrate and unicornuate tentilla has an entirely different kind of nectophore for which reason the genus *Moseria* was created by Totton (1965).

Key to species of **Halistemma**

1.	Nectophore huge, longer than broad, with broad flap like mouth plates.	*amphytridis*
	Nectophore broader than long, with 2–4 vertical oblique ridges on lateral sides.	2
2.	Nectophore with 4 vertical ridges descending from upper lateral ridges at an angle of about 30°	*striata*
	Nectophore with 2 vertical ridges; tip of terminal filament of tentilla coiled or with appendage..	3
3.	Terminal filament of tentilla with acorn-shaped appendage, without basal involucrum.	*cupulifera*
	Terminal filament of tentilla simple, with cone shaped coiled tip and inconspicuous involucrum	*rubrum*

8. **Halistemma rubrum** (Vogt, 1852)

(Fig. 15 a–f)

Agalma rubra Vogt, 1852, p. 522.

Stephanomia rubra Bigelow, 1911, p. 348.

Halistemma rubrum Daniel, 1974, p. 45, Text-fig. 3, E–G (cf. for detailed synonymy)

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 11 col., 36 n., 24 br. *Bay of Bengal:* 12 col.; 66 n.; 51 br.; 6 bits of siphosome with gastrozooids, palpons, gonodendra. *South West Indian Ocean:* 14 col.; 68 n.; 27 br.; bits of siphosome. *South East Indian Ocean:* 14 col.; 68 n.; 65 br. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 10 col.; 77 n.; 12 br. *Bay of Bengal:* 13 col.; 86 n.; 71 br. *South West Indian Ocean:* 14 col.; 71 n.; 74 br. *South East Indian Ocean:* 24 col.; 101 n.; 69 br.

Description: Size: Colony extremely long, growing upto two metres; highly contractile. Stem 1.5 mm in diameter.

Nectosome: 20–25 cm long about one tenth total length, bearing upto 30 pairs of nectophores.

Pneumatophore: Thin, spindle-shaped, 3 mm long, pigmented apex; with 8 septae.

Nectophore: Size varies according to age — young nectophores, 3.5 $\times$ 4.33 mm; mature nectophore 13.0 $\times$ 10.5 mm. Lateral extensions or wings not prominent, (as in *A. okeni* or *A. elegans*) comparatively short, with a median lappet or lobe between lateral extensions. Median lappet, rectangular, prominent or small with pedicular canal in centre. Dorso-lateral ridges bifurcate in mid-region of nectophore, inner branches diverging towards each other near ostium. Lateral vertical ridges very oblique (angle of 45°) compared to *A. elegans* (angle of nearly 90°). Lateral oblique ridges may or may not join ventro-lateral ridges.

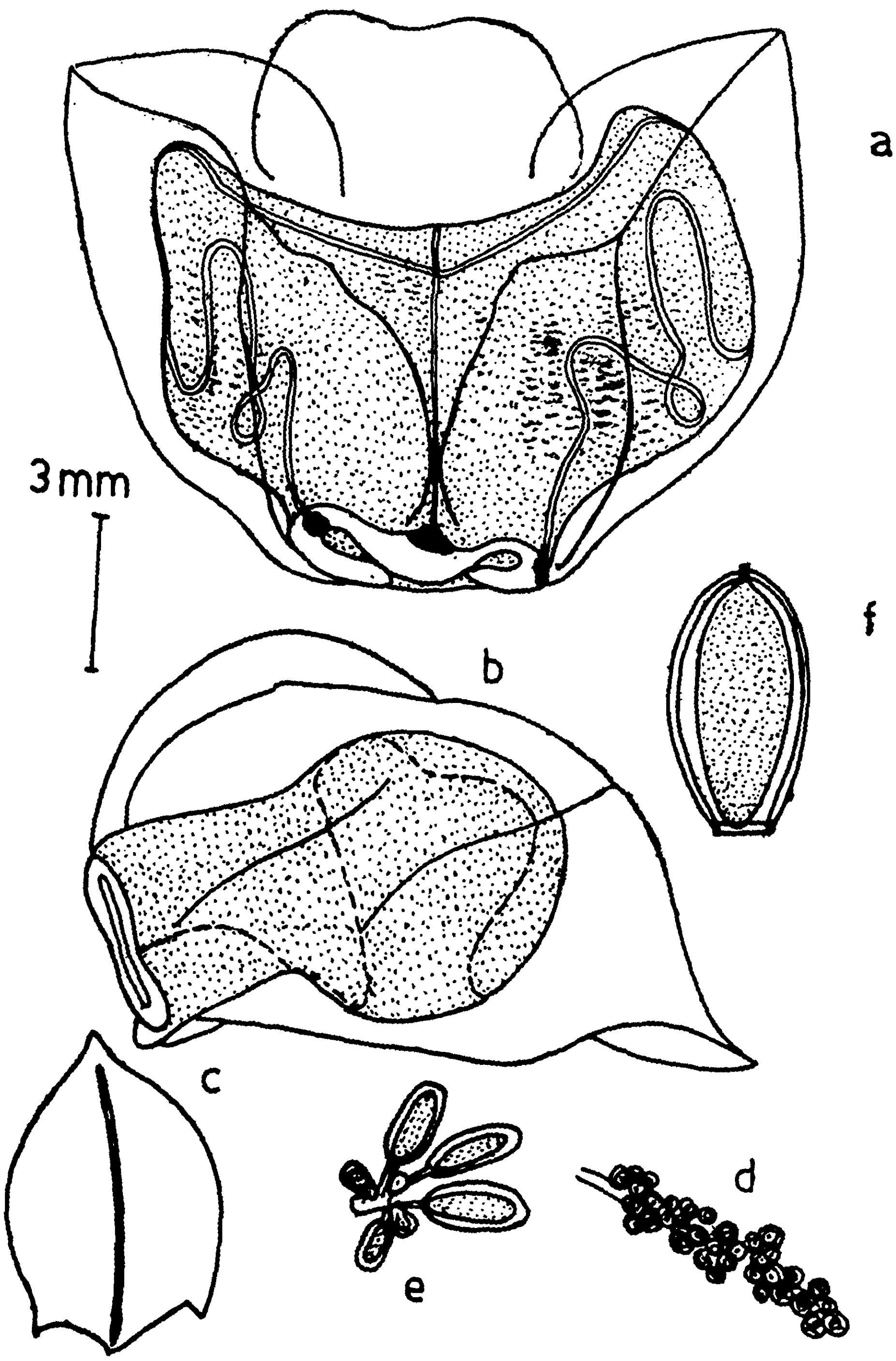


FIG. 15. *H. rubrum* (Vogt) (a–f). a & b. nectophore; c. bract; d. female gonodendron; e. male gonodendron; f. male gonophore.

Dorsal and ventral radial canals short, simple, arising from pedicular canal at 2/3rd distance from ostium. Lateral radial canals dip down before ascending at lateral corners of nectosac (characteristic feature), taking a semicircular course at lateral side and join circular (ring) canal. Mouth plate may or may not be present.

Siphosome: Ten times as long as nectosome, growing upto 176 cm covered with numerous bracts. With dissolved cormidia. 70 or more gastrozooids, spaced 2.5 cm apart, 15–17 mm long, 2 mm wide, with elongate ovate basigaster, 4.5 mm long.

Tentacle: (Fig. 15, c) With 4–6 unicornuate vermilion tentilla. Cnidoband loosely coiled with 8–10 turns, 5.0 mm long, tentilla 10.0 mm long when extended. With inconspicuous involucrum at junction of pedicel and cnidoband. Cnidoband with sabre-shaped numerous nematocysts (70 μ long, 7 μ wide) and a row of bean shaped ones at proximal sides (70 μ long, 20 μ wide). Single terminal filament 2 cm long, terminating in cone shaped coil of ten turns.

Each cormidium with one gastrozooid, 2 or 3 small proximal palpons, one longer distal palpon; male and female gonodendra, at bases of palpons.

Palpon: Active, vermiform, 11.0 mm long, 2 mm wide, with simple palpacles, bearing small nematocysts.

Female gonodendron: At base of distal palpon, about one third distance from last gastrozooid with broad muscular stalk, and groups of medusoid gonophores (codonid type), 5.0 mm in diameter, when mature. Single large ova with yolk granules. Keeps contracting and expanding (in living condition).

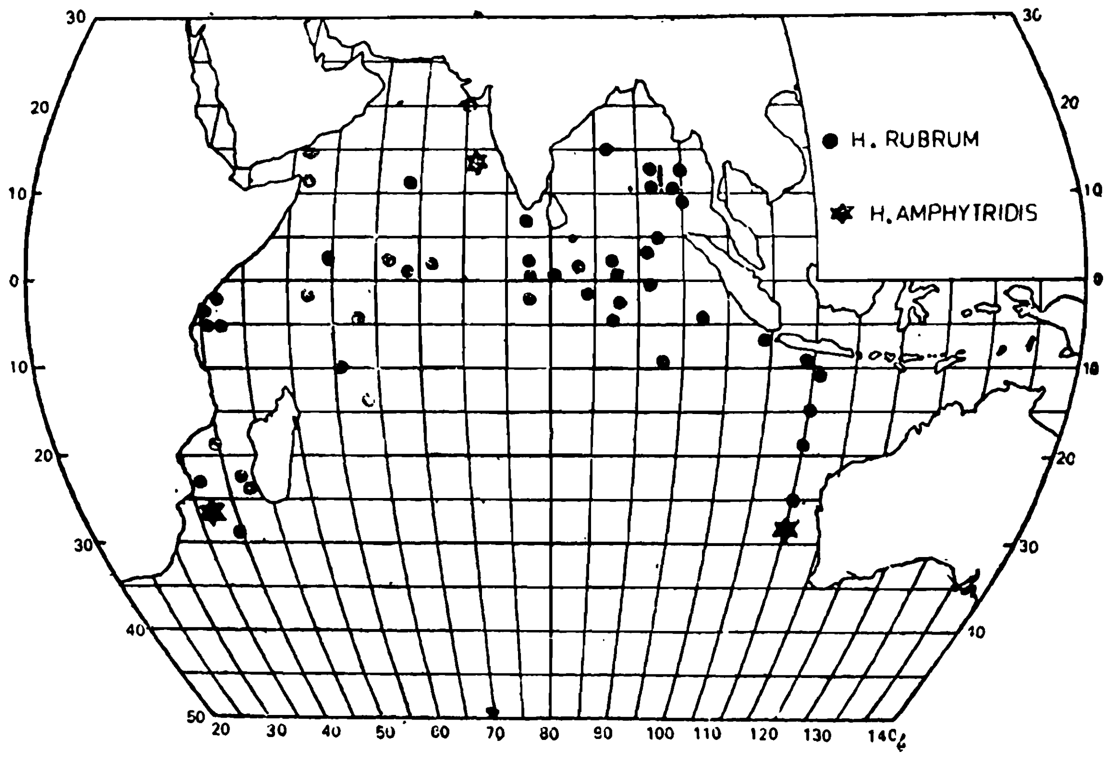
Male gonodendron: Occur distal to female gonodendron, at bases of three large palpons situated between two gastrozooids. With reduced stalk, bearing 8–10 mature male gonophores, each budded at an angle of 120° in transverse plane from bases of its predecessor. 6.0 mm long; keeps pulsating until set free.

Bracts: Numerous, covering entire siphosome, leaf-like, thin with three small distal teeth. Attached to stem by broad muscular lamella extending to one third proximal length of bract. Bracteal canal central, with a pad of nematocyst at distal end.

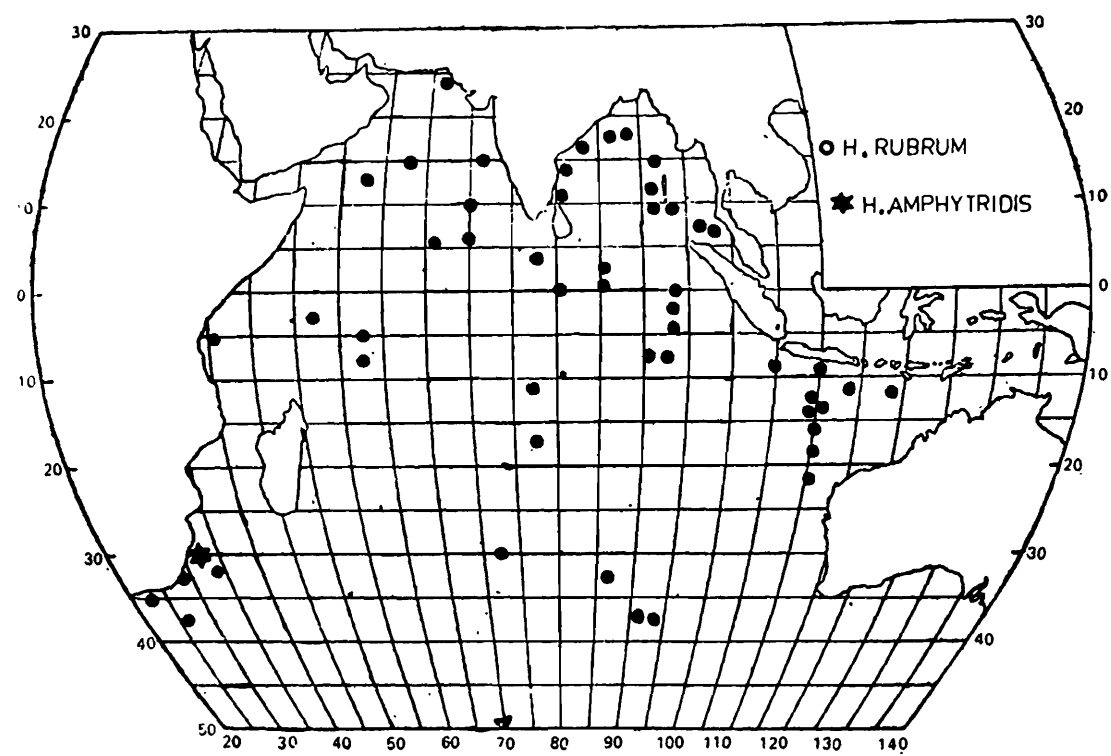
Type locality: Off Nice, Mediterranean Sea.

Distribution: (Maps 9 & 10) At each station, only 1 or 2 colonies were collected per haul. The number of records and distribution of *H. rubrum* in the different zones of the Indian Ocean during the two seasons are given in maps 9 & 10.

H. rubrum occurred in all the zones during the two seasons, in the Indian Ocean. It was collected mostly during the night time (82% of the capture). During SW/SE monsoon season its range of



Map 9. Distribution of *H. rubrum* and *H. amphytridis* during SW/SE monsoon season. 1–2 colonies/haul.



Map 10. Distribution of *H. rubrum* and *H. amphytridis* during NE/NW monsoon season. 1–2 colonies/haul.

distribution extended from 20° N latitude in the Arabian Sea to 30° S latitude along the African coast and from 15° N latitude in the Bay of Bengal to 25° S latitude along the 110° E longitude and 15° S latitude in the mid-ocean region. It occurred in abundance in the equatorial belt region and near the Andamans. During NW/NE monsoon season *H. rubrum* occurred scattered, away from the equator. Its range of distribution extended from 25° N latitude in the Arabian Sea to 36° S along the African coast and from 20° N latitude in the Bay of Bengal to 21° S latitude along 110° E longitude and to 37° S latitude in the mid-ocean region.

Monthly variations: Arabian Sea: In the western part *H. rubrum* occurred at three stations, *i.e.* Gulf of Aden during March and August and near the equator during August. In the eastern part it occurred at few stations in months other than April, June and September. It occurred mostly near the equator and south of Cape Comorin. *Bay of Bengal:* Along the Indian coast *H. rubrum* occurred at few stations during January and March while in the central region of the Bay it occurred during April. Near Andaman islands and north of Sumatra it was collected during March, April and September. Near the equator it was recorded at most of the stations during May, June, July, September and November. *South West Indian Ocean:* In the African region it was collected during January, July and August. In the Oceanic region it occurred at few stations during January, March, July, August, September, October and December. *South East Indian Ocean:* In the Australian region it occurred at few stations near the equator, south of Java and along 110° E longitude during April, May, July and September. In the Oceanic region it occurred during January, November and December.

9. **Halistemma amphytridis** (Lesueur & Petit, 1807) (Fig. 16 a, b)

Stephanomia amphytridis Lesueur & Petit, 1807, pl. 29, fig. 5.

Stephanomia amphytridis Bigelow, 1911, p. 287, pl. 18, figs. 1–8.

? *Halistemma amphytridis* Daniel, 1974, p. 47, Text-fig. 3, H–J (cf. for detailed synonymy).

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 1 br. *South West Indian Ocean:* 100 br. *South East Indian Ocean:* 2 n; 1 br. (Daniel, 1974). NORTH EAST/NORTH WEST MONSOON SEASON: *South West Indian Ocean:* 3 n.; 106 br.

Remarks: The identity of the nectophores described under this name by Daniel (1974) is not certain since the nectophores of *H. amphytridis* have never been described before. All the four previous descriptions were based upon bits of siphosomes only (Lesueur & Petit, 1807; Huxley; 1859; Lens & van Riemsdijk, 1908; Bigelow, 1911). These were collected from eastern Tropical Pacific and off the east coast of Australia. The nectophore desciibed below differs a great deal from the typical "*Halistemma*" type of nectophore and warrants a creation of new genus and new species, but in this account it is still retained as *H. amphytridis* (=*Stephanomia amphytridis*).

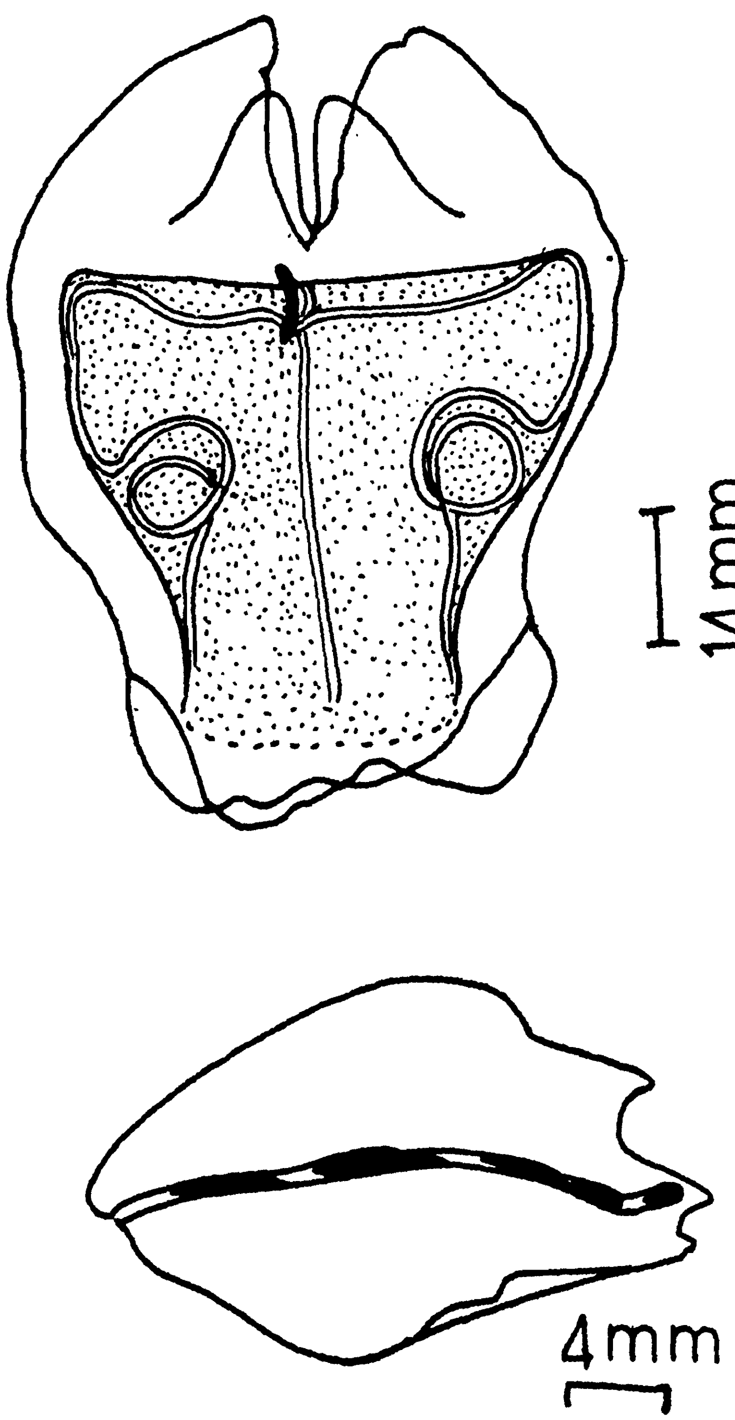


FIG. 16. *H. amphytridis* (Lesueur & Petit). a. nectophore; b. bract.

Description: *Size:* 33.0 mm long; 25.0 mm broad.

Nectophores: Longer than broad; number and course of ridges not discernible; with prominent lateral wings and median lappet occurring as two lobes. Nectosac with broad proximal half and narrowing towards ostium. Musculature highly developed. Radial canals thick and clear. Dorsal and ventral radial canals straight without sigmoid curves. Lateral radial canals dip down at proximal surface of nectosac, ascend upwards at lateral corners; descend along lateral surfaces; taking nearly two circular courses once on dorsal and then on ventral side of nectosac and then join ring-canal. Mouth of nectophore broad, wide open; mouth plates broad, flap-like. Pedicular canal short, thick slightly below proximal surface of nectosac.

Bract: 29 mm long, 15.0 mm broad and 1.2 mm thick. Uniformly thick except thicker at proximal middle region. Leaf-like with asymmetrical shape. Three blunt teeth at distal end and two small ones on lateral edges. Bracteal canal thick, at centre, extending upto tip of bract. Four pads of opaque material nematocysts (?) in canal. Resemble bracts described by Huxley (1859) and Bigelow (1911b).

Type locality: Between Le Havre and Mauritius.

Distribution: (Maps 9 & 10). *H. amphytridis* occurred along the south-east coast of Africa during January and near Indian coast in the Arabian Sea during May (maps 9 & 10).

Genus 6. **Cordagalma** Totton, 1932

Anthemodes Haeckel, 1888, p. 229 (Part).
Cordagalma Totton, 1932, p. 325.

Agalmidae with fragile, small semi-contractile stem, nectophores characteristically heart-shaped; tentacle with larval type of tentilla and prismatic, pyramidal bracts.

Monotypic genus for *C. cordiformis* Totton, 1932.

10. **Cordagalma cordiformis** Totton, 1932
(Fig. 17, a–h)

? *Anthemodes ordinata* Haeckel, 1888, p. 229, pls. XIV, XV.
Cordagalma cordiformis Totton, 1932, p. 325, Text-figs. 8, 9.
Cordagalma cordiformis Daniel, 1974, p. 49, Text-fig. 3, K–N.

Type Specimen: British Museum (Nat. Hist.) London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Bay of Bengal:* 5 n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 18 n. *Baty of Bengal:* 5 n.

Remarks: The monotypic genus *Cordagalma* was established by Totton (1932) for a very small, fragile, characteristically heart-shaped nectophores. Till 1968, *C. cordiformis* was known only from its nectophores and the rest of the colony was unknown. Complete specimen was described by Carre (1968) from the Mediterranean

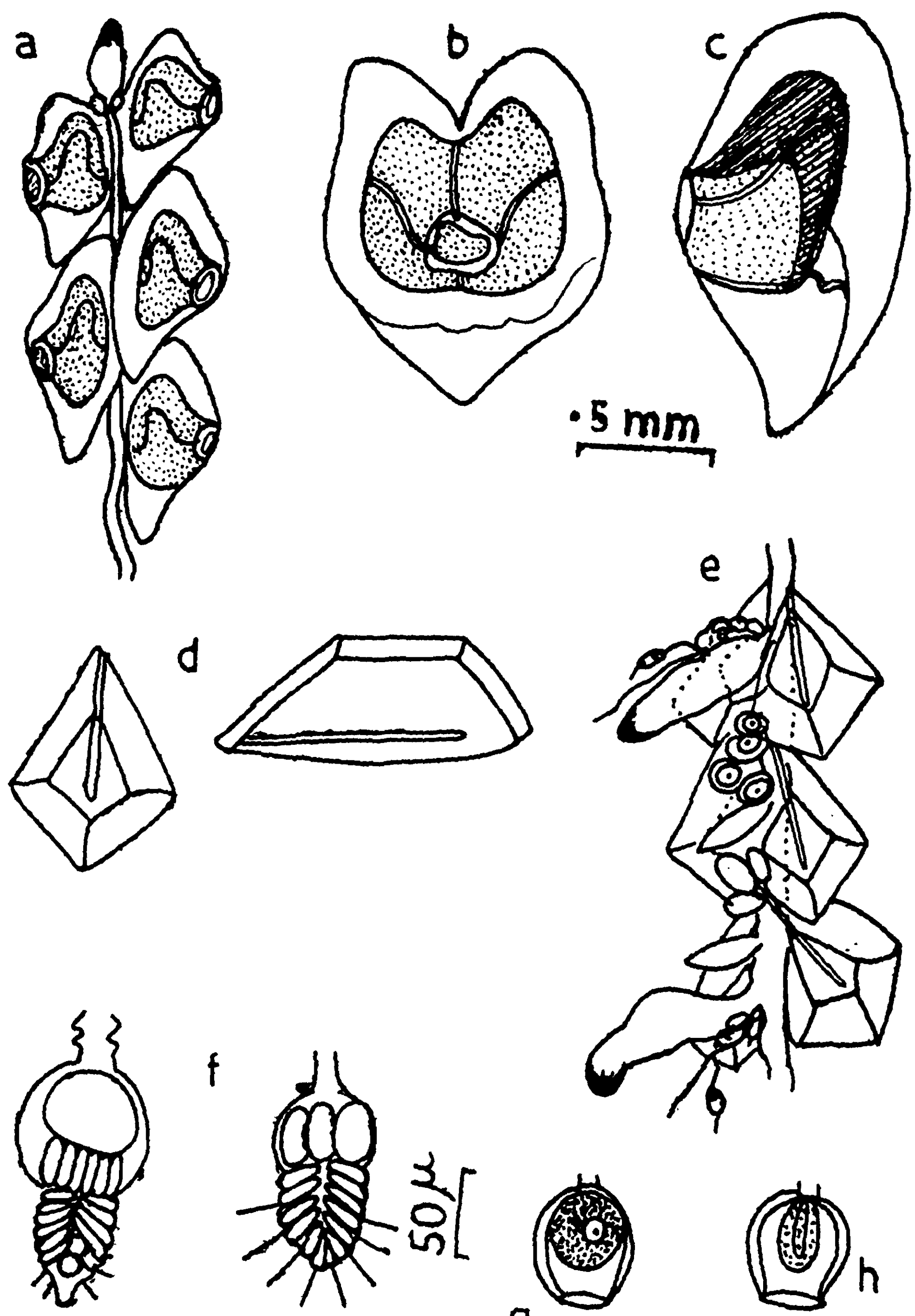


FIG. 17. *C. cordiformis* Totton (a–h). a. part of nectosome; b & c. ostial and lateral viess of nectophore; d. bract; e. part of stem showing cormidia and bracts; f. tentacular knobs of tentilla; g. female gonophore; h. male gonophore. (Figs a, d-h from carre, 1968).

sea. Except for the structure of the nectophores, *C. cordiformis* resembles *Anthemodes ordinata* Haeckel (1888) in all other characters of the siphosome, gastrozooid with its larval type of tentilla and in the characteristic prismatic pyramidal bracts.

Description: *Size:* 30 cm long semicontractile and fragile.

Nectosome: 10 cm long; bearing 7 pairs of biserially and alternately arranged nectophores.

Pneumatophore: Small, fusiform, pigmented apex.

Nectophores: 7 mm × 6 mm × 4 mm in size. Upto 7 pairs of mature and several buds of immature ones present. Small, fragile, typically heart-shaped. When viewed with ostium uppermost, two lateral lobes or wings of nectophore separated from one another by a sharp cleft, lateral sides narrowing beyond ostium into a blunt tip, resembling the heart. Deeply grooved on the ventral side. Nectosac almost heart-shaped, with ostium lying in centre of nectophore on dorsal side. Pedicular canal at base, directly opposite to ostium. Dorsal and ventral radial canals short, straight. Lateral radial canals simple, running upwards to half the length of nectosac, then curving down without forming any sigmoid loops on lateral sides before joining circular canal. Point of attachment to nectosome unusually low.

Siphosome: 20 cm long; 0.12 mm thick.

Gastrozooids: Well spaced, 2.0 mm long with pigmented base; with hepatic bands. Tentilla larval type, cnidosacs round to oval-shaped with a row of proximal large bean-shaped and distal elongated cigar-shaped, stenostele type of nematocysts; 6–8 sharp bristles (cnidocils ?) radiating from tip. No terminal filament. Resemble tentilla of protosiphon of *Nanomia bijuga*.

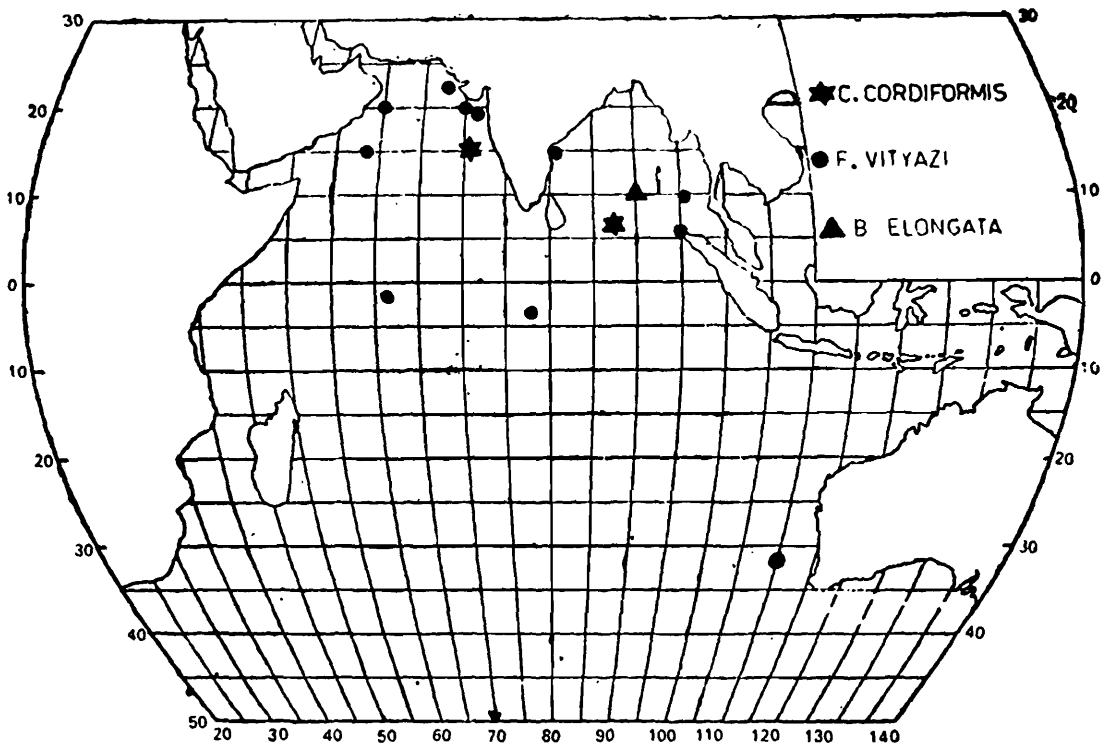
Palpons: In two groups, in internode between two gastro zooids. Female gonophores at base of proximal palpon; male-gonophores at base of distal palpon.

Female gonophores: (Gynophores) in groups of various growth stages. Mature gonophore with short stalk, round-shaped, typically medusoid structure. A single ovum borne on manubrium.

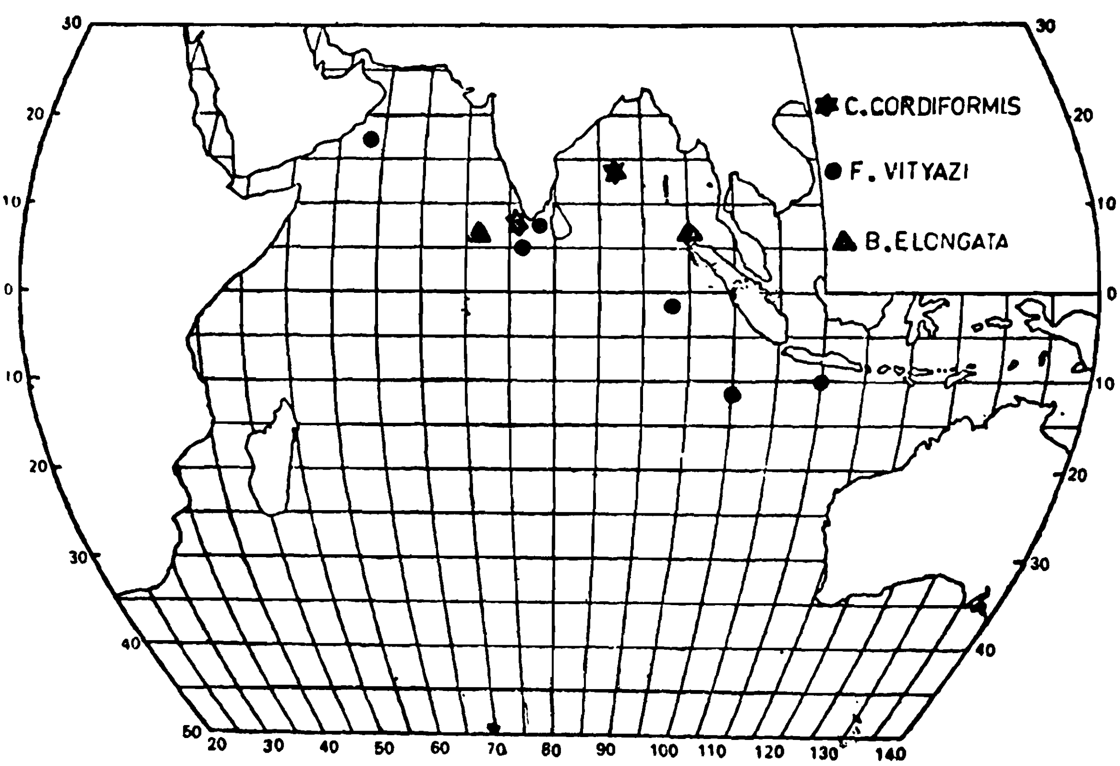
Male gonophores (androphores): Distal to female gonophores, similar in size and shape; germ cells borne on spadix of manubrium,

Bracts: Entire stem covered with numerous prismatic, pyramidal, trapezoidal-shaped bracts. Ventral facet broader than dorsal facet. *i.e.* Pyramid with its apex sliced off forming a smaller trapezoidal facet on dorsal side. Four faceted sides oblique. Thick bracteal canal in centre. Attached to stem by small peg-like pedicel. Resemble bracts of *Anthemodes ordinata* (Haeckel, 1888) in every respect.

Type locality: Great Barrier Reef, Australia.



MAP 11. Distribution of *C. cordiformis*, *F. tityazi* and *B. elongata* during SW/SE monsoon season. 1 colony/haul.



MAP 12. Distribution of *C. cordiformis*, *F. vityazi* and *B. elongata* during NE/NW monsoon seasons. 1 colony/haul.

Distribution: (Maps 11 & 12). This species was known previously from Atlantic, Pacific and Indian Ocean. In the I.I.O.E. collections this species have been recorded only four times — twice from the Bay of Bengal and twice from the Arabian Sea (map 12). These records were made during the North East and South West monsoon periods.

Genus 7. **Nanomia** A. Agassiz, 1865

Cupulita Quoy & Gaimard, 1824, p. 580.
Nanomia A. Agassiz, 1865, p. 180.

Agalmidae with elongated, highly contractile stem, with brightly pigmented spots on nectosome and ostium of nectophores; tentilla involucrate at base and unicornuate; male and female gonodendra alternating on either side at bases of palpons.

Type Species: *N. Cara* A. Agassiz, 1865. Only *N. bijuga* is recorded from Indian Ocean.

Although Bigelow (1911b) included all known species with unicornuate tentilla under the genus *Stephanomia*, Totton (1954) showed that the generic names of *Stephanomia* and *Cupulita* were not valid. The reasons for not using these names have been dealt with under the genus *Halistemma*.

The genus *Nanomia* Agassiz was revived to accommodate *bijuga* Delle Chiaje, 1841 and *cara* Agassiz, 1865.

Key to species of **Nanomia**

Nectophores flattened in the horizontal plane without pigment spots.	*cara*
Nectophores flattened stem side to ostial side with pigment spots.	*bijuga*

11. **Nanomia bijuga** (Delle Chiage, 1841)
(Fig. 18 a–g)

Physophora bijuga Della Chiage, 1841, pl. 181, figs. 3–6.
Stephanomia bijuga Bigelow, 1911, p. 284, pl. 19; figs. 5–11, pl. 20, figs. 1–3.
Nanomia bijuga Daniel, 1974, p. 50, Text-fig. 4, A–G (cf. for detailed synonymy).

Type Specimen: Place of deposit not known.

Material Examined: South West/South East Monsoon Season: *Arabian Sea:* 100 col.; 656 n.; 20 br.; bits of siphosome. *Bay of Bengal:* 54 col.; 211 n.; 9 br.; bits of siphosome. *South West Indian Ocean:* 35 col.; 166 n.; 3 br.; 6 bits of siphosome. *South East Indian Ocean:* 21 col.; 162 n. North East/North West Monsoon Season: *Arabian Sea:* 90 col.; 395 n.; 6 br.

Bay of Bengal: 24 col.; 48 n. *South West Indian Ocean:* 34 col.; 162 n. *South East Indian Ocean:* 9 col.; 18 n.; 8 br.

Elongated, slender, highly contractile, pinkish in living condition, with red pigmented spots on nectosome and nectophores; gastrozooids and palpons with network of red pigment.

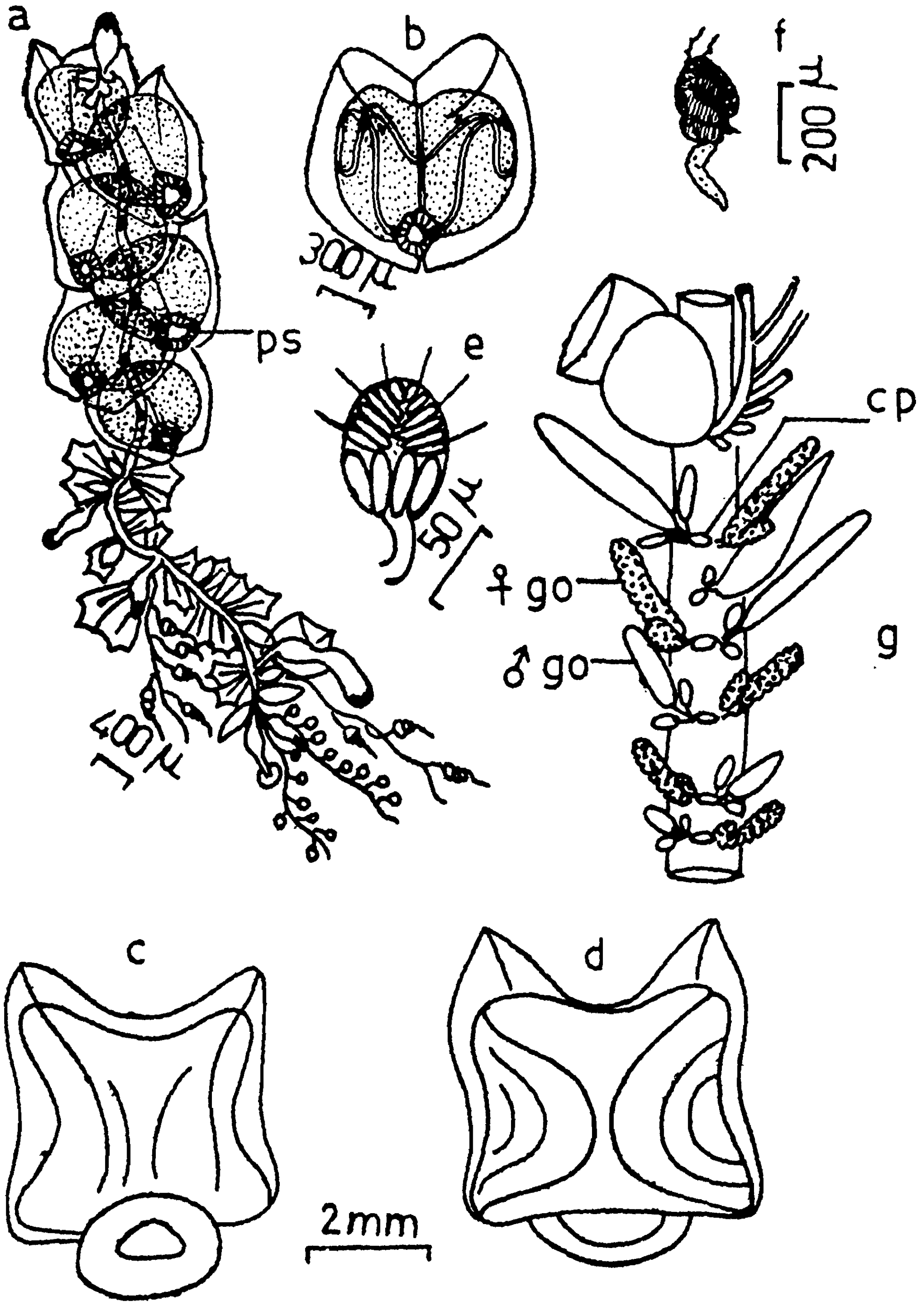


FIG. 18. *N. bijuga* (Delle chiaje) (a–g). a. entire showing pigment spots (ps) on nectosome and ostium; b. fresh nectophore; c & d. preserved nectophore dorsal and ventral views; e. larval tentillum; f. adult tentillum; g. stem showing arrangement of male and female gonodendra, on either side of cut end of palpon (cp). (Fig. g from Totton, 1965, fig. 35).

Description: *Size:* Grows upto 45 cm long.

Pneumatophore: 1.8–2.00 mm long, 1–2 mm diameter, with 8 septa. Apex with light brown pigment spots, surrounded by wine-red coloured polygonal pigmented cells.

Nectosome: One fifth of total length with 8–25 pairs of biserial and alternate nectophores. Red pigment spots occur on nectosome at points of attachment of nectophores.

Nectophores: Square-shaped (preserved nectophores) when viewed from abaxial or axial sides, flattened from stemside to ostial side. Upper lateral corners with sharp ear-like expansions. 1.33 mm to 3.67 mm long and 1.17 mm to 3.17 mm broad. Soft, almost round-shaped in living condition, highly transparent with red pigment spots on velum of ostium at junction of lateral radial canals. Nectosac not extending into lateral ear-like extensions, with bulged rounded appearance. Ostium directed dorsally. Lateral radial canals long and looped; loops situated higher up than in any other species of Agalmidae. Mouth plates small and clefted.

Two dorso-lateral ridges extend from apices of lateral wings to ostium. Vertical ridges present but faintly marked.

Siphosome: Four-fifth of total length, slender, highly contractile, with dissolved cormidia.

Gastrozooids: Twenty-four fully formed, well spaced gastrozooids in a colony 45 cm long. 8.0 mm by 2 mm, stalked. Basigaster well developed, with extensible probosis and flexible mouth opening. Net work of red pigment at base and irregular red spots around mouth. Red pigment patches on stem.

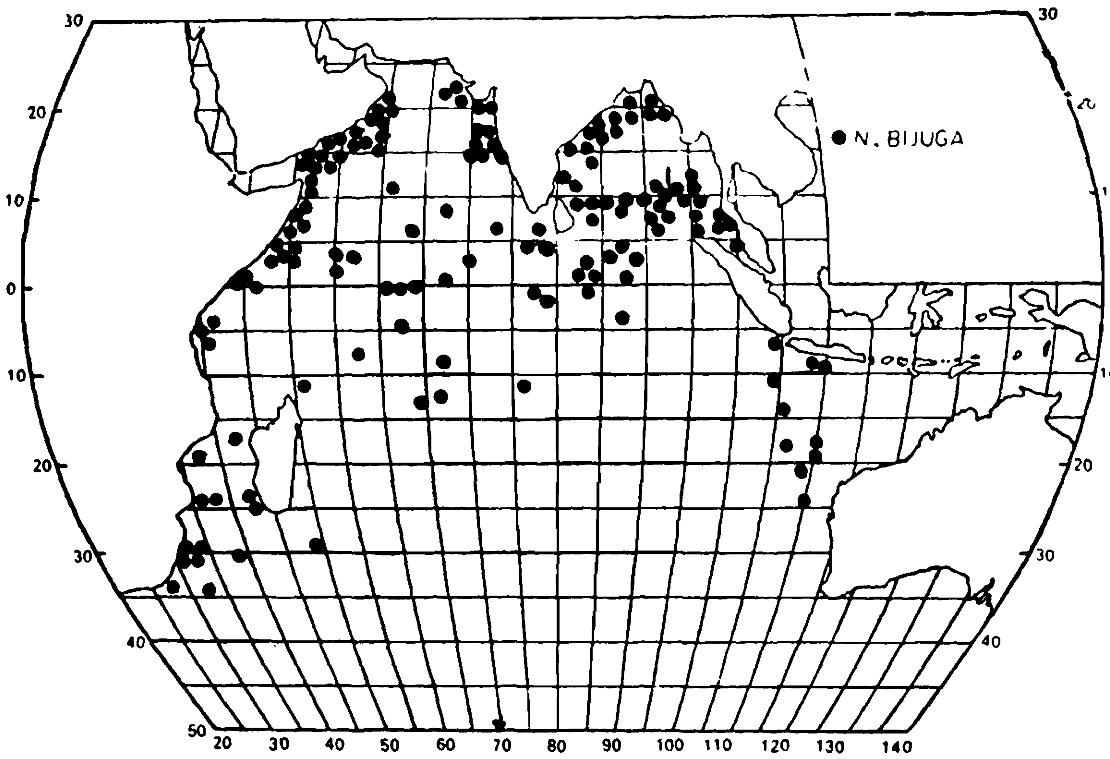
Tentacle: Protosiphon (primary gastrozooid) with larval type of tentilla; other gastrozooids with adult type. At times larval type of tentilla persist in all gastrozooids in colonies measuring 10–20 mm long.

Larval type of tentilla: With many tentilla ending in rounded cnidosacs; with 6–8 proximal, bean shaped, large and distal radially arranged cigar shaped slender nematocysts; 6–8 stiff bristles (cnidocils) at distal surface; without terminal filament.

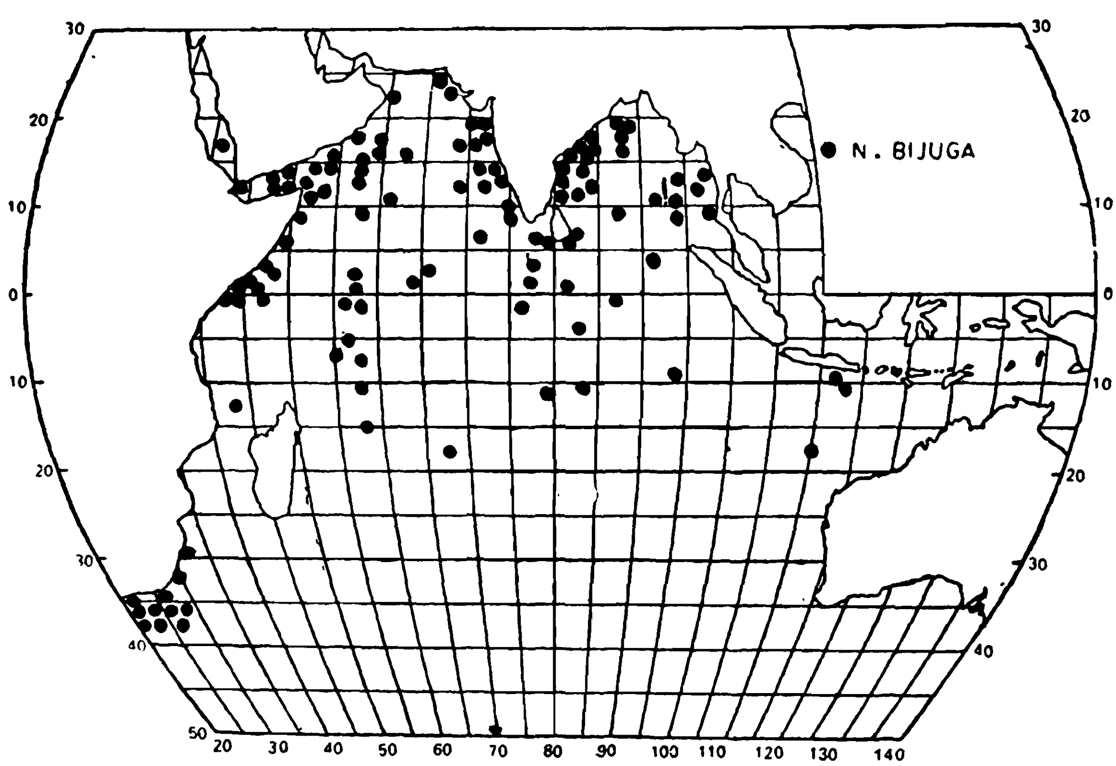
Adult type of tentilla: 6–8 tentilla in a tentacle; with coiled maroon coloured cnidoband 2½ turns and single terminal filament (unicornuate) covered at base with involucrum.

Palpons: About 6 palpons in a row on ventral side of internode between two gastrozooids. Network of red pigment at base, and transparent at distal half. Palpacles very fine, short, threadlike. Male and female gonodendra alternate at bases of palpons.

Female Gonodendra: Gonophores borne on long stalk of gonodendron as two bunches of grapes, on one side at base of a palpon. Each gonophore very small, sessile, highly reduced, with a single ovum.



MAP 13. Distribution of *N. bijuga* during SW/SE monsoon season. 1—4 colonies/haul.



MAP 14. Distribution of *N. bijuga* during NE/NW monsoon season. 1—4 colonies/haul.

Male Gonodendra: Stalk of gonodendron highly reduced; with 2 or 3 pedicelate gonophores on other side of same palpon (bearing female gonodendron) at its base; largest gonophore with a short stalk, elongated and saccular in structure (*i.e.* without medusoid umbrella). Smaller ones budded from base of predecessor.

Bracts: Numerous, covering entire stem. Two types, single large ones situated at base of each gastrozooid; numerous smaller ones along entire stem. Large bracts, broad, thicker, trident, and at times folded to form chambers for retraction of gastrozooids. Smaller ones, thin, stiff, tetragonal shaped, attached at right angles to stem by pointed small peg-like pedicels. Bracteal canal extends to tip of central teeth.

Type locality: Off Sicily, Mediterranean Sea.

Distribution: (Maps 13 & 14). The I.I.O.E. material has a good collections (mostly nectophores and few bracts) of this species. The number of colonies collected was not more than 3 or 4 in each haul though the number of nectophores varied from 2–20. The number of records and distribution of *N. bijuga* in the different zones of the Indian Ocean during the two seasons are presented in maps 13 & 14.

A perusal of maps shows that *N. bijuga* occurred throughout the Indian Ocean during both seasons especially in the Arabian Sea and Bay of Bengal. The number of night time catches were more in these zones than in the South West Indian Ocean where there was not much night/day variations. In the South East Indian Ocean the day captures were more during SW/SE monsoon season than during NW/NE monsoon season.

During both the seasons it occurred in great abundance near the land masses and along the equator. During SW/SE monsoon season the distribution of *N. bijuga* extended from 25° N latitude to 35° S latitude along the African coast and to 25° S latitude along 110° E longitude and to 15° S latitude in the mid-oceanic region. *N. bijuga* was not collected from the central regions of the Arabian Sea and Bay of Bengal. In the Bay of Bengal however, *N. bijuga* occurred as a rich belt along 10° N latitude extending from each coast of India, and across the Bay of Bengal to the coast of Malaya. During NW/NE monsoon season its distribution extended from 25° N latitude to 35° S latitude along the African coast while it occurred down to 20° S latitude in mid-ocean region and along 110° E longitude.

Monthly variation: *Arabian Sea:* In the Western part *N. bijuga* occurred in great abundance along the coastal regions of Arabia, Somali coast and Gulf of Aden during July, August and December. It was not collected during September. In the Eastern Region it occurred mainly along the west coast of India during May and November. It was recorded in all the months except in June.

Bay of Bengal: In the Indian region it occurred almost throughout the year (except during October and November) especially during April and June. In the Andaman and Burma region it occurred during August and September, in greater number of stations than during January, March, April, June and July. *South West Indian Ocean:* Along the African coast it occurred usually during January and October. In the oceanic region it was recorded at few stations throughout the year. *South East Indian Ocean: N. bijuga* occurred during August April and May. In the oceanic region it was recorded at very few stations.

Genus 8. **Frillagalma** Daniel, 1966

Agalmidae with soft nectophores where all the ridges are flared out and frilled.

Monotypic genus for *F. vityazi* Daniel, 1966.

12. **Frillagalma vityazi** Daniel, 1966

(Fig. 19 a–d)

Frillagalma vityazi Daniel, 1966, p. 689.

Type Specimen: Holotype & Paratypes in Zoological Survay of India (Reg. No. P. 1807 & P. 1808/1).

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 14 n. *Bay of Bengal:* 7 n.; 3 br. *South West Indian Ocean:* 3 n.; 11 br. *South East Indian Ocean:* 4 n.; 1 br. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 1 n.; 9 br. *South East Indian Ocean:* 28 n.; 48 br.

Known only from its characteristic nectophores.

Nectophore: 3.7–4.8 mm long; 3.5–4.5 mm wide; small, soft, and transparent. All ridges prominent, flared out, frilled or fluted in appearance. Dorso-ventrally flattened with median longitudinal grooves on dorsal and ventral sides. Juvenile nectophore with dorso-lateral ridges of both sides close together alongside median groove, not extending to ventral side.

Mature nectophores with broader median longitudinal groove; two dorso-lateral ridges placed very much to lateral edges of nectophore, continuing on ventral side as ventro-lateral ridges. On dorsal side two pairs of very short, frilled ridges extend into median groove as anterior and posterior ridges. Near ostium dorso-lateral ridges bifurcate surrounding ostium as inner and outer ridges. Dorso, and ventro-lateral ridges joined by short vertical ridge. Ostium directed ventrally.

Nectosac large, round, ostium broad, oval or quadrangular shaped. Musculature well developed; with four radial canals —

simple, straight; lateral radial canals not forming loops but curve downward in mid region of nectosac on lateral surfaces before joining ring canal.

Bracts: Found in same sample as nectophores, differ from all other bracts of Agalmidae. Figured in fig. 19 d, probably belongs to this species. Needs confirmation. Resemble bracts of *A. okeni* but differ from it is possessing extra spines between distal facets.

Type locality: 05° 11' S latitude; 91° 11' E longitude — Eastern Indian Ocean.

Distribution: (Maps 11 & 12). *Arabian Sea:* During SW/SE monsoon season *F. wityazi* was collected at five stations; two located in the western part during May and July, three located south in Kathiawar during May. During NW/NE monsoon season it occurrep

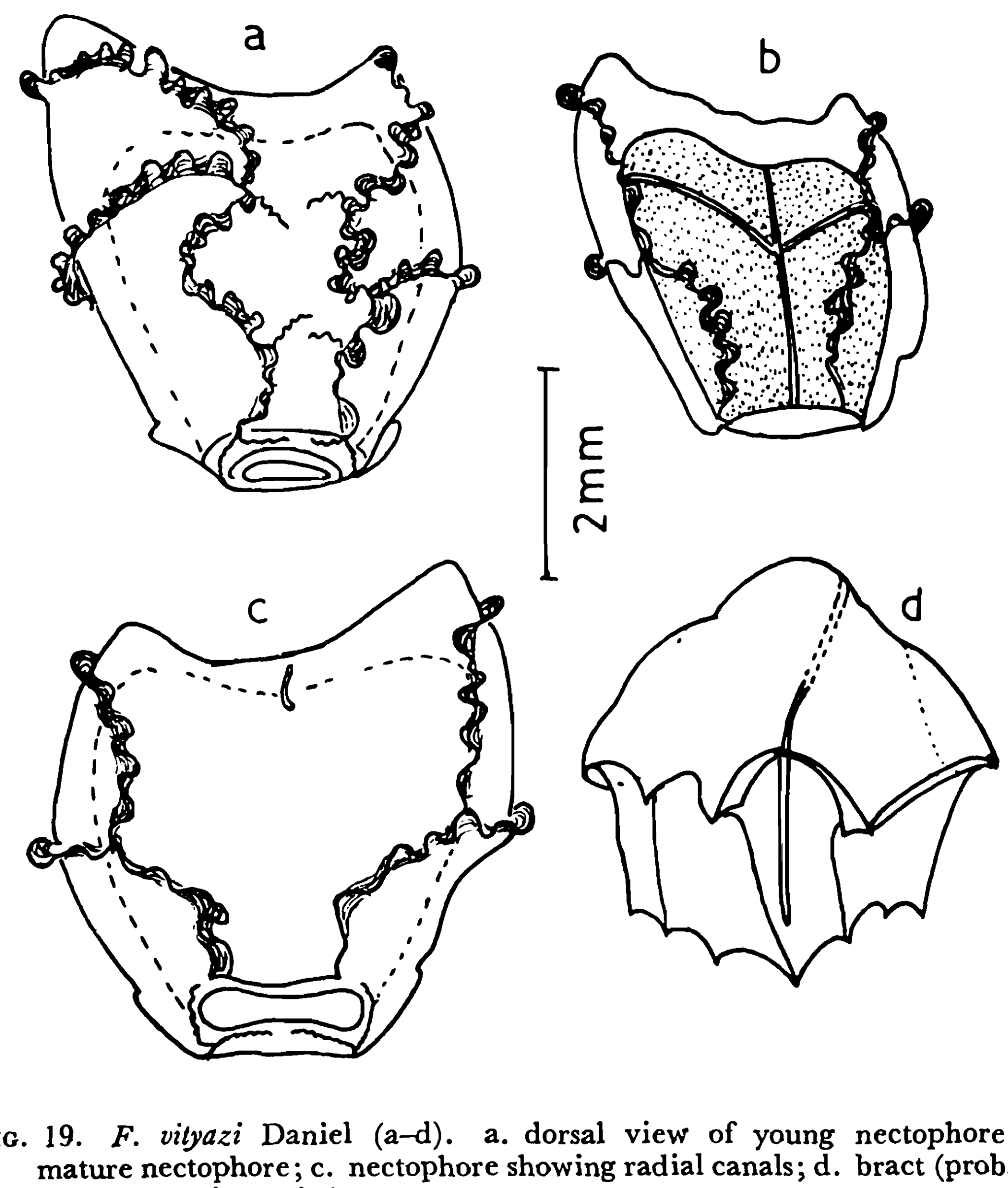


Fig. 19. *F. vityazi* Daniel (a–d). a. dorsal view of young nectophore; b. mature nectophore; c. nectophore showing radial canals; d. bract (probably belongs to this species).

at three stations; one on the western part during January and the other two south of Cape Comorin during December. *Bay of Bengal:* During SW/SE monsoon season it was collected along the Indian coast during June and on the eastern coast of Andaman during September and north of Sumatra during August. It was not collected during NW/NE monsoon season. *South West Indian Ocean:* During SW/SE monsoon season it occurred in the equatorial belt during August (2 stations) and September (1 station). It was not collected during NE/NE monsoon season. *South East Indian Ocean:* During SW/SE monsoon season it was not collected, but during NW/NE monsoon season it occurred at three stations, *i.e.* 2 stations in the oceanic region during January and December and the other station in the South of Java during January.

The previous record (Daniel, 1966) was from the equatorial belt, from a depth of 200–0 m. The present records extend its distribution to the Arabian Sea and Bay of Bengal.

Genus 9. **Lychnagalma** Haeckel, 1888

Agalmidae with elongated nectosome and siphosome, characteristic multicornuate tentilla with involucrate cnidoband, terminal ampulla and a corona of eight radial horns or filaments.

Two species of *Lychnagalma*, *L. utricularia* (Claus, 1879) from Messina, Mediterranean Sea and *L. vesicularia* Haeckel, 1888 off Belligemma, Sri Lanka, Indian Ocean, have been described. The validity of Haeckel's species is doubtful since it does not appear to differ from *L. utricularia.*

Type Species: *L. utricularia* (Claus, 1879).

13. **Lychnagalma utricularia** (Claus, 1879)
(Fig. 20 a–g)

Agalmopsis utricularia Claus, .879, p. 190, pl. 1, figs. 1, 2, 5a–d, f.
Lychnagalma vesicularia Haeckel, 1888, p. 235, pl. 16.
Lychnagalma utricularia Totton, 1965, p. 73, pl. XVI, figs. 1–7.

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 25 n. *Bay of Bengal:* 16 n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 41 n. *Bay of Bengal:* 37 n. *South West Indian Ocean:* 10 n. *South East Indian Ocean:* 9 n.

Nectosome: As in *N. bijuga* with 6–8 pairs of biserial, alternate nectophores.

Pneumatophore: Small, ovate, with octoradial red-brown pigment at apex; 8 radial septae, and annular septum. Lower half lined with greenish air secreting pneumadenia.

Nectophore: Like *N. bijuga,* but squarish to rectangular in front view. Convex dorsal surface with median rounded ridge fitting into corresponding groove on concave ventral surface of preceding

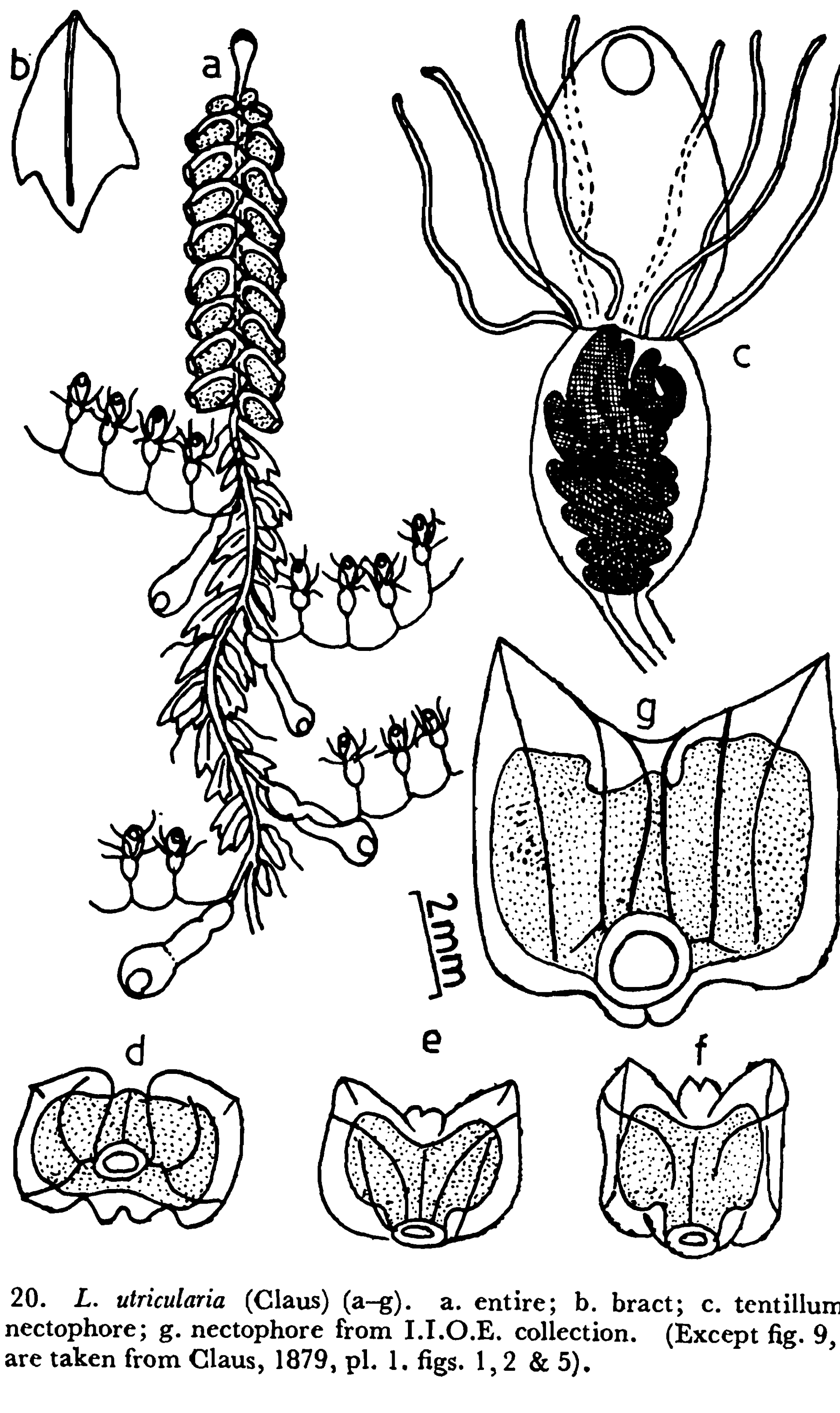


Fig. 20. *L. utricularia* (Claus) (a–g). a. entire; b. bract; c. tentillum; d–f. nectophore; g. nectophore from I.I.O.E. collection. (Except fig. 9, others are taken from Claus, 1879, pl. 1. figs. 1, 2 & 5).

nectophore. Lateral apical corners expanded into small wings, with two pairs of ridges — dorsal and dorso - lateral ridges; dorso-laterals not joining dorsal ridges. Vertical ridge oblique, towards proximal end of nectophore. Ventro - lateral ridges present. Two transverse ridges at distal end of nectophore connect dorsal and dorso - lateral ridges at ostium. With median slightly bilobed lappet. Radial canals not drawn by previous workers. Nectosac squarish, with lateral pouches and neck near ostium. Nectophores collected during I.I.O.E. weie badly preserved and had lost their musculature.

Siphosome: Longer, with dissolved cormidia.

Gastrozooid: With exceptionally long stalk, bearing unique tentacle at base.

Tentacle: With many tentilla all directed upwards. cnidosac with long red-purple cnidoband forming 7–8 spiral turns enclosed in an ovate involucrum; 4–5 proximal spiral turns lying transversely, middle ones — oblique and distal ones vertical; terminal median ampulla large, oval, vesicular, with oil globule acting as hvdrostatic float; base of ampulla surrounded by eight slender, motile, upright long filaments.

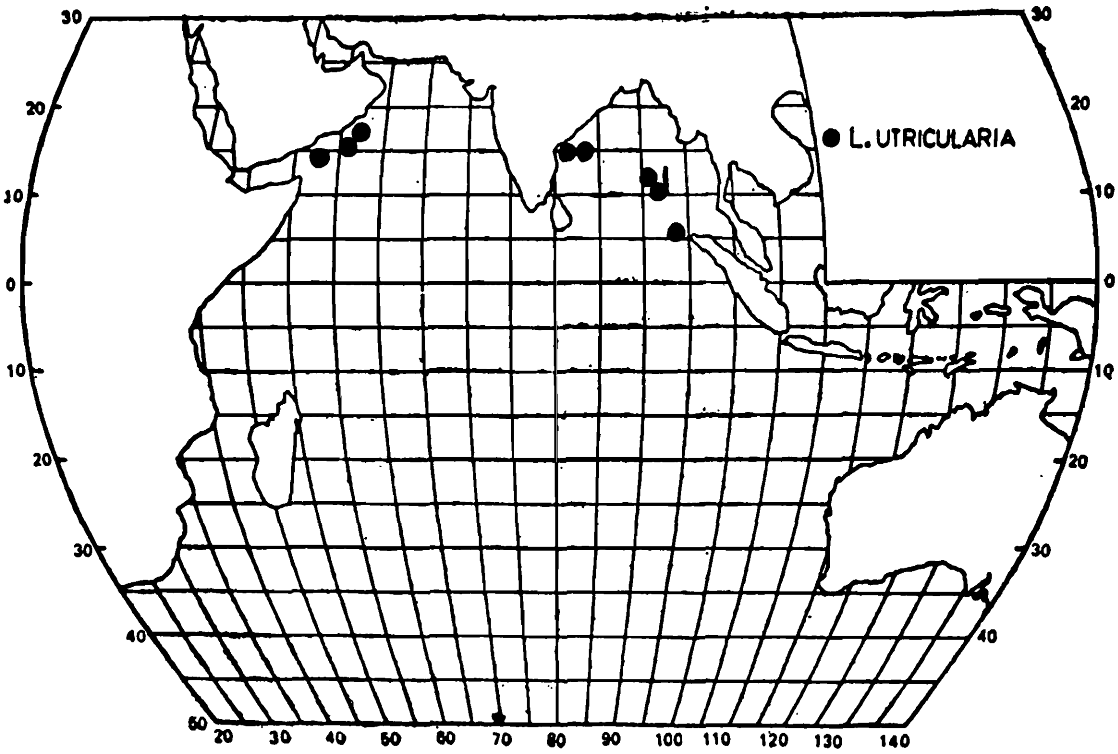
Gonodendra: About two male, 4 female gonodendra between two gastrozooids, at bases of 6–10 palpons. Male gonophores 0.7–0.8 mm long with distinct umbrella; female gonophores larger.

Bract: Flat, scale-like, ovate or triangular with convex dorsal and concave ventral sides. Attached to stem by small peg-like pedicle. Broad distal end with 2 or 3 short pointed teeth.

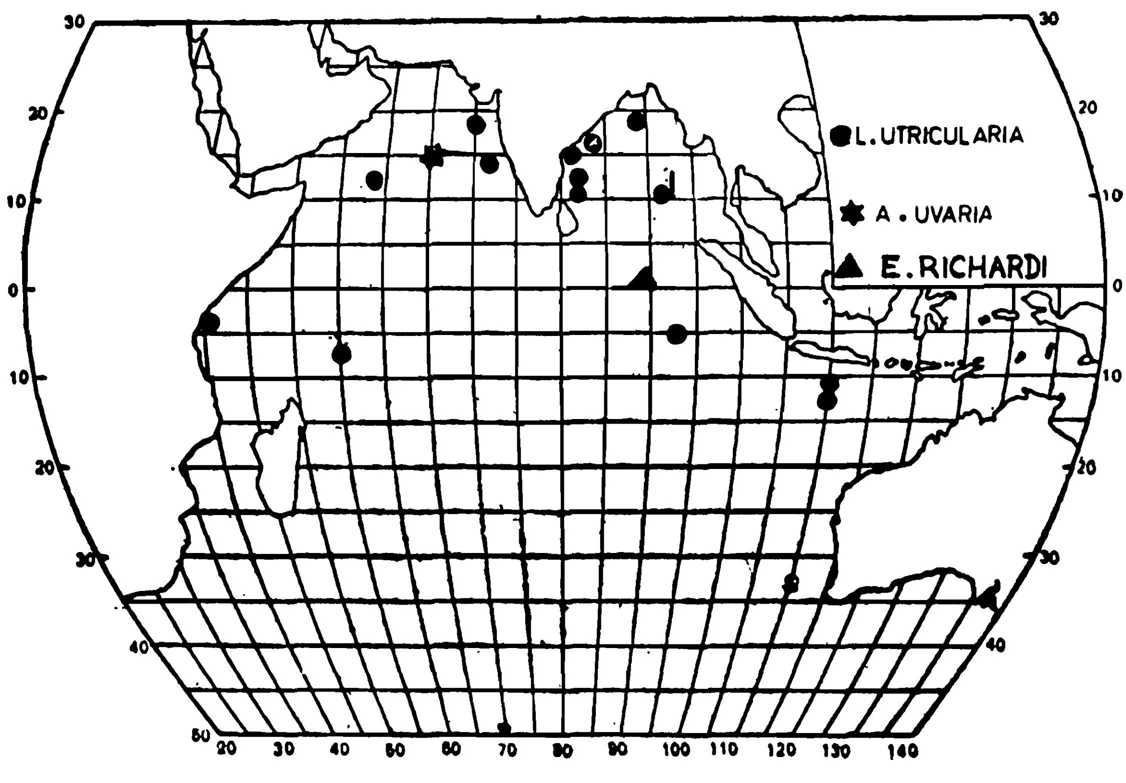
Remarks: Only the nectophores were collected during the International Indian Ocean Expedition. The nectophores resemble those of *Nanomia bijuga* but are larger and broader, with characteristic two pairs of ridges on the dorsal surface. Near the ostium a transverse ridge connects these two pairs of ridges, resembling those of *L. utricularia* described by Claus (1879) and Totton (1965). Complete colony with the presence of the characteristic multicornuate, involucrate tentillum will confirm the identity of this species and its seasonal distribution. (Only pneumatophore and stems devoid of gastrozooids with the characteristic tentilla, bracts and gonophores were present in the same samples).

Type locality: Mediterranean Sea.

Distribution: (Maps 15 & 16). During the I.I.O.E. *L. utricularia* occurred in only 20 stations in the Indian Ocean, of which eleven stations were situated in the Bay of Bengal. Only 5–16 nectophores were present in each haul. The species appears to come up mostly during the night in thirteen stations. *Bay of Bengal:* It was collected during the SW/SE monsoon period near the



MAP 15. Distribution of *L. utricularia* during SW/SE monsoon season. 1—2 colonies/haul.



MAP 16. Distribution of *L. utricularia* and *A. uvaria* and *E. richardi* during NE NW monsoon season. 1—2 colonies/haul.

Andaman Islands (September) and near Sumatra (August). Near the Indian coast it was collected only during the month of June. During NE/NW monsoon regime it was taken near Burma (March); on the Indian coastal regions during January, March and April. All the collections were made during the night time. *Arabian Sea:* It was collected near the Arabian coast in June and July during day time (SW/SE monsoon period) and in November (NE/NW monsoon period). Along the western coast of India it occurred during February and March (NE/NW monsoon regime). *South East Indian Ocean:* It was collected from only one station in the oceanic region during December. *South West Indian Ocean:* From the oceanic region it was collected during February and along the African coast during January.

Genus 10. **Erenna** Bedot, 1904

Agalmidae known from depths, with large nectophores having muscle free strip of nectosac at the lateral corners below the un-looped, pigmented lateral radial canals which have short or long fine horn-canals extending into the lateral wings of the nectophore

14. **Erenna richardi** Bedot, 1904

(Fig. 21 a–c)

Erenna richardi Bedot, 1904, p. 10, pl. 2.
Erenna richardi Totton, 1965, p. 73, Text-figs. 38, 39; Pl. XIV, figs. 10, 11.

Type Specimen: Institute Oceanographique, Monaco.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *South East Indian Ocean:* 23 n.; 10 br. (from lat. 00° 38′ S; long. 80° 03′ E).

Rare deep sea species with characteristic black pigmented endoderm, the colour being derived probably from feeding on pigmented deep-sea fish. Known only from fragments of loose nectophores, gastrozooids, bracts and tentacles.

Nectophore: Large, measuring 32 mm × 25 mm × 2 mm lateral corners of nectophore produced into well developed wings. Median lappet, may be present between lateral wings. Nectosac with muscle free strip at lateral corners of nectosac just below lateral radial canals. Endoderm of radial canals with black pigment. Lateral radial canals with short or long horn-canals which extend right into lateral wings.

Tentacles: 18 cm long, with characteristic hypertrophied cnidoband forming a very formidable stinging organ, and mass of vacuolated endoderm surrounding axial and diverticular canals. Nematocysts large — 70 μ × 23 μ.

Bracts: Elongated, upto 20 mm × 3 mm × 1 mm with a pair of short hook-like processes 7 mm from the proximal end, and another pair at distance of 3 mm from distal end. With characteristic terminal sphere of nematocysts. Muscular lamella attached to 3/4th length of bract. Bracteal canal close to dorsal surface curving down at tip. Bracts in groups of 5–6 in four rows on either side of stem in each cormidium.

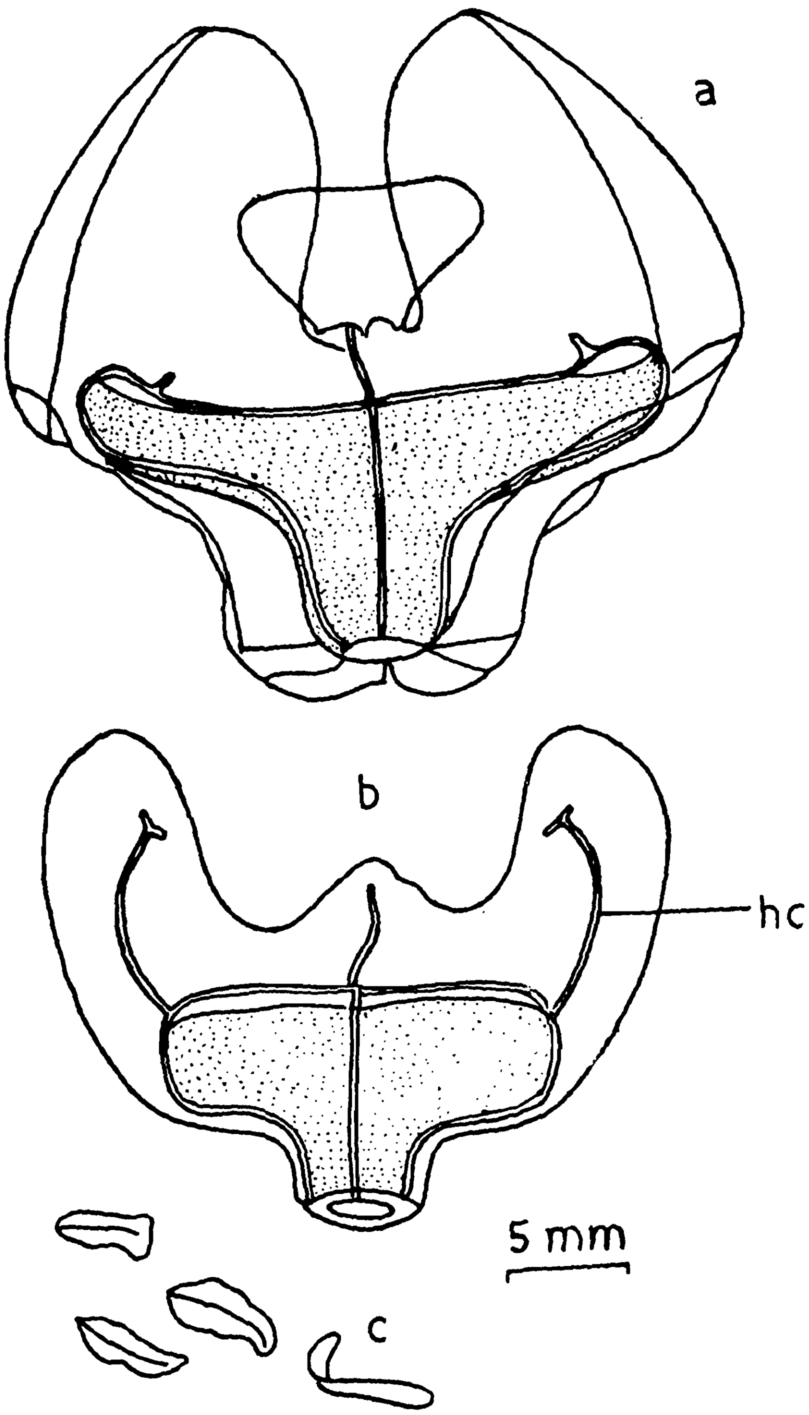


FIG. 21. *E. richardi* Bedot (a–c). a & b. nectophore with horn canal (hc); c. bracts. (From Totton, 1965, figs. 38, 39 and pl. XIV, fig. 11).

Type locality: Between Portugal and Azores.

Distribution: (Map 16). It is a deep sea form occurring commonly at great depths of 1200 m to 2000 m. So far it has been recorded between Portugal and the Azores, East Indies (Pacific,) Galapagos Islands (Pacific) and in the Gulf of Gascony (Bay of Biscay). From the Indian Ocean it was taken at lat. 00° 38′ S; 89° 03′ E longitude, during September (upwelling period.)

Family V PYROSTEPHIDAE Moser, 1925

Physonectae with long nectosome, biserially arranged nectophores deeply embayed towards ostium, lacking musculature on adaxial side of nectosac and simple or looped radial canals.

Two valid genera: *Pyrostephos* Moser, 1925 and *Bargmannia* Totton, 1954. The monotypic genus *Pyrostephos* for *P. vanhoeffeni* Moser, 1925 is restricted to the Antarctic Ocean and has not been recorded from any other oceans.

Key to genera of PYROSTEPHIDAE

Nectophores with breadth greater or equal to length	**Pyrostephos**
Nectophores twice as long as broad.	**Bargmannia**

Genus 11. **Bargmannia** Totton, 1954

Bargmannia Totton, 1954, p. 69.

Pyrostephidae known only from its loose large, elongated nectophores, fragments of orange coloured stem, large detached gastrozooids; nectophores lacking musculature on adaxial side of nectosac; radial canals simple and straight except the lateral radial canals which have slight sigmoid curves at lateral sides of nectosac.

Monotypic genus for *B. elongata* Totton, 1954.

15. **Bargmannia elongata** Totton, 1954

(Fig. 22 a–d)

Bargmannia elongata Totton, 1954, p. 69, Text-fig. 28.

Bargmannia elongata Daniel, 1974, p. 59, Text-fig. 40–R (cf. for detailed synonymy).

Type Specimen: British Museum, London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Bay of Bengal:* 9 n.; 1 broken bit of siphosome. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 6 n. *Bay of Bengal:* 36 n., 1 long stem.

Descriptions based on loose parts — nectophores, bits of siphosome and gastrozooids. Tentacles and bracts not known.

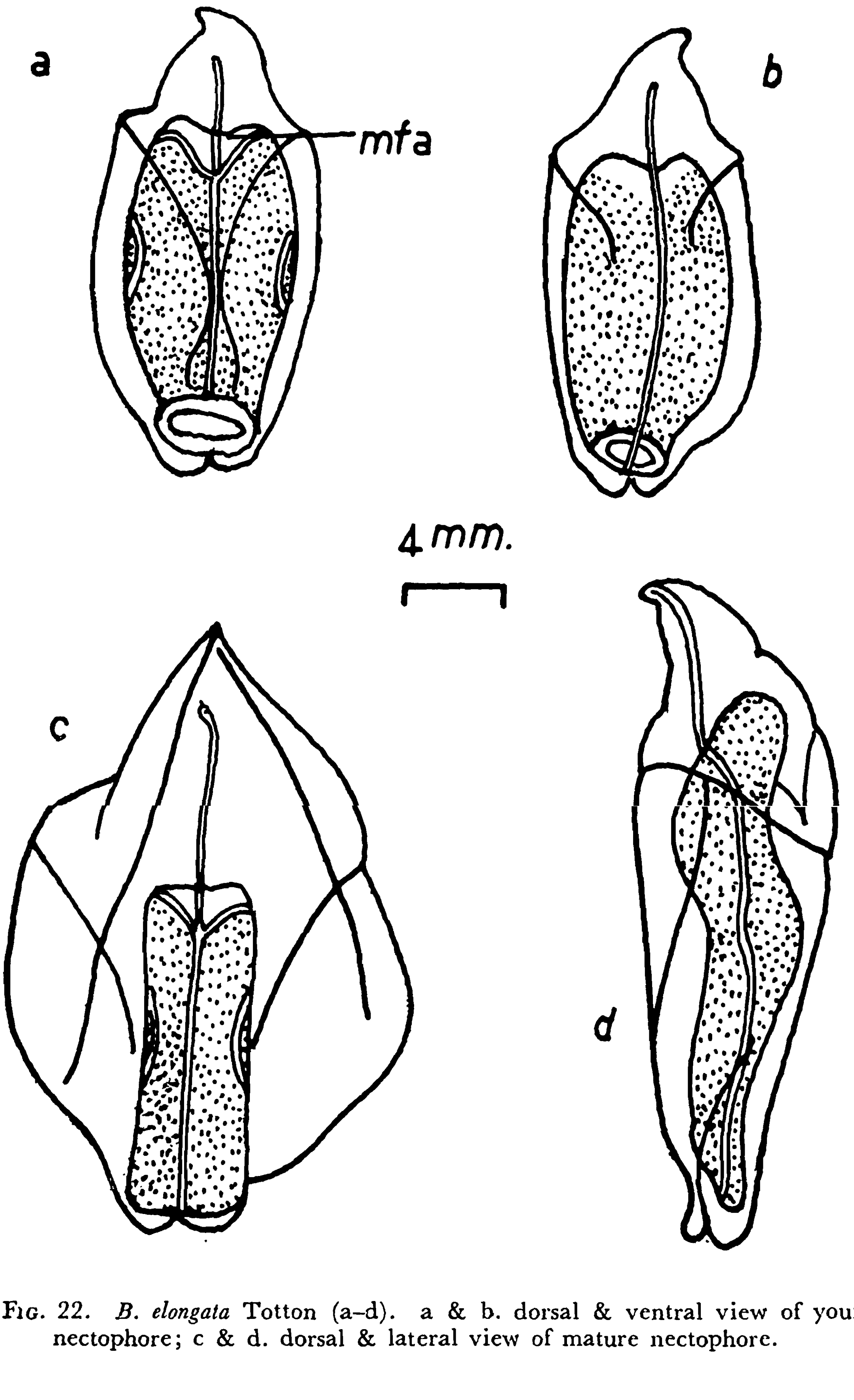


FIG. 22. *B. elongata* Totton (a–d). a & b. dorsal & ventral view of young nectophore; c & d. dorsal & lateral view of mature nectophore.

Pneumatophore: Small 6 mm × 1 mm with two chambers.

Nectophore: 4.0 to 11.0 mm long; 2.2 to 5.53 mm broad; twice as long as broad. Younger nectophore almost cylindrical from apex of nectosac to ostium; older ones bulged in mid-region. Proximal 1/4th part flat, triangular with pedicular canal lying in centre, extending to proximal tip. Muscular lamella extend along entire length of triangular extension on ventral side. Dorso-lateral ridges prominent, extending from lateral upper edge, curving towards centre and diverging again terminating near lateral corners of ostium. Dorso-and ventro-lateral ridges connected by a single very much oblique lateral ridge, extending from proximal end of nectosac to ostium. Nectosac cylindrical with a slight notch or embayment at proximal end, without musculature in this region; filled with mesoglea. Dorsal and ventral radial canals simple and straight; lateral radial canal with slight sigmoid curve at lateral sides of nectosac. Ostium dorsal, with clefted mouth-plates.

Siphosome: Orange coloured, 3.0 mm thick, with remains of continuous series of muscular lamellae of bracts.

Gastrozooids: 30 mm × 7 mm with series of large irregular ridges and villi of mesoglea projecting into lumen.

Type locality: Cape Verde Islands (North Atlantic).

Distribution and seasonal variations: (Maps 11 & 12). Collected only twice, from the Bay of Bengal during March and June; Once from the Arabian Sea during October (Daniel, 1974).

Family VI. PHYSOPHORIDAE Eschscholtz, 1829 (*pro parte*)

PHYSOPHORIDAE Huxley, 1859 p. 102
DISCOLABIDAE Haeckel, 1888, p. 263

Physonectae with elongated nectosome bearing biserially arranged nectophore but reduced siphosome which expands laterally into a spiral sac with cormidia occurring on outer rim of facetted sides.

Monotypic family for genus *Physophora* Forskàl, 1775.

Genus 12. **Physophora** Forskàl, 1775

Physophora Forskal, 1775, p. 119.
Discolabe Eschscholtz, 1829, p. 155.

The various Atlantic and Mediterranean species of *Physophora* were united by Chun (1897b). Subsequent workers also (Lens & van Riemsdijk, 1908; Bigelow, 1911b) who studied material from the Indo-Pacific and eastern tropical Pacific, came to the same conclusion that only one species of *Physophora* i.e., *P. hydrostatica* Forskål, as valid. The structure of *P. hydrostatica* was studied in detail by Gegenbaur (1859b), Claus (1860, 1878), Sars (1877), Lens & van Riemsdijk (1908) and Totton (1954, 1965a).

The species of *Discolabe* i.e. *D. tetrasticha* Philippi, 1843 and *D. quadrigata* Haeckel, 1888b were not recognized as valid, since the quadriserial nectosome is due to the spirally twisted stem as explained by Gegenbaur (1853). The evidence published by Haeckel for the latter species was considered unsatisfactory by Totton (1965). Thus, the genus includes only one valid species, i.e., *P. hydrostatica* Forskål.

Monotypic genus for *P. hydrostatica*, Forskål, 1775.

16. **Physophora hydrostatica** Forskål, 1775
(Fig. 23, a–f)

Physophora hydrostatica Forskal, 1775, p. 114.

Physophora hydrostatica Daniel, 1974, p. 60 Text-fig. 4, M–P (cf. for detailed synonymy).

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 4 col.; 2 n.; 6 p. *Bay of Bengal:* 15 col.; 20 n.; 32 p.; 1 l. br.; 10 gz.; 16 t. *South West Indian Ocean:* 10 col.; 16 p.; 9 n.; 15 l.br.; 3 t. *South East Indian Ocean:* 21 col.; 10 n.; 69 p.; 20 l.br.; 7 gz.; 2 t. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 6 col.; 4 nect.; 1 l.br.; 8 p.; 1 gz. *Bay of Bengal:* 11 col.; 25 nect.; 4 l.br.; 12 p.; 5 gz.; 1 t. *South West Indian Ocean:* 9 col.; 4 n.; 4 l.br.; 4 p.; 2 gz. *South East Indian Ocean:* 11 col.; 13 n.; 8 l.br.

Description: *Size:* Nearly 8.5 cm long, from apex of pneumatophore to tip of palpon.

Nectosome: Well elongated bearing 4–6 pairs of biseria alternately arranged nectophores.

Pneumatophore: 5.0 mm long; narrow, borne on mobile long stalk, with plum coloured pigment at apex; basal pore present.

Nectophore: 1.5 cm × 1.0 cm with lateral apical corners expanded into wings. Nectosac with sub-angular lateral expansion extending into lateral wings of nectophore; with deep embayment on upper adaxial side and prominent cylindrical neck and ostium. Dorsal and ventral radial canals forming three and two slight loops respectively before joining circular canal. Lateral radial canals highly sinuous; on ventral side running half way upto apical expansion, turning sharply down, taking two long loops, ascending to apical expansion, turning dorsal and downwards again making three small loops before joining circular canal. With cleft mouth-plates below large ostium.

Siphosome: Proximal part of protosiphon never elongating to form stem; becoming hypertrophied in horizontal plane to form spiral sac-like basally facetted siphosome — 14.5 mm wide. Each facet bearing a cormidium.

Palpons: Characteristic, 26–36 in number long, 22 mm or more in length; at outer most circle. Very active when alive,

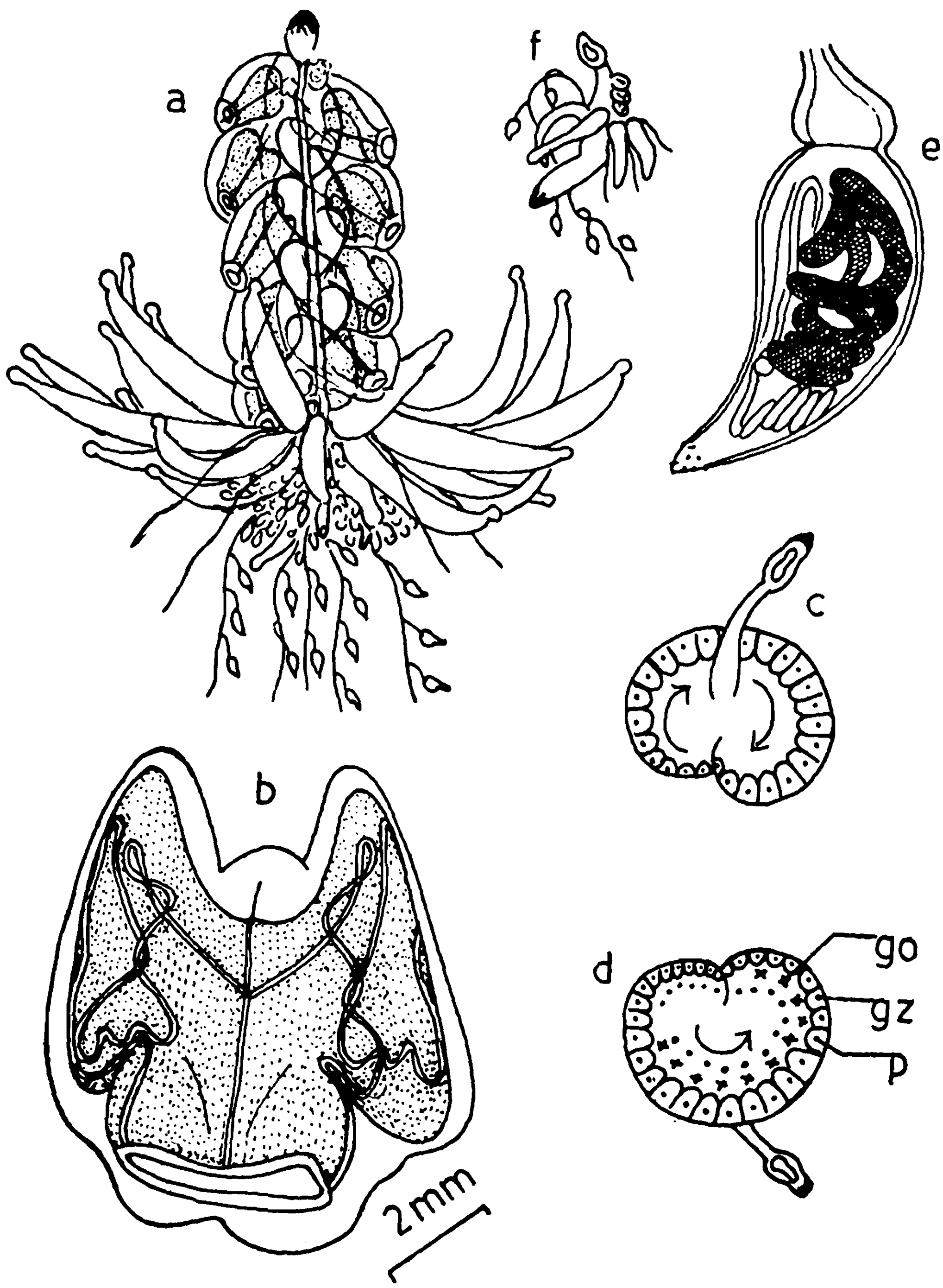


FIG. 23. *P. hydrostatica* Forskal (a–f). a. entire; b. nectophore; c & d. arrangement of cormidia on siphosome; e. tentillum; f. larval stage. (Fig. a, from Totton, 1965, pl. XV).

greenish pink, sessile, attached over a central papilla; heavily armed with nematocysts at tip. With fine long palpacle at base. Palpons bend upward as far as pneumatophore on stimulation (characteristic feature when alive).

Gastrozooids: Smaller than palpons, fewer in number corresponding to number of facets on siphosome, sessile.

Tentacle: Long, bearing many tentilla ending in characteristic cnidosacs. Terminal part of peduncle hypertrophied alongside coiled cnidoband; with proximal end becoming distal end. No terminal filament.

Gonodendra: Male and female gonodendra in a whorl between palpons and gastrozooids. Male gonophores at various growth stages, with pedicel, elongated, with well developed umbrella. Female gonophores tiny, ovoid, monovon with reduced umbrella; with peculiar radial canals — four canals, not joining ring canal, link up two and two distally to form 'U' shaped lateral loops. Impressions of 'U' shaped canals formed on ovum make it appear as four eggs.

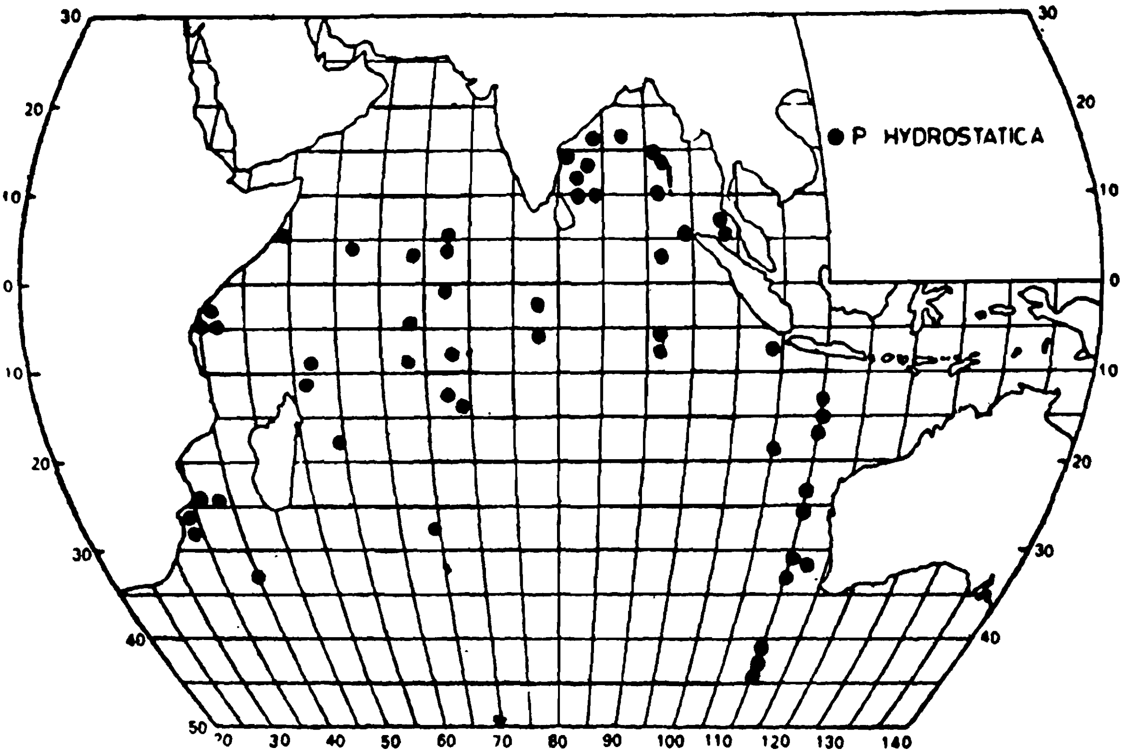
Bract: Present only in early larval stage — large, dome or umbrella shaped, and dropping off as nectosome elongates. Bracts absent in mature colony.

Type locality: Mediterranean Sea.

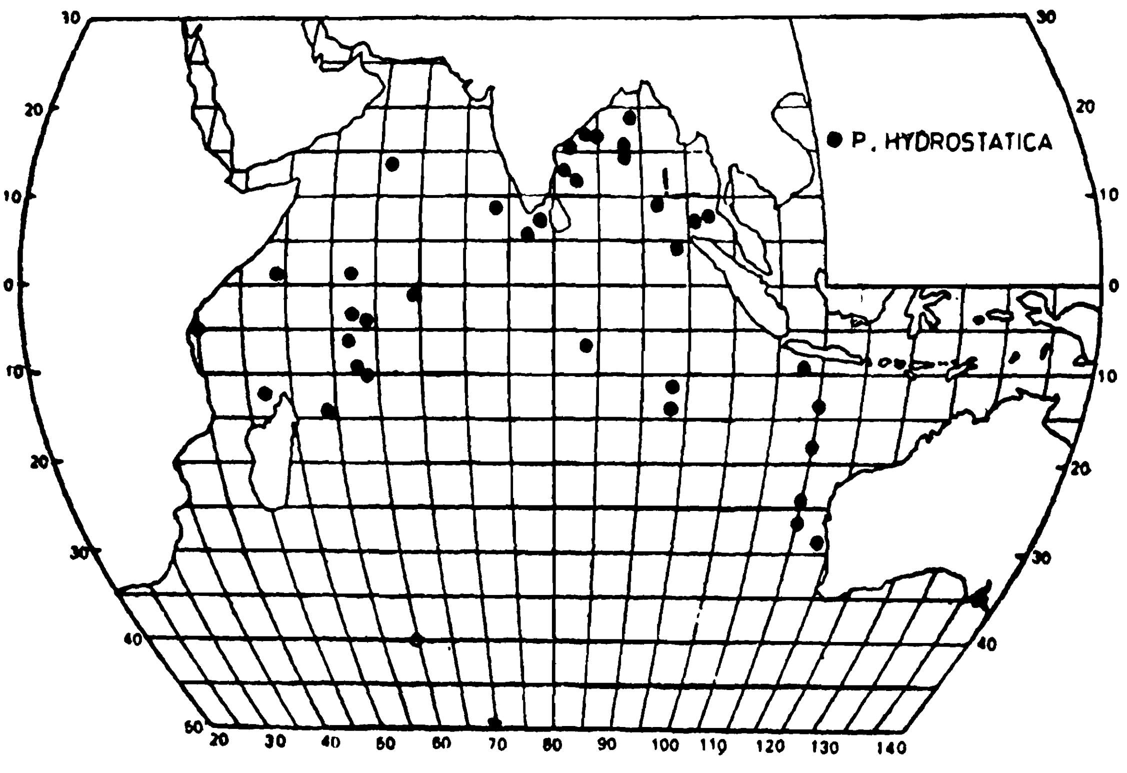
Distribution: (Maps 17 & 18). Maps 17 and 18 give the distribution of *P. hydrostatica* in the Indian Ocean during the two seasons. One colony per haul was collected at each station.

P. hydrostatica occurs throughout the Indian Ocean during both the seasons. During SW/SE monsoon season this species occurred mostly during night time in the Arabian Sea and Bay of Bengal (northern summer) while the day time occurrences are more in South West Indian Ocean (southern winter). During NE/NW monsoon season (i.e. northern winter) this species occurred in greater number of stations in the day time in the Arabian Sea and Bay of Bengal than in the South West and South East Indian Ocean having southern summer where the night captures were more.

During SW/SE monsoon season the distribution of *P. hydrostatica* extended from 20° N latitude in the Arabian Sea to 35° S latitude along the African coast and from 17° N latitude in the Bay of Bengal to 45° S latitude along 110° E longitude and to 30° S latitude in the mid ocean. It occurred more in the equatorial belt region and Bay of Bengal than in the Arabian Sea. During NE/NW monsoon *P. hydrostatica* was recorded from 15° N latitude in the Arabian Sea and 15° S latitude off the African region from 17° N latitude in the Bay of Bengal to 30° S latitude along 110° E longitude and 15° S latitude in the mid-ocean except at one station which is



MAP 17. Distribution of *P. hydrostatica* during SW/SE monsoon season. 1 colony/haul.



MAP 18. Distribution of *P. hydrostatica* during NE/NW monsoon season. 1 colony/haul.

located at 40° S latitude/60° E longitude. It did not occur much in the equatorial belt region as in SW/SE monsoon season. It appeared to move away from the equator during NE/NW monsoon season.

Monthly variation: Arabian Sea: It occurred along the coast of Somali land during August and in the central regions during May. It did not occur along the north west coast of India but occurred off Cochin and Cape Comorin during April, October, November and December. *Bay of Bengal:* In the Indian region it occurred maily along the east coast of India during April and June. It also occurred at rare stations during January, March, May and July. Near Andaman islands north of Sumatra and Malaya, colonies were collected during March, April, August and September. It was rare in January and February. *South West Indian Ocean:* Along the African coast it occurred at few stations during January, July, August, September and October. In the oceanic region it occurred at few stations established during all the months except in February, August and November. *South East Indian Ocean:* In the Australian region it was collected during January, April (Maximum), May, August, September and October. In the oceanic region it was rarely collected during August, September, October and December.

Family VII. ATHORYBIIDAE Huxley, 1859

ANTHOPHYSIDAE Brandt, 1835, p. 35
PLEOPHYSIDAE Fewkes, 1888, p. 317

Physonectae with both nectosome and siphosome reduced, bearing a corona of bracts; gastrozooids with involucrate and tricornuate tentilla.

Two valid genera: *Athorybia* Eschscholtz, 1829 and *Melophysa* Haeckel, 1888.

Key to genera of ATHORYBYBIIDE

Nectosome absent; without nectophore; bracts thin distally with seven inconspicuous longitudinal rows of nematocysts on dorsal surface.	**Athorybia**
Nectosome reduced, with 1 or 2 nectophores; bracts with 8–9 longitudinal rows of strong tubercles or papillae on dorsal surface.	**Melophysa**

Both the genera occur in the Indian Seas.

Genus 13. **Athorybia** Eschscholtz, 1829

Athorybia Eschscholtz, 1829, p. 153.
Anthophysa Brandt, 1835, p. 35.

Athorybiidae without nectosome. With a reduced vesicular siphosome bearing a corona of thin, striated bracts; tentilla involucrate, tricornuate or dendritic.

Two valid species: *A. rosacea* (Forskål, 1775) and *A. lucida** Biggs, 1978.

The best known Athorybiidae is the Mediterranean *Physophora rosacea* Forskål, 1775. Two closely related species: *Rhizophysa heliantha* Quoy & Gaimard, 1827 and *R. melo* Quoy & Gaimard, 1827, were described from the Straits of Gibraltar. These species were included in the genus *Athorybia* by Eschscholtz, 1829. But Brandt (1835) included these three species and a fourth species from the North Pacific, *Anthophysa rosea* (based on unpublished and only a manuscript description by Mertens) in the Family Anthophysidae. Haeckel (1888b) recognised four genera: *Athorybia* Eschscholtz, 1829; *Anthophysa* Brandt, 1835; *Rhodophysa* Haeckel, 1888b and *Melophysa* Haeckel, 1888 under Anthophysidae. Bigelow (1911b, p. 294; 1931) however considered only *Athorybia* and *Anthophysa* as valid. The genera *Rhodophysa* and *Melophysa* were treated as problematic and doubtful since these were neither described in detail nor figured, and each was based on a single specimen which was soon lost. He felt that the descriptions of *Ahorybia rosacea* given by Forskäl could apply equally to any *Athorybia*. Therefore, Bigelow (1911b; 1931) assigned a species with distinctly thick, ribbed, tuberculated bracts (*Athorybia melo* Quoy & Gaimard) as *A. rosacea*. The species with thin, striated bracts was assigned to *Anthophysa rosea* Brandt, 1835.

However, Totton (1954, p. 57) considered *Athorybia rosacea* Forskål as valid; and synonymised *Anthophysa rosea* with *Athorybia rosea*. He felt that *Rhizophysa melo* Quoy & Gaimard was distinct, due to the presence of a short nectosome, and included it under *Melophysa* Haeckel. He considered only *Athorybia* and *Melophysa* as valid.

Key to species of **Athorybia**

Bract with characteristic longitudinal rows of nematocysts..	*rosacea*
Bracts without longitudinal rows of nematocysts	*lucida*

17. **Athorybia rosacea** (Forskål, 1775)
(Fig. 24, a–e)

Physophora rosacea Forskal, 1775, p. 120.

Anthophysa rosea Bigelow, 1911, p. 296, pl. 20, figs. 7–13; pl. 21, figs. 1–5, pl. 23, figs. 1–5.

Athorybia rosacea Daniel, 1974, p. 64, Text-fig. 5, A–H (cf. for detailed synonymy)

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* *Athorybia lucida* was described by Biggs, 1978. Lack of longitudinal rows of nematocysts in bract is a larval character and therefore, the validity of this species is uncertain.

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 2 col. *Bay of Bengal:* 3 col.; 1 gz. *South West Indian Ocean:* 3 col. *South East Indian Ocean:* 8 col.; 2 p.; 3 br. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 2 col.; 5 br. *Bay of Bengal:* 1 col. *South West Indian Ocean:* 1 col.; 2 br. *South East Indian Ocean:* 8 col.; 3 p.; 3 gz.

Description: *Size:* Upto 14 mm in diameter.

Nectosome: Nectosome and nectophores absent.

Pneumatophore: Large, 4.0 mm in diameter. Apically pigmented with reddish brown granules, or flecks arranged in radiating clusters. Apical half thin walled, transparent basal half thick, opaque due to presence of opaque gas – secreting giant cells in septa connecting saccus to pneumatophore form irregular oı finger like processes clearly seen on surface. Contracted specimen with pneumatophore half covered on one side by enlarged nectostyle or growing point or zone of proliferation for bracts and gastrozooids.

No apical pore; basal pore large, round 0.65 mm in diameter in a specimen measuring 13.0 mm in diameter. When living specimen sinks down, bracts close down and minute air bubbles appear amongst them probably released through this basal opening. Morphologically longitudinal axis tilted to ventral side: two zones of proliferation for bracts and gastrozooids on ventral side. In contracted specimen this zone lies above level of apex of pneumatophore as a hood-like structure; with minute buds (papilla-like) on its surface.

Cormidia: Arranged in linear manner in young colony with 8 gastrozooids; in alternate manner towards left and right side in colony with 10–12 gastrozooids and in radial manner around vesicular siphosome in colony with 16–18 gastrozooids, with bilateral and radial symmetry.

Bracts: In 4 or 5 to 8 or 9 groups (according to growth stages) with 3–4 bracts in each group, in a corona around pneumatophore forming several circlets. Three times as long as broad, with a keel at thick proximal end for attachment to muscular lamella. Distal half thin, dorso-ventrally flattened. Convex dorsal surface with seven inconspicuous longitudinal rows of nematocysts.

Gastrozooids: Borne on stalks, with well developed basigaster, and eight radiating hepatic ridges in stomach region. Tentacle at base bearing two types of tentilla.

Tentacle: 6 cm long, bearing 25–30 tentilla, 1–2 mm apart, and 2–3 mm long. Terminal part of tentacle thick, devoid of tentilla. Cnidoband involucrate, either straight (young) or with 2–2½ loosely coiled spiral turns (older). Tricornuate—two long, slender lateral horns and small median ampulla. Dendritic — fewer in number at distal end of tentacle; with many branches. With 'rosette' like structure at base and dorsal spur.

Palpon: Many vermiform, transparent, forming a circlet above gastrozooids; bearing nematocysts at pink tips. Palpacles small, inconspicuous. At bases of special 8 or 9 secondary gono-palpons occur gonodendra.

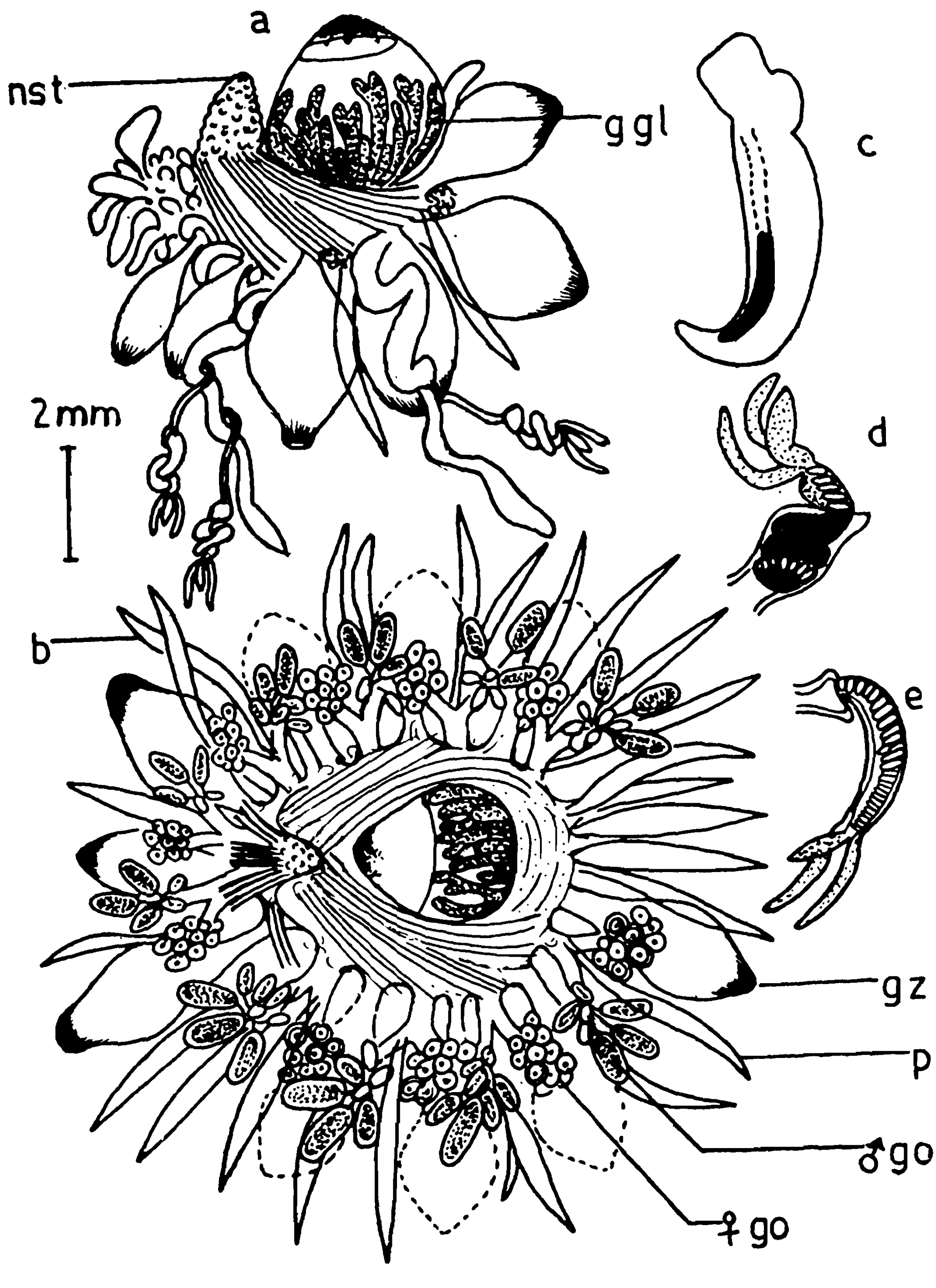


FIG. 24. *A. rosacea* (Forskal) (a–e). a. entire — young specimen; b. mature specimen; c. bract; d & e. tentillum; n st – necto style.

Gonodendra: With thick stalks, 8–9 in number, between two gastrozooids, dividing into two branches, each bearing male and female gonostyles in alternate manner (*i.e.*, two male or two female gonostyles do not occur side by side).

Male Gonophores: With long pedicels, medusoid; manubrium bearing sperms.

Female Gonophores: With short pedicels, medusoid; single ovum. Two radial canals lying close.

Type locality: From Straits of Gibraltar.

Distribution: (Maps 19 & 20). Maps 19 & 20 give the distribution of *A. rosacea* in the Indian Ocean during the two seasons. One colony per haul was collected at each station.

Arabian Sea: *A. rosacea* occurred in the Red Sea, Gulf of Aden and near the equator during February, June and December. *Bay of Bengal:* During SW/SE monsoon season it occurred at four stations all located in the central regions of the Bay of Bengal during February, April and May. During NE/NW monsoon season it occurred at one station only located South of Sri Lanka during February. *South West Indian Ocean:* During SW/SE monsoon season it was collected at three stations located near Mombasa during July and in the Mozambique channel during October and on the western coast of Madagascar during August. During NE/NW monsoon season it was collected only at one station located in the oceanic region during March. *South East Indian Ocean:* During SW/SE monsoon season it occurred at seven stations of which four are located south of Java during May, July and August; at two stations along the 110° E longitude off Western Australia during August. During NE/NW monsoon season it occurred off western Australia along 110° E longitude during January and March.

A. rosacea occurred in the night time during the northern summer and in the day time during the southern winter. It occurred in greater numbers in the South East Indian Ocean than in the other three zones of the Indian Ocean.

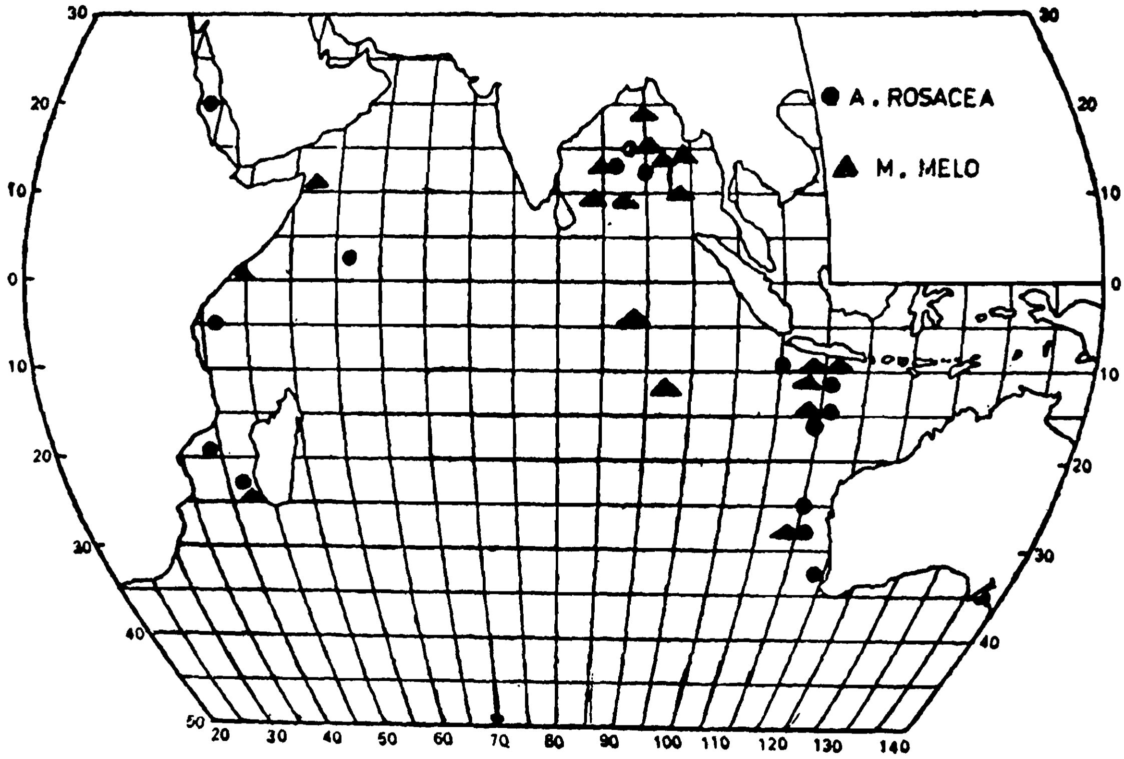
Genus 14. **Melophysa** Haeckel, 1888

Melophysa Haeckel, 1888, p. 42.

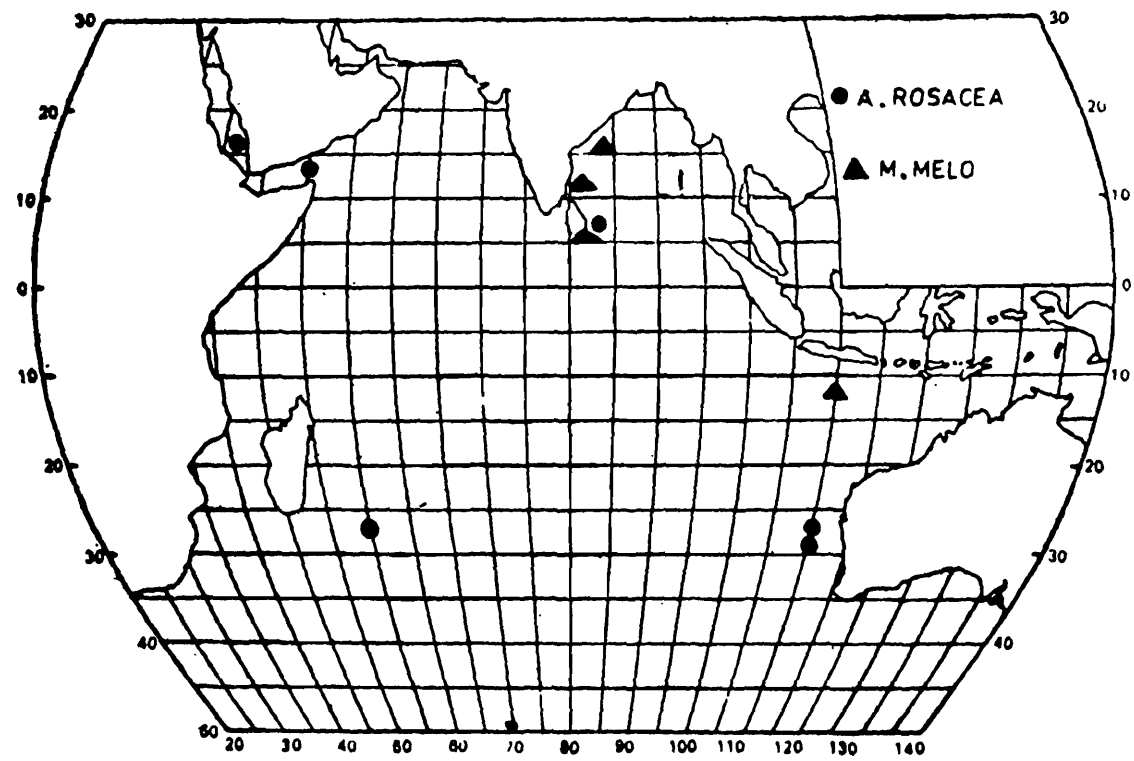
Athorybiidae with reduced nectosome and one or two functional nectophores and reduced siphosome with large, thick tuberculated and ribbed bracts; tentilla with 6–8 coils in cnidoband, involucrate and tricornuate.

The validity of this genus and species is discussed under the genus *Athorybia*.

Monotypic genus for *M. melo* (Quoy & Gaimard, 1827).



MAP 19. Distribution of *A. rosacea* and *M. melo* during SW/SE monsoon season. 1 colony/haul.



MAP 20. Distribution of *A. rosacea* and *M. melo* during NE/NW monsoon season. 1 colony/haul.

18. **Melophysa melo** (Quoy & Gaimard, 1827)
(Fig. 25, a–f)

Rhizophysa melo Quoy & Gaimard, 1827, p. 180, pl. 5c, figs. 1–9.
Athorybia rosacea Bigelow, 1931, p. 578, figs. 217–220.
Melophysa melo Daniel, 1974, p. 68, Text-fig. 5, I–O (cf. for detailed synonymy).

Type Specimen: Museum National d'Histoire Naturelle, Paris.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 2 col.; 2 n. *Bay of Bengal:* 9 col.; 4 n.; 21 br. *South West Indian Ocean:* 1 col. *South East Indian Ocean:* 9 col.; 2 n.; 22 br.; 1 p. NORTH EAST/NORTH WEST MONSOON SEASON: *Bay of Bengal:* 3 col.; 12 br. *South East Indian Ocean:* 3 col.; 4 n.; 25 br.; 6 p.; 4 gz.

Description: Size: About 2–2.5 cm long.

Pneumatophore: Ovoid or pear-shaped, with septa containing giant gas-secreting cells, forming a part of secondary ectoderm.

Nectosome (or Nectostyle): Short, reduced with usually one main functional nectophore or rarely with second smaller functional nectophore.

Nectophore: Younger nectophore with long, oblique pedicel and smaller nectosac, 14.0 mm long, 6.0 mm broad near expanded region. Lateral sides of pedicel folded to form a groove embracing nectosome. Faintly marked two lateral and one median ridges on dorsal surface. Larger, mature nectophore with shorter pedicel and broader nectosac region 10.0 mm long; 8.0 mm broad. Ridges more prominent. Except the ventral radial canal, the dorsal and lateral radial canals sinuous forming loops before joining ring canal. Nectosac ovoid without lateral wings. Ostium dorsal.

Bracts: Diagnostic, thick, gelatinous, borne in 9 or more groups of 3 or 4 bracts each, in a corona below nectosome, on strong muscular lamellae. Larval bracts with smooth dorsal surface, 20 mm long, with prominent keel (11.0 mm thick) for attachment. Mature bracts similar, with 8–9 strong longitudinal ridges with 25–30 tubercles or conical papillae in each row on dorsal suiface.

Gastrozooids: Eight, alternating radially with groups of muscular lamellae of bracts.

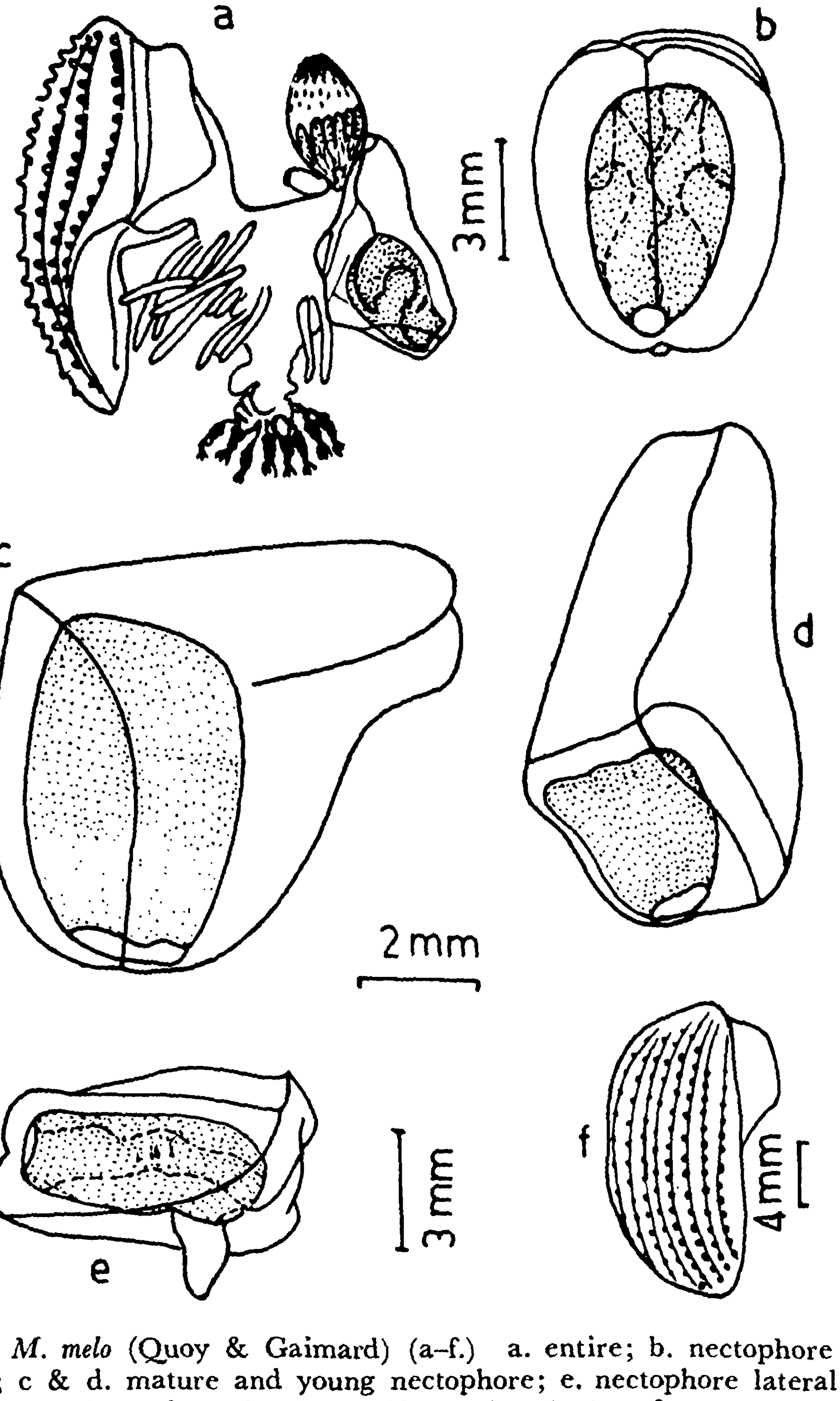
Tentacles: Bearing many tentilla, involucrate, tricornuate with 7 or 8 spiral coils in cnidoband.

Palpons: forming a corona below bracts, long, slender, sessile, 12.0 mm in length; distal end vermiform, bearing large nematocysts at tip.

Gonodendra: Male and female gonodendra in pairs, alternating with gastrozooids at bases of palpons. Detailed structure still unknown.

Type Locality: Straits of Gibraltar.

Distribution: (Maps 19 & 20). *Arabian Sea:* During SW/SE monsoon season *M.melo* was collected from only two stations located



FIG; 25. *M. melo* (Quoy & Gaimard) (a–f.) a. entire; b. nectophore dorsal view; c & d. mature and young nectophore; e. nectophore lateral view. f. bract. Fig. a from Bigelow, 1931; Figs. b & e from Totton, 1965, fig. 50 c & e).

at the mouth of the Gulf of Aden during September and on the African coast near the equator during August. It was not collected during NE/NW monsoon season. *Bay of Bengal:* During SW/SE monsoon season it was collected from nine stations all located in the central region of the Bay of Bengal during April, June and September except at one station located on the eastern side of the Andaman group of islands during September. During NE/NW season it occurred at three stations, two along the Indian coast during April and the other south of Sri Lanka during February. *South West Indian Ocean: M. melo* was collected only once on the south-western coast of Madagascar during SW/SE monsoon in August. It was not collected during NE/NW monsoon season and in the oceanic region. *South East Indian Region:* During South East/South West monsoon season it was collected at seven stations located one near the equator during September; one station in the oceanic region in August; four stations south of Java along 110°E longitude during May and one station off western Australia during June. During NE/NW monsoon season it occurred off south of Java along 110°E longitude during April.

M. melo occurred in greater numbers in the Eastern Indian Ocean (Bay of Bengal and South East Indian Ocean) than on the western sector of the Indian Ocean. During the northern summer it occurred mostly during the night while it occurred during the day in the southern winter.

Family VIII. FORSKALIIDAE Haeckel, 1888

Physonectae with cone-shaped or cylindrical nectosome bearing numerous multiserial nectophores all arising from one meridian of twisted stem, with 4 simple straight radial canals. Siphosome elongated with gastrozooids borne on long stalks covered with many bracts; tentilla non-involucrate and unicornuate.

Only one valid genus *Forskalia* Kölliker, 1853.

Genus 15. **Forskalia** Kölliker, 1853

Forskalia Kolliker, 1853, p. 2.
Strobila, Forskaliopsis, Haeckel, 1888, p. 242, 247.

Forskaliidae with numerous multiserial nectophores; tentilla non involucrate and unicornuate.

The validity of some *Forskalia* species is still uncertain. The earlier revisors of this group, Bedot (1893a) and Schneider (1898) came to very different results, the former recognizing five species and the latter three species, both basing their diagnosis chiefly on colour which fades on preservation. Of the five species — *F. contorta* Milne Edwards, 1841; *F. leuckarti* Bedot, 1893; *F. cuneata* Chun, 1897b; *F. edwardsi* Kölliker, 1853; and *F. tholoides* Haeckel, 1888b.

Totton (1965) who had the opportunity to study living material from the Mediterranean Sea, confirmed the validity of *F. edwardsi* and *F. leuckarti* and tentatively considered *F. tholoides* and *F. cuneata*, as well as *F. formosa* Keferstein & Ehlers, 1860 and *F. misakiensis* Kawamura, 1954, as doubtful species.

Unfotunately the collections examined by the author do not throw any confirmatory light upon the validity of these doubtful species. Due to bad preservation, the stem is denuded of all zooids; colour and musculature had been lost in the nectophore. Therefore, only the external morphological characters of the nectophore are used to identify the species and the following species are still retained:

Type Species: *F. edwardsi* Kölliker, 1853.

1 *F. edwardsi* Kölliker, 1853. 2. *F. leuckarti* Bedot, 1893. 3. *F. formosa* Keferstein & Ehlers, 1860. 4. *F. tholoides* Haeckel, 1888. and 5. *F. cuneata* Chun, 1888. 6. *F. misakiensis* Kawamura, 1954.

The first five species are represented in the Indian Ocean. Except *F. edwardsi* and *F. cuneata*, others occur in the Indian Seas. *F. edwardsi* is a cold water species which probably comes up to 200–0 m depth range during upwelling of deeper cold water in the Indian Ocean.

F. cuneata is a rare species recorded from the Red Sea and Gulf of Aqaba by Totton (1954).

Key to Species of **Forskalia**

1.	Nectophores with pigmented *rete* or spots or bands.	2
	Nectophores without any pigment spots.	4
2.	Nectophores with disc-shaped pigmented *rete* in peidcular canal; wider than deep, concave above; incision on both sides close to lateral horns of nectosac... ..	*leuckarti*
	Nectophores with pigmented spots or bands	3
3.	Nectophores with yellow pigmented spots at junction of upper radial and circular canals; incision on right hand side only, proximal portion elongate and flattened from above..	*edwardsi*
	Nectophores with 4–6 red bands on each side of subumbrella; truncated bracts with bracteal canal bent at right angles	*cuneata*
4.	Nectophores with stem side incision creating two unequal lobes; gastrozooids with short stalks.	*formosa*
	Nectophores without any incision, forming long, triangular, tapering peduncles twice as the length of nectosac.	*tholoides*

19. **Forskalia leuckarti** Bedot, 1893
(Fig. 26, a–d)

Stephanomia contorta Milne Edwards, 1841, p. 193.
Forskalia leuckarti Bedot, 1893, p. 250.
Forskalia leuckarti Totton, 1965, p. 102, pl. XX, figs. 3–4.

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEAON: *Arabian Sea:* 10 col.; 15 n.; 8 br. *Bay of Bengal:* 8 col.; 12 n.; 1 siphosome. *South West Indian Occan:* 6 n. *South East Indian Ocean:* 3 col; 6 n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 7 col.; 7 n.; 7 br. *Bay of Bengal:* 5 col; 7 gz. *South West Indian Ocean:* 4 col; 11 n.; bits of siphosome. *South East Indian Ocean:* 2 col.; 1 siphosome; 3 br.

Remarks: Even though the prior name for this species was *Stephanomia contorta* Milne Edwards 1841 because of the confusion that existed in the synonymy of this species and its nomenclature, the revisor of this family Bedot (1893) renamed Milne Edward's and Leuckart's (1853) species as *F. leuckarti*.

Description: Size: Colony grows upto 60 cm. in length.

Pneumatophore: Small and slender.

Nectosome: With 8 or 9 spiral turns, each with 9 or 10 nectophores — multiserial.

Nectophores: 15–19 mm long; 15–20 mm broad; 6–8 mm thick. Two deep incision on lateral sides dividing nectophore into two slightly unequal lobes at place of attachment to muscular lamella. With deep oblique lateral fold or inpocketing on either side of ostium. Characteristic brick-red, disc-shaped *rete* on pedicular canal from very early stage (2 mm in length). With two oval patches of nematocysts on ventral side.

Siphosome: 30 cm or more, bearing 40–50 gastrozooids, numerous bracts covering entire stem.

Gastrozooids: 10–20 mm long borne on long peduncles 12 mm or more in length. Gastric region with 8–12 rose — red hepatic ridges.

Tentacles: Tentillum ending in fiery red cnidoband with 2–4 spiral turns, non involucrate and unicornuate, large bean shaped nematocysts (0.51 mm × 0.16 mm) on lateral sides of cnidoband; with minute nematocyst (0.0003 mm) on long terminal filament.

Palpons: Vermiform, 30–50 mm long in expanded condition; enlarged terminal part with red liquid; in living condition discharging red liquid on agitation into surrounding water.

Gonodendra: Upto 4 gonodendra between two gastrozooids, at bases of single pedunculate palpons; female gonodendron larger, (30 mm) over topping male gonodendron, highly contractile, bifurcated at distal end, each branch bearing clusters of numerous medusoid female gonophores at various stages of growth. Male gonodendron with short stalk bearing fewer, long, oval shaped, medusoid gonophores with long pedicels. Male gonophores with 4

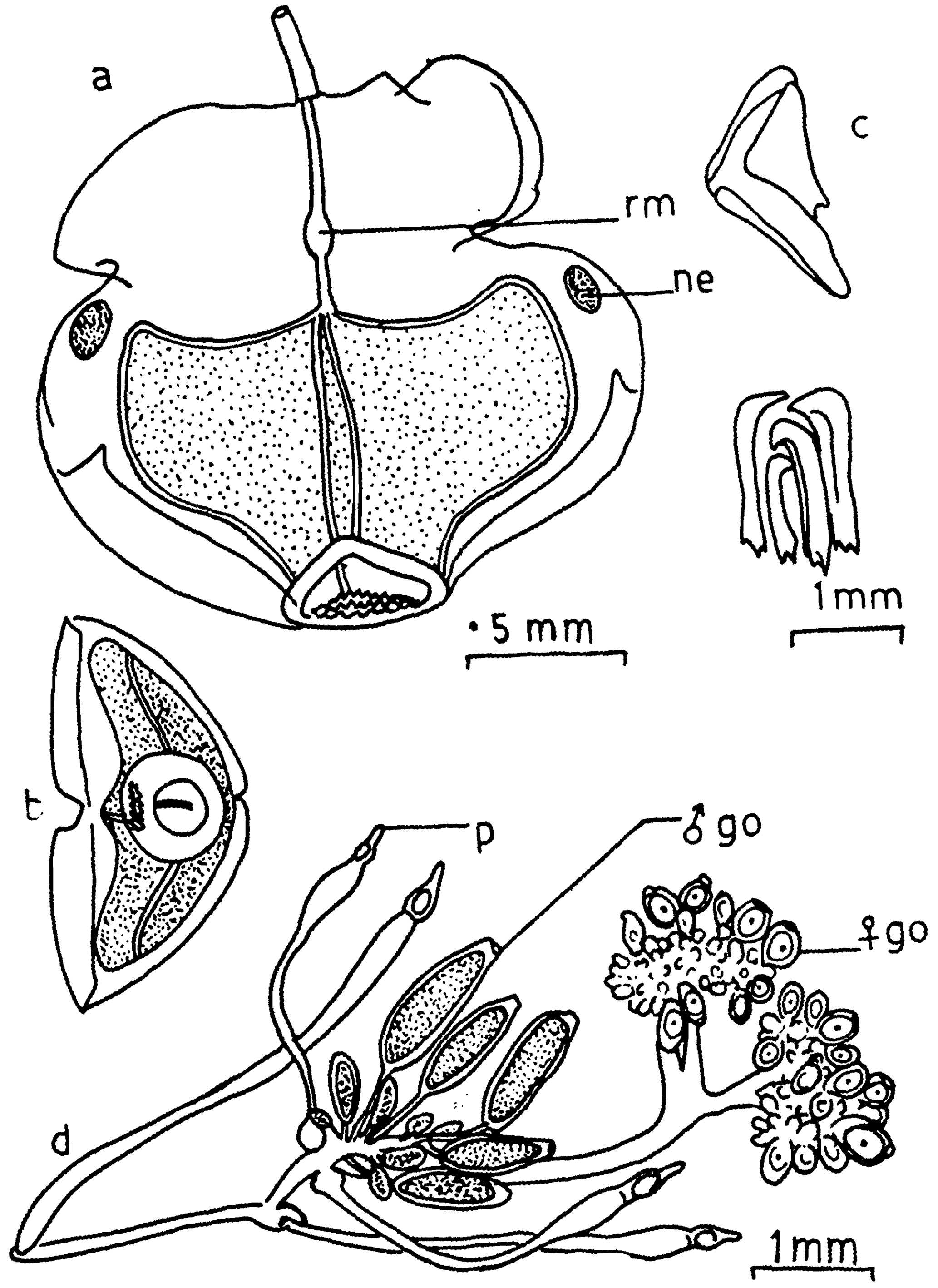
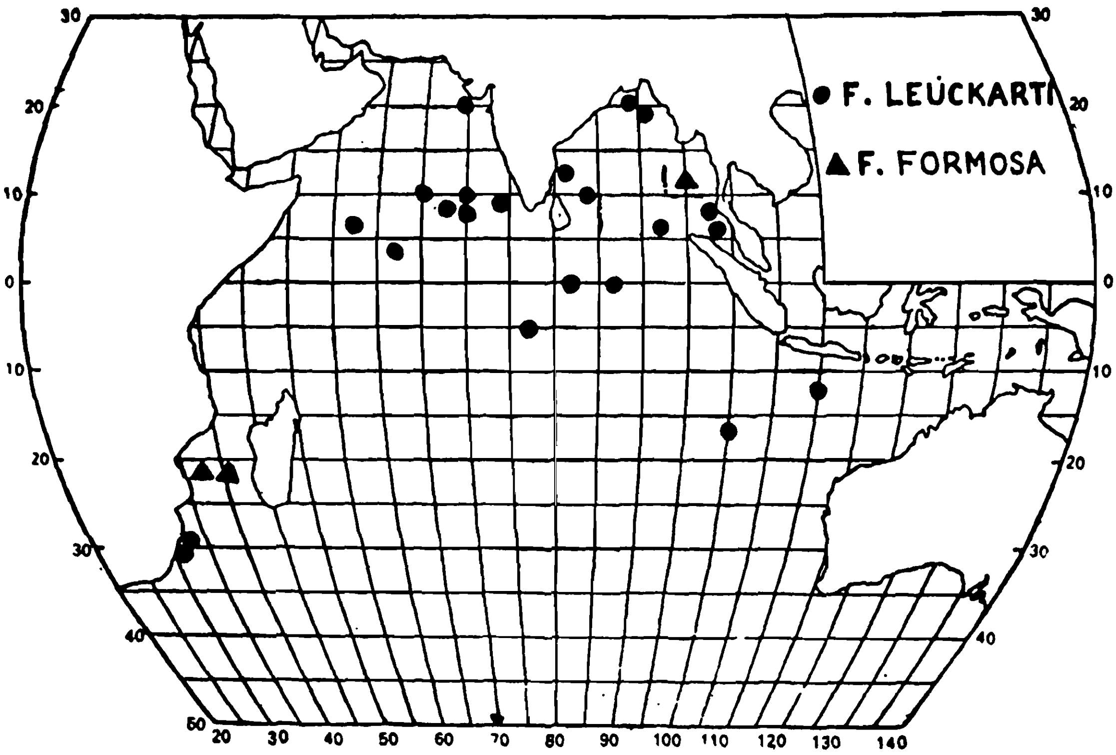
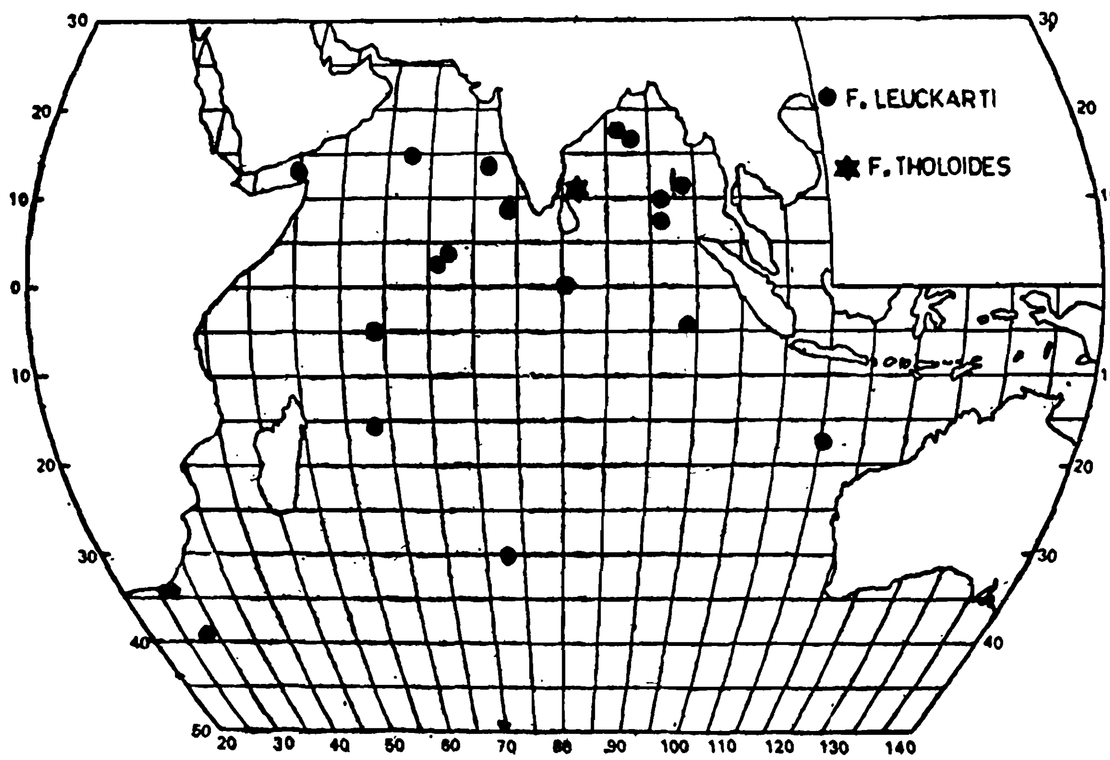


FIG. 26. *F. leuckarti* Bedot (a–d). a & b. nectophore; c. bracts; d. male & female gonodendra, ne – nematocyst patch; rm – *rete mirabile*. (After Totton, 1965, figs. 56, 57, 59 & 60).



MAP 21. Distribution of *F. leuckarti*, and *F. formosa* during SW/SE monsoon season. 1 colony per haul.



MAP 22. Distribution of *F. leuckarti*, and *F. tholoides* during NE/NW monsoon season. 1 colony per haul.

radial canals; females usually with 4 radial canals or with 6–8 radial canals, or reticular.

Bracts: Very numerous, overlapping like tiles on a roof; shape and size differ according to position. 4 or 5 bracts near cormidia leaf-like, envelop bases of peduncles. 6–8 peduncular bracts in overlapping, imbricating rows, flattened and triangular in shape; pair of bracts, mirror images of each other; bent at right angle at proximal end and similarly bent bracteal canal tying on ventral side.

Type locality: Mediterranean Sea.

Distribution: (Maps 21 & 22). Distribution of *F. leuckarti* during the two seasons and their monthly occurrence in the different zones in the Indian Ocean are prsented in maps 21 and 22. Only one colony was recorded from each haul.

It is seen that *Forskalia leuckarti* was collected from few stations located throughout the Indian Ocean during both the seasons. Their distribution extended from 20°N to 40°S latitude.

In the Arabian Sea this species was recorded mostly during, May and at few stations during January, February, March, June August and October. In the Bay of Bengal they were recorded during January, February, March, June, July August and September. In the South West Indian Ocean these were collected during January, April, May, July, August, September and December. From South East Indian Ocean they were recorded from few stations only duiing April, July, October and December.

20. **Forskalia formosa** Keferstein & Ehlers 1860

(Fig., 27 a)

Forskalia formosa Keferstein & Ehlers, 1860, p. 254, pl. 5, fig. 22.
Forskalia formosa Totten, 1965, p. 108, pl. XX, fig. 5.

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Bay of Bengal:* 2 col.; 7 n.; 4 gz.; 1 br. *South West Indian Ocean:* 6 n.

Remarks: Rare species collected only once or twice from Messina, Mediterranean Sea. Collected from the Indian Ocean for the first time by the I.I.O.E. Nothing much is known about this species.

Description: Size: Upto 60 cms.

Nectophore: Same size as *F. edwardsi.* Without any pigment spots on nectophore. Stem side incision creates two unequal lobes, left lobe being very long. No red-coloured enlargement along pedicular canal or infolding beside ostium as in *F. leuckarti*. No lateral incision.

Gastrozooid: Borne on very short peduncles not longer than gastrozooid. With brick-red liver stripes on stomach wall. Cnidoband of tentilla, bright brick-red, with $2\frac{1}{2}$–3 spiral turns, 0.5 mm long, non-involucrate and unicornuate.

Palpons: longer than stalk of gastrozooid.

Type locality: Mediterranean Sea.

Distribution: (Map 21): It was collected from only three I.I.O.E. stations. Two located between SE coast of Africa and

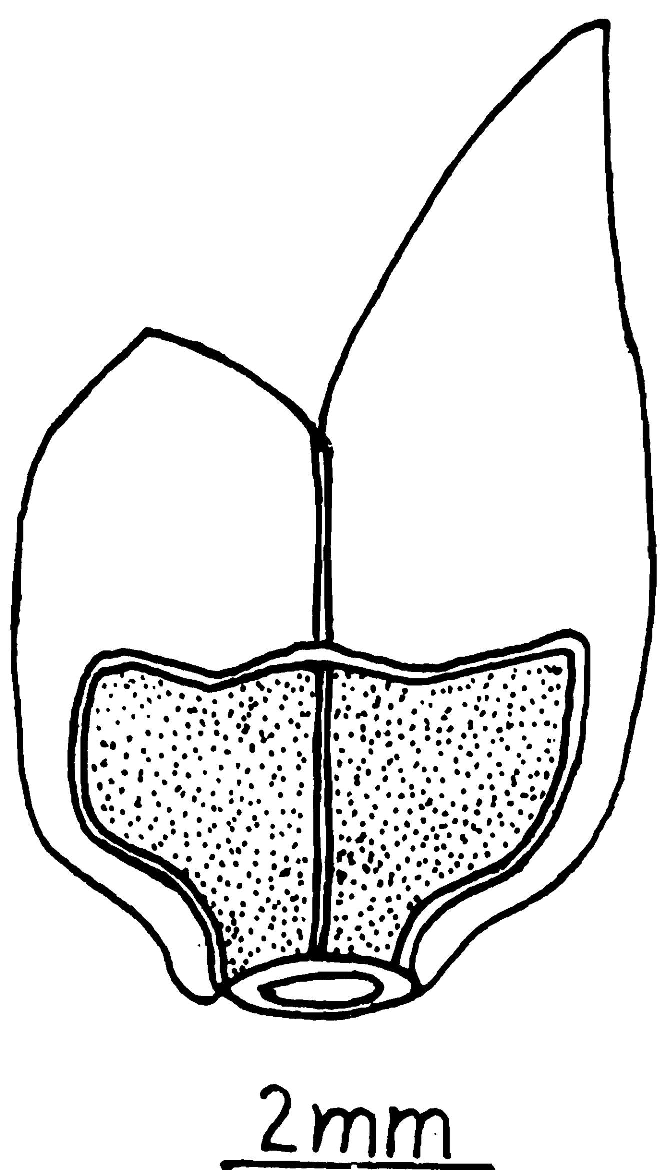


FIG. 27. *F. formosa* Keferstein & Ehlers nectophore. (From Keferstein & Ehlers, 1860, pl. 5, fig. 22).

Madagascar and once near Andaman group of Islands. All the records were made during August.

21. **Forskalia tholoides** Haeckel 1888

(Fig. 28, a–e)

Forskalia tholoides Haeckel, 1888, p. 244, pls. 8-10.
Forskalia tholoides Totton, 1965, p. 108.

Type Specimen: Most of Haeckel's Specimens are not present in the British Museum.

Material Examined: One very young colony — recorded off South East Coast of India. (=*F. contorta* Daniel & Daniel 1963).

Description: *Size:* Upto 40–60 cms.

Nectosome: Very large, campanulate, multiserial with diameter of 30–40 mm. With 16–20 longitudinal rows on twisted stem (laeotropic spiral) in medium sized colony. With 300–400 nectophores in longer colony.

Pneumatophore: Small ovate, with 8 vertical septa, pink in colour at apex. With basal pore.

Nectophore: Prismatic, polygonal lateral facets. Attached to stem by long, triangular pedicel—twice as long as breadth of nectophore. With long pedicular canal without *rete*, joining nectosac at top, dividing into four simple straight radial canals before joining circular canal.

Siphosome: 3–4 times longer than nectosome, bearing 40–50 cormidia on spirally twisted stem (dexiotropic spiral — opposite to twisting of nectosome).

Gastrozooids: 10–15 mm long, borne on long peduncles 15–20 mm in length, covered with series of small bracts. With 16 red longitutinal liver ridges — 4 long per radial 4 shorter interradial and 8 small adradial between former and latter.

Tentacles: Long, strong, bearing tentilla; tentilla non involucrate, unicornuate; cnidoband with 4 spiral coils, large nematocysts on lateral sides, and minute ones on terminal filament.

Gonodendra: Arise from bases of gonopalpons. Stalks long, bearing clusters of gonophores, female at proximal stalk and male at distal part. Female gonophore smaller, pyriform or subspherical, monovon, with net work of spadicine canals. Male gonophore ovate or club-shaped with central spadix. Both umbrella with 4 radial canals connected by a small ring canal at velum.

Bract: Siphosome covered with innumerable bracts (1000), mostly small, leaf-like without crest or denticles. Larger protective ones on outside of siphosome. Larger bracts three sided, prismatic asymmetrical, dorsal surface denticulated.

Type locality: Canary Island (North Atlantic Ocean).

Distribution: Collected once off SE coast of India during the month of June (Map. 22).

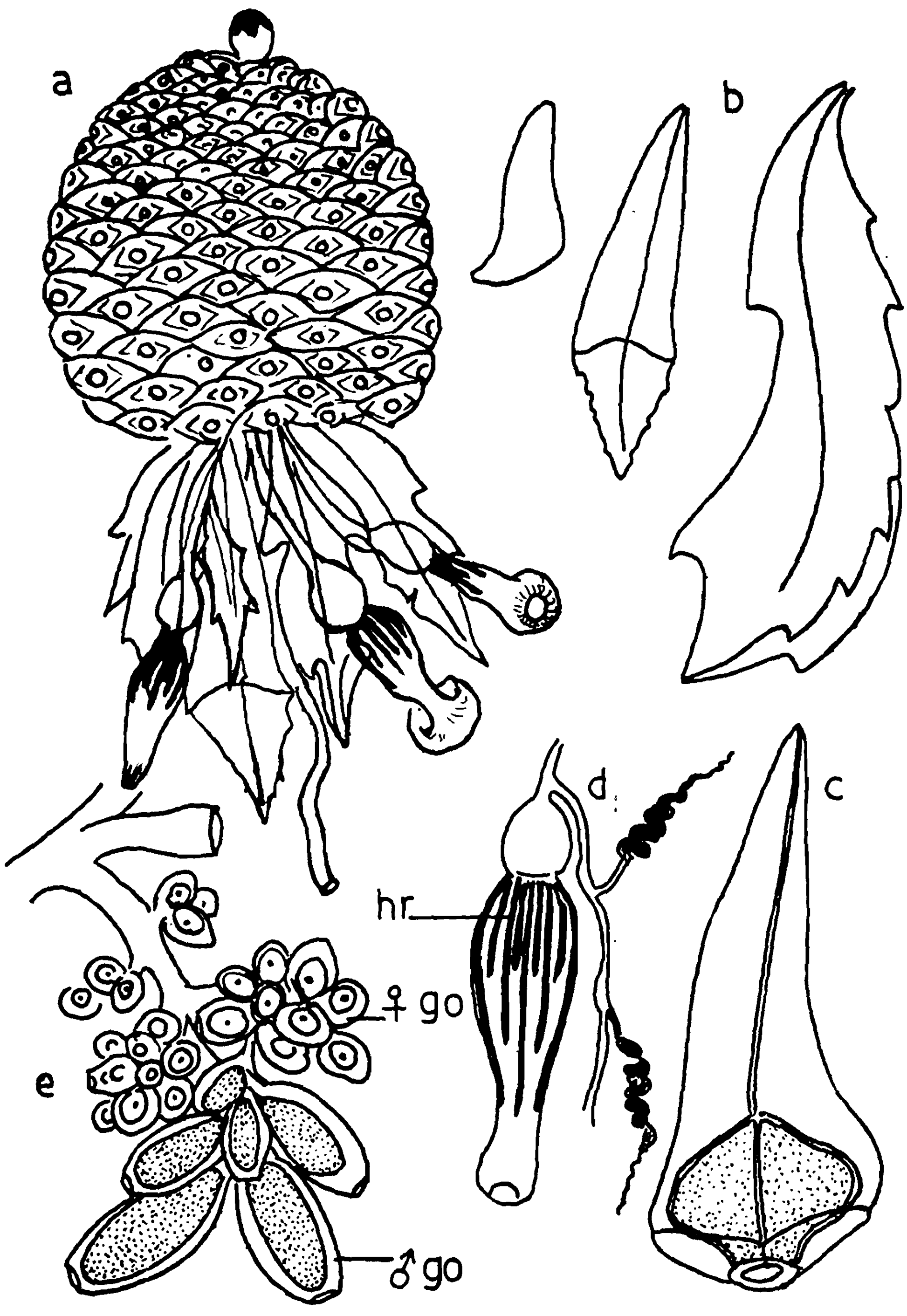


FIG. 28. *F. tholoides* Haeckel (a–e). a. entire; b. bracts; c. nectophore d. gastrozooid with hepatic ridges (hr) and tentacle; e. male & female gonodendra. (After Haeckel, 1888, pls. 8—10).

Suborder III **CALYCOPHORAE** Leuckart, 1854

Siphonophora without apical gas-filled pneumatophore; nectosome reduced with single or one to several pairs of similar or dissimilar nectophores with somatocyst. Siphosome elongated, highly contractile bearing many ordinate cormidia with free internodes (polygastric or asexual phase); each cormidum consisting of a bract (except in the family Hippopodiidae), a gastrozooid, its tentacle and a succession of gonophores and without palpons (except in the genus *Stephanophyes* which possesses vestigeal ones). Older cormidia break off as free swimming individuals (eudoxid phase or sexual phase), producing sexual gonophores (adult or third phase of which one may be asexual (special nectophore) and specialised for propulsion.

For historical review of this suborder refer Daniel (1974, p. 73). Six families are recognised and arranged as follows:

1. PRAYIDAE Kölliker, 1853. 2. HIPPOPODIIDAE Kölliker 1853. 3. DIPHYIDAE Quoy & Gaimard, 1827. 4. CLAUSOPHYIDAE Totton, 1965. 5. SPHAERONECTIDAE Huxley, 1859. 6. ABYLIDAE L. Agassiz, 1862.

Family X PRAYIDAE Kölliker, 1853

Calycophorae usually large, slow moving prayids with relatively large amounts of mesoglea for floatation of the large and heavy stem. Nectophores large, rounded, a pair of opposed (except in *Stephanophyes* where there is a ring of four nectophores), similar or a short succession of larger, definitive hetero morph ones, usually devoid of ridges (except in some species of sub-family Nectopyramidinae). Somatocyst typically small or thin, thread-like and often branching extensively. Cormidia set free as eudoxids; bracts with characteristically branched canals and with large gonophores and asexual special nectophores may be present.

Nine genera and eighteen species of Prayids are recognised provisionally.

The family is divided into three sub-families as follows:

1. Amphicaryoninae Chun. 1888a. 2. Prayinae Chun. 1897b. 3. Nectopyramidinae Bigelow, 1911b.

Key to subfamilies of PRAYIDAE

1. Nectophores biserial, smooth devoid of ridges and opposed..	2
Nectophores always single, usually with angles, ridges and serrations, somatocyst simple or complexly branched.	NECTOPYRAMIDINAE

2. Nectophores very unequal in size, somatocyst simple..	AMPHICARYONINAE
Nectophores large, equal in size, simple somatocyst, or with dilated tip or branched.	PRAYINAE

Subfamily (i) AMPHICARYONINAE Chun, 1888a

Prayidae with two nectophores of unequal sizes, larval one not caducous and first heteromorph one smaller or reduced with nectosac functional, vestigeal or absent. Eudoxid with canal system reduced to a pair of lateral canals, dorsal and ventral canals being absent.

Two valid genera: *Amphicaryon* Chun, 1888 and *Maresearsia* Totton, 1954.

Key to genera of AMPHICARYONINAE

Young definitive nectophore shield-like, reduced with or without vestigeal nectosac..	**Amphicaryon**
Young definitive nectophore comparatively large, with functional nectosac..	**Maresearsia**

Genus 16. **Amphicaryon** Chun, 1888

Mitrophyes Haeckel, 1888, p. 131.

Amphicaryon Chun, 1888, p. 1162.

Amphicaryoninae with young definitive nectophore reduced or shield-like; nectosac reduced, vestigeal or absent. Eudoxid with reduced canal system, to a pair of lateral hydroecial canals, dorsal and ventral canals being absent.

Though the generic name *Mitrophyes* Haeckel, 1888b, has priority over *Amphicaryon* Chun, 1888a by a few months, on the basis of *nomina conservanda* the latter name has been retained.

Type Species: *A. acaule* Chun, 1888.

Four species of *Amphicaryon* are known at present.

Key to species of **Amphicaryon**

1. Vestigeal nectophore embraced by larger nectophore; radial canals simple and straight..	2
Vestigeal nectophore not embraced by larger nectophore, radial canals either simple or branched in the proximal half..	3
2. Vestigeal nectophore with reduced nectosac, which does not open to exterior, but with 4 distinct radial canals.. ..	*acaule*
Vestigeal nectophore without nectosac but with 3 highly reduced radial canals..	*peltifera*

3. Vestigeal nectophore with highly reduced nectosac; dorsal canal simple, lateral canals absent, ventral canal reticulated on ventral wall. Larger nectophore with proximal half of lateral radial canals branched.	*ernesti*
Vestigeal nectophore with small but functional nectosac, 4 simple radial canals in both nectophores..	*intermedia*

Of these four species *A. acaule* and *A. intermedia* occur in the Indian Seas.

22. **Amphicaryon acaule** Chun, 1888a
(Fig. 29, a–e)

Amphicaryon acaule Chun, 1888, p. 1162.
Amphicaryon acaule Bigelow, 1911, p. 195, pl. 4, figs. 1–8.
Amphicaryon acaule Daniel, 1974, p. 76, Text — fig. 6, A–E.

Type Specimen: Place of deposit not known from literature.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 6 p.g. (compl.); 3 f.n.; 1 v. n.; 10 br.,; 4 go.; 1 eu. (compl.). *Bay of Bengal:* 13 p.g. (compl.); 5 f.n.; 4 v.n.; 6 eu. (compl.); 38 br.; 32 go. *South West Indian Ocean:* 13 p.g. (compl.); 10 f.n.; 5 v.n.; 23 eu. (compl.); 37 br.; 5 go. *South East Indian Ocean:* 29 p.g. (compl.); 13 f.n.; 5 v.n.; 57 eu (compl.); 29 br.; 11 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 34 p.g. (compl.); 7 f.n.; 3 v.n.; 13 eu. (compl.); 60 br.,; 62 go. *Bay of Bengal:* 13 p.g. (compl.); 4 f.n.; 2 v.n.; 9 eu (compl.); 23 br.; 5 go. *South West Indian Ocean:* 16 p.g. (compl.); 4 f.n.; 3 v.n.; 12 eu. (compl.); 33 br.; 16 go. *South East Indian Ocean:* 13 p.g. (compl.); 6 f. n.; 4 v.n.; 16 eu. (compl.); 31 br. 16 go.

Polygastric phase: Two nectophores of unequal size and shape. No reserve buds present. Older larger larval nectophore retained; younger heteromorph nectophore embraced by larger one, vestigeal, and shield-like in shape.

Functional Nectophore : Smooth, devoid of ridges, round to oval in shape, 2.5–4.5 mm long (largest upto 15 mm in height) 3.4–4.3 mm broad. Nectosac well developed, 0.93–1.6 mm long, 0.55–1.4 mm wide, with broad ostium 1.4 mm in diameter. All radial canals simple straight, unbranched, join circular canal at ostium; ostium lying slightly below surface of nectophore. Somatocyst small, distinct and curved. Hydroecium large, circular in shape, shallow, occurring on upper lateral side of nectophore. Stem long, highly contractile, bearing many cormidia.

Vestigeal Nectophore: Nearly circular, flat, firm, shield-like in shape, 2.33–3.45 mm in length, 2.16–3.25 mm in breadth, inne concave surface fit like a shield over hydroecium of larger nectophore forming a cavity for retraction of stem and cormidia. Somatocyst small, thin short canal occurring on inner concave surface. Nectosac highly reduced, non-functional, no ostium; with 4 simple, straight radial canals which join at their distal ends; no circular canal.

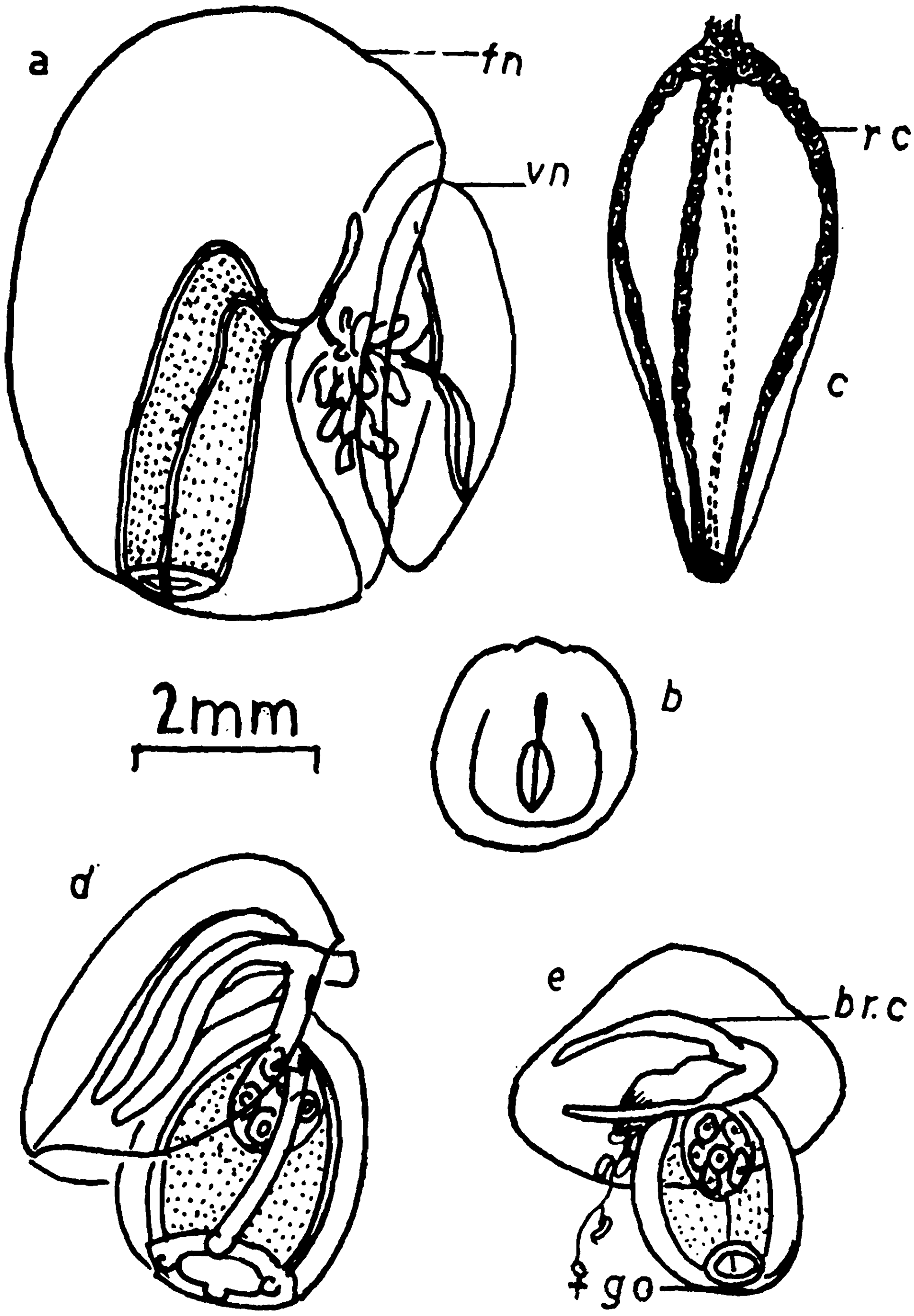


FIG. 29. *A. acaule* (a–e). a. entire, with functional (younger) nectophore (fn) and older non-functional vestigeal nectophore (vn); b. vestigeal nectophore; c. reduced nectosac of vestigeal nectophore showing radial canals (rc); d. cormidium; e. eudoxid phase (bract with 2 bracteal canals brc). (*Figs. C & D from Bigelow, 1911, pl. 4, figs. 4 & 5*).

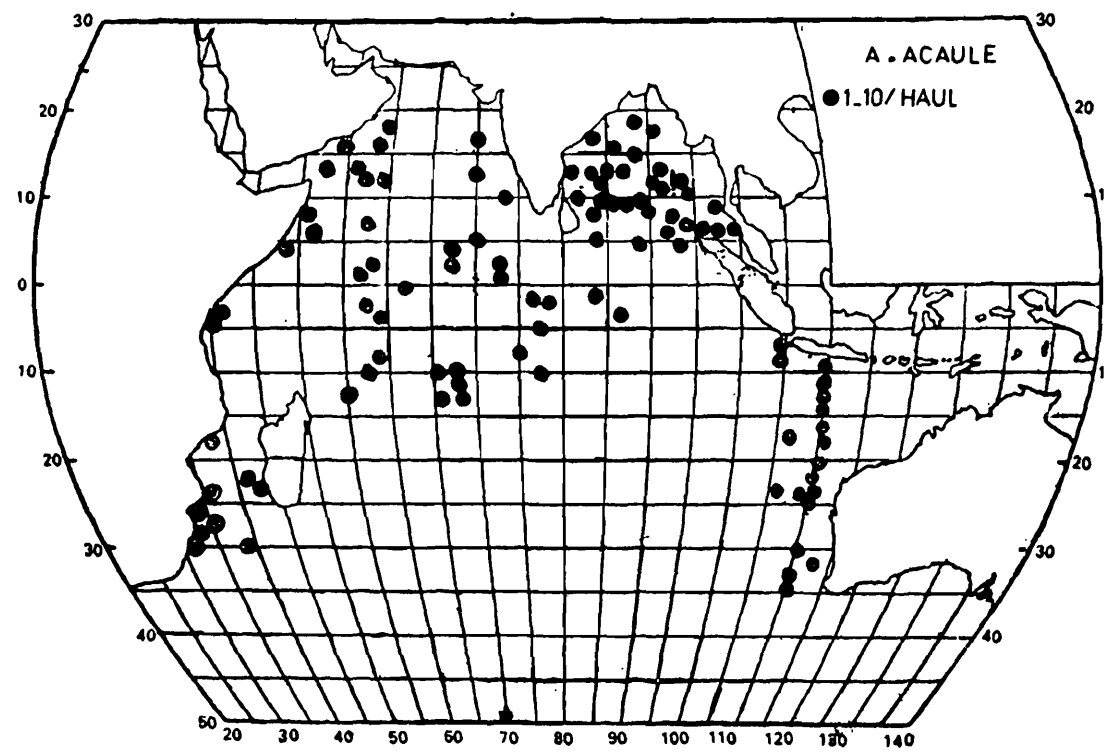
Eudoxid phase: Older cormidia detach from polygastric phase, lead independent life. Bract dome shaped 2.0 mm long, 1.6 mm broad, smooth without any ridges. Bracteal or hydroecial cavity deep, conical, with phyllocyst occurring as two lateral bracteal canals originating from slightly enlarged central body. Dorsal and ventral branches not developed. Single gastrozooid, tentacle with tentilla bearing kidney-shaped cnidosacs. Gonophore smooth, devoid of ridges, rounded in shape; 1.4 mm long, 1.2 mm broad, manubrium bearing germ cells. Nectosac well developed, with broad ostium and 4 simple, unbranched radial canals. Each eudoxid with either male or female gonophore. Female gonophore bears 4 ova on manubrium.

Type locality: Canary Island (North Atlantic Ocean)

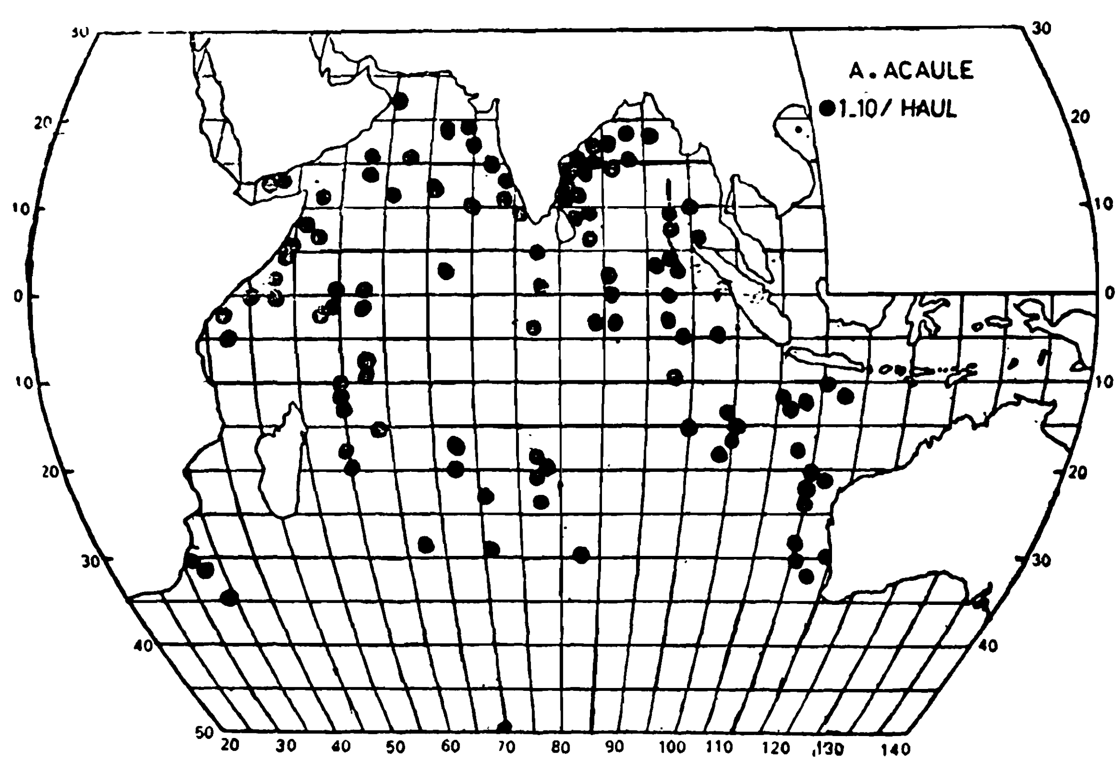
Distribution: (Maps 23 and 24). The distribution, abundance and the seasonal variation of *A. acaule* are presented in maps 23 and 24. The number of polygastric and eudoxid phases collected at each station did not exceed 10.

A. acaule was recorded from all the four zones of the Indian Ocean, during both the seasons. The night catches were more than the day catches. During SW/SE monsoon season its distribution extended from 20°N latitude to 30°S latitude along the African coast and 35°S latitude along 110°E longitude and in the mid-ocean down to 15°S latitude. During NE/NW monsoon season *A. acaule* occurred scattered all over the ocean extending from 20°N to 40°S latitude along the African coast and 31°S latitude along the 110°E longitude and in the mid-ocean down to 30°S latitude.

Arabian Sea: Except in September *A. acaule* was recorded throughout the year in the western region (Somali and Arabian Coast and Gulf of Aden). In the eastern part of the Arabian Sea it occurred during most of the months except in June, July and September. It occurred in greater numbers during March, May and November. *Bay of Bengal:* Except during July and October *A. acaule* was recorded throughout the year, mostly during April and June along the Indian coast and neighbouring areas. Near the Andaman islands and Burma it occurred mainly during September. It was not collected during June. *South West Indian Ocean:* Along the African Coast it occurred during January and August and it was rare during the other months. In the Oceanic region it occurred throughout the year except in November. It appeared in greater number of stations during January, April and June. *South East Indian Ocean:* Along the 110°E longitude *A. acaule* was recorded during May and August. It was not collected during March, June, July and November and rare in the other months. In the oceanic region it was collected mostly during December. It occurred at rare stations during January, May and October.



MAP 23. Distribution of *A. acaule* during SW/SE monsoon season.



MAP 24. Distribution of *A. acaule* during NE/NW monsoon season.

A. acaule appears to be a common species in the Indian Ocean occurring both along the land masses and in the mid-ocean of the tropical regions.

23. **Amphicaryon intermedia** Daniel, 1970

(Fig. 30, a, b)

Amphicaryon intermedia Daniel, 1970, p. 147.

Amphicaryon intermedia Daniel, 1974, p. 77, Text — fig. 6, F–H.

Type Specimen: Zoological Survey of India, Calcutta, India.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *South West Indian Ocean:* 2 p. g. (compl.) NORTH EAST/ NORTH WEST MONSOON SEASON: *Arabian Sea:* 1 p. g. (compl.) *South East Indian Ocean:* 1 p.g. (compl.)

Polygastric phase: Two nectophores of unequal size, shape, and both functional.

Larger nectophore: Smooth, devoid of ridges as in *A. acaule*, longer than broad — 3.85 mm in length, 2.25 mm in breadth. Hydroecium shallow, large occur on ventral side. Somatocyst small, thick, curved towards dorsal side. Nectosac 2.10 mm long, 1.30 mm wide with ostium of 1.0 mm in diameter. Radial canals — 4, simple, straight, unbranched join circular canal around ostium; ostium lying below surface of nectophore with a funnel-like slope towards ostium.

Smaller nectophore: Not flat and shield-like as in *A. acaule;* dome-like in shape, not embraced by larger nectophore. 3.25 mm long, 2.75 mm broad. Rounded on dorsal side, concave with a shallow, circular hydroecium in middle region on ventral side in contact with hydroecium of larger nectophore. Nectosac small but well developed, 1.00 mm in length, with small ostium 0.25 mm in diameter. Ostium round in shape, open, lying below outer surface of nectophore which slopes downward like a funnel as in larger nectophore. Radial canals simple straight and unbranched.

Eudoxid phase: Unknown.

Type locality: Arabian Sea.

Distribution: (Maps 25 & 26). Recorded only thrice during I.I.O.E. — on western coast of India in June, between SE coast of Africa and Madagascar during August and in mid-oceanic region near Equator during December.

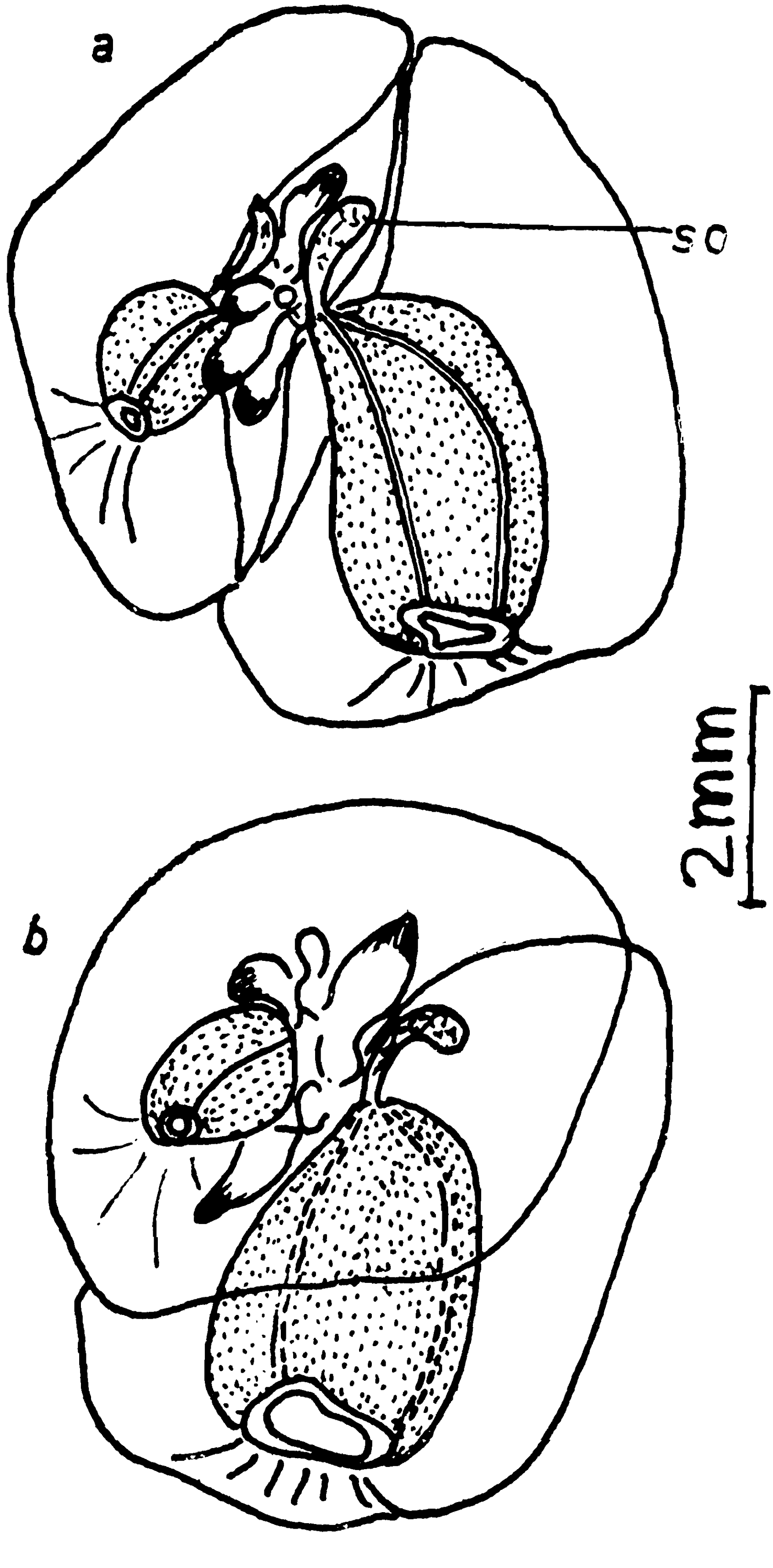
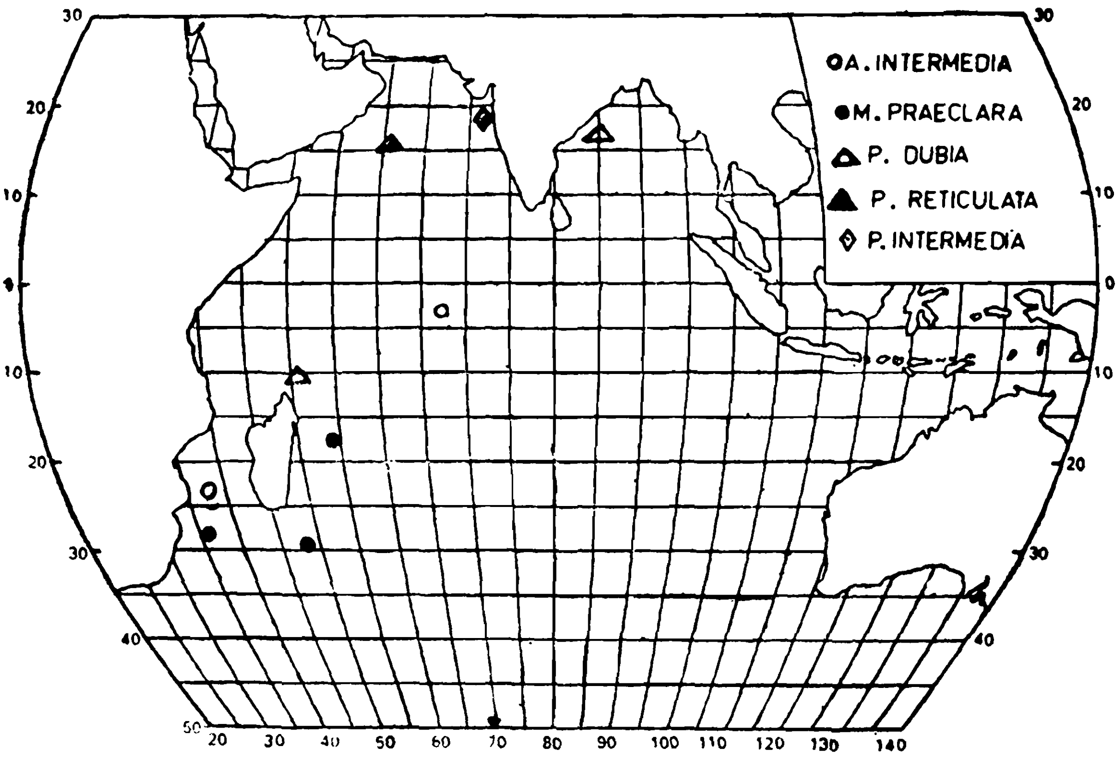
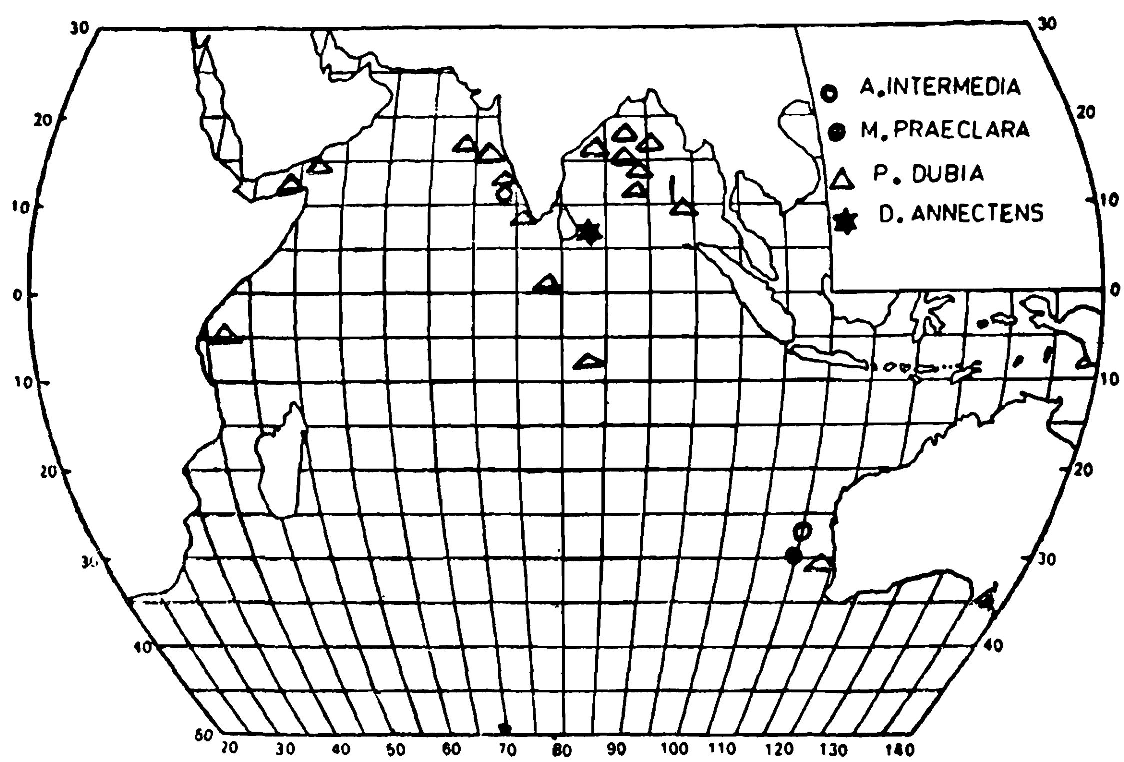


FIG. 30. *A. intermedia* Daniel. a & b. both the functional nectophores intact.



MAP 25. Distribution of *A. intermedia*, *M. prdeclura*, *P. dubia*, *P. reticulata*, *P. intermedia*, during SW/SE monsoon season. 1—3 colonies per haul.



MAP 26. Distribution of *A. intermedia*, *M. praeclara*, *P. dubia*, *D. annectens* during NE/NW monsoon season. 1—3 colonies per haul.

Genus 17. **Maresearsia** Totton, 1954

Maresearsia Totton, 1954, p. 97.

Amphicaryoninae with two large nectophores of unequal size but well developed and functional nectosac in both. Basal part of radial canals hypertrophied.

Genus *Maresearsia* consists of *M. praeclara* Totton, 1954 and *M. sphaera* Stepanjants, 1967. Validity of *M. sphaera* is not certain.

24. **Maresearsia praeclara** Totton, 1954
(Fig. 31, a–c)

Maresearsia praeclara Totton, 1954, p. 97, Test. fig. 46–48, p. VII
Maresearsia praeclara Daniel, 1974, p. 80, Test–fig. 6, I.
Maresearsia sphaera Stepanjants, 1967.

Type Specimen: British Museum, London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *South West Indian Ocean:* 2 p. g. (compl.); 1 larger nect.; 1 smaller n. NORTH EAST/NORTH WEST MONSOON SEASON: *South East Indian Ocean:* 2 p.g. (compl.)

Polygastric phase: Consisting of two large, smooth, rounded functioal nectophores devoid of any ridges, and unequal in size.

Larger nectophore: Almost globular in shape, 12.2 mm in diameter hydroecium deeply conical with broad opening. Somatocyst oval in shape, borne on a thin, short stalk. Nectosac in holotype longer than broad; but in Indian Ocean specimen short, broad, 3.3 mm in length 4.0 mm in breadth. Proximal half of lateral radial canal hypertrophied with blind branches. Ostium of nectosac very small.

Smaller Nectophore: 5.0 mm in breadth, smooth, rounded in shape, proximal half fits into hydroecium of larger nectophore. Nectosac in holotype long and oval in shape with very small ostium. Indian Ocean form varies slightly in shape, 4.0 mm in length and 2.67 mm in breadth, with broad ostium. Proximal half of lateral radial canals with short blind diverticula.

Stem with many gastrozooids occur within hydroecium. Gastrozooid 4.6 mm long.

Eudoxid phase: Bracts large rounded, phyllocyst with two longer curved branches and a shorter branch. Gonophore nearly traingular in shape. With well developed nectosac, broad ostium and 4 radial canals.

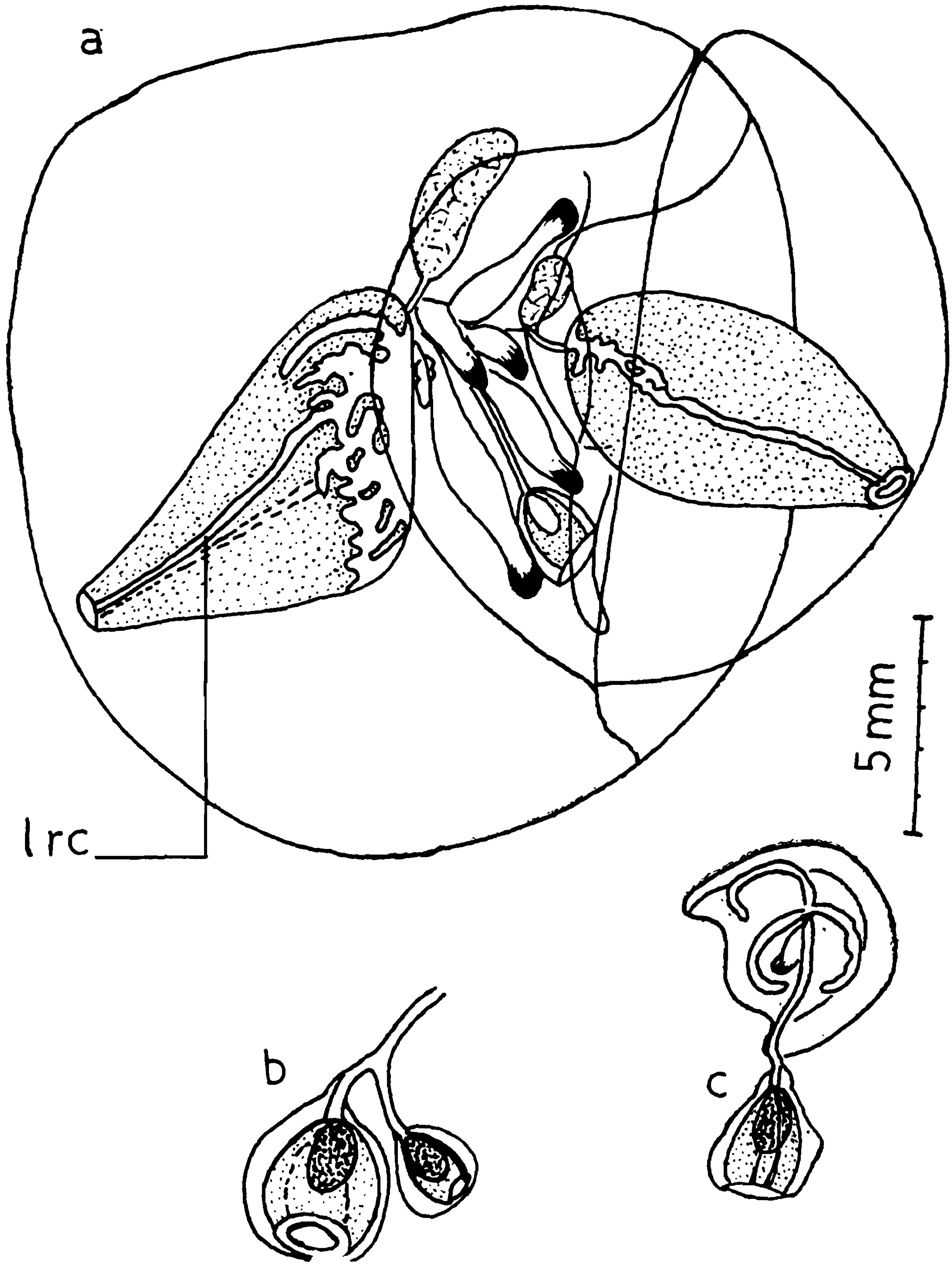


FIG. 31. *M. praeclara* Totton (a–c). a. entire showing hypertrophied lateral radial canal (lrc); b. gonophores; c. eudoxid phase. (After Totton, 1954, figs. 46–48 & pl. VII).

Type locality: Bermuda (Western Atlantic Ocean).

Distribution: (Maps 25 & 26). Five specimens of this species were recorded from a depth of 200-0 m (*vide* maps 25 & 26). These specimens were recorded along the coasts of Africa and Madagascar during July–September and along 110°E longitude, off south-west coast of Australia during January. From west coast of India during November.

Subfamily (ii) PRAYINAE Chun, 1897

Prayidae possessing one to several pairs of smooth structually similar nectophores with simple or branched somatocyst; nectosac with simple straight or meandering lateral radial canals or with multiform radial canals. Eudoxids with bracts possessing branched bracteal canal-system, with or without specieal nectophores and central organ.

Six valid genera: *Rosacea sensu* Bigelow, 1911; *Praya* Quoy & Gaimard in Blainville, 1834; *Prayoides* Leloup, 1934; *Lilyopsis* Chun, 1885, *Desmophyes* Haeckel, 1888 and *Stephanophyes* Chun, 1888. Of these six genera, *Rosacea, Praya, Prayoides* and *Desmophyes* have been recorded from the Indian Ocean and Indian Seas; *Stephanophyes* and *Lilyopsis* have not been reported from the Indian Ocean.

Key to genera of PRAYINAE

1.	Nectophores biserial. Reserve bells may be present.	2
	Nectophores in corona. Palpons present..	**Stephanophyes**
2.	Nectophores biserial, somatocyst simple.	3
	Somatocyst branched.	**Praya**
3.	Nectophores biserial, somatocyst simple lying at surface of hydroecium.	4
	Prolonged into mesoglea...	5
4.	Nectophores biserial, somatocyst simple, at surface, radial canals simple but meandering.. ..	**Rosacea**
	Somatocyst very short..	**Prayola**
	Lateral radial canals branched..	**Prayoides**
5.	Nectophores biserial, somatocyst simple, prolonged into mesoglea with dilated tip, simple straight, radial canals..	**Desmophyes**
	With meandering radial canal..	**Lilyopsis**

Genus 18. **Rosacea** *sensu* Bigelow, 1911b

Rosacea Bigelow, 1911, p. 201.

Prayinae with a pair of large smooth enlongated nectophores often replaced by reserve nectophores of slightly different shape and structure; somatocyst simple lying on dorsal surface of hydroecium; nectosac with meandering lateral radial canals. Eudoxids with four main bracteal canals in bracts, large gonophore and no special (asexual) nectophores.

Bigelow (1911b) included two species: *R. plicata* Quoy & Gaimard *sensu* Bigelow, 1911b and *R. medusa* (Metschnikoff, 1870) under this genus. But Totton (1954) considered *R. medusa* as a doubtful synonym of *Lylyopsis rosea* Chun, 1885. *Rosacea villafranchae* Carre, 1969, resembles the nectophores of *Desmophyes annectens* Haeckel, 1888 in having simple somatocyst prolonged into mesoglea with dilated tip and simple straight radial canals, but with distinct eudoxids. Three species: *R. plicata*, *R. cymbiformis* and *R. flaccida* Biggs, Pugh & Carre, 1978,* are recognised as valid.

Key to species of **Rosacea**

1. Nectophores with hydroecium extending as shallow groove along entire length of nectophore.. *cymbiformis*

   Nectophores with hydroecium extending as deep conical depression mainly at centre of nectophore.. *plicata*

25. **Rosacea plicata** *sensu* Bigelow, 1911b
(Fig. 32, a–d)

Rosacea plicata Bigelow, 1911, p. 201, pl. 2, figs. 7–9.
Rosacea plicata Daniel, 1974, p. 84, Text-fig. 6, M–O. (cf. for detailed synonymy).

Type Specimen: National Museum, U.S.A.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 9 n. *Bay of Bengal:* 4 n. *South West Indian Ocean:* 2 n. *South East Indian Ocean:* 4 n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 10 n.; 8 eu. (compl.). *Bay oj Bengal:* 2 n. *South West Indian Ocean:* 5 n. *South East Indian Ocean:* 2 n.

Polygastric phase: (Fig. 32, a, b, c). A pair of large smooth, round to oval nectophores of equal size. Nectophores develop from reserve bells after the larval ones fall off. Larval nectophores caducous, upto 12 mm in length; definitive nectophores measure upto 32 mm in length.

*Diagnostic key character not given in the abstract, original reference for checking and writing out the key, is not available.

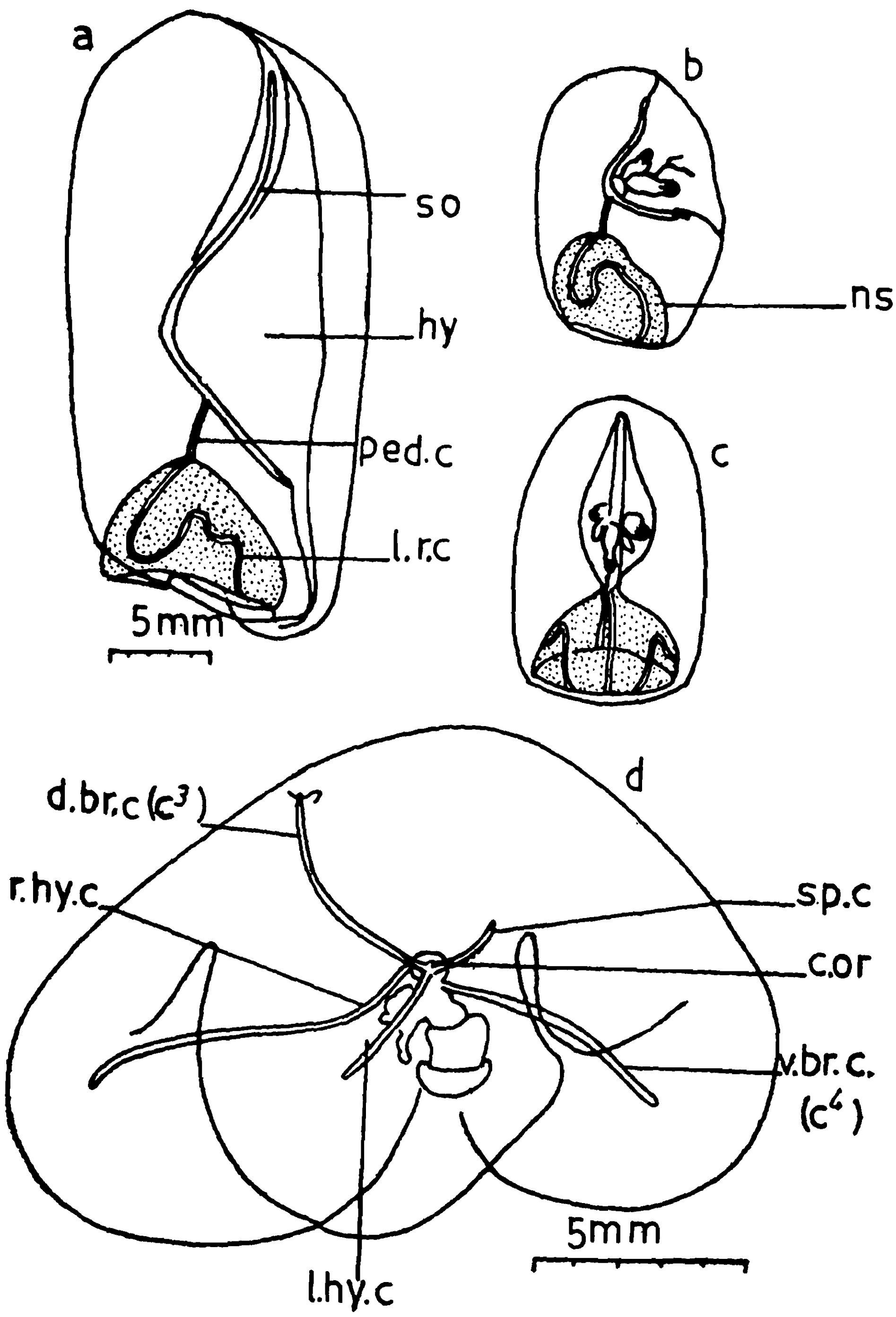


FIG. 32. *R. plicata* Quoy & Gaimard (a–d). a. definitive nectophore; b. nectophore — lateral view; c. ventral view, d. bract. (*Abbreviation used:* c.or – central organ; d.br.c. (c3) – dorsal bracteal canal; hy – hydroecium; l.hy.c – left hydroecial canal; lrc – lateral radial canal; ns – nectosac; ped. c – pedicular canal; r hy c – right hydroecial canal; so – somatocyst (pallial canal); sp c – spur canal; v br c – (c4) ventral bracteal canal). (Figs. a & d after Totton, 1954, figs. 42; b & c after Bigelow, 1911, pl. 2, figs. 7 & 8).

Larval nectophore: Caducous, small with short circumscribed, slit-like hydroecial opening as in Hippopodiidae. Pallial canal (part of somatocyst) bent sharply round *Central Organ*. Lateral radial canals with sigmoid course.

Definitive nectophores: Bigger, elongated, 21-32 mm long; hydroecium deeply conical; with deep pocket for attachment of muscular lamella. Somatocyst thin, thread like lying close to dorsal wall of hydroecium bent at apex of hydroecium, extending down beyond pedicular canal. Lateral radial canals longer, with meandering course, before joining circular canal. Dorsal and ventral radial canals, shorter, simple straight. Opening of hydroecium not extending entire length as in *R. cymbiformis*.

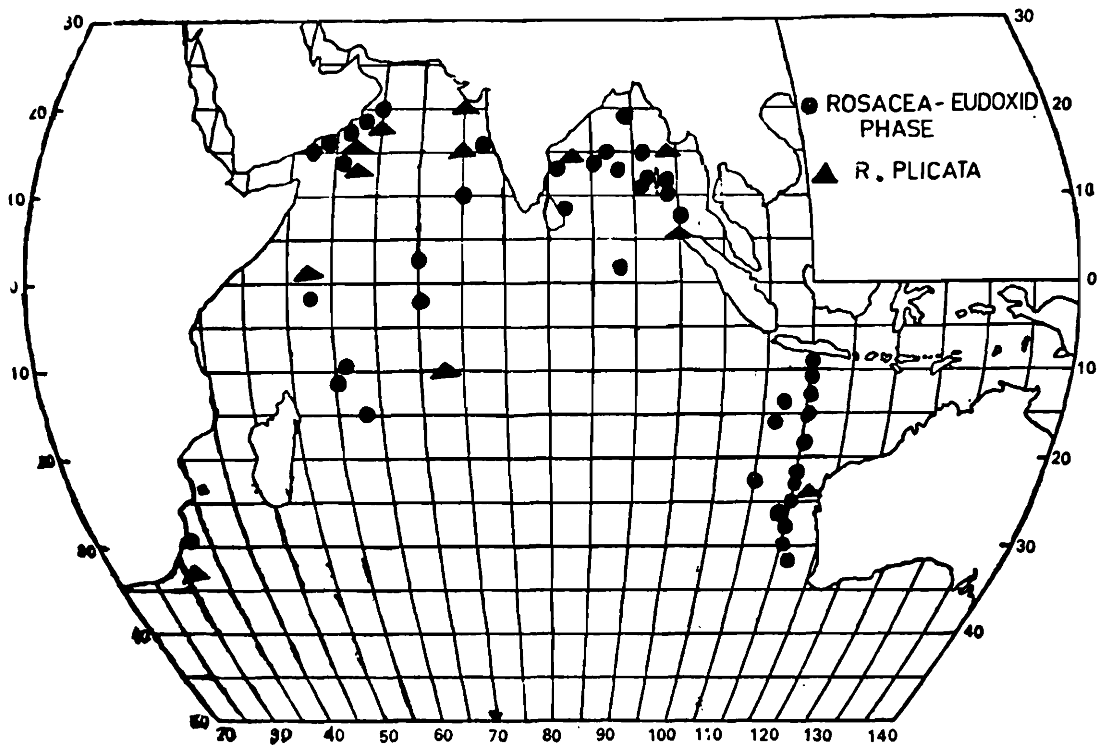
Eudoxid phase: Fig. 32d. Bract globular, smooth, 18.0 mm in diameter, 3 lobed; distinguished from eudoxids of *R. cymbiformis* only from origin of dorsal bracteal canal — distal to spur canal on left hydroecial canal; with 6 bracteal canals — dorsal, ventral, two spur canals, left and right hydroecial canals. Bracteal cavity or hydroecium conical bounded by three lobes of bract. Right hydroecial canal longer than left. Spur canals very short; dorsal canal reaches upto dorsal surface of bract. Central organ present. *Gonophores* bear male or female germ cells upon short manubrium. Radial canals simple, straight and join circular canal. No tubercles, pigment spots or tentacles present around mouth of nectosac.

Type locality: Eastern Tropical Pacific.

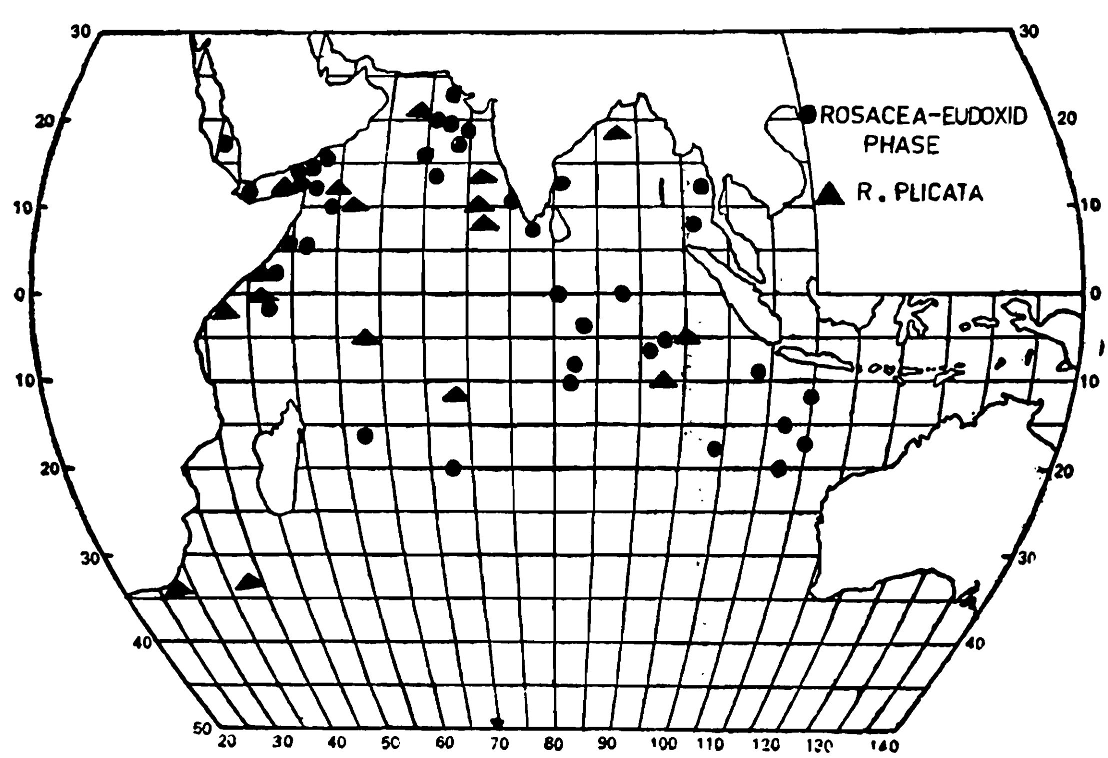
Distribution: (Maps 27 & 28). The distribution of *R. plicata* and its occurrence in the different regions of the Indian Ocean are presented in Maps 27 and 28.

R. plicata occurred in a few stations in all the four zones of the Indian ocean during both the seasons.

Arabian Sea: In the western part of the Arabian Sea, it occurred during January, July and December while it was collected during May, August, October, November and December in the eastern part. *Bay of Bengal:* Along the Indian Coast it occurred during January, March and June. Near Andaman islands and Burma it was recorded during August and September. *South West Indian Ocean:* It was recorded from five stations; three located along the African coast during January and October and the others located in the oceanic region during February and June. *South East Indian Ocean: R. plicata* was recorded along the Australian coast during July and in the oceanic region during December.



MAP 27. Distribution of *R. plicata* and eudoxids of *Rosacea* sp. during SW/SE monsoon season. 1—10 Specimens per haul.



MAP 28. Distribution of *R. plicata* and eudoxids of *Rosacea* sp. during NE/NW monsoon season. 1—10 Specimens per haul.

26. **Rosacea cymbiformis** (Delle Chiaje, 1841) (Fig. 33, a–f)

Physalia cymbiformis Delle Chiaje, 1841, Atlas tab. 33, fig. 1.
Praya cymbiformis Bigelow, 1911, p. 200, pl. 2, figs. 1–5.
Rosacea cymbiformis Daniel, 1974, p. 65, Text-fig. 6, K.L.P. (cf. for detailed synonymy)

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 6 n.; 8 eu. (compl.); 13 br. *Bay of Bengal:* 13 n.; 12 eu. (compl.); 20 br. *South West Indian Ocean:* 11 n.; 8 eu. (compl.); 1 br. *South East Indian Ocean:* 9 n.; 6 eu. (compl.); 16 br.; 1 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 20 n.; 41 eu. (compl.); 43 br.; 7 go. *Bay of Bengal:* 35 n.; 5 eu. (compl.); 15 br. *South West Indian Ocean:* 5 n.; 10 br. *South East Indian Ocean:* 4 n.; 18 eu.; 8 br.

Polygastric phase: (Fig. 33, a, b, c) Larval nectophore caducous, smaller (5.5 mm length) with as many as 5 reserve nectophore buds of future definitive nectophores. Definitive nectophores — in pairs, first one partially embracing second in its hydroecium; upto 60 mm in length, cylindrical or kidney shaped. Hydroecium shallower than that of *R. plicata* extending entire length of nectophore on ventral side extending beyond ostium of nectosac. Somatocyst thin, long, curved in middle, its lower limb extending down well below apex of nectosac. Pedicular canal arising from lower limb of somatocyst. Lateral radial canals take a meandering course from pedicle to circular canal. Dorsal and ventral radial canals simple and straight. Ostium of nectosac directed outward (towards dorsal side) and downwards.

Stem: Extremely long, highly contractile bearing 45–60 cormidia in a 90 cm. long stem. Older cormidia break loose as eudoxids. Male and female eudoxids borne on same stem.

Eudoxid phase: (Fig. 33 d) Bract reach 9.0 mm in length, round to oval in shape, three lobed as in *R. plicata.* Convex proximally, concave distally. Hydroecium (bracteal cavity) conical, bounded by three lobes. Phyllocyst differs from that of *R. plicata* : (1) the dorsal bracteal canal arises from a point on left hydroecial canal, (2) proximal to short longitudinal spur canal (distal to the spur canal in *R. plicata*). Muscular lamella extends from right hydroecial canal to stem and along stem to base of gastrozooid and from base of basigaster down to ventral canal.

Gonophore: 2 or 3 gonophores arise at base of gastrozooid on opposite side to tentacle. No special or asexual nectophore present. Manubrium bears germ cells, female bearing 6 or more eggs. Egg and sperms mature at the time of release of gonophores. Probably male and female gonophores occur in the same eudoxid.

Tentacle: 27 cm long with 60 tentilla placed 4–5 mm apart, and terminal filament extending to 13 mm in length. A single animal may fish more than 35 metre of armed line, the tentacles forming a formidable net.

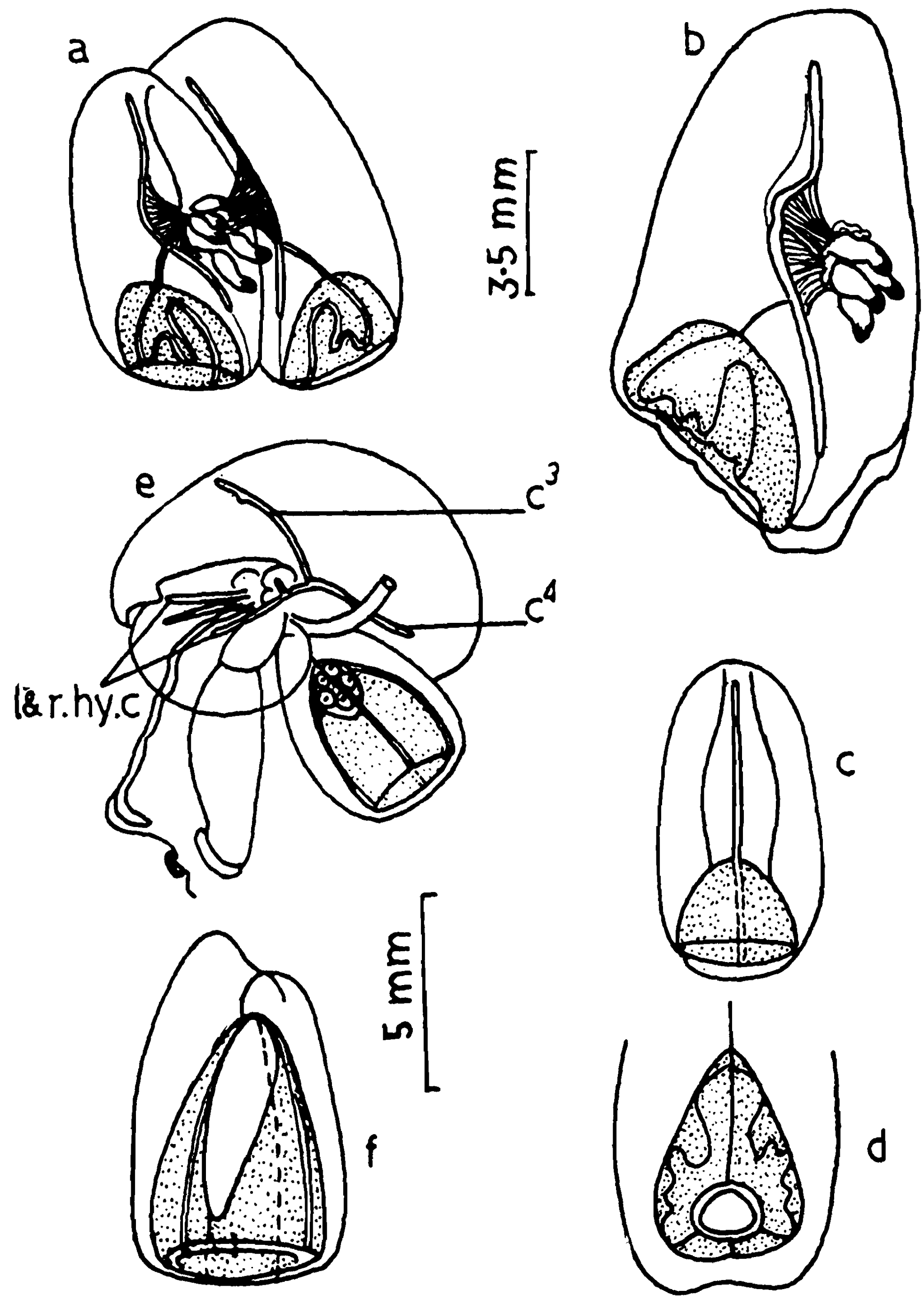
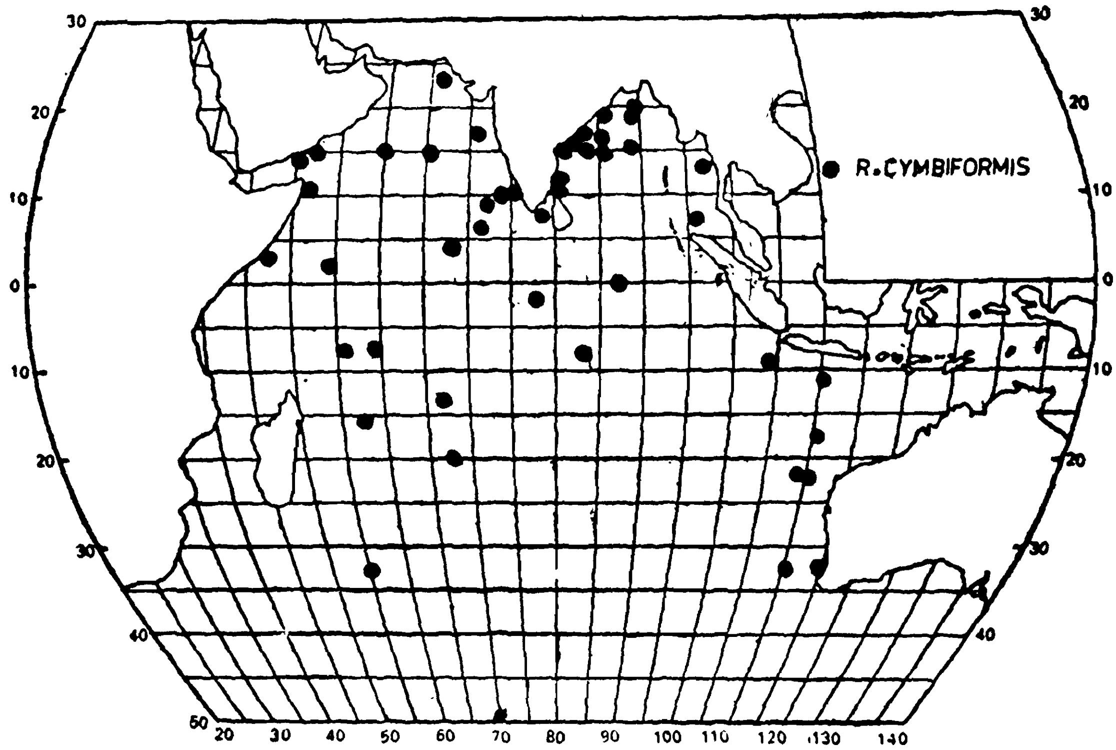
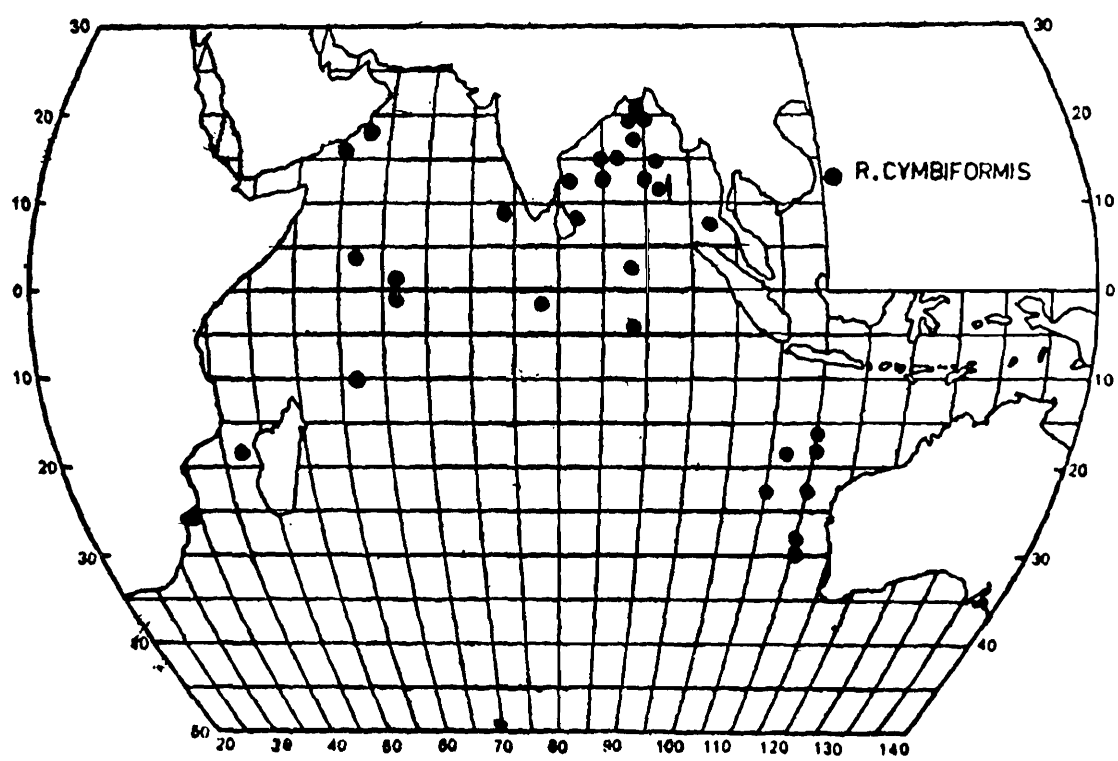


FIG. 33. *R. cymbiformis* (Delle chiaje) (a–f). a. both nectophores intact; b. definitive nectophore; c & d. ventral and dorsal view of nectophore; e. eudoxid phase; f. male gonophore. (Fig. e from Bigelow, 1911, pl. 2, fig. 4).



MAP 29. Distribution of *R. cymbiformis* during SW/SE monsoon season. 1—3 colonies per haul.



MAP 30. Distribution of *R. cymbiformis* during NE/NW monsoon season. 1—3 colonies per haul.

Type locality: Mediterranean Sea.

Distribution: (Maps 29 & 30). The distribution of *R. cymbiformis* and the eudoxid phase of *Rosacea* spp. in the Indian Ocean are presented in Maps 27, 28 (eudoxids) 29 and 30 (polygastric phase).

R. cymbiformis was recorded from all the main zones of the Indian Ocean. In Bay of Bengal and South East Indian Ocean the night captures were more than the day catches while in the Arabian Sea and South West Indian Ocean, the day captures were more. It occurred usually along the coast of India and in the equatorial belt region and Chagos Archipelago in the mid-ocean (15°S lat.).

Arabian Sea: *R. cymbiformis* was recorded from a maximum number of stations during December in the western part (Arabian Coast, Gulf of Aden, Somali coast). In the Red Sea it was collected during June. Along the west coast of India it occurred at many stations during March and November. *Bay of Bengal: R. cymbiformis* occurred mostly along the Indian coast and in the central region of the Bay, during May and June. Near the Andaman Islands and Burma coast it occurred during January and April. *South West Indian Ocean:* It was recorded from very few stations along the African Coast. It was not collected during April, August and November. In the oceanic region it occurred at few stations, and was not collected during January, June and November *South East Indian Ocean:* Except in October and November *R. cymbiformis* was collected during all the months along 110°E longitude, specially during August. In the Oceanic region it was recorded at few stations only in January, September, October and December.

Genus 19. **Praya** Quoy & Gaimard, 1833

Praya Quoy & Gaimard, 1833, p. 104.
Nectodroma Bigelow, 1911, p. 204.

Prayinae with a pair of huge, smooth, elongated and opposed, similar nectophores; nectosac with multiform (branched or reticulate) radial, subumbral canals and branched somatocyst. Eudoxid with flattened semicircular bract having 4 main bracteal canals and flattened gonophores with branched pedicular canals. No central organ.

Type Species: *P. dubia* (Quoy & Gaimard, 1833)

Two valid species of *Praya: P. dubia* (Quoy & Gaimard, 1833) and *P. reticulata* (Bigelow 1911).

Key to species of PRAYA

1. Nectosac with many distally branched radial canals, joined together by transverse canals forming a reticulum... *reticulata*

Nectosac with many distally branched radial canals, not joined together by transverse canals.... *dubia*

27 **Praya dubia** (Quoy & Gaimard, 1833) (Fig. 34, a–e)

Diphyes dubia Quoy & Gaimard, 1833, p. 104, pl. 5, figs. 34–36.

Nectodroma dubia Bigelow, 1911, p. 204, pl. 3, figs. 8, 9.

Praya dubia Daniel, 1974, p. 87, Text-fig. 7, A & B. (cf. for detailed synonymy)

Type specimen: Museum National d'Histoire Naturelle, Paris.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Bay of Bengal:* 1 n. *South West Indian Ocean:* 1 n. *South East Indian Ocean:* 2 n.; 1 stem. NORTH WEST/NORTH EAST MONSOON SEASON: *Arabian Sea:* 6 n.; 493 br.; 106 go.; pieces of stem. *Bay of Bengal:* 5 n.; 82 br.; 76 go. *South West Indian Ocean:* 1 n. *South East Indian Ocean:* 2 n.; 6 br.

Polygastric phase: (Fig. 34a). A pair of broad, smooth, opposed, huge, elongated, similar nectophore upto 85 mm long 50 mm broad with one or two reserve buds. Apex obliquely truncated, with nectosac situated on dorsal side, 2/3rd distance from apex; ventral wall extending well below ostium of nectosac. Hydroecium as deep groove extending from apex to below the level of ostium of nectosac, bounded by two lateral flaps; partially closed above by a small gelatinous flap and entirely enclosed below by lateral flaps.

Somatocyst with three main branches, thick, opaque white strands seen very clearly and brightly within the transparent mesoglea. Median branch lying in mid longitudinal region; runs anteriorly almost upto apex of nectophore, dividing into two lateral branches extending to lateral edges of nectophore. These curve re-run downwards (posteriorly) terminating on either side at the level of the apex of the nectosac. Lateral branches with four pairs of short, blind diverticula. Posteriorly median branch extends down as far as level of ostium of nectosac. Pedicular canal thin and thread-like.

Nectosac — 1/4 total length of nectophore, at posterior end on one side of nectophore; with well developed musculature; 12 radial canals arise from pedicular canal and divide two times or more towards distal end to form 50 or more canals near ostium.

Eudoxid phase: (Fig. 34e) large, (20 mm × 10 mm × 4 mm) bract dome shaped, rounded, smooth on dorsal surface, concave with conical-shaped bracteal cavity on ventral side. Bracteal canal system with 4 main branches — dorsal, ventral and left and right hydroecial canals; dorsal canal reaches upto apex of bract; ventral directed backward; left and right hydroecial canals directed forwards on either side of hydroecium; right hydroecial canal not recurved at tip as in *P. reticulata;* dorsal bracteal canal not so long or recurved as in *P. reticulata;* ventral bracteal canal not branched.

Two grooves on dorsal surface, one shallow, transverse, for opening of dorsal bracteal canal; deeper vertical groove near hydroecium for passage of tentacle.

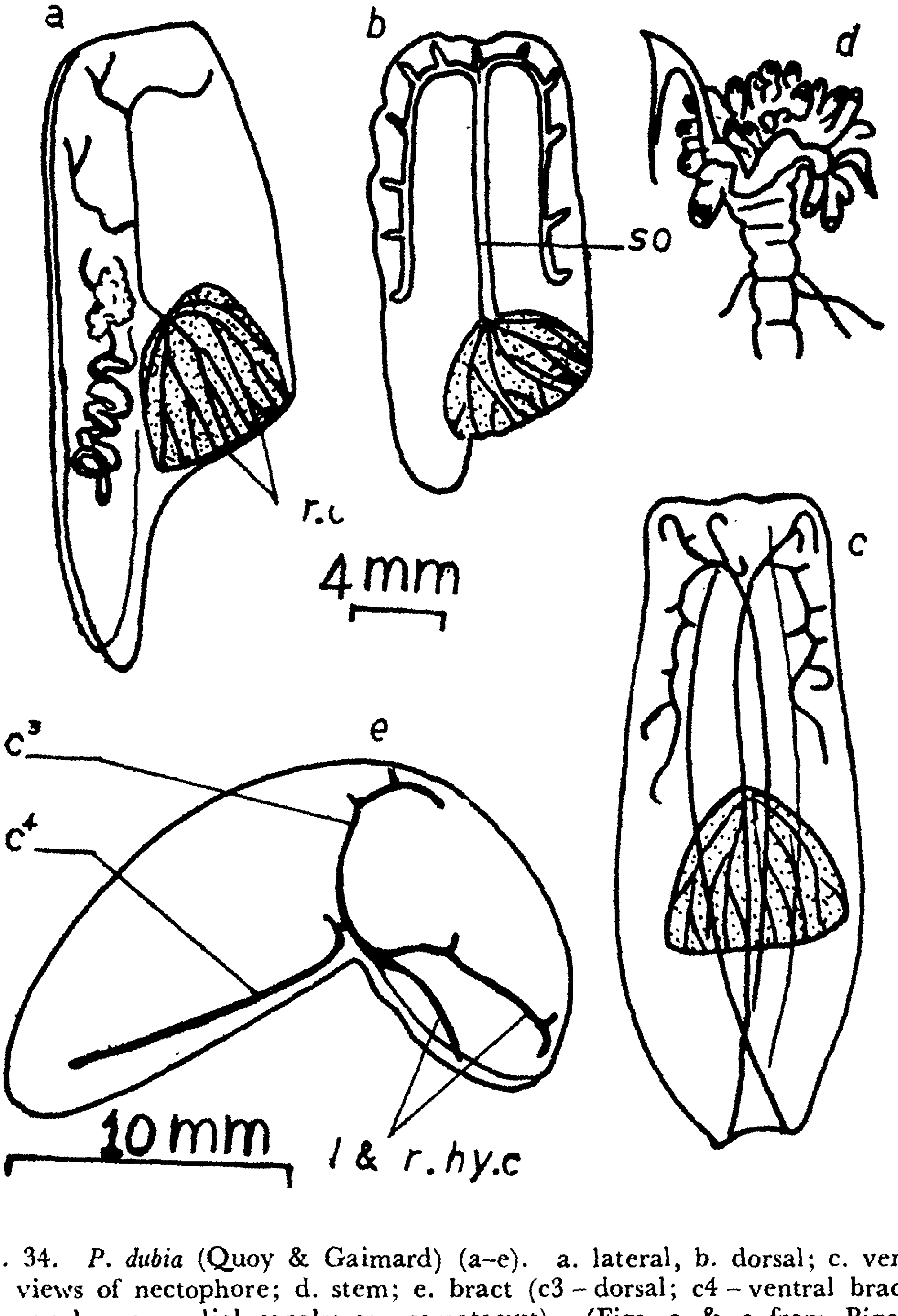


FIG. 34. *P. dubia* (Quoy & Gaimard) (a–e). a. lateral, b. dorsal; c. ventral views of nectophore; d. stem; e. bract (c3 – dorsal; c4 – ventral bracteal canals; rc – radial canals; so – somatocyst). (Figs. a & c from Bigelow, 1911, pl. 3, figs. 8 & 9; fig. e from Totton, 1965, fig. 70).

Gonophores laterally flattened, conical in shape with broad mouth opening. Pedicular canal simple, not branched as in *P. reticulata.*

Type locality: Kangaroo Island, Off Adelaide (South Australia).

Distribution: (Maps 25 & 26). The distribution of *P. dubia* and its occurrence in the different regions of the Indian Ocean are presented in maps 25 and 26.

During SW/SE monsoon season *P. dubia* was recorded only at two stations, (i) one located in the Bay of Bengal (April) and the other in the north coast of Madagascar (July).

During NE/NW monsoon season it occurred at greater number of stations in the Arabian Sea and Bay of Bengal than in South West and South East Indian Ocean. In the Arabian Sea it occurred in the Gulf of Aden during December; in the central region during February; off Cochin during April and October and along the equator during December. In the Bay of Bengal it occurred in the central region during January (2 stations) and March (5 stations) and south of Nicobar Island during March.

28. **Praya reticulata** (Bigelow, 1911)

(Fig. 35, a–d)

Nectodroma reticulata Bigelow, 1911, p. 208, pl. 1, figs. 7, 8, pl. 3, figs. 1–7.
Praya reticulata Daniel, 1974, p. 88, Text-fig. 7c.
(cf. for synonymy)

Type Specimen: United States National Museum, U.S.A.

Material Examined: NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 1 n.; 1 go. (Daniel, 1974).

Polygastric Phase: (Fig. 35a) similar to *P. dubia*, subcylindrical in shape, truncate at upper end obliquely truncate below; 55 mm long and 20 mm broad. Hydroecium extending entire length on ventral surface; with two ventral flaps overlapping to form a closed groove. Somatocyst as in *P. dubia*, extending from apex of nectophore down to level of ostium of nectosac, giving off short lateral branches bifurcating at tip.

Nectosac smaller, pedicular canal oblique branching into eight main radial canals in nectosac, dividing dichotomously, and joined together by short transverse canals, forming a network of canals.

Eudoxid phase: (Fig. 35 c, d). Large, 20 mm long laterally flattened, convex dorsally, concave ventrally as in *P. dubia*. Tip of right hydroecial canal long and recurved; ventral canal may bear small lateral branches. Gastrozooids lemon yellow in colour in distal half and at junction of tentacle and basigaster; with reddish liver stripes.

Stem 82 cm long in contracted state; upto 3 m in length when expanded.

Gonophore 9.0 mm × 7.0 mm; laterally flattened triangular in shape; pedicular end blunt, slightly trilobed, with short trifid branches of pedicular canals. Nectosac triangular in shape with broad oval-shaped ostium. Radial canals branched. Without manubrium probably special nectophore.

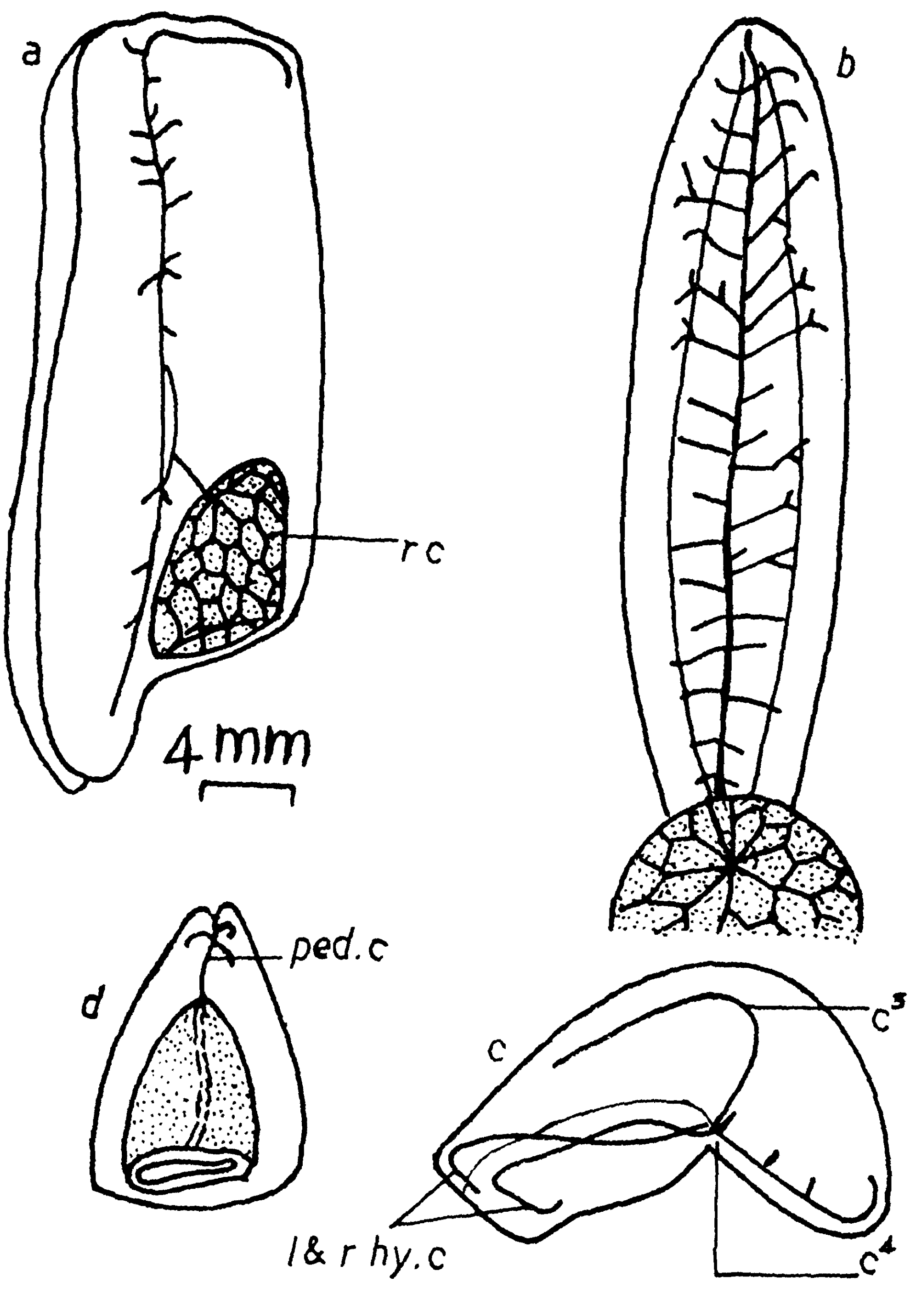


FIG. 35. *P. reticulata* (Bigelow) (a–d). a. lateral view of nectophore; b. dorsal view; c. bract; d. gonophore. (Figs. a & b after Bigelow, 1911, pl. 3, figs. 2 & 5; c from Totton, 1965, fig. 74 G).

Type locality: Eastern Tropical Pacific Ocean.

Distribution: (Map. 25). Recorded from the oceanic region of the Arabian Sea during October.

Genus 20. **Prayoides** Leloup, 1934

Prayinae with simple, unbranched somatocyst as in *Rosacea;* four subumbral radial canals; lateral canals branch only once and not so profusely as in *Praya.*

Monotypic genus for *P. intermedia* Leloup, 1934.

29. **Prayoides intermedia** Leloup, 1934
(Fig. 36)

Rosacea (*Prayoides*) *intermedia* Leloup, 1934, pl. II, fig. 4.
Prayoides intermedia Daniel, 1974, p. 89, Text. fig. 7, D.

Type Specimen: Museum Royal Histoire Naturelle, Belgique.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 1 n. (Daniel, 1974).

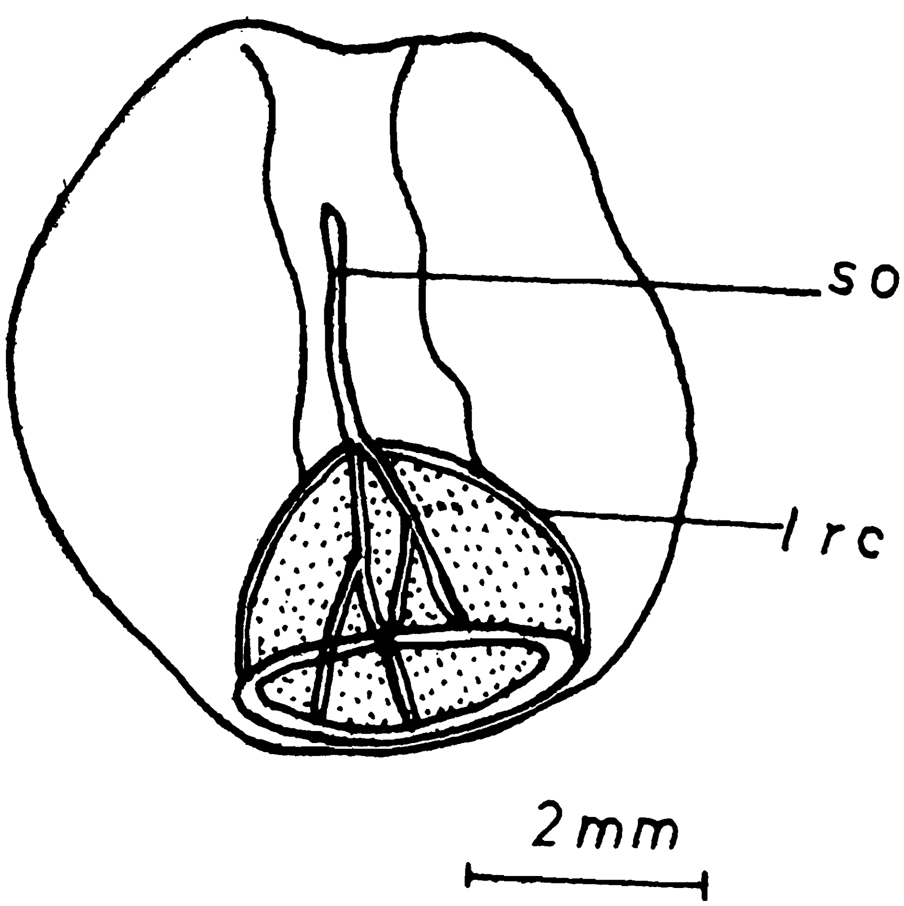


FIG. 36. *P. intermedia* Leloup — nectophore.

Polygastric phase: (Fig. 36) A pair of smooth, *Rosacea* like nectophores, 7.5–12 mm in length; 5–8 mm in breadth. Hydroecial groove shallow extending on entire ventral surface as in *R. cymbiformis*. Somatocyst short, thin, directed towards anterior end; not extending down beyond pedicular canal. Nectosac thin-walled, with 4 radial canals; lateral radial canals divide into two.

Eudoxid phase: Unknown.

Type locality: Between Cape Verde and Freetown (5°N lat.; 20°W long.) (North Atlantic).

Distribution: (Map 25). In the Indian Ocean it was recorded only once from the Arabian Sea by *I.N.S. Kistna* — 18° 45′ N lat.; 71° 45′ E long. on 13-10-62 from a depth of 200–0 m.

Genus 21. **Desmophyes** Haeckel, 1888a

Desmophyes Haeckel, 1888a, p. 36.

Prayinae with one to several (3) pairs of rounded, biserially arranged similar nectophores; ostium of nectosac bearing minute red pigment flecks, tubercles and directed downwards and outwards. Somatocyst simple, club-shaped, prolonged into mesoglea. All radial canals simple, and straight. Eudoxid with 6 main bracteal canals, a median pear-shaped central organ and with large asexual nectophores and reduced unisexual gonophores.

Genus *Desmophyes* consists of two valid species: *D. annectens* Haeckel, 1888; and *D. villafranchae* (Carré, 1969).

Key to species of DESMOPHYES

Central organ present in bract..	*annectens*
Central organ absent in bract; dorsal canal originating from right hydroecial canal..	*villafranchae*

30. **Desmophyes annectens** Haeckel, 1888 (Fig. 37, a–e)

Desmophyes annectens Haeckel, 1888, p. 170, pl. 30.
Desmophyes annectens Totton, 1965, p. 128, pl. XXII, figs. 4–6; pl. XXIV; figs.. 1–9.

Type Specimen: Most of Haeckel's specimens are not present in British Museum.

Material: Recorded by Haeckel (1888) off southern coast of Sri Lanka during December.

Polygastric phase: (Fig. 37, a, b) Usually a pair, 30 mm in length and 15 mm in breadth (rarely 2 or 3 pairs) of rounded, wedge shaped soft highly transparent, nectophores loosely joined together; with several reserve buds of nectophores. Somatocyst simple, club-shaped (or dilated tip) lies obliquely in mesoglea. Hydroecium shallow; combined hydroecium of two nectophores spindle shaped. Nectosac relatively very small with straight and simple, radial canals (not meandering as in *Rosacea*) occurs at lower part of nectophore, its ostium directed downwards and outwards. Ostium surrounded by a ring of minute red pigment flecks and tubercles.

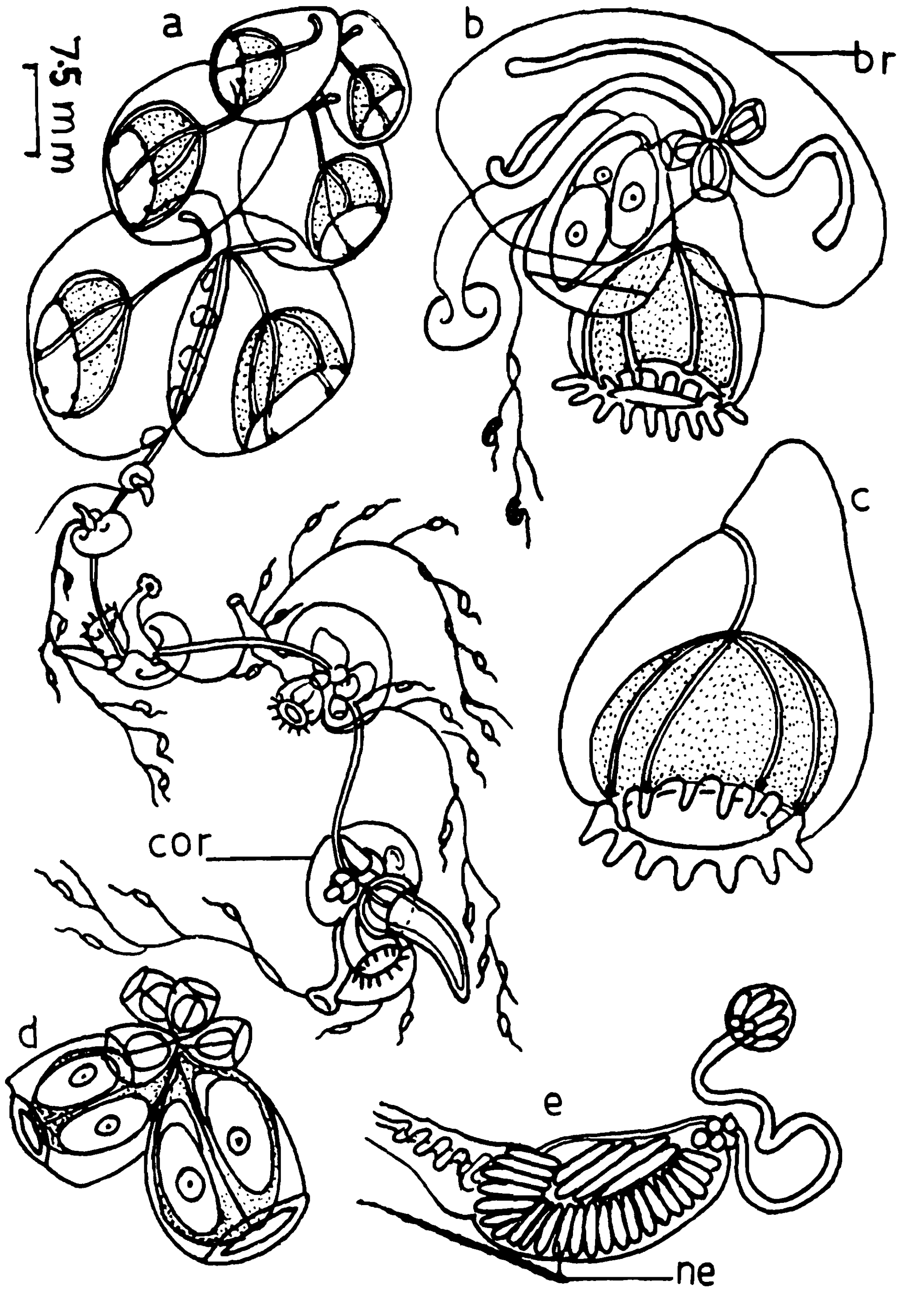


FIG. 37. *D. annectens* Haeckel (a–e). a. entire specimen; b. eudoxid; c. special nectophore; d. female gonophores; e. tentillum (for. – cormidum). (After Haeckel, 1888, pl. 30).

Eudoxid phase: (Fig. 37, b, c, d) Bract dome-shaped, bounded below by two lateral hydroecial flaps, with a relatively large asexual (special) nectophore and a bunch of smaller gonophores, at base of gastrozooid. Sexes of eudoxids alternate on the stem, (*i.e.* in an eudoxid all gonophores are of one sex). A median, pear-shaped vesicle — central organ lies at junction of five bracteal canals — 3 long and 2 short. Bracteal cavity (hydroecium) conical in shape and deep.

Special nectophore nearly triangular in shape, with conical-shaped nectosac, four simple straight radial canals, pigment spots at junctions of radial and circular canals, with tubercles surrounding ostium. Gonophores with short umbrella; male gonophores with very small umbrella; manubrium 3-4 times as long as umbrella and project out.

Type locality: Off Sri Lanka, Bay of Bengal, Indian Ocean.

Distribution: (Map. 26). It was recorded by Haeckel off southern coast of Sri Lanka during December.

Subfamily (iii) NECTOPYRAMIDINAE Bigelow, 1911

Prayidae with single nectophore bearing ridges, angles and serrations. Somatocyst either simple or complexly branched. Hydroecium deep and conical. Radial canals of nectosac originating separately from pedicular canal. Eudoxid phase: bracts usually with four main bracteal canals either simple or branched; special nectophore present (except in *N. diomedeae*).

This genus includes four distinct, aberrant species: *N. thetis* Bigelow, 1911a; *N. diomedeae* Bigelow, 1911b; *N. natans*, Bigelow, 1911b; and *N. spinosa* Sears, 1952. They have great affinity with not only *Rosacea* and *Amphicaryon* but also with *Hippopodius*. Nectophores of species of *Nectopyramis* are always taken singly, and without any reserve buds. These larval nectophores instead of being caducous are retained (neotenic), except in *N. spinosa* where two types: the caducous larval bell and the other heteromorph definitive nectophore, are developed.

Type Species: *Nectopyramis thetis* Bigelow, 1911a.

Monotypic sub-family for genus *Nectopyramis* Bigelow, 1911a.

All the four mid-deep water species occur in the Indian Ocean but not in the Indian Seas.

Family XI: HIPPOPODIIDAE Kölliker, 1853

Hippopodinae Kolliker, 1853, p. 28.
Polyphyidae Chun, 1882, p. 677.

Calycophorae with a succession of up to 12 or more similar nectophores which are smooth, or facetted; with spines or protuberances; with large *rete mirabele* in ventral radial canal during young growth stages. Bracts absent, Cormidia not separating as eudoxid as in all other Calycophores.

Two valid genera: *Hippopodius* Quoy & Gaimard 1827 and *Vogtia* Kölliker, 1953.

Key to genera of HIPPOPODIIDAE

1.	Nectophore horse-shoe shaped, smooth..	**Hippopodius**
	Nectophore prismatic and facetted..	**Vogtia**

Genus 22. **Hippopodius** Quoy & Gaimard, 1827

Gleba Forskal, 1775, p. 14 (preoccupied — see Chun, 1897).
Hippopodius Quoy & Gaimard, 1827, p. 172.
Polyphyes Haeckel, 1888, p. 178.

Hippopodiidae with a series of horse-shoe shaped nectophores none of which are normally shed; possessing usually four rounded smoky coloured protuberances just above the nectosac.

Monotypic genus for *H. hippopus* (Forskål, 1775).

31. **Hippopodius hippopus** (Forskål, 1775)
(Fig. 38, a–g)

Gleba hippopus Forskal, 1775, p. 14.
Gleba hippopus Forskal, 1776, taf. 43, fig. R.
Hippopodius hippopus Bigelow, 1911, p. 208.
Hippopodius hippopus Daniel, 1974, p. 94, Text–fig. 7, G–P.
(cf. for detailed synonymy)

Type Specimen: Place of deposit not known from literature.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 376 n. *Bay of Bengal:* 432 n. *South West Indian Ocean:* 294 n.; 15 ♂ go.; 25 ♀ gon. *South East Indian Ocean:* 490 n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 211 n. *Bay of Bengal:* 679 n. *South West Indian Ocean:* 192 n. *South East Indian Ocean:* 343 n.

Nectophore: Number in each colony varies from a few to several pairs. Larval nectophore caducous, replaced by series of secondary heteromorph ones retained throughout life. Definitive nectophore 21.5 mm wide, horse-shoe shaped with four rounded smoky coloured knobs, forming an arch above ostium. Apical

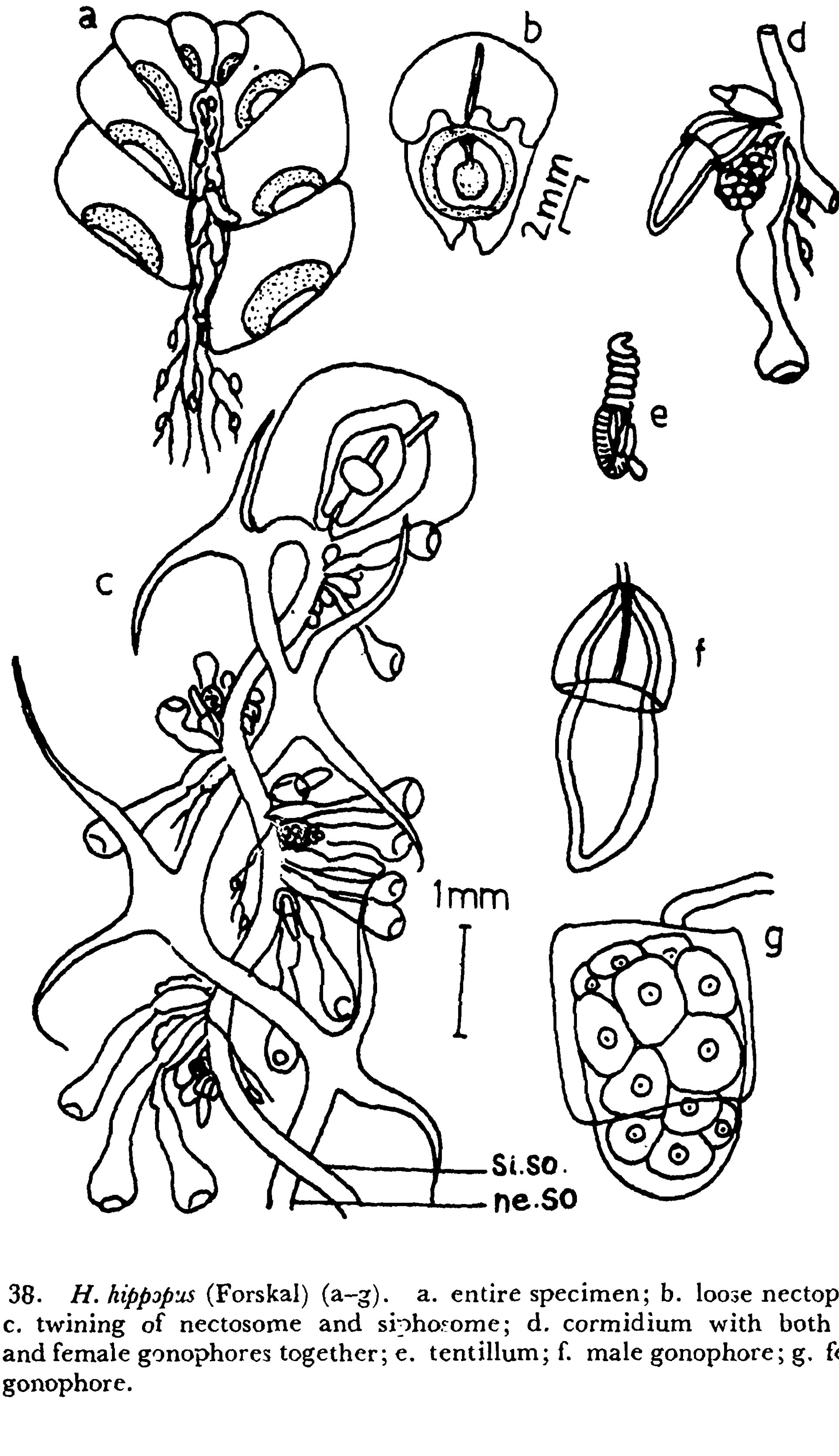


FIG. 38. *H. hippopus* (Forskal) (a–g). a. entire specimen; b. loose nectophore; c. twining of nectosome and siphosome; d. cormidium with both male and female gonophores together; e. tentillum; f. male gonophore; g. female gonophore.

semi-circular facet smooth edged, with a cleft below nectosac; shape and space between clefts varies according to age and preservation. Nectosac in preserved contracted material flat and shallow due to rolling-up of margin of nectosac; relaxed specimens with large, round nectosac. Lateral radial canals arise from dorsal radial canal near upper margin of nectosac. Large *rete mirabele* (of unknown function) in ventral radial canal, opaque, large, rounded, square bilobed or pear shaped in younger nectophores; very much reduced, thin, cigar-shaped or absent in older nectophores.

Somatocyst long, thin, thread-like directed towards apical facet almost to apex of nectophore. Hydroecium dome-shaped, deep, possessing a younger nectophore, which in turn may have a still younger nectophore within its hydroecium. Hydroecium of all nectophores form a narrow cylindrical tube for retraction of stem and cormidia.

Stem: Upper part of stem possessing nectophore — nectosome — is deflexed, curved around lower part of stem — siphosome — in wide spiral turns. Gastrozooids at regular intervals, pink in colour, pedicellate, with sub-cylindrical basigaster, large stomach, and highly retractile proboscis. Tentacles very long, bearing many long lateral tentilla; with yellow ellipsoidal cnidosacs; cnidoband curved round till its apical end lies near base, with long terminal filament; cnidoband with large four to six ensiform (cigar-shaped) nematocysts at base and many narrow elongated ones at lateral sides.

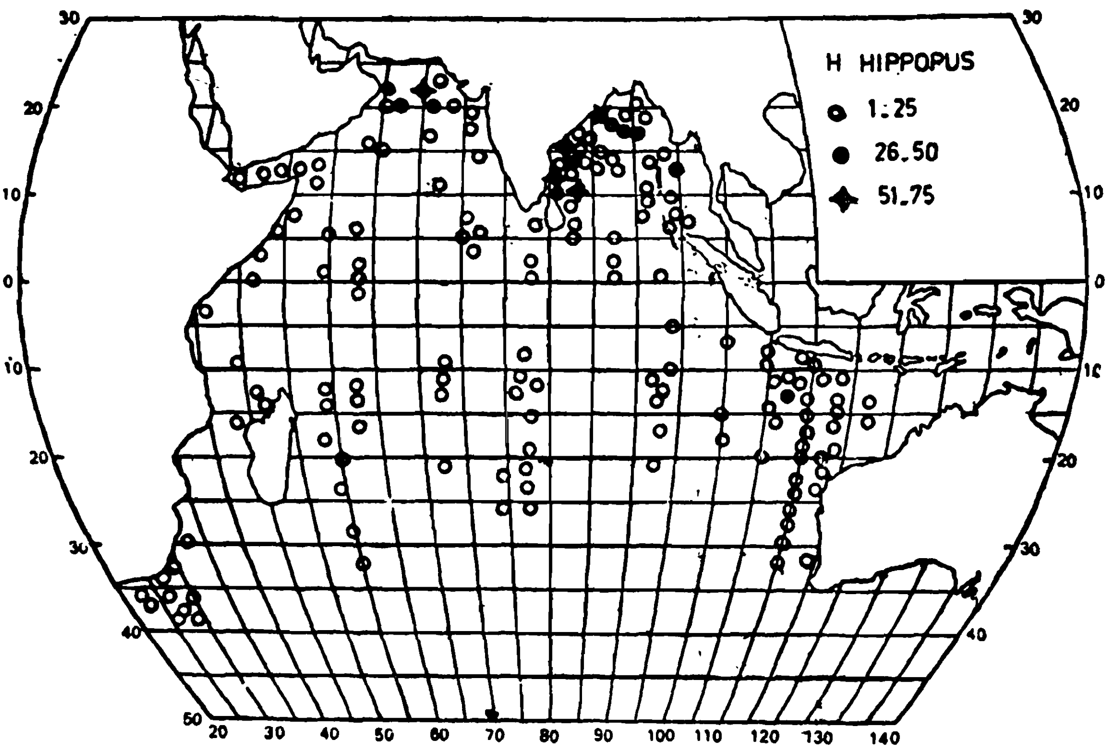
Gonophores: Both male and female gonophores occur together in bunches in each cormidum at base of gastrozooid; pedicellate; manubria of gonophores protrude freely from ostia of little medusae; female manubrium bears 8–12 large eggs.

Type locality: Mediterranean Sea.

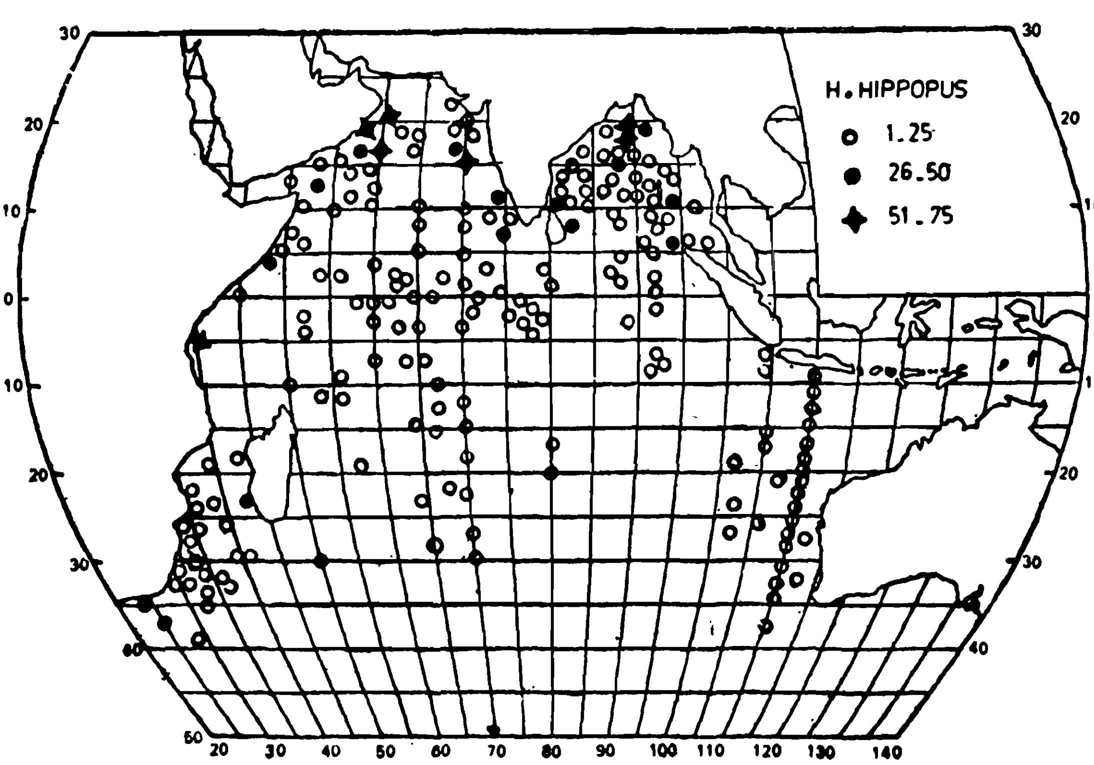
Distribution: (Maps 31 & 32). The distribution and abundance (number of loose nectophores) of *H. hippopus* during the two seasons are presented in maps 31 and 32; and the number of nectophores collected ranged from 1–75 per haul.

A perusal of the maps show that *H. hippopus* is one of the common, abundant species which occurred in the Indian Ocean. In the Bay of Bengal the maximum number of records (more than 50% of the stations established) occurred during SW/SE monsoon season. Usually day catches were more than the night catches except in the South East Indian Ocean during NE/NW monsoon season.

It occurred in abundance in the Arabian Sea and Bay of Bengal. Its distribution extended from 22°N latitude to nearly 40°S latitude along the African coast and 36°S latitude along the 110°E longitude, and in the mid-ocean down to 30°S latitude.



MAP 31. Distribution of *H. hippopus* during SW/SE monsoon season.



MAP 32. Distribution of *H. hippopus* during NE/NW monsoon season.

During SW/SE monsoon season, in the Arabian Sea, along the Arabian Coast its density ranged from 51–75 nectophores per haul, while along the Indian coast, density of 26–50 nectophores per haul occurred. In the Bay of Bengal the maximum density range of 51–75 nectophores per haul were recorded in the central regions. Along the equatorial belt and mid-ocean regions, *H. hippopus* was recorded from many stations but only 1–10 nectophores per haul occurred. Similarly, along the African coast and 110°E longitude, 11–25 nectophore per haul were recorded.

During NE/NW monsoon season, *H. hippopus* occurred scattered from the equatorial belt. The highest range of density from 51–75 nectophores per haul and lower densities of 26–50 per haul occurred along the Indian coast and in the central regions of the Bay of Bengal. In the Arabian Sea, very few hauls recorded 26–51–75 number of nectophores. In the mid-ocean only low density of 1–10 per haul were recorded. Along South Africa and 110°E longitude density range of 1–11–25 nectophores per haul were recorded at few stations.

Arabian Sea: Along the Arabian coast, Gulf of Aden and Somali coast *H. hippopus* occurred in great abundance during July. It was collected in all the months except in September and October. In the eastern part it was collected, in many stations during May. It was not present during June and September.

Bay of Bengal: Along the Indian coast and in the neighbouring areas *H. hippopus* occurred in great abundance during January, April (maximum) and June. It was not collected during October. In the Andaman Island and Burma region it occurred in high numbers during September. It was not recorded during January June, October and December.

South West Indian Ocean: Along the African coast it was collected during January and October. In the oceanic region it was recorded during all the months (maximum in June) except in November.

South East Indian Ocean: Along the 110°E longitude *H. hippopus* was collected during January (maximum), May and August. It did not occur during March and November. In the Oceanic region it was recorded at very few stations. It was not collected during February, May, June, October and November. The centre of distribution of this species appears to be from the Equator.

Genus 23. **Vogtia** Kölliker, 1853

Hippopodiidae with several pairs of similar and facetted nectophores either smooth walled or bearing tubercle-like spines.

Of the five species of *Vogtia* so far known — *V pentacantha* Kölliker, 1853; *V spinosa* Keferstein & Ehlers, 1861; *V glabra*

Bigelow, 1918; *V. serrata* Moser, 1925 and *V. kuruae* Alvarino, 1967, the first four are considered to be valid. *V. kuruae* rsembles *V. serrata* in its shape, size and structure. It is observed that among the species of *Vogtia* there are considerable variations in (1) the amount and kind of spinosity from specimen to specimen (2) the shape and morphological features in the first (oldest) to the last (youngest) of a series of nectophores and (3) the degree of contraction of the nectosac on preservation (Totton, 1965).

Both *V. serrata* and *V. kuruae* are cold deep water species and it is probable that *V. kuruae* is a young (developing) nectophore of *V. serrata.*

Type Species: *V pentacantha* Kölliker, 1853.

Of these, the first three *V. pentacantha V. spinosa* and *V. glabra* occur all over the Indian Ocean while *V. serrata* occurs only near south east coast of Africa.

Key to spcies of **Vogtia**

1.	Nectophores pentagonal and facetted..	2
	Nectophores elongated and triangular, or smooth and rounded with pointed apex..	3
2.	With spines on facets and on edges..	*spinosa*
	With spines only on edges, facets smooth..	*pentacantha*
3.	Nectophores elongated and triangular with hollows under lateral corners with smooth facets and edges..	*serrata*
	Nectophores smooth and rounded with a pointed apex with two prominences above ostium.. ..	*glabra*

32. **Vogtia spinosa** Keferstein & Ehlers, 1861
(Fig. 39, a–d)

Vogtia spinosa Kefertein & Ehlers, 1861, p. 24, pl. 5, fig. 16.

Vogtia spinosa Bigelow, 1911, p. 210, pl. 15, fig. 5–12.

Vogtia spinosa Daniel, 1974, p. 98, Text-fig. 8 A & B.
(cf. for detailed synonymy)

Type Specimen: Place of deposit not known from literature.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 10 n. *Bay of Bengal:* 6 n. *South West Indian Ocean:* 6 n. *South East Indian Ocean:* 11 n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 9 n. *Bay of Bengal:* 1 n. *South East Indian Ocean:* 17 n.

Nectophore: Larval nectophore caducous. Definitive nectophores occur in a series of one to several pairs, all similar in shape and structure. Nectophores short, pentagonal, prismatic, 11.7 mm

–15.0 mm long, 16.5 mm–20 mm wide, with pointed tip at anterior end; dorsal facet produced into flared out pointed tips at lateral ends; dorsal, lateral facets and ridges bear varying number of tubercle-like characteristic spines; ventral facet smooth; devoid of spines. Base of nectophore below nectosac produced into two clefts as in *H. hippopus*.

Somatocyst simple, thin, thread-like and unbranched as in *H. hippopus*. Nectosac large, round with large round ostium; lateral

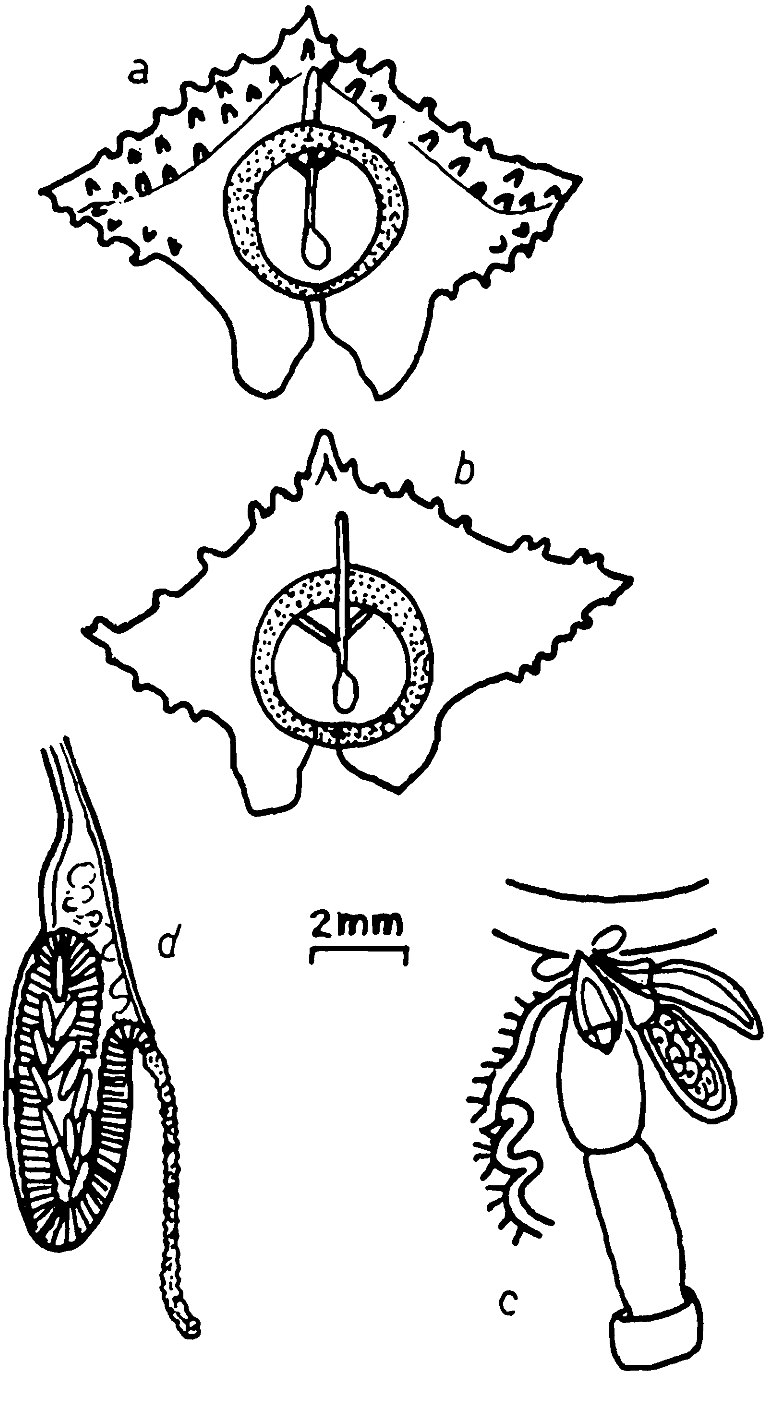


FIG. 39. *V. spinosa* Keferstein & Ehlers (a–d). a & b. nectophore-dorsal & ventral views; c. cormidium; d. tentillum.

radial canals arise at different points from dorsal radial canal. *Rete mirabele* on ventral radial canal, covering entire upper surface of nectosac in young nectophore; as two lateral wings in older nectophores.

Gastrozooids with short stalks, pink in colour, tentacles bearing bright yellow to brick-red tentilla in life. Both male and female gonophores present in each cormidium as in *H. hippopus*.

Type locality: Coast of Brazil.

Distribution: (Maps 33 & 34). The maps 33 and 34 show the distribution of this species in the different zones of the Indian Ocean.

V. spinosa occurred at very few stations, during both the seasons in the Arabian Sea and South East Indian Ocean while it was not collected during SW/SE monsoon seaons in the Bay of Bengal and during NE/NW monsoon season in the South West Indian Ocean. In the Arabian Sea it was collected in the central region during August and off Somali coast during January. In the Bay of Bengal it occurred in the Andaman and Burma region during October. In the South West Indian Ocean it occurred along the African coast and in the Oceanic region during October. In the South East Indian Ocean it occurred only in the oceanic region during September (11–25 nectophores per haul) and December.

33. **Vogtia pentacantha** Kölliker, 1853
(Fig. 40, a, b)

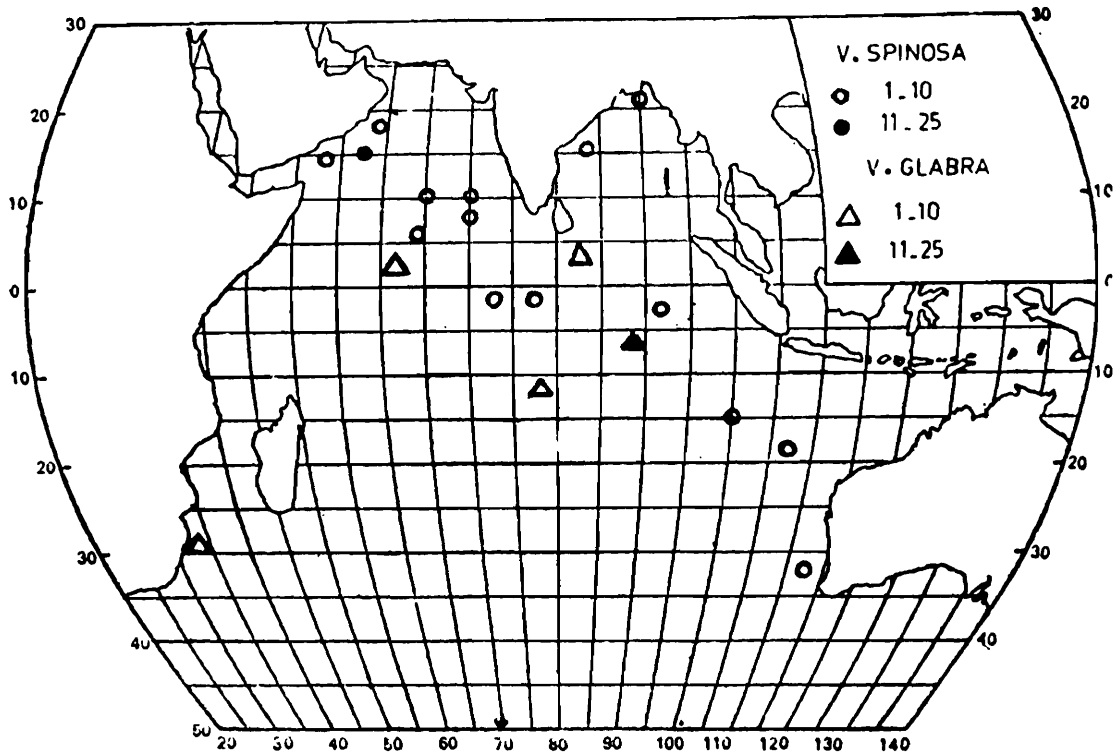
Vogtia pentacantha Kolliker, 1853, p. 31, pl. VIII.
Vogtia pentacantha Daniel, 1974, p. 99, Text–fig. 8, C & D.
(cf. for detailed synonymy)

Type Specimen: Place of deposit not known from literature.

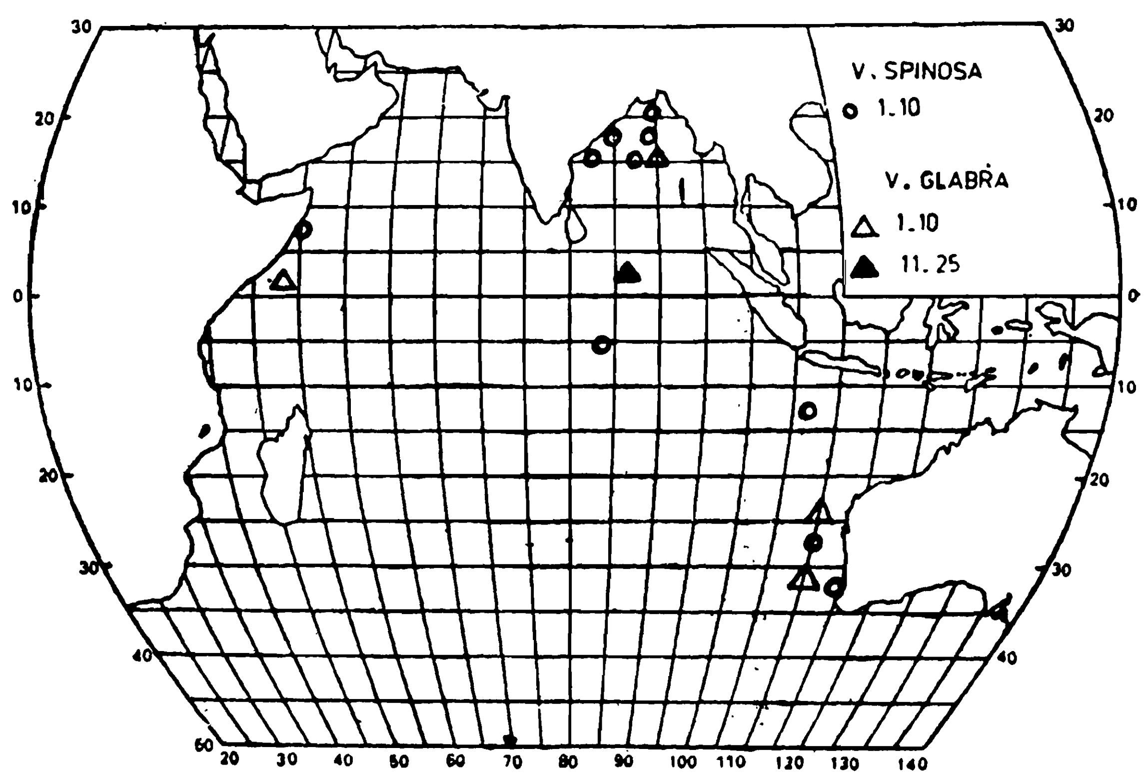
Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 69 n. *Bay of Bengal:* 194 n. *South West Indian Ocean:* 20 n. *South East Indian Ocean:* 10 n. NORTH EAST/NOTH WEST MONSOON SEASON: *Arabian Sea:* 62 n. *Bay of Bengal:* 232 n. *South East Indian Ocean:* 32 n.

Definitive nectophore: 13.0 mm long, 15.3 mm broad. Similar to *V. spinosa*, nectophores pentagonal in shape, prismatic, and lateral tips not prolonged into wings; all facets smooth devoid of spines; with characteristic spines only at edges (ridges) of facets.

Somatocyst, hydroecium, stem as in *V spinosa* and gonophores as in *V spinosa* and *H. hippopus.*



MAP 33. Distribution of *V. spinosa* and *V. glabra* during SW/SE monsoon season.



MAP 34. Distribution of *V. spinosa* and *V. glabra* during NE/NW monsoon season.

Type locality: Messina, Mediterranean Sea.

Distribution: (Maps 35 & 36). The distribution and abundance of (loose nectophores and few colonies) of *V pentacantha* in the two seasons in the different zones in the Indian Ocean are presented in maps 35 and 36. *V pentacantha* occurred in abundance in the Bay of Bengal and Arabian sea during both the seasons. It was rarely collected south of the Equator. Its distribution extended from 25°N latitude to 17°S latitude in the mid-ocean and 14°S latitude along 110°E longitude. It was not collected in the South

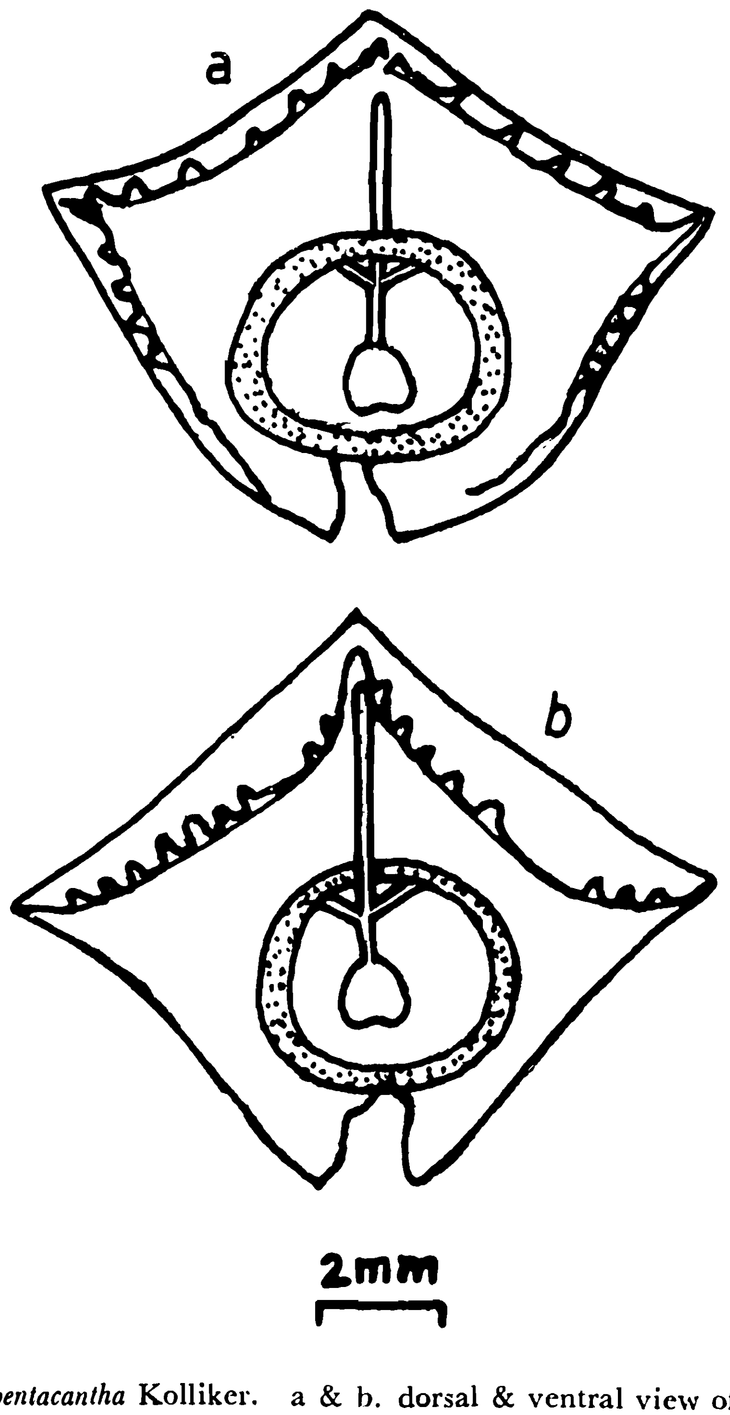
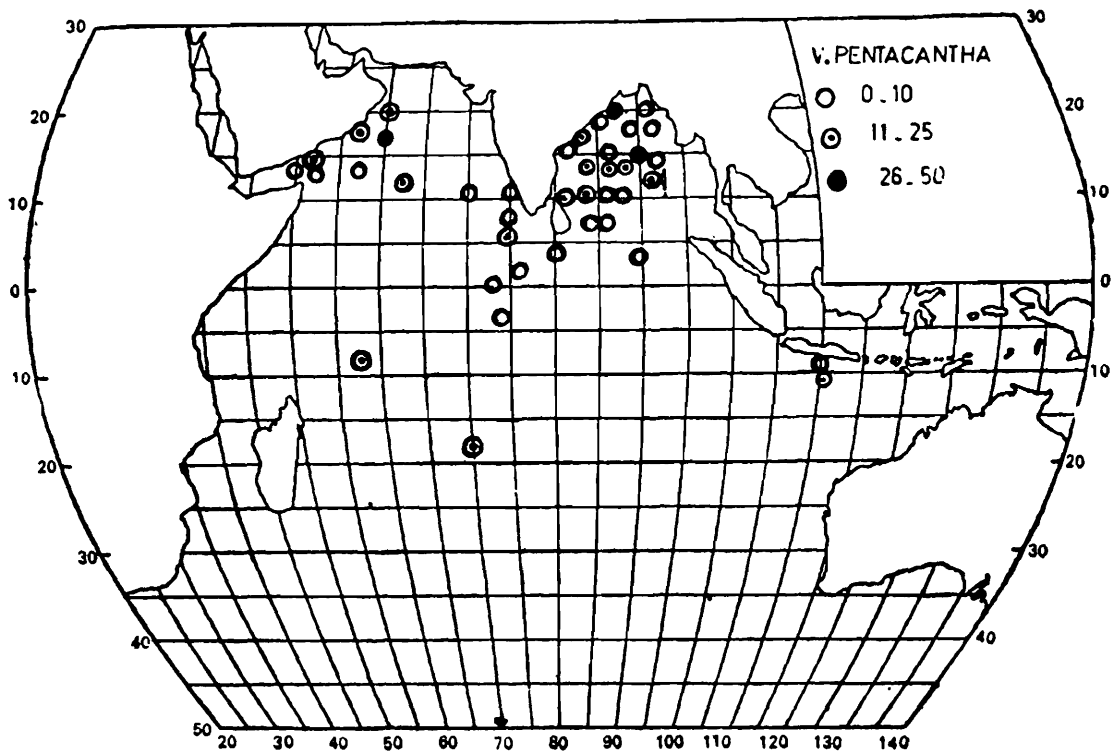
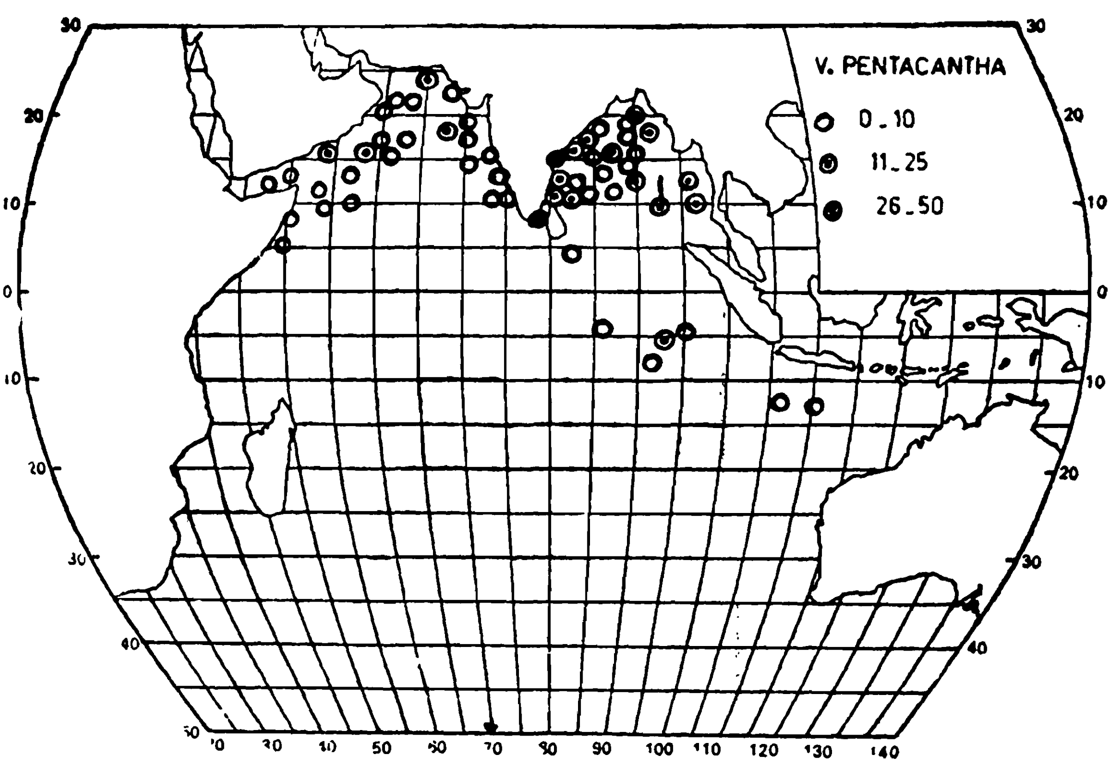


FIG. 40. *V. pentacantha* Kolliker. a & b. dorsal & ventral view of nectophore.



MAP 35. Distribution of *V. pentacantha* during SE/SW monsoon season.



MAP 36. Distribution of *V. pentacantha* during NE/NW monsoon season.

West Indian Ocean during the NE/NW monsoon season. In the Arabian Sea and Bay of Bengal, few stations recorded maximum density of 26–50 nectophores per haul. Usually only 1–10 or 11–25 nectophores per haul were collected.

Arabian Sea: Except in January, February and September, *V. pentacantha* was collected at few stations in the western part covering Somali coast, Gulf of Aden and Arabian coast during July and December. In the eastern part it was collected during February and March, at a few stations during April, May, August, October and November.

Bay of Bengal: In the central region (except in October and November) *V. pentacantha* was recorded throughout the year especially during April. Near the Andaman Islands it was recorded during April, and it was rarely collected during March, July and September.

South West Indian Ocean: It was recorded near the African coast. In the oceanic region it was recorded at few stations during April, June and July.

South East Indian Ocean: Along the 110°E longitude, south of Java it was collected at one station each during January, February, April and July. In the Oceanic region it was collected only during December.

34. **Vogtia glabra** Bigelow, 1918
(Fig. 41, a)

Vogtia glabra Bigelow, 1918, p. 407, pl. 4, figs. 2–7.
Vogtia glabra Daniel, 1974, p. 100, Text–fig. 8, E & F. (cf. for detailed synonymy).

Type Specimen: U. S. National Museum, U.S.A.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 12 n. *Bay of Bengal:* 2 n. *South West Indian Ocean:* 6 n. *South East Indian Ocean:* 8 n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 2 n. *Bay of Bengal:* 9 n. *South East Indian Ocean:* 13 n.

Definitive nectophore: 4.0 mm–15.2 mm in length, 3.17–13.0 mm in breadth — (*i.e* longer than broad resembling young nectophores of *H. hippopus*). Lateral sides not prolonged into pointed tips as in *V. spinosa* and *V pentacantha;* apically produced into a pointed (or slightly blunt) tip. With two rounded prominences above ostium.

Somatocyst, radial canals in nectosac, hyrdoecium, stem and cormidia as in other *Vogtia* spp. Nectosac not as large as in *V. spinosa* and *V. pentacantha* but deeper and smaller.

Type locality: Straits of Florida (25° 34′ N. lat.; 79° 24′ W long.)

Distribution and seasonal variations: (Maps 33 & 34).

V glabra is a rare species and its distribution in the different zones of the Indian Ocean is presented in maps 33 & 34.

V glabra occurred during both the seasons in all the zones except in South West Indian Ocean where it did not occur during NE/NW monsoon season. In the Arabian Sea it was recorded at 7 stations during SW/SE monsoon of which 4 were located in the central region (during May) and 3 along the Arabian coast (during June & July). During NE/NW monsoon season it occurred at one station located along the Somali coast during December. In the Bay of Bengal it occurred during January, March and April.

In the South West Indian Ocean *V glabra* occurred in the oceanic region during October. In the South East Indian Ocean it occurred off Western Australia and in the Oceanic region during February, April, June, August, September and October.

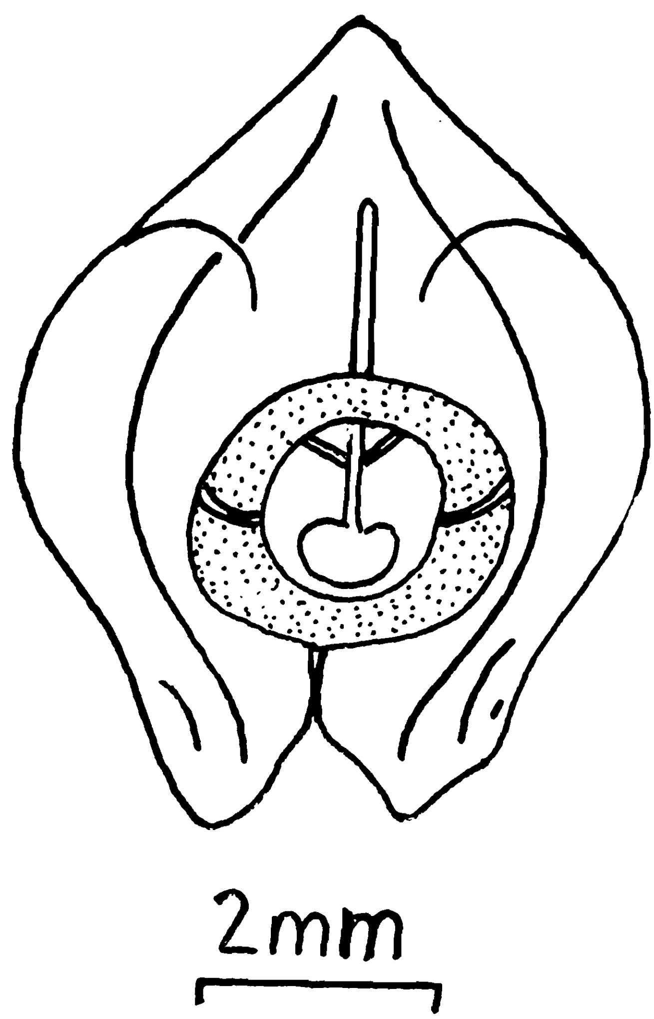


FIG. 41. *V. glabra* Bigelow; dorsal view of nectophore.

Family XII: DIPHYIDAE Quoy & Gaimard, 1827.

Calycophorae with two subequal, dissimilar nectophores placed one behind the other; anterior nectophore pyramidal or smooth with blunt apex, possessing somatocyst, with or without ridges, ostial teeth and hydroecium; posterior nectophore with apical prolongation which fits into hydroecium of anterior nectophore or truncated when hydroecium is absent. Cormidia separate as free swimming eudoxids which may have special nectophores.

Only two sub-families, Sulculeolariinae Totton, (1954) and Diphyinae Moser (1925) are recognised.

Key to subfamily of DIPHYIDAE

Nectophores smooth, blunt at apex and devoid of ridges...	Sulculeolariinae
Nectophores with pointed tip and ridges..	Diphyinae

Subfamily (i) SULCULEOLARIINAE, Totton, 1954

Monotypic subfamily for the genus *Sulculeolaria* Blainville, 1830.

Genus 24. **Sulculeolaria** Blainville, 1830

Sulculeolaria Blainville, 1830, p. 60.

Galeolaria Blainville, 1830 (preoccupied — Lamarck, 1818)

Galetta Stechow, 1921, p. 248.

Sulculeolariinae with anterior nectophores apically blunt, smooth, devoid of ridges; ostial teeth varying in number or absent; hydroecium absent; with large wing-like divided mouth plates. Posterior nectophore sub-cylindrical in shape with truncated apical end, undivided mouth plate and looped lateral radial canals.

Totton (1954) has given a detailed historical account of the different species of *Sulculeolaria* and showed that at least three species: *Diphyes biloba* Sars, 1846; *D. turgida* Gegenbaur, 1853; *Galeolaria chuni* Lens & van Riemsdijk, 1908 and probably a fourth species *Sulculeolaria angusta* Totton, 1954, have been described under the name of *G. australis* Quoy & Gaimard, 1834. Bigelow & Sears (1937), Totton (1954) have shown that *S. quadridentata* Quoy & Gaimard, 1834 is a synonym of *S. quadrivalvis* Blainville, 1830. Previous workers have used the generic name *Galetta* for species without teeth around the ostium of anterior nectophore (Leloup, 1955a) and *Sulculeolaria* for species with teeth around the ostium (Totton, 1954, p. 101) but Totton (1965) used the latter name for all the species. Till 1965 only 7 valid species of *Sulculeolaria* were known (Totton 1965; Daniel, 1974) as follows:

1 *S. quadrivalvis* Blainville, 1830 (=*S. quadridentata* Quoy & Gaimard, 1834). 2. *S. biloba* (Sars, 1846). 3. *S. turgida* (Gegenbaur, 1853). 4. *S. angusta* Totton, 1954. 5. *S. chuni* (Lens & van Riemsdijk, 1908). 6. *S. monoica* (Chun, 1888). 7. *S. bigelowi* (Sears, 1950).

To this list, three species, *S. brintoni* Alvarino, 1968; *S. pacifica* Stepanjants, 1973* and *S. tropica* Zhang, 1980 were added; the first from the Gulf of Thailand and South China Sea, the second from the North Pacific Ocean and third from the Tropico-Equatorial Western Pacific Ocean.

S. brintoni resembles *S. quadrivalvis* in many featues such, as shape, size, long somatocyst, two dorsal ostial teeth and differs from it in some minor variable characters such as the shape of basal plates (mouth-plates), lateral canals extending upto upper one-fourth of nectosac, and connected with the ventral canal; left commissural canal being shorter than the right. In *S. quadrivalvis* considerable morphological variations have been noted. There are anterior nectophores without ostial teeth, with only a pair of dorsal teeth and with both dorsal and lateral pairs of teeth (=*S. quadridentata*) and intermediate forms (Totton, 1965; Daniel, 1974). Even the position, origin and length of commissural and lateral canals vary according to the rank of the anterior nectophore and due to preservation.

Further, the studies on the embryology and growth stages of *S. chuni*, *S. turgida* and *S. quadrivalvis* reared in the laboratory at Villefranche, (Mediterranean Sea) by Carré, (1979) have shown morphological variations in the successively budded anterior nectophores relating to the rank of the nectophore. Thus these variations have led to the description of new species. Therefore, *S. brintoni* Alvarino, 1968, is considered as a synonym of *S. quadrivalvis* Blainville, 1830.

According to Zhang (1980), *S. tropica* is closely related to *S. bigelowi* (Sears, 1950) from which it is distinguished in the ventral canal being complete and not divided into two before entering the ring canal as in *S. bigelowi;* lateral radial canal entering the ventral canal instead of directly joining the ring canal as in *S. bigelowi* and the ventro-basal facet being smaller about one third to half as long as total length of nectophore (including the mouth-plates) and mouth-plates with slightly pointed distal edges while in *S. bigelowi* the ventro-basal facet is very olique, large and wide about half as long as the nectophore (excluding the exceptionally long mouth-plates) and mouth-plates with rounded distal edges.

*Author is unable to comment upon *S. pacifica* Stepanjants (1973) due to lack of the original reference: "Galettinae (Diphyidae - Siphonophora 300 YPH. **52**(5), 649-658 (In Russian).

However, *S. tropica* resembles *S. angusta* Totton, 1954, more than *S. bigelowi* in the general shape and size of the nectophore, shape and size of the ventro-basal facet, minute somatocyst (0.C4 mm or slightly more, in both the species), no commissural canals, ventral canal not dividing into two and mouth-plates having rounded, pointed distal edges. Confusion has risen mainly because Totton (1965) p. 149 had not drawn the lateral radial canals in his text-figure 89 of *S. angusta* although it is present and Zhang pointed out the apparant absence of the lateral canals as a mark of difference between the two species. Therefore, *S. tropica* Zhang, 1980, is treated as a synonym of *S. angusta* Totton, 1954. Carré, (1979) considered *S. angusta* as a synonym of *S. turgida*, but the posterior nectophore differs from those of *S. turgida*.

Key to species of **Sulculeolaria**

Anterior nectophore:

1.	Nectophores elongated..	2
	Nectophore conical in side view with broad oblique base..	*bigelowi*
2.	Ostial teeth absent.	3
	Ostial teeth present..	4
3.	Somatocyst long.	*chuni*
	Somatocyst small..	5
4.	With two dorsal ostial teeth.	*quadrivalvis*
	With three dorsal ostial teeth.	*monoica*
5.	With commissural canals...	6
	Without commissural canals.	*angusta*
6.	With a pair of exceptionally long commissural canals arising from lateral radial canals..	*biloba*
	With short commissural canals..	*turgida*

Posterior Nectophore:

1.	Nectophores with ostail teech...	2
	Nectophores without ostial teeth..	3
2.	With two dorsal ostial teeth....	*quadrivalvis*
	With three dorsal ostial teeth.	*monoica*
3.	Mouth-plate either with two side-pieces or emarginated distally..	4
	Mouth-plate unidivided, with round margin.	*turgida*
4.	Mouth-plate emarginate distally..	5
	Mouth-plate with two side-pieces and a central thickening..	*biloba*
5.	Mouth-plate long, thicknened proximally with a small prominence..	*angusta*
	Mouth-plate thin, with a notch at the distal edge....	*chuni*

Seven species are recorded in the Indian seas.

35. **Sulculeolaria quadrivalvis** Blainville, 1830

(Fig. 42, a, b)

Sulculeolaria quadrivalvis Blainville, 1830, p. 126.

Galeolaria quadridentata Quoy & Gaimard, 1834, p. 45, pl. 5, figs. 32, 33.

Sulculeolaria brintoni Alvarino, 1968, p. 344, fig. 3.

Sulculeolaria quadrivalvis Daniel, 1974, p. 104, Text-fig. 9, A, B & K.
(cf. for detailed synonymy)

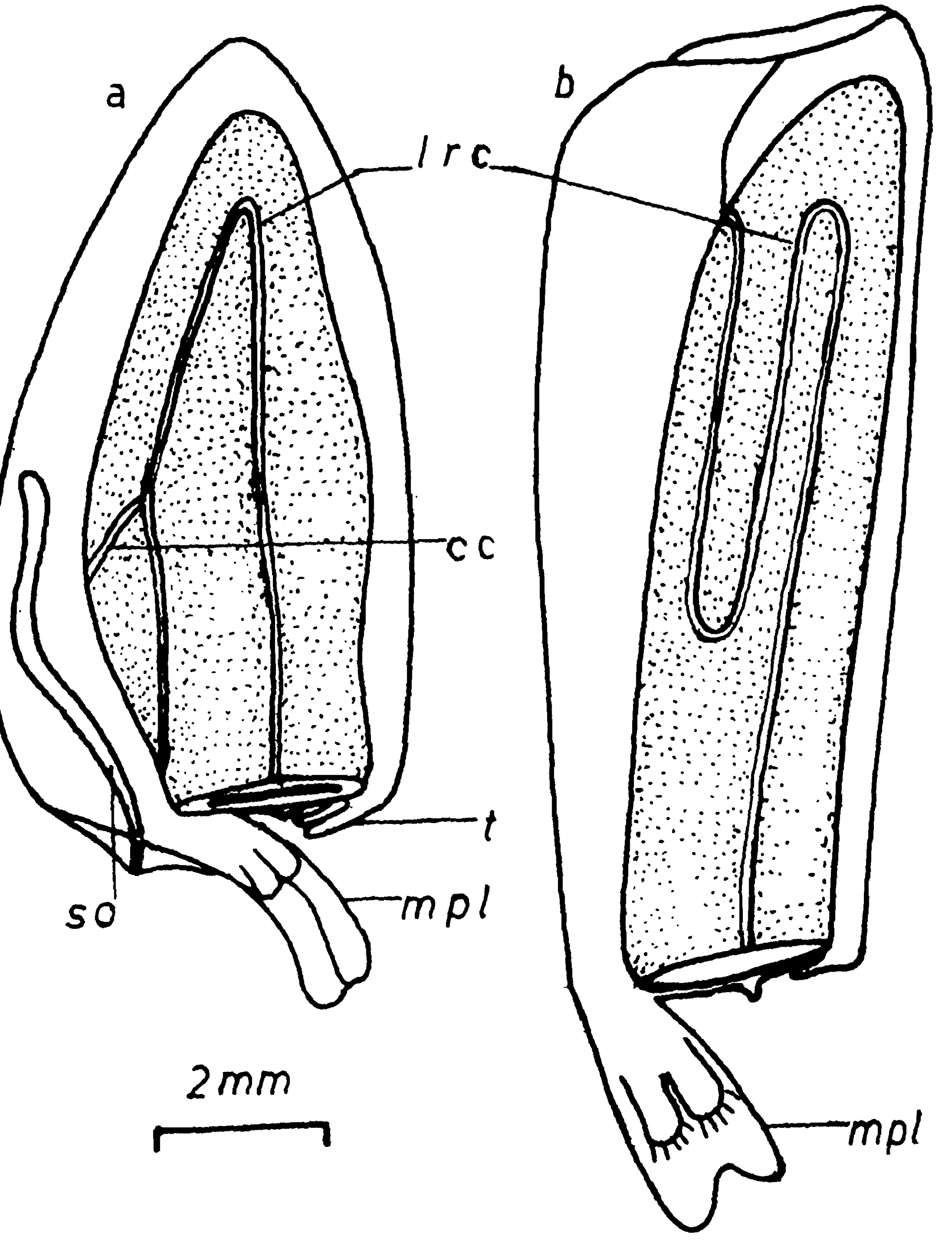


Fig. 42. S. quadrivalvis Blainville. a anterior nectophore; b. posterior nectophore; (cc-commissural canal; lrc-lateral radial canal; mpl-mouth plate; t-teeth).

Type Specimen: Museum National d'histoire Naturelle, Paris.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 23 a. n.; 29 p.n. *Bay of Bengal:* 31 a.n.; 31 p.n. *South West Indian Ocean:* 22 a.n.; 20 p.n. *South East Indian Ocean:* 18 a.n.; 14 p.n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 18 a.n.; 20 p.n. *Bay of Bengal:* 11 a.n.; 12 p.n. *South West Indian Ocean:* 15 a.n.; 15 p.n. *South East Indian Ocean:* 6 a.n.; 5 p.n.

Polygastric phase: Anterior nectophore: (Fig. 42, a) 18.0 mm in length, smooth, devoid of ridges, with blunt apex and broad base. Bidentate forms ('*quadrivalvis*') with two triangularly shaped dorsal ostial teeth—always bent or tucked inwards ostium of nectosac. Quadridentate form ('*quadridentata*') with two dorsal teeth as well as two small to large triangular lateral teeth around ostium of nectosac. Nectosac large sub-cylindrical, slightly bent, with blunt apex and well developed musculature; all canals arise near baso-ventral corner of nectosac from pedicular canal; lateral canals connected by oblique commissural canal. Hydroecium absent. Somatocyst thin, long, characteristically curved, reach upto middle of nectosac on dorsal side. Sub-ostial lamellae or mouth-plate occur as two basolateral wings due to deep division between wings; inner margin of mouth plate thick and raised into oval shaped vertical pads. Reserve buds of anterior and posterior nectophores often present.

Posterior nectophore: (Fig. 42 b) Upto 19.0 mm long, sub-cylindrical in shape, with truncated broad apical end, smooth, devoid of any ridges. Nectosac with two characteristic constrictions at right angles to one another. Two dorsal and two lateral teeth present around ostium. Lateral radial canals form a long loop extending from base to apex before joining ring-canal. Mouth-plate long, large occur as two baso-ventral wings with thickened vertical pads as in anterior nectophore. Hydroecium is a shallow open groove.

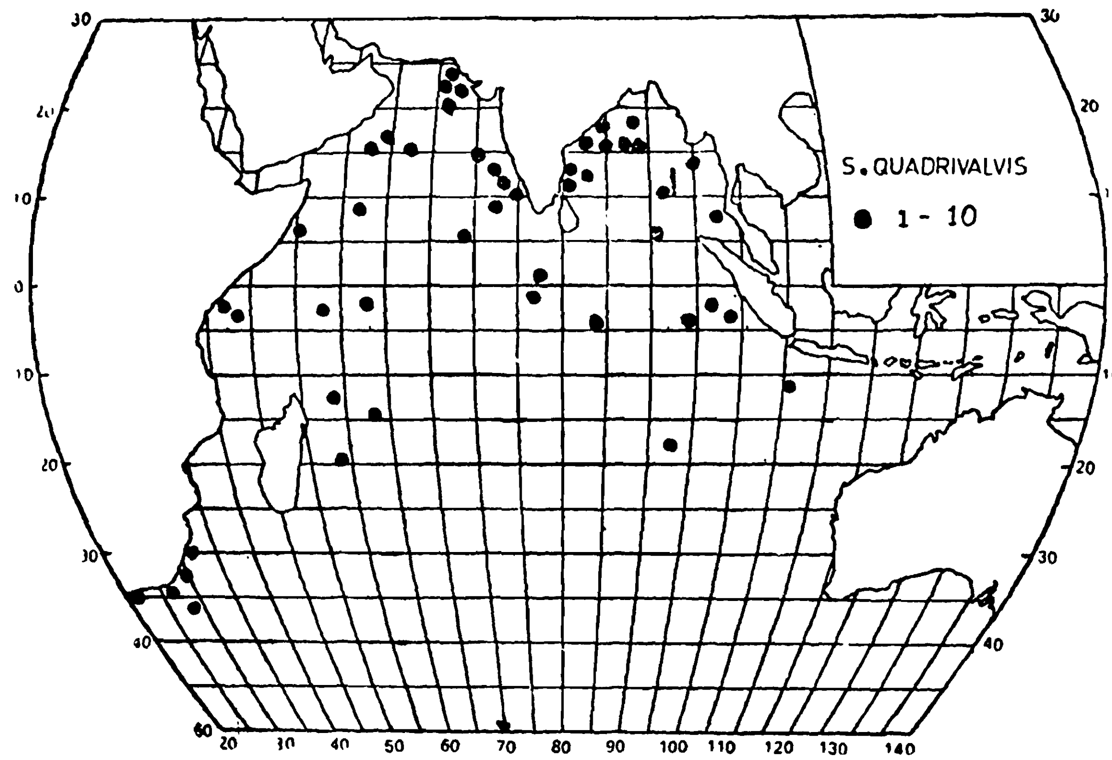
Stem: Long, bearing numerous (nearly 200) cormidia.

Eudoxid phase: male and female gonophores borne on separate colonies (Vogt, 1854, p. 112). Manubrium of male gonophores — vermillion and female colourless.

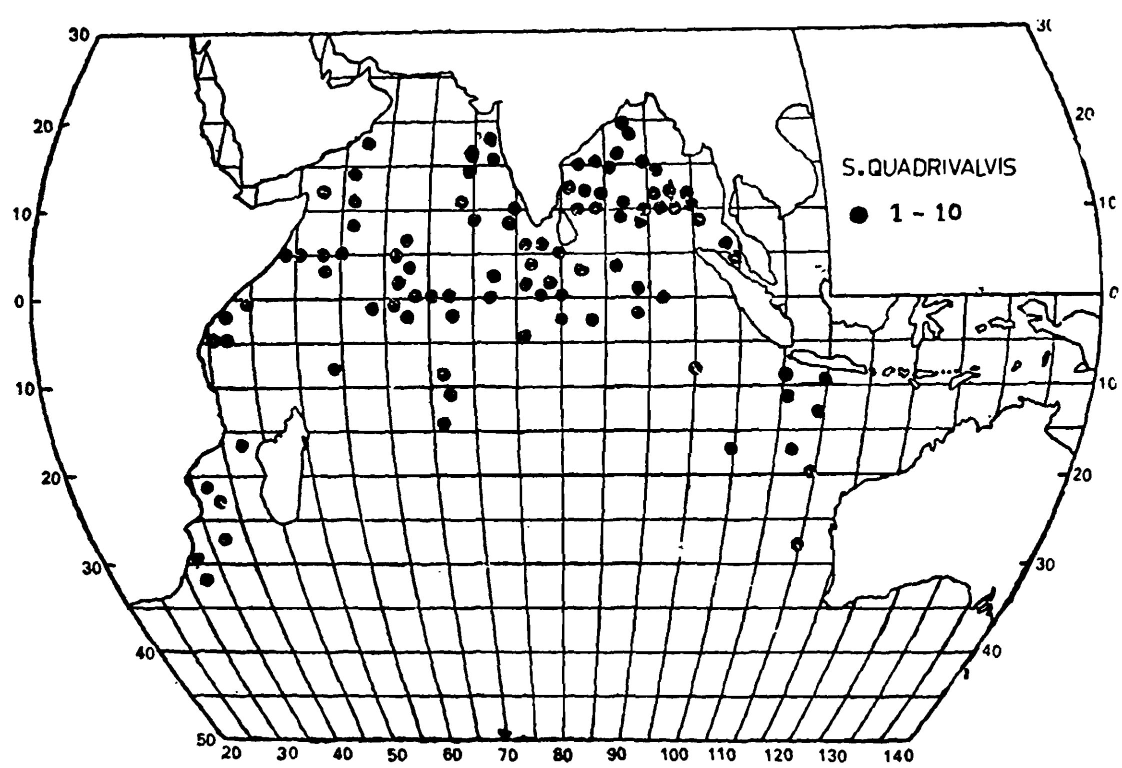
Type locality: North Sea.

Distribution: (Maps 37 & 38). The distribution and occurrence of *S. quadrivalvis* in the Indian Ocean are presented in maps 37 and 38.

S. quadrivalvis occurred in greater abundance during the SW/SE monsoon season than during NE/NW monsoon season. There was no marked variation in the number of night/day collections except in the Arabian Sea where the day catches were more during SW/SE monsoon season than in the NE/NW monsoon season. During



MAP 37. Distribution of *S. quadrivalvis* during SW/SE monsoon season.



MAP 38. Distribution of *S. quadrivalvis* during NE/NW monsoon season.

SW/SE monsoon season the distribution of *S. quadrivalvis* extended from 25°N to 32°S latitude along the African coast and 30°S along the 110°E longitude. In the mid-ocean it extended down to 15°S. During NE/NW monsoon season however, it extended from 25°N latitude in the Arabian Sea, to 35°S latitude along the African coast and 20°N in the Bay of Bengal to 12°S latitude south of Java (*vide* maps 37 & 38). At each station the number of specimens collected was only 1–5 or 10 per haul.

Monthly variations

Arabian Sea: In the western part (Arabian and Somali coasts and Gulf of Aden) *S. quadrivalvis* occurred at few stations during March May, June, July, August, October and December. In the eastern part (coast of Pakistan and India) it occurred in maximum number of stations during May and August, and it was not collected during June and September.

Bay of Bengal: Along the Eastern India coast and neighbouring areas it occurred in maximum number of stations during April and June, and did not occur during October. Near the Andaman Islands it occurred in a number of stations during September. It was rare during March, April, August and October.

South West Indian Ocean: Along the African coast it was collected mostly during January and June and was not present during November. In the Oceanic region it occurred at few stations during each month except in July, October and November.

South East Indian Ocean: Along the 110°E longitude it occurred at few stations during February, April, May and September. In the Oceanic region it occurred during April, May, July, September, October and December.

36. **Sulculeolaria biloba** (Sars, 1846)
(Fig. 43, a–c)

Diphyes biloba Sars, 1846, p. 45, taf. 7, figs. 16–21.
Sulculeolaria biloba Daniel, 1974, p. 106, Text-fig. 9; L.M & N.
(cf. for detailed synonymy)

Type Specimen: Place of deposit not known from literature.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 14 a. n.; 9 p.n. *Bay of Bengal:* 7 a.n.; 6 p.n. *South West Indian Ocean:* 4 a. n.; 3 p.n. *South East Indian Ocean:* 12 a.n. 11 p.n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 7 a. n.; 8 p.n. *Bay of Bengal:* 9 a.n.; 8 p.n. *South West Indian Ocean:* 3 a. n.; 4 p.n. *South East Indian Ocean;* 18 a. n.; 18 p.n.

Polygastric phase: Anterior nectophore: Large 26 mm long, similar to *S. quadrivalvis* in shape, absence of ridges and hydroecium. Somatocyst short, ovoid, with long axis oblique. Dorsal side, with a tooth-like projection extending beyond level of ostium. Lateral teeth absent. Mouth-plates long, broad, divided without vertical thickened pads. Characteristic pit-like depression at base of somatocyst. Oblique commissural canal exceptionally long join-

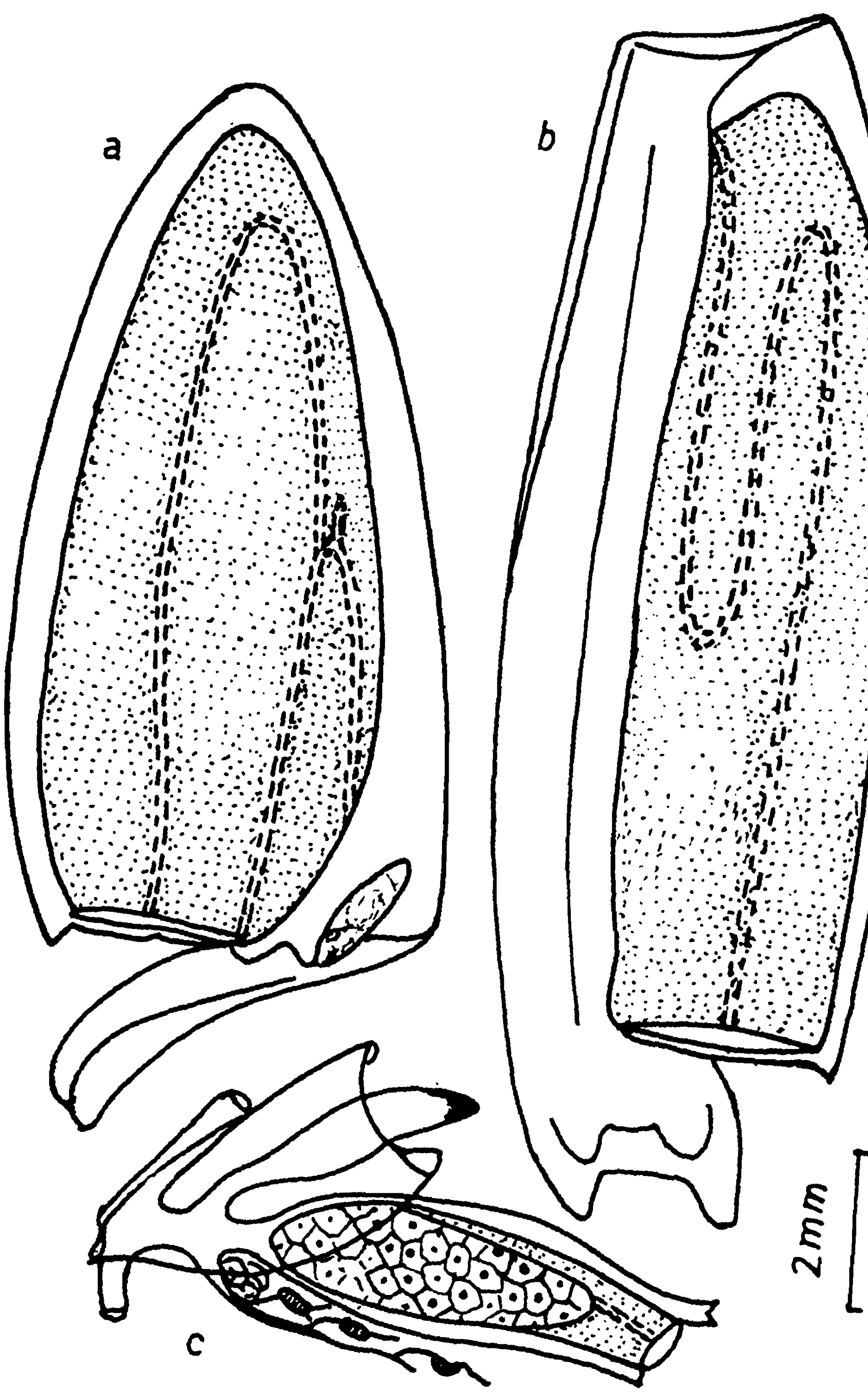


FIG. 43. *S. biloba* (Sars) (a–c). a. anterior nectophore; b. posterior nectophore; c. cormidium. (Fig. c. from Totton, 1965, fig. 83 A).

ing lateral radial canals at mid-length of nectosac. Reserve bud of both anterior and posterior nectophores present.

Posterior nectophore: 26 mm in length, 6.5 mm in breadth. No dorsal or lateral teeth around ostium. Mouth-plate caracteristically shaped, consisting of two side pieces distinctly separated in middle by a raised thickened notch.

Stem: long, bearing numerous cormidia.

Eudoxid phase: not identified.

Type locality: North Sea.

Distribution: (Maps 39 & 40). The distribution and records of *S. biloba* in the four zones of the Indian Ocean are presented in maps 39 & 40. One to three anterior nectophores were collected per haul. *S. biloba* was collected in all the four zones of Indian Ocean during both the seasons. It occurred in greater abundance in the South East Indian Ocean. It was usually captured during the night time.

During SW/SE monsoon season, the maximum number of records were within the equatorial belt (5°N to 5°S lat.) region. Its distribution extended from 17°N latitude to 17°S latitude. During NE/NW monsoon season *S. biloba* occurred scattered all over the Indian Ocean. Its range of distribution extended from 20°N latitude to 36°S latitude along the African coast and 40°S latitude along the 110°E longitude, and 12°S latitude in the mid-oceanic region.

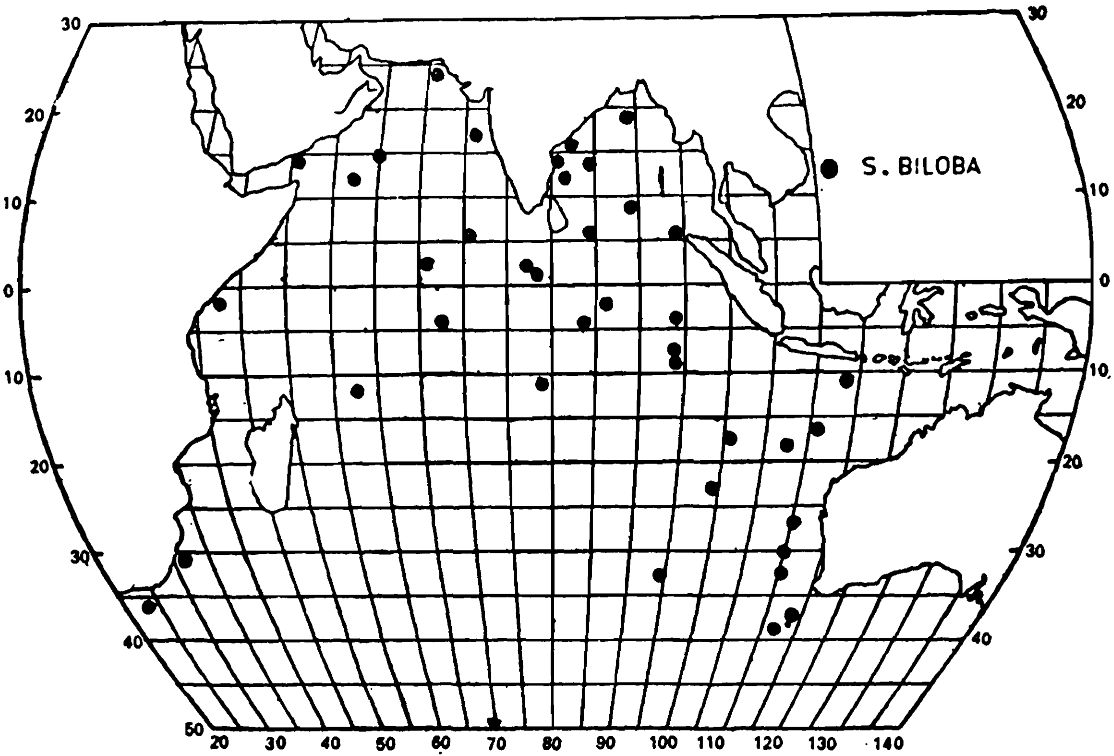
Monthly variation

Arabian Sea: On the western part *S. biloba* occurred along the Somali coast during August; in the Gulf of Aden during February and during March and May in the central region. On the eastern part it occurred off Karachi, Bombay and Goa during February, May and November. Near the Equator it occurred during January, May, August October and December.

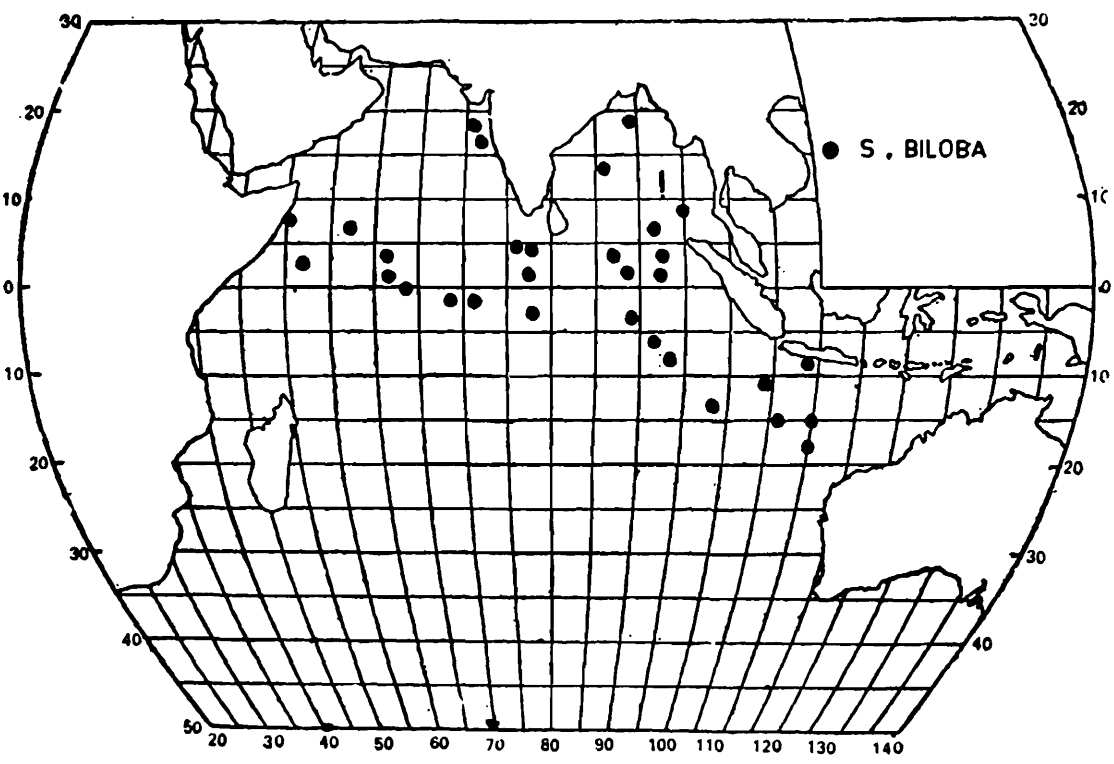
Bay of Bengal: It occurred during April and May in the central region of the Bay. Along the Indian coast it was collected during January, February, March and September. It occurred on the northern region of Sumatra during January and August. Near the Equator it was collected during June, September and December.

South West Indian Ocean: *S. biloba* was recorded at few stations during both the seasons. In the oceanic region and within the equatorial belt region it occurred during March, April, June, August, October and December. It occurred near the African coast during January.

South East Indian Ocean: In the Australian region it was recorded during January, February, March, May, July, August and September. In the oceanic region it was usually captured



MAP 39. Distribution of *S. biloba* during SW/SE monson season. 1—3 Specimens per haul.



MAP 40. Distribution of *S. biloba* during NE/NW monsoon season. 1—3 Specimens per haul.

during December. It was also collected at few stations during January, April, August, September and October.

37. **Sulculeolaria turgida** (Gegenbaur, 1853)
(Fig. 44, a–c)

Diphyes turgida Gegenbaur, 1853, p. 344, taf. XVI, figs. 12–21.
Sulculeolaria turgida Daniel, 1974, p. 107, Text-fig. 8, J & K.
(cf. for detailed synonymy)

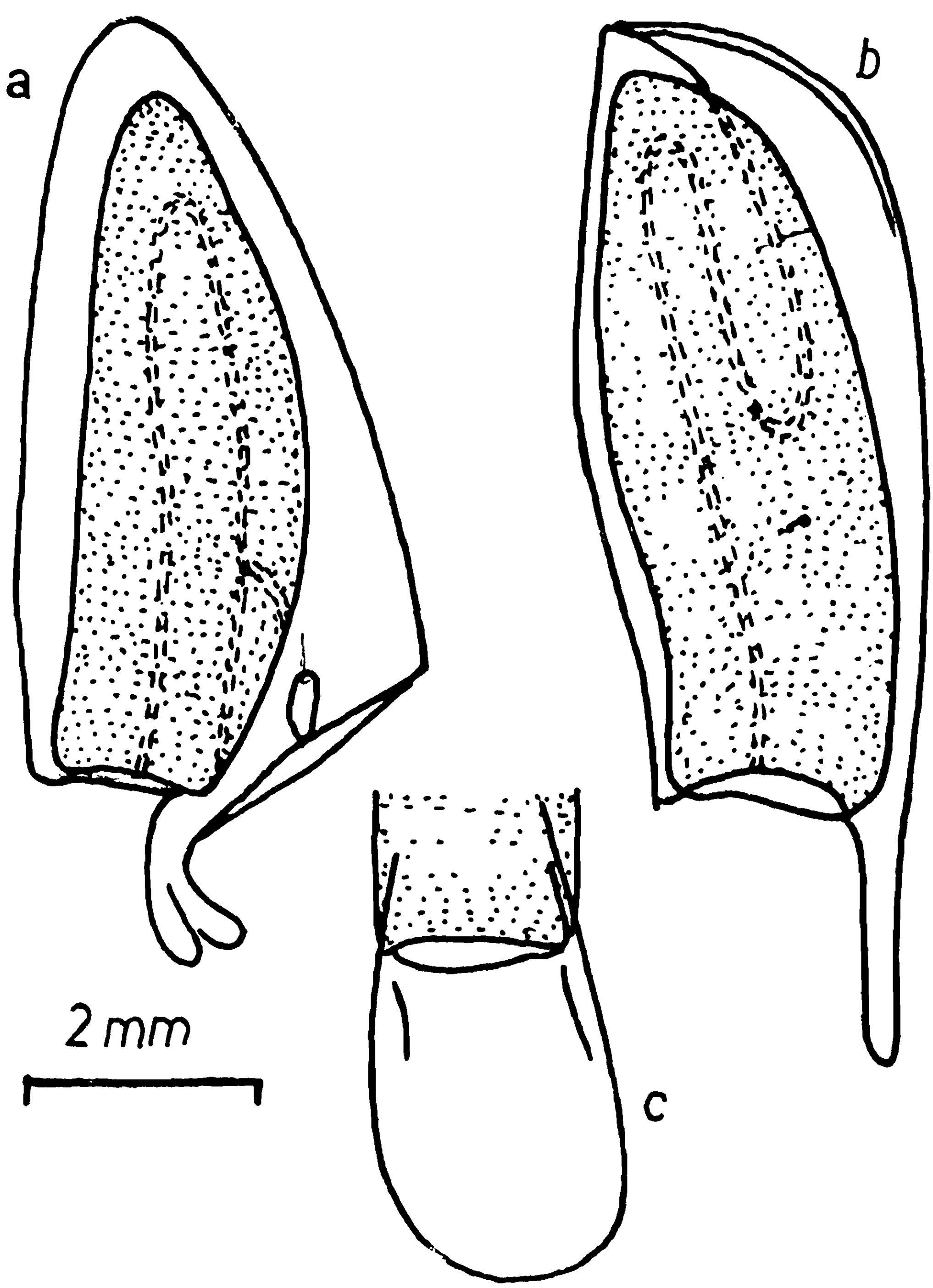


FIG. 44. *S. turgida* (Gegenbaur) (a–c). a. anterior nectophore; b. posterior nectophore; c. mouth — 'late of posterior nectophore.

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 37 a. n.; 39 p.n. *Bay of Bengal:* 21 a.n.; 22 p. n. *South West Indian Ocean:* 44 a. n.; 30 p.n. *South East Indian Ocean:* 39 a.n.; 58 p.n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 24 a. n.; 27 p.n. *Bay of Bengal:* 10 a. n.; 12 p. n. *South West Indian Ocean:* 9 a. n.; 11 p.n. *South East Indian Ocean:* 22 a.n.; 23 p.n.

Polygastric phase: Anterior nectophore: grows upto 9 mm in length and smooth, firm and blunt at apex. Ostial teeth absent. Somatocyst small 1.00 mm long. Hydroecium absent. Oblique commissural canal present.

Posterior nectophore: about 9.0 mm long, 2–3.2 mm wide. Ostial teeth absent. Hydroecium is a shallow open groove bounded by hydroecial folds. Mouth-plate 2 mm long, smooth, undivided rounded and thin, without notch in margin or thickened middle.

Stem: Both male and female gonophores occur on same stem.

Eudoxid phase: Not known.

Type locality: Messina, Mediterranean Sea.

Distribution: (Maps 41 & 42). The distribution in the four zones of the Indian Ocean during the two seasons are given in maps 41 and 42. Only 1–5 nectophores per haul were collected.

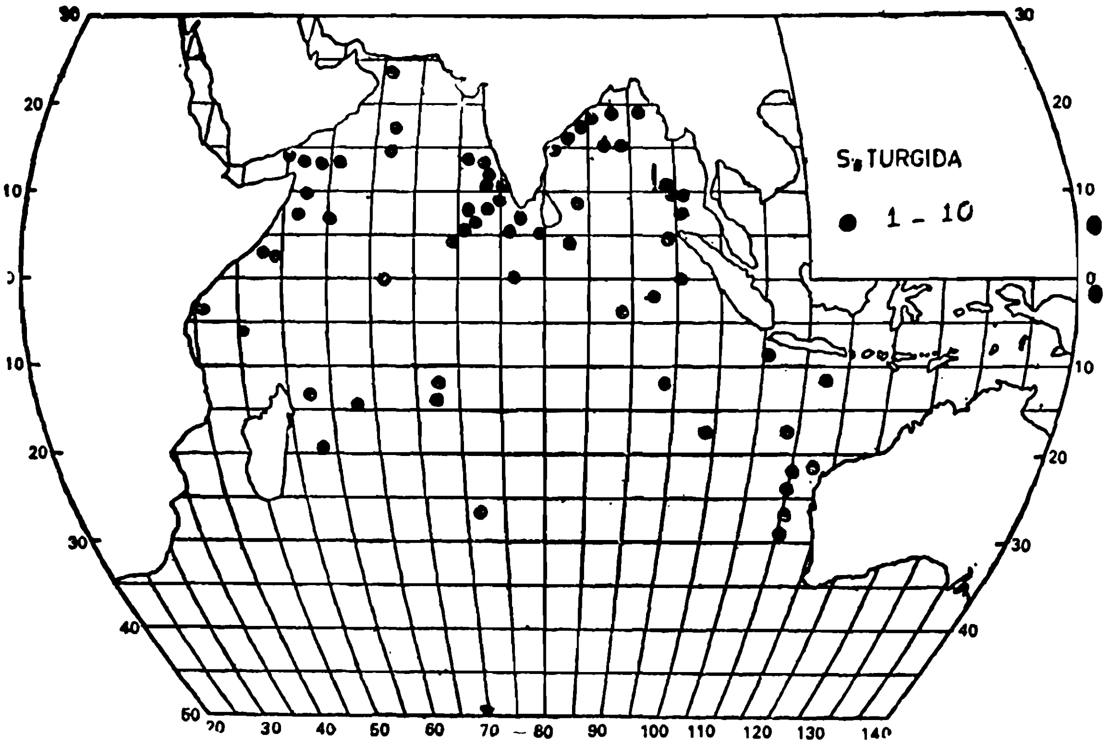
S. turgida occurred in greater numbers during SW/SE monsoon season than during NE/NW monsoon season. Usually this species was captured more during the day time.

It occurred mostly within 10°N to 10°S latitude during SW/SE monsoon season while it occurred scattered during NE/NW monsoon season. During SW/SE monsoon season its range of distribution extended from 20°N latitude to 35°S latitude along the African coast and along 110°E longitude and to 20°S in the mid-oceanic region. During NE/NW monsoon season its distribution extended from 25°N latitude to 5°S latitude along the African coast and nearly 30°S along 110°E longitude and in the mid-oceanic region.

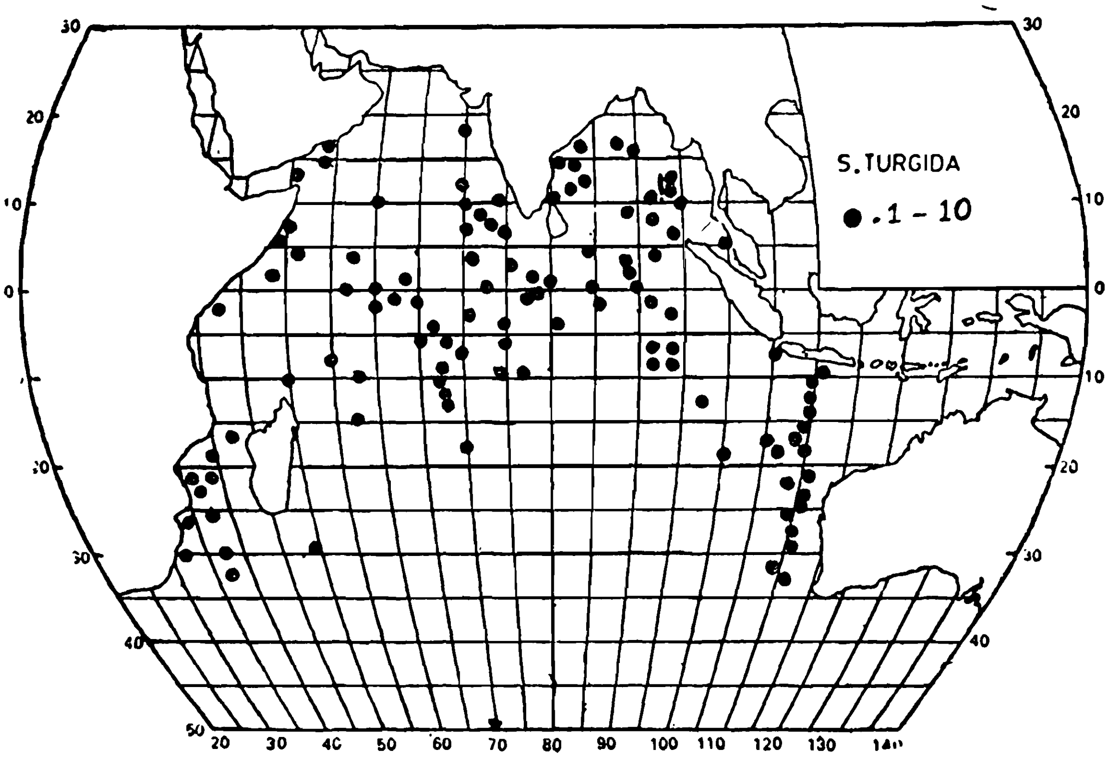
Monthly variations:

Arabian Sea: In the western part along the Arabian coast, Gulf of Aden and Somali coast *S. turgida* occurred during February, August, November and December. In the central region it occurred during March and May. In the Indian region it was collected throughout the year (except in June and September) with maximum number during May and August.

Bay of Bengal: Along the Indian coast and Sri Lanka *S. turgida* occurred during all the months excepting October and



MAP 41. Distribution of *S. turgida* during SW/SE monsoon season.



MAP 42. Distribution of *S. turgida* during NE/NW monsoon season.

November. Near Andaman Islands, Burma and Malaya it occurred at maximum number of stations during August and September and at few stations in the other months (except January, June, July and December).

South West Indian Ocean: In the African region it occurred during July and November off Mombasa and along the southern coast of Africa and Madagascar during July, August and October. In the oceanic region it occurred during all the months excepting October and November with maximum number occurring in April and June.

South East Indian Ocean: In the Australian region it occurred mainly during April, May and August (maximum). It was not collected during February, October and November. In the oceanic region it was recorded in smaller numbers in all the months except February, October and November.

38. **Sulculeolaria angusta** Totton, 1954
(Fig. 45, a–c)

Sulculeolaria angusta Totton, 1954, p. 108, Text-fig. 53.
Sulculeolaria angusta Daniel, 1974, p. 110, Text-9, C & D.

Type Specimen: British Museum, (Nat. Hist.) London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 46 a.n.; 23 p.n. *Bay of Bengal:* 17 a.n.; 11 p.n. *South West Indian Ocean:* 39 a.n.; 22 p.n. *South East Indian Ocean:* 29 a.n.; 16 p.n. NORTH WEST/NORTH EAST MONSOON SEASON: *Arabian Sea:* 31 a.n.; 11 p.n. *Bay of Bengal:* 29 a.n.; 13 p.n. *South West Indian Ocean:* 21 a.n.; 19 p.n. *South East Indian Ocean:* 21 a.n.; 12 p.n.

Polygastric phase: Anterior nectophore: 8.4 mm long, 4.0 mm wide at base, resemble *S. turgida*. Somatocyst very small 0.04–0.33 mm in length as in *S. monoica*. Hydroecium and ostial teeth absent. No commissural canals. Mouth-plates as in *S. turgida* but with roundly pointed distal edges.

Posterior nectophore: 10.0–13.5 mm long, 3.0–3.5 mm broad; long and slender. No ostial teeth. Mouth-plate 3.25 mm long, thickened proximally with a small, median prominence, margin not rounded as in *S. turgida* but with a notch. Truncated apex broad.

Eudoxid phase: Unidentified.

Type locality: Off Natal (Africa), Indian Ocean.

Distribution: (Maps 43 & 44). The records and distribution in the four zones of the Indian Ocean during the two seasons are given in maps 43 & 44. Only 1–3 nectophores per haul were collected.

S. angusta occurred in all the four zones of the Indian Ocean during both the seasons. During both the seasons in the Arabian Sea and SW/SE monsoon season in the South West Indian Ocean, the day captures were more while in the Bay of Bengal and South East Indian Ocean the night captures were more.

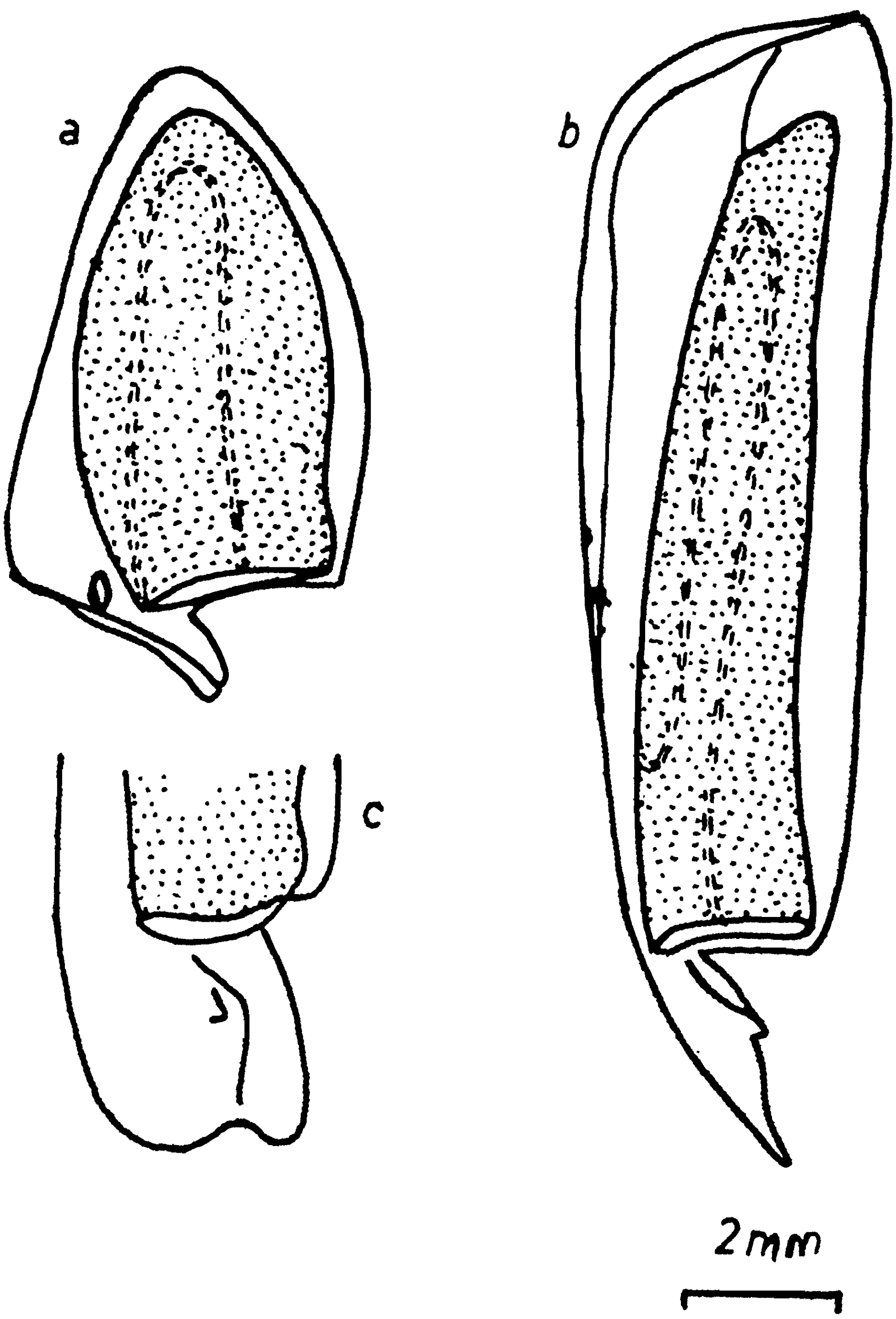
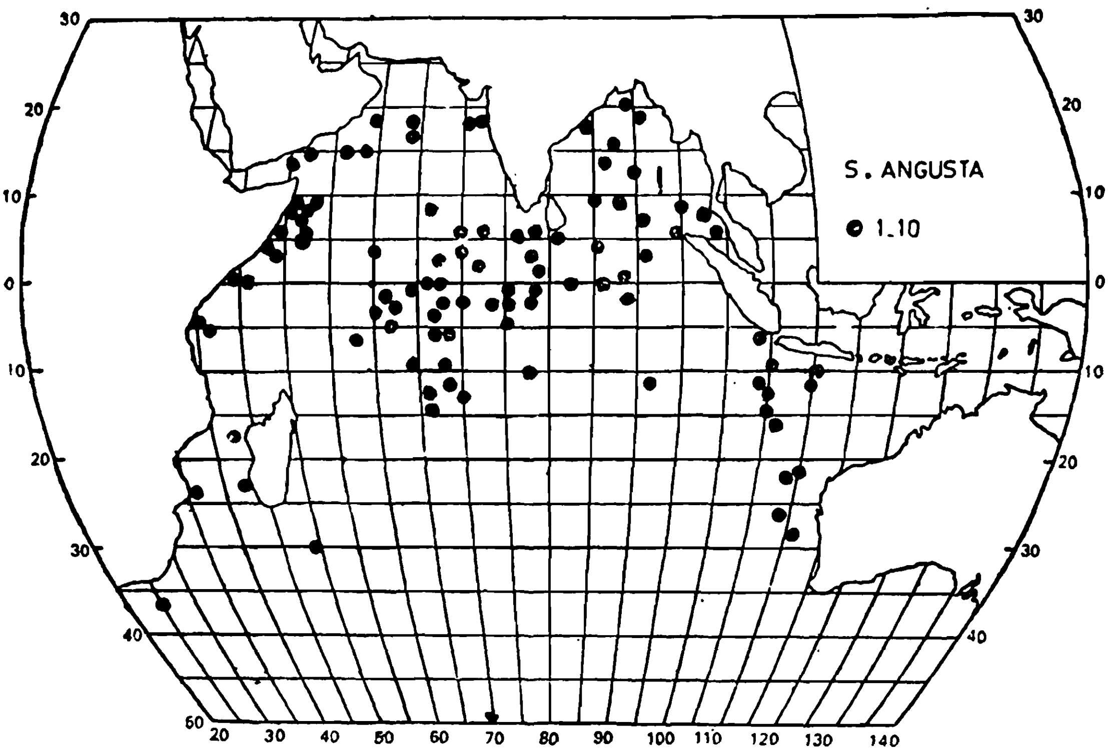
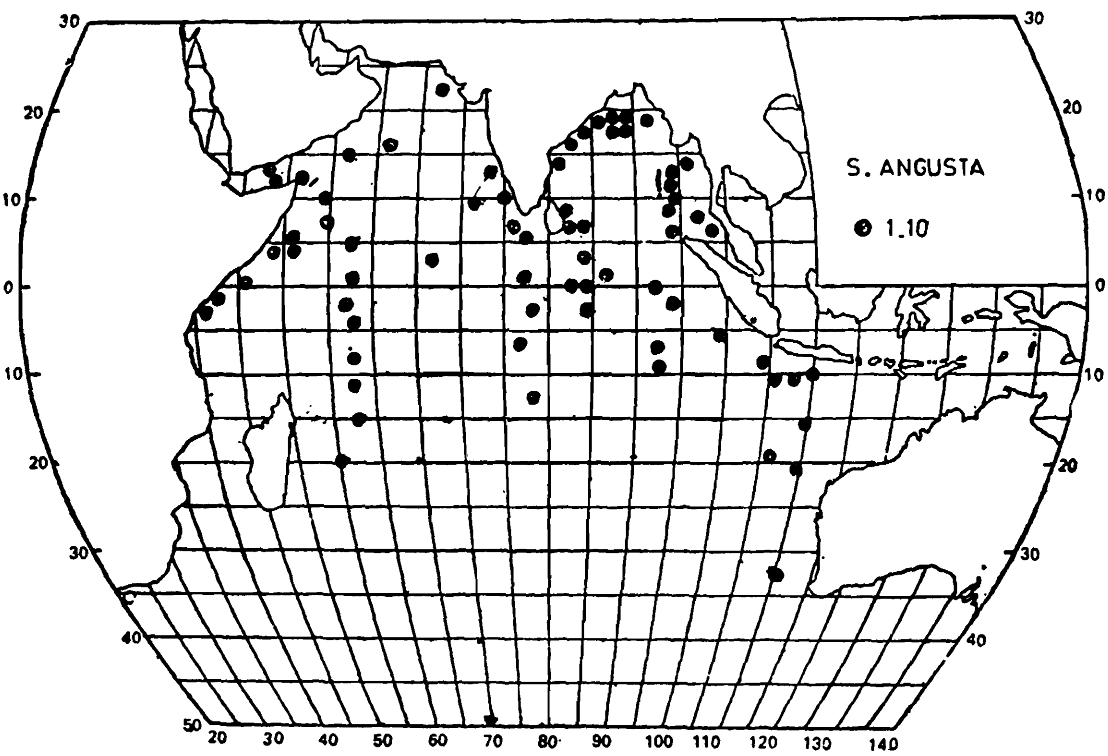


FIG. 45. *S. angusta* Totton (a–c). a. anterior nectophore; b. posterior nectophore; c. mouth plate of posterior nectophore.



MAP 43. Distribution of *S. angusta* during SW/SE monsoon season.



MAP 44. Distribution of *S. angusta* during NE/NW monsoon season.

S. angusta occurred in great numbers within 10°N to 10°S latitude. During SW/SE monsoon season its distribution extended from 20°N latitude in the Arabian Sea to 36°S latitude along the African coast and from 25°N latitude in the Bay of Bengal to 27°S latitude along 110°E longitude and 15°S latitude in the mid-ocean. During NE/NW monsoon season its distribution extended from 25°N to 5°S latitude (except one at 30°S lat.) along the African coast and 32°S latitude along 110°E longitude and to 20°S latitude in the mid-oceanic region.

Monthly variations:

Arabian Sea: In the western part *S. angusta* occurred in the Gulf of Aden and Somali coast during January, February, August, October and December. In the eastern part it occurred throughout the year (except in April) especially during May and August.

Bay of Bengal: In the Indian rgion it occurred throughout the year, especially during April (except in June and October). In the Andaman Islands and Burma regions it was collected from many stations during March, and at a few stations during February, April, August and September.

South West Indian Ocean: In the African coastal regions it occurred during January, April, July, August, October and November. In the Oceanic region it occurred throughout the year (except in February and May) with maximum number during April and June.

South East Indian Ocean: In the Australian region *S. angusta* occurred in all the months except March, October and December. In the oceanic region it was collected few times during May, August, September, October, November and December.

39. **Sulculeolaria chuni** (Lens & van Riemsdijk, 1908) (Fig. 46, a, b)

Galeolaria chuni Lens & van Riemsdijk, 1908, p. 61, pl. IX, figs. 78, 79.
Sulculeolaria chuni Daniel, 1974, p. 111, Text-fig. 8, G,H & I.
(cf. for detailed synonymy)

Type Specimen: Zoologisch Museum, Amsterdam.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 217 a.n.; 153 p.n. *Bay of Bengal:* 295 a. n.; 244 p. n. *South West Indian Ocean:* 200 a. n.; 185 p.n. *South East Indian Ocean:* 161 a.n.; 176 p. n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 160 a. n.; 135 p.n. *Bay of Bengal:* 116 a.n.; 101 p. n. *South West Indian Ocean:* 136 a. n.; 107 p.n. *South East Indian Ocean:* 108 a.n.; 92 p.n.

Polygastric phase: Anterior nectophore: Length ranges from 3.4 mm to 7.0 mm and breadth from 2.0 mm to 4.3 mm; with blunt apex devoid of ridges hydroecium and ostial teeth absent. Mouth-plates smaller than other species rounded and slightly overlapping. Somatocyst long, from 1.67 mm to 4.0 mm, thin or club-shaped lying close against nectosac. Some smaller nectophores without commissural canal but present in others.

Posterior nectophore: Lenth ranges from 6.0 mm to 9.0 mm and breadth from 2.75 to 3.25 mm; No ostial teeth. Mouth-plate or basal lamella upto 2.5 mm long and 2.75 mm wide with a deep notch at edge.

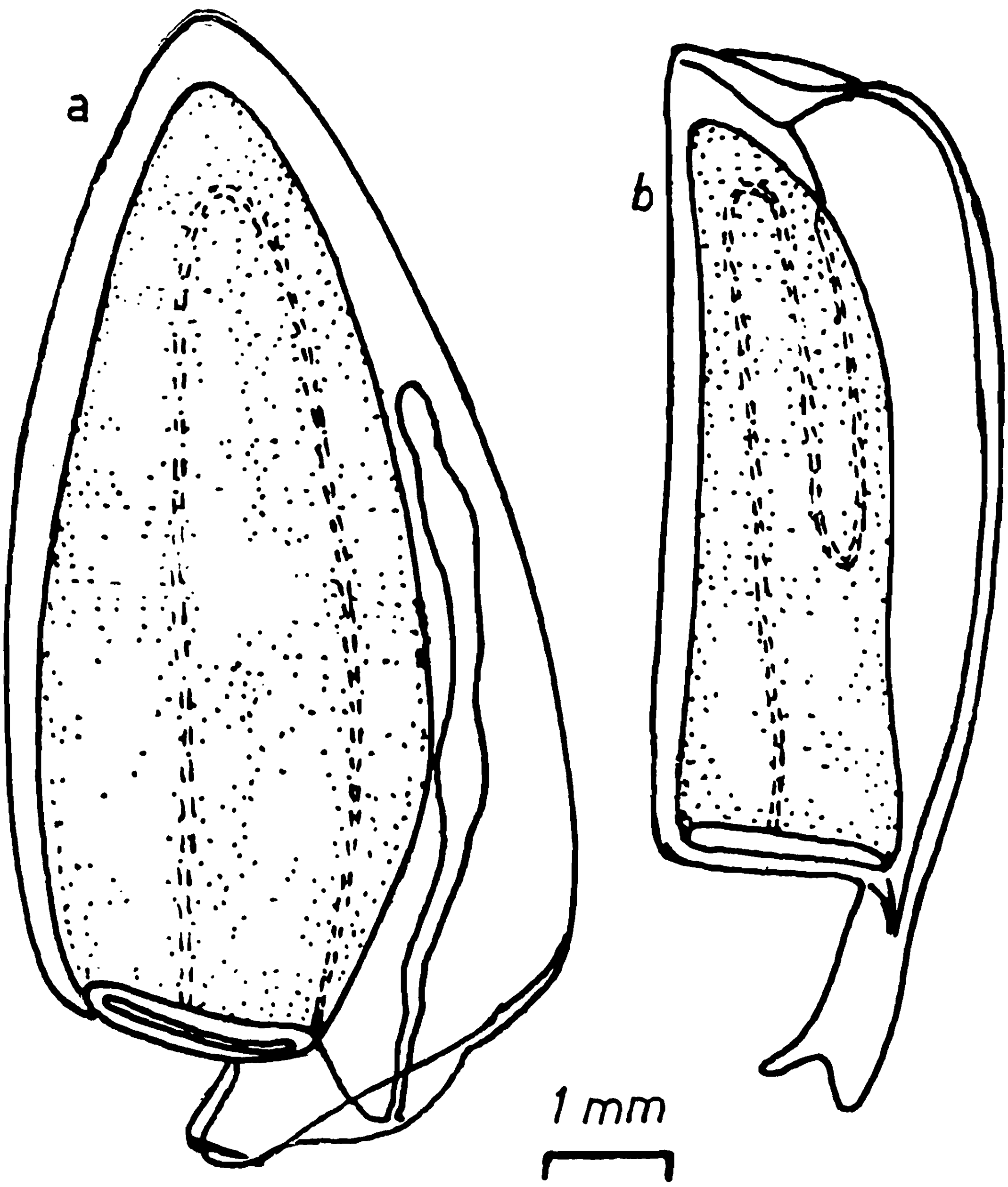


FIG. 46. *S. chuni* (Lens & van Riemsdijk) (a & b). a. anterior nectophore; b. posterior nectophore.

Eudoxid phase: Not identified.

Type locality: Sabuda Island, Malay-Archipelago (Pacific Ocean).

Distribution: (Maps 45 & 46). The number of records and distribution in the four zones of the Indian Ocean during the two seasons and its monthly variations are given in maps 45 and 46. The number of specimens collected per haul ranged from 1–25; 26–50 and 51–75.

S. chuni occurred all over the Indian Ocean. It usually occurred in greater numbers in the day stations.

During SW/SE monsoon season it occurred in great abundance in the Bay of Bengal, equatorial belt region and along the 110°E longitude. In the Arabian Sea the maximum catch per haul (26–50 per haul) occurred along the Somali coast and off Cochin; and at the equator 51–75 specimens per haul was collected. In the Bay of Bengal Maximum catch per haul (26–50/haul) was collected along the east coast of India, in the central region of the Bay and near the Andaman Islands. The range of 1–25 specimens per haul occurred at few places along Somali coast, west and east coast of India, in the equatorial belt region and south of Java.

During NE/NW monsoon season the maximum density of 51–75 specimens per haul occurred in the Gulf of Aden. The range of 26–50 per ahul occurred in the Gulf of Aden and off Cape Comorin. The range of 1–25 per haul occurred few times along the Somali coast, equatorial belt region, Madras coast, Andaman Islands and west coast of Australia.

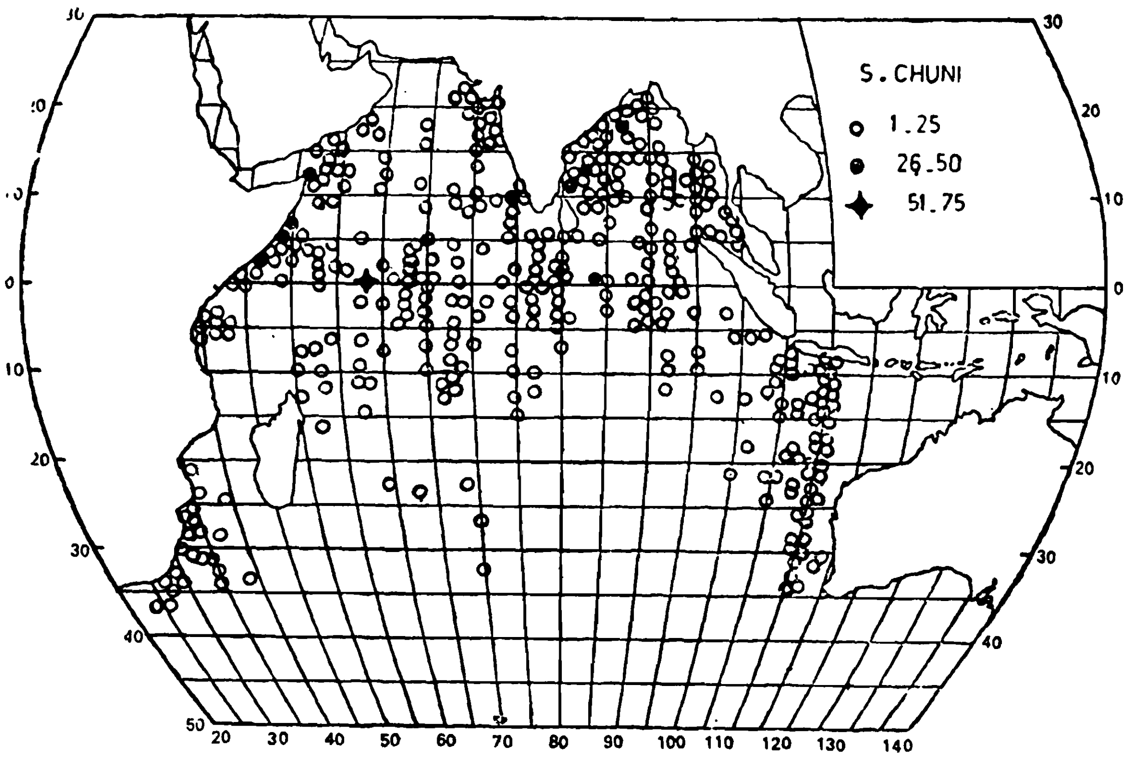
The range of distribution of *S. chuni* in both the seasons extended from 25°N latitude to 40°S latitude along the African coast, to 32°S latitude along 110°E longitude and to 35°S latitude in the mid-oceanic regions.

Monthly variations:

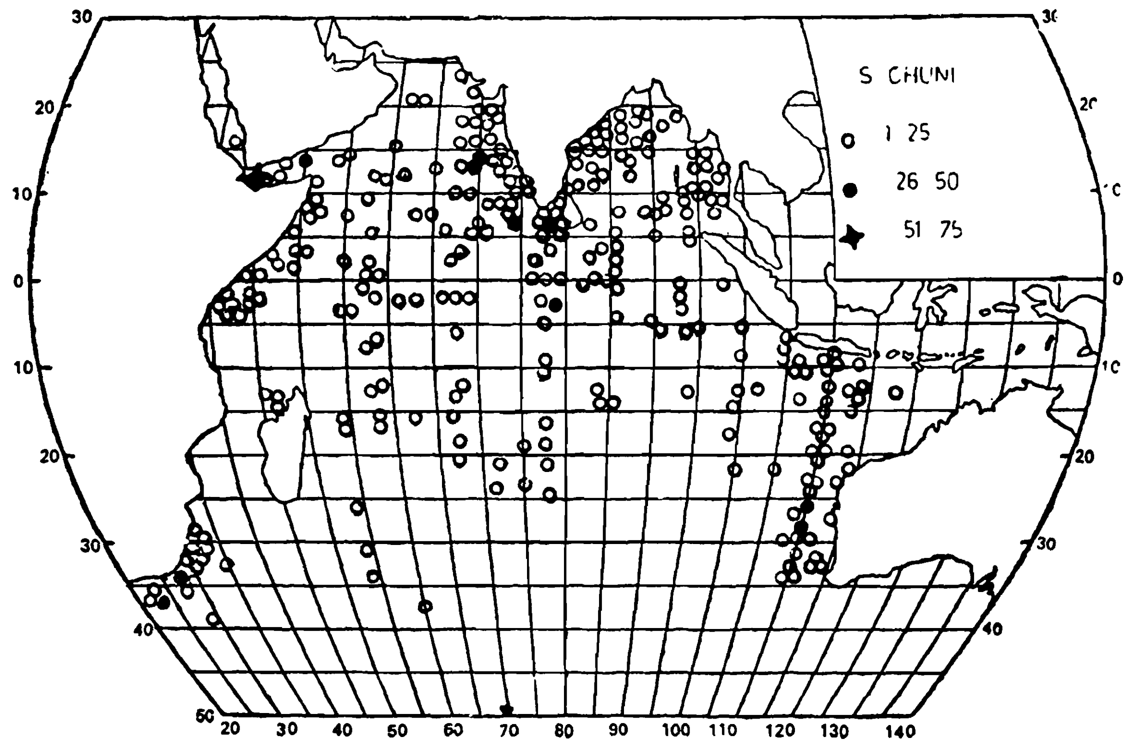
Arabian Sea: *S. chuni* occurred throughout the year in the western region (except in September) and in maximum numbers during August. In the Indian region it occurred throughout the year. It occurred in the maximum number of stations during May and rare during February and August.

Bay of Bengal: *S. chuni* occurred throughout the year in both the regions. It was collected from many stations during April and June in the Indian region and during September in the Andaman and Burma region.

South West Indian Ocean: It occurred throughout the year in this zone. The maximum number of records was made during January in the African region; April and June in the oceanic region.



MAP 45. Distribution of *S. chuni* during SW/SE monsoon season.



MAP 46. Distribution of *S. chuni* during NE/NW monsoon season.

South East Indian Ocean: In the Australian region it was collected in all the months except in October and November. The maximum number of records was during April, May and August. In the oceanic region except in February it was collected in all the months. The maximum number of records was during December.

40. **Sulculeolaria monoica** (Chun, 1888)
(Fig. 47, a–d)

Epibulia monoica Chun, 1888, p. 1157.
Galeolaria monoica Bigelow, 1911, p. 239, pl. 6, figs. 4–9.
Sulculeolaria monoica Daniel, 1974, p. 112, Text-figs. 9, H. I. & J.
(cf. for detailed synonymy)

Type Specimen: Place of deposit not known from literature.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 10 a.n.; 18 p.n. *Bay of Bengal:* 22 a.n.; 7 p.n. *South West Indian Ocean:* 22 a.n.; 31 p.n. *South East Indian Ocean:* 22 a.n.; 21 p.n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 9 a.n.; 12 p.n. *Bay of Bengal:* 16 a.n.; 19 p.n. *South West Indian Ocean:* 18 a.n.; 10 p.n. *South East Indian Ocean:* 17 a.n.; 19 p.n.

Polygastric phase: Anterior nectophore: Upto 14.5 mm in length and 7.5 mm in breadth; large with bulged middle region, blunt apex, devoid of ridges and hydroecium. Ostium surrounded by characteristic number of teeth — 3 dorsal teeth — middle one triangular with pointed tip, two dorso-lateral ones placed close to this median one, larger, triangular but with blunt tips; smaller triangularly shaped lateral teeth. Mouth-plates large, divided with two teeth like processes on proximal inner surfaces. Baso-ventral plane very oblique. Somatocyst very small 0.3 mm long. Commissural canal present.

Posterior nectophore: Up to 15.3 mm in length, 5.3 mm in breadth — cylindrical with broad truncated apex. Ostial teeth similar to anterior nectophore in number, shape and arrangement. Mouth-plate long, wide, undivided, with a small notch in distal margin; with two tooth-like processes on inner proximal surface.

Eudoxid phase: not identified.

Type locality: Canary Island.

Distribution (Maps 47 & 48). Distribution in the four zones of the Indian Ocean during the two seasons are presented in maps 47 and 48. Only 1–5 specimens per haul.

S. monoica occurred in all the four zones of the Indian Ocean during both the seasons. The night occurrence was more during SW/SE monsoon season in the Arabian Sea and South East Indian Ocean, and during NE/NW monsoon season in the Bay of Bengal and South West Indian Ocean.

High concentration of *S. monoica* occurred in the equatorial belt region during SW/SE monsoon season. Its distribution ex-

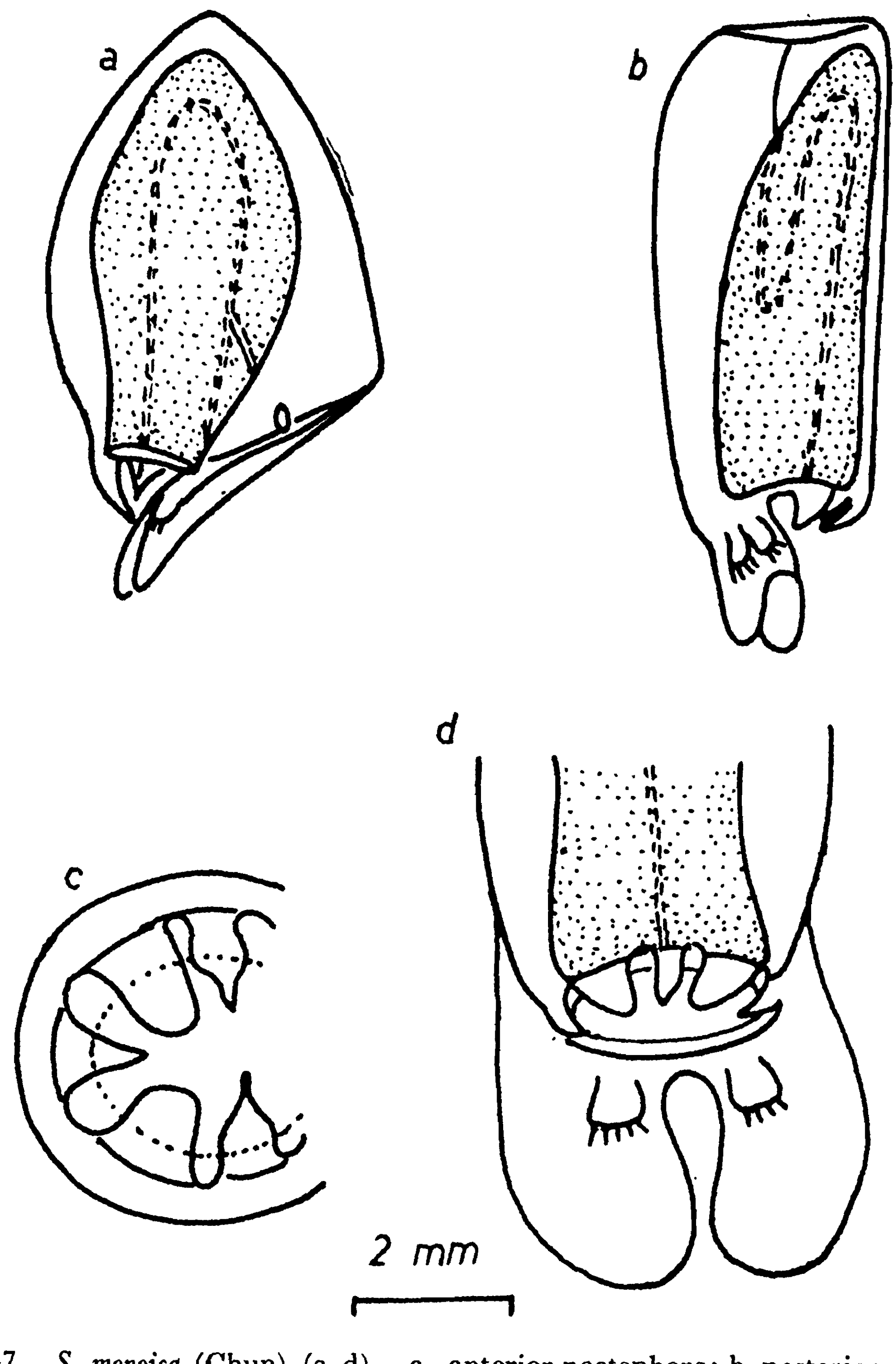
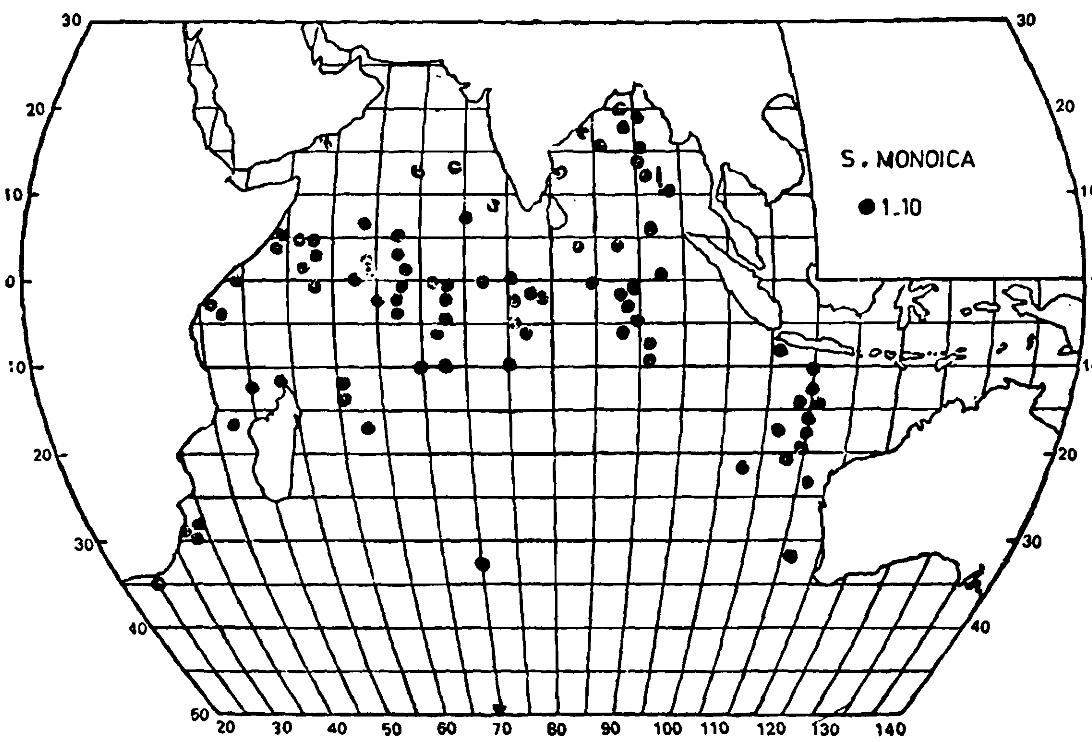
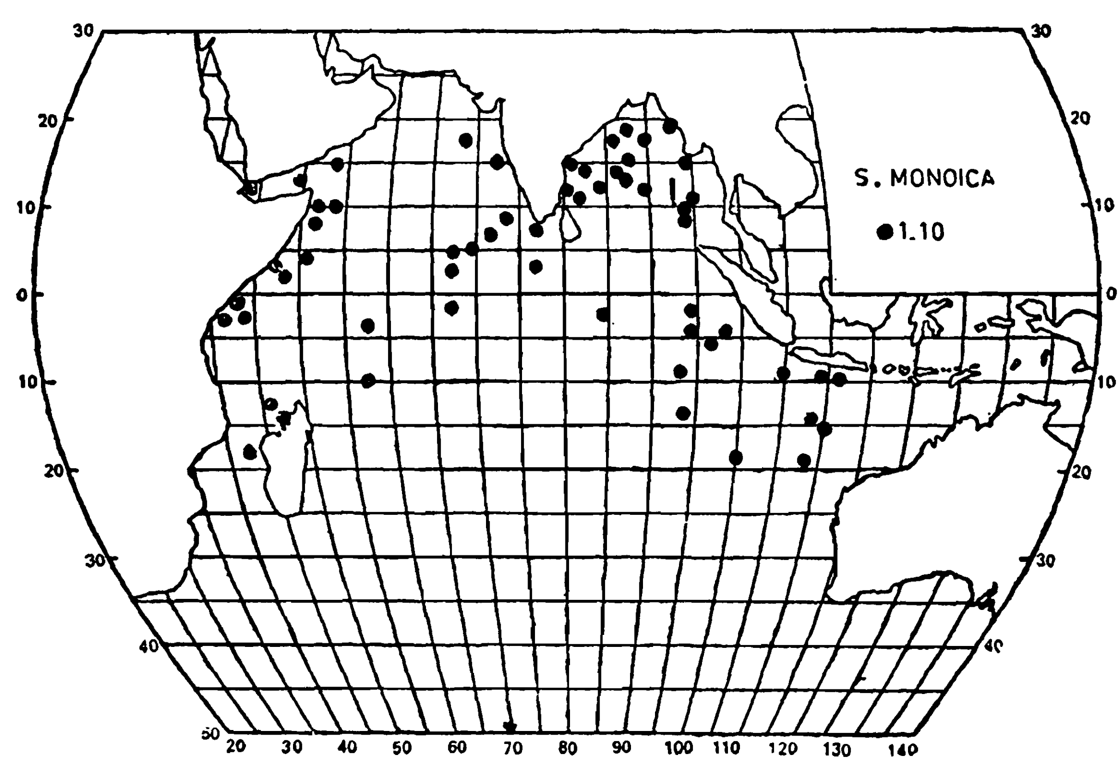


FIG. 47. *S. monoica* (Chun) (a–d). a. anterior nectophore; b. posterior nectophore; c. ostial view showing teeth of anterior nectophore; d. dorsal view of posterior nectophore.



MAP 47. Distribution of *S. monoica* during SW/SE monsoon season.



MAP 48. Distribution of *S. monoica* during NE/NW monsoon season.

tended from 16°N latitude in the Arabian Sea to 35°S latitude along the African coast and from 25°N latitude in the Bay of Bengal to 32°S latitude along the 110°E longitude, to 20°S latitude in the mid-oceanic region. During NE/NW monsoon season its distribution extended from nearly 20°N latitude to only 20°S latitude along the African coast and 110°E longitude; to 5°S latitude in the mid oceanic region.

Monthly variations:

Arabian Sea: In the western part it occurred along Somali coast and Gulf of Aden and near the equator during January, February, March, May, June, August and December. In the eastern part it occurred at a few places during January, February, March, May, August and November.

Bay of Bengal: In the Indian region it occurred during January to June with maximum occurrence during March. In the Andaman Islands and Burma region it was collected only during March, April, (Maximum) July and September.

South West Indian Ocean: In the African region it was recorded during January, April, July (maximum), October, and November. In the oceanic region it was collected during months other than February, May, November and December.

South East Indian Ocean: In the Australian region it was collected during January, April, and May and rare during August and September. In the oceanic region it occurred in maximum number of times during September and December. It was rare during January, July, August and October.

41. **Sulculeolaria bigelowi** (Sears, 1950)
(Fig. 48, a, b)

Galetta bigelowi Sears, 1950, p. 1–16, Figs. 1, 2.
Sulculeolaria bigelowi Totton, 1965, p. 152.

Type Specimen: U.S. National Museum, USA.

Material Examined: South West/South East Monsoon Season: *Arabian Sea:* 5 a.n.; 1 p.n.(?) *Bay of Bengal:* 4 a.n.; 1 p.n.(?) *South West Indian Ocean:* 19 a.n.; 4 p.n.(?). *South East Indian Ocean:* 11 a.n.; 3 p.n. (?). North East/North West Monsoon Season: *Arabian Sea:* 25 a.n.; 8 p.n.(?). *Bay of Bengal:* 8 a. n.; 4 p.n. (?). *South West Indian Ocean:* 11 a.n.; 1 p.n. *South East Indian Ocean:* 10 a.n.

Polygastric phase: Anterior nectophore: Small, 5.0 mm–7.0 mm in length, conical, with broad base 4.0 mm wide, and baso-ventral facet half as long as nectophore, less mouth-plate. Mouth-plates exceptionally long and wide. No ostial teeth, hydroecium and commissural canals.

Posterior nectophores: With broad oblique anterior end and narrow ostial end; probably belong to this species.

Eudoxid phase: not identified.

Type locality: Marshall Island, South Pacific Ocean.

Distribution: (Maps 49 & 50). Its distribution in the four zones of the Indian Ocean during both the seasons are presented in maps 49 and 50.

S. bigelowi occurred in all the four zones of the Indian Ocean during both the seasons. There was not much night/day variation in the occurrence of this species.

During SW/SE monsoon season *S. bigelowi* occurred within the equatorial belt region and in the mid-ocean to 25°S latitude between 60°E–80°E longitude and along 110°E longitude down

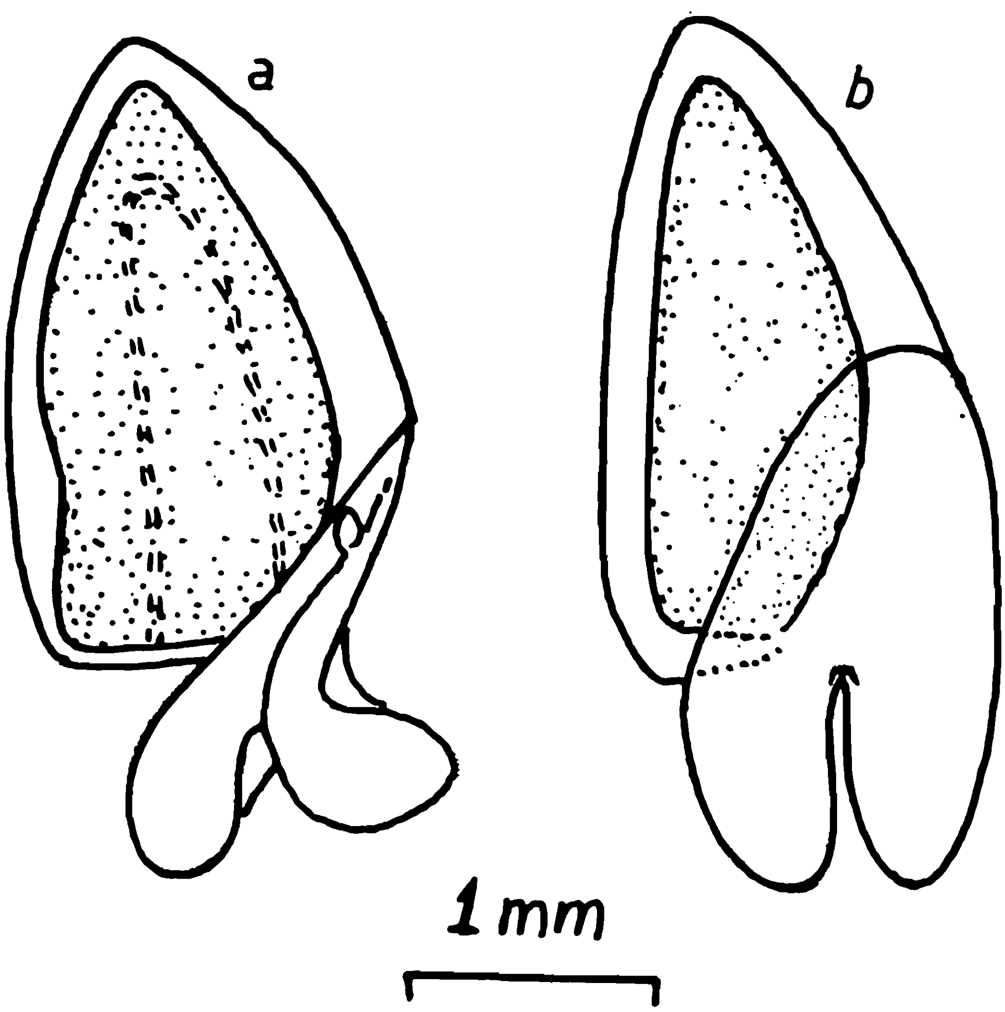
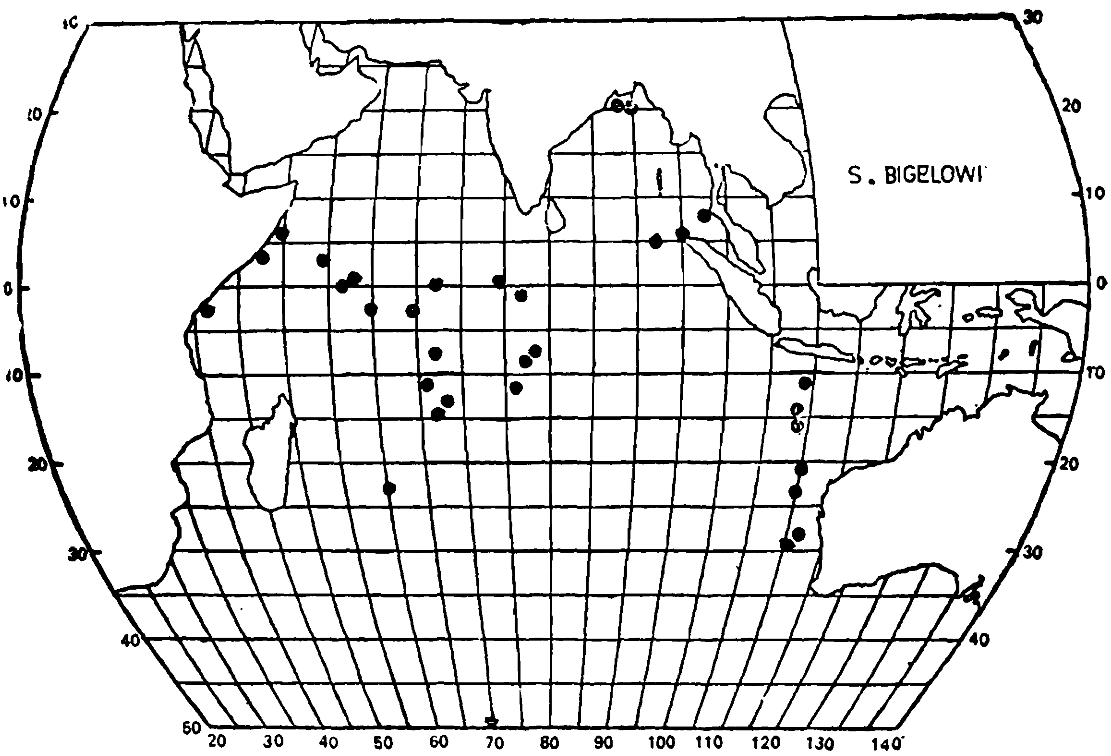
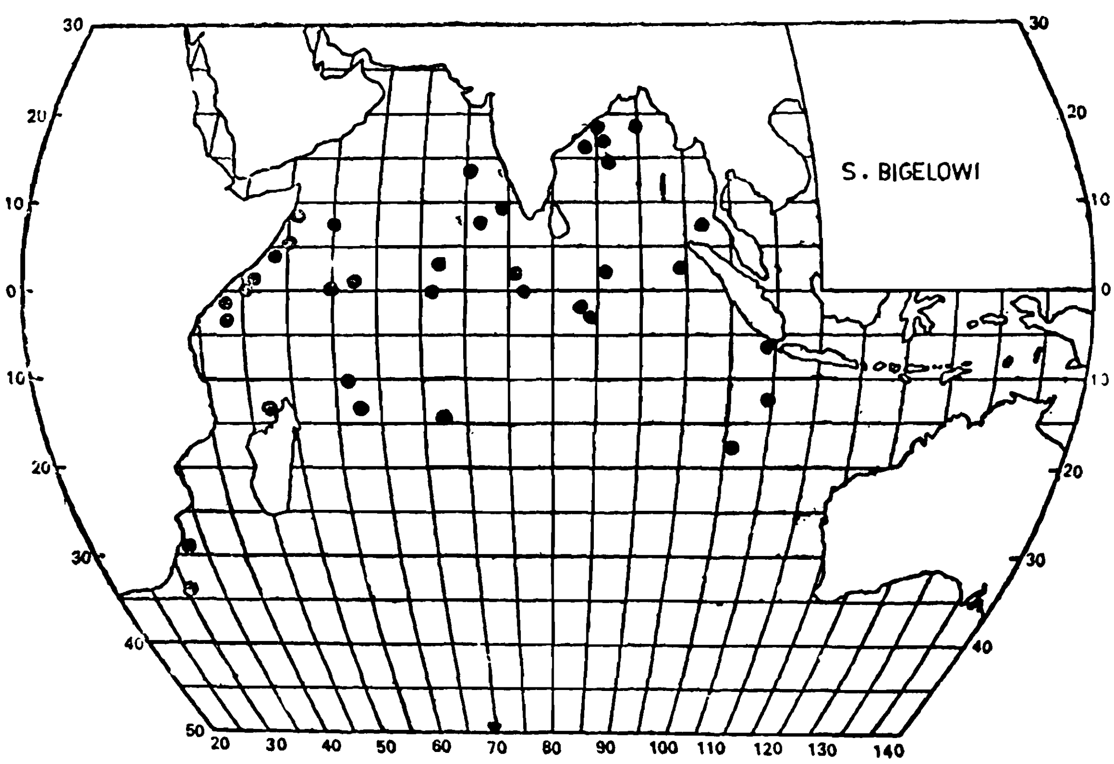


FIG. 48. *S. bigelowi* (Sears). a & b. lateral and ventral view of anterior nectophore.



MAP 49. Distribution of *S. bigelowi* during SW/SE monsoon season. 1—3 Specimens per haul.



MAP 50. Distribution of *S. bigelowi* during NE/NW monsoon season. 1—3 Specimens per haul.

to 30°S latitude. In the Bay of Bengal it extended up to 25° N latitude. During NE/NW monsoon season its distribution extended from 10°N latitude in the Arabian Sea to 35°S latitude along the African coast and from 20°N latitude in the Bay of Bengal to 25°S latitude along 110°E longitude and 15°S latitude in the mid-oceanic region. During this season it appeared scattered.

Monthly variations:

Arabian Sea: In the western part it was collected at few places during January, February, March, June, August and December. In the eastern region it occurred during January, February, April and August.

Bay of Bengal: It was recorded a few times during January, March, April and November in the Indian region. In the Andaman Islands and Burma region it occurred during January, March, April, August and September.

South West Indian Region: In the African region it was collected during January, July and October. In the oceanic region it occurred almost throughout the year except in July, November and December.

South East Indian Region: In the Australian region it occurred during January, March, April, May and August. In the oceanic region it was recorded only during October and December.

Genus 25. **Eudoxia** Eschscholtz, 1825

Eudoxia Eschscholtz, 1825, p. 743.

Eudoxid phases of Calycophorae which have not been connected with the polygastric phases, are usually included under this genus till the identification with their respective polygastric phases have been firmly established.

Therefore, *Eudoxia macra* Totton, 1954 of unknown parentage was tentatively included by him in the family Diphyidae, until the polygastric phase is known.

In the I.I.O.E. collections are present many eudoxids of *Eudoxia macra* (both entire and loose bracts and gonophores) and a few loose bracts and gonophores which do not belong to *E. macra*. These new bracts are named as *Eudoxia indica* n. sp.

Type Species: *Eudoxia macra* Totton, 1954.

Key to species of Eudoxia

1. Bract with rounded conical tip and flattened neck-shield..	2
2. Phyllocyst spindle-shaped....	*macra*
Phyllocyst globular...	*indica*

42. **Eudoxia macra** Totton, 1954
(Fig. 49, a–c)

Eudoxia macra Totton, 1954, p. 119, fig. 62.
Eudoxia macra Totton, 1965, p. 191, fig. 130.

Type Specimen: British Museum, (Nat. Hist.), London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 4 br.; 115 go.; 1 eu. (compl.) *Bay of Bengal:*

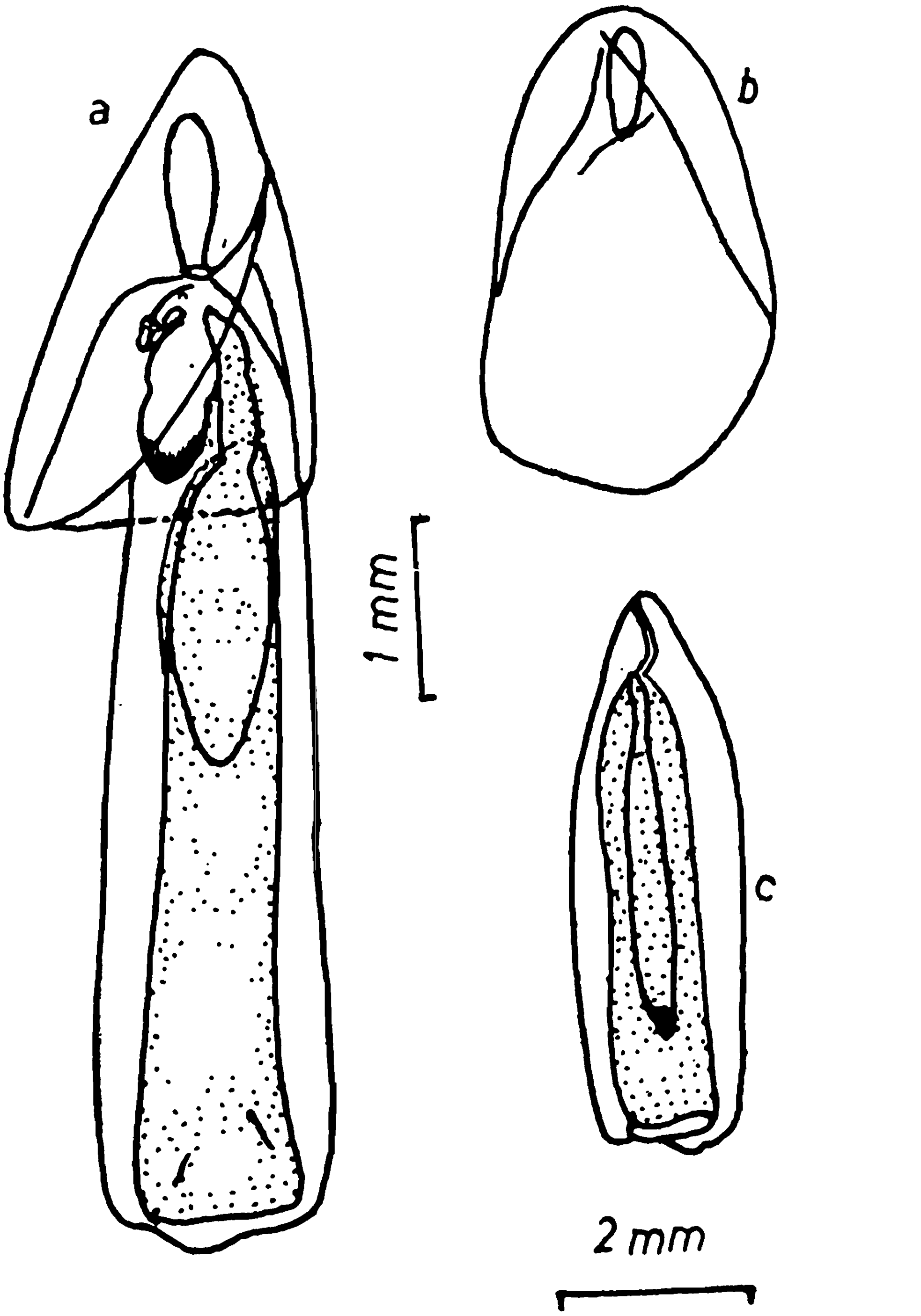


FIG. 49. *E. macra* Totton (a–c). a. entire eudoxic with bract and gonophor intact; b. bract; c. male gonophore. (Fig. a after Totton, 1954, fig. 62).

14 br.; 141 go. *South West Indian Ocean:* 5 br.; 129 go. *South East Indian Ocean:* 5 br.; 104 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 12 br.; 131 go. *Bay of Bengal:* 1 eu. (compl.) 3 br.; 67 go. *South West Indian Ocean:* 7 br.; 125 go. *South East Indian Ocean:* 7 br.; 73 go.

Description: Eudoxid phase: Overall length 4.05 mm *Bract:* 1.25–4.0 mm long, with rounded smooth conical apex, neck-shield flattened, thin, broad, with smooth margin, without serrations or dentition. Resemble bracts of *D. bojani.* Lateral edges usually curve inward when loose or around proximal extended end of gonophore, when attached. Sutural surface grooved. Phyllocyst small, spindle shaped-asymmetrically placed on sloping bracteal cavity.

Gonophore: 2.5–3.0 mm long, smooth thin, without any prominent ridges, teeth or mouth-plate. Proximal end not truncated but blunt and conical. Pedicular canal from phyllocyst descending, enter nectosac slightly below apex of nectosac. Four radial canals — 2 dorso-lateral and 2 ventro-lateral present. Two slight rounded ridges overlie the two dorso-lateral canals. Hydroecial folds close-together forming a shallow groove. Manubrium bearing sex-cells, long, extending to half the length of gonophore.

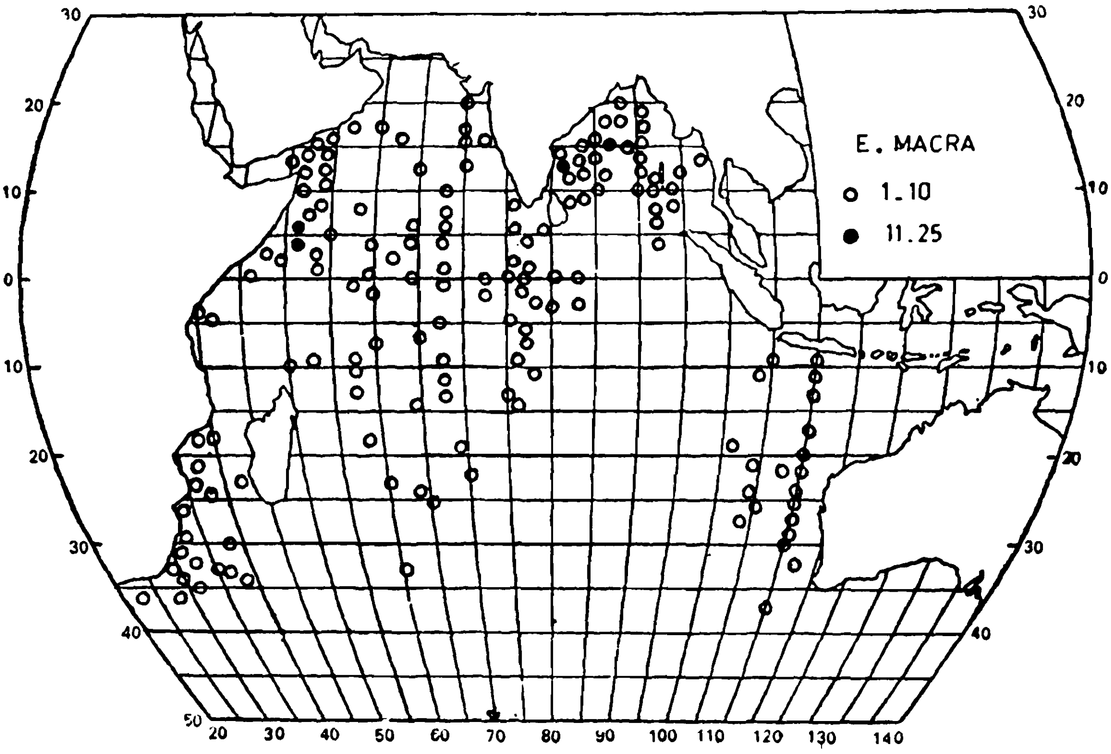
Type locality: Off South and East coast of Africa, Indian Ocean.

Distribution: (Maps 51 & 52). Its ditribution in the four zones of the Indian Ocean during the two seasons are presented in maps 51 and 52. Usually only 1–10 eudoxids per haul were collected. Along Somali coast 11–25 eudoxids per haul were collected, while the density range of 11–25 eudoxids per haul occurred in the Bay of Bengal near the Indian coast.

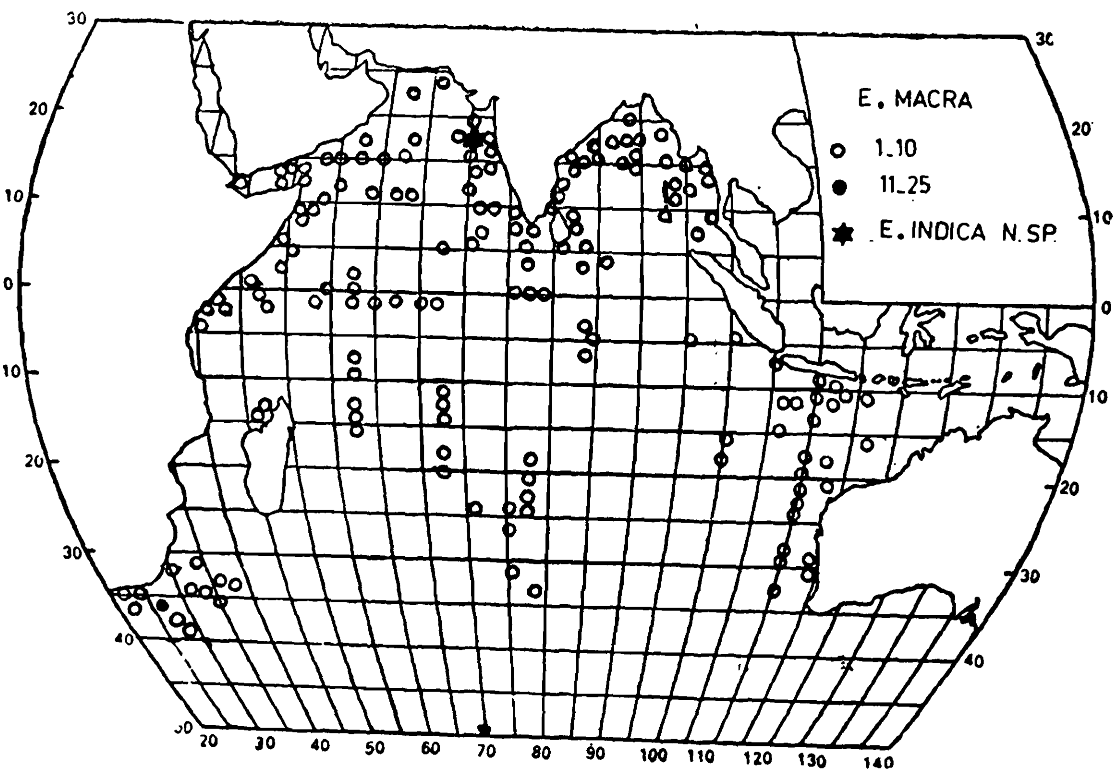
E. macra occurred in great abundance in all the four zones of the Indian Ocean during both the seasons, especially in the Arabian Sea, Bay of Bengal and South West Indian Ocean. It occurred in great numbers during day time. During both the seasons its distribution extended from 25°N latitude to nearly 40°S latitude along the African coast and along the 110°E longitude and in the mid-oceanic regions. During SW/SE monsoon season it occurred in great abundance within the equatorial belt region (10°N to 10°S latitude). In the South East Indian Ocean it occurred south of Java between 100°E to 110°E longitude. During NE/NW monsoon season it occurred scattered in the oceanic region.

Monthly variation:

Except in the oceanic region of the South East Indian Ocean, *E. macra* occurred almost throughout the year in the Indian Ocean. *Arabian Sea:* In the western part it occurred in the maximum



MAP 51. Distribution of *E. macra* during SE/SW monsoon season.



MAP 52. Distribution of *E. macra* and *E. indica* n.sp. during NE/NW monsoon season.

number of places in February, August and December. In the eastern part it was collected during all the months except in July. The maximum numbers occurred during February, May and August.

Bay of Bengal: It occurred in great abundance during April and June. It was not collected during September and October. Near the Andaman Islands and Burma region it was collected in greater numbers during March and September. It was recorded during January, February and December.

South West Indian Ocean: In the African region the maximum number of catches was made during January and October. In the oceanic region it was collected during January, April, June and November.

South East Indian Ocean: E. macra was collected during January, February, May, August and December in the Australian region. It did not occur during November. In the oceanic region it occurred a few times during January, May, July, October and December.

43. **Eudoxia indica** n. sp.

(Fig. 50 a, b)

Type Specimen: Zoological Survey of India, Calcutta, India.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: nil; NORTH EAST/NORTH WEST MONSOON SEASOON: *Arabian Sea:* 1 br.

Eudoxid phase: Bract: (Fig. 50 a, b) up to 3.2 mm in length and 1.7 mm in breadth resembling *E. macra* in shape and structure. Phyllocyst nearly globular measuring 1.2 mm in diameter. These bracts are smaller than those of *E. macra*.

Remarks: In size and shape the somatocyst, this new species, *Eudoxia indica* differ greatly from *E. macra*.

The eudoxid, *E. macra* was tentatively included in the Family Diphyidae by Totton (1954, 1965, p. 191) since its parentage — polygastric phase is still unknown. It is felt that *E. macra* and *E. indica* n. sp. are probably related to the species of the genus *Sulculeolaria* of the family Diphydae because of the following reasons: 1. the bracts and gonophores of *E. macra* resemble the developing cormidia of *Sulculeolaria turgida* described by Bigelow, (1931). 2. the ventral side of the gonophore of *E. macra* resemble the ventral sides (hydroecial groove) of the posterior nectophore of *Sulculeolaria* species and 3. the distribution of *E. macra* in the entire Indian Ocean from 200–0 m depth, resemble the distribution pattern of *Sulculeolaria chuni* (in its wide distribution, along the land masses and in the mid-oceanic region.

E. macra probably belongs to *S. chuni* because of its abundant and wide distribution as in the case of *S. chuni*. It is not certain to which parentage *E. indica* n. sp. belongs to since most of the species of *Sulculeolaria* occur in the region where *E. indica* n. sp. was collected.

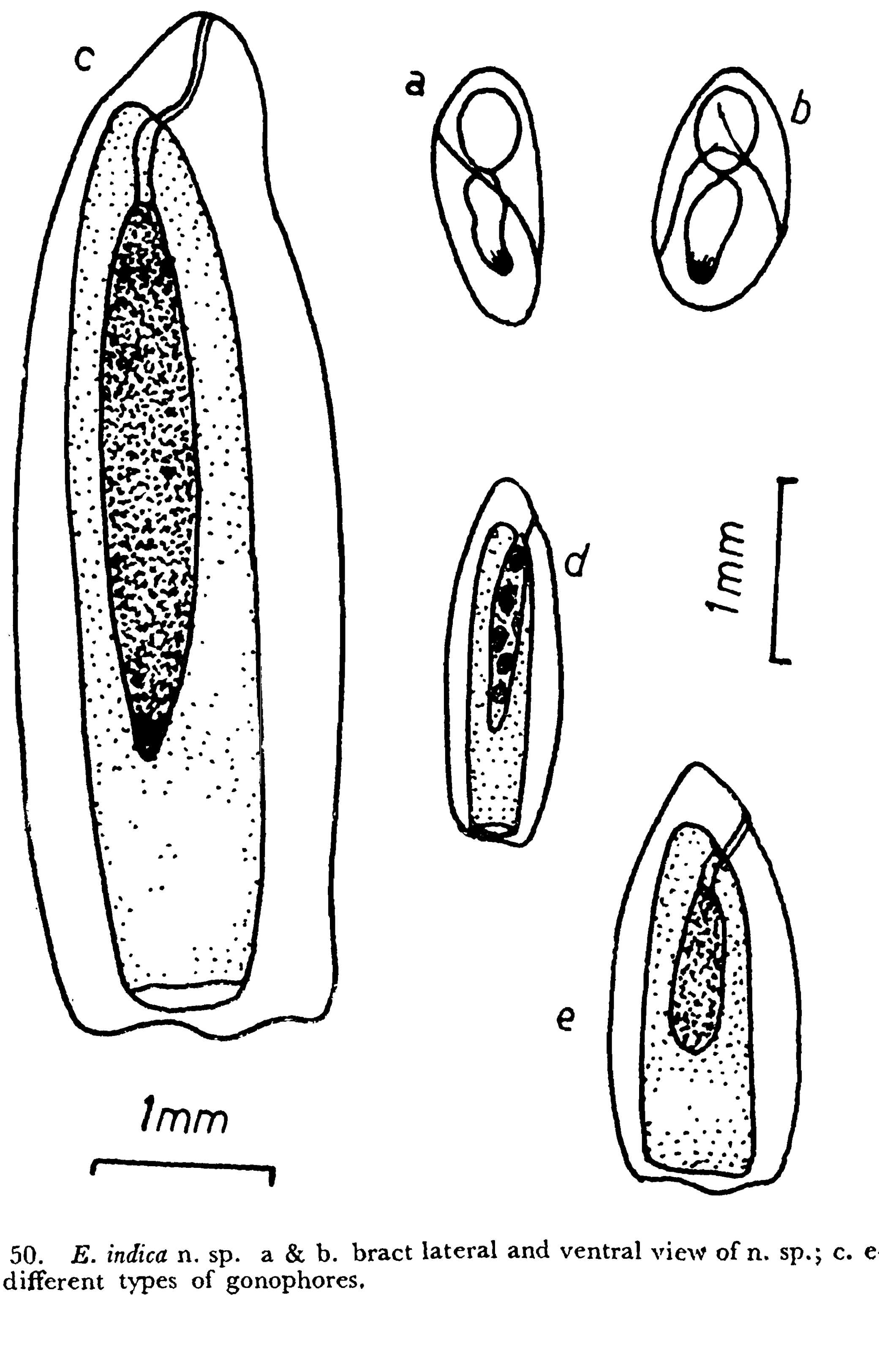


FIG. 50. *E. indica* n. sp. a & b. bract lateral and ventral view of n. sp.; c. e– different types of gonophores.

Further, in the I.I.O.E. collections there are three types of gonophores present, which more or less resemble each other in their general shape and structure. One type well decribed and figured by Totton, 1954 belongs to *E. macra*. The second type is short and squat (Fig. 50 e) and the third type is very long (5.0 6.5 mm in length–figure 50 c) thus differing from the gonophores of *E. macra*.

Distribution: (Maps 52) Recorded from a depth of 200–0 m during March near the west coast of India.

Subfamily (ii) DIPHYINAE Moser, 1925

Diphyopsiinae Haeckel, 1888.

Diphyidae with generally two dissimilar nectophores, anterior one pyramidal, with ridges, with or without ostial teeth and hydroecium; posterior nectophore at times reduced or absent, with either truncated articulating proximal end or produced into triangular prolongation which fits into hydroecium of anterior nectophore; hydroecium as open shallow groove or deep, temporarily closed by overlapping hydroecial flaps or wings. Cormidia always separate as eudoxids with or without special nectophores.

Six valid genera are recognised as follows: 1. *Diphyes* Cuvier, 1817; 2. *Lensia* Totton, 1932; 3. *Muggiaea* Busch, 1851; 4. *Dimophyes* Moser, 1925; 5. *Chelophyes* Totton, 1932; and 6. *Eudoxoides* Huxley, 1859.

Key to genera of DIPHYINAE

Anterior nectophore:

1.	Nectophore with divided mouth-plate.	2
	Nectophore with undivided mouth-plate..	3
2.	Nectophore pyramidal with five or more complete ridges..	4
	Nectophore pyramidal with three complete ridges....	**Chelophyes**
3.	With long somatocyst and deep hydroecium, mouth-plate not open on ventral side..	**Diphyes**
	With shorter somatocyst and shallower hydroecium, mouth-plate wide open on ventral side....	**Dimophyes**
4.	Without ostial teeth, with either deep or very shallow hydroecium...	5
	With inconspicuous dorsal ostial tooth, with medium sized hydroecium..	**Eudoxides**
5.	With deep hydroecium; mouth-plates long and slightly over lapping; somatocyst lies in close contact with nectosac...	**Muggiaea**
	With very shallow hydroecium and very small rounded overlapping mouth-plates..	**Lensia**

Genus 26. **Diphyes** Cuvier, 1817

Diphyes Cuvier, 1817.
Diphyopsis Haeckel, 1888, p. 152.

Diphyinae with anterior nectophore, 5 ridged-dorsal and laterals ending in 3 conspicuous serrated ostial teeth. Somatocyst long. Hydroecium deep. Mouth-plate large, undivided. *Rete mirabele* present at velar ends of all four radial canals. Posterior nectophore also five ridged, ending in 3 conspicuous serrated ostial teeth. Hydroecium deep, tubular, temporarily closed by hydroecial folds or wings.

Eudoxids with conical or shield-like bracts with elongated or knob-shaped phyllocyst. Special nectophore with or without small proximal lobe that fits into conical hydroecium of bract. Gonophores with four ridges and four teeth, manubrium bears male or female gonads.

Type Species: *D. dispar* Chamisso & Eysenhardt, 1821.

The following four species of *Diphyes* are recognised: 1. *D. dispar* Chamisso & Eysenhardt, 1821, 2. *D. bojani* Eschscholtz, 1825, 3. *D. chamissonis* Huxley, 1859 and 4. *D. antarctica* Moser, 1925.

D. antarctica is restricted to the Antarctic Ocean while the other 3 species of *Diphyes* are very common and occur in great abundance in the Indian seas.

Key to species to Diphyes

Anterior nectophore:

1.	Nectosac prolonged apically....	2
	Nectosac not prolonged apically..	3
2.	Somatocyst inclined towards nectosac; dorsal wall of mouth-plate smooth..	*dispar*
	Somatocyst lies alongside nectosac; dorsal wall of mouth-plate with thickened tooth-like projection..	*bojani*
3.	Somatocyst long; mouth-plate undivided; dorsal tooth conspicuous....	*chamissonis*
	Somatocyst short; mouth-plate divided; dorsal tooth inconspicuous....	*antarctica*

Posterior nectophore:

1.	Posterior nectophore well developed..	2
	Nectophore reduced..	*antarctica*
2.	Nectophore broad; dorsal wall of mouth-plate smooth....	*dispar*
	Nectophore narrow; dorsal wall of mouth-plate with thickened tooth-like projection..	*bojani*

(N. B. No posterior nectophore developed in *D. chamissonis*)

Eudoxid phase:

1. Bracts thick, either rounded or elongated, phyllocyst long; special nectophore or gonophore lying below bract..	2
Bract thin, shield-like, phyllocyst knob-like, special nectophore lying nearly parallel to bract..	*bojani*
2. Bract elongated, with long neck-shield; gonophore with obscure dorsal tooth.....	*antarctica*
Bract rounded with special nectophores....	3
3. With short neck-shield; pedicular canal oblique.... ..	*dispar*
With long neck-shield; pedicular canal horizontal....	*chamissonis*

Of the above mentioned species, the following are represented all over the Indian Ocean: *D. dispar D. bojani*, and *D. chamissonis*,

44. Diphyes dispar Chamisso & Eysenhardt, 1821 (Fig. 51 a–e)

Salpa (Bipartita) lanceolata bipartita Bory de St. Vincent, 1804, 1, pl. VI, figs. 3 A–C.

Diphyes dispar Chamisso & Eysenhardt, 1821, p. 365, pl. 33, fig. 4.

Diphyopsis dispar Bigelow, 1911, p. 257, pl. 10, fig. 1, pl. 11, fig. 3.

Diphyes dispar Daniel, 1974, p. 115, Text-fig. 10 A–C. (cf. for detailed synonymy)

Type Specimen: Place of deposit not known from literature.

Material Examined: South West/South East Monsoon Season: *Arabian Sea:* 317 a.n.; 102 p.n.; 87 eu. (compl.); 103 br.; 213 sp. n; 72 go. *Bay of Bengal:* 325 a.n.; 77 p.n.; 93 eu. (compl.) 223 br.; 244 sp.n.; 37 go. *South West Indian Ocean:* 263 a.n.; 50 p.n.; 37 eu. (compl.); 140 br.; 117 sp. n.; 11 go. *South East Indian Ocean:* 379 a.n.; 68 p.n.; 120 eu. (compl.); 229 br.; 227 sp. n.; 22 go. North East/North West Monsoon Season: *Arabian Sea:* 2 p.g. (compl.); 196 a.n.; 52 p.n.; 99 eu. (compl.); 123 br.; 135 sp. n.; 30 go. *Bay of Bengal:* 1 p.g. (compl.); 263 a.n.; 80 p.n.; 36 eu. (compl.); 103 br.; 97 sp. n.; 6 go. *South West Indian Ocean:* 108 a.n.; 18 p.n.; 39 eu (compl.); 113 br.; 84 sp. n.; 24 go. *South East Indian Ocean:* 150 a.n.; 32 p.n.; 38 eu. (compl.); 105 br.; 113 sp. n.; 14 go.

Polygastric phase: *Anterior nectophore:* (Fig. 51 a) Length: 14.0 mm–39.0 mm; breadth: 7.5 mm–20.0 mm firm, prismatic, pyramidal, transparent with five prominent, complete, slightly serrated ridges all meeting at apical pointed tip; one dorsal, 2 lateral ridges end near ostium of nectosac in broad, pointed, recurved teeth; two ventral ridges extend well beyond level of ostium forming 1/3rd of length of hydroecium. Mouth-plate undivided. Nectosac proper sub-cylindrical, apically narrows abruptly into a thin long tube, dilated at tip. Somatocyst long, thin, spindle-shaped, inclined toward nectosac extending up to apex of necto-

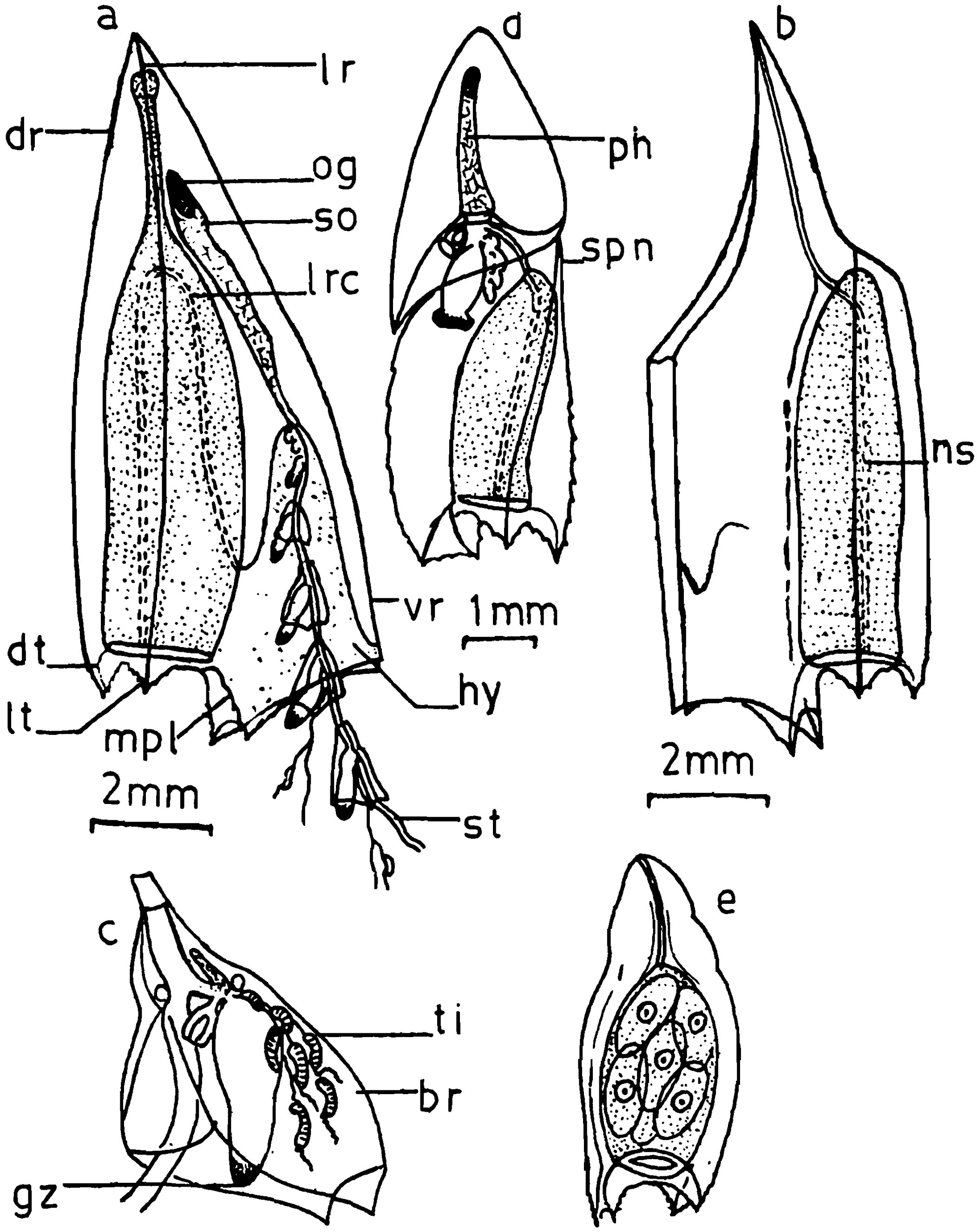


FIG. 51. *D. dispar* Chamisso & Eysenhardt (a–e). a. anterior nectophore; b. posterior nectophore; c. cormidium; d. eudoxid phase; e. female gonophore. (br – bract; dr – dorsal ridge; dt – dorsal tooth; gz – gastrozooid; hy – hydroecium; lr – lateral ridge; lrc – lateral radial canal; lt – lateral tooth; m pl – mouth plate; ns – nectosac; og – oil globule; ph – phyllocyst (or bracteal canal = somatocyst); so – somatocyst; sp.n – special nectophore; vr – left & right ventral ridges).

phore. Hydroecium deep, conical, inclined towards ventral wall of nectophore, 5.8 mm to 18.0 mm deep with quadrilateral ostium 5.0 mm–15.0 mm in length. Pedicular canal from somatocyst descending to ventral corner of nectosac, dividing into four radial cnals, clearly seen in the muscular region of nectosac.

Posterior nectophore: (Fig. 51b) 13.3 mm–30.0 mm long; 6.5 mm–15.0 mm broad; anteriorly produced into triangular extension fitting into hydroecium of anterior nectophore. Ridges and ostial teeth as in anterior nectophore. Pedicular canal lies within triangular extension, entering nectosac slightly below apex of nectosac, four radial canals; simple, straight. Hydroecium formed by two hydroecial wings, meeting at proximal end and in mid region; margin of left wing curving over right wing forming a temporary tube. No somatocyst.

Siphosome or stem: (Fig. 51 c). Long, thin, tubular, extremely contractile bearing numerous cormidia; older ones detach as eudoxids.

Eudoxid phase: (Fig. 51 d). Overall length 7.5–10.0 mm. Bract 3.1 mm in length and 2.3 mm in breadth, conical, with blunt apex, thick with mesoglea. No ridges or serrations on bract. Phyllocyst long, broad at base, tapering towards apex; oil globule present at times within phyllocyst. Hydroecium deep, conical housing gastrozooid, its tentacle, a special nectophore, and 2 or 3 gonophores of one sex.

Special nectophore: 3.8–5.0 mm in length, 2·0–4 mm in breadth with 5 prominent complete ridges gently serrated towards base, ostial teeth as in anterior and posterior nectophore. Pedicular canal oblique, joining nectosac at apex; four radial canals originating at apex, simple and straight.

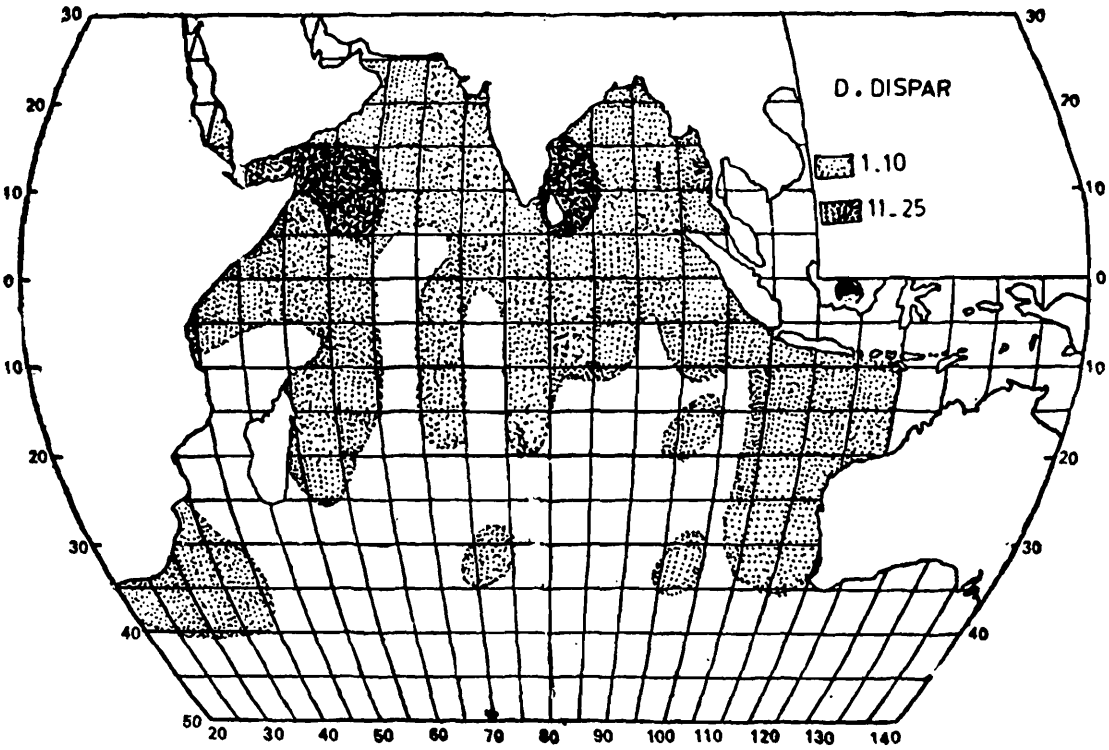
Gonophores: (Fig. 51 e) Smaller, 1/3rd of special nectophore in length 2 or 3 in number, of same sex, two of them mirror images of each other. Female manubrium bearing 4–8 ova. Nectosac well developed; with four radial canals. Four small teeth around ostium.

Type locality: Equatorial Pacific Oecan.

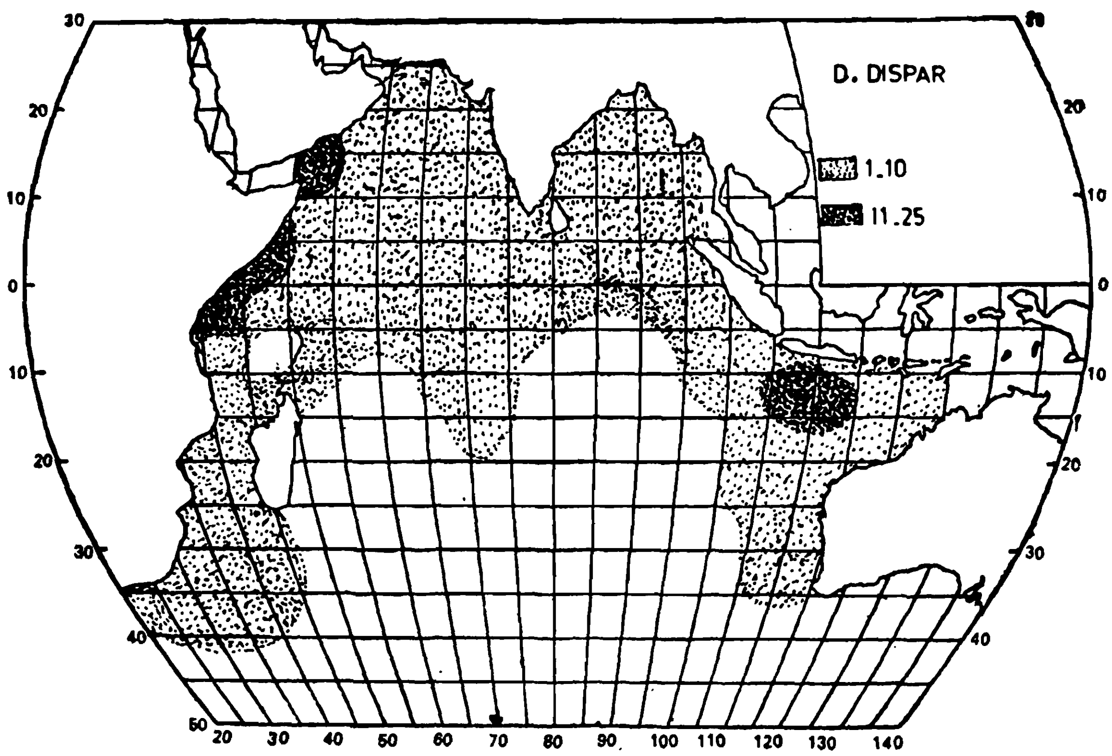
Distribution: (Maps 53 & 54; 55 & 56). *D. dispar* is one of the common and abundant species occurring in the Indian Ocean. The maps 53, 54, 55 and 56 give the distribution and abundance in each 5° square of the ocean.

These maps show the distribution and abundance of the polygastric (53 & 54) and eudoxid phases (55 & 56) of *D. dispar* during both the seasons.

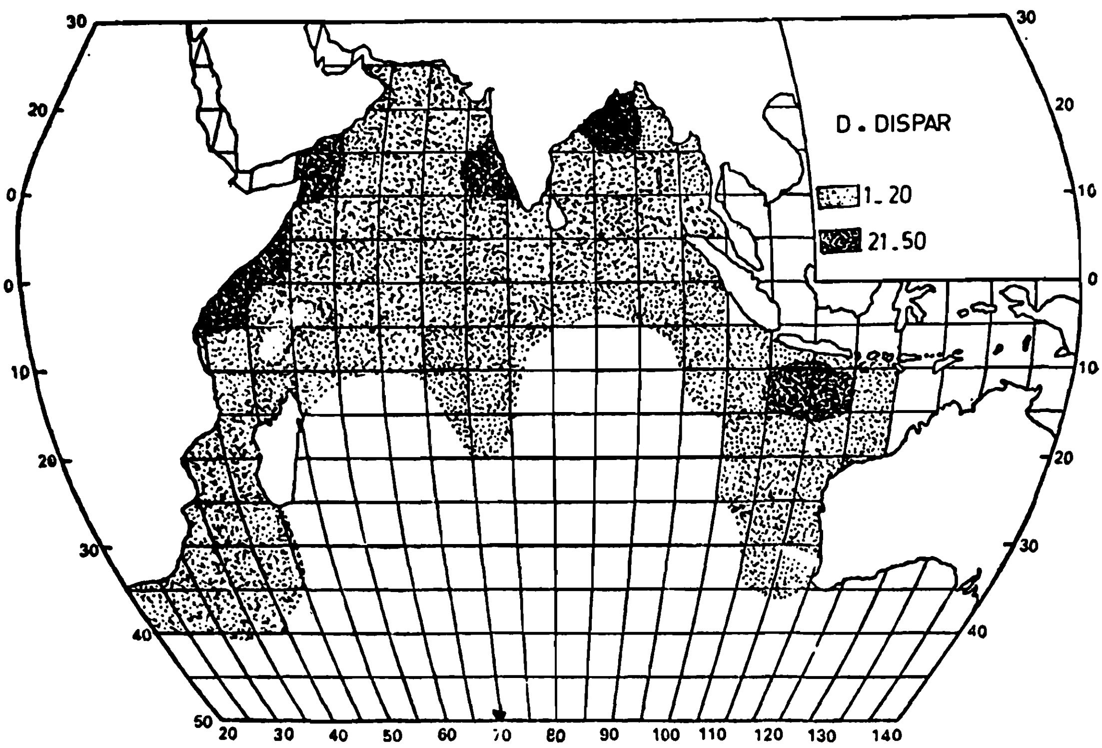
During SW/SE monsoon season the polygastric and eudoxid phases occurred throughout the Indian Ocean extending from



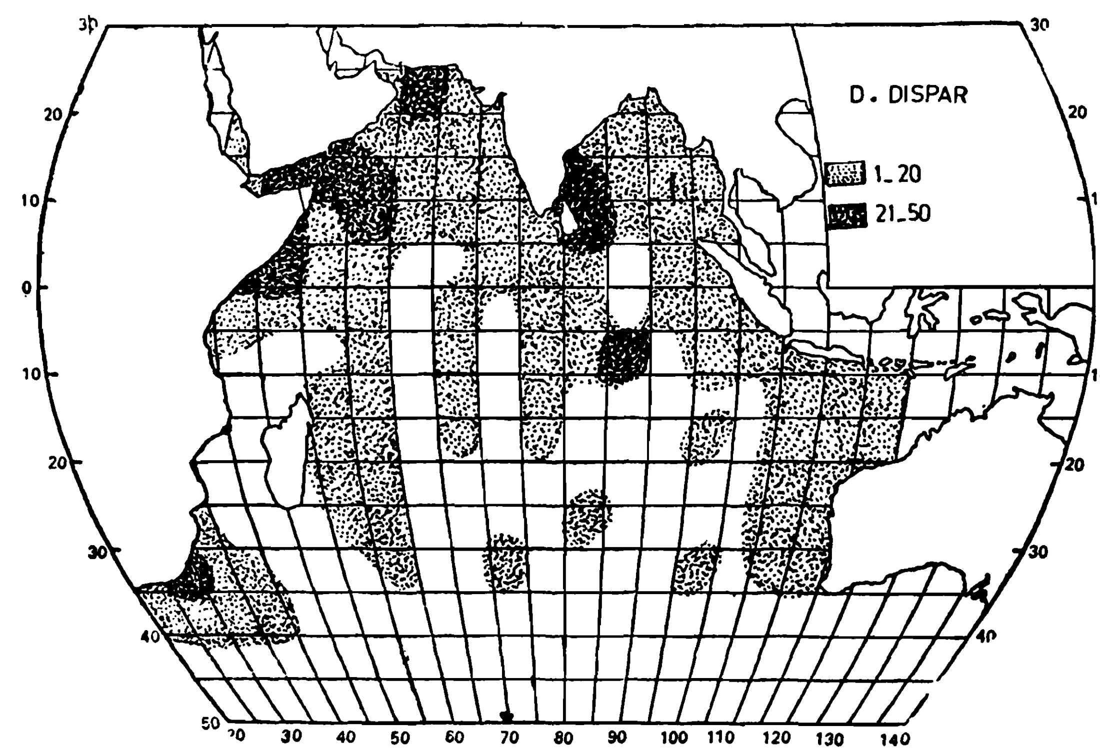
MAP 53. Distribution of *D. dispar* — polygastric phase during SW/SE monsoon season.



MAP 54. Distribution of *D. dispar* — polygastric phase during NE/NW monsoon season.



MAP 55. Distribution of *D. dispar* — Eudoxid phase during SW/SE monsoon season.



MAP 56. Distribution of *D. dispar* — Eudoxid phase during NE/NW monsoon season.

25°N latitude and 40°S latitude near the land regions. In the mid-ocean it extended down to 30°S latitude. The polygastric phase occurred in great numbers (11–25 numbers per haul) along Somali coast, Gulf of Aden, Cape Comorin, Orissa coast and north of Sumatra in the northern hemisphere; along the equator, west coast of Madagascar and south of Java in the southern hemisphere.

During NE/NW monsoon season polygastric and eudoxid phases occurred all over the Indian Ocean (down to 40°S latitude). The polygastric phase occurred in great numbers in Gulf of Aden, east coast of India (Madras), Sri Lanka and southern tip of Africa. The eudoxid phase occurred in great numbers in the Gulf of Aden, off Gulf of Oman, east coast of India and Sri Lanka, southern tip of Africa and a small region in the mid-ocean. *D. dispar* occurred more along the coastal regions than in the central oceanic regions.

Its occurrence in the day collections was slightly more than in the night collections. It is further observed that *D. dispar* occurred almost throughout the year in all the eight regions of the Indian Ocean.

Monthly variations:

Arabian Sea: *D. dispar* is widely distributed on the western part (Arabian and Somali coast) during August and December. On the eastern part (Pakistan and Indian coast) it occurred during May and August, and to some extent during February and March.

Bay of Bengal: On the Indian region *D. dispar* is widely distributed during April (maximum) and January and July. On the Burma and Andaman region it occurred during September (maximum) and in March. It seems to be absent during January.

South West Indian Ocean: It occurred throughout the year. On the African coastal region it was widely distributed during January (maximum) July and October. In the oceanic region it seems to be more or less uniformly distributed.

South East Indian Ocean: It is widely distributed along 110°E longitude extending from south of Java to 35°S latitude mainly during August (maximum), January and April. It was not collected during November. In the oceanic region it occurred in many places during December and in less numbers during September. It was not collected during February.

45. **Diphyes bojani** (Eschscholtz, 1825)
(Fig. 52, a–e)

Eudoxia bojani Eschscholtz, 1825, p. 743, taf. 5, fig. 15 (eudoxid).

Diphyes bojani Bigelow, 1911, pp. 251, 256, pl. 7, figs. 2, 3, pl. 8; fig. 6; pl. 9, figs. 1, 2; pl. 10. figs. 2, 3; pl. 11, figs. 5, 7, 8; pl. 12, fig. 1.

Diphyes bojani Daniel, 1974, p. 121, Text-fig. 10, D–F.
(cf. for detailed synonymy)

Type Specimen: Place of deposit not known from literature.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 2 p.g. (compl.); 351 a.n.; 94 p.n.; 281 eu. (compl.) 103 br.; 308 sp. n. *Bay of Bengal:* 1 p.g. (compl.); 255 a.n.; 69 p.n.; 202 eu (compl.); 58 br.; 207 sp. n. *South West Indian Ocean:* 2 p. g. (compl.); 310 a.n.; 87 p.n.; 165 eu. (compl.); 78 br.; 228 sp. n.; *South East Indian Ocean:* 1 p.g. (compl.); 269 a.n.; 84 p.n.; 233 eu. (compl.); 71 br.; 286 sp. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 237 a.n.; 57 p.n.; 288 eu. (compl.); 49 br.; 158 sp. n. *Bay of Bengal:* 176 a.n.; 44 p.n.; 248 eu. (compl.); 52 br.; 150 sp. n. *South West Indian Ocean:* 143 a.n.; 47 p.n.; 107 eu. (compl.); 52 br.; 109 sp. n. *South East Indian Ocean:* 1 p.g. (compl.); 275 a.n.; 70 p.n.; 139 eu (compl.); 54 br.; 217 sp. n.

Polygastric phase: Anterior nectophore: (Fig. 52a) slenderly pyramidal, upto 14.0 mm in length, 4.0 mm in breadth with pointed apex; base not as broad as in *D. dispar;* five ridges, completely or partly serrated; dorsal and laterals ending in small triangular, recurved teeth around ostium; dorsal tooth not so large as in *D. dispar.* Nectosac 12.0 mm long, gradually narrows towards apex; radial canals as in *D. dispar;* somatocyst 5.0 mm long, lies against wall of nectosac not inclined as in *D. dispar.* Hydroecium 3.5–4.5 mm in length, deep, not inclined, ostium not as broad as in *D. dispar.* Mouth-plate undivided, with a prominent median vertical crest on dorsal side (diagnostic feature).

Posterior nectophore: (Fig. 52a, b) up to 10 mm in length, resemble *D. dispar* in shape, but very slender with basal half of ridges serrated. Characteristic median tooth-like crest present on dorsal side of mouth-plate. Ostial teeth and hydroecial tube as in *D. dispar.*

Eudoxid phase: (Fig. 52 c, d, e) total length about 6—7 mm. Bract–3.0 mm in length, 1.8 mm in breadth, shield-like in shape, thin, leaf-like with thickened mid region; with two teeth on serrated margin of bract. Bract attached parallel to long axis of special nectophore. Phyllocyst knob-like or with slight prolongation at one end, lying in mid-region of bract.

Special nectophore: 4.9 mm long; with 4 well serrated, flared out twisted ridges.

Gonophores: reduced, small sac-like (styloid type) without medusoid umbrella, of one sex in each eudoxid.

Distribution: (Maps 57 & 58; 59 & 60). *D. bojani* also is a very common and abundant species in the Indian Ocean. Its distribution and abundance in the Indian Ocean are given in maps 57, 58, 59 and 60.

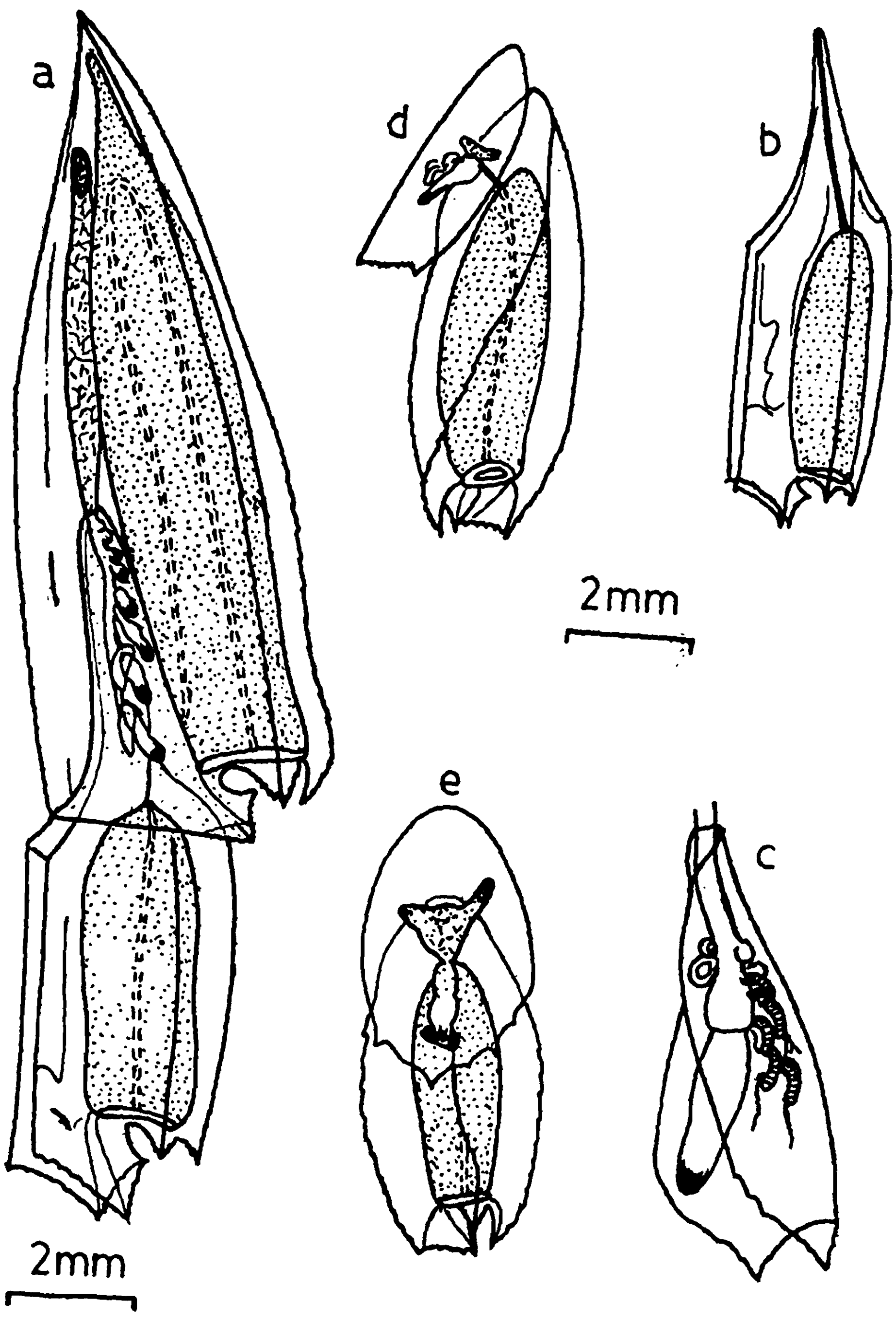
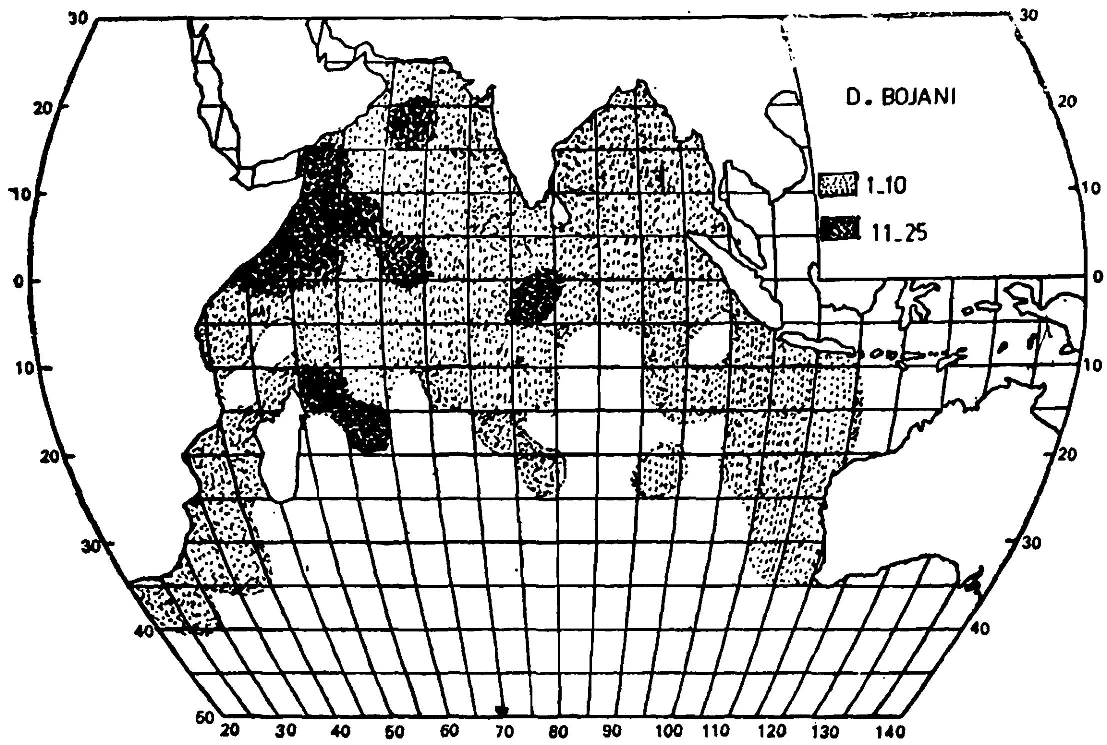
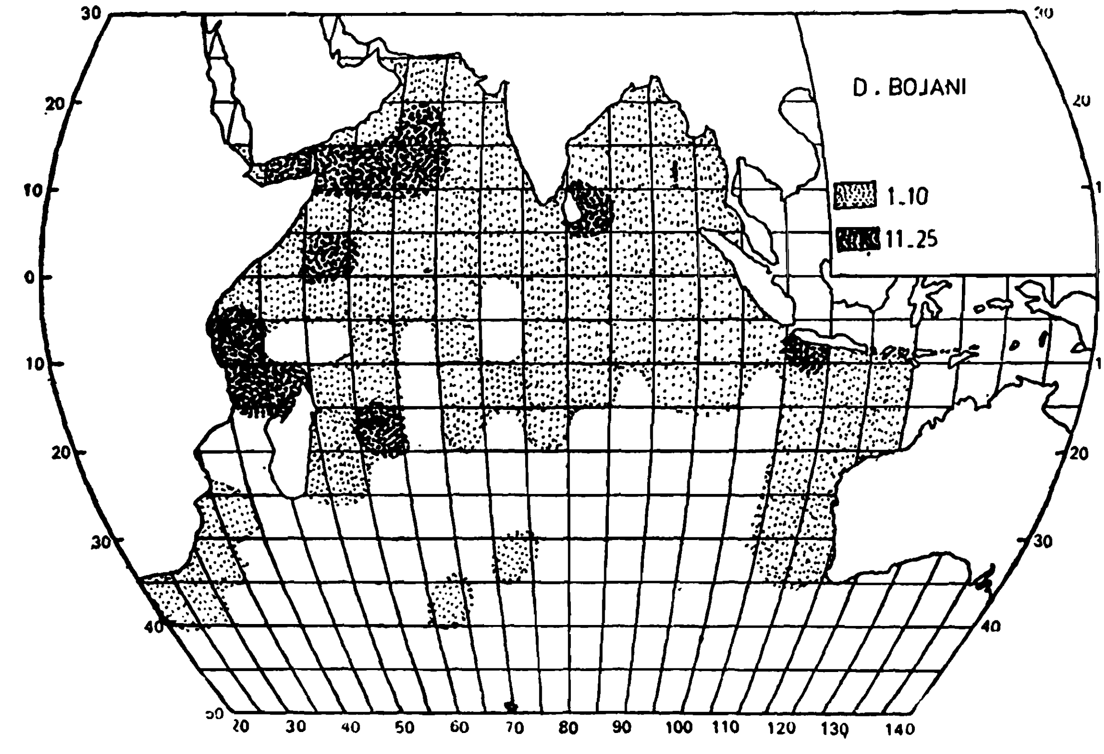


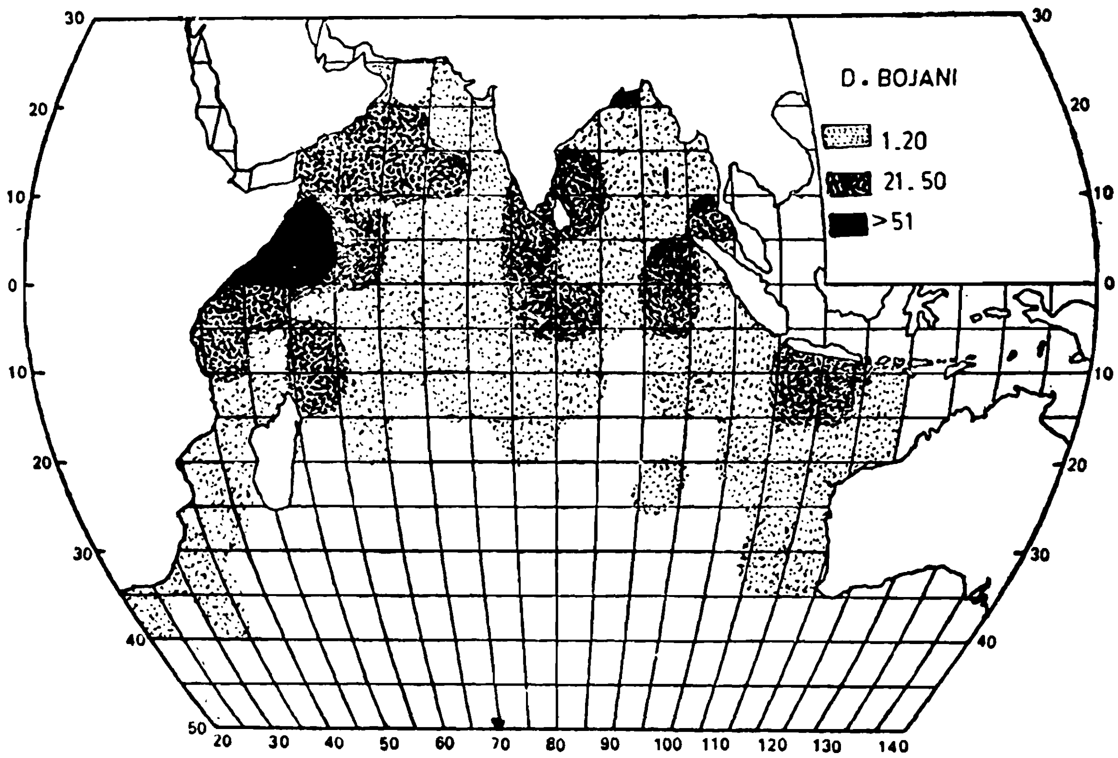
FIG. 52. *D. bojani* (Eschscholtz) (a–e). a. entire with both nectophores intact; b. posterior nectophore; c. cormidum; d & e. lateral & ventral view of eudoxid phase.



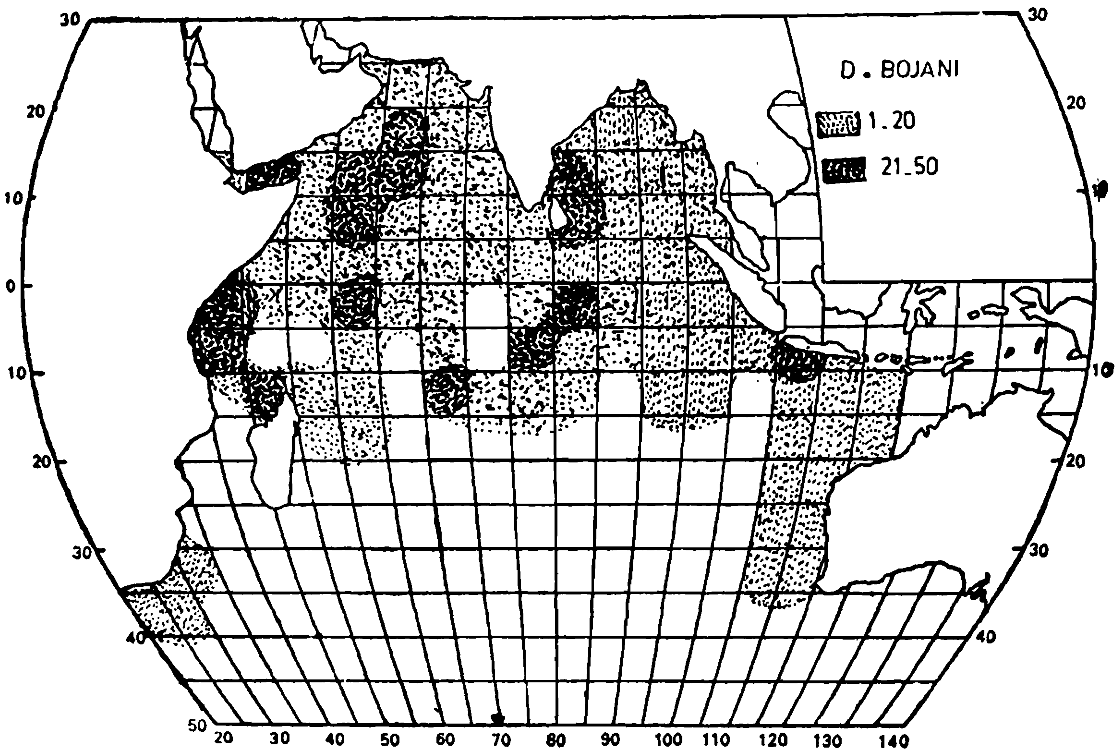
Map 57. Distribution of *D. bojani* — Polygastric phase during SW/SE monsoon season.



Map 58. Distribution of *D. bojani* — Polygastric phase during NE/NW monsoon season.



MAP 59. Distribution of *D. bojani* — Eudoxoid phase during SW/SE monsoon season.



MAP 60. Distribution of *D. bojani* — Eudoxid phase during SE/SW monsoon season.

A study of the distribution and abundance of *D. bojani*, as presented in these maps, reveals that it occurs, as with *D. dispar*, mainly along the land masses (40°S latitude) than in the mid-ocean region (25°S latitude). It is poorly represented below 10°S latitude.

During SW/SE monsoon season *D. bojani* occurred in greater abundance than during NE/NW monsoon season. The polygastric phase occurred in maximum numbers along Somali coast, Gulf of Aden, Chagos Archipelago and near equator in mid-ocean. The eudoxid phase occurred in large area in the Arabian Sea (1–20 eudoxids/haul) with the maximum density of more than 50/haul occurring only along the Somali coast. The density ranging from 21–50 in number per haul occurred on the east coast of India, Cape Comorin and Sri Lanka down to 5°S latitude, west of Malaya, west of Sumatra, south of Java and along the coast of Mombasa (Africa).

During NE/NW monsoon season the polygastric phase occurred in great abundance off Mombasa, Somali coast, Gulf of Aden and neighbouring region, Sri Lanka and South of Java. The eudoxid phase at the range of 1–20 example per haul, occurred on the coast of Africa and north-west of Madagascar, Gulf of Aden, central region of Arabian Sea, West and East coasts of India, south of Java and in mid-ocean (from equator — 15°S latitude).

D. bojani occurred in greater abundance in the Arabian Sea and Bay of Bengal than south of the Equator. It occurred more during the day time than during night time, in all the zones except in Bay of Bengal where the night/day collections were the same.

Monthly variations:

It occurred in all the eight regions of the Indian Ocean, throughout the year.

Arabian Sea: *D. bojani* is widely distributed on the western part during August (maximum) and also during December. Along the eastern part it appeared in vast areas during February, May (maximum) and August.

Bay of Bengal: *D. bojani* occurred in vast areas along the Indian coast and neighbouring regions during January, February, April (maximum) and July. Near Andamans and Burma it occurred during September.

South West Indian Ocean: On the African cost it occurred during January and October. In the oceanic region it appeared to be distributed more or less in an uniform manner throughout the year.

South East Indian Ocean: Along the 110°E longitude from south of Java to 35°S latitude it occurred mainly during January and August (maximum) and also during April and May. It was not collected during March and November. In the oceanic region, it is more or less uniformly distributed during the year except in February. During December it occurred in most of the places.

It is observed that *D. dispar* and *D. bojani* show similar pattern in their distribution and abundance in the Indian Ocean. Further, the number of eudoxids released by the polygastric phase is not correspondingly more where the maximum polygastric phase occurred, showing that the eudoxids (sexual phase) move away from their parent polygastric (asexual phase). The data collected showed that the eudoxid phases occurred in greater numbers in the near surface waters, *i.e.* above the thermocline.

46. **Diphyes chamissonis** Huxley, 1859
(Fig. 53 a–b)

Diphyes chamissonis Huxley, 1859, p. 36, pl. 1, fig. 3.
Diphyopsis chamissonis Bigelow, 1911, p. 347.
Diphyes chamissonis Daniel, 1974, p. 125, Text–fig. 10, G–I.
(cf. for detailed synonymy)

Type Specimen: British Museum (Nat. Hist.) London.

Material Examined: South West/South East Monsoon Season: *Arabian Sea:* 566 a.n.; 943 eu. (compl.); 562 br. 541 sp. n. *Bay of Bengal:* 411 a.n.; 264 eu. (compl.); 173 br.; 216 sp. n. *South West Indian Ocean:* 16 a.n.; 9 eu. (compl.) 3 br.; 11 sp.n. *South East Indian Ocean:* 89 a.n.; 37 eu. (compl.); 26 br.; 68 sp.n. North East/North West Monsoon Season: *Arabian Sea:* 370 a.n.; 553 eu. (compl.); 222 br.; 271 sp. n. *Bay of Bengal:* 121 a.n.; 213 eu. (compl.); 64 br.; 168 sp.n. *South West Indian Ocean:* 30 a.n.; 23 eu. (compl.); 2 br.; 12 sp. n. *South East Indian Ocean:* 16 a.n.; 8 eu. (compl.), 3 br.; 8 sp. n.

Polygastric phase: Consisting of only Anterior nectophore; posterior nectophore never developed.

Anterior nectophore: 10.0 mm long, firm, pyramidal, bulged in mid region, with 5 complete ridges serrated at base; 3 serrated teeth around ostium; somatocyst 3.5 mm long, thick spindle-shaped usually with oil globule, lying alongside of nectosac. Nectosac not produced into narrow tube at apex, sub-cylindrical slightly bulged; radial canals as in *D. dispar* and *D. bojani*. Hydroecium deep 4.75–5 mm long with square-shaped ostium.

Eudoxid phase: (Fig. 53 b) total length about 8.50 mm; bract — 3.75 × 1.8 mm; special nectophore — 4.75 × 2.0 mm. Bract similar to *D. dispar*. Neck-shield as long as head piece. extending down to half of special nectophore. Phyllocyst long, thick and fingershaped with oil globule.

Special nectophore articulates with bract at an angle of 45° to long axis; pedicular canal horizontal not oblique as in *D. dispar*, entering nectosac at a point below apex of nectosac. Each eudoxid with gonophores of one sex only; gonophores 5–6 in number sac-like devoid of medusoid umbrella (styloid type).

Type locality: East Coast of Australia.

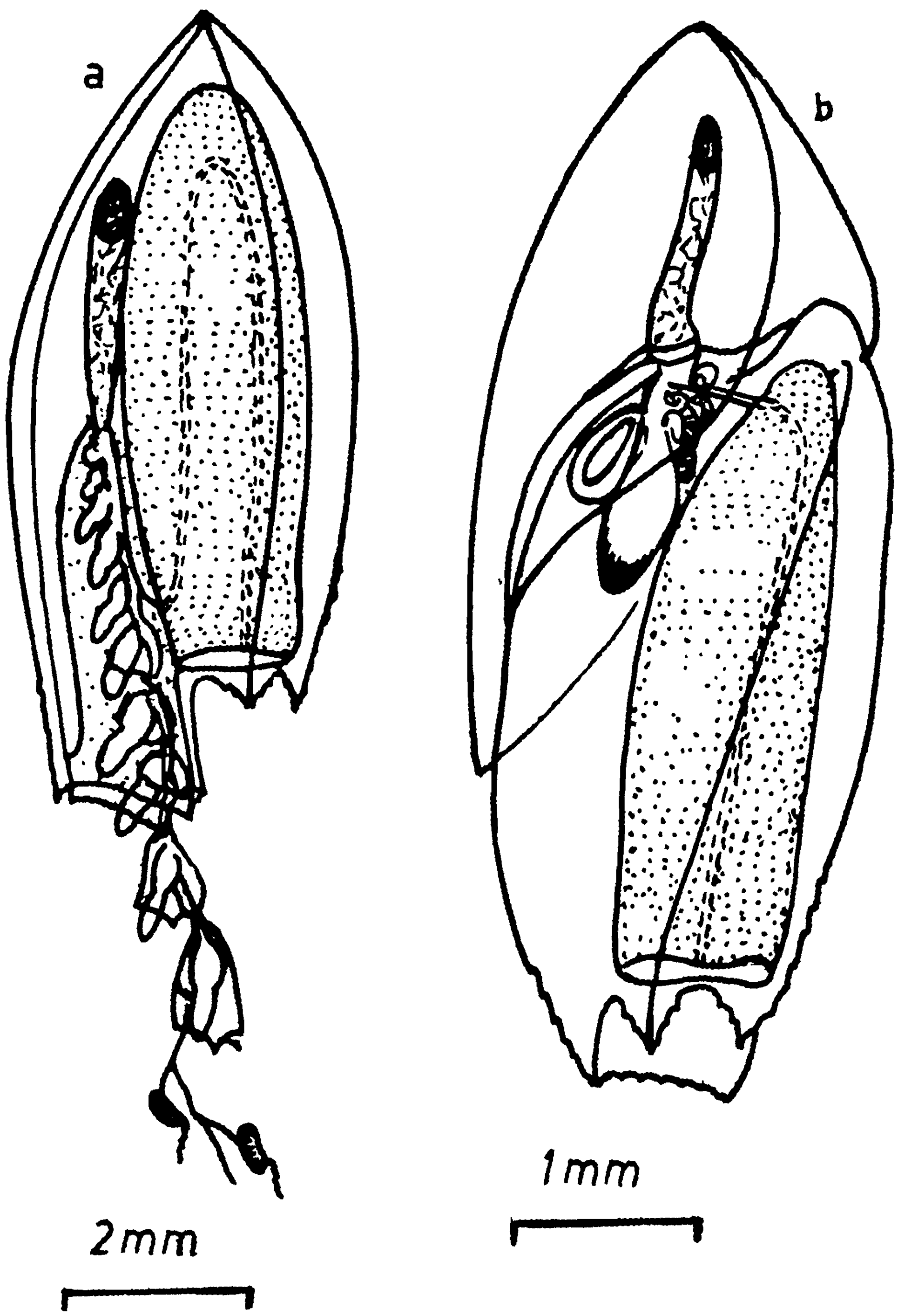


FIG. 53. *D. chamissonis* Huxley (a & b). a. anterior nectophore; b. eudoxid phase.

Distribution: (Maps 61 & 62). *D. chamissionis* is a neritic species which usually occurred in great abundance near the land masses. Its distribution and abudnance are given in maps 61 and 62.

The polygastric and eudoxid phases occurred in great abundance in the neritic zones in the Arabian Sea, Bay of Bengal and South of Java. It is rarely recorded on the south-east coast of Africa and western coast of Australia, during both the seasons. It generally, occurred in greater numbers during the day time than during the night.
Monthly variations:

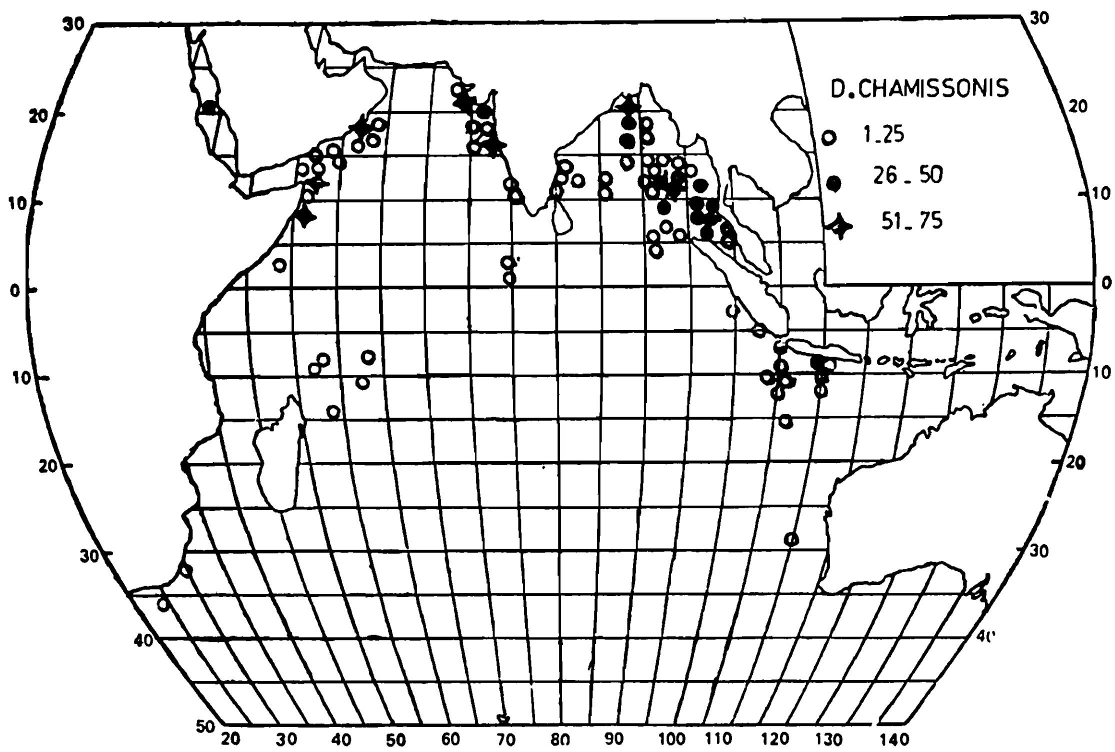
Arabian Sea: During SW/SE monsoon season *D. chamissonis* occurred along the Somali coast, Gulf of Aden, Red Sea and Arabian coast during June, July and August. On the Indian coast it occurred during May and near the Laccadive and Minicoy Islands during April. The number of examples per haul was greater in the neritic zones of Arabia and India than in the neritic areas surrounding the oceanic Islands (Chagos Archipelago and Laccadive and Minicoy Islands) during both the seasons. During NE/NW monsoon seasons it occurred in fewer number of stations. On the western part, it occurred in the Red Sea, Gulf of Aden, Arabian Coast and Gulf of Oman during October to December. On the eastern part, it occurred along the coast of Pakistan during October, November, and January to March along the Indian coast.

Bay of Bengal: During SW/SE monsoon season *D. chamissonis* occurred along the Madras coast during May and June and its distribution extended to the Central regions of the Bay of Bengal in a semi-circle and joined the coastal regions of Orissa. It occurred in great abundance around the Andaman group of Islands and between Sumatra and Malaya during August and September.

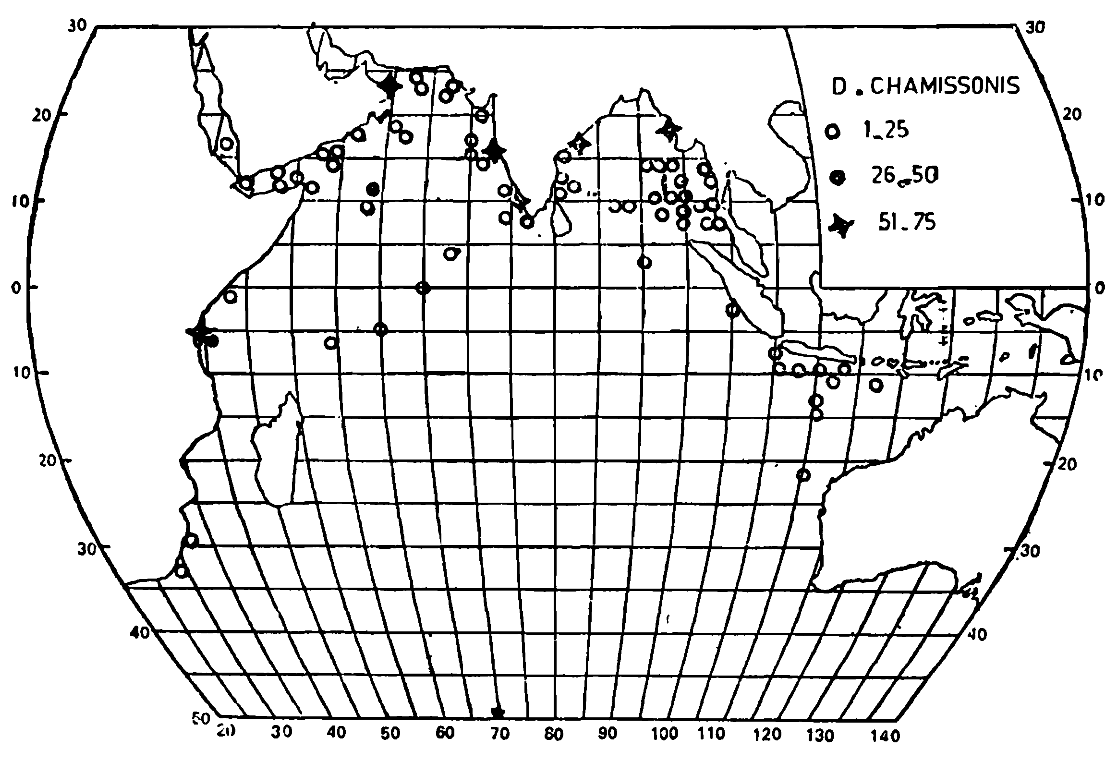
South West India Ocean: During both the seasons it occurred at few places on the south-east coast of Durban during January, April, July, September and October. On the coast of Mombasa it occurred during January. Near the Oceanic Islands it occurred during February and July.

South East Indian Ocean: It occurred mainly south of Java during January, February, April, May, July, August and December. It was rarely collected on the western coast of Australia.

The distribution of *D. chamissonis* in the Indian Ocean shows three interesting features — their occurrence (i) in abundance in the neritic zones along the coast line in the northern part of the Indian Ocean. (ii) in the oceanic region of the Bay of Bengal during both the monsoon periods and (iii) in the oceanic regions of the Arabian Sea from Laccadive Islands to Chagos group of Islands during January.



MAP 61. Distribution of *D. chamissonis* during SW/SE monsoon season.



MAP 62. Distribution of *D. chamissonis* during NE/NW monsoon season.

It is probable that their occurrence in the oceanic region may be due to the entry of the major rivers of India creating an upper layer of "low salinity water-mass" in the Bay of Bengal, influencing the distribution of the species.

Genus 27 **Lensia** Totton, 1932

Diphyinae with 3, 5, 7 or many nonserrated ridges in small anterior nectophore; very shallow hydroecium, short, rounded, overlapping divided mouth-plates; short or medium sized somatocyst and without ostial teeth. Posterior nectophore small, fragile, anteriorly truncated without peducle, and ostial teeth; lateral radial canals not looped but with apical bent (sigmoid curve). Eudoxids small, bracts with broad smoothly rounded very short neck-shield. With or without special nectophore, gonophores resembling posterior nectophor when present or reduced and saccular, and very short mouth plate.

The earliest record of *Lensia* was that of *L. conoidea* (Keferstein & Ehlers, 1861). Upto 1934, eight species now included in genus *Lensia* were known (Chun, 1886; Lens & van Riemsdijk, 1908; Bigelow, 1911a; Moser, 1925; and Leloup, 1933, 1934a). Twenty Seven species were added on to this list (Totton, 1941, 1954, 1965; Daniel & Daniel) 1963 a, b.; Daniel, 1970; Patriti, 1970; Stepanjants, 1970, 1977; Rengarajan, 1973 and Margulis 1970) Of these, *L. peresi* resembles *L. hotspur* Totton, 1941 in its shape, size, ridges and small inclined somatocyst but differs from it in possessing a shallow, slopping hydroecium and mouth-plates that do not overlap. However, the depth of hydroecium varies in a number of specimens, and the mouth-plates are either overlapping or not overlapping depending upon the state of preservation. Therefore, *L. peresi* is treated as a doubtful species. *L. minuta* and *L. multilobata* are considered as valid species differing from all the other species of *Lensia*. A study of these thirty-five species shows that the number of ridges varies greatly, but they have certain common characters such as the shallow hydroecium (except in *L. havock* Totton; *L. exeter* Totton, *L. hostile* Totton), short somatocyst (except in *L. conoidea* (Keferstein and Ehlers) *L. multicristata* (Moser) and *L. panikkari* Daniel), lack of ostial teeth and the lateral radial canals of the posterior nectophore (when known) being slightly curved at their proximal ends.

Diagnostic characters of *L. asymmetrica* Stepanjants, 1970; *L. zenkevitchi* Margulis, 1970 and *L. canupusi* Stepanjants, 1977 are not available for the preparation of keys. According to Margulis (1970), *L. zenkevitchi* resembles *L. hostile*. These species were not collected from the Indian Ocean.

Type Species: Lensia subtiloides (Lens & van Riemsdijk, 1908)

The species of *Lensia* are divided into four main groups "A", "B", "C", "D", for easy identification (Daniel, 1974).

The Group "A" is characterized by the occurrence of five complete (or some incomplete) ridges in the anterior nectophores. It is furher sub-divided into four small sub-groups, viz., A 1-4.

The Group "B" is distinguished by the apically blunt anterior nectophores which lack complete ridges.

The Group "C" is demarcated by its members all having seven ridges complete, or some incomplete.

The Group "D" is diagnosed by the occurrence of many ridges — the multicristate forms, which may have a velar ridge above the ostium of the nectosac.

Key to the four groups of species of the Genus **Lensia**

1.	Nectophore with 3–5 ridges.... ...	2
	Nectophore with 7 or multiple ridges....	3
2.	Nectophore with 5 complete or some incomplete ridges, with pointed tip..	Group "A"
	Nectophore with blunt apex which lacks complete ridges..	Group "B"
3.	Nectophore with 7 complete or some incomplete ridges..	Group "C"
	Nectophore with multiple (many crested) ridges with or without velar ridges..	Group "D"

The list of the 33 valid species of *Lensia* is given below:

Group A

Sub-group "A–1"

1. *Lensia subtiloides* (Lens & van Riemsdijk, 1908). 2. *L. conoidea* (Keferstein & Ehlers, 1861). 3. *L. hotspur* Totton, 1941. 4. *L. gnanamuthui* Daniel & Daniel, 1963b. 5. *L. roonwali* Daniel, 1970. 6. ? *L. peresi* Patriti, 1970.

Sub-group "A–2"

7. *L. hardy* Totton, 1941. 8. *L. fowleri* (Bigelow, 1911a). 9. *L. challengeri* Totton, 1954. 10. *L. minuta* Patriti, 1970.

Sub-group "–3"

11. *L. achilles* Totton, 1941. 12. *L. baryi* Totton, 1965b. 13. *L. cordata* Totton, 1965b.

Sub-group "A–4"

14. *L. leloupi* Totton, 1954. 15. *L. tottoni* Daniel & Daniel, 1963a. 16. *L. panikkari* Daniel, 1970. 17. *L. nagabhushanami* Daniel, 1970.

GROUP B

18. *L. campanella* (Moser, 1925). 19. *L. cossack* Totton, 1941. 20. *L. subtilis* (Chun, 1886). *L. subtilis* var. *chuni* Totton, 1965. 21. *L. meteori* (Leloup, 1934a). 22. *L. tiwarii* Daniel, 1970.

GROUP C

23. *L. multicristata* (Moser, 1925). 24. *L. hunter* Totton, 1941. 26. *L. havock* Totton, 1941.

GROUP D

26. *L. lelouveteau* Totton, 1941. 27. *L. exeter* Totton, 1941. 28. *L. hostile* Totton, 1941. 29. *L. grimaldi* Leloup, 1933. 30. *L. ajax* Totton, 1941. 31. *L. reticulata* Totton, 1954. 32. *L. multilobata* Rengarajan, 1973.

Key to species of LENSIA

(Modified after Totton, 1965)

Group A

Sub-group A-1: (with complete lateral ridges):

1.	Five complete non-crested straight ridges...	2
	Five non-crested ridges, with right-ventral ridge not reaching apex; all ridges slightly twisted.	*roonwali*
2.	Five complete non-crested straight ridges; short somatocyst either stalked or non-stalked and inclined.	3
	Five complete non-crested straight ridges, somatocyst either half as long as nectophore or very minute..	4
3.	With short, stalked somatocyst; mouth-plates 1/3rd as long as somatocyst.	*subtiloides*
	With short, non-stalked and inclined somatocyst.	*hotspur* (= ?*peresi*)
4.	Somatocyst half as long as nectophore.. ..	*conoidea*
	Somatocyst very minute, placed close to ventral corner of nectosac..	*gnanamuthui*

Sub-group A–2: (with complete, straight, lateral ridges, somatocyst lying at or below ostial level):

1.	Five single crested ridges; somatocyst below ostial level..	2
	Five single crested ridges; somatocyst at level of ostium; hydroecium extending below somatocyst; with notch in baso-ventral ridge......	3

2.	Five single crested ridges; somatocyst horizontal, below ostial level; hydroecium not extending below somatocyst..	*fowleri*
	Five single crested ridges; somatocyst spheroidal, with beak-shaped basal extension of dorsal ridge...	*challengeri*
3.	Somatocyst borne on very thin stalk, inclined ventrally..	*hardy*
	Somatocyst borne on thick, short stalk not inclined ventrally...	*minuta*

Sub-group A – 3 (with complete, but distal ends of, lateral ridge bent dorsal):

1.	With short either spindle-shaped or heart-shaped somatocyst..	2
	With long somatocyst with terminal constriction....	*baryi*
2.	With short spindle-shaped somatocyst...	*achilles*
	With short heart-shaped somatocyst..	*cordata*

Sub-group A – 4 (With lateral ridges not reaching ostium)

1.	Somatocyst lying close against wall of nectosac..	2
	Somatocyst not lying close against wall of nectosac....	3
2.	Somatocyst lying close against wall of nectosac; more than half as long as nectophore.	*panikkari*
	Somatocyst lying close against wall of nectosac; short...	*nagabhushanami*
3.	Somatocyst short, not lying close against wall of nectosac; mouth-plates half as long as somatocyst.	*leloupi*
	Somatocyst short, not lying close against wall of nectosac, inclined ventrally....	*tottoni*

Group B

1.	Three non-crested ridges only (no ventro-lateral ridges between lateral and ventral facet)..	2
	Ridges very inconspicuous, somatocyst short, tubular and inclined over nectosac..	*tiwarii*
2.	Three non-crested ridges; apex of nectophore either twisted or not twisted..	3
	Three to five non-crested, furrowlike ridges...	4
3.	Three non-crested ridges; apex of nectophore twisted; very minute mouth-plates........	*campanella*
	Three non-crested ridges; apex of nectophore not twisted; with short mouth-plates...	*cossack*
4.	Three to five non-crested, furrowlike ridges; somatocyst globular and long, thin pedicel.	*subtilis*
	Three to five non-crested furrowlike ridges; somatocyst small on very short pedicel...	*meteori*

Group C

1.	Five crested longitudinal ridges and two ventrolateral crests; some incomplete.....	2
	Seven crests, complete, apex to base..	*havock*
2.	Seven crests, some incomplete, ventrolateral pair meeting mouth-plate...	*hunter*
	Seven crests some incomplete, ventrolateral pair not meeting mouth-plate....	*multicristata*

Group D

1.	Five ridges, each with more than a single crest.	2
	At least five ridges; branching with reticulations or lobed..	6
2.	Five two-crested ridges and a horizontal basal (velar) ridge..	*grimaldi*
	Five ridges each with more than two crests and a velar ridge..	3
3.	Five multicristate ridges and a velar ridge..	4
	Five multicristate ridges but no velar ridge...	5
4.	Five multicristate (3) ridges and a velar ridge......	*exeter*
	Five multicristate (3–7) ridges and a velar ridge........	*lelouveteau*
5.	Five multicristate ridges; no velar ridge; crests extending to ostium...	*hostile*
	Five multicristate ridges; no velar ridge; crests not extending to ostium....	*ajax*
6.	At least 5 ridges; branching with reticulation.	*reticulata*
	With scale-like extensions of ridges, appearing like lobes all over nectophore..	*multilobata*

Except *L. baryi* all the species of *Lensia* are represented in the Indian Ocean.

The following eighteen species of *Lensia* are represented in the Indian Seas:

Group A: Sub-group A–1 : *Lensia subtiloides; L. hotspur, L. gnana muthui & L. conoidea. Sub-group A–2: L. fowleri & L. challengeri. Sub-group A–3:* no representatives. *Sub-group A–4 : L. leloupi: L. panikkari;. L. nagabhushanami, L. tottoni.*

Group B: L. campanella; L. cossack; L. subtillis; L. meteori.

Group C: L. multicristata.

Group D: L. lelouveteau, L. multilobata, & L. ajax.

47. **Lensia subtiloides** (Lens & van Riemsdijk, 1908) (Fig. 54 a–d)

Diphyes subtiloides Lens & van Riemsdijk, 1908, p. 46, pl. 7, figs. 59–61.
Lensia subtiloides Daniel, 1974. p. 130, Text-fig. 10, J–N.
(cf. for detailed synonymy)

Type specimen: Zoologisch Museum, Amsterdam.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 4 p.g. (compl.); 740 a.n.; 352 p.n.; 116 br.; 505 go; 1 eu (compl.). *Bay of Bengal:* 1290 a.n.; 3C8 p.n.; 4 p.g. (compl.); 55 br.; 897 go.; 2 eu. (compl.). *South West Indian Ocean:* 38 a.n.; 12 p.n.; 1 go. *South East Indian Ocean:* 94 a.n.; 24 p.n.; 1 br.; 1 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 804 a.n.; 272 p.n.; 5 eu. (compl.); 328 br.; 773 go. *Bay of Bengal:* 537 a.n.; 70 p.n.; 57 br.; 201 go;. 4 eu (compl.). *South West Indian Ocean:* 13 a.n.; 5 p.n.; 4 go. *South East Indian Ocean:* 30 a.n.; 7 p.n.; 2 br.; 5 go.

Polygastric phase: Anterior nectophore: About 6.7 mm long, 3.5 mm wide at base, with 5 complete non-crested, non-serrated ridges. Somatocyst upto 2.2. mm in length, club-shaped, inclined towards ventral wall of nectophore. Hydroecium shallow conical depression, 0.5 mm in depth, lying at level of ostium. Mouth-plates small rounded divided and over-lapping.

Posterior nectophore: Upto 5.0 mm in length and 2.0 mm in breadth. Ridges as in anterior nectophore. Hydroecium-very shallow open groove. Mouth-plate small, undivided and rounded in shape. Pedicular canal entering nectosac nearly at apex. With a small tooth at apex of right hydroecial fold.

Eudoxid phase: Bract 2.0 mm long, conical, neck-shield short with rounded smooth margin, bracteal cavity conical; phyllocyst club-shaped. Special nectophore similar to posterior nectophore but smaller about 3.5 mm in length. Sexes separate in eudoxid phase; gonophores highly reduced without umbrella, sac-like (styloid type.)

Type locality: Sulu Island, Malay Archipelago.

Distribution: (Maps 63 & 64). The number of records, distribution, and abundance of *L. subtiloides* are presented in maps 63 and 64. Number of specimens per haul ranged from 1–15, 26–50 and 51–75.

L. subtiloides occurred in great abundance in the Arabian Sea and Bay of Bengal than in the South West and South East Indian Ocean. Except in Bay of Bengal during NE/NW monsoon season, *L. subtiloides* occurred in greater number of stations during day time. In the South West and South East Indian Ocean very few records of this species were made during NE/NW monsoon season.

Being a neritic species *L. subtiloides* occurred in great abundance along the coastal regions, during both the seasons. Their density of occurrence in the different regions ranged from a maximum of

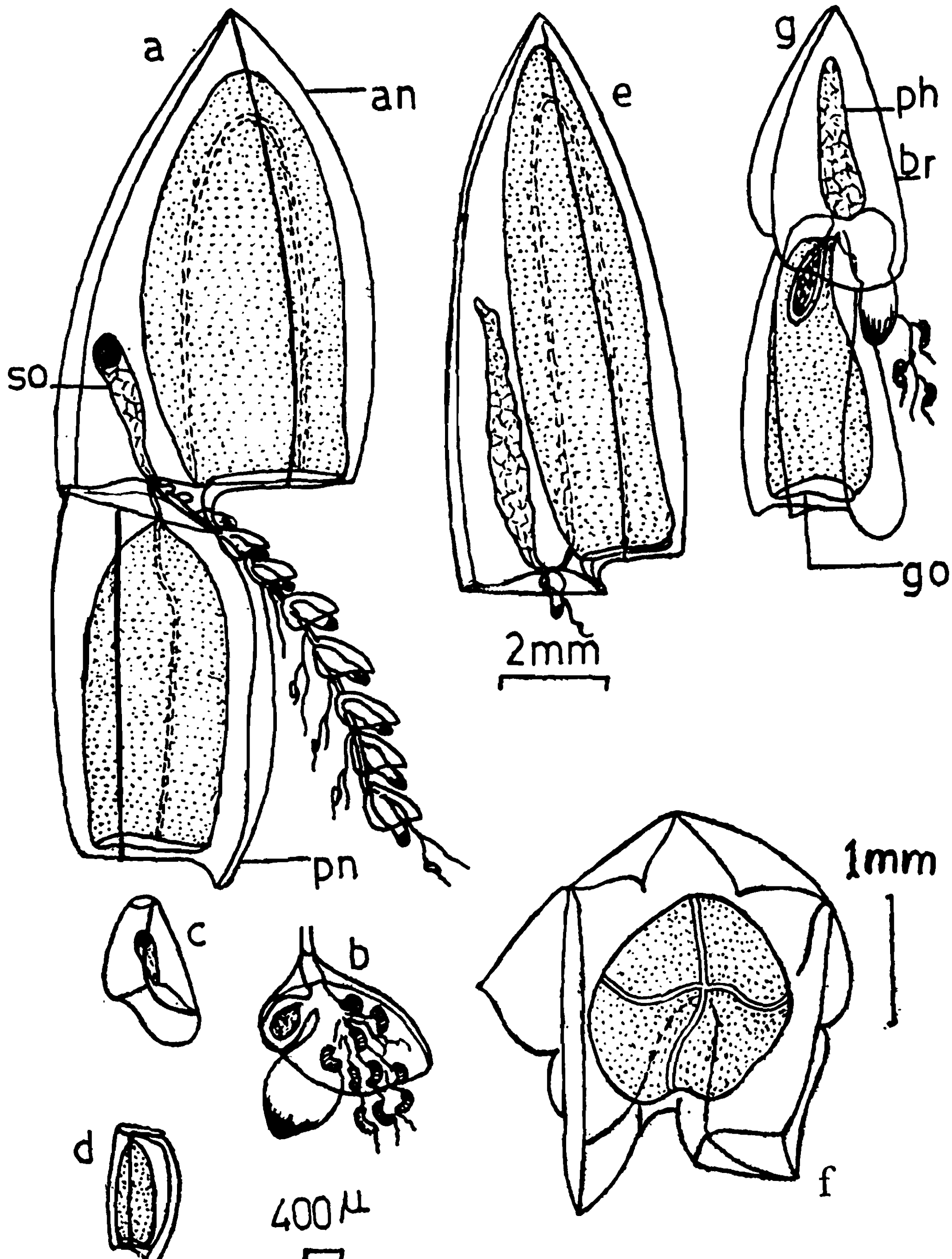
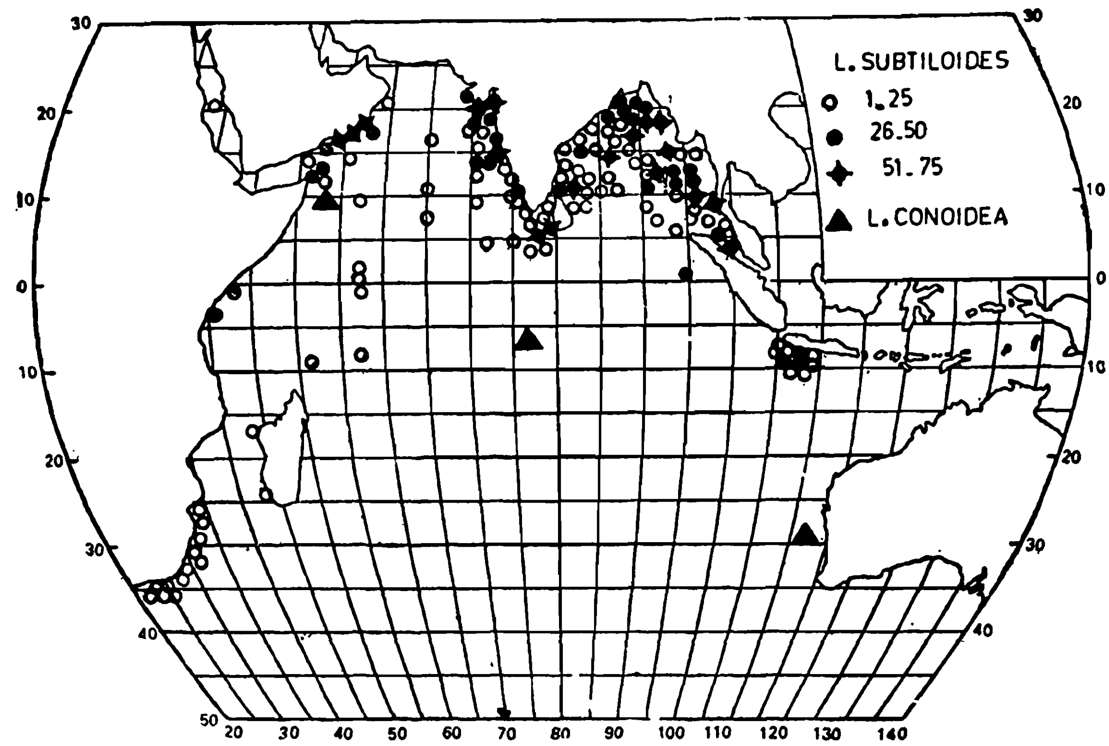
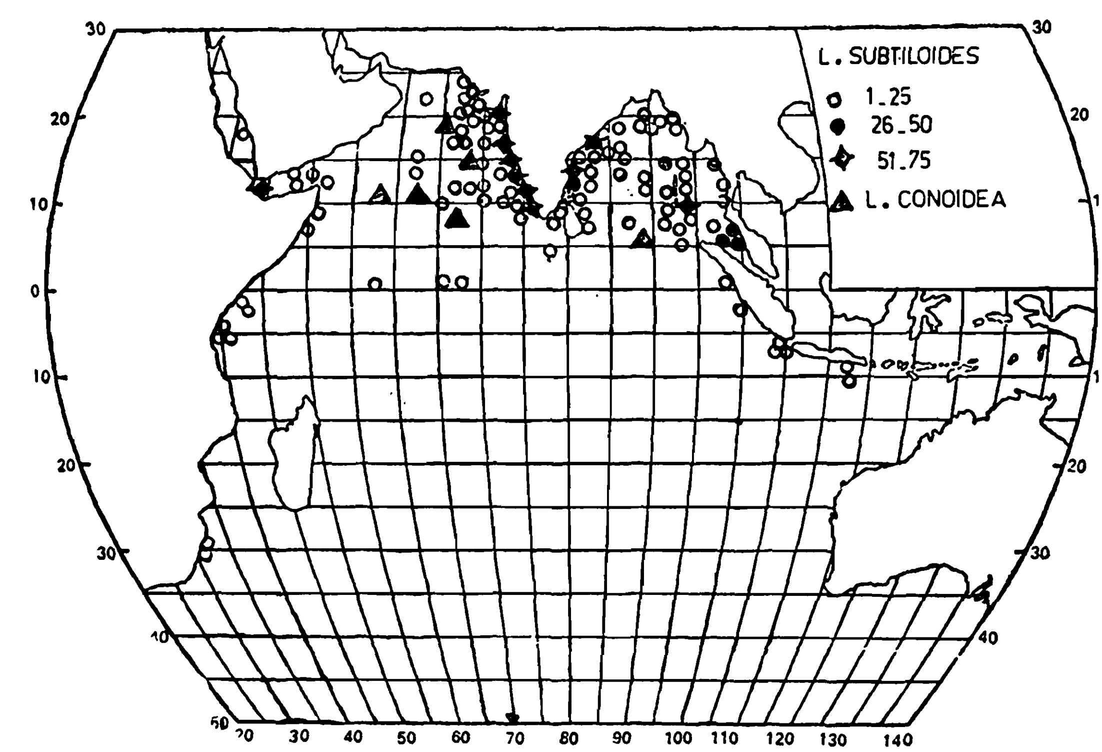


FIG. 54. *L. subtiloides* (Lens & van Riemsdijk) (a–d). a. polygastric phase — with both nectophores intact; b. cormidium; c. eudoxid — phase — bract; d. special nectophore. *L. conoidea* Kefferstein & Ehlers (e–g). e. anterior nectophore; f. posterior nectophore; g. eudoxid phase. (an – anterior nectophore; br – bract; go – gonophore; ph – phylocyst; so – somatocyst). Fig. e after Bigelow & Sears, 1937, fig. 27; Fig. g after Moser, 1925, pl. 4, fig. 3; Fig. f after Totton, 1954, fig. 56).



MAP 63. Distribution of *L. subtiloides* and *L. conoidea* during SW/SE monsoon season.



MAP 64. Distribution of *L. subtiloides* and *L. conoidea* during NE/NW monsoon season.

51–75 specimens per haul and a minimum of 1–25 per haul. The eudoxid phases were collected at most of the time along with the polygastric phases.

Monthly variations:

Arabian Sea: In the western region it occurred at the maximum number of places, during June and July. It was not collected during January, March, September and October. In the eastern region it occurred in great abundance during May and in lesser number of places during February and March. It occurred throughout the year.

Bay of Bengal: In the Indian region it occurred in maximum number of places (Stations) during April and June and in lesser number of stations during January. It was not collected during October and November. In the Andaman and Burma region it was mostly collected during March and September. It was not collected during January, June and December.

South West Indian Ocean: Along the African coast it was recorded during January, April, June, July, August, September, October and November. In the oceanic region it occurred near Seychelles and Mauritius Islands only during January, June and July. It did not occur in the mid-oceanic region.

South East Indian Ocean: Along the 110°E longitude it occurred mostly south of Java during January, February, April, May, July, August and September and along the south western coast of Australia during February. In the oceanic region it occurred near some islands during December.

Although *L. subtiloides* is considered to be a true neritic species, its distribution in the Indian Ocean shows that it can tolerate varying range of salinity *i.e.* its occurrence in the junction of the Red sea and Gulf of Aden known for its high salinity (Totton, 1954), and in the coastal regions where big rivers enter the sea (areas of low salinity). Further, in the Bay of Bengal it is seen that *L. subtiloides* occurred in greater abundance along the coast of India, across the Bay of Bengal to Andaman Islands and between Sumatra and Malaya. This was probably because of the presence of an upper layer of water mass with low salinity due to the emptying of the major Indian rivers (Godavari, Krishna, Mahanadi, Ganges and Bhrahmaputra) into the Bay of Bengal.

48. **Lensia conoidea** (Keferstein & Ehlers, 1861)

(Fig. 54 e–g)

Diphyes conoidea Keferstein & Ehlers, 1861, p. 16 pl. V, b.
Lensia conoidea Daniel, 1974, p. 132, Text-fig. 10, 0 & P.
(cf. for synonymy)

Type Specimen: Place of deposit not known from literature.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 4 a.n. *South West Indian Ocean:* 1 a.n. *South East Indian Ocean:* 4 a.n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 6 n. *Bay of Bengal:* 3 a.n.

Polygastric phase: Anterior nectophore: Upto 20 mm long, firm, slenderly pyramidal with 5 complete, straight ridges; dorsal ridge extending beyond level of ostium into a small tooth-like projection. Somatocyst half of nectosac in length, thick, or thin with a short stalk. Hydroecium shallow; right hand wing of mouth-plate overlapping left side. Pedicular canal descending.

Posterior nectophore: Upto 18 mm long, with 5 complete ridges. Apical end of nectosac extend beyond entry of pedicular canal. Mouth-plate with notch in middle, left lobe longer than right. Articulating surface of right hydrecial wing square shaped.

Eudoxid phase: Relatively large. Bract conical, with long phyllocyst. Gonophores 4.5 mm long, with a mouth-plate 0.35 long, and slightly convex distal border. Right or left hydroecial ridge may be deeper with corresponding difference in twisting of hydroecium.

Type Locality: Naples and Messina, Italy, Mediterranean Sea.

Distribution: (Maps 63 & 64). Recorded from south and east coast of Africa; from south east Indian Ocean and Arabian Sea, during October and November; from Bay of Bengal during December.

49. **Lensia hotspur** Totton, 1941

(Fig. 55 a–b)

Lensia hotspur Totton, 1941, p. 155, figs. 14–16.
Lensia hotspur Daniel, 1974, p. 133, text-fig. 11, C & D.
(cf. for detailed synonymy)

Type Specimen: British Museum (Nat. Hist.), London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 2 p.g. (compl.); 521 a.n.; 319 p.n.; 18 eu. (compl.); 144 br.; 359 go. *Bay of Bengal:* 480 a.n.; 329 p.n.; 10 eu. (compl.) 146 br.; 332 go.; 2 p.g. (compl.); *South West Indian Ocean:*

470 a.n.; 267 p.n.; 30 eu. (compl.); 100 br. 326 go. *South East Indian Ocean:* 1 p.g. (compl.); 489 a.n.; 210 p.n.; 47 eu. (compl.); 126 br.; 265 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 1 p.g. (compl.); 683 a.n.; 397 p.n.; 50 eu. (compl.); 543 br.; 800 go. *Bay of Bengal:* 377 a.n.; 224 p.n.; 6 eu. (compl.) 65 br. 109. go. *South West Indian Ocean:* 2 p.g. (compl.); 460 a.n.; 265 p.n.; 25 eu (compl.), 254 br; 492 go. *South East Indian Ocean:* 259 a.n.; 120 p.n.; 15 eu. (compl.); 52 br. 98 go.

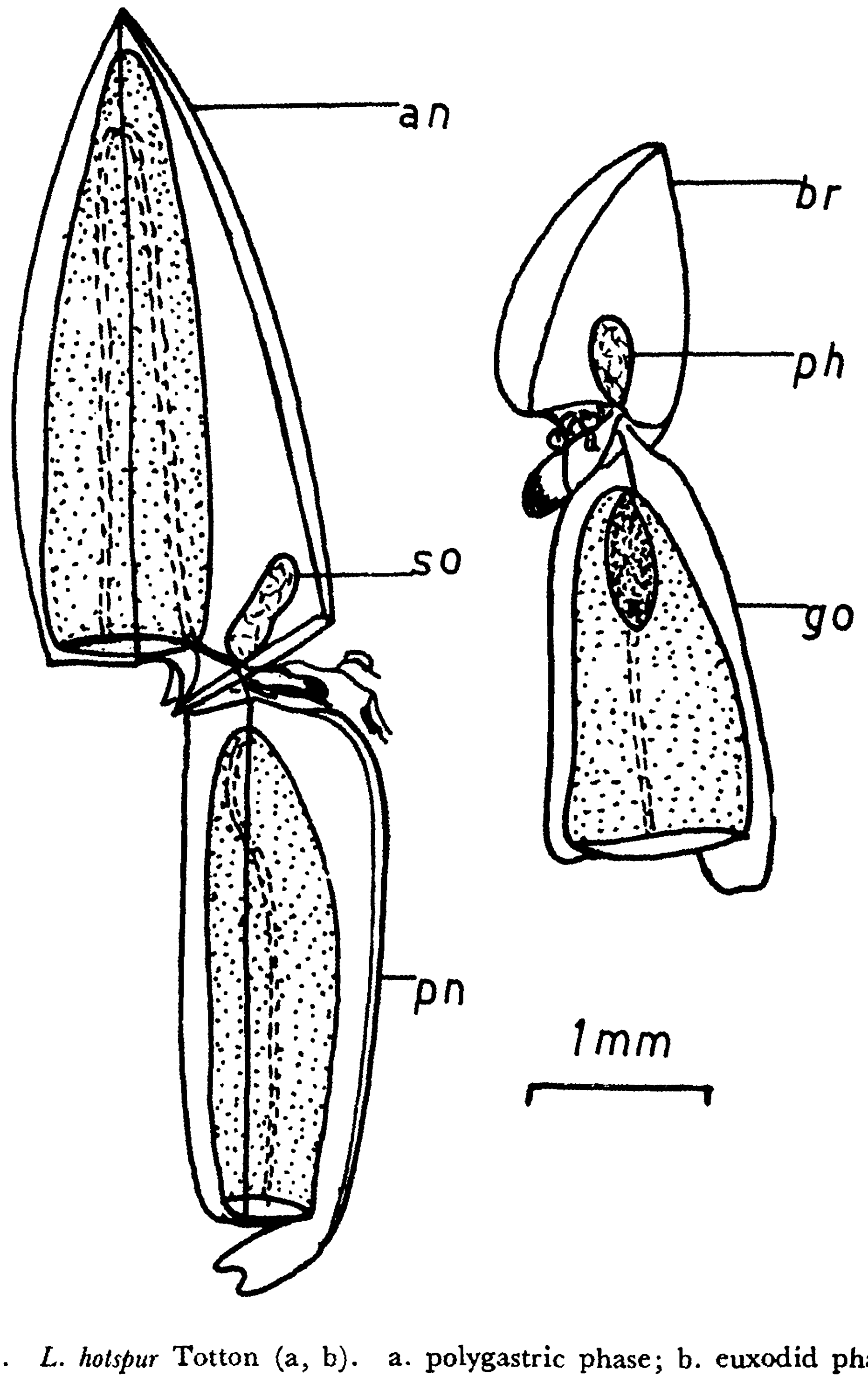


FIG. 55. *L. hotspur* Totton (a, b). a. polygastric phase; b. euxodid phase.

Polygastric phase: Anterior nectophore: 5.0–7.0 mm long, 2.3 mm wide,· slenderly pyramidal, with 5 complete straight ridges. Hydroecium very shallow or usually absent. Somatocyst, small (0. 65 mm) ovate or club-shaped inclined towards ventral side, without stalk; base of somatocyst project slightly below baso-lateral ridge. Mouth-plates short and overlapping.

Posterior nectophore: Nearly equal to anterior nectophore in length. Mouth-plate with rounded notch in distal margin. Upper articulating end of left ventral hydroecial wing not square but angular.

Eudoxid phase: Bract 1.2 mm long, as in *L. subtiloides;* phyllocyst long and slender, neck-shield smooth. *Gonophore*-like posterior nectophore but small, with a notch in mouth plate.

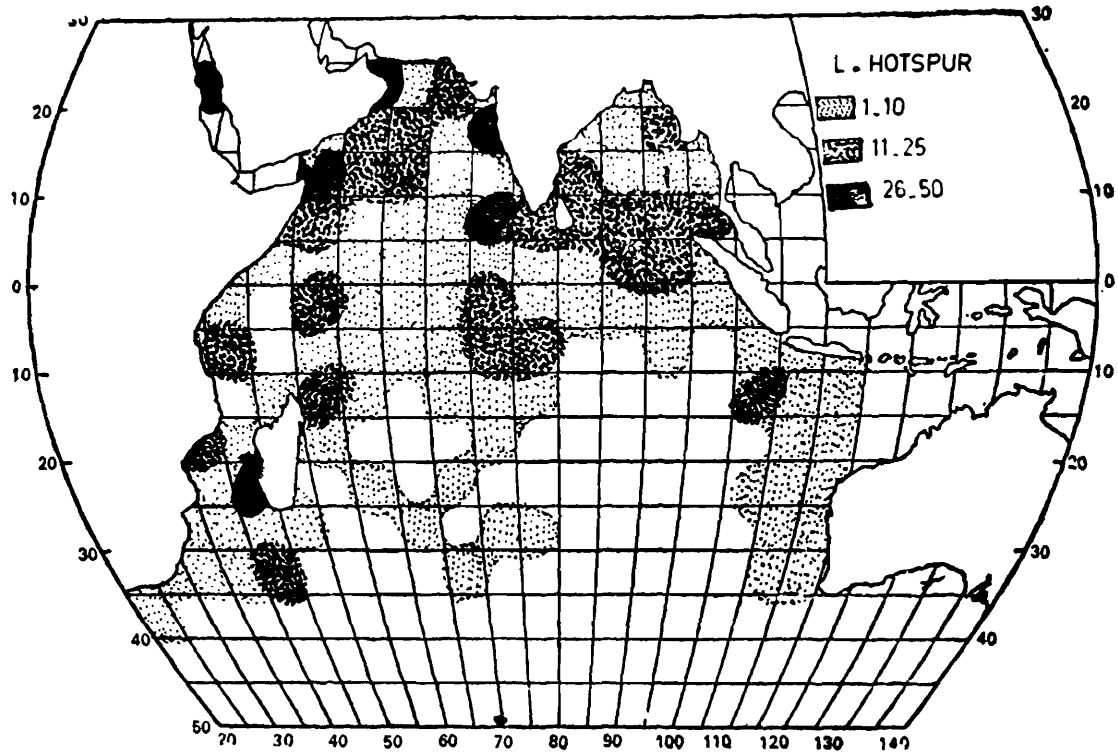
Type locality: Off Cape of Good Hope, South Atlantic Ocean.

Distribution: (Maps 65, 66, 67 & 68). The numbr of reords, distribution in the Indian Ocean during the two monsoon seasons are presented in maps 65, 66, 67 and 68.

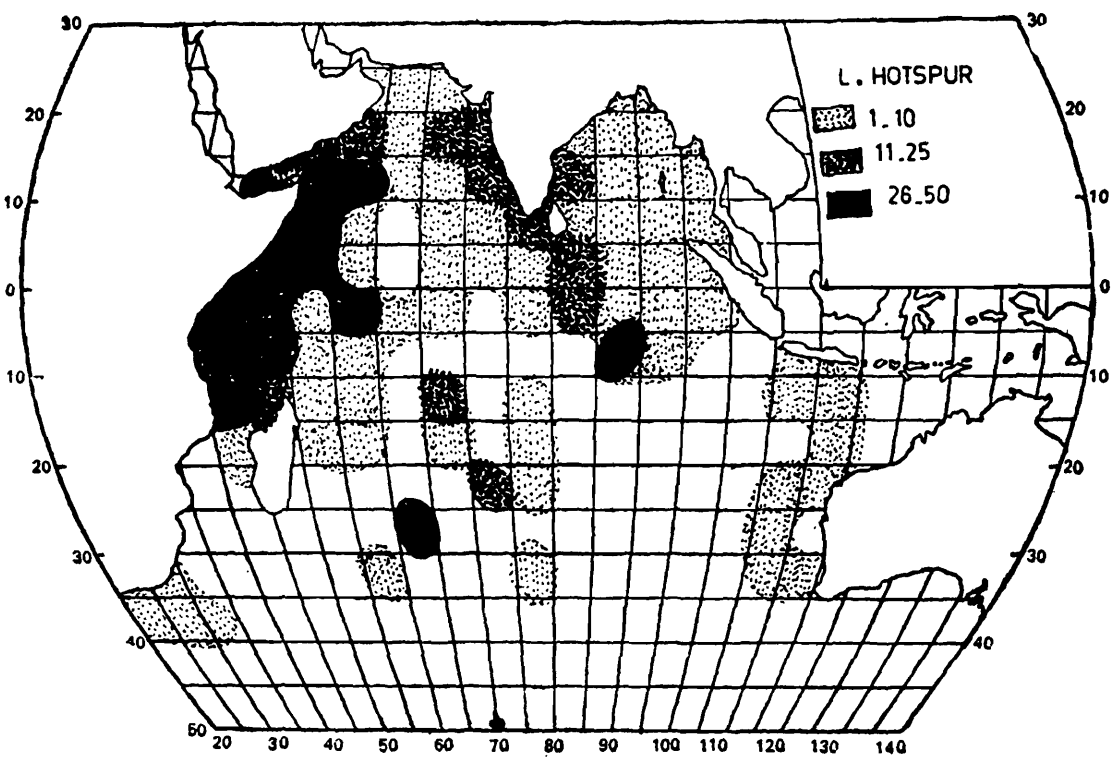
L. hotspur occurred in great abundance in the four zones of the Indian Ocean during both the seasons. The day collections were more in the Arabian Sea, and South West Indian Ocean during both the seasons and during SW/SE monsoon season in the South East Indian Ocean.

The maps 65 and 67 shows the distribution and abundance of the polygastric and eudoxid phases of *L. hotspur* during SW/SE monsoon season. The highest density range of 26-50 polygastric phases per haul occurred in the Red Sea, Gulf of Aden, Gulf of Oman, along Bombay and Goa, off Cochin and south west of Madagascar. The lower density of 11–25 polygastric phases/haul occurred along the Arabian Coast to 65°E longitude in the Arabian Sea, along Karachi, Somali Coast, Mombasa coast, South Africa (20°S latitude) north of Madagascar, off Cape Comorin, coast of Madras, Burma coast, rich belt across the Bay of Bengal, off south of Java and in the mid-ocean near the equator. The highest density range of eudoxids per haul (26–50) occurred in the Red Sea, Gulf of Aden, Gulf of Oman, Arabian Coast, South Africa (20°S latitude) and off south of Java. The next range 11–25 eudoxids per haul occurred around peninsular India, across the Bay of Bengal as a "rich belt" and near the Somali coast and Mombasa.

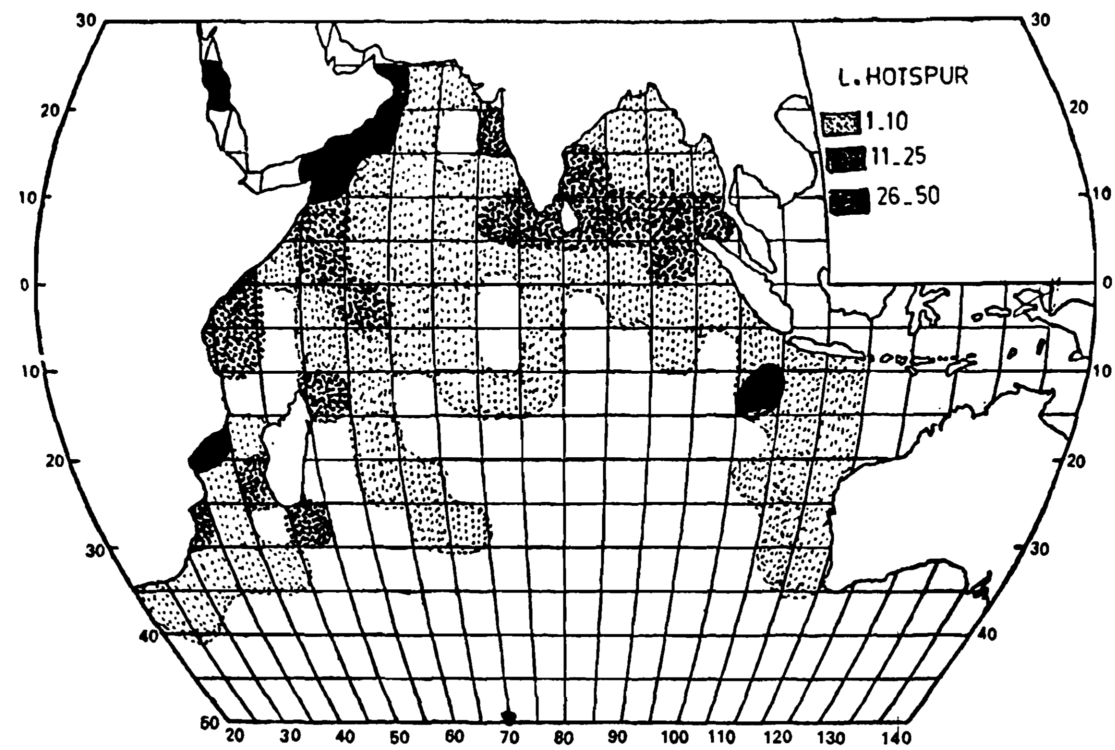
During NE/NW monsoon season (maps 66 & 68) the highest range of 26–50 polygastric phases per haul occurred along the Somali coast and Mombasa. The next range of 11–25 polygastric phases per haul occurred in the Gulf of Aden, Off Somali coast, Madras coast Burma and Malaya, north of Madagascar and in the central regions of the Ocean. The highest number of 26–50



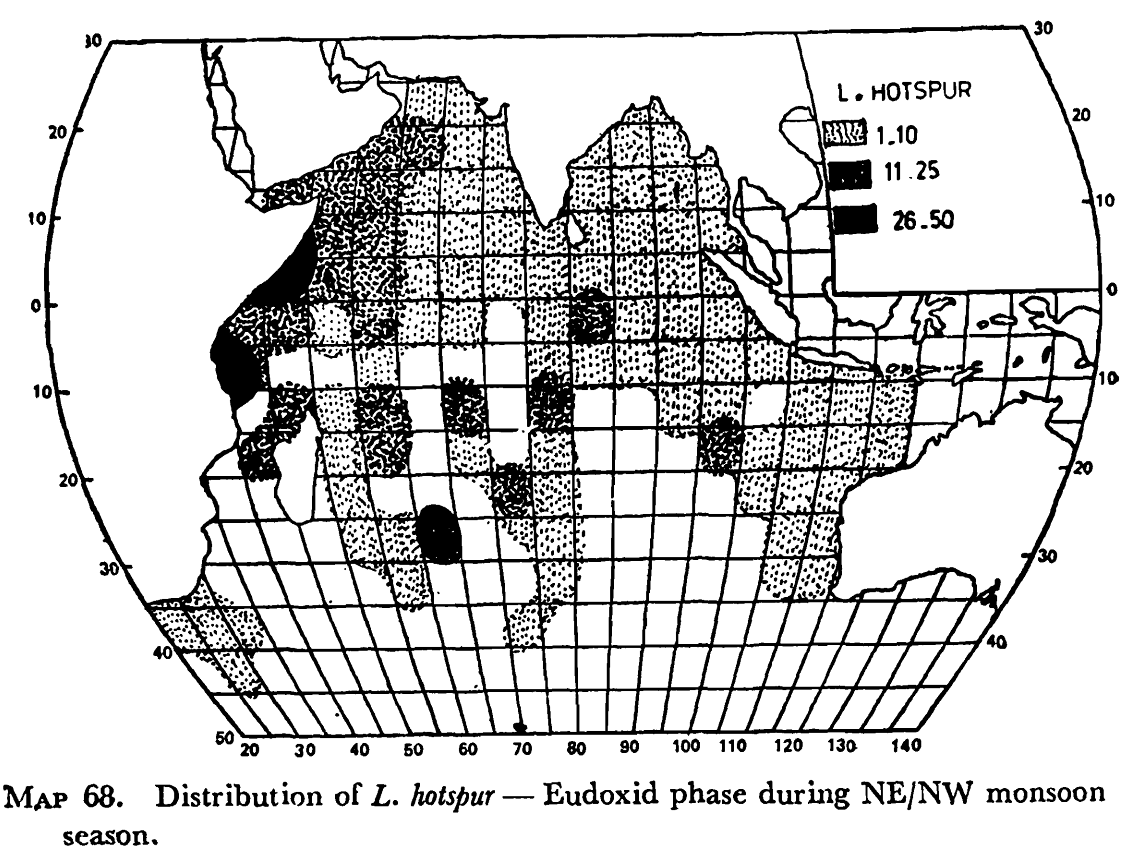
MAP 65. Distribution of *L. hotspur* — Polygastric phase during SW/SE monsoon season.



MAP 66. Distribution of *L. hotspur* — polygastric phase during NE/NW monsoon season.



MAP 67. Distribution of *L. hotspur* — Eudoxid phase during SW/SE monsoon season.



MAP 68. Distribution of *L. hotspur* — Eudoxid phase during NE/NW monsoon season.

eudoxids per haul occurred along the Somali coast, Gulf of Aden and in a small area between 5°S–10°S latitude/85°E–90°E longitude.

Poor density of 1–10 polygastric/eudoxid phases occurred in central regions of Arabian Sea, Bay of Bengal and in the mid-ocean region during both the seasons.

Monthly variations:

Except during November and February in the oceanic regions of South West and South East Indian Ocean, *L. hotspur* occurred throughout the year in the eight regions in the Indian Ocean.

Arabian Sea: The maximum records were during August and December in the western region and during May in the eastern region.

Bay of Bengal: The richest collections were made during April and June in the Indian Region and during September in the Andamans and Burma region.

South West Indian Ocean: It occurred in the maximum number of stations during January and October while it occurred during April and June in the Oceanic region.

50. **Lensia gnanamuthui** Daniel & Daniel, 1963
(Fig. 56, a, b)

Lensia gnanamuthui Daniel & Daniel, 1963, p. 751, fig. 1.
Lensia gnanamuthui Daniel & Daniel, 1963, p. 203, fig. V, 4 & 5.

Type Specimen: Zoology Research Laboratory, Univ. of Madras, India.

Material Examined: NORTH EAST/NORTH WEST MONSOON SEASON: *Bay of Bengal:* 2 a.n. (Daniel & Daniel, 1963).

Polygastric phase: *Anterior nectophore:* Small, pyramidal, 3.8 mm in length, 1.8 mm in breadth, with 5 distinct, straight, complete ridges, resembling *L. subtiloides.* Hydroecium not very deep, lying below level of ostium, gradually sloping toward ventral side. Somatocyst characteristically minute, 0.3 mm long, placed close to ventral corner of nectosac near ostium, with a short stalk and globular tip. Mouthplates as in *L. subtiloides.*

Posterior nectophore: not identified

Eudoxid phase: not identified.

Type locality: Off Madras Coast, Bay of Bengal.

Distribution: (Map 70). Collected from surface plankton off Madras coast during February and March.

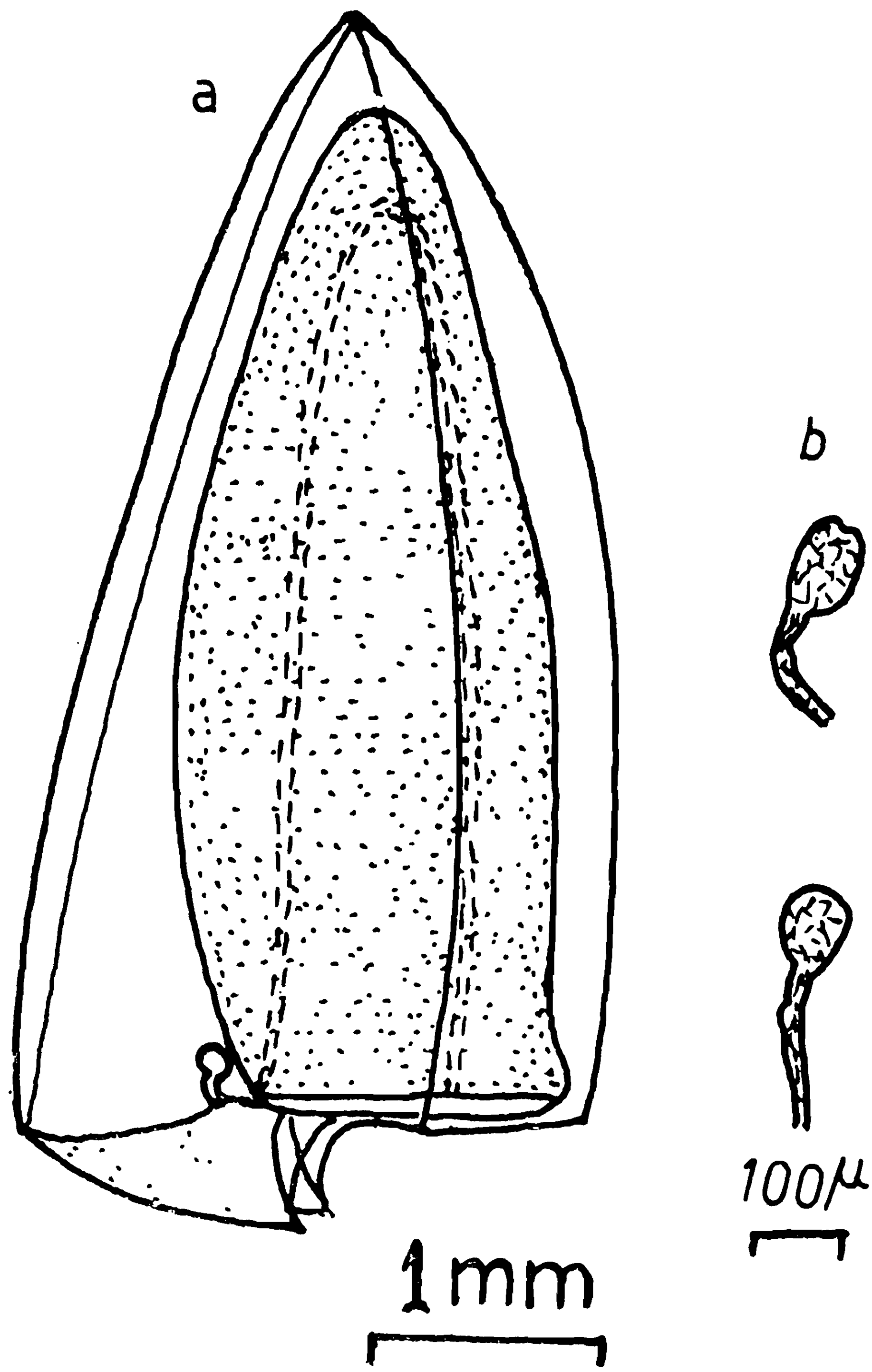
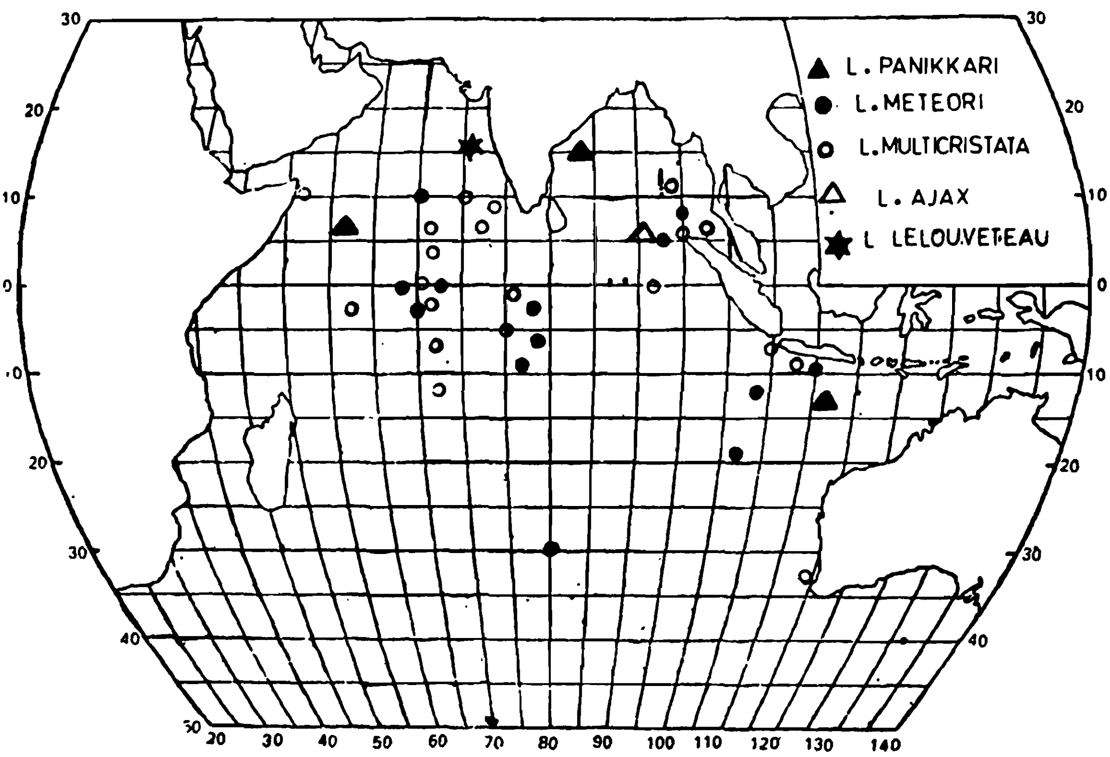
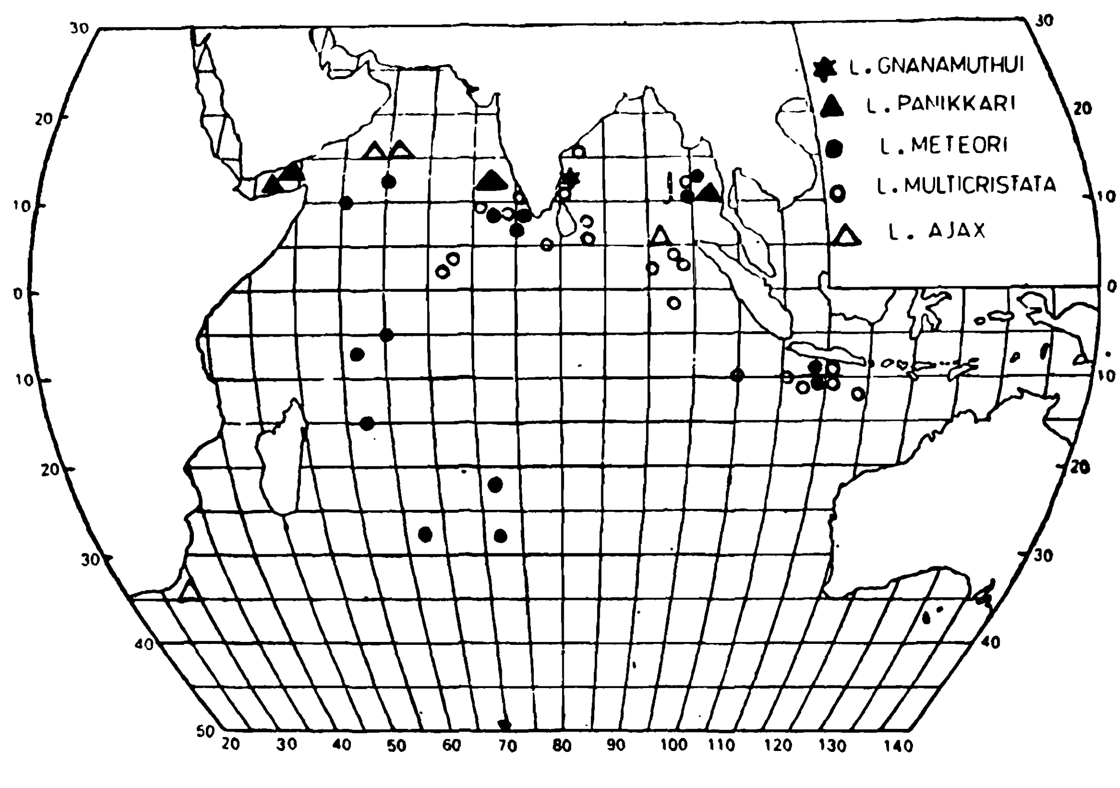


FIG. 56. *L. gnanamuthui* Daniel & Daniel (a, b). a. anterior nectophore; b. somatocyst.



MAP 69. Distribution of *L. panikkari*, *L. meteori*, *L. multicristata*, *L. ajax* and *L. leouveteau* during SW/SE monsoon season. 1—3 Specimens per haul.



MAP 70. Distribution of *L. gnansmuthui*, *L. panikkarai*, *L. meteori*, *L. multicristata* and *L. ajax* during NE/NW monsoon season. 1—3 Specimens per haul.

51. **Lensia fowleri** (Bigelow, 1911a)
(Fig. 57, a–e)

Diphyes fowleri Bigelow, 1911a, p. 346, pl. 28, fig. 5.
Lensia fowleri Daniel, 1974, p. 135, Text-fig. 11, F & H (cf. for detailed synonymy)

Type Specimen: Museum of Comparative Zoology, at Harvard college, USA.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 20 a.n.; 3 p.n.; 1 br.; 2 go. *Bay of Bengal:* 31 a.n.; 7 p.n.; 4 eu. (compl.) 12 br.; 39 go. *South West Indian Ocean:* 41 a.n.; 23 p.n.; I eu. (compl.), 2 br.; 8 go. *South East Indian Ocean:* 212 a.n.; 68 p.n.; 20 eu. (compl.) 38 br.; 93 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 64 a.n.; 37 p.n.; 3 eu. (compl.); 22 br.; 37 go. *Bay of Bengal:* 23 a.n.; 3 p.n.; 5 br.; 14 go. *South West Indian Ocean:* 46 a.n.; 18 p.n.; 2 eu. (compl.); 9 br.; 13 go. *South East Indian Ocean:* 155 a.n.; 51 p.n.; 7 eu. (compl.); 19 br.; 76 go.

Polygastric phase: Anterior nectophore: Upto 15 mm long, firm, slenderly pyramidal, with 5 complete, slightly crested ridges, bases of laterals bending ventrad. Ventro-basal region of necto phore long, extending well below level of ostium. Somatocyst — ovate, or globular lying below level of ostium, with pedicular canal nearly vertical and ascending. Hydroecium very shallow, extending towards mouth-plates. Mouth-plates long, overlapping, right larger than left.

Posterior nectophore: About three-quarters length of anterior nectophore, with 5 complete ridges. Articulating end of right hydroecial wing forming a triangular end. Mouth-plate long with notch in mid-region.

Eudoxid phase: Bract elongated with smooth blunt apex, 4.3 mm long, 2.0 mm at base. Head-piece twice as long as neck-shield; neckshield with smooth distal margin. Phyllocyst globular. Gonophore 5 mm long; 1.3 mm wide, without mouth-plate; Female manubrium bearing 16 eggs.

Type locality: Eastern Tropical Pacific.

Distribution: (Maps 71 & 72). The records and distribution this species in the four zones of the Indian Ocean during the two seasons are given in maps 71 and 72. 1–10 specimens/haul were collected.

L. fowleri occurred in all the four zones during the two seasons. It was recorded many times in the South East Indian Ocean. Night collections were greater during SW/SE monsoon season in Arabian Sea, both the seasons in Bay of Benga and NE/NW monsoon season in South West Indian Ocean.

During both the seasons *L. fowleri* occurred from nearly 25°N latitude to nearly 40°S latitude along the African coast and 35°S latitude along 110°E longitude and the mid-oceanic regions. During SW/SE monsoon season it occurred in great abundance in the Bay of Bengal and South West and South East Indian Ocean. It

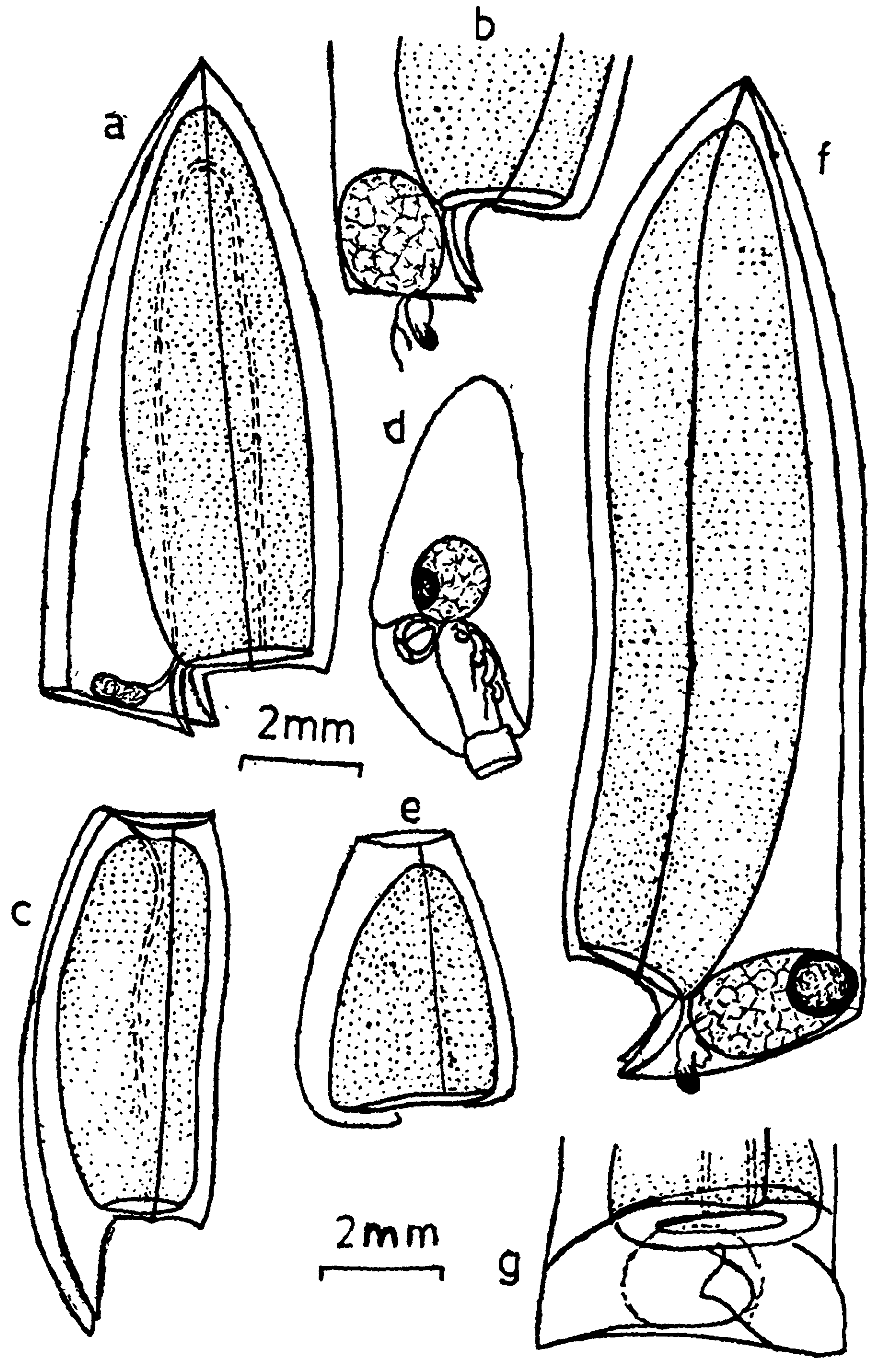
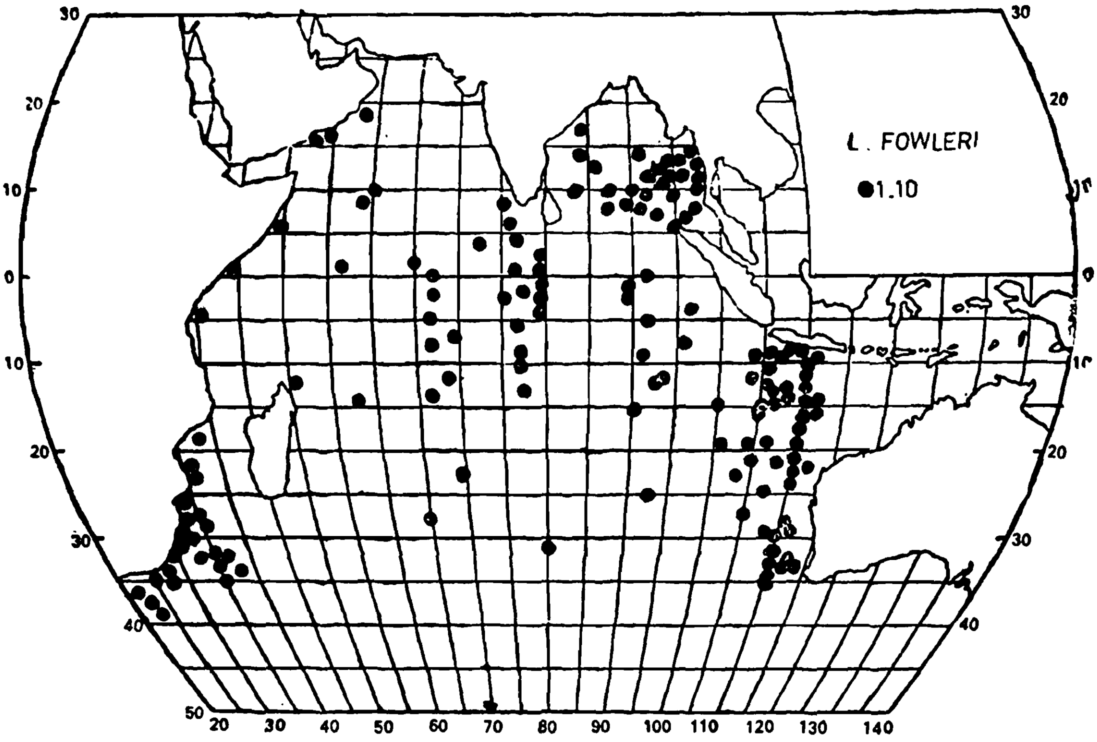
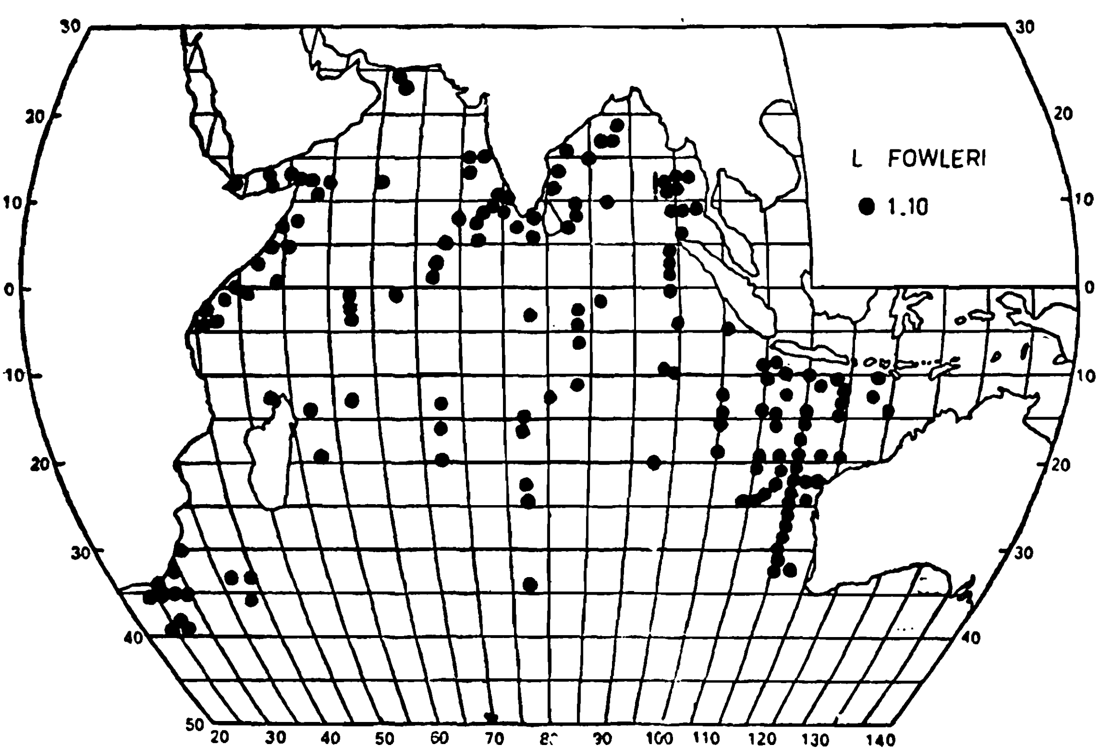


Fig. 57. *L. fowleri* (Bigelow) (a–e). a & b. anterior nectophore lateral view and basal view; c. posterior nectophore; d. bract; e. gonophore.– *L. challengeri* Totton (f, g). f. anterior nectophore lateral view; g. anterior nectophore dorsal view.



MAP 71. Distribution of *L. fowleri* during SW/SE monsoon season.



MAP 72. Distribution of *L. fowleri* during NE/NW monsoon season.

occurred at very few places in the Arabian Sea. During NE/NW monsoon season it occurred scattered all over the Indian Ocean.

Monthly variations:

Arabian Sea: In the western part, *L. fowleri* occurred in the maximum number of stations during December, and at few stations during the months other than March, September and October. In the eastern part, it occurred in greater numbers during February than during the other months except in June and September.

Bay of Bengal: In the Indian region it occurred throughout the year except in October. In the Andaman and Burma region it was recorded mostly during September, and fewer times during February, March, April, August and November.

South West Indian Ocean: *L. fowleri* was recorded throughout the year but more frequently during January and October. In the oceanic region, except during May, August and November it was collected at a few stations in the other months.

South East Indian Ocean: The maximum records of this species were made from the Australian region where it occurred during January, April, May and August. It was not collected during November. In the oceanic region it was collected at few places in months other than February, April, May and November.

52. **Lensia challengeri** Totton, 1941
(Fig. 57, f, g)

Lensia challengeri Totton, 1941, p. 154, fig. 13 (in part).
Lensia challengeri Daniel, 1974, p. 138, Text-fig. 11, E, G & P (cf. for synonymy)

Type Specimen: British Museum (Nat. Hist.,) London.

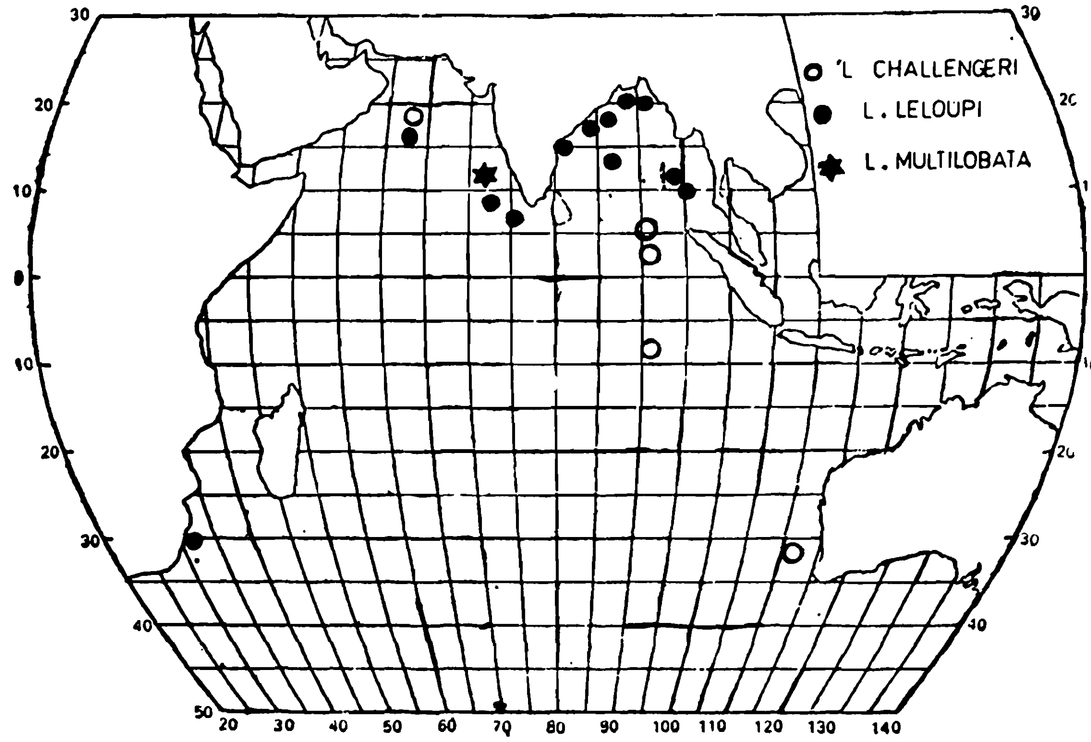
Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 1 a.n. *Bay of Bengal:* 2 a.n. *South East Indian Ocean:* 2 a.n.; 1 p.n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 8 a.n.; 2 p.n.

Polygastric phase: *Anterior nectophore:* About 8.0 mm long, firm, slenderly pyramidal, with 5 complete ridges. Somatocyst ovate, inclined towards ventral side lying at level of ostium. Basoventral region not extending well below level of ostium, as in *L. fowleri*. Hydroecium not extending toward ventral side. Mouthplates not as long as in *L. fowleri*, smaller, left broader than right.

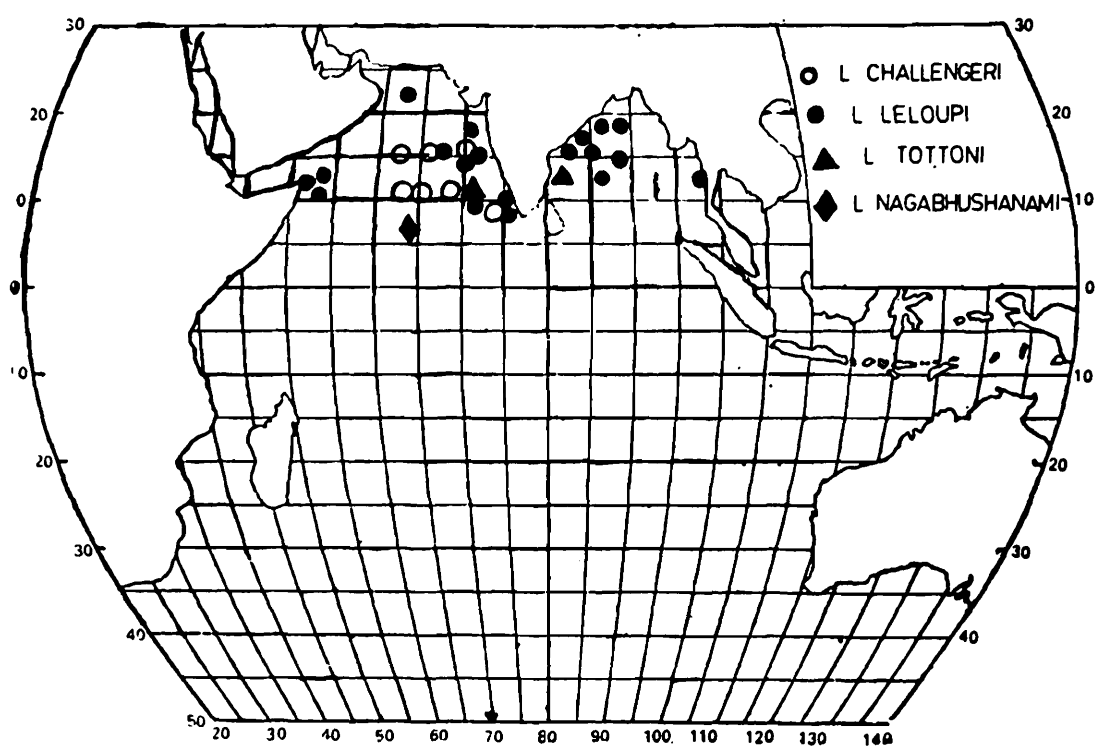
Posterior nectophore: 8.0 mm long, with 5 ridges; mouthplate long with a deep notch in middle.

Eudoxid phase: Unknown.

Distribution: (Maps 73 & 74). Recorded from South East Indian Ocean and from Arabian Sea. From the Oceanic region



MAP 73. Distribution of *L. challengeri*, *L. leloupi* and *L. multilobata* during SW/SE monsoon season. 1—3 specimens per haul.



MAP 74. Distribution of *L. challengeri*, *L. leloupi*, *L. tottoni* and *L. nagabhushanami* during NE/NW monsoon season. 1—3 specimens per haul.

during August; Bay of Bengal in September; Arabian Sea during October and November; off west coast of Australia in September.

53. **Lensia leloupi** Totton, 1954
(Fig. 58, a, b)

Lensia leloupi Totton, 1954, p. 113, Fig. 55c.
Lensia leloupi Totton, 1965, p. 161, text-fig-97. A.
Lensia leloupi Daniel, 1974, P. 138, Text-fig. 10, Q & R.

Type Specimen: British Museum (Nat. Hist.), London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 4 a.; 1 p.n. *Bay of Bengal:* 9 a.n.; 6 p.n.
SEASON: *Arabian Sea:* 4 a.; 1 p.n. *Bay of Bengal:* 9 a.n.; 6 p.n.
South West Indian Ocean: 1 a.n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 20 a.n.; 13 p.n. *Bay of Bengal:* 32 a.n.; 4 p.n.

Polygastric phase: Anterior nectophore: About 6.55 mm long, 3.4 mm wide, resembles *L. subtiloides,* broadly pyramidal with 5 ridges, dorsal and ventrals complete, laterals not reaching ostium. Apex of nectosac close to apex of nectophore. Somatocyst 1.7 mm long lying close to nectosac. Hydroecium deeper and mouth-plates longer than in *L. subtiloides.* Latero-ventral facet broadly triangular.

Posterior nectophore: Length same as anterior nectophore, with 5 ridges, laterals not reaching base. Mouth-plate large, undivided and smooth edged.

Eudoxid phase: Unknown.

Type locality: Cape Lopez, Gulf of New Guinea.

Distribution: (Maps 73 & 74). The number of records and its distribution are presented in maps 73 & 74. Only 1–3 anterior nectophores were collected per haul.

L. leloupi occurred during both the seasons in the Arabian Sea and Bay of Bengal and once during SW/SE monsoon season in the South West Indian Ocean. Day collections were more in the Arabian Sea while the night occurrence was more in the Bay of Bengal.

In the Arabian Sea it occurred during the months of February and December in the Gulf of Aden. In the Indian region it was collected during February, March, April, May and October.

In the Bay of Bengal it occurred along the Indian coast during January and June; during March and April in the Central region; and during March, April and August near the Andamans and Burma.

Recorded from South and East Coast of Africa and from North West Indian Ocean (Arabian Sea); from a depth of 300–0 m; 476–0 m. From the Arabian Sea during September and October.

In the South West Indian Ocean it was recorded only once near Durban in July.

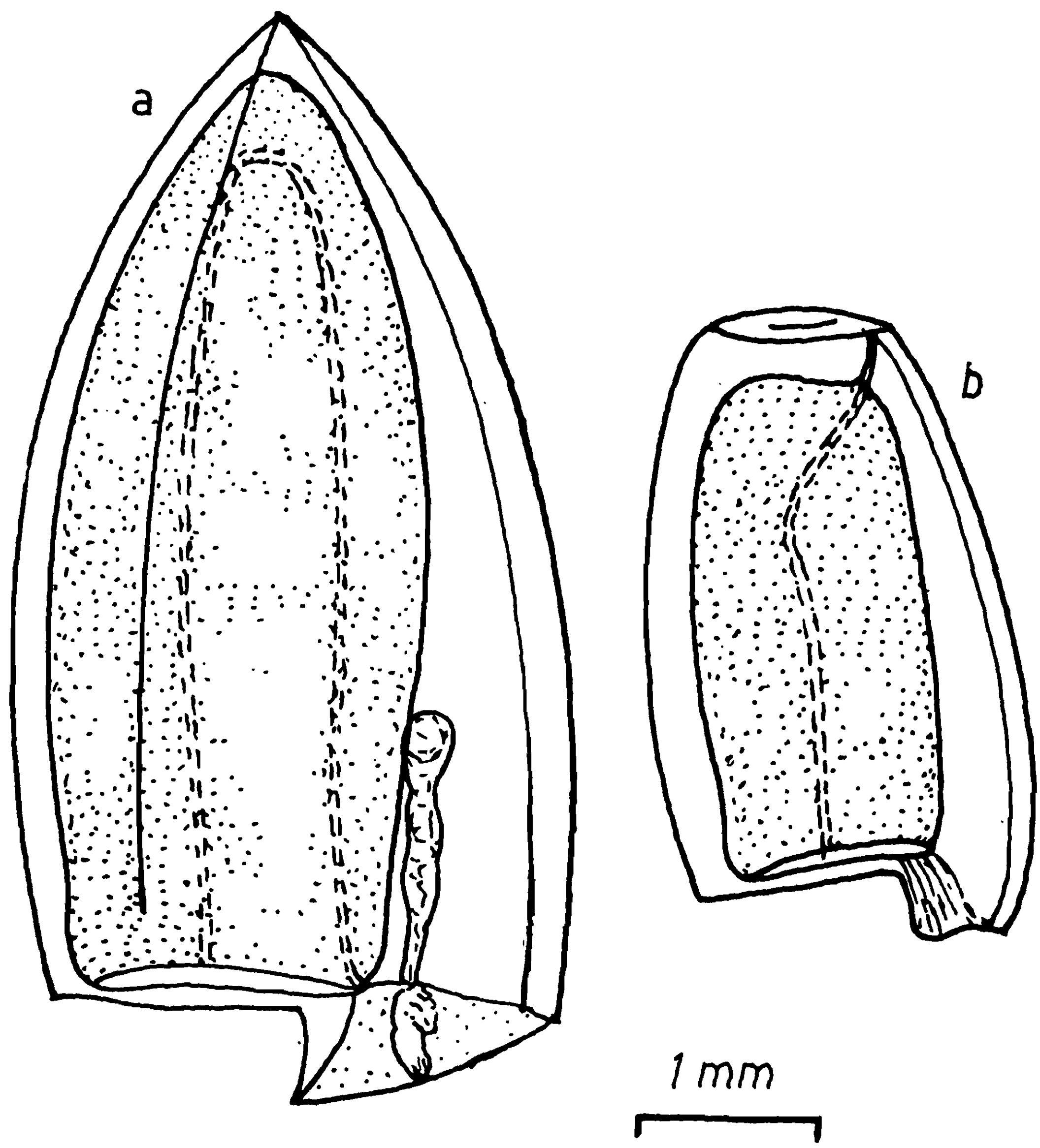


FIG 58 *L. leloupi* Totton (a, b). a. anterior nectophore; b. posterior nectophore.

54. **Lensia tottoni** Daniel & Daniel, 1963
(Fig. 59 a)

Lensia tottoni Daniel & Daniel, 1963, p. 621, fig. 1.
Lensia tottoni Rengarajan, 1973, p. 141, fig. 11 C.

Type Specimen: Zoology Research Laboratory, Univ. of Madras, India.

Material Examined: NORTH EAST/NORTH WEST MONSOON SEASON: *Bay of Bengal:* 3 a. n. (Daniel & Daniel, 1963). *Arabian Sea:* 1 a.n. (Rengarajan; 1973).

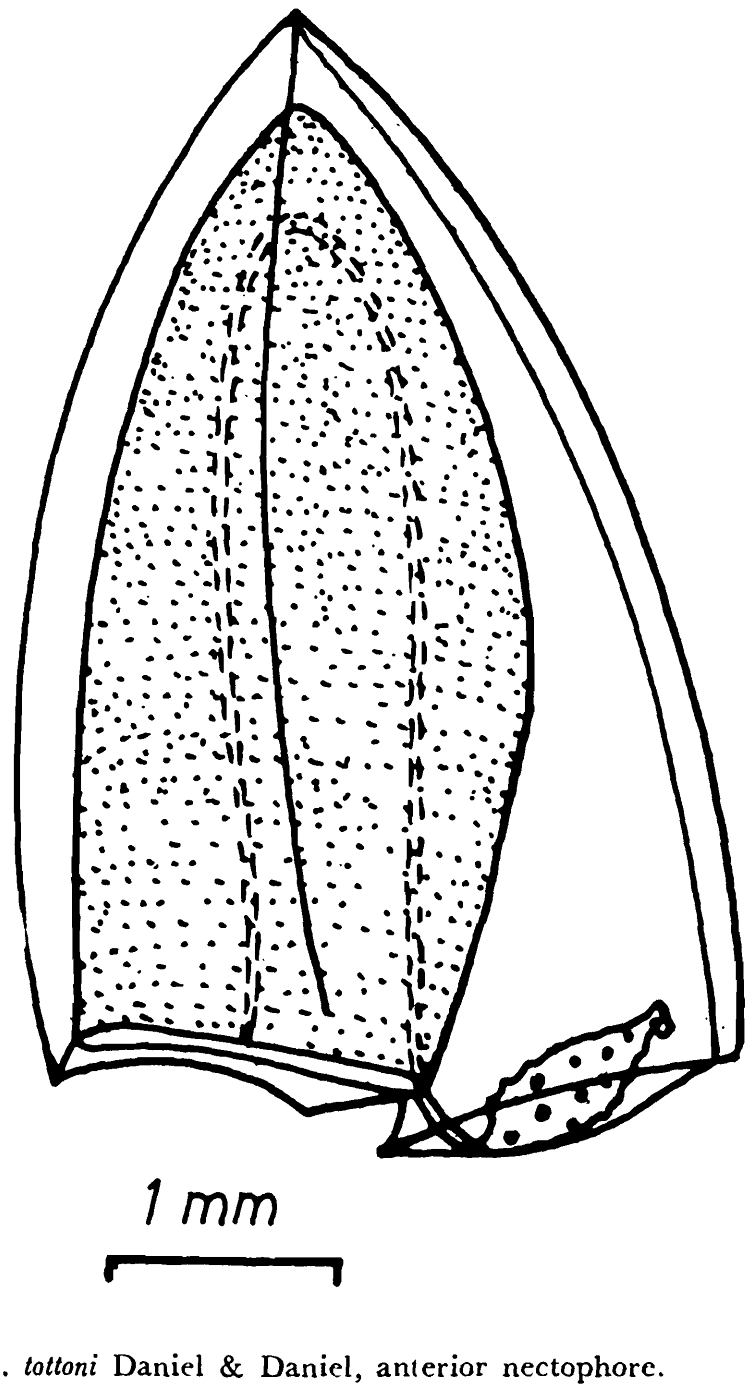


FIG. 59. *L. tottoni* Daniel & Daniel, anterior nectophore.

Polygastric phase: Anterior nectophore: Pyramidal with broad base 5.3 mm in length, 2.75 mm in breadth. With 5 complete, non crested straight longitudinal ridges; — dorsal ridge extending beyond velar level in a small tooth-like projection; laterals bend ventro-orally, terminating above velar level; baso-ventral ridge prominent, horizontal, equal to diameter of ostium in length. Baso-ventral facet project downward beyond baso-ventral ridge. Hydroecium completely absent. Somatocyst not stalked, highly transparent, oblique *i.e.* inclined towards ventral wall, with round yellow concretions within it. Mouth-plates as in *L. subtiloides.*

Posterior nectophore: Not known.

Eudoxid phase: not known.

Type locality: Off Madras coast, Bay of Bengal.

Distribution: (Map 74). Collected from off Madras coast during September and from west coast of India During January and February.

55. **Lensia panikkari** Daniel, 1970
(Fig. 60)

Lensia panikkari Daniel, 1970, p. 150, fig. 1.
Lensia panikkari Daniel, 1974, p. 139, text-fig. 12. A.

Type Specimen: Zoological Survey of India, Calcutta, India.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 2 a.n. *Bay of Bengal:* 1 a.n. *South East Indian Ocean:* 1 a.n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 8 a.n.; 5 p.n. *Bay of Bengal:* 1 a.n.

Polygastric phase: Anterior nectophore: 9.7 mm in length, 4.5 mm in breadth, slenderly pyramidal, with 5 prominent, slightly crested ridges, dorsal and ventrals complete, laterals not reaching base as in *L. leloupi* and *L. tottoni.* Ventral facet narrow. Somatocyst more than half the length of nectophore but varies, thin, club-shaped, with long stalk lying close to nectosac, as in *L. multicristata.* Hydrecium as in species of *Lensia.* Mouth-plates as in *L. leloupi.* Baso-ventral ridge very short.

Posterior nectophore: not known for certain. The truncated anterior end narrow, similar to the narrow ventral facet of the anterior nectophore; long, slender, with 5 ridges, laterals not reaching base. Mouth-plate medium sized with a slight notch.

Eudoxid phase: not known.

Type locality: Lat. 32: 48′S long. 103: 58′E (South eastern Indian Ocean.

Distribution: (Maps 69 & 70). Recorded from Gulf of Aden (December), West coast of India (February), East coast of India (September), near Burma (March) Equator (May) and South of Java (April).

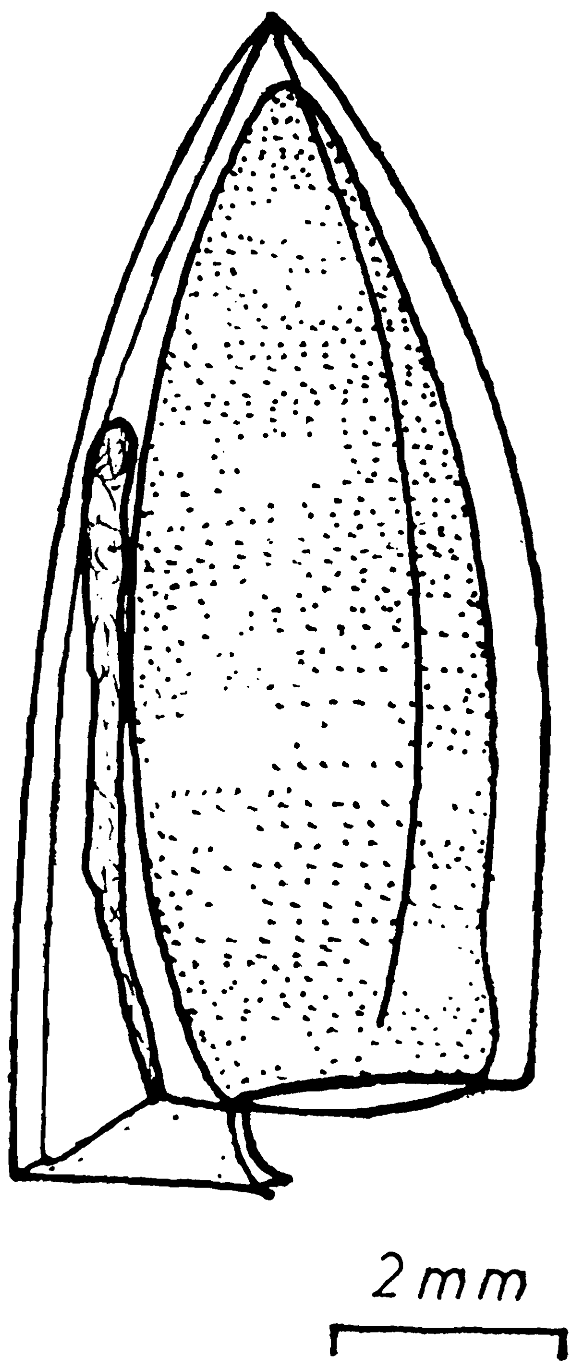


FIG. 60. *L. panikkari* Daniel, anterior nectophore.

56. **Lensia nagabhushanami** Daniel, 1970
(Fig. 61)

Lensia nagabhushanami Daniel, 1970, p. 150, fig. 1 f.
Lensia nagabhushanami Daniel, 1974, p. 141, text-fig. 12. E.

Type Specimen: Zoological Survey of India; Calcutta, India

Material Examined: NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 1 a.n. (Daniel, 1970, 1974).

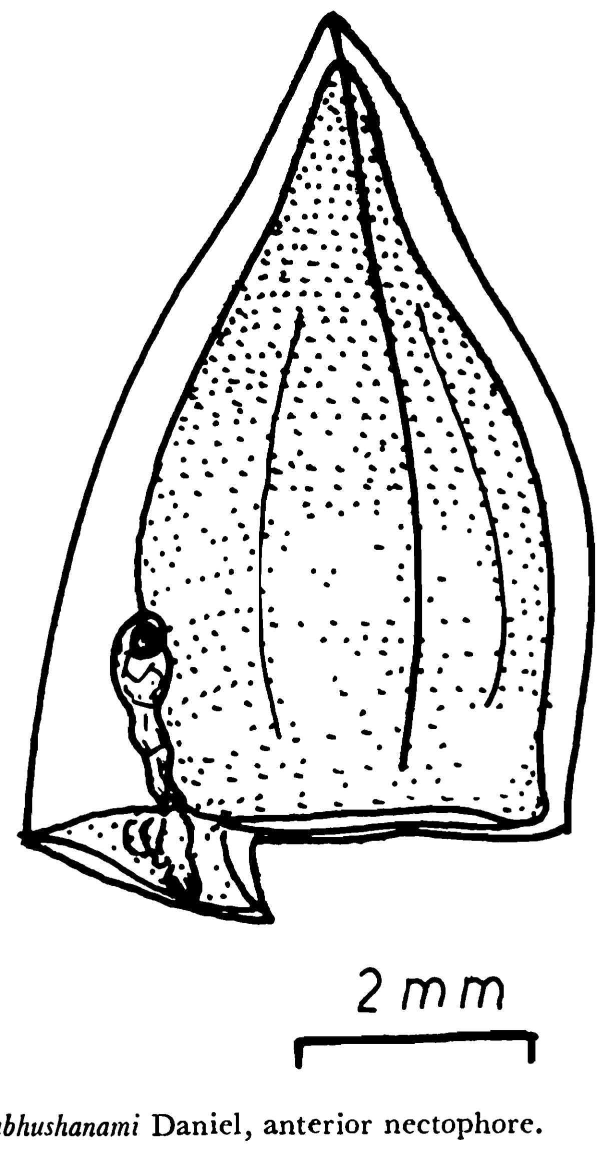


FIG. 61. *L. nagabhushanami* Daniel, anterior nectophore.

Polygastric phase: Anterior nectophore: About 8.5 mm in length, 5.0 mm in breadth, with 5 ridges, dorsal and ventrals reaching velar level, laterals not reaching base. Nectophore with pointed tip, bulged middle and broad ostium; and grooves on either side of lateral ridges. Nectosac similarly shaped like nectophore apically produced into a blunt tube reaching upto tip, bulged mid-region and large round ostium. Somatocyst 1.7 mm long, stalked, club-shaped lying in contact with nectosac. Hydroecium as in *L. subtiloides*. Baso-ventral ridge oblique.

Posterior nectophore: not known.

Eudoxid phase: not known.

Type locality: Lat. 8°0'N; Long. 63°0'E; Arabian Sea.

Distribution: (Map 74). It was recorded from mid-ocean region in the Arabian Sea during November.

57. **Lensia campanella** (Moser, 1925)
(Fig. 62 a–d)

Galeolaria campanella Moser, 1925, p. 152, pl. IV, figs. 1, 2.
Lensia campanella Daniel, 1974, p. 142, text-fig. 11B (cf. for detailed synonymy)

Type Specimen: Museum Für Naturkunde, Berlin.

Material Examined: South West/South East Monsoon Season: *Arabian Sea:* 101 a.n.; 61 p.n.; 1 br.; 63 go. *Bay of Bengal:* 1 p.g. (compl.); 306 a.n.; 40 p.n.; 4 br.; 186 go. *South West Indian Ocean:* 115 a.n.; 33 p.n.; 46 go. *South East Indian Ocean:* 125 a.n.; 55 p.n.; 1 br.; 61 go. North East/North West Monsoon Season: *Arabian Sea:* 147 a.n.; 40 p.n.; 5 br.; 97 go. *Bay of Bengal:* 167 a.n.; 29 p.n.; 94 go. *South West Indian Ocean:* 95 a.n.; 43 p.n.; 27 go. *South East Indian Ocean:* 99 a.n.; 44 p.n.; 3 eu.

Polygastric phase: Anterior nectophore: About 3.3 mm in length, 1.5 mm in breadth with characteristically twisted, blunt apex (about half a complete turn); 5 incomplete ridges — dorsal ridge vestigeal, laterals and left ventral reach base, terminating near apex, right ventral originate near apex, continuing at base resembling letter 'L' as basal ridge and not joining left ventral. Somatocyst minute 0.5 mm in length oblique, globular or club-shaped. Hydroecium nearly absent, sloping off to about 45' Apex of nectosac partly twisted. Mouth-plates very small and divided.

Posteriar nectophore: About 2.1 mm long and 1.25 mm vide, with faintly marked ridges. Apex of nectosac flat. Mouth plate small and rounded.

Eudoxid phase: Bract — minute, resemble *L. subtiloides*. Gonophore small — 2.3 mm long. With flat proximal end; without mouth-plate.

Type locality: Tropical Atlantic (West coast of Africa).

Distribution: (Maps 75 & 76). The number of records and its distribution during the two seasons are presented in maps 75 and 76.

L. campanella occurred in great abundance throughout the Indian Ocean during the two seasons, especially in the Bay of Bengal. It occurred in greater numbers during the day time.

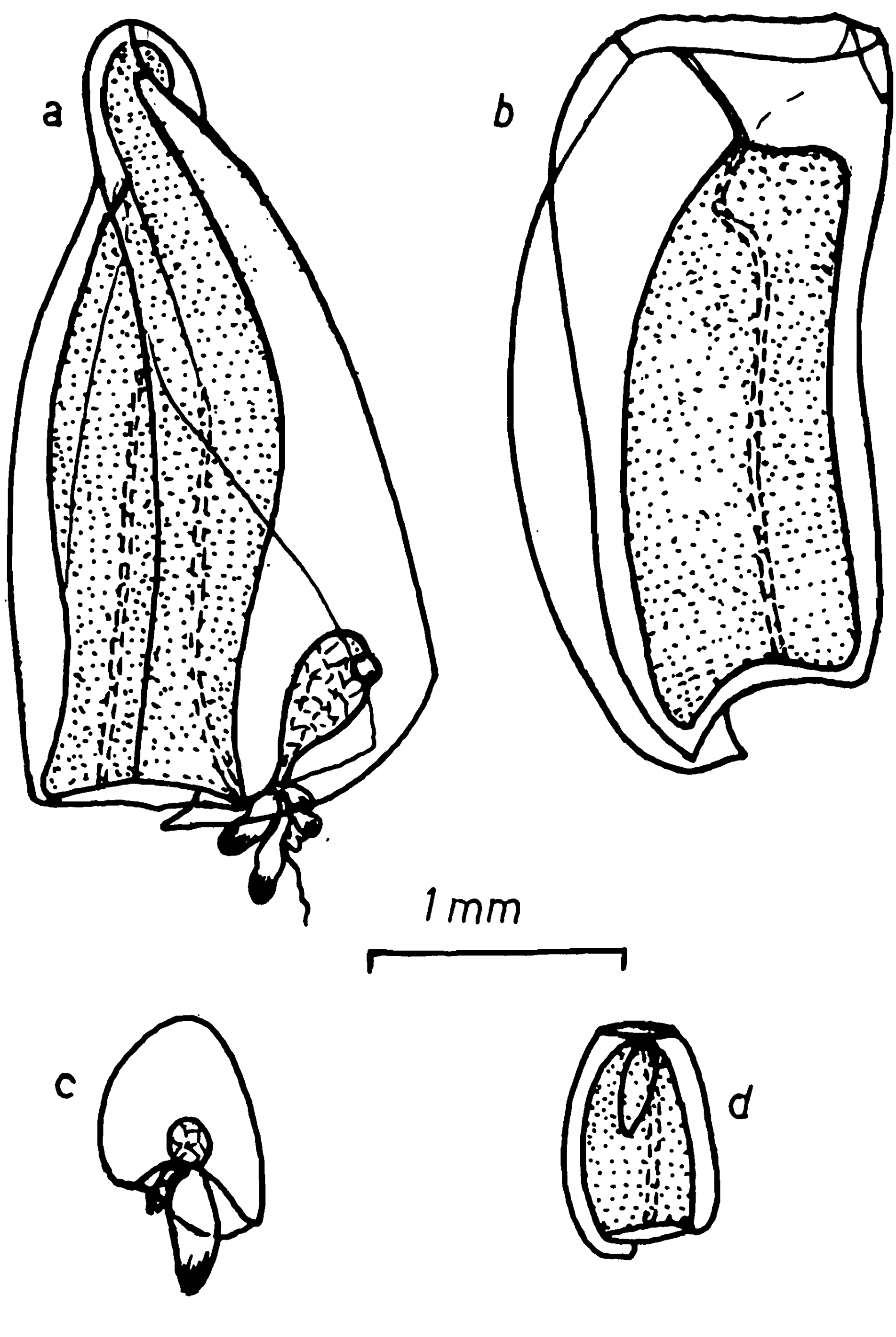
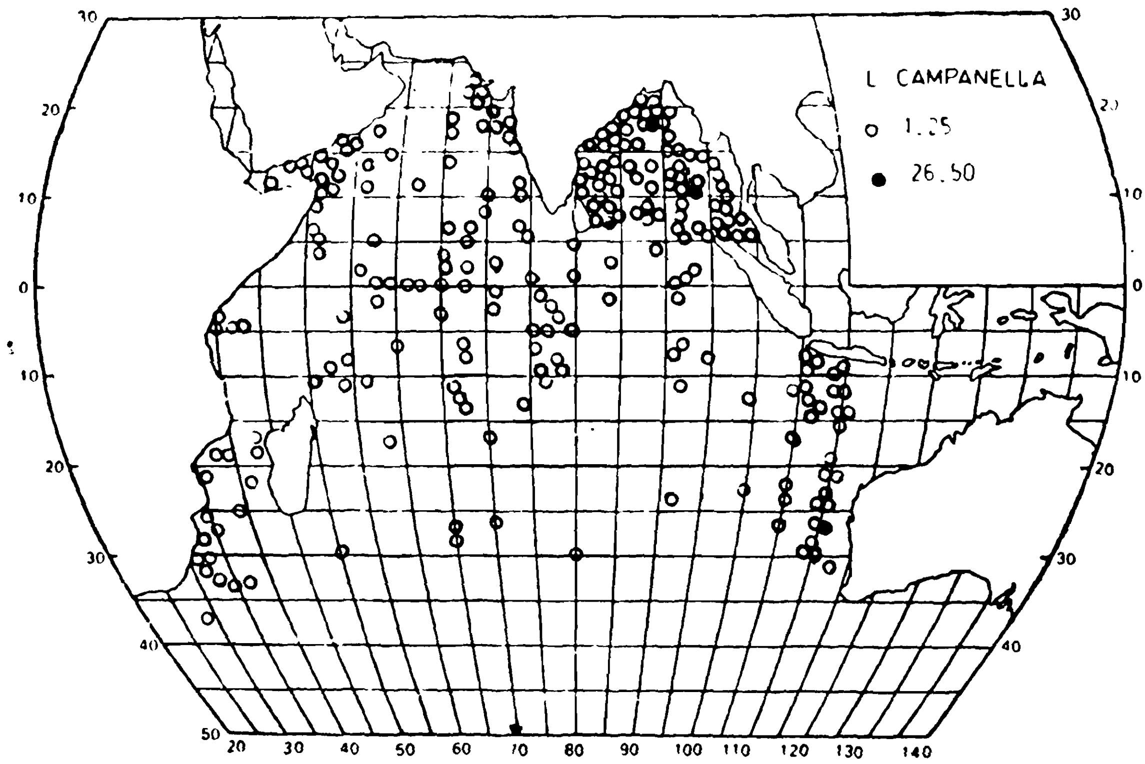
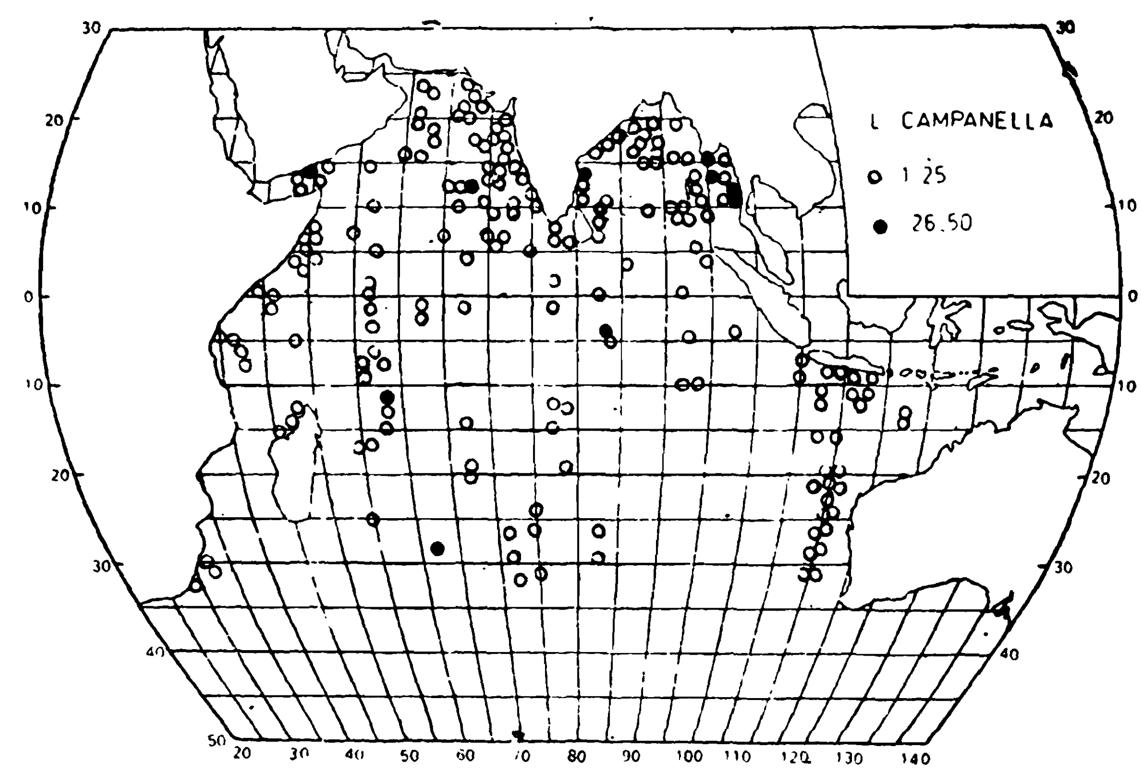


FIG. 62. *L. campanella* (Moser) (a–d). a. anterior nectophore; b. posterior nectophore; c bract; d genophore.



MAP 75. Distribution of *L. campanella* during SW/SE monsoon season.



MAP 76. Distribution of *L. campanella* during NE/NW monsoon season.

During both the seasons its distribution extended from 25 N° latitude to 35°S latitude. High concentration of *L. campanella* occurred in the Bay of Bengal (SW/SE monsoon season) and in the Arabian Sea (NE/NW monsoon season).
Monthly variations:

Arabian Sea: Except in September *L. campanella* was collected throughout the year. In the western part the maximum occurrence was during August and December and during May in the eastern region.

Bay of Bengal: In the Indian region it was recorded throughout the year except in October and occurred in abundance during June. In the Andaman Islands and Burma region it occurred in vast areas during September. It was not collected during June and November.

South West Indian Ocean: In this zone this species was collected almost throughout the year (except November). In the African region it occurred mostly during July and October and during April and June in the Oceanic region.

South East Indian Ocean: In the Australian region except in June and November *L. campanella* was collected in all the months the maximum records in August. In the Oceanic region it was rare during May, August, September, October and December (Maximum).

58. **Lensia cossack** Totton, 1941

(Fig. 63 a–d)

Diphyes subtiloides Browne, 1926, p. 76.
Lensia cossack Totton, 1941, p. 150, figs. 8, 9.
Lensia cossack Daniel, 1974, p. 143, text-fig. 10. T.

Type Specimen: British Museum (Nat. Hist.) London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 49 a.n.; 31 p.n.; 7 go. *Bay of Bengal:* 52 a.n.; 53 p.n.; 28 go. *South West Indian Ocean:* 77 a.n.; 65 p.n.; 2 br.; 18 go. *South East Indian Ocean:* 108 a.n.; 76 p.n.; 7 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 45 a.n·; 20 p.n.; 1 br.; 8 go. *Bay of Bengal:* 36 a.n.; 17 p.n.; 1 br.; 6 go. *South East Indian Ocean:* 84 a.n.; 52 p.n.; 11 go. *South West Indian Ocean:* 97 a.n.; 60 p.n.; 18 go.

Polygastric phase: Anterior nectophore: About 6.0–11.6 mm in length, firm, with 4 incomplete ridges a dorsal, laterals and a ventral and four longitudinal folds in nectophore and nectosac; with blunt apex. Ventrobasal facet oblique, horse-shoe shaped.

Somatocyst ovoid, oblique nearly 1/3rd length of nectophore when well preserved. Hydroecium absent. Mouth-plate very short.

Posterior nectophore: Indian Ocean form smaller, 6.3 mm long, 3.0 mm wide, firm with 4 incomplete ridges — dorsal absent. Mouthplate very short with slight notch in mid-region.

Eudoxid phase: Bract 1.5 mm long, dome-shaped with short neck-shield, broad at base. Phyllocyst ovoid. Hydroecium shallow.

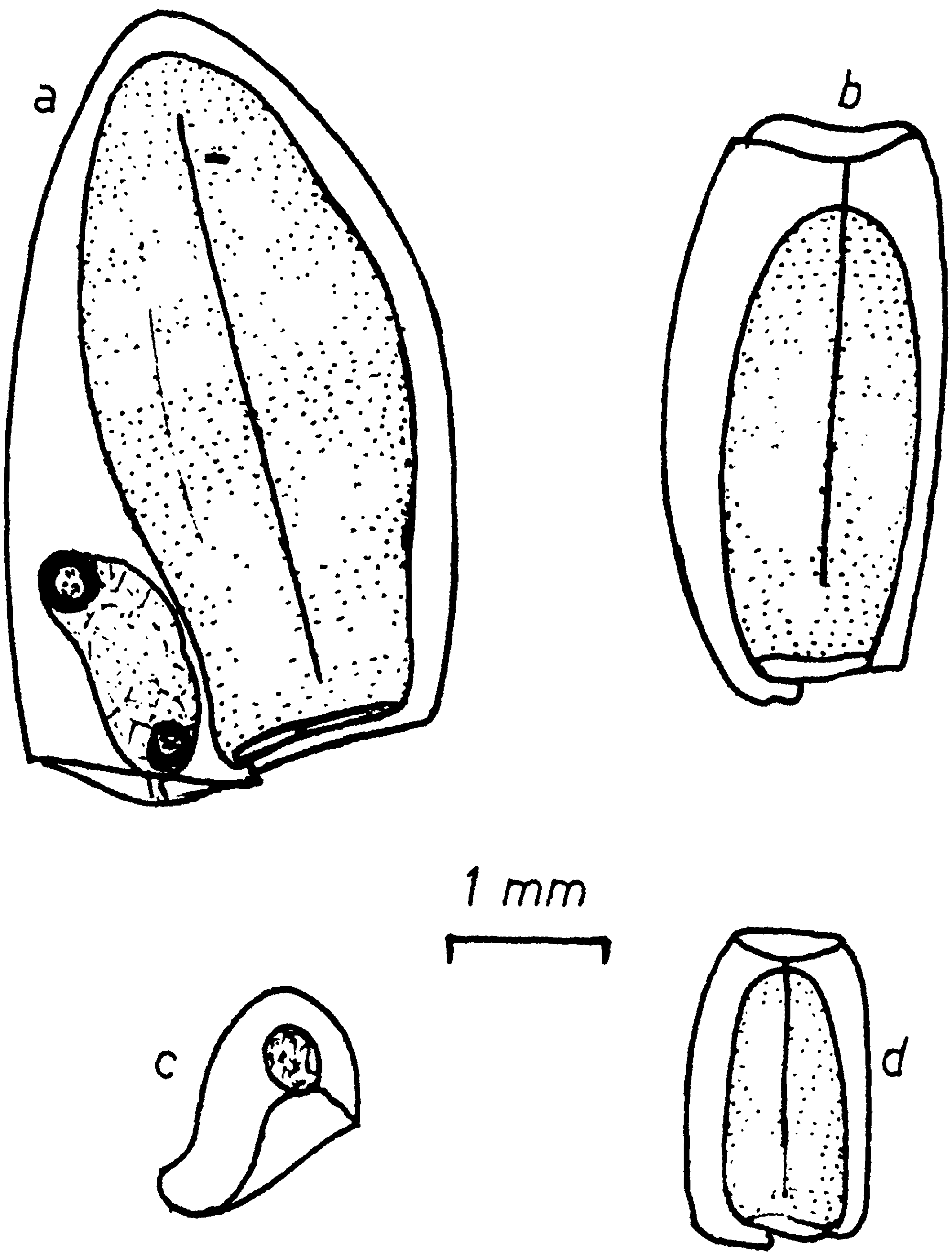


FIG. 63. *L. cossack* Totton (a–d). a. anterior nectophore; b. posterior nectophore; c. bract; d. gonophore.

Gonophore about 3.4 mm long 2.2 mm wide, almost squarish in shape. Resemble posterior nectophore. Without manubrium.

Type locality: Lat. 33°20'S; Long 15°18'E, Cape of Good Hope (South Atlantic).

Distribution: (Maps 77 & 78). The number of records, distribution of *L. cossack*, in the different regions of the Indian Ocean are presented in maps 77 and 78. At most of the areas, the number of specimens collected was 1–10 per haul. In the Arabian Sea near Gulf of Aden, Somali and Indian cost, density of 11–25 specimens per haul was collected. Along the Equator 26-50 specimens per haul was collected.

L. cossack was recorded from all the zones of the Indian Ocean during both the seasons. It occurred in greater numbers during the day collections (except in South East Indian Ocean during NE/NW monsoon season, where the night captures were more.)

During the two seasons the distribution of *L. cossack* extended from 25°N latitude to 40°S latitude along the African coast, to nearly 35°S latitude along 110°E longitude and mid-oceanic regions.

During SW/SE monsoon season it occurred in great abundance in the south western sector of the Indian Ocean and the Bay of Bengal. There was a paucity of *L. cossack* in the oceanic region in the south eastern sector of the Indian Ocean and it again occurred in abundance along 110°E longitude. During NE/NW monsoon season *L. cossack* occurred scattered all over the Indian Ocean.

Monthly variations:

Arabian Sea: In the western part *L. cossack* was recorded during all the months except in September. The maximum records were during August. In the eastern part it was collected during all the months except in April and June, and from maximum number of stations during May.

Bay of Bengal: Except during November *L. cossack* was collected in all the other months but occurred mostly during April and June. In the Andaman and Burma region it was recorded during September. It was not collected during January and February.

South West Indian Ocean: It was collected from the African region, especially during January and October (except in September). In the oceanic region it occurred throughout the year except in November.

South East Indian Ocean: In the Australian region it was collected during January, April and August (Maximum). It was not collected during November. In the Oceanic region it occurred at a few stations during the months other than February, April and June.

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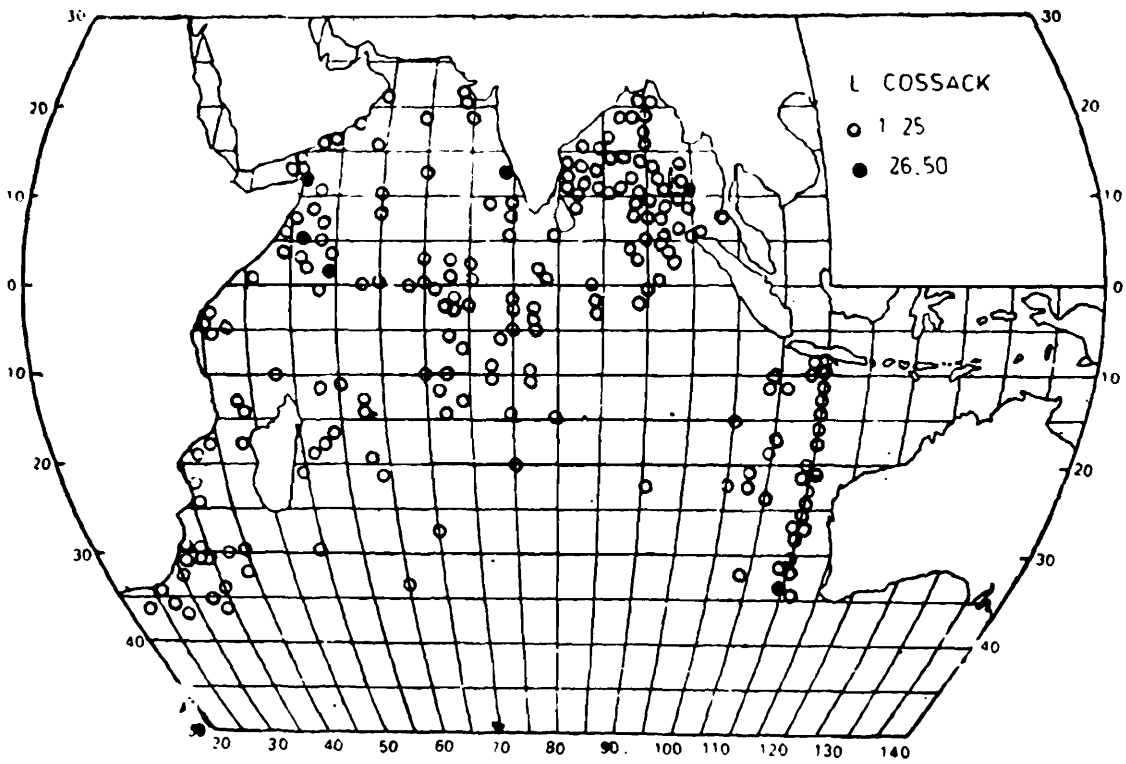
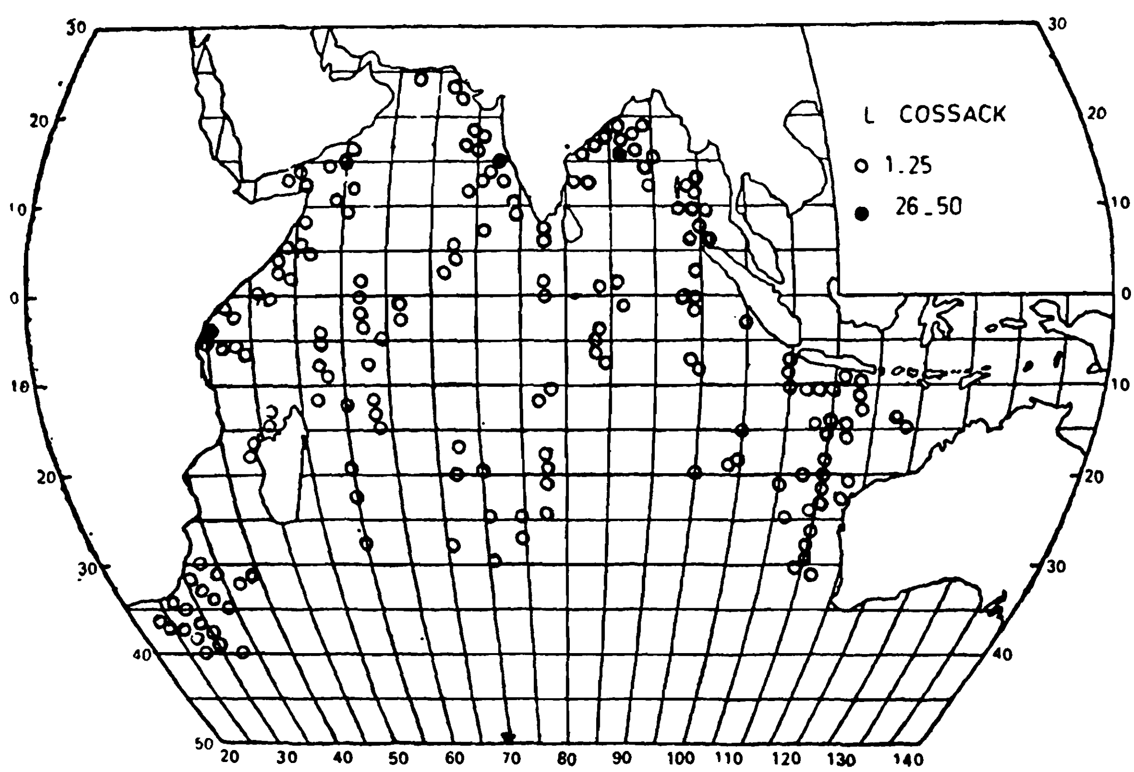


MAP 77. Distribution of *L. cossack* during SW/SE monsoon season.



MAP 78. Distribution of *L. cossack* during NE/NW monsoon season.

59. **Lensia subtilis** (Chun, 1886)

(Fig. 64, a–f)

Diphyes subtilis Chun, 1886, p. 681.

Diphyes subtilis Bigelow, 1911, p. 347.

Lensia subtilis Daniel, 1974, p. 144, text-fig-11, L, M, N & O (cf. for detailed synonymy).

Type Specimen: Place of deposit not known from literature.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 110 a.n.; 20 p.n.; 20 go. *Bay of Bengal:* 64 a.n.; 30 p.n.; 1 eu (compl.) 15 go. *South West Indian Ocean:* 1 p.g· (Compl.) 369 a·n.; 153 p.n.; 2 br.; 157 go.; 1 eu (compl.). *South East Indian Ocean:* 4 p.g. (compl.); 473 a.n.; 204 p.n.; 25 eu (compl.); 19 br.; 274 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 99 a.n.; 29 p.n.; 2 eu. (compl.); 1 p.g. (compl.); 2 br.; 23 go. *Bay of Bengal:* 18 a.n.; 4 p.n. *South West Indian Ocean:* 3 p.g. (compl.) 687 a.n. 240 p.n.; 3 eu. (compl.); 3 br.; 120 go. *South East Indian Ocean:* 363 a.n.; 122 p.n.; 3 eu. (compl.); 2 br.; 145 go.

Polygastric phase: Anterior nectophore: Length ranges from 3.0 mm to 11.0 mm, with blunt apex, smooth, 4 longitudinal, noncrested fold-like vestigeal incomplete ridges — a dorsal, laterals, and a ventral. Basal articulating facet oblique and rounded, somatocyst (diagnostic) — with very thin, long stalk and globular tip, extending to nearly half the length of the nectosac. Hydroecium absent. Mouth-plates short with slightly overlapping rounded distal ends.

Posterior nectophore: Same length as anterior nectophore, with faintly marked ridges. Apically truncate. Hydroecial groove shallow. Mouth-plate very small, rounded.

Eudoxid phase: Bract 1.25 mm long, rounded with shallow cavity. Phyllocyst short, ovoid or club-shaped. Neck-shield short. Gonophore 2.2 mm long. Hydroecial fold at proximal end only. Mouth-plate very small. Manubrium yellow in colour, female — bearing 20–30 ova.

Type Locality: Mediterranean Sea.

Distribution: (Maps 79 & 80). The number of records and the distribution during the two seasons and the monthly variation of *L. subtillis* are presented in maps 79 & 80. The number of specimens per haul ranged from 1–25, 26–50 and 51–75.

Even though *L. subtilis* occurred in all the zones of the Indian Ocean during both the seasons, the richest concentration occurred in the equatorial belt region and in the mid-oceanic region. The poorest collection was taken in the Bay of Bengal. During both the seasons the distribution of *L. subtilis* extended from nearly 20°N latitude to 40°S latitude along the African coast and mid-oceanic region and 35°S latitude along 110°E longitude. The highest density range of 51–75 specimens per haul was recorded only twice, one located along the Somali coast and the other along 110°E longitude. The range of 26–50 specimen per ahul occurred at few places along the Somali coast, equator and mid-oceanic region below 15:S latitude.

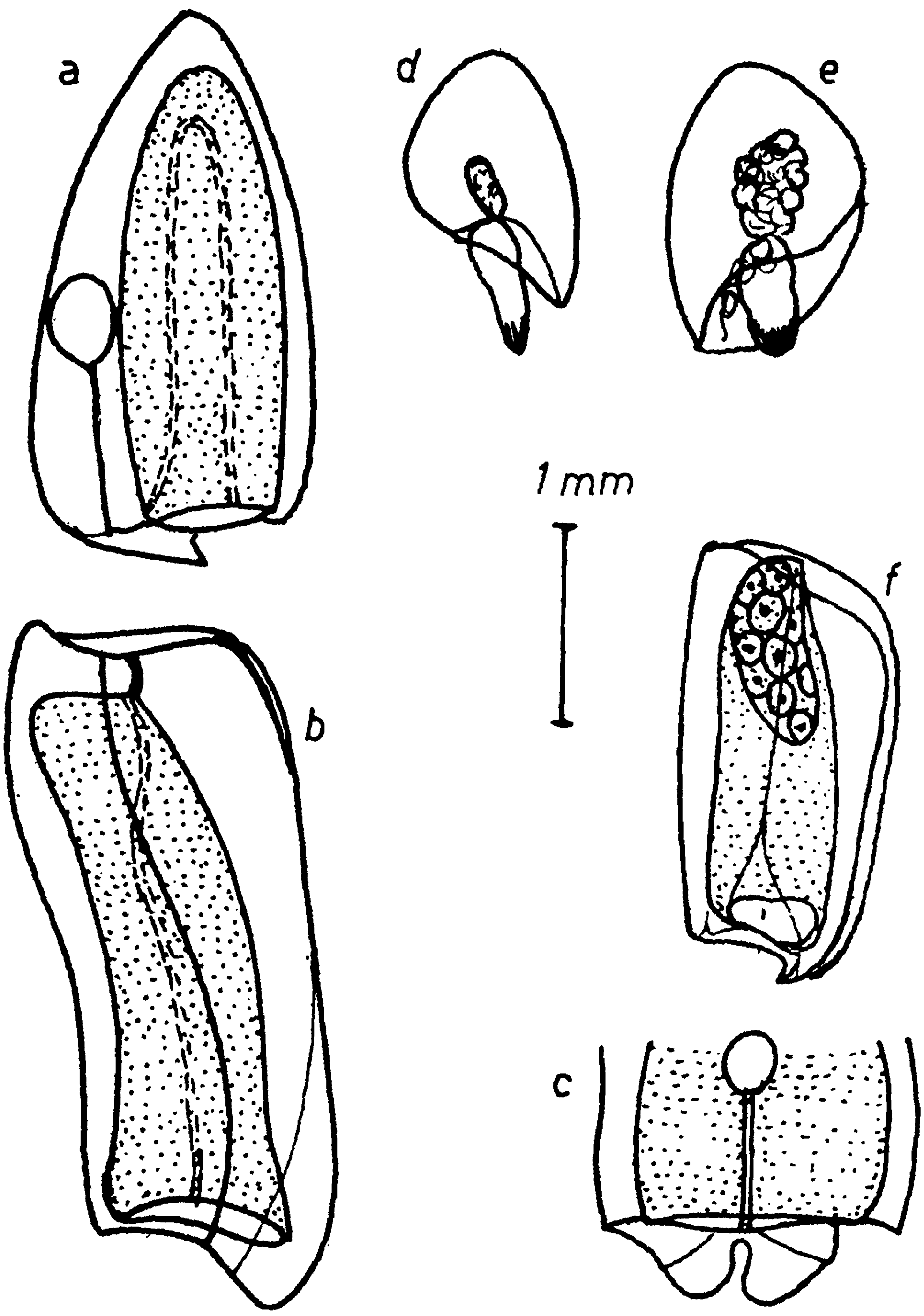
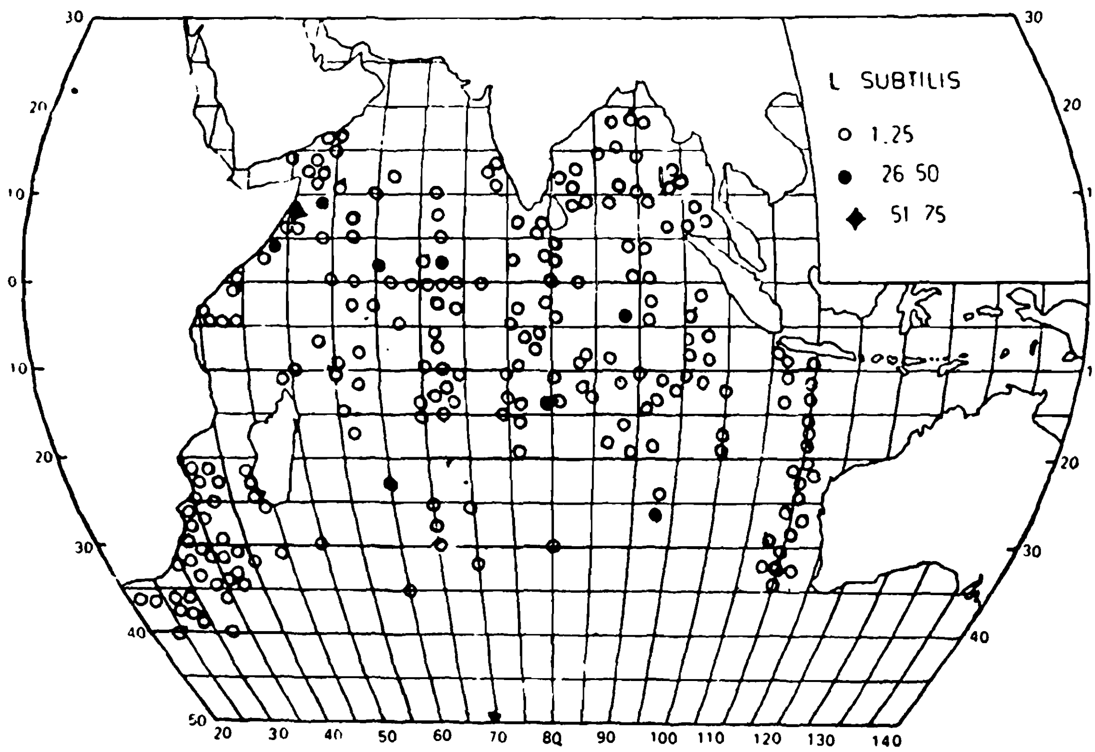
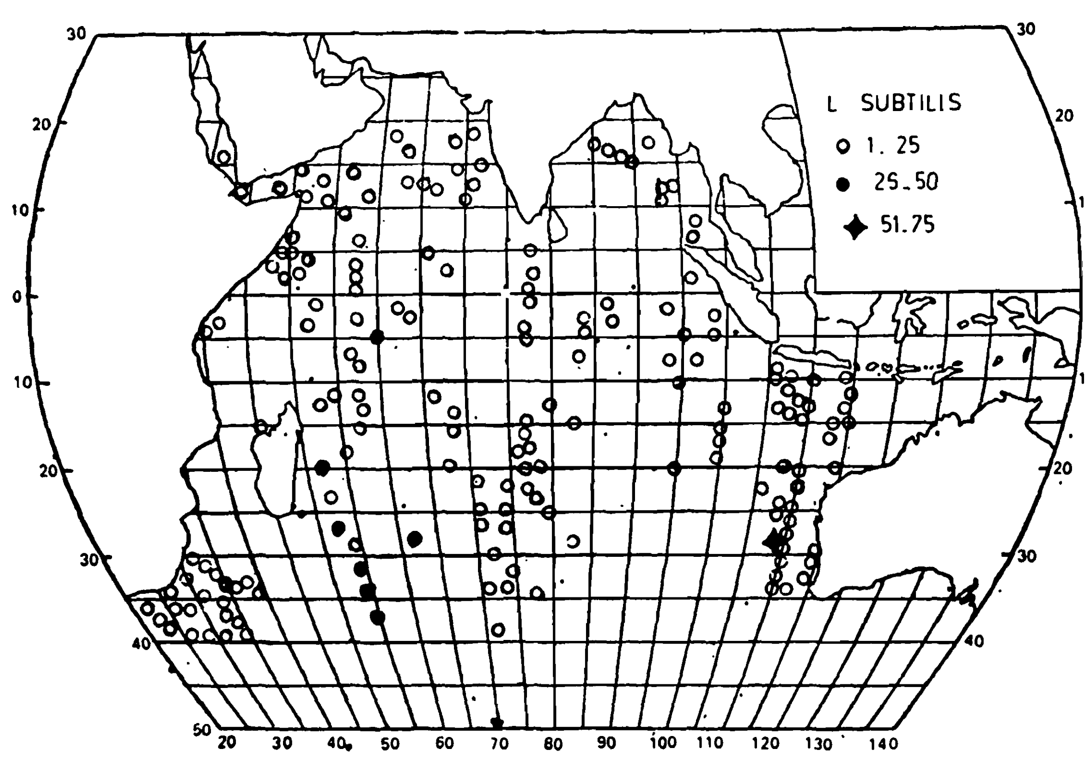


FIG. 64. *L. subtilis* (Chun) (a–f). a. anterior nectophore, b. posterior nectophore; c. ventral view of anterior nectophore; d, e. bracts; f. female, gonophore.



MAP 79. Distribution of *L. subtilis* during SW/SE monsoon season.



MAP 80. Distribution of *L. subtilis* during NE/NW monsoon season.

Monthly variations:

Except in June *L. subtilis* was collected during all the months in the western part (Somali coast and Equator), with the maximum concentration being in August. In the eastern part it was recorded at a few stations during all the months except in October and November.

Bay of Bengal: In this zone *L· subtilis* was collected from few stations only. In the Indian region it was recorded mostly during June and during September in the Andaman and Burma region. It was very rare, being absent for more than three months in the Indian region and 5 months in the Andaman region.

South West Indian Ocean: Except during November *L. subtilis* occurred during all the other months. In the African region the maximum records were during July; and during April in the oceanic region.

South East Indian Ocean: In the Australian region it was not collected during June and November. It was common during January and August. In the oceanic region it occurred generally during December and it was poorly represented in the other months. During February, April and November it was not collected.

60. **Lensia meteori** (Leloup, 1934)
(Fig. 65, a, b)

Galetta meteori Leloup, 1934, p. 15, fig. 6.
Lensia meteori Daniel, 1974, p. 145, Text-fig. 11, Q.R,S,&T.
(cf. for detailed synonymy)

Type Specimen: Museum Royal Histoire Naturelle, Belgique.
Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 2 a.n.; 1 p.n. *Bay of Bengal:* 3 a.n. *South West Indian Ocean:* 11 a.n.; 5 p.n. *South East Indian Ocean:* 8 a.n.; 2 p.n. NORTH EAST/NORTH WEST MONSOON SEASON;: *Arabian Sea:* 6 a.n. *Bay of Bengal:* 1 a.n.; 1 p.n. *South West Indian Ocean:* 6 a.n.; 3 p.n. *South East Indian Ocean:* 2 a.n.

Polygastric phase: Anterior nectophore Upto 5.0 mm in length, 3.0 mm in breadth, without ridges, smooth with blunt apex; delicate, young ones rounded, bubble-like. Nectosac large, rounded with very little mesoglea between wall of nectosac and nectophore, and rounded ostium. Somatocyst small with short stalk and laterally expanded distal end, occurring at baso-ventral corner of nectosac. "Basal facet" almost vertical (not oblique as in *L. subtilis*). Hydroecium very shallow. Mouth-plates longer than in *L. subtilis*, rounded and overlapping.

Posterior nectophore: about same size as anterior nectophore, resembling it in appearance, being bulged, transparent, bubble-like, rounded ostium and with very little mesoglea between wall of nectosac and nectophore. Articulating end truncate but with a small peg-like extension on one end, and oblique fitting well with the almost vertical baso-ventral facet of anterior nectophore.
Eudoxid phase: not yet identified.

Type locality: Cape Vert, Freetown (West Africa).

Distribution: (Maps 69 & 70). The number of records and the distribution of *L. meteori* during the two seasons are presented in maps 69 and 70.

L. meteori was recorded only 12 times in all the four zones of the Indian Ocean during both the seasons.

Arabian Sea: *L. meteori* occurred in the western part during October and December and off Cochin during February and April. In the central region and along the Equator it occurred during May and June.

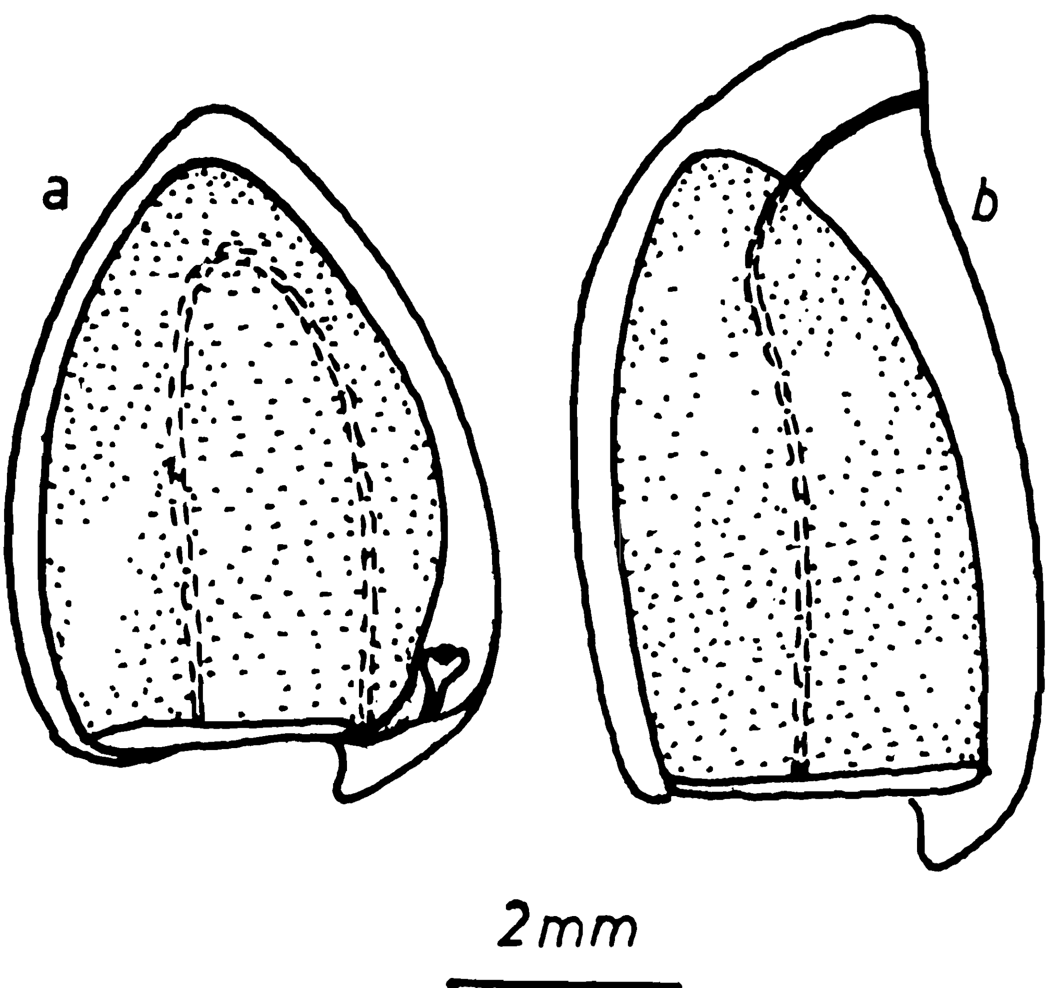


FIG. 65. *L. meteori* Leloup (a-b). a. anterior nectophore; b. posterior nectophore.

Bay of Bengal: *L. meteori* was collected only in the Andaman and Burma region during March, August and September.

South West Indian Ocean: It occurred in the oceanic region during March to July, October and December.

South East Indian Ocean: It was collected south of Java during April, May and September. In the oceanic region it occurred during October.

61. **Lensia multicristata** (Moser, 1925)

(Fig. 66)

Galeolaria multicristata Moser, 1925, p. 165, pl. 111.; fig. 9.
Lensia multicristata Daniel, 1974, p. 146, Text-fig-10, S (cf. for detailed synonymy)

Type Specimen: Museum Für Naturkunde, Berlin.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 8 a.n.; 2 p.n. *Bay of Bengal:* 4 a.n. *South West Indian Ocean:* 9 a.n.; 2 p.n. *South East Indian Ocean:* 9 a.n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 8 a.n.; 1 p.n. *Bay of Bengal:* 8 a.n. *South East Indian Ocean:* 9 a.n.

Polygastric phase: Anterior nectophore: Grows upto 10.0 mm in length, slenderly pyramidal, with 7 longitudinal ridges, one dorsal, two dorsolaterals, two ventro-laterals and two ventrals; dorsal ridge and ventrals complete reaching apex and base (velar edge); dorsolaterals arise from apex but not eaching base; ventro laterals rise near apex and terminate before rreaching base. Basal margin of ventral facet rounded. Hydroecium shallow lying below level of ostium. Somatocyst long, slender, fusiform or linear, nearly half as long as nectosac, with thread-like stalk, lying close to nectosac. Mouth-plates medium sized, with rounded edges.

Posterior nectophore: With 5 longitudinal ridges, laterals not reaching ostial margin. Hydroecium shallow distally. Mouth-plate wide, short, rounded with a slight median notch. A small tongue-shaped projection present at proximal end of right hydroecial fold.

Eudoxid phase: Not yet identified.

Type locality: Tropical Atlantic; west coast of Africa.

Distribution: (Maps 69 & 70). The occurrence and distribution in the four zones of the Indian Ocean during the two seasons are presented in maps 69 & 70.

L. multicristata was collected during both the seasons in the Arabian Sea, Bay of Bengal, South East Indian Ocean and during SW/SE monsoon in the South West Indian Ocean.

L. multicristata occurred in the Central region of the equatorial belt region, Andaman region, south of Java and western Australia.

Arabian Sea: It occurred along the Somali coast during September. Off Cochin and in the central regions of the Arabian Sea during January, March, May, August, November and December.

Bay of Bengal: In the Indian region it occurred during February off Sri Lanka and along the Indian coast during March

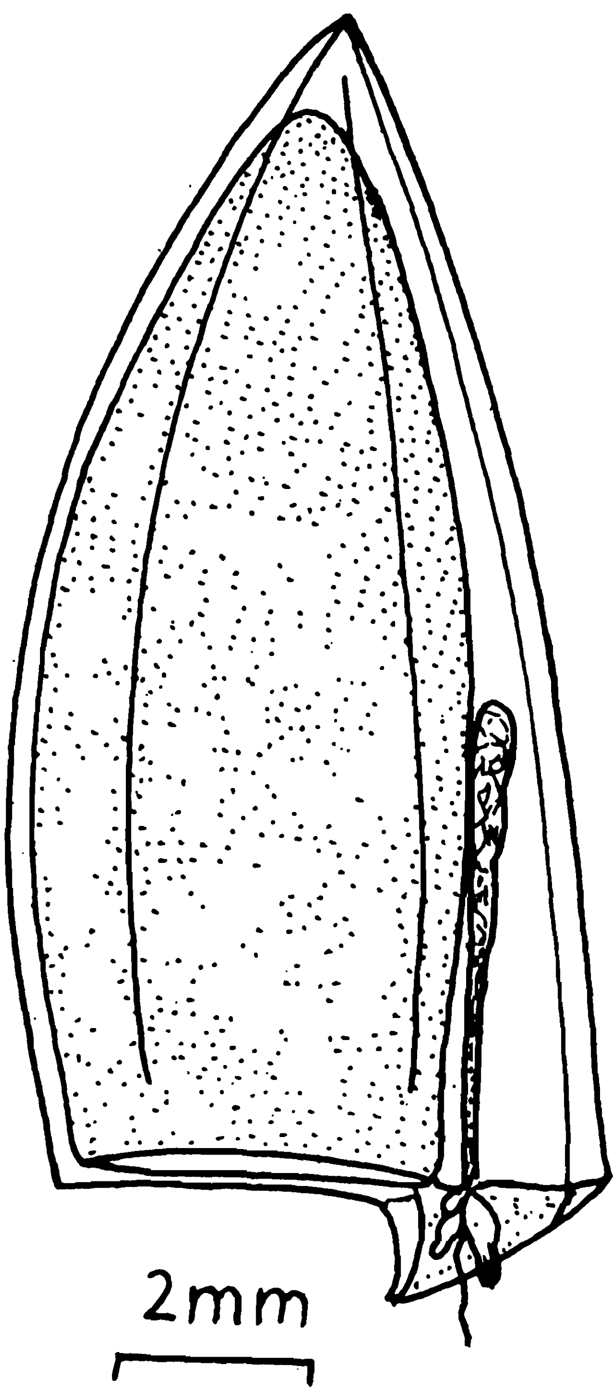


FIG. 66. *L. multicristata* (Moser) anterior nectophore.

and April. In the Andaman and Burma region during January, April, September, November and December·

South West Indian Ocean: It was not collected in the African region. In the oceanic region it occurred during April, May, June, July and October.

South East Indian Ocean: It was recorded in the Australian region, south of Java during January, February, March, September and December. It occurred in the oceanic region during December.

62. **Lensia lelouveteau** Totton, 1941
(Figs. 67 a, b)

Lensia lelouveteau Totton, 1941, p. 171, figs. 108, 109.
Lensia lelouveteau Rengarajan, 1973, p. 140, fig. 7c.

Type Specimen: British Museum (Nat. Hist·) London.

Material: Recorded from the Arabian Sea (Rengarajan, 1973) and from South East Coast of Africa (Totton, 1954).

Polygastric phase: Anterior nectophore: Multicristate form. Many ridges, some complete, some incomplete, some vestigeal, occurring in five groups; 3 or more in dorsal group; 7 or 8 in lateral groups; 4–6 in ventro-lateral groups. Velar ridge (cross-ridge) present at 0.75 mm above ostium. Ventro-basal margin of hydroecium well-rounded. Somatocyst squat, kidney shaped with thin short stalk. Mouth-plates, long, rounded and overlapping.

Posterior nectophore: Unknown.

Eudoxid phase: Unknown.

Type locality: South Atlantic (Lat. 32°20′S; Long. 15°18′E).

Distribution: It occurred in the mid-oceanic region of the Arabian Sea during April, and from SE coast of Africa.

63. **Lensia ajax** Totton, 1941
(Fig. 67 c)

Lensia ajax Totton, 1941, p. 147, figs. 4, 5.
Lensia ajax Daniel, 1974, p. 148, Text-fig. II, U & V.

Type specimen: British Museum (Nat. Hist.), London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Bay of Bengal:* 1 a.n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 2 a.n.

Recorded by Daniel (1974) and from South East Coast of Africa (Totton, 1954).

Polygastric phase: Anterior nectophore: Upto 13.0 mm in length 6.6 mm in breadth; with 5 groups of 3 (sometimes 2 or 4) longitudinal ridges, without velar ridge. All ridges terminate well above level of ostium. Lateral groups consisting of 4 ridges, only 2 or 3 reaching apex. Ventral groups with about 3 or 4 ridges, some vestigeal, some (2) reaching apex, and two reaching edges of

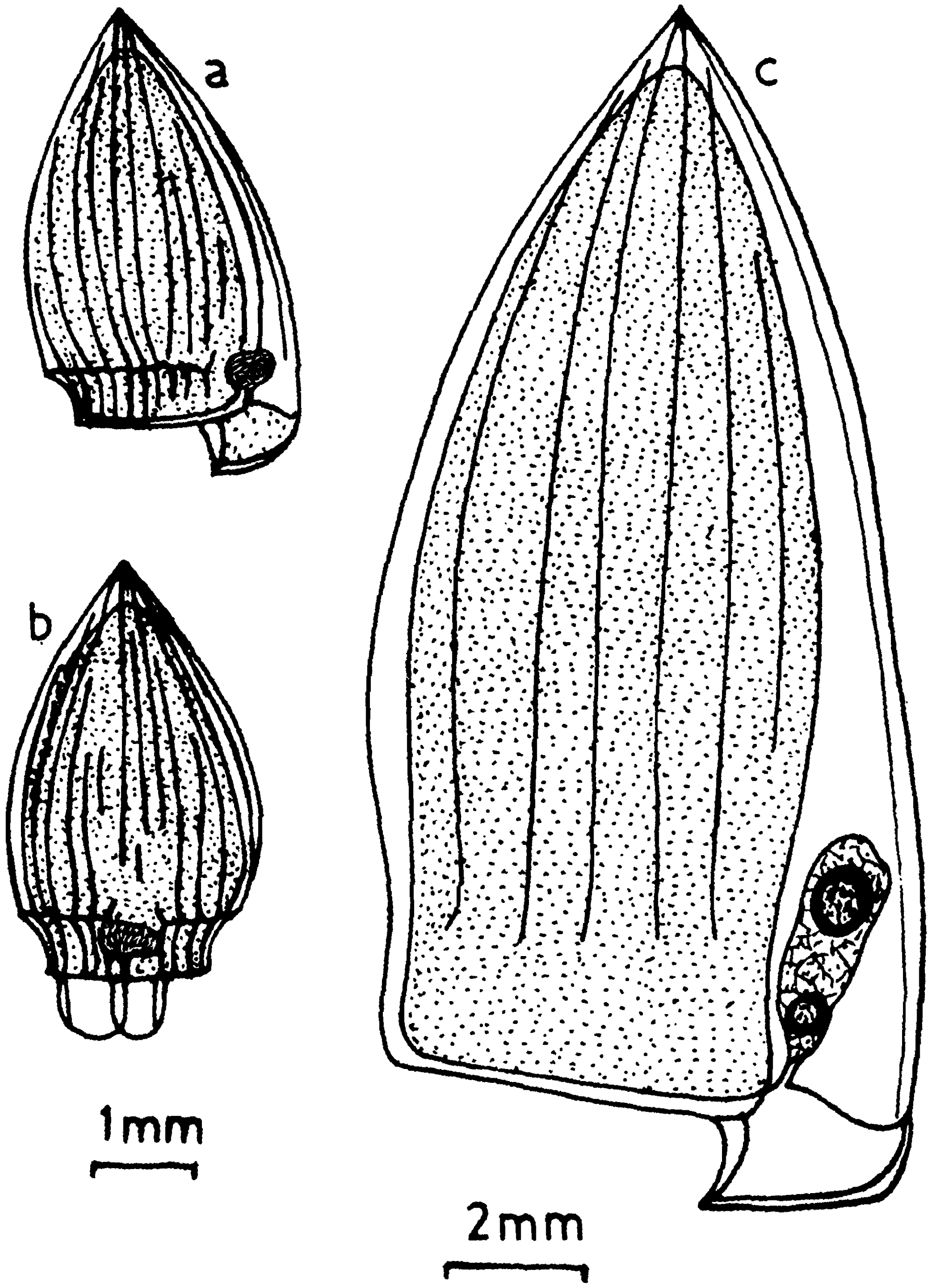


FIG. 67. *L. lelouveteau* Totton (a, b). a & b. anterior nectophore lateral & ventral view. (After Totton, 1941, figs. 22 & 23).
L. ajax Totton, c. anterior nectophore.

mouth-plates. Dorsal group with 3 ridges, middle one reaching apex. Nectosac bulged in mid-region, narrower near ostium. Hydroecium 1.4 mm in depth, lying below level of ostium, open on ventral side. Somatocyst 2.73 mm long, club-shaped with one or two oil globules and short stalk. Mouth-plates large broad, and overlapping.

Posterior nectophore: Not yet identified.

Eudoxid phase: Not yet identified.

Type locality: South Atlantic Ocean.

Distribution: (Maps 69 & 70). *L. ajax* was recorded during October along the Arabian coast and near Sumatra during September (Daniel, 1974).

64. **Lensia multilobata** Rengarajan, 1973
(Fig. 68 a–c)

Lensia multilobata Rengarajan, 1973, p. 141, Fig. 8, a, b, c,

Type Specimen: Central Marine Fisheries Research Institute, Mandapam Camp, Tamil Nadu, India.

Material Examined: Recorded from Arabian Sea during May (South West/South East monsoon season) by Rengarajan (1973).

Polygastric phase: *Anterior nectophore:* (Fig. 68 a) minute, 2.0 mm in length, 1.68 mm in width. Number of ridges uncertain

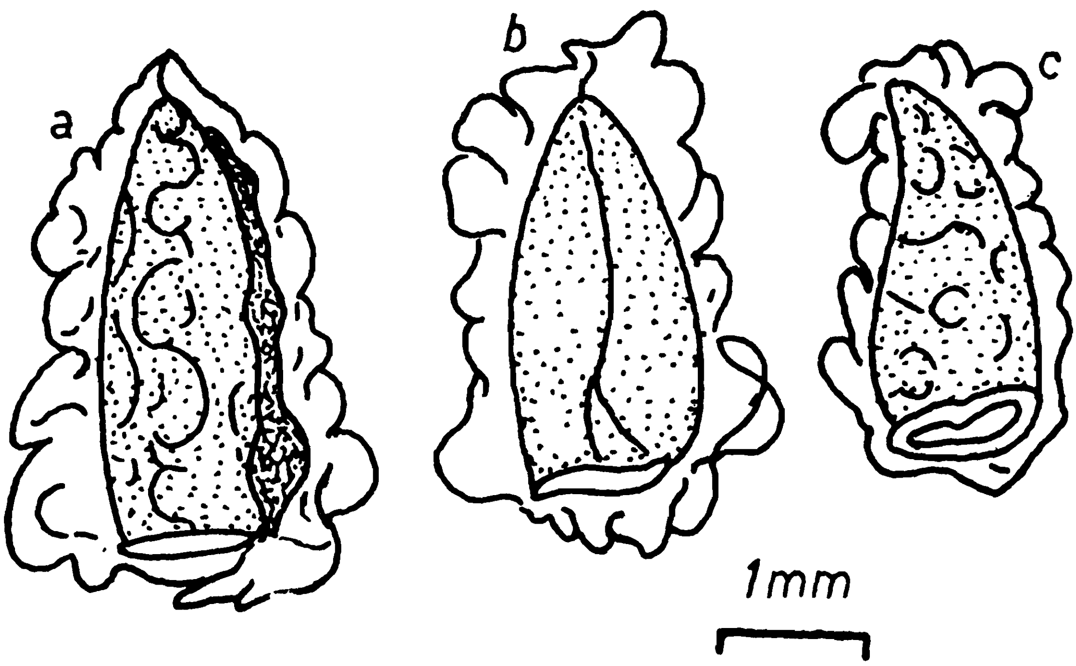


FIG. 68. *L. multilobata* Rengarajan (a–c). a. anterior nectophore; b. posterior nectophore; c. gonophore. (After Rengarajan, 1973, fig.8a-c).

due to overlapping; meet at apex; with scale like expansions, giving appearance of lobes all over nectophore. Nectosac 1.58 mm in length, extending to almost tip of nectophore. Somatocyst 0.40–1.34 mm in length, spindle — shaped. Hydroecium indistinct, with small mouth-plates.

Posterior nectophore: (Fig. 68 b) 2.0 mm in length, squarish with scale like flaps along ridges. Nectosac as in anterior nectophore. Pedicular canal short lying close to apex of nectosac. Mouth-plate well developed.

Eudoxid phase: Bract not known. Gonophore (Fig. 68 c) Resemble polygastric phase in nature of ridges and nectosac. 1.86 mm in length. With small mouth-plate.

Type locality: Lat. 17°21'N; Long. 72°35'E. Arabian Sea.

Distribution: (Map. 73). Recorded from the Arabian Sea during May.

Genus 28. **Muggiaea** Busch, 1851

Muggiaea Busch, 1851, p. 40.

Diphyinae with small pentagonal, five-ridges in anterior nectophore (except *M. bargmannae*), without ostial teeth and posterior nectophores. Mouth-plates broad, rounded, divided, and overlapping. Hydroecium deep, placed against nectosac. Somatocyst variable in length.

Four species of *Muggiaea* were recognized prior to Bigelow's time: *M. kochi* (Will, 1844) Chun (=*M. Pyramidalis* Busch=*Monophyes primordialis* Chun); *M. pyramidalis* Haeckel, 1888; *M.* (*Cymbonectes*) *huxleyi* (Haeckel, 1888) and *M. atlantica* Cunningham, 1892. Neither Chun (1892) nor Schneider (1898) recognized *M. pyramidalis* Haeckel as distinct from *M. kochi*. The validity of *M. huxleyi*, known from one record only, was doubted by Bigelow. Therefore, he considered only two valid species of *Muggiaea: M. kochi* and *M. atlantica* on the basis of the length of the somatocyst and the hydroceium. Two more species were added by Totton (1954): *M. delsmani*, from Java Sea and *M. bargmannae* from the Arctic and Antarctic Oceans, as follows:

1. *M. kochi* Will, 1844; 2. *M. atlantica* Cunningham, 1892,; 3. *M. delsmani* Totton, 1954; 4. *M. bargmannae* Totton, 1954.

Type Species: *Muggiaea kochi* (Will, 1844)

Key to species of MUGGIAEA

1.	Nectophore with short somatocyst..	2
	Nectophore with long somatocyst.	3
2.	Nectophore with short somatocyst; hydroecium sharply conical..	*kochi*

Nectophore with shorter somatocyst; hydroecium shallower with upper wall nearly horiozntal..	*delsmani*
3. Nectophore with long narrow somatocyst extending beyond apex of nectosac; deep hydroecium...	*atlantica*
Nectophore with rounded apex; somatocyst tubular to sausage-shaped, reaching more than half length of the nectosac; shallow hydroecium...	*bargmannae*

Of these, *M. atlantica* and *M. delsmani* (both neritic species) occur in the Indian Ocean. (*M. kochi* recorded from Atlantic and Pacific Oceans and *M. bargmannae* only from Arctic and Antarctic Oceans).

65. **Mugiaea atlantica** Cunningham, 1892

(Fig. 69)

Muggiaea atlantica Cunningham, 892, p. 214.

Muggiaea atlantica Daniel, 1974, p. 149, Text-fig. 12, F. (cf. for detailed synonymy)

Type specimen: British Museum (Nat. Hist.) London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 133 a.n. *South West Indian Ocean:* 189 a.n.; 1 eu. (compl.); 6 br.; 99 go.; 5 'calyconula' larva. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 111 a.n. *South West Indian Ocean:* 491 a.n.; 5 br.; 107 go.; 10 'calyconula' larvae.

Polygastric phase: Anterior nectophore: 3.83 mm in length, 1.23 mm in breadth; with 5 ridges, complete, slightly serrated, at base. No ostial teeth. Hydroecium 1.2 mm long, half its length, extending below level of ostium. Somatocyst 2.3 mm long, slender, lying in contact with nectosac and extending above apex of nectosac. Nectosac 2.6 mm long, sub-cylindrical with usual diphyid type 4 radial canals. Mouth-plates divided broad, rounded margin and slightly overlapping.

Posterior nectophore: not developed.

Eudoxid phase: 2–2.5 mm in total length. Bract small, conical, broad flat sutural surface. Somatocyst placed centrally in small cavity. Gonophore cylindrical, with 4 complete ridges, slightly twisted; ventral ridges (right one stronger) extend beyond ostium forming a short curved mouth-plate. Two gonophores mirror-images of each other. Manubrium long extending 2/3rd length of nectosac with pink tip. Radial canals take spiral course as ridges. Tentacle with 21 tentilla; with kidney shaped cnidosacs.

Type locality: English Channel.

Distribution: (Maps 81 & 82). The distribution of *M. atlantica* in the neritic zones along the Arabian, and African coasts are presented in maps 81 & 82.

It was recorded only along the southern coast of Africa and along the Somali coast, Gulf of Aden and Arabian coast. It was not collected along the coastal regions of India, Burma, Malaya, Indonesia or Australia.

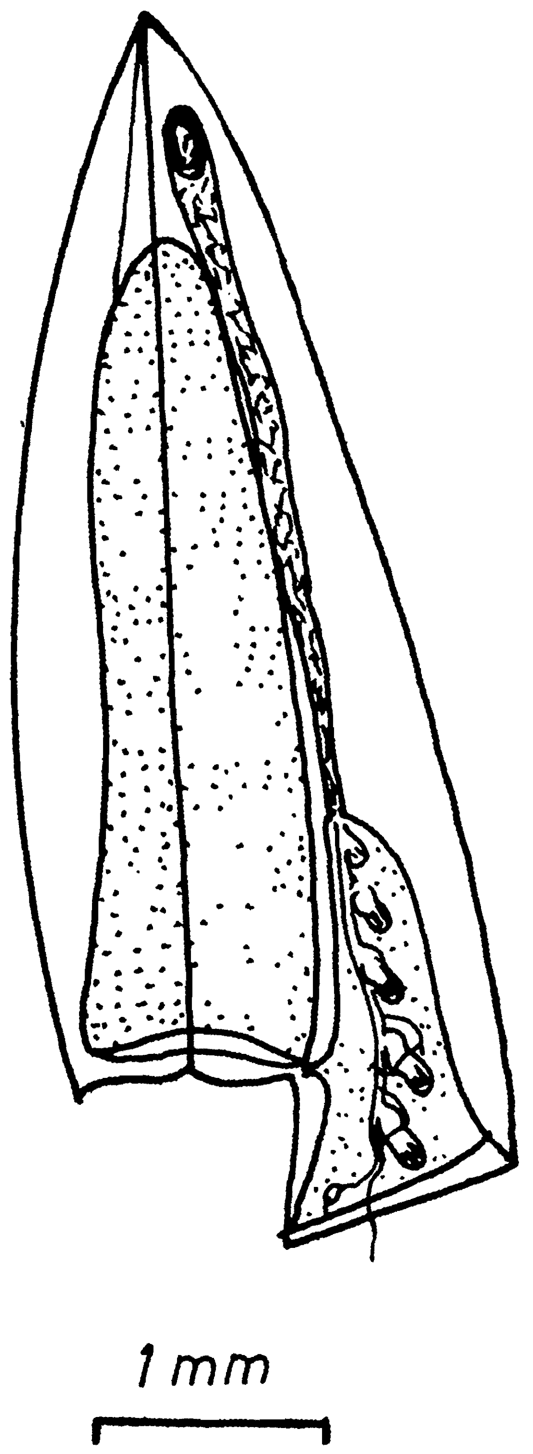


FIG. 69. *M. atlantica* Cunningham, anterior nectophore.

The highest density of 51–75 specimens per haul occurred in the southern tip of Africa and Gulf of Aden. The eudoxids were collected along with the polygastric phases.

Along the Somali coast, Gulf of Aden and Arabian coast, *M atlantica* occurred during January, March, August, October, November and December (maximum records). The eudoxid phases occurred during October to December.

Along the South African coast it occurred during January, April, July and October. Eudoxids occurred during July and October.

M. atlantica is a true neritic species and is discontinuously distributed along the coasts of Arabia, Somali land and southern Africa. Previous records (Daniel, 1974) were also from the Arabian coast.

66. **Muggiaea delsmani** Totton, 1954

(Fig. 70)

Muggiaea delsmani Totton, 1954, p. 123, text-fig. 55-B.

Muggiaea delsmani Daniel, 1974, p. 150, text-fig. 12, G & H.
(cf. for detailed synonymy)

Type Specimen: British Museum (Nat. Hist.) London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 29 n. *Bay of Bengal:* 8 n. NORTH EAST/ NORTH WEST MONSOON SEASON: *Bay of Bengal:* 8 n.

Polygastric phase: Anterior nectophore: With 5 complete, non serrated ridges, pyramidal, 4.13 mm in length and 2.0 mm in breadth. No ostial teeth. Hydroecium 1.0 mm long, shallow, inclined toward nectosac and its apex nearly horizontal, with a slight notch on ventral wall. Somatocyst 0·75 mm long, with a stalk and a thicker tip, lying close against wall of nectosac. Mouth-plates rounded, divided and left plate slightly overlapping right plate. Apex of nectosac not reaching tip of nectophore.

Posterior nectophore: not developed.

Eudoxid phase: unidentified.

Type locality: Java Sea (Lat. 5°57′ S; Long. 108°23′E).

Distribution: (Maps 81 & 82). Distribution of *M. delsmani* is presented in maps 81 and 82. During SW/SE monsoon season it was collected along the west coast of India (25°N lat. to 15°N′ lat.) during May. It also occurred between Malaya peninsula and Sumatra during August and September. During NE/NW monsoon season it occurred along the east coast of India during January and along Burma coast during March.

Previously it was recorded along the coast of Orissa. It is a true neritic species which occur along the coastal regions of Indonesia (Java Sea-from the Pacific Ocean) Malaya, Burma, east and west coasts of India.

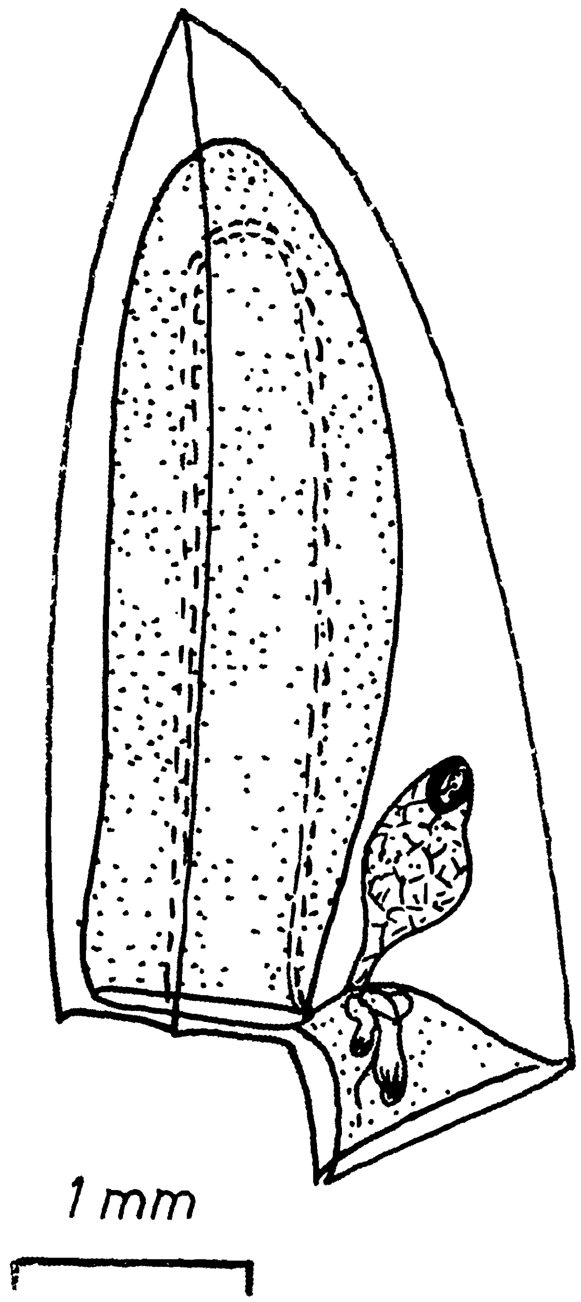
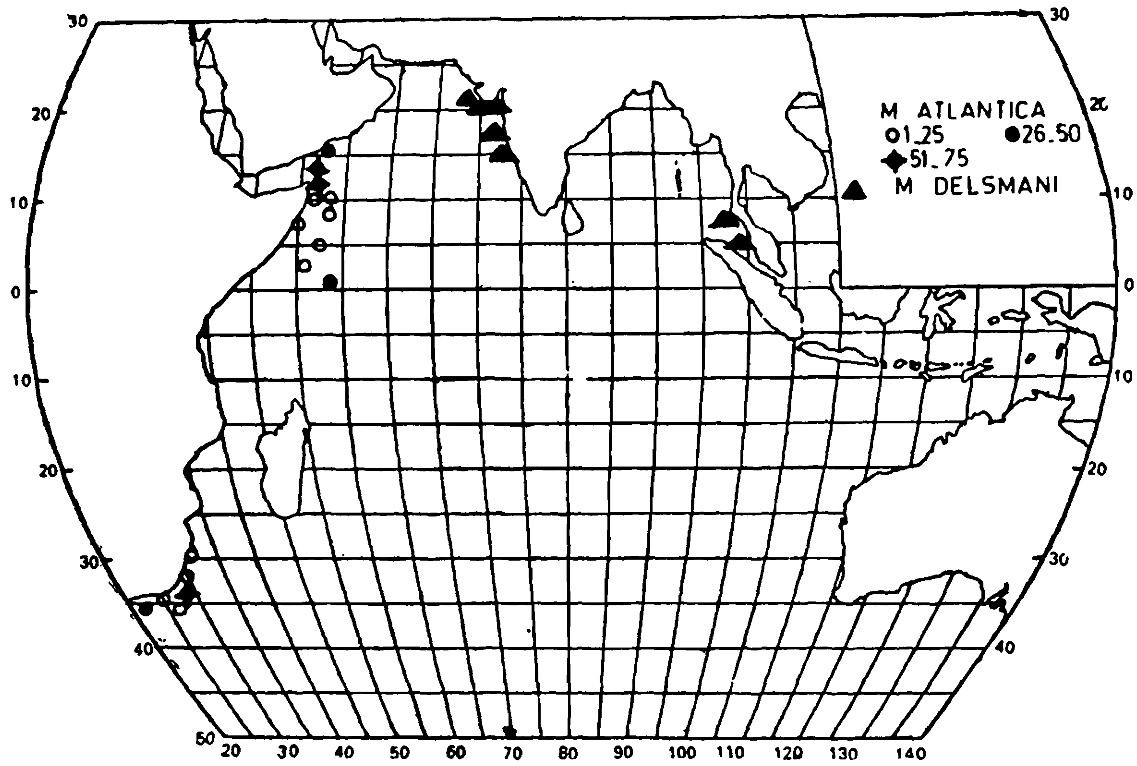
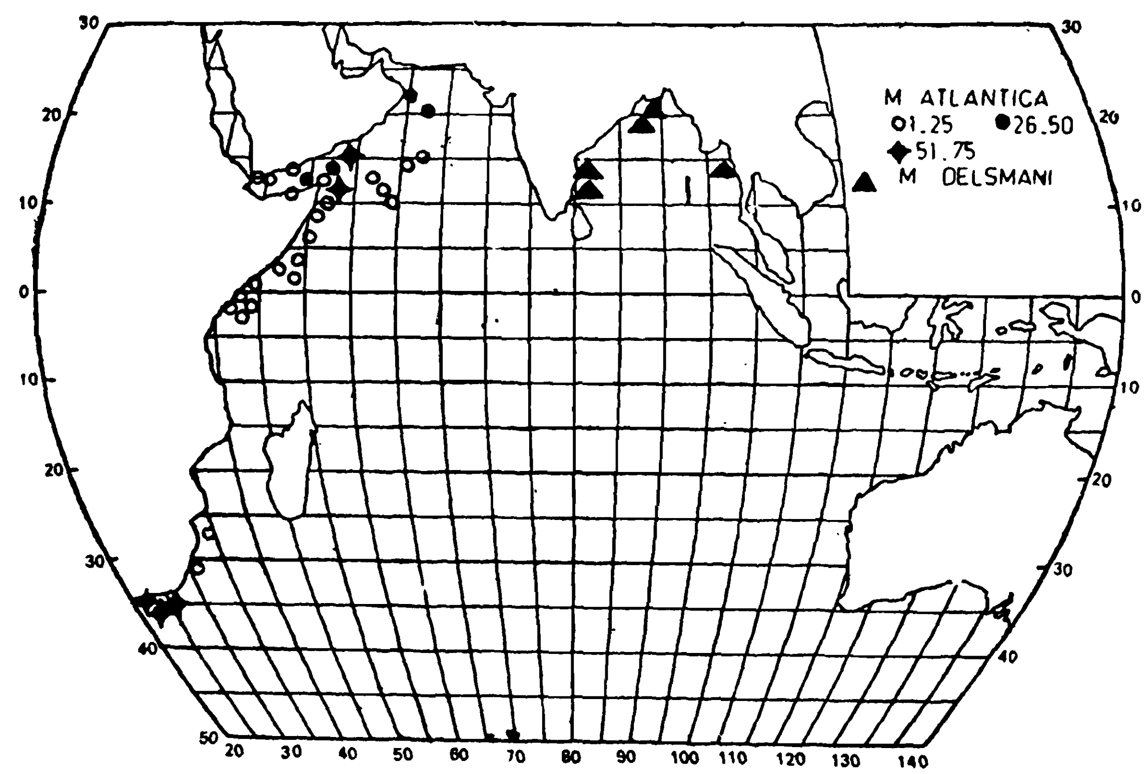


FIG. 70. *M. delsmani* Totton, anterior nectophore.



MAP 81. Distribution of *M. atlantica* and *M. delsmani* during SW/SE monsoon season.



MAP 82. Distribution of *M. atlantica* and *M. delsmani* during NE/NW monsoon season.

Genus 29. **Dimophyes** Moser, 1925

Dimophyes Moser, 1925, p. 389.

Diphyinae with anterior nectophore not pyramidal, rounded apex and with incomplete ridges. Mouth-plate undivided, smoothly rounded and wide open on ventral side. Posterior nectophore reduced, half enclosed in hydroecium.

This species was included in the genus *Muggiaea* by Schneider (1898, p. 89) under family Monophyidae but retained in the Diphyidae by Bigelow. However, this genus *Dimophyes* was regarded as constituting a monotypic Family Dimophyidae by Moser (1925). In general shape of the nectophore and the somatocyst *D. arctica* resembles *M. bargmannae* and differs in the structure of the mouth-plates and in the presence of a reduced posterior nectophore which is never developed in *Muggiaea*.

Monotypic genus for *D. arctica* (Chun, 1897).

67. **Dimophyes arctica** (Chun, 1897)
(Fig. 71 a–c)

Diphyes arctica Chun, 1897, p. 19, taf. 1; figs. 1–10.
Dimophyes arctica Daniel, 1974, p. 151, text-fig. 12, I & J.
(cf. for detailed synonymy)

Type Specimen: Place of deposit not known from literature.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 11 a.n. *Bay of Bengal:* 24 a.n. *South West Indian Ocean:* 22 a.n. *South East Indian Ocean:* 3 a.n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 15 a.n. *Bay of Bengal:* 26 a.n. *South West Indian Ocean:* 21 a.n. *South East Indian Ocean:* 10 a.n.

Polygastric phase: Anterior nectophore: Upto 10.0 mm in length, 5.0 mm in breadth, with rounded apex. Only incomplete lateral ridges, not reaching apex or base, present. No ostial teeth. Somatocyst varies in length, 5.0 mm, broad at base, tapering toward apex, or spindle shaped reaching upto half the length of the nectophore and lies close against wall of nectosac. Hydroecium–characteristically shaped as 'Spathe' of Arum—lily, apex, slightly above level of ostium, with major portion lying below level of ostium. Mouth-plate undivided, rounded with smooth edge and wide open on ventral side.

Posterior nectophore: Obsolescent, reduced in size with rounded truncated articulating surface; hydroecial groove deep proximally shallow distally, bounded by two wings. Plane of ostium vertical instead of horizontal, *Eudoxid phase:* About 9 mm long. Bract with thick head pieces broadly conical, and thin, broad and long neck-shield. Large globular part of phyllocyst lies within head piece and fine basal horn within neck-shield. Gonophore about 7 mm long, without hydroecial groove, female manubrium bears 80–100 ova.

Type locality: Baffin Bay (Arctic Ocean).

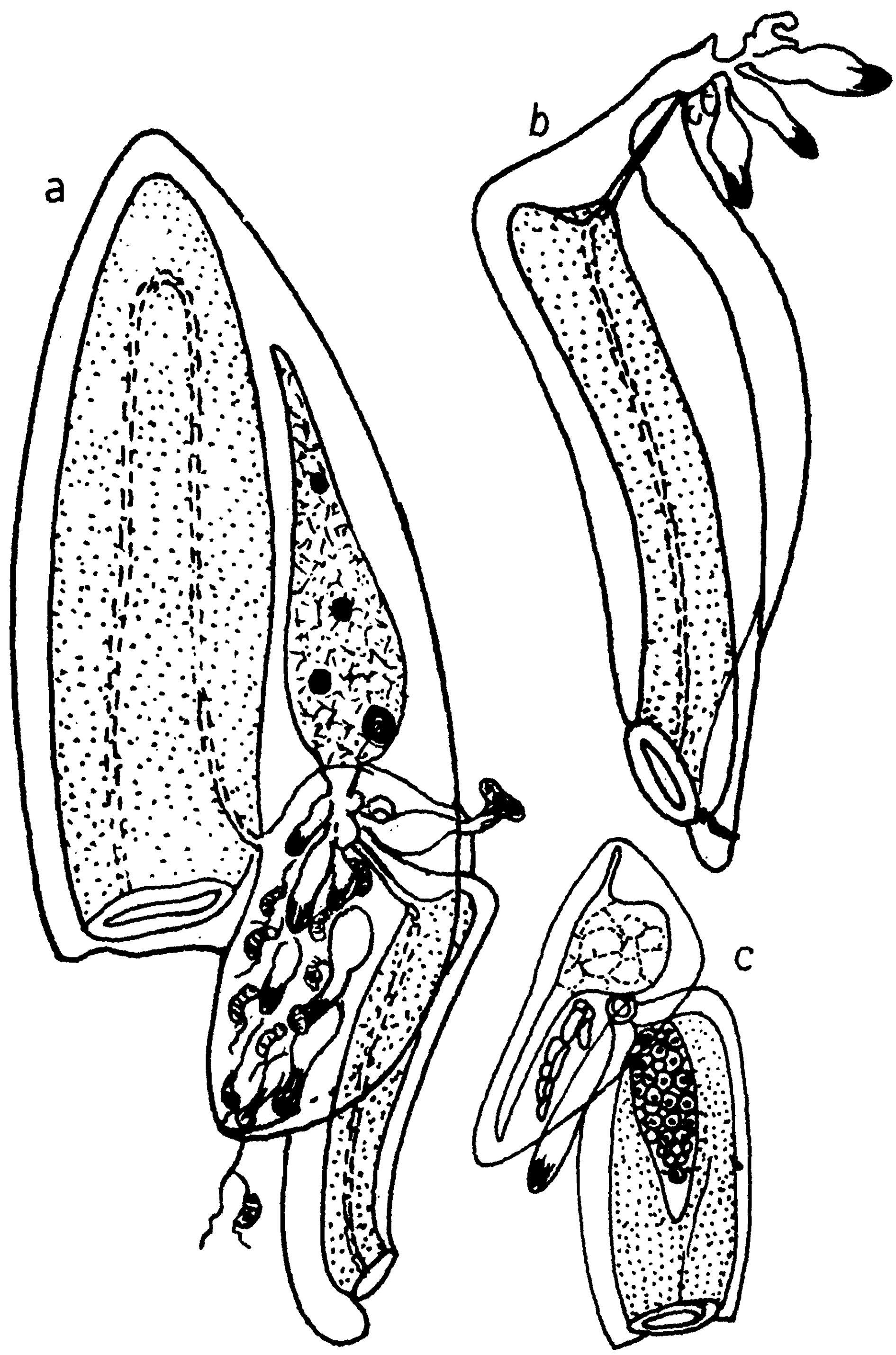


FIG. 71. *D. arctica* (Chun) (a–c). a. polygastric phase intact; b. posterior nectophore; c. eudoxid phase. (Figs. a, b after Moser, 1925, pl. 26, figs: 1, 2; Fig. c from Chun, 1897b, pl. 1, fig. 6).

Distribution: (Maps 83 & 84). The number of records and distribution of *D. arctica* in the four zones of the Indian Ocean during the two seasons are presented in maps 83 and 84. Usually 1–10 nectophores per haul was collected at each station.

It was recorded from all the four zones of the Indian Ocean during both seasons.

D. arctica occurred in many stations located within 15°N latitude and 15°S latitude. It was not recorded outside this area, showing that upwelling of cold deeper waters occur in this area.
Monthly variations:

Arabian Sea: In this region it occurred in the Gulf of Aden, Somali coast and Equator during January, February, May, June, August, September, October and November.

Bay of Bengal: It occurred mostly in the Andaman and Burma region and near the Equator during February, March (Maximum), April, August, September and November.

South West Indian Ocean: In the African region it occurred near the Equator (10°S lat.) during January, July and November. In the oceanic region except during February, it was collected throughout the year.

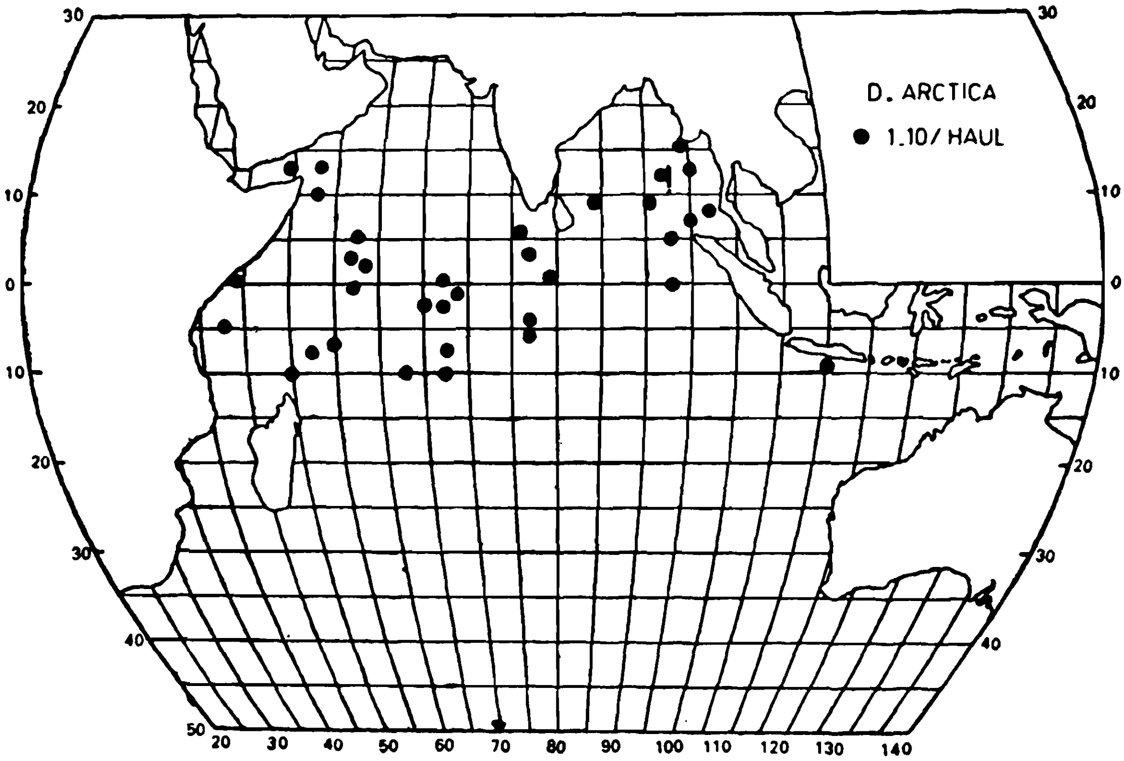
South East Indian Ocean: In the Australian region it occurred south of Java during January, May and December. In the oceanic region near the Equator it was collected during September, October and December.

D. arctica is a cold mid-water species and it does not usually occur in the upper strata of water (200–0 m) depth. Its occurrence in these collections show that it is brought up along with the upwelling deeper water up to the lower boundary of the thermocline. Only a few anterior nectophores at a time are brought up and and so far no eudoxids of this species has been collected, from the 200–0 m depth. *D. arctica* is considered as an "indicator" species. Therefore, it is noted that their occurrence in the particular regions mentioned above corresponds with the upwelling regions. In the Indian Ocean upwelling of deeper cold-water mass occurred along the Somali coast, off Cochin, equatorial belt region, Andaman regions and South of Java.

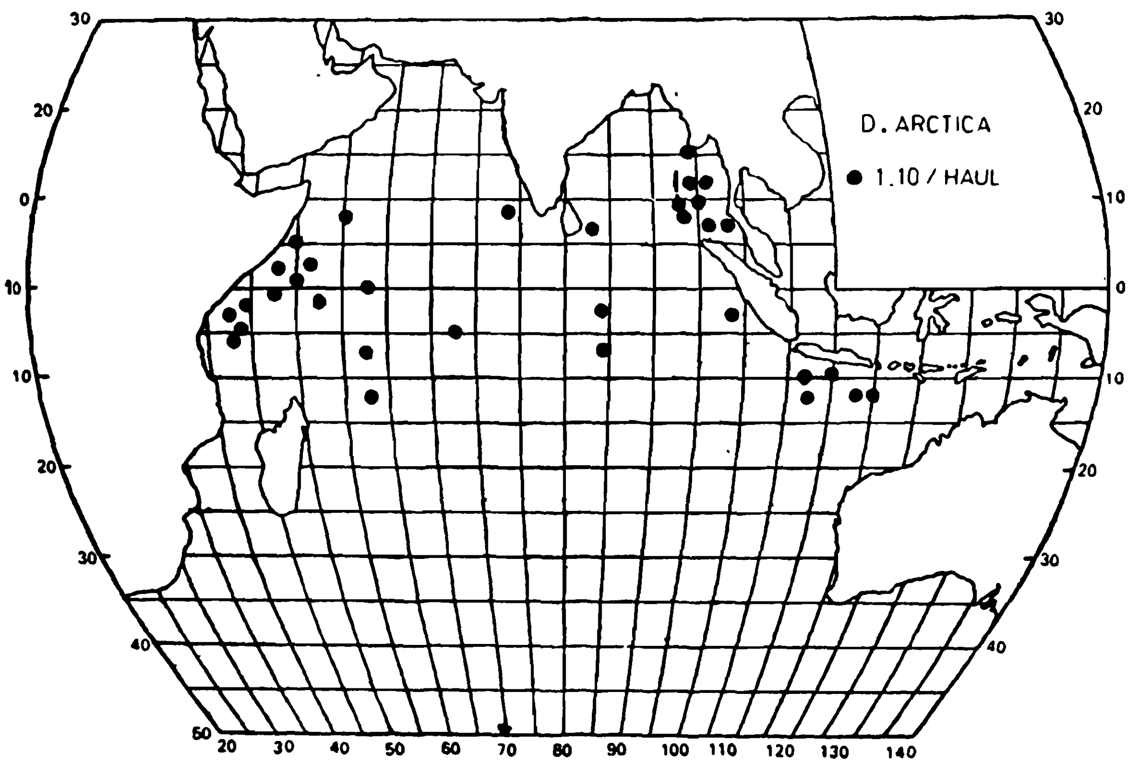
Genus 30. **Chelophyes** Totton, 1932

Chelophyes Totton, 1932, p. 353.

Diphyinae with vestigeal dorsal ridge and 3 serrated complete ridges in anterior nectophore. Hydroecium with large divided serrated tooth-like mouth-plates. Posterior nectophore with a flap on left hydroecial wing reaching over to right side to form a closed hydroecial cavity, ending in prominent serrated teeth. Eudoxid



MAP 83. Distribution of *D. arctica* during SW/SE monsoon season.



MAP 84. Distribution of *D. arctica* during NE/NW monsoon season.

phase with conical bracts, short neck-shield and large gonophore. No special nectophore.

In 1932, *Diphyes appendiculata* Eschscholtz, 1829 and *D. contorta* Lens & van Riemsdijk, 1908 which resemble each other more than either resembles any other species, were placed into a new genus *Chelophyes* Totton (1932).

Type Species: Chelophyes appendiculata (Eschscholtz, 1829).

Two valid species: *C. appendiculata* (Eschscholtz, 1829) and *C. contorta* (Lens & van Riemsdijk, 1908).

Key to species of **Chelophyes**

Anterior nectophore with 3 complete ridges; left lateral ridge not reaching apex; somatocyst long and inclined...	*.appendiculata*
Anterior nectophore with 3 complete ridges; right lateral ridge not reaching apex; somatocyst long and bent like a 'J' (hockey-stick shaped)..	*contorta*

Both the species occur all over the Indian Ccean.

68. **Chelophyes appendiculata** (Eschscholtz, 1829) (Fig. 72 a–e)

Diphyes appendiculata Eschscholtz, 1829, p. 138, pl 12, fig. 7.

Diphyes appendiculata Bigelow, 1911, p. 248, pl. 7, figs. 5, 6, pl 8; figs. 7, 8; pl. 9, figs. 6; pl. 10, fig. 6; pl. 11, fig. 1.

Chelophyes appendiculata Daniel, 1974, p. 154, text-fig. 12, K, L M & N (cf. for detailed synonymy).

Type Specimen: Place of deposit not known from literature.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 1 p.g. (compl.); 187 a.n.; 107 p.n. *Bay of Bengal:* 1 p.g. (compl.); 104 a.n.; 60 p.n. *South West Indian Ocean:* 7 p.g. (compl.); 381 a.n.; 175 p.n.; 1 br.; 7 go, *South East Indian Ocean:* 18 p.g. (compl.); 612 a.n.; 299 p.n.; 1 eu. (compl.); 32 br.; 39 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 1 p.g. (compl.); 127 a.n.; 66 p.n. *Bay of Bengal:* 2 p.g. (compl.); 112 a.n.; 63 p.n.; 1 eu (compl.); 10 br., 4 go. *South West Indian Ocean:* 2 p.g. (compl.); 390 a.n.; 141 p.n.; 10 eu. (compl.); 189 br.; 235 go. *South East Indian Ocean:* 11 p.g. (compl.); 662 a.n.; 270 p.n.; 7 eu. (compl.) 55 br., 82 go.

Polygastric phase: Anterior nectophore: Upto 12.3 mm in length, 4.3 mm in breadth, pyramidal with pointed tip, 5 ridges—2 ventrals and right lateral complete, right lateral curved toward dorsal side, left lateral ridge arise slightly below apex of nectophore but reaching base, dorsal ridge vestigeal occurring at base only, and serrated from mid-region to base. No ostial teeth (except for a slight dorsal projection). Somatocyst 6.0 mm long, thin, club-shaped, inclined towards nectosac. Hydroecium 3.0 mm long, sharply conical inclined towards ventral wall of nectophore. Mouth-plates broad, long, divided, overlapping ending in pointed serrated tips.

Posterior nectophore: About 7.7 mm long, 2.7 mm wide, slender, ridges as in anterior nectophore. No ostial teeth. Ventral ridges extended to form hydroecial wings and end in two serrated

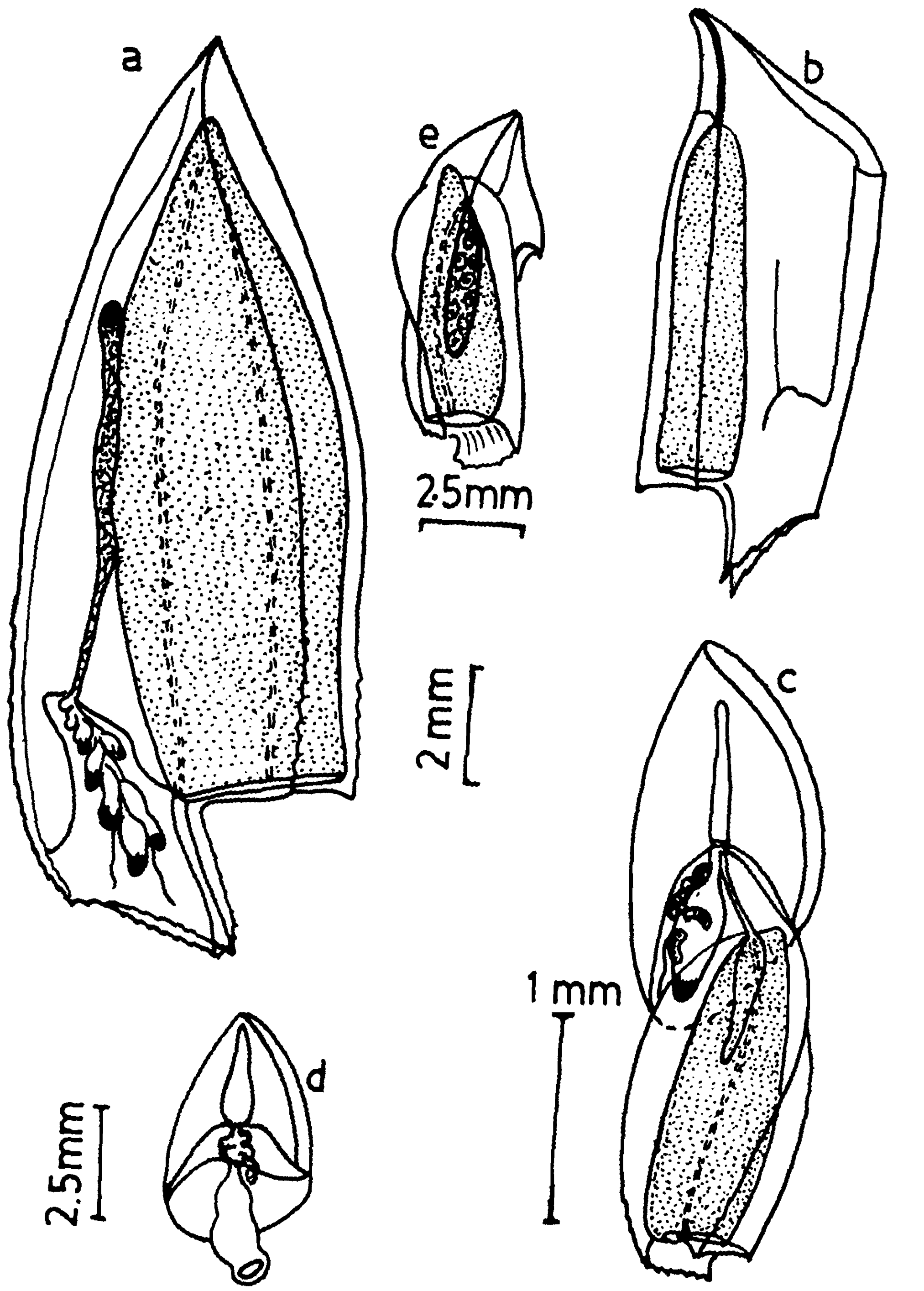


FIG. 72. *C. appendiculata* (Eschscholtz) (a–e). a. anterior nectophore; b. posterior nectophore; c. eudoxid phase; d. bract; e. gonophore.

teeth of which left one is larger; traingular flap from left hydroecial wing cover hydroecium completely.

Eudoxid phase: Bract upto 3.1 mm in length, conical, apex pointed with conical braceal cavity. Phyllocyst long, cylindrical with tapering apex reaching upto apex. Neck-shield short, margin smooth without any teeth or serration. No special nectophore. Gonophores 3.5 mm long, with 4 ridges, slightly curved, ending in teeth near ostium, male and female gonophore occur in different eudoxids.

Type locality: North Atlantic Ocean

Distribution: (Maps 85 & 86). The distribution and abundance of this species in the different regions of the Indian Ocean are presented in maps 85 and 86.

C. appendiculata occurred all over the Indian Ocean especially in the southern hemisphere. Its range of distribution extended from 20°N latitude to 45°S latitude. It occurred, both during night and day without much variation.

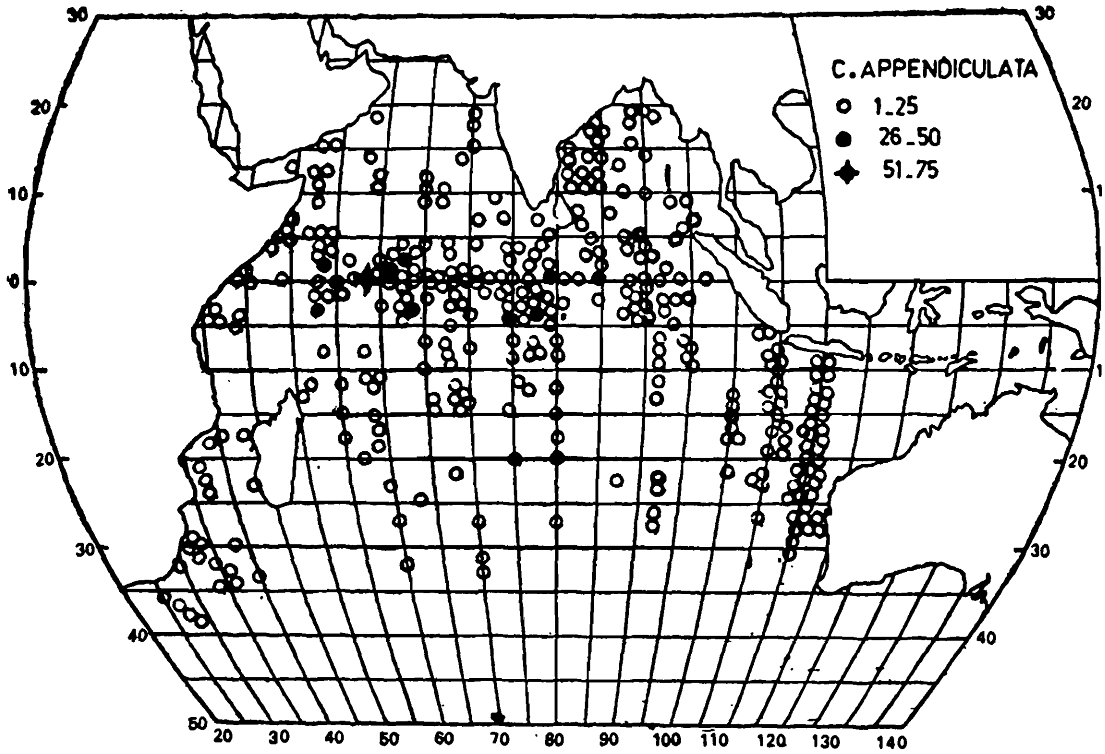
During SW/SE monsoon season, *C. appendiculata* occurred in the range of 1-25 per haul in most of the stations and 26–50 specimens per haul in the equatorial belt regions. From most of the stations, only the polygastric phases were recorded.

During NE/NW monsoon season, at most of the stations only 1–25 specimens per haul was collected. At a few stations, located north-west of Madagascar, central mid-ocean and near 110°E longitude it occurred in the range of 26–50 and 51–75 specimens per haul. The eudoxid phases occurred in great numbers within 30°S and 45°S latitude and in fewer numbers within 20°S and 30°S latitudes. The eudoxid phases were not collected in the equatorial belt and in the norhtern hemisphere. It is probable that breeding and the development of this species takes place in the colder waters as seen from the occurrence of the sexual phase-eudoxid phase—in the colder waters within the 30°S to 45°S latitude.

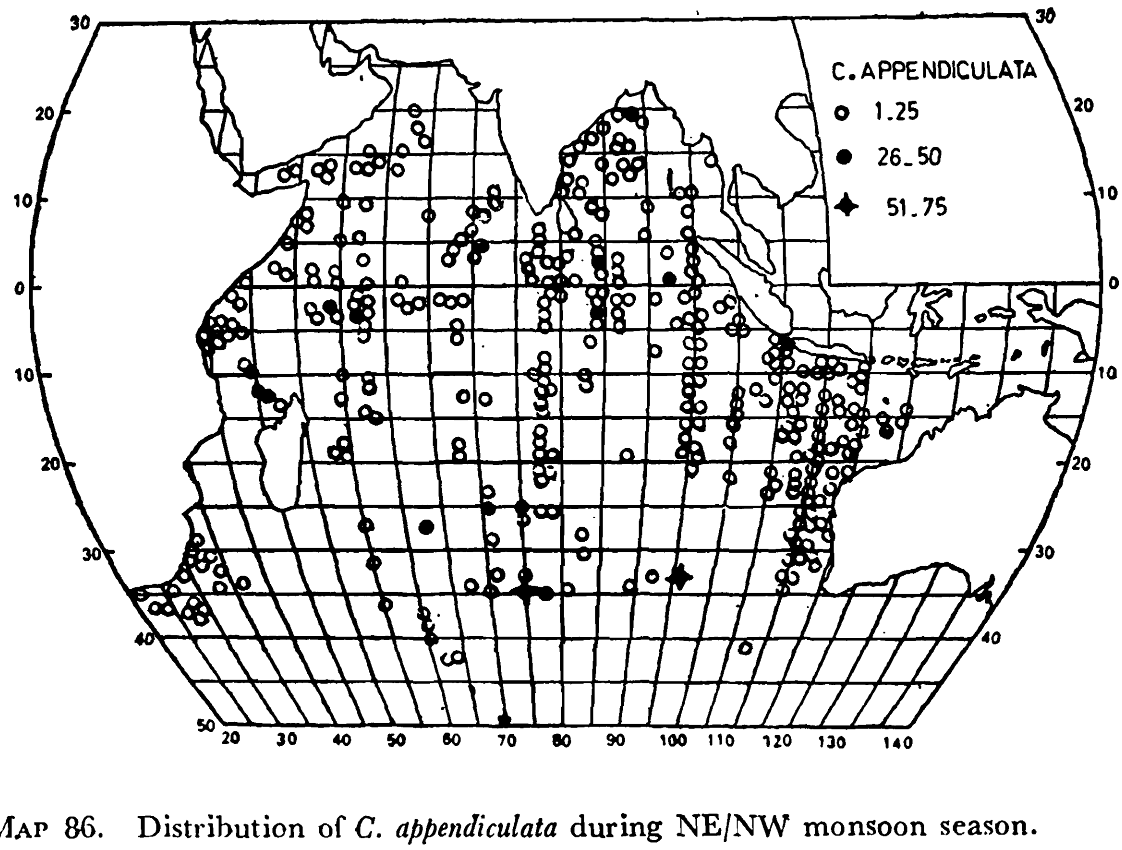
Monthly variations:

Arabian Sea: On the western region it occurred mainly during August and also during February, June and December. It is absent in May and September. On the eastern region it was captured in maximum number of hauls during August and also during May. It occurred in small number of hauls throughout the year.

Bay of Bengal: On the Indian region it occurred during April (maximum) and in February and May. It was not recorded during January and October. Near Andaman islands and Burma



Map 85. Distribution of *C. appendiculata* during SW/SE monsoon season.



Map 86. Distribution of *C. appendiculata* during NE/NW monsoon season.

it occurred at few stations. It was collected during July and October.

South West Indian Ocean: Along the African coast it occurred during January, July and October. In the oceanic region it occurred throughout the year. The maximum occurrence were during January, April, July and December.

South East Indian Ocean: In this region *C. appendiculata* was collected throughout the year. Along the 110°E longitude it occurred during January (maximum), February, April and December. In the oceanic region it occurred during December and at few stations during the rest of the year.

Large forms of *C. appendiculata* measuring nearly one and a half times the usual size occurred in the regions between 30°S 45°S latitudes. This shows that probably temperature plays an important part in the size attained by the animals. Another interesting feature observed in the distribution of *C. appendiculata* is the occurrence of the eudoxid phase in the southern regions of the Indian Ocean.

69. **Chelophyes contorta** (Lens & van Riemsdijk, 1908)
(Fig. 73 a–d)

Diphyes contorta Lens & van Riemsdijk, 1908, p. 39, pl. VI, figs. 48–50.
Chelophyes contorta Daniel, 1974, p. 156, Text-fig. 12, O, P & Q.
(cf. for detailed synonymy)

Type Specimen: Zoologisch Museum, Amsterdam.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 6 p.g. (compl.); 1559 a.n.; 297 p.n.; 65 eu. (comple.); 372 br.; 755 go. *Bay of Bengal:* 4 p.g. (compl.); 2199 a.n.; 392 p.n.; 35 eu (compl.) 321 br.; 697 go. *South West Indian Ocean:* 4 p.g. (compl.); 840 a.n.; 168 p.m.; 48 eu. (compl.); 203 br.; 331 go. *South East Indian Ocean:* 7 p.g. (compl.); 684 a.n.; 96 p.n.; 24 eu (compl.); 63 br.; 161 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 13 p.g. (compl.); 1793 a.n.; 595 p.n.; 71 eu. (compl.)496 br.; 1024 go. *Bay of Bengal:* 1 p.g. (compl.); 1222 a.n.; 191 p.n.; 21 eu. (compl.)115 br.; 277 go. *South West Indian Ocean:* 4 p.g. (compl.); 986 a.n.; 180 p.n.; 50 eu. (compl.); 277 br.; 663 go. *South East Indian Ocean:* 7 p.g. (compl.); 656 a.n.; 148 p.n.; 26 eu. (compl.) 107 br.; 218 go.

Polygastric phase: Anterior nectophore: About 5.1 mm long, 2.25 mm wide, serrated ridges, only 2 laterals and left ventral complete, reaching apex and base, right ventral incomplete arising slightly below apex, and dorsal vestigeal arising from middle of nectophore and reaching base. No ostial teeth. Somatocyst 2.75 mm long, characteristically shaped like 'hockey-stick' with straight stalk and curved tip. lying across nectosac on right side. Hydroecium 2.25 mm long conical, lying below level of ostium, inclined towards ventral side. Baso-ventral edge sloping, end in two prominent pointed, serrated teeth like mouth-plates, slightly overlapping.

Posterior nectophore: Bowed in appearance, 3.5 mm long and 2.0 mm wide, ridges as in anterior nectophore. No ostial teeth. Hydroecial wings serrated, broad at proximal end tapering into

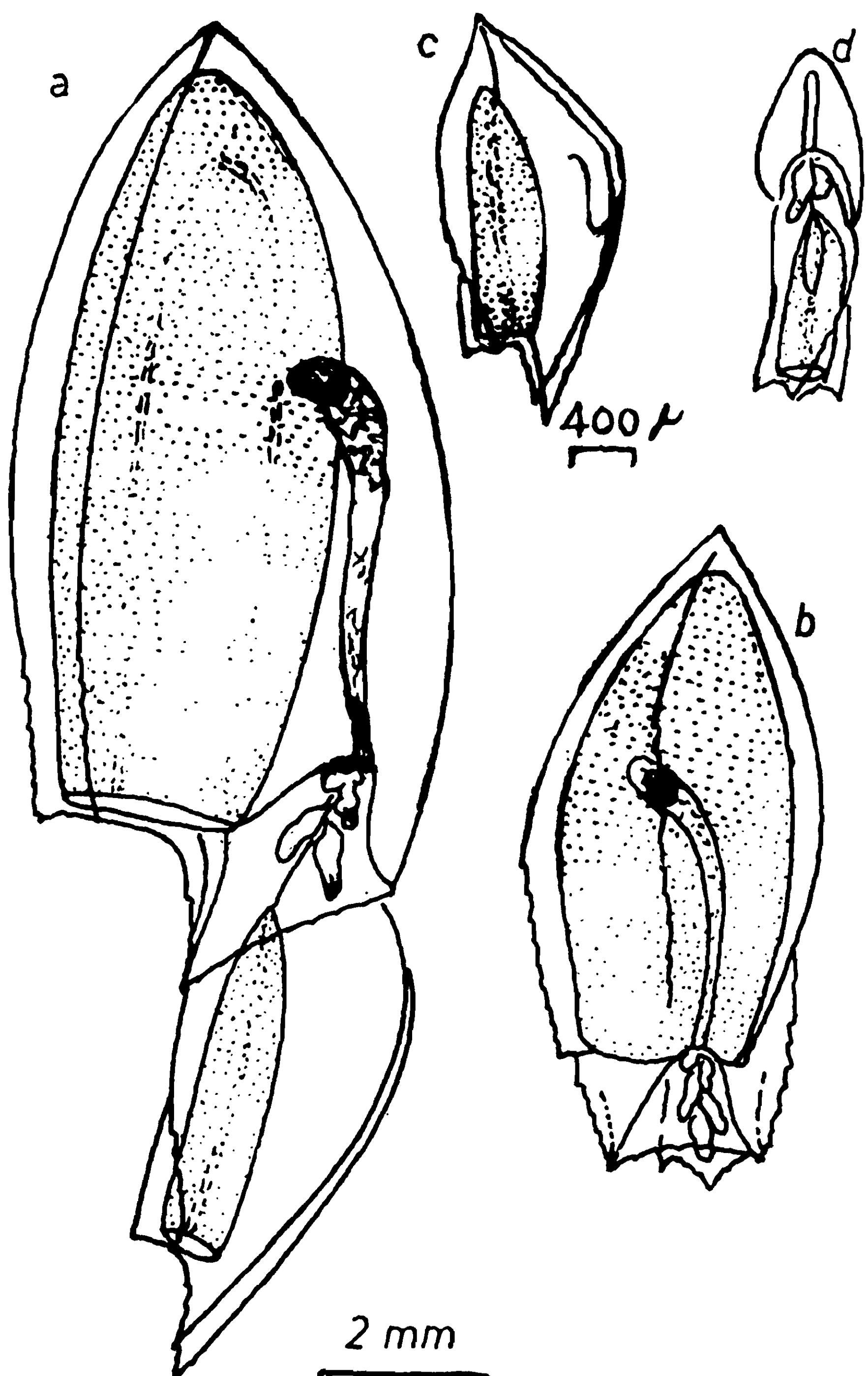


FIG. 73. *C. contorta* (Lens & van Riemsdijk) (a–d). a. both nectophores intact; b. anterior nectophore — ventral view; c. posterior nectophore; d. eudoxid phase.

two pointed teeth; hydroecial groove open above and closed below with a flap-like extension from hydroccial wing.

Eudoxid phase: Small, bract with pointed apex, similar to *C. appendiculata*. Bract 2.0 mm long, slender and pointed. Gonophores small 2.5—3 mm long.

Type locality: Malay Archipelago.

Distribution: (Maps 87, 88, 89 & 90). The distribution and abundance of this species in the Indian Ocean in the different regions are presented in maps 87, 88, 89 and 90.

C. contorta is a common species which occurred all over the Indian Ocean, especially in the Arabian Sea and Bay of Bengal, being distributed in more than 75% of the area. In the South West and East Indian Ocean it occurred in 50% of the total number of hauls in these regions. It occurred in greater number of hauls made during the day time in all the zones except in the Bay of Bengal. Maps 87-90 give the population density of *C. contorta* during the two seasons.

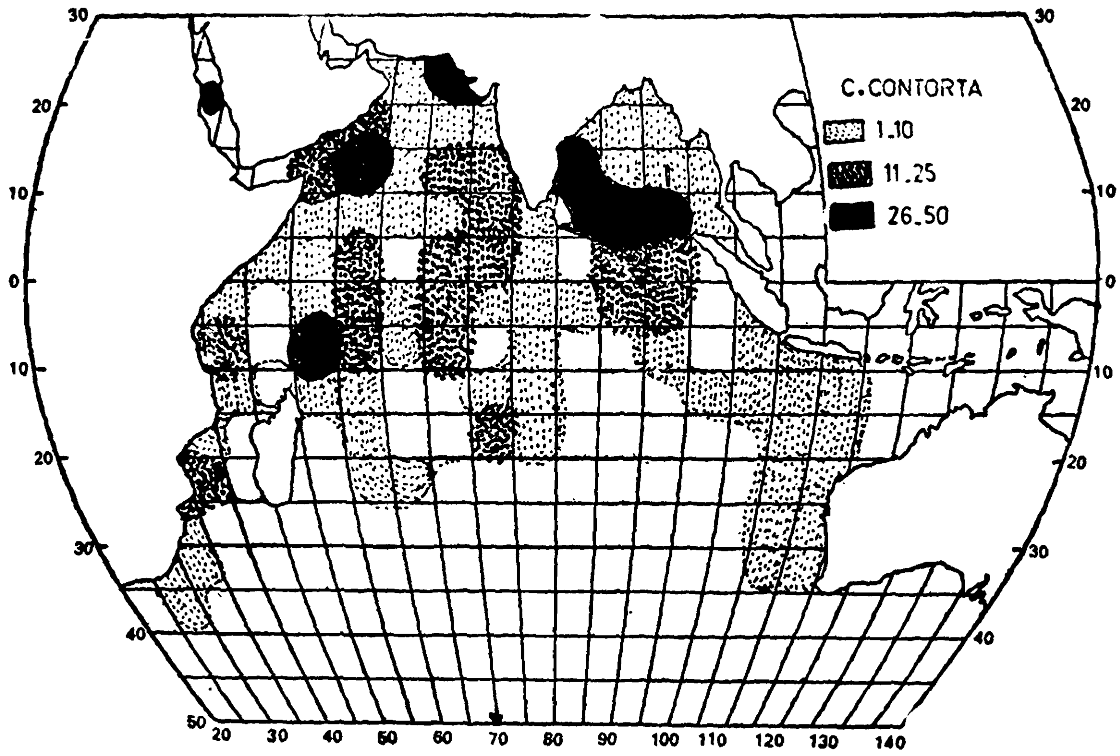
During SW/SE monsoon season the maximum population density (26-50 specimens per haul) of the polygastric phases were collected in the Red Sea, two small regions along the Somali and Arabian coasts and off Pakistan. On the western coast of Indai, it occurred south of Goa, around Peninsular India upto 15°N latitude in the Bay of Bengal, and in the rich belt (between 5°N and 10°N latitude) across the Bay of Bengal to Burma and Malayan coast. Similar population density occurred in the equatorial belt between 50°E to 60°E longitude. The eudoxid phase occurred almost in the same regions as the polygastric phases and its population density ranged from 26–50 specimens per haul.

During NE/NW monsoon season the polygastric phases of *C. contorta* occurred in maximum number per haul (26-50/haul) along the Somali coast, Gulf of Aden, central region of the Arabian Sea, western and eastern coasts of India and in the central midocean, south of the Equator. The eudoxid phases (26-50/hauls) occurred on the west coast of India, and in the central mid-ocean regions where the polygastric phase occurred in similar numbers.

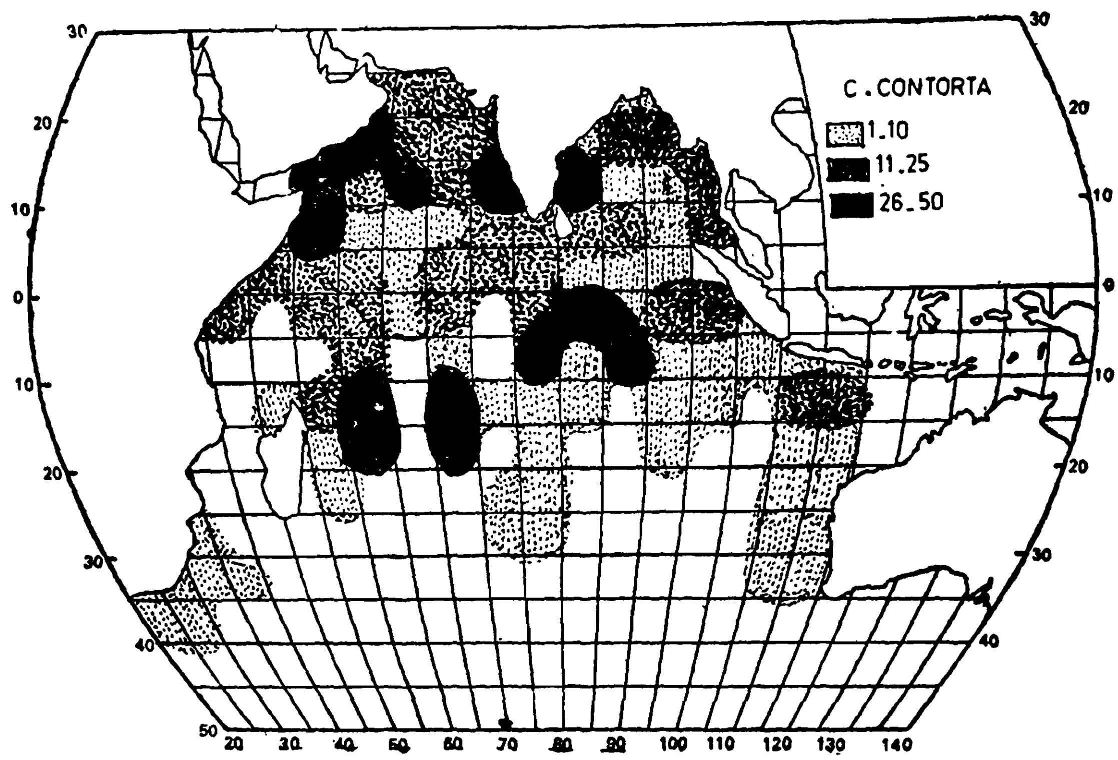
Monthly variations

Arabian Sea: On the western region, *C. contorta* occurred during August (maximum number of hauls) and December. On the eastern region it occurred during February, March, May (maximum) August, November and December.

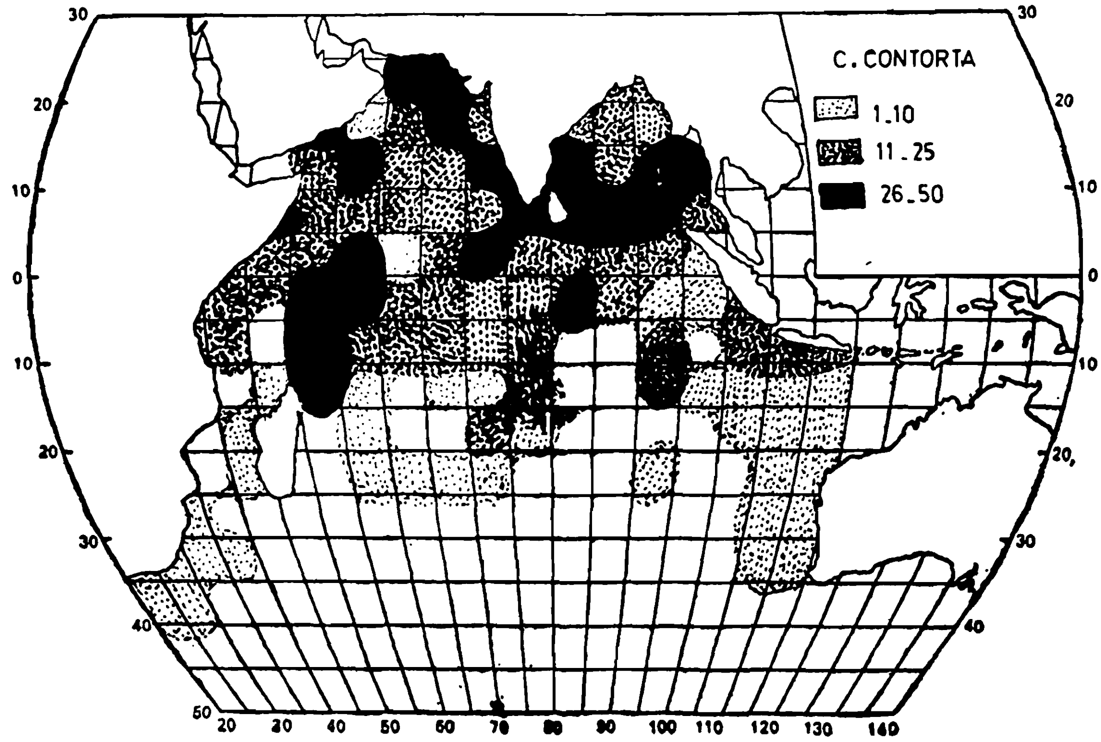
Bay of Bengal: In the Indian region it was collected in maximum number of hauls during April and in lesser number of hauls during January, February and June. Near Andaman Islands



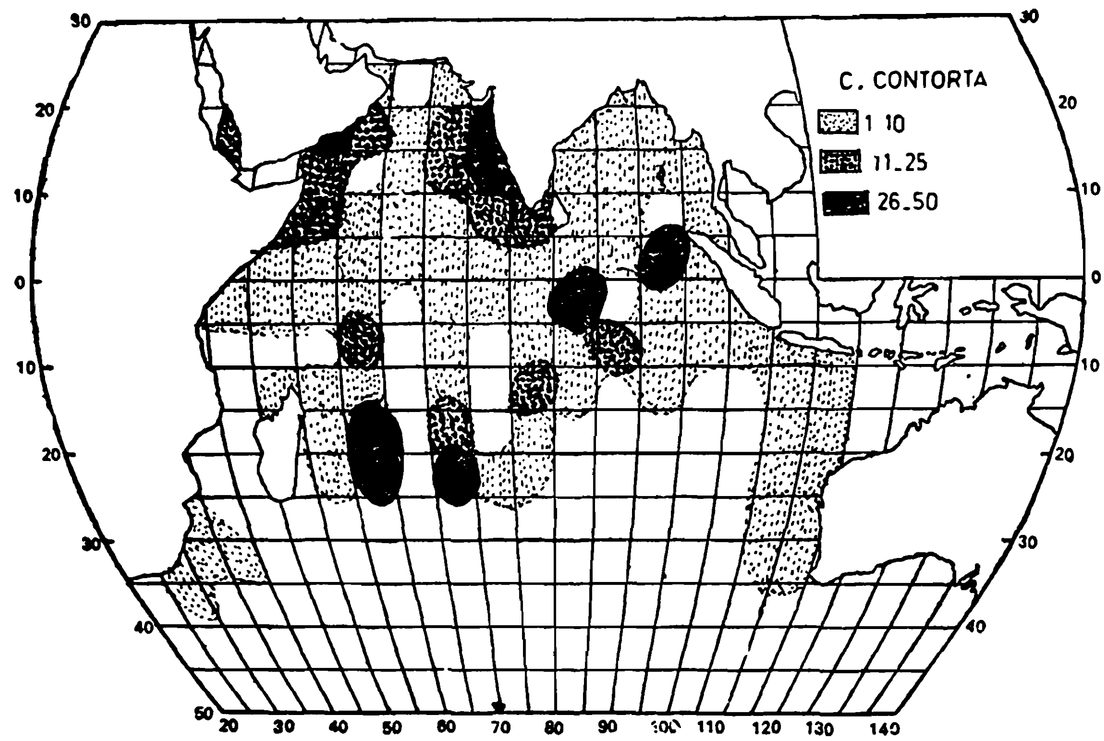
MAP 87. Distribution of *C. contorta* — Polygastric phase during SW/SE monsoon season.



MAP 88. Distribution of *C. contorta* — Polygastric phase during NE/NW monsoon season.



MAP 89. Distribution of *C. contorta* — Eudoxid phase during SW/SE monsoon season.



MAP 90. Distribution of *C. contorta* — Eudoxid phase suring NE/NW monsoon season.

and Burma it occurred during March, April and September (maximum).

South West Indian Ocean: Along the African coast it was collected during January, July and October. In the oceanic region it occurred during January, April and June.

South East Indian Ocean: Along the 110°E longitude extending from south of Java to 35°S latitude it occurred during January (maximum number of hauls) April, May and August. In the oceanic region it occurred mostly during December.

The noteworthy features observed in the distribution of *C. contorta* are (i) the occurrence of large forms in the cold southern waters and (ii) occurrence in the mid-oceanic regions in abundance when it was suspected to be a neritic species (Totton, 1954, p. 130, Totton, 165, p. 187).

Genus 31. *Eudoxoides* Huxley, 1859

Eudoxoides Huxley, 1859, p. 59.

Diphyinae with 5 complete ridges in a pyramidal or twisted anterior nectophore; no conspicuous ostial teeth; mouth-plate divided, baso-lateral angles produced into lancet-shaped wings. Posterior nectophore when present with broad hydroecial wings and curved teeth on margin. Eudoxids with sharply pointed apex, sutural surface forming an acute angle with dorsal wall of hydroecial cavity.

The generic name of *Eudoxoides* was used by Huxley for the eudoxid of *Diphyes mitra* Huxley, 1859 which he named as *Eudoxoides sagittata*. When the family Diphidae was reviewed by Totton (1932), the genus *Eudoxoides* was revived. Two species of *Diphyes*: *D. mitra* and *D. spiralis* Bigelow, 1911b are included in this genus.

Type Species: *Eudoxoides mitra* (Huxley, 1859).

Two valid species: *E. mitra* (Huxley, 1859) and *E spiralis* Bigelow 1911).

Key to species of **Eudoxoides**

Nectophore with five longitudinal, straight complete ridges, dorsal tooth present....	*mitra*
Nectophore with five longitudinal twisted ridges; left ventral ridge meets right ventral ridge before reaching apex; no ostial teeth....	*spiralis*

70. **Eudoxoides mitra** (Huxley, 1859)
(Fig. 74 a–e)

Diphyes mitra Huxley, 1859 p. 36, pl. I, fig. 4; p, 59; pl. IV, fig 1

Diphyopsis mitra Bigelow, 1911, p. 258, pl. 7 fig. 9; pl. 9; fig. 4; pl. 10, figs. 4, 5; pl. 11; fig. 6; pl. 12, fig. 5.

Eudoxoides mitra Daniel, 1974, p. 159, text-fig. 13, C-H (cf. for detailed synonymy)

Type Specimen: British Museum (Nat. Hist.), London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 1 p. g. (compl.); 662 a.n.; 128 p.n.; 154 eu (compl.); 769 br.; 1,001 go. *Bay of Bengal:* 1 p. g. (compl.); 951 a.n.; 168 p.n.; 193 eu (compl.) 964 br.; 1198 go. *South West Indian Ocean:* 1 p.g. (compl.); 664 a.n.; 80 p.n.; 172 eu (compl.); 875 br.; 1015 go. *South East Indian Ocean:* 1 p.g. (compl.); 964 a.n.; 127 p.n.; 334 eu (compl.); 1341 br.; 1585 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 5 p.g. (compl.); 1746 a.n.; 346 p.n. 438 eu. (compl.) 2860 br.; 3395 go. *Bay of Bengal:* 1 p. g. (compl.); 458 a.n.; 65 p.n.; 104 eu (compl.) 460 br.; 624 go. *South West Indian Ocean:* 357 a.n. 40 p.n.; 112 eu. (compl.) 616 br. 680 go. *South East Indian Ocean:* 648 a.n.; 91 p.n.; 146 eu. (compl.) 860 br.; 1046 go.

Polygastric phase: Anterior nectophore: Upto 12.0 mm in length, with five, serrated, complete and straight ridges, only dorsal ridge ending in a single characteristic tooth at ostium; no lateral teeth. Hydroecium small, truncate above, 2.5 mm in length, with major part of it lying below level of ostium. Somatocyst 2.3 mm long, pear-shaped, with short stalk. Mouth-plate divided into two serrated wings, outer angle acute, left wing longer, bearing a secondary triangular flap or tooth.

Posterior nectophore: 2/3rd length of anterior nectophore; ridges and dorsal tooth as in anterior nectophore. Apical-dorsal notch present between apex and pedicel. Hydroecial groove open except near upper end; broad right hydroecial flap overlapping longer tongue shaped extension of left wing, forming a closed canal; right and left hydroecial wings end in pointed serrated teeth below ostium, left tooth longer; deeply curved tooth occur on each hydroecial wing at level of ostium.

Eudoxid phase: About 8.0 mm in length, bract and gonophore nearly equal in length. Bract with pointed apex, sutural surface forming acute angle with dorsal wall of deep, conical bracteal cavity. Ridges and edge of neck-shield serrated; with small pointed teeth at distal edge. Phyllocyst pear-shaped, Pedicel of gonophore long, with four prominent flared serrated ridges ending in two teeth. Mouth-plate with concave edge and two lateral teeth. No special nectophore; manubrium shrinks completely after shedding sperms or eggs.

Type locality: South East of Mauritius.

Distribution: (Maps 91, 92, 93 and 94). The distribution and abundance of *E. mitra* in the Indian Ocean in the different regions are presented in maps 91, 92, 93 and 94.

It occurred in great abundance throughout the Indian Ocean. It also occurred in greater abundance along the land masses

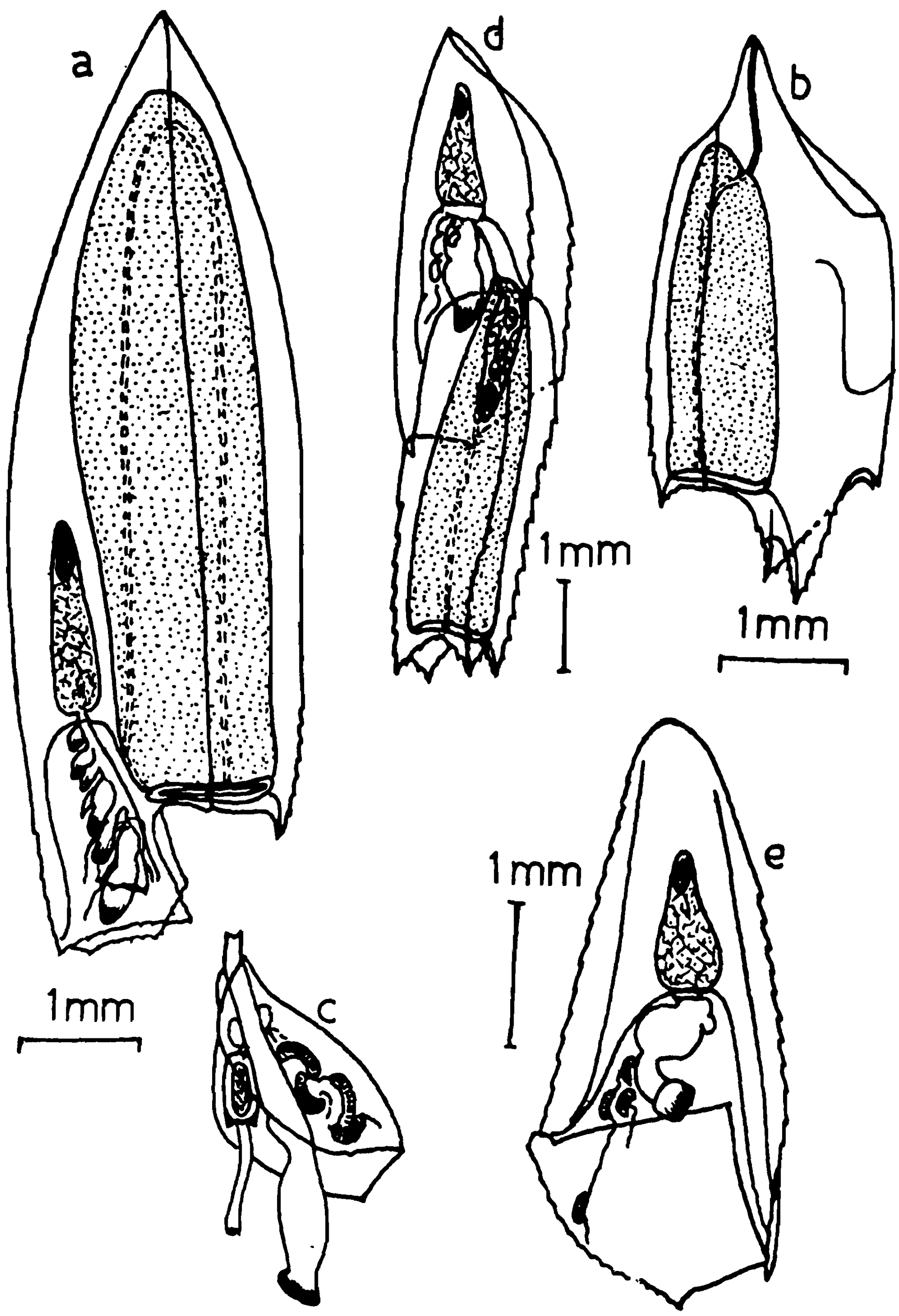
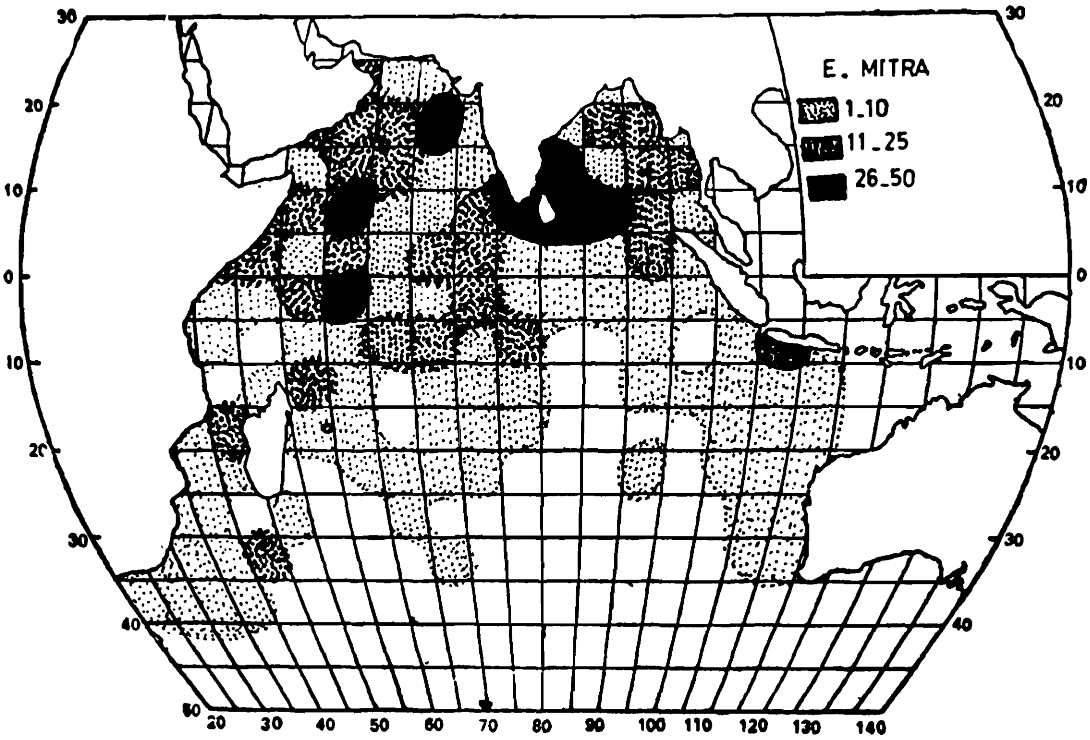
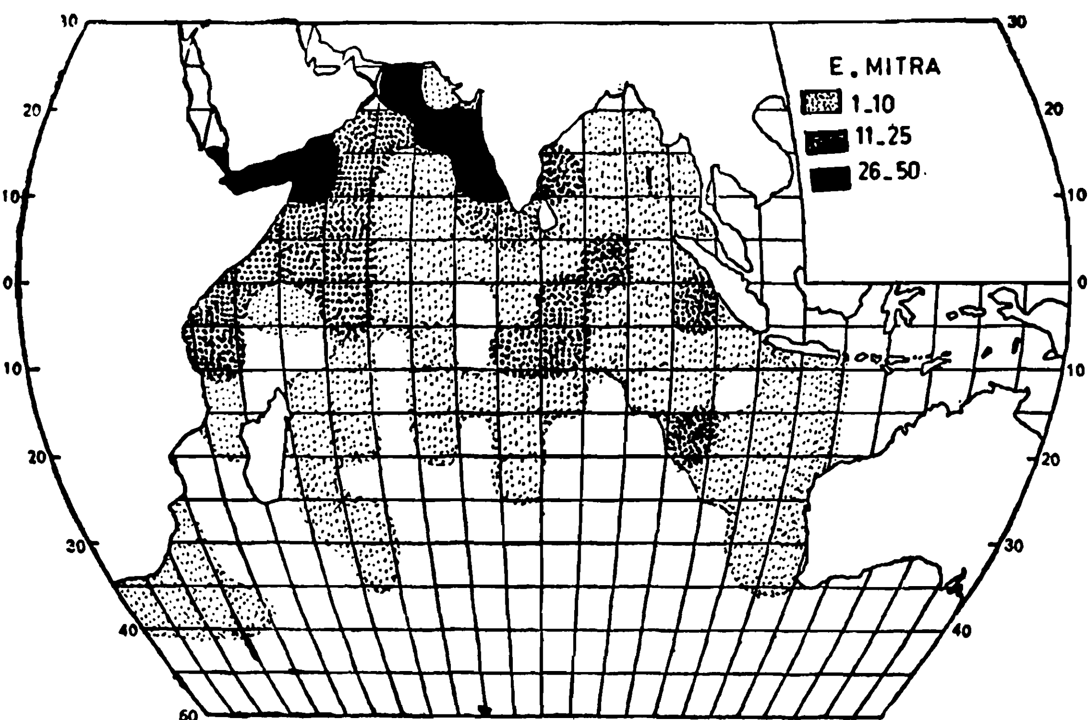


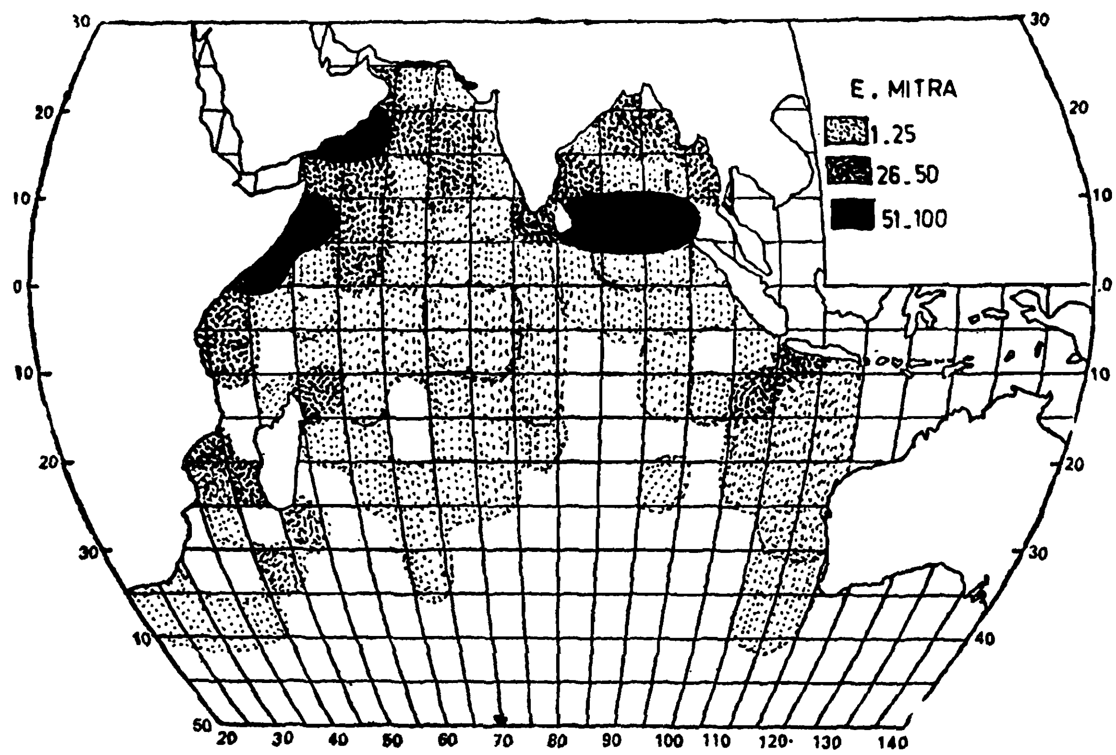
FIG. 74. *E. mitra* (Huxley) (a–e). a. anterior nectophore; b. posterior nectophore; c. cormidium; d. eudoxid phase; e. bract.



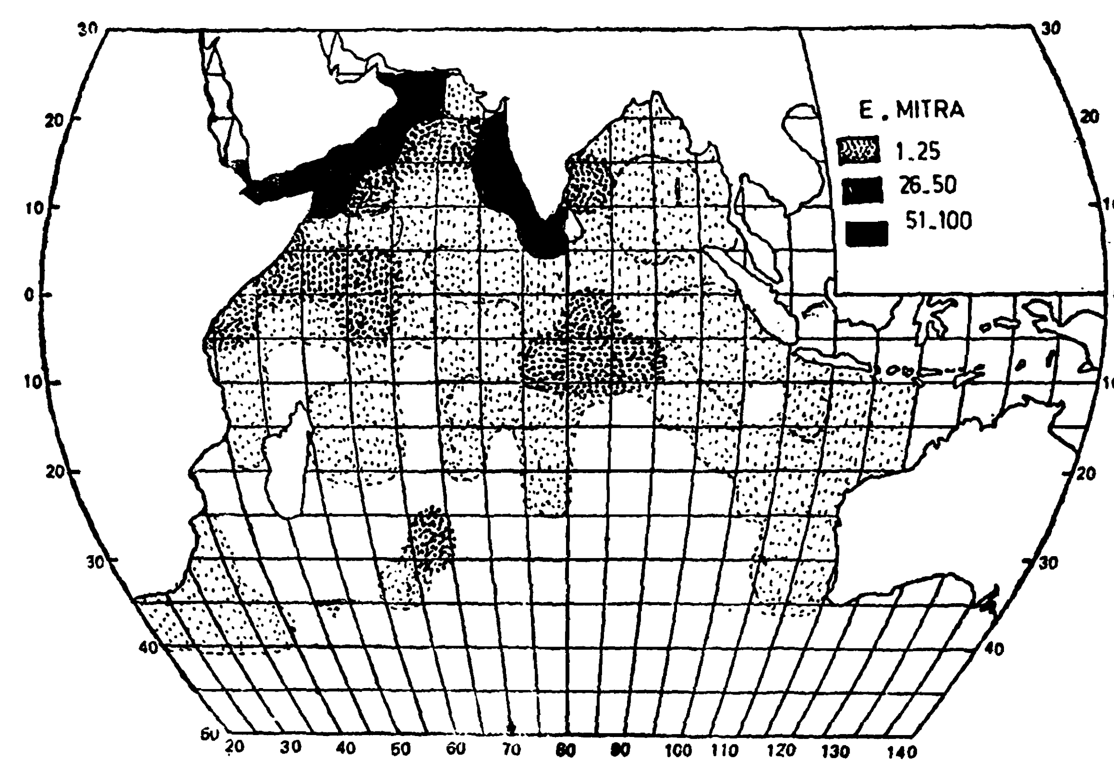
MAP 91. Distribution of *E. mitra* — Polygastric phase during SW/SE monsoon season.



MAP 92. Distribution of *E. mitra* — Polygastric phase during NE/NW monsoon season.



Map 93. Distribution of *E. mitra* — Eudoxid phasc during SW/SE monsoon season.



Map 94. Distribution of *E. mitra* — Eudoxid phase during NE/NW monsoon season.

(down to 40°S lat.) than in the mid-oceanic regions (in few places down to 35°S lat.).

During SW/SE monsoon season (Map 91) the polygastric phase of *E. mitra* in the range of 26–50 examples per haul occurred between 50°E to 60°E longitude from 10°N latitude to 5°S latitude, and in the central region of the Arabian Sea. Similar numbers occurred south of Cochin, Cape Comorin, Madras coast and across the Bay of Bengal between 5°N–10°N latitude as far as Sumatra. Lower density range of 11–25 examples per haul occurred along Somali coast, West of Madagascar, equatorial belt, north Bay of Bengal, around Andaman Island, Burma and south of Java. The eudoxid phase (Map 93) of *E. mitra* occurred in great abundance in the range of 51–100 examples or more per haul along Somali coast, Arabian coast, Central Arabian Sea and as a belt across the Bay of Bengal. The lesser density range of 26–50 examples per haul occurred in the western region mostly along the African and Arabian coasts, from Gulf of Oman in the north and west of Madagascar in the South, along the coastal regions of the Bay of Bengal and south of Java.

During NE/NW monsoon season (Map 92) the polygastric phase of *E. mitra* occurred in the range of 26–50 specimens per haul only in the Arabian Sea (in Gulf of Aden, Off Gulf of Oman, west coast of India around Cape Comorin and Gulf of Manner–between India and Sri Lanka. *E. mitra* is poorly represented in the collections from the Bay of Bengal in this season. Eudoxid phase (Map 94) in the range of 51-100 specimens per haul occurred only in the Arabian Sea in the same regions where the polygastic phase occurred. Lower density range of 26–50 eudoxids per haul occurred along the Somali and Afican coasts, euqatorial belt region in the mid-ocean, Madras coast and south of Java.

·It was very common, occurring in more that 75% of the stations established in the different zones of the Indian Ocean. It occurred mostly during the day time.

Monthly variations

Arabian Sea: *E. mitra* occurred throughout the year in this region. In the western region it occurred widely during July, August (maximum) and December. In the eastern region it occurred mostly during February and May (maximum) and during March, August and December.

Bay of Bengal: *E. mitra* occurred throughout the year. In the Indian region it occurred in abundance during January, April (maximum) and June. In Andaman and Burma region it was collected during March, April and September (maximum).

South West Indian Ocean: *E. mitra* occurred throughout the year. It occurred during January (maximum), July and October on the African region while in the oceanic region it was widely distributed during January and June (Maximum).

South East Indian Ocean: It occurred along the 110°E longitude during January and August (maximum) and during April, May and December. In the oceanic region it occurred mainly during December.

71. **Eudoxoides spiralis** (Bigelow, 1911)
(Fig. 75 a–c)

Diphyes spiralis Bigelow, 1911, p. 249, pl. 7, fig. 4; pl. 8, fig. 1, 2; pl. 9, fig. 3; pl. 11; fig. 4.

Eudoxoides spiralis Daniel, 1974, Text-figs. 12, R-U, 13 A & B. (cf. for detailed synonymy)

Type Specimen: Museum of Comparative Zoology at Harvard College, USA.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 329 a.n.; 29 eu. (compl.); 100 br.; 260 go. *Bay of Bengal:* 7 a.n.; 4 eu (compl.); 2 br.; 7 go. *South West Indian Ocean:* 1105 a.n.; 100 eu (compl.) 367 br.; 1165 go. *South East Indian Ocean:* 1433 a.n.; 269 eu. (compl.); 344 br.; 1396 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 204 a.n.; 8 eu. (compl.); 29 br.; 87 go. *Bay of Bengal:* 14 a.n.; 3 go. *South West Indian Ocean:* 749 a.n.; 79 eu (compl.); 303 br.; 898 go. *South East Indian Ocean:* 914 a.n.; 49 eu. (compl.); 97 br.; 622 go.

Polygastric phase: Anterior nectophore: About 11 mm long, with 5 twisted longitudinal slightly serrated ridges—dorsal, 2 laterals and left ventral ridges complete reaching apex and base, right ventral arising near apex very close to left ventral ridge. Contracted nectophores (preserved) with strongly twisted ridges and nectosac. Somatocyst 1.5 mm long, cylindrical in shape, asymmetrical in position. Hydroecium 1.5 mm long, conical, not truncated as in *E. mitra*. Baso-ventral margins concave, ending in serrated prominent teeth. Mouth-plate divided into two lanceolate wings, right one larger than left; left wing with triangular flap as in *E. mitra*.

Posterior nectophore: not developed.

Eudoxid phase: Bract 2.1 mm long; gonophore 3.25 mm long. Bract similar to *E. mitra* but smaller with shorter neck-shield. Phyllocyst cylindrical reaching apex. No teeth on margin of neck-shield. Sutural surface at right angle with dorsal wall of hydroecium. Hydroecium not deep. Gonophore pedicel short, almost truncated at articulating end. Four serrated twisted ridges ending in teeth. Manubrium long, bearing either male or female germ cells.

Type locality: Gulf of California (Eastern Tropical Pacific).

Distribution: (Maps 95 & 96). The distribution and abundance of *E. spiralis* in the Indian Ocean in the different regions are presented in maps 95 and 96.

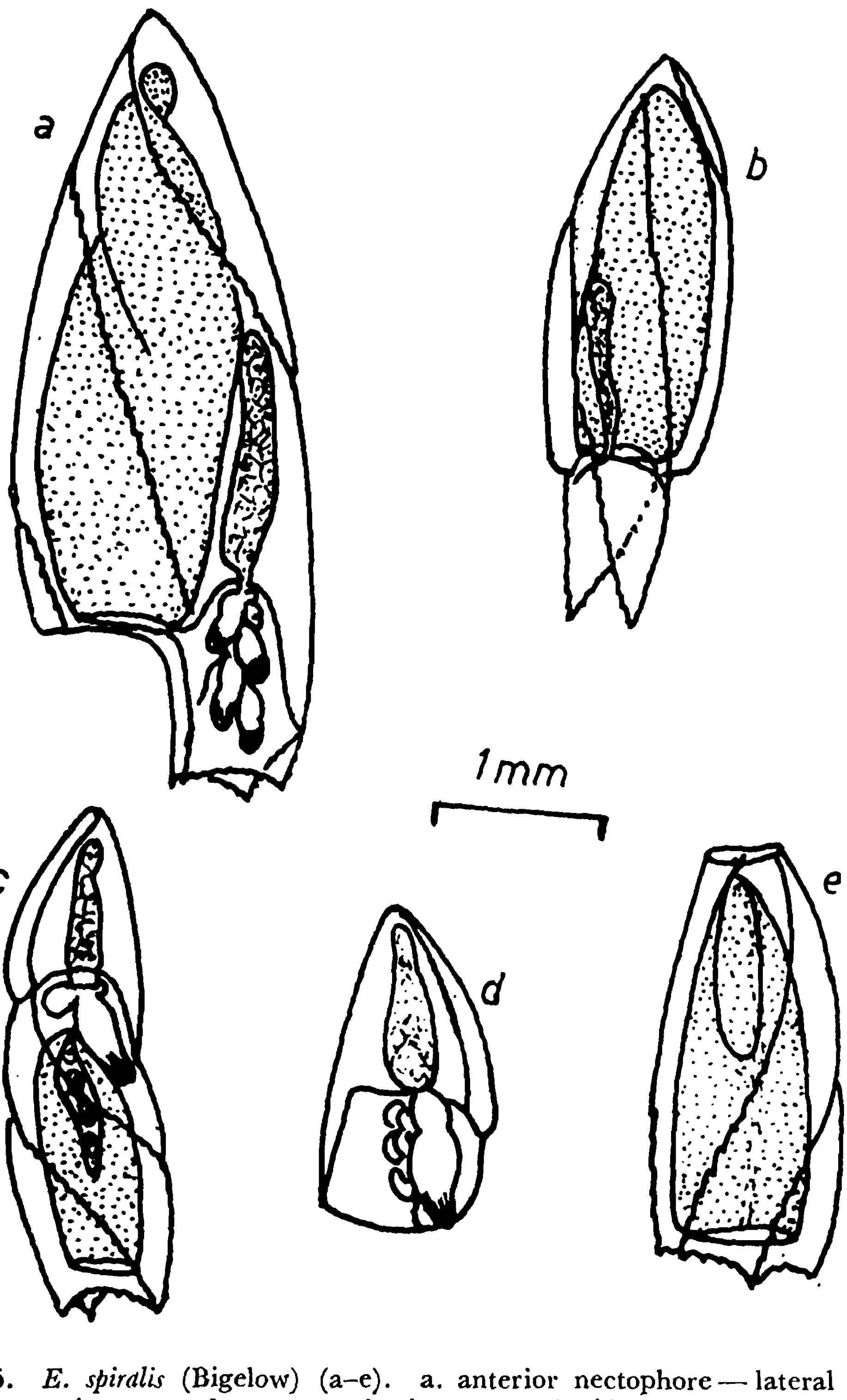
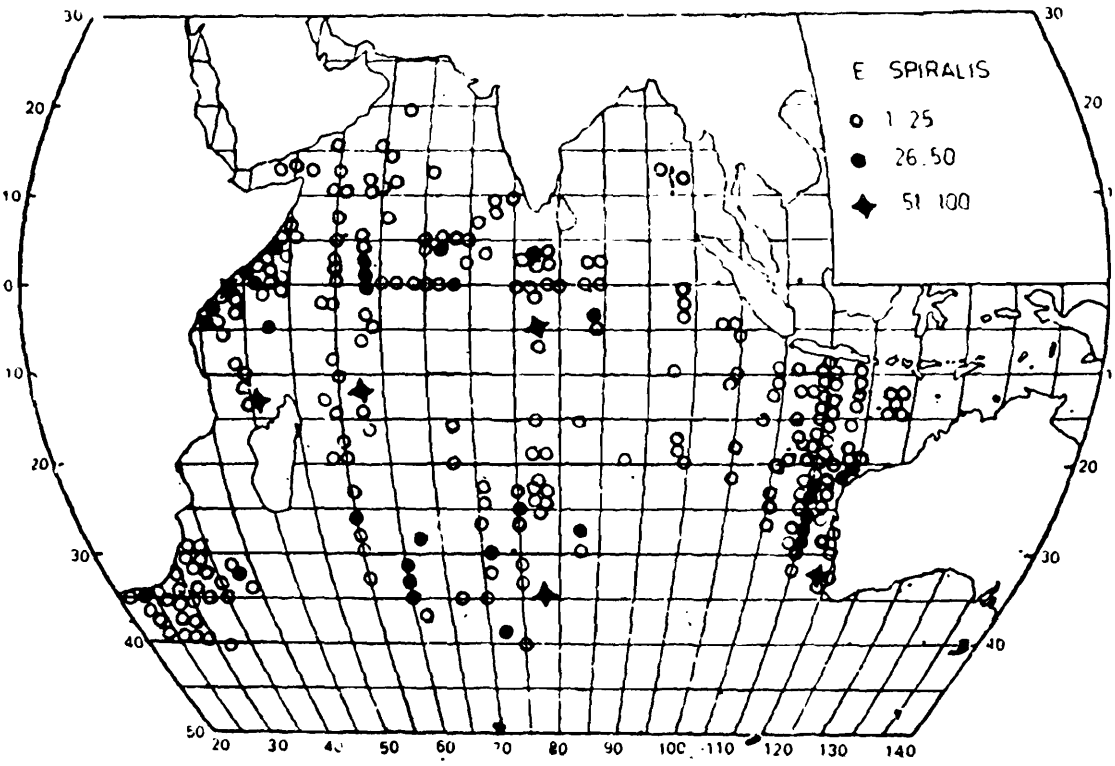
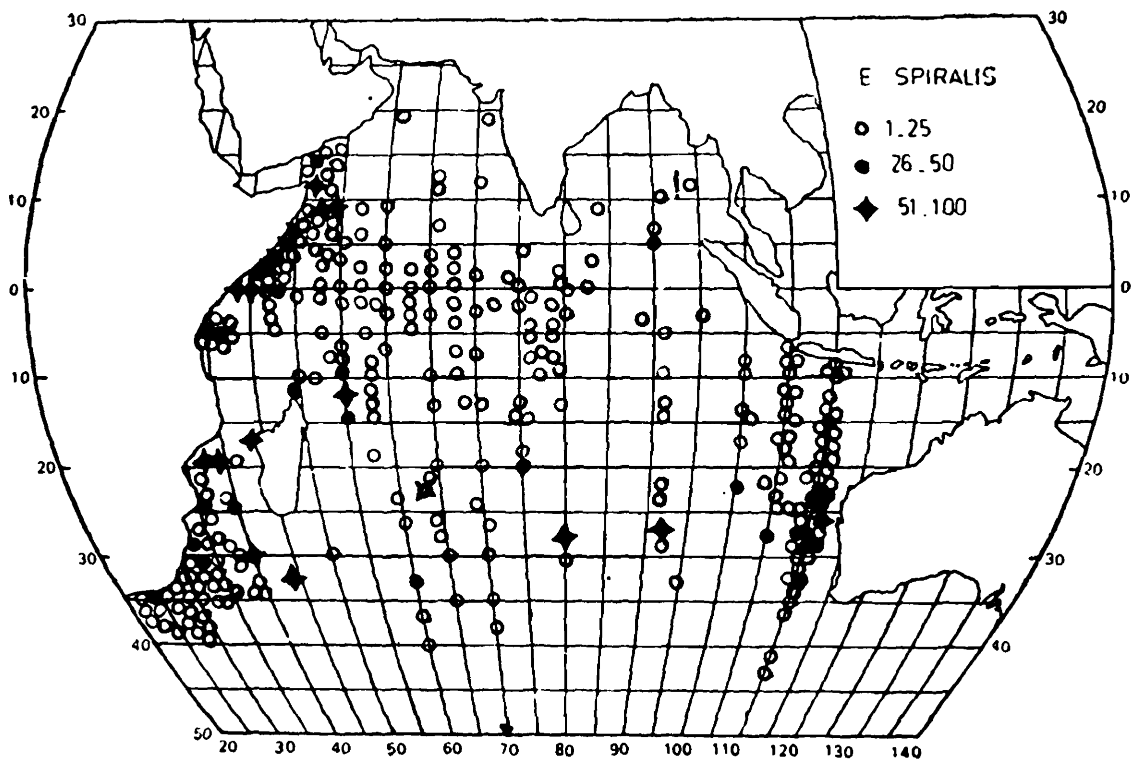


FIG. 75. *E. spiralis* (Bigelow) (a–e). a. anterior nectophore — lateral view; b. anterior nectophore ventral view; c. eudoxid phase; d. bract; e.— gonophore.



MAP 95. Distribution of *E. spiralis* during SW/SE monsoon season.



MAP 96. Distribution of *E. spiralis* during NE/NW monsoon season.

A perusal of the maps shows that during SW/SE monsoon season *E. spiralis* occurred in greatest numbers in the equatorial belt and south of the Equator both along the land masses and in the mid-ocean. It was not recorded north of 20°N latitude in the Arabian Sea or north of 12°N latitude in the Bay of Bengal. Its distribution extended down as far as 45°S latitude. The maximum density of 51–100 specimens per haul were made along the Somali coast, south eastern coast of Africa and along 110°E longitude off Australia. Both polygastric and eudoxid phases occurred all over the Ocean. In the Bay of Bengal, however, only the eudoxid phases were recorded along 10°N latitude and south of the Andaman Island, while the polygastric phases and eudoxids occurred near the Equator.

During NE/NW monsoon season also *E. spiralis* did not occur north of 20°N latitude and extended down to 45°S latitude. Population density ranging from 51–100 specimens per haul occurred along Somali coast, south of Africa, central regions of the ocean and along 110°E longitude off western Australia.

A noteworthy feature about this species is the occurrence of specimens measuring double or more than double the usual length, within 30°S to 45°S latitude. The Bay of Bengal was very poorly represented by *E. spiralis.*

Monthly variations:

Arabian Sea: *E. spiralis* occurred almost throughout the year (except during September). It occurred in a greater numbers on the western regions *i.e.* Somali coast and Gulf of Aden than on the eastern region. Except for four stations (two in the central region and two along 70°E longitude off Bombay and Goa) all the other places in which *E. spiralis* occurred were located within the equatorial belt. On the western region it occurred during August (maximum) and during January, February and December. On the eastern region it was rare, occurred in all the months except in May.

Bay of Bengal: On the Indian region it occurred mainly along the Equator during February. On the Madras coast it occurred during April and near the Andamans during March and April.

South West Indian Ocean: It occurred in 75% of the stations established during the expedition. Along the African coast it occurred during January (maximum) July and October. In the oceanic region it occurred during January, April, June and December in greater numbers than during the other months.

South East Indian Ocean: Along the 110°E longitude it occurred throughout the year, (maximum during January and August). In the oceanic region *E. spiralis* was collected during August and December.

Family XIII: CLAUSOPHYIDAE Totton, 1965

CLAUSOPHYINAE Bigelow, 1913, p. 73.
HETEROPYRAMIDINAE Moser, 1925, p. 117
CHUNIPHYNAE Moser, 1925, p. 360
THALASSOPHYINAE Moser, 1925, p. 367
CRYSTALLOPHYINAE Moser, 1925, p. 356

Calycophorae with somatocysts in both anterior and posterior nectophores; eudoxid with two lateral branches (left and right hydroecial canals) of phyllocyst lying in neck-shield of bract.

Chun (1897b) considered *Diphyes ovata* Keferstein & Ehlers 1860 (=*Clausophyes ovata*) as a connecting link between two families Prayidae and Diphyidae. Bigelow (1913, p. 71), however, pointed out that *Clausophyes* was really an offshoot of the Diphyidae basing his conclusion mainly on the anterior and posterior nectophores of *C. galeata* Lens & van Riemsdijk, 1908, which were dissimilar and also because the somatocyst of the posterior nectophore was structurally like that of the anterior one in being a specialized organ deeply embedded in the gelatinous substance, whereas, in Prayids, it was merely a slight thicknened extension of the canal system. As pointed out by Totton (1965) it is probable that the anterior nectophore of the Clausophyidae is the larval one retained and the posterior one is the first definitive heteromorph nectophore which develops a somatocyst, unlike those of Abylids. He therefore considered the Clausophyids to be more primitive than the Abylids and established this family Clausophyidae (based on the earliest known species of *Clausophyes*) to include the six mid-water species recognized till then in five subfamilies.

The following valid genera are included in this Family: *Clausophyes* Lens & van Riemsdijk, 1908; *Chuniphyes* Lens & van Riemsdijk, 1908; *Crystallophyes* Moser, 1925; *Heteropyramis* Moser, 1925 and *Thalassophyes* Moser, 1925.

Key to genera of CLAUSOPHYIDAE

1.	Nectophores pyramidal; somatocyst broad or spindle shaped at base...	2
	Nectophore smooth, rounded, somatocyst thin and long with spindle-shaped apical expansion....	**Clausophyes**
2.	Somatocyst with thin, long median branch reaching upto apex; ostial teeth present.	3
	Somatocyst with short median branch; no ostial teeth or mouth-plate..	4
3.	Four ridges at apex, dividing dichotomously below to form eight ridges at base; somatocyst broad at base; hydroecium not extending entire length of nectophore..	**Chuniphyes**

Five ridges at apex which do not divide dichotomously; somatocyst spindle-shaped; hydroecium extending almost entire length of nectophore..	**Crystallophyes**
4. Five ridges with opaque spots at apex and on lateral ridges...	**Heteropyramis**
Five ridges without opaque spots on lateral ridges...	**Thalassophyes**

All the genera are represented in the Indian Ocean.

Genus 32. **Chuniphyes** Lens & van Riemsdijk, 1908

Chuniphyes Lens & van Riemsdijk, 1908, p. 13.

Clausophyidae with pointed, pyramidal anterior nectophore having four ridges at apex, dividing dichotomously below apex; broad conical hydroecium; somatocyst with broad base and thin branch extending upto apex; ostial teeth present. Posterior nectophore longer, three ridges at apex with or without markedly asymmetrical ventro-basal teeth. Eudoxid phase with thin leaflike folded bract; phyllocyst with thin median branch and two long longitudinal branches. Gonophore with ridges, flattened dorsoventrally.

Type Species: *Chuniphyes multidentata* Lens & van Riemsdijk, 1908.

Two valid species: *C. multidentata* Lens & van Riemsdijk, 1908 and *C. moserae* Totton, 1954.

Key to species of **Chuniphyes**

Somatocyst with butterfly-shaped base and long thin apical branch...	*multidentata*
Somatocyst with cylindrical base and irregularly-shaped thin apical branch..	*moserae*

Both the species are present in the Indian Seas,

72. **Chuniphyes multidentata** Lens & van Riemsdijk, 1908 (Fig. 76 a–g)

Chuniphyes multidentata Lens & van Riemsdijk, 1908, p. 13, pl. I, figs. 9–11, pl. II, figs. 12–15.

Chuniphyes multidentata Bigelow, 1911, p. 262, pl. 8, fig. 9, pl. 10, figs. 7, pl. 12, fig. 6.

Chuniphyes multidentata Daniel, 1974, p. 167, Text-fig. 13, I-P.
(cf. for detailed synonymy)

Type Specimen: Zoologisch Museum, Amsterdam.

Material Examined: South West/South East Monsoon Season: *Bay of Bengal:* 2 a.n. *South East Indian Ocean:* 1 p. g., (compl.); 22 a.n.; 5 p.n.

These deep sea records were made by the *R. V Vityaz* (Daniel 1974). Recorded also from south east coast of Africa. (Totton, 1954).

Polygastric phase: Anterior nectophore: Bathy-pelagic form, shrunk, coloured pink in preserved material. Upto 36 mm in length, with pointed tip and four ridges at apex; dorsal and laterals dividing dichotomously at 3–5–7.5 mm (according to age) below

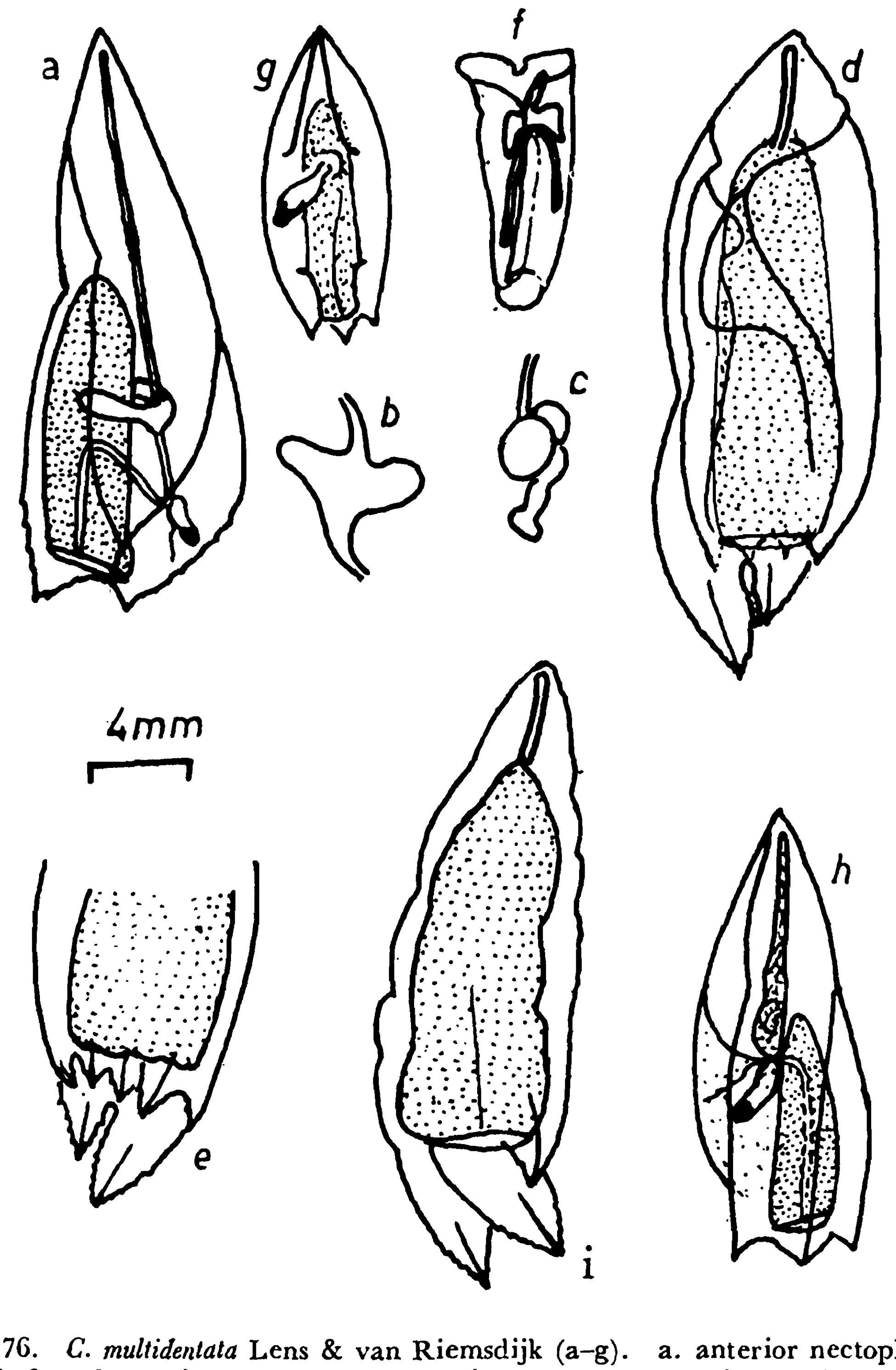


FIG. 76. *C. multidentata* Lens & van Riemsdijk (a–g). a. anterior nectophore; b & c. base of somatocyst; d. posterior nectophore; e. dorsal view of posterior nectophore; f. bract; g. gonophore. *C. moserae* Totton (h, i). h. anterior nectophore; i. posterior nectophore.

apex and 8 ridges reach base; dorso-laterals end in prominent teeth, two dorsals and two ventro-laterals in minor ones; all ridges faintly serrated at base. Ventral ridge divides into two at upper end of opening of conical hydroecium, which run down, forming edges of hydroecium, with prominent teeth at basal margin. Somatocyst shape varies—butterfly shaped, broad, the two wings embracing nectosac in middle region; apical branch thin; thread-like extend upto tip of nectophore; or with knob-like base. Ostium of hydroecium wide and oblique. Nectosac half the length of nectophore, with looped short lateral radial canals.

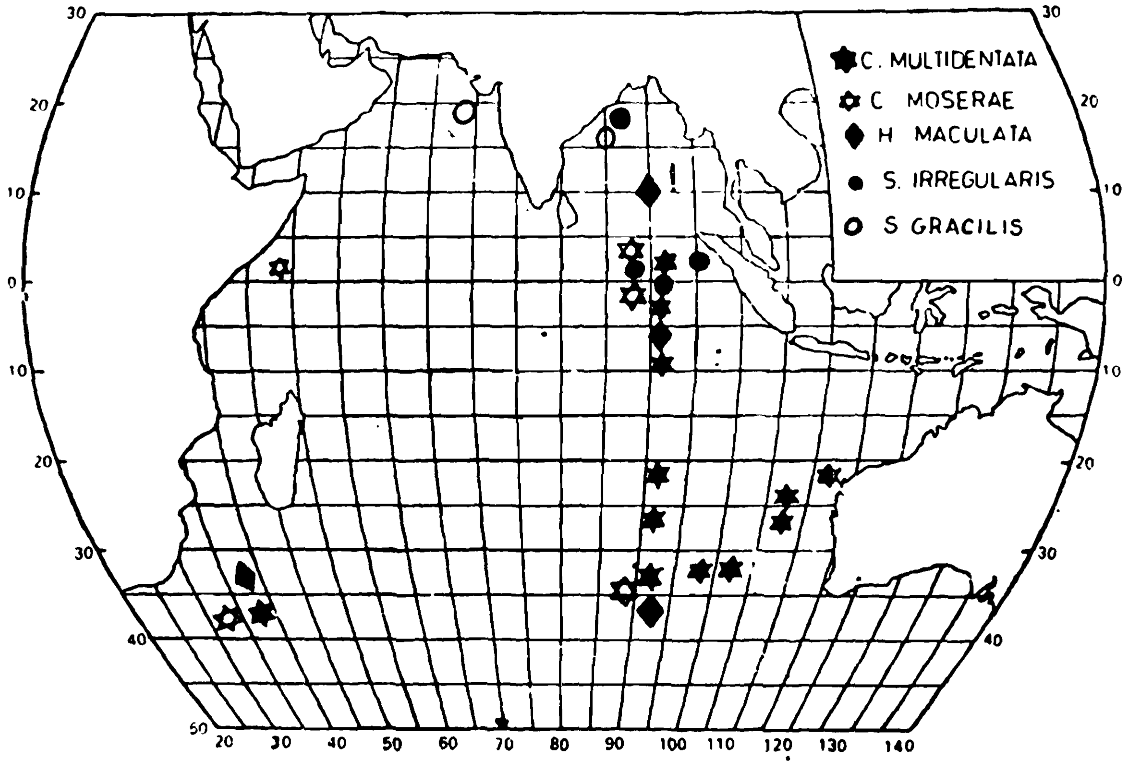
Posterior nectophore: Upto 40 mm in length, with three ridges at apex-one dorsal, two ventro-laterals each dividing dichotomously lower down, and six ridges at ostial lever ending in teeth. Two baso-ventral teeth broad, long, with left one longer than right. Hydroecium is a long, open, broad groove extending entire length of nectophore; proximally a broad flap-like structure from right hydroecial wing cover hydroecial groove; flap on left wing much reduced. Somatocyst thin thread-like extend upto tip of nectophore, and with pedicular canal leading to four radial canals.

Eudoxid phase: *Bract:* (Fig. 76 f) Upto 7.73 mm in length, thin, dorso-ventrally flattened, membraneous, with lateral sides rolled when loose, right-hand side overlapping the other; phyllocyst 5.67 mm in length with broad thick three armed anterior portion and two long thin, thread-like longitudinal branches directed posteriorly, left branch being longer than the other. Apical rounded notch present in middle of ract.

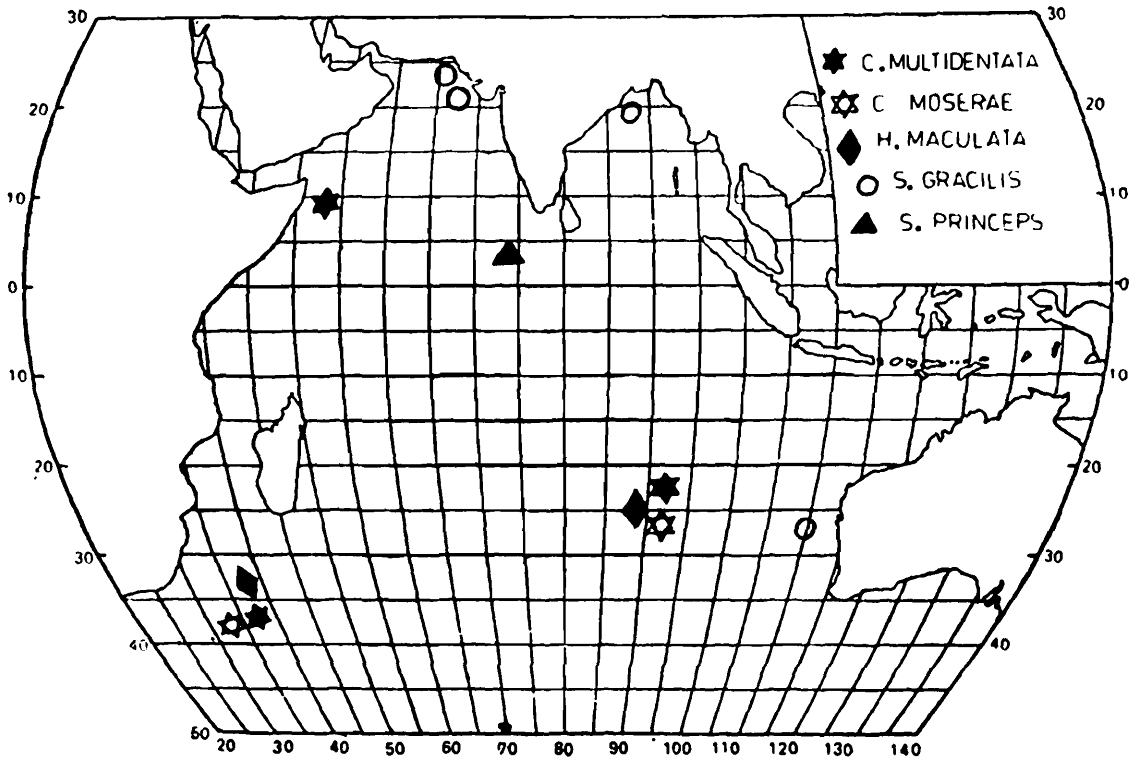
Gonophore: (Fig. 76, g) with pointed tip. 5 longitudinal ridges dorsal and lateral ridges complete ending in teeth at ostium, ventrals incomplete terminating near shallow gutter-like hydroecial groove, and at base as two short ridges ending in two minor teeth near ostium. No gonad bearing manubrium observed within nectosac.

Type locality: Malay Archipelago.

Distribution: (Maps. 97 & 98.) *C. multidentata*, a bathypelagic form was recorded near south east coast of Africa and off South West coast of Australia from a depth of 10C0—200 m. Along 91°E long. it occurred during July, August and September near the Equator.



MAP 97. Distribution of *C. multidentata*, *C. moserae*, *C. maculata* and *S. irregularis* during SW/SE monsoon season. 1–3 Specimens per haul.



MAP 98. Distribution of *C. multidentata*, *C. moserae*, *H. maculata*, *S. gracilis* and *S. princeps* during NE/NW monsoon season. 1–3 Specimens per haul.

73. **Chuniphyes moserae** Totton, 1954
(Fig. 76 h, j)

Chuniphyes moserae Totton, 1954, p. 131, fig. 66A.
Chuniphyes moserae Daniel, 1974, p. 169, Text-fig. 13, Q. 14, A.

Type Specimen: British Museum (Nat. Hist.), London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Bay of Bengal:* 2 a.n.; 1 p.n. *South East Indian Ocean:* 2 a.n.; 1 p.n.

These deep records were made by the *R. V Vityaz* (Daniel, 1974). Also recorded from South East Coast of Africa and off Somaliland (Totton, 1954).

Polygastric phase: Anterior nectophore: (Fig. 76, h) 10.0 mm long, 4.0 mm wide; resembles *C. multidentata* in general shape, appearance, number of ridges, and dichotomous dividing of ridges; lateral ridges dividing near tip of nectophore. Somatocyst not expanded horizontally at base but fusiform or spindle-shaped, extending anteriorly into a short canal with small side branches. Hydroecium broad, conical, 5.0 mm long, extending upto apex of nectosac. Nectosac comparatively longer (6.0 mm), pedicular canal not 'U' shaped as in *C. multidentata*, entering nectosac at 4.67 mm from ostium (i. e., at higher level when compared to *C. multidentata*).

Posterior nectophore: (Fig. 76, j) Nectophores with symmetrical ventral teeth of almost equal size, relatively thin wall of mesoglea separating hydroecial groove from nectosac; probably belong to this species.

Eudoxid phase: not distinguished from *C. multidentata.*

Distribution: (Maps 97 & 98). Bathypelagic form recorded from a depth of 2400–1150 m off Italian Somali land, off Zanzibar, South and East Coast of Africa and South Eastern Indian Ocean off Australian coast (July). In the oceanic region of Bay of Bengal during August and September.

Genus 33. **Heteropyramis** Moser, 1925

Heteropyramis Moser, 1925, p. 117.

Clausophyidae with anterior nectophore having five ridges at apex; hydroecium extending 2/3rd length of nectophore; with series of opaque spots on dorso-lateral ridges. Eudoxid phase: bracts with four-ridges; long neck-shield with two lateral longitudinal branches of phyllocyst, and a thick median branch.

Monotypic genus for *H. maculata* Moser, 1925.

74. **Heteropyramis maculata** Moser, 1952
(Fig. 77 a–b)

Heteropyramis maculata Moser, 1925, p. 117, pl. II, Text-fig. 26, 27.
Heteropyramis maculata Daniel, 1974, p. 170, Text-fig. 14 D.
(cf. for detailed synonymy)

Type Specimen: Museum Für Naturkunde, Berlin.

Matrial Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Bay of Bengal:* 1 br. *South East Indian Ocean:* 1 br.

Recorded by the *R. V Vityaz* (Daniel, 1974) and also near south east coast of Africa (Totton, 1954).

Polygastric phase: Anterior nectophore: (Fig. 77 a) Upto 13.0 mm in length, pyramidal, with 5 longitudinal ridges, not dividing into two; without ostial teeth or mouth plate. Hydroecium conical, with broad ostium extending to 2/3rd of nectophore. Series of characteristic opaque spots (about 9 in number but varies) on lateral ridges. Nectosac pear-shaped, 6.5 mm long lying below somatocyst. Somatocyst with oblique spindle-shaped basal portion and short thin vertical branch.

Posterior nectophore: not known.

Eudoxid phase: (Fig. 77 b) Bract pyramidal, with four-ridges at apex, broad neck-shield. Phyllocyst with main median branch similar to somatocyst of anterior nectophore in shape and two curved lateral branches extending into neck-shield. Opaque spots at tip and at base of dorso-lateral ridges.

Gonophore: With 5 ridges (*i.e.* with additional dorsal ridge), with opaque spots at bases of dorso-lateral ridges.

Type locality: Antarctic Ocean.

Distribution: (Maps, 97 & 98). This is a mid-water species recorded from a depth of 750–500 m near South East coast of Africa; in the oceanic region of south east Indian Ocean and Bay of Bengal during September.

X Family XIV SPHAERONECTIDAE Huxley, 1859

Calycophorae with a single rounded nectophore; short curved or straight or globular somatocyst; large nectosac and a cylindrical or funnel-shapped hydroecium. Cormidia always separate as eudoxids.

Monotypic family for the genus *Sphaeronectes* Huxley, 1859.

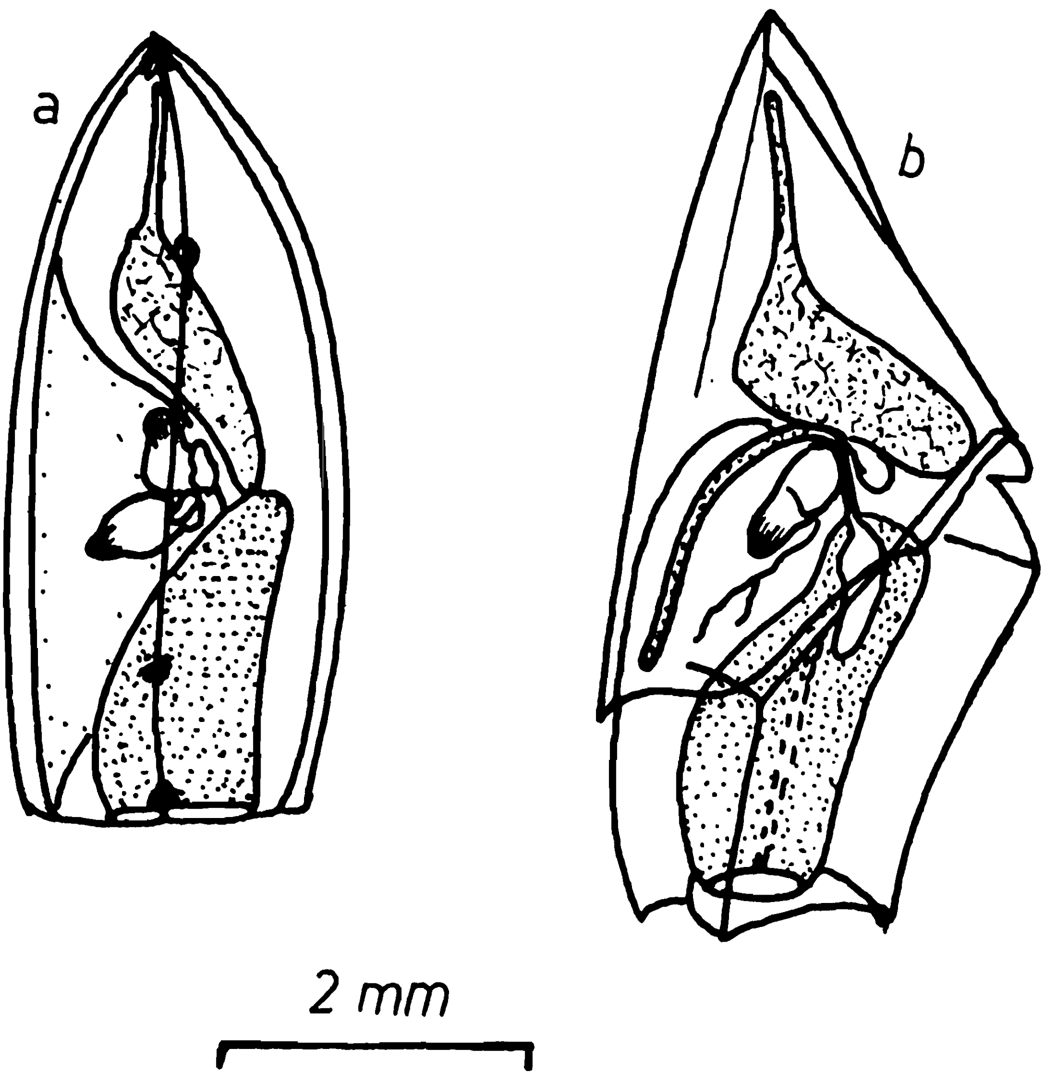


Fig. 77. *H. maculata* Moser (a, b). a. anterior nectophore; b. eudoxid phase. (After Totton, 1965, fig 135 A & D)

Genus 34. **Sphaeronectes** Huxley, 1859

Diplophysa Gegenbaur, 1853, p. 291 (eudoxid phase).

Sphaeronectes Huxley, 1859, p. 50.

Monophyes Claus, 1874, p. 29.

Sphaeronectidae with single rounded nectophore, short somatocyst and cylinderical or funnel shaped hydroecium.

This genus had been studied by Claus (1873) and Chun (1892). The validity of the then known 5 spcies: *S.* (*Monophyes*) *gracilis* (Claus), *S. kollikeri* Huxley, *S.* (*Monophyes*) *irregularis* Claus *S.* (*Monophyes*) *brevitruncata* Chun, and *S.* (*Monophyes*) *princeps* Haeckel, was discussed in detail by Chun (1892), Schneider (1898) and Bigelow (1911b). Chun recognized the first four species mentioned above as valid while Schneider considered them to be of one varietal series. However, Bigelow recognized three species: *S. truncata Will* (=*S. gracilis*), *S. irregularis* and *S. princeps*.

Bigelow (1911b) agreed with Schneider (1898) in uniting *S. kolliheri* with *S. gracilis* since there was much individual variation in the nature of the curvature of the somatocyst. Applying the rules of priority they established *S. truncata* Will 1844, relegating *S. gracilis* and *S. kollikeri* as its synonyms since the eudoxid phase of a species of *Sphaeronectes* had already been described as *Ersaea truncata* by Will (1844)· But Totton (1965) was of the opinion that the eudoxid described by Will could either belong to *S. gracilis* or to *S. irregularis* since they both occur in the Mediterranean Sea. Therfore, he reinstated *S. gracilis* Claus, 1873 as valid, and included *S. kollikeri* as its synonym and treated *S. truncata* as a doubtful synonym.

The differences between *S. irregularis* and *S. brevitruncata* were so slight, based on variable characters such as the size of the somatocyst and number of groups of cormiida, that these two species were united by Bigelow (1911b) under the older name *S. irregularis* Claus.

The third species described by Haeckel from the Indian Ocean as *Monophyes princeps* had not been discussed by Chun (1892) Schneider (1898) or by Totton (1965). Bigelow (1911b) was of the opinion that, "in case characters such as the high nectosac (higher than in *S. irregularis*) and the hydroecium in the form of a mere groove, prove constant and that the specimen was in fact a Monophyid, *S. princeps* would deserve recognition" However, this species has not been recorded since Haeckel described it in 1888. To these species, four more species *S. gamulini* Carre, 1966 *S. japonica* (Stepanyants, 1967) *S. bougisi* Carre, 1968a and *S. fragilis* Carre, 1968b, were added.

This genus thus includes *S. gracilis* (Claus, 1873); *S. irregularis* (Claus, 1873); ? *S. princeps* Haeckel, 1888; *S. gamulini* Carre, 1966; *S. japonica* (Stepanyants, 1967) *S. bougisi* Carrè, 1968a and *S. fragilis* Carrè, 1968b. *S. japonica* resembles *S. irregularis* in many respects. The validity of *S. princeps* and *S. japonica* needs confirmation. *S. bougisi* and *S. fragilis* were collected from the Mediterranean Sea.

Type Species: Sphaeronectes gracilis (Claus, 1873)

Of these, *S. princeps* recorded only once from the Indian Ocean by Haeckel (1888), with high nectosac and mere groove like hydroecium and *S. japonica* which resemble *S. irregularis* are considered to be doubtful species.

Key to species of **Sphaeronectes**

1.	Converging of pedicular and all radial canals to the same point..	2
	Converging to two points one ventral where pedicular, dorsal and ventral canals converge and the other apical where the two laternal canals meet dorsal canal..	*bougisi*
2.	Converging point of radial canals apical in position and dorsally curved somatocyst.	*gracilis*
	Converging point of radial canals ventral in position..	3
3.	Somatocyst upright with indistinct stalk..	*irregularis*
	Somatocyst with thin thread like stalk and globular tip..	4
4.	Somatocyst upright; short hydroecium..	*fragilis*
	Somatocyst lying horizontally across nectosac.	*gamulini*

S. gracilis, *S. irregularis* and ? *S. princeps* are present in the Indian Ocean.

75. **Sphaeronects gracilis** (Claus, 1873)
(Fig. 78, a)

Monophyes gracilis Claus, 1873, p. 258, (=*Diplophysa inermis*) p. 27, taf. 4, figs. 1–4
Sphaeronectes truncata Bigelow, 1911, p. 184.
Sphaeronectes gracilis Daniel, 1974, p. 173 Text-fig. 14 C & D.
(cf. for detailed synonymy)

Type Specimen: Place of deposit not known from literature.

Material Examined: South West/South East Monsoon Season: *Arabian Sea:* 1 n. *Bay of Bebgal:* 1 n. North East/North West Monsoon Season: *Arabian Sea:* 21 n. *Bay of Bengal:* 4 n. *South East Indian Ocean:* 2n.

Polygastric phase: consisting of single nectophore, 8.0 mm in diameter, smooth, rounded in shape. Somatocyst usually curved towards dorsal side of hydroecium, or twisted or straight. Hydroecium deep, cylindrical, with round ostium, apex being higher than level of nectosac. Nectosac small, broad with large ostium, with well developed velum. Lateral radial canals simple, straight, not conspicuously arched or bowed.

Eudoxid phase: Bract: small, globular, with ovoid somatocyst. Hydroecium not deep. Eudoxid phase figured in Fig. 78 d, probably belongs to this species.

Gonophore: One and half times larger than bract, with broad ostium; well developed velum. Four radial canals, simple, straight.

Type locality: Mediterranean Sea.

Distribution: (Maps 97 & 98). *S. gracilis* occurred off the coast of Kathiawar, during October and November.

The previous records from the Indian Ocean were between Sumatra and Malaya during September; from south of Kathiawar during October; and off Orissa (Bay of Bengal) during March. (Daniel, 1974).

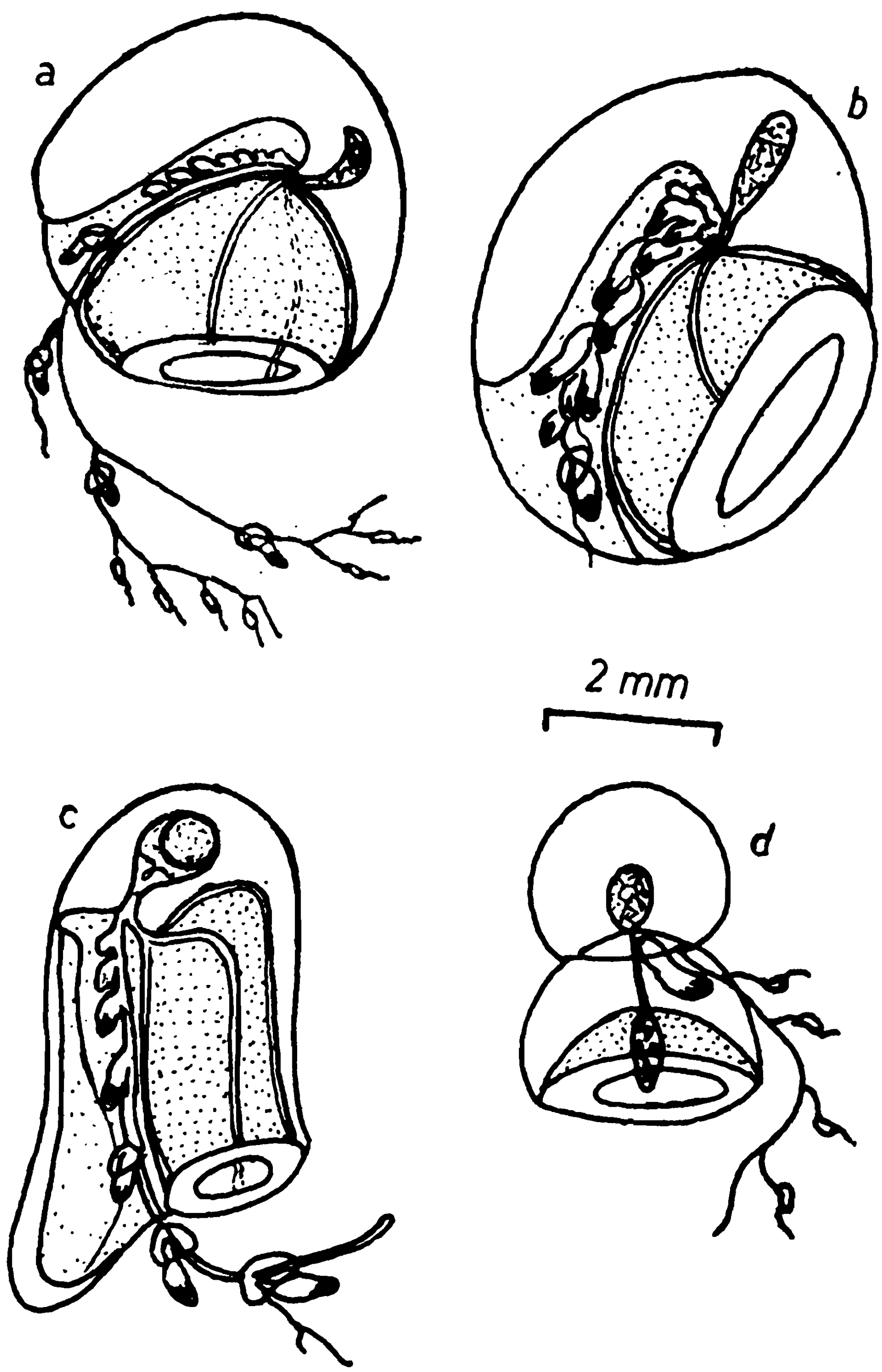


FIG. 78. Nectophores of: a. *S. gracilis* (Claus); b. *S. irregularis* (Claus); c. *S. princeps* Haeckel; d. eudoxid phase of *sphaeronectes* sp.
(Fig. C After Haeckel, 1888; pl. 27, fig. 13).

76. **Sphaeronectes irregularis** (Claus, 1873)
(Fig. 78 b)

Monophyes irregularis Claus, 1873, p. 259.
Monophyes irregularis Bigelow, 1911, p. 346.
Sphaeronectes irregularis Totton, 1965, p. 203.

Type Specimen: Place of deposit not known from literature.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Bay of Bengal:* 8 n.

Polygastric phase: Smaller than *S. gracilis* 5.7 mm in diameter and 7.1 mm. in depth. Nectosac upto 4.3 mm. in diameter and 2.8 mm. in depth. Somatocyst short, and straight. Hydroecium shorter than in *S. gracilis*, more open on dorsal side. Lateral radial canals arched or bowed in appearance.

Eudoxid phase: Similar to *S. gracilis.*

Type locality: Mediterranean Sea.

Distribution: (Maps 97 & 98). *S. irregularis* occurred near equator during June.

77. **Sphaeronectes princeps** (Haeckel, 1888)
(Fig. 78 c)

Monophyes princeps Haeckel, 1888, p. 129, pl. 27, figs. 13, 14.

Type Specimen: Most of Haeckel's Specimens were lost.

Material: Recorded only once by Haeckel (1888) between Maldive Island, and Socotra.

Nectophore: 6 mm long, 3 mm broad. Smooth ovate with flat constriction near base. Hydroecium groove-like formed by two hydroecial wings, right wing larger, overlapping smaller left wing. Nectosac sub--cylindrical, high; pedicular canal short, entering nectosac below apex of nectosac; 4 radial canals join circular canal at velum· Somatocyst ovate, with oil globule.

Type locality: Between Maldive Island and Socotra (Indian Ocean).

Distribution: (Map 98). Recorded only once by Haeckel (1888) between Maldive Island and Socotra during March.

XV Family ABYLIDAE L. Agassiz, 1862

Calycophorae with two dissimilar nectophores anterior one smaller, prismatic, with hydroecium closed on ventral side; somatocyst placed on dorsal side of hydroecium (except in *Bassia*).

Posterior nectophore larger, bearing large teeth (comb teeth) on hydroecial wings, and without somatocyst. Cormidia always separating as eudoxids with large gonophores; special nectophore absent.

The older workers recognized two-families: Abylinae L. Agassiz; and Ceratocymbinae Moser, of the Family Diphyidae (Bigelow, 1911b, 1931, Moser, 1925), except Totton (1932) and Leloup (1934) who elevated Abylinae to the status of a Family the Abylidae. Totton (1954) agreed with Sears (1953) in not recognizing the sub-family Ceratocymbinae of Moser as valid. The genus *Ceratocymba* considered as monotypic for *C. sagittata* Quoy & Gaimard, with peculiar prolongation of the apex of the superior nectophore hardly seemed sufficient reason to warrant a special sub-family. Sears agreed with Totton (1932) who showed its close relationship to the genus *Abyla*. Further, Sears transfered two species *A. leuckarti* Huxley and *A. dentata* Bigelow, until then included under *Abyla*, to the genus *Ceratocymba* and described a new species *C. intermedia* which formed a well-defined transition from a species with no apical prlongation (species of *Abyla* and *C. leuckarti* and *C. dentata*) to a marked one as seen in *C. sagittata*. Likewise, in agreement with Totton's view later workers (Leloup, 1934; Bigelow & Sears, 1937; Sears, 1953) transferred the genus *Enneagonum*—a true monophyid—from the Family Monophyidae (Bigelow, 1911b, = *Cuboides*) to this Family Abylidae, leading to a more natural grouping of the heterogenous genera.

Sears (1953) described some new genera and species as *Pseudabyla irregularis*, *P. dubia*, *Pseudocymba asymmetrica*, *P. animala* *Abylopsoides ventralis*, *A. dorsalis*, *A. basalis*, *Pseudoabylopsis anomala* which according to Totton (1954) belong to species of *Abyla*, *Ceratocymba* or *Abylopsis*, whose development have been abnormal. All these eight new species described by Sears (1953) are based on specimens which are (i) badly damaged (2) aysmmetrical due to either suppression of certain ridges and facets or overgrown with additional ridges and facets (3) very rare (one or two specimens only) and (4) not having the structure of normal healthy specimens. They are probably freaks.

The Family is divided into two subfamilies: Abylinae L. Agassiz (for *Abyla* and *Ceratocymba*) and Abylopsinae Totton (for *Abylopsis*, *Bassia* and *Enneagonum*).

Key to sub-families of ABYLIDAE

Anterior nectophore with rectangular apical facet....	ABYLINAE
Anterior nectophore with a ridge instead of an apical facet....	ABYLOPSINAE

Subfamily (i) ABYLINAE L. Agassiz, 1862

DIPHYABYLINAE Lens & van Riemsdijk, 1908, p. 36.
CERATOCYMBINAE Moser, 1925, 149.
ABYLINAE Totton, 1932 p. 332; 1954, p. 16.

Abylidae with anterior nectophore usually having a rectangular apical facet.

Two genera *Ceratocymba* Chun, 1888, and *Abyla* Quoy & Gaimard, 1827, are recognized in this sub-family.

Key to genera of ABYLINAE

Anterior nectophore:

Anterior nectophore with apical facet divided by a transverse ridge..	**Abyla**
Anterior nectophore with apical facet not divided by a transverse ridge..	**Ceratocymba**

Posterior nectophore:

Left lateral ridge running down to mid-dorsal tooth and not to left tooth; dorsal ridge absent..	**Abyla**
Left and right lateral ridges terminating on lateral teeth and short dorsal ridge terminating in dorsal tooth...	**Ceratocymba**

Eudoxid

Eudoxid is an "amphiroa" *i.e.* bract with rectangular dorsal facet; thick posterior branch of phyllocyst not recurved at its tip.	**Abyla**
Eudoxid is a "cymba", *i.e.* bract flattened with a prominent ridge on median dorsal side, the tip of posterior branch of phyllocyst recurved....	**Ceratocymba**

Genus 35. **Ceratocymba** Chun, 1888

Cymba Quoy & Gaimard, 1827, p. 16 (eudoxid).
Ceratocymba Chun, 1888, p. 1160.

Abylinae with apical facet of anterior nectophore not divided by a transverse ridge; posterior nectophore with short, median dorsal ridge terminating in dorsal tooth; eudoxid is a "*cymba*"

The genus is here considered to contain five valid species namely *C. leuckarti* (Huxley, 1959); *C. dentata* (Bigelow, 1918); *C. intermedia* Sears, 1953; *C. sagittata* Quoy & Gaimard, 1827; and *C. indica* Daniel, 1970.

Key to species of **Ceratocymba**

Anterior nectophore:

1.	Nectophore not produced apically into a pointed tip..	2
	Nectophore produced apically into a pointed tip..	3
2.	Apical facet flat; lateral ridges not expanding into wings; finely serrated...	*leuckarti*
	Apical facet concave; lateral ridges expanding into wings; strongly serrated...	*dentata*
3.	Nectosac twice as long as hydroecium...	4
	Nectosac one half as long as hydroecium...	*intermedia*
4.	Nectophore triangular; nectosac reaching nearly upto apex of nectophore..	*sagittata*
	Nectophore not triangular, with a constriction at level of somatocyst; nectosac reaching mid-level of elongated portion of nectophore...	*indica*

Posterior nectophore:

1.	Nectophore 3–4 times as long as it is wide; narrow...	2
	Nectophore equal or slightly longer than anterior nectophore; broad.......	3
2.	Soft and slender; finely serrated; 5–6 comb-teeth on right hydroecial wing..	*leuckarti*
	Nectophore firm and slender, strongly serrated; 15–16 comb-teeth on right hydroecial wing..	*dentata*
3.	Left ventral tooth long; 6–7 comb-teeth on right hydroecial wing...	*sagittata*
	Left ventral tooth twice as long as in *C. sagittata;* four comb-teeth on right hydroecial wing...	*indica*

Eudoxid phase:

1.	Bract with incomplete ridge on left side..	2
	Bract with complete ridge on left side..	*leuckarti*
2.	Bract broad, ridge not reaching base...	*dentata*
	Bract slender; ridge not reaching apical facet.	*sagittata*

(N. B. Bracts are not known in *C. intermedia* and *C. indica*).

Except *C. intermedia,* others are recorded from the Indian Ocean. *C. leuckarti*, *C. dentata* and *C. sagittata* occur in the Indian Seas.

78. **Ceratocymba leuckarti** (Huxley, 1859)
(Fig. 79 a–f)

Abyla leuckarti Huxely, 1859, p. 49; pl. 3; fig. 2.
Ceratocymba leuckarti Daniel, 1974, p. 177, Text-fig. 14, E–G.
(cf. for detailed synonymy)

Type Specimen: Place of deposit not known.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 8 a.n.; 6 p.n.; 19 eu. (compl.); 1 br.; 34 go. *Bay of Bengal:* 3 p.g. (compl.); 38 a.n.; 16 p.n.; 64 eu (compl.); 8 br.; 97 go. *South West Indian Ocean:* 12 a.n.; 5 p.n.; 13 eu. (compl.); 9 br.; 25 go. *South East Indian Ocean:* 1 p.g. (compl.); 34 a.n.; 13 p.n.; 43 eu (compl.); 5 br., 52 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 8 a.n.; 4 p.n.; 16 eu (compl.); 1 br.; 18 go. *Bay of Bengal:* 3 p.g. (compl.); 38 a.n.; 28 p.n.; 45 eu (compl.); 27 br.; 90 go. *South West Indian Ocean:* 11 a.n.; 5 p.n.; 4 eu (compl.); 2 br.; 8 go. *South East Indian Ocean:* 4 p.g. (compl.); 49 a.n.; 20 p.n.; 40 eu. 15 br.; 61 go.

Polygastric phase: (Fig. 79 a, b). *Anterior nectophore:* Laterally flattened, rectangular in side view; 4.7 mm in length, 3.00 mm in breadth and 2.0 mm in thickness; not apically produced into a pointed apex as in *C. Sagittata.* Apical facet flat, cutting dorsal and ventral facets nearly at right angles; apical and dorsal facets rectangular in shape; ventral facet narrow, ending in a pointed tip at base; lateral facets incompletely and unequally divided into two by incomplete lateral ridges. Basal 2/3rd of all ridges serrated. Dorsal ridges and lateral facets end in pointed serrated teeth around ostium of nectosac. Nectosac (3.5 mm long), hydroecium (3.85 mm long), and Somatocyst (2.6 mm long) parallel to each other with apices at same level.

Posterior nectophore: Nearly 2 1/2 times as long as anterior nectophores—11.83 mm long—laterally flattened, slender, fragile. Dorsal ridge vestigeal, ending in a tooth at ostium; left lateral ridge displaced toward dorsal side, both ridges ending in teeth near dorsal tooth. Hydroecium open, deep; hydroecial wings broad; right hydroecial wing thickned at edge bearing 5–6 comb-teeth on inner apical side; with 5–6 denticulations at ostial end; ventral teeth slightly unequal in size. Apex of nectophore produced into thin elongated apophysis fitting into deep hydroecium of anterior nectophore. Basal end of ridges serrated.

Eudoxid phases: (Fig. 79 c–f). Bract 5.0 mm in length; 3.75 mm broad, dorso-ventrally flattened, with 5 facets. Apical and basal facets flat, rectangular in shape; upper convex side with 2 ridges, median dorsal, and left lateral ridges prominent and complete and asymmetrical. Phyllocyst with 3 branches—two thread-like thin branches directed apically toward apical angles of bract, and a thick branch lying below median dorsal ridge, with distal tip curved upwards. Bracteal cavity not very deep, conical in shape.

Gonophore: With 5 ridges—dorsal ridge small and vestigeal ending in dorsal tooth; two lateral ridges complete, originating

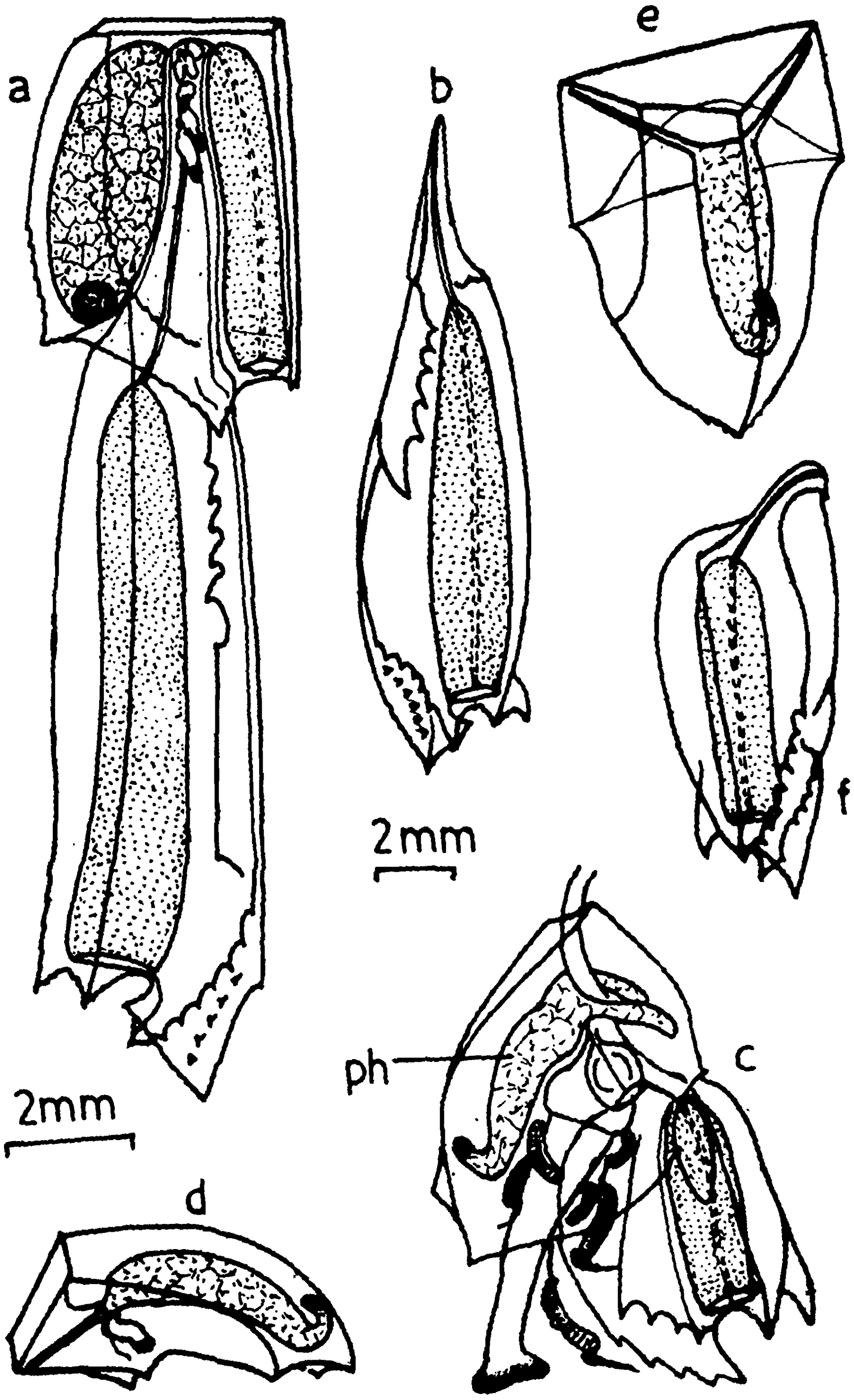


FIG. 79. *C. leuckarti* (Huxley) (a–f). a. entire polygastric phase with both anterior and posterior nectophores intact; b. posterior nectophore; c. cormidium; d. bract side view; e. bract dorsal view; f. gonophore.

from apex of nectosac and ending in teeth at base; ventral ridges form edges of expanded bydroecial wings and end in teeth. Basal ends of ridges serrated. Two gonophores in an eudoxid are mirror images of each other with peg-like apophysis.

Type locality: Lat. 32°33'N; Long. 72°14'W, between Chesapeake Bay and Bermuda.

Distribution and seasonal variations: (Maps 99 & 100). The distribution and abundance of *C. leuckarti* in the Indian Ocean in the different regions are presented in maps 99 and 100.

C. leuckarti occurred in all the four zones of the Indian Ocean. The highest concentration of this species occurred in the Bay of Bengal. It was also well represented in South East Indian Ocean. The night/day catches did not show much variation in the two seasons in the four zones of the Indian Ocean.

During both the seasons *C. leuckarti* occurred from 20°N latitude to 30°S latitude along the land masses and down to 20°S latitude in the central mid-ocean (except at one place-30°S lat.). It was observed that in the usually Siphonophore rich areas such as the Somali coast, and Gulf of Aden, *C. leuckarti* was not collected during both the seasons except at one station located along the Somali coast. High concentration of this species was noted in the equatorial belt, Bay of Bengal, along the 110°E longitude within 0°–25°S latitudes. In the Bay of Bengal as observed in other regions the species moved closer to the coastal regions during NE/NW monsoon season. It was rarely observed along the coastal regions of Burma or Malaya.

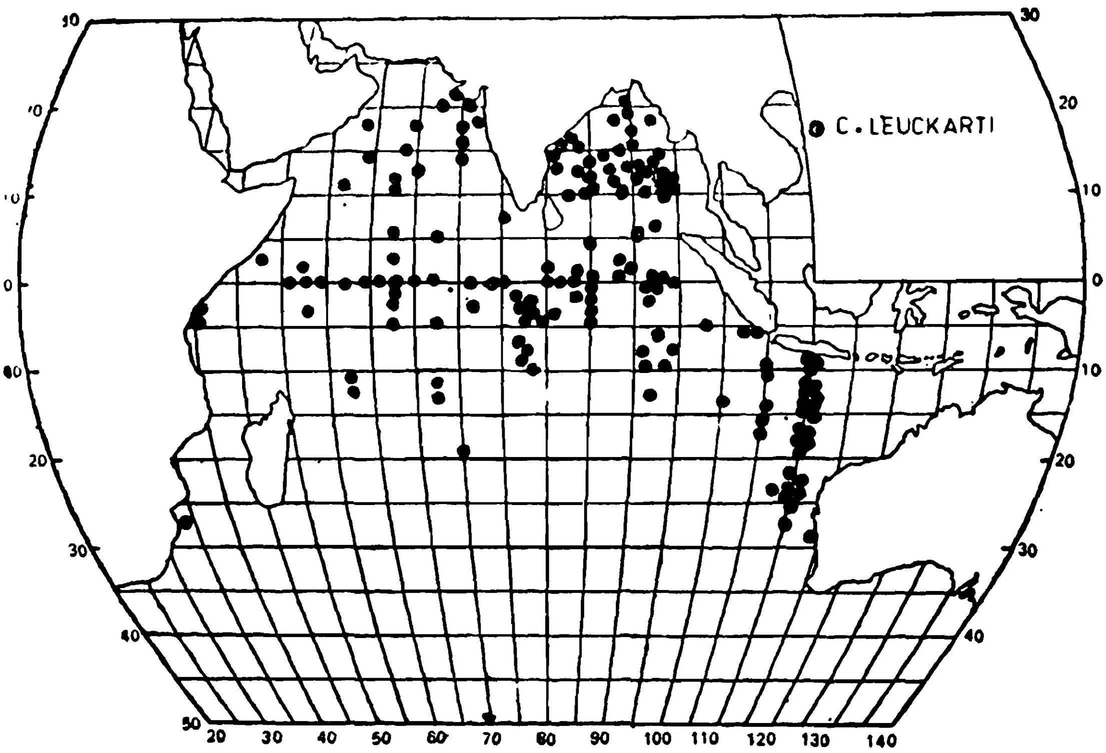
Monthly variations:

Arabian Sea: On the western part of the Arabian Sea, it occurred usually near the Equator and off the mouth of the Gulf of Aden during August. It was rarely captured on the Arabian coast. On the Indian coast it occurred during most of the months (except June, October and November) especially during May.

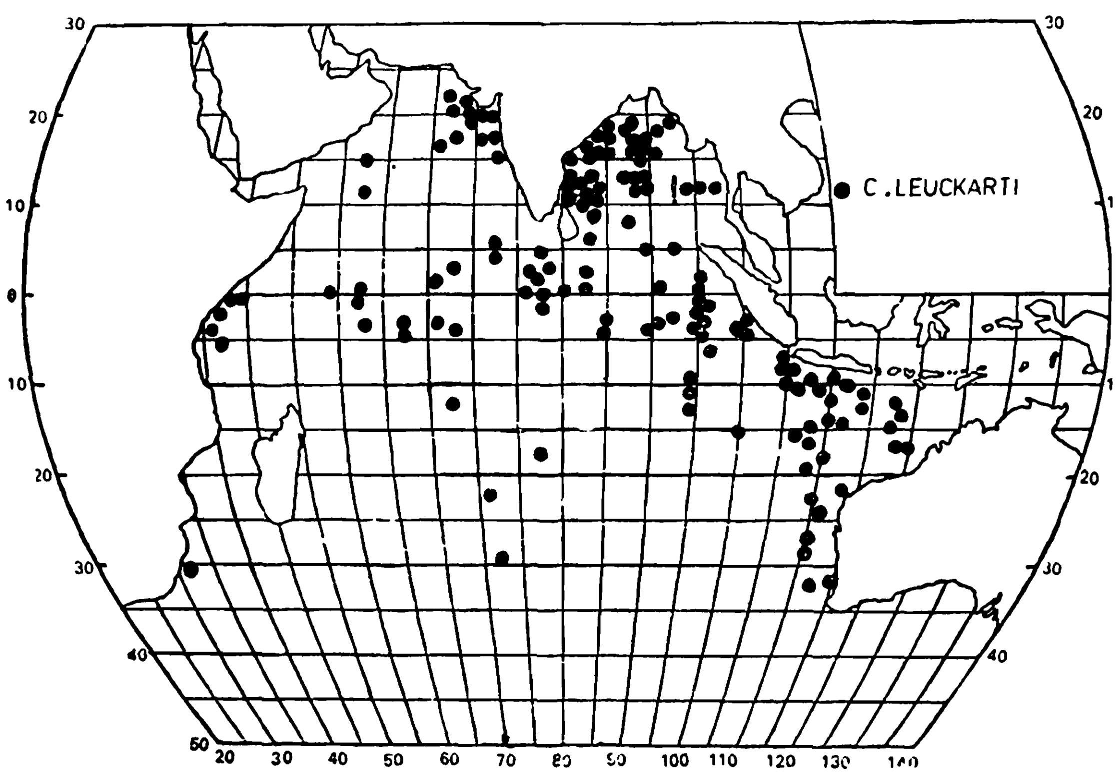
Bay of Bengal: On the Indian region *C. leuckarti* occurred in great abundance during April and January. On the Andaman and Burma region it occurred during September. In the central region it was collected during April.

South West Indian Ocean: It was rarely collected along the African coastal regions, while it occurred throughout the year in the oceanic region.

South West Indian Ocean: Along the 110°E longitude it occurred in vast areas during January and in May and August. In the oceanic region it occurred in great numbers during December.



MAP 99. Distribution of *C. leuckarti* during SW/SE monsoon season.
1–5 Specimens per haul.



MAP 100. Distribution of *C. leuckarti* during NE/MW monsoon season.
1–5 Specimens per haul.

79. **Ceratocymba dentata** (Bigelow, 1918)
(Fig. 80 a-e)

Abyla dentata Bigelow, 1918, p. 409, pl. 5, figs. 1-4.
Ceratocymba dentata Daniel, 1974, p. 179, Text-fig. 14, H-N
(cf. for detailed synonymy)

Type Specimen: Museum of comparative Zoology at Harward College, USA.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 3 a.n.; 1 br.; 1 go. *Bay of Bengal:* 1 a.n. *South West Indian Ocean:* 1 a.n. *South East Indian Ocean:* 3 a.n.; 4 p.n.; 1 eu. (compl.); 1 br.; 3 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 1 go. *South West Indian Ocean:* 2 go. *South East Indian Ocean:* 5 a.n.; 2 p.n.; 3 eu. (compl.); 3 br.; 5 go.

Polygastric phase: (Fig. 80, a, b & c). *Anterior nectophore:* Upto 11.0 mm in length, opaque, nearly cuboidal in shape, with prominent, serrated ridges—laterals expanded into wings; horizontal and transverse apical ridges absent. Dorsal facet triangular, strongly bowed with heavily serrated lateral margins and deeply emarginated base; its apex produced into a short peak with apex of nectosac extending into it.

Posterior nectophore: Upto 55.0 mm in length, three times as long as wide, opaque, with prominent serrated ridges, dorsal vestigeal, ending in a large strong tooth; lateral ridges take a twisted course, ending in smaller teeth around ostium. Right ventral hydroecial wing bear 16 comb-teeth; left ventral wing with 7 spiny teeth on thickened basal end; both end in unequal teeth at base.

Eudoxid phase: (Fig. 80 d, e) *Bract:* about 20.0 mm long and 18.0 mm broad; large, strong and opaque. Dorsal median ridge arched, prominent and complete; left lateral ridge incomplete, always joining apico-dorsal ridge, not reaching posterior margin. Phyllocyst as in *C. leuckarti* but median thick, posteriorly directed branch occupying only anterior half of bract.

Gonophores: Two gonophores (male & female) in same eudoxid, mirror images of each other, large, 11.3 mm in length, with broad proximal end. Ridges prominent, more or less like that of posterior nectophore with basal halves well serrated; a large conspicuous hook-like tooth occur from one of the hydroecial wing, curved toward floor of hydroecium. Ostial teeth prominent.

Type locality: Lat. 32°33′ N; Long. 72°14′ W—Chesapeake Bay to Bermuda (Western Atlantic).

Distribution: (Maps 101 & 102). *C. dentata* was collected from the four zones of the Indian Ocean, but rare. It occurred mostly along the 110°E longitude.

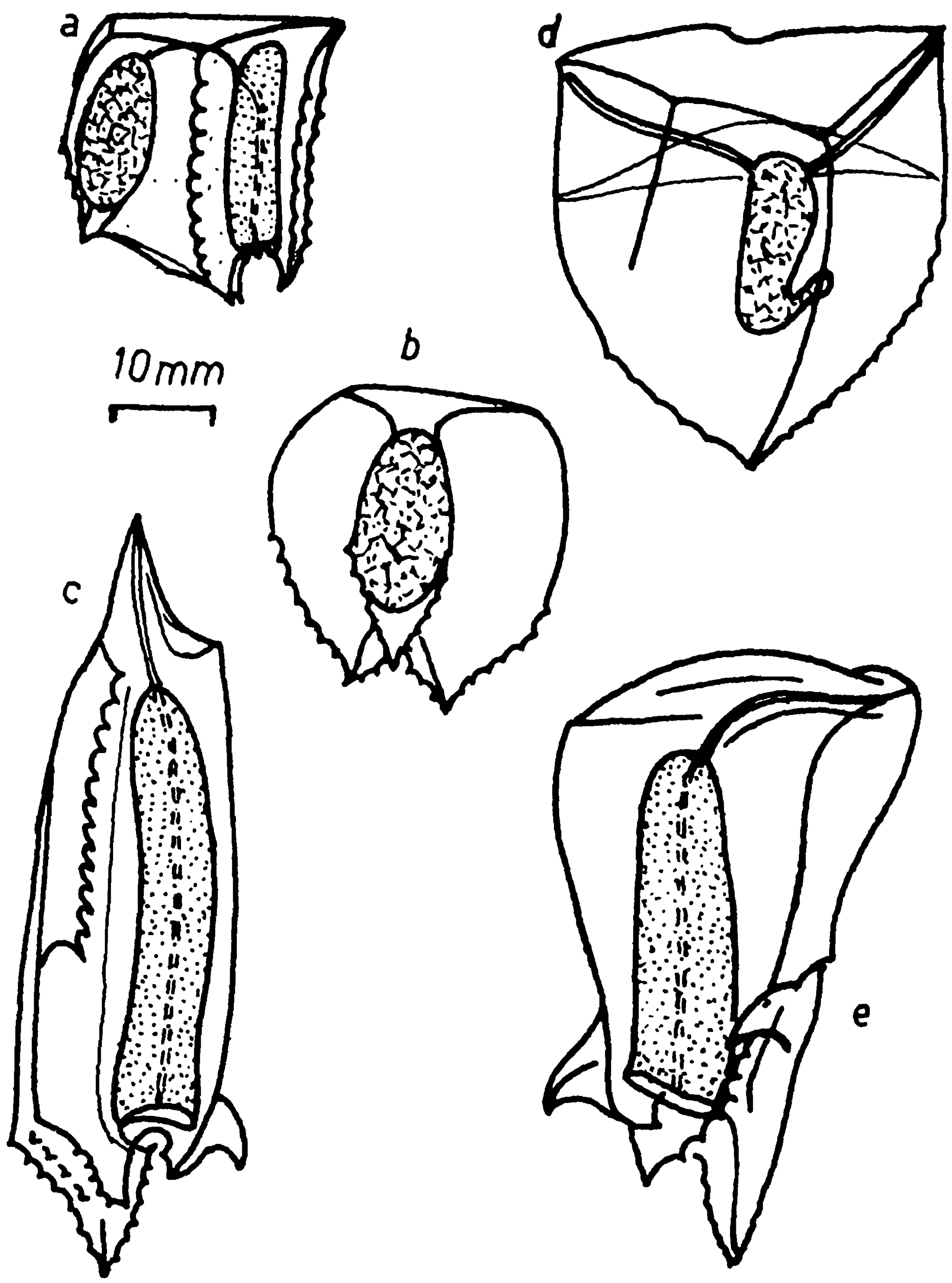
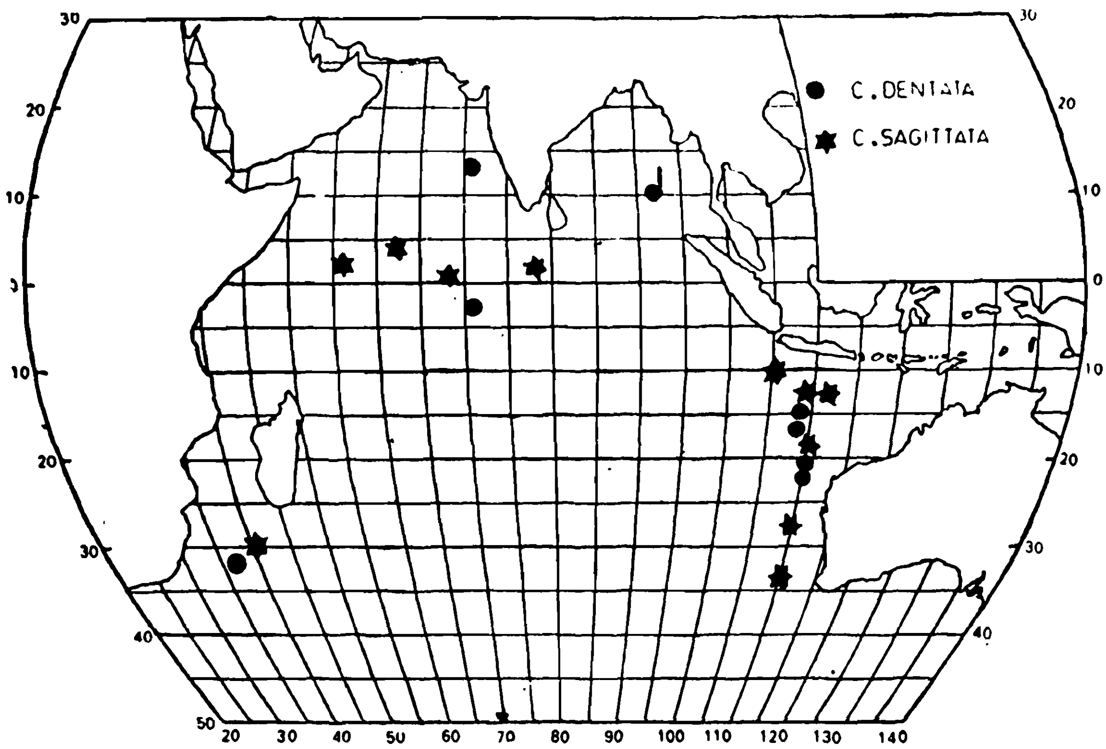
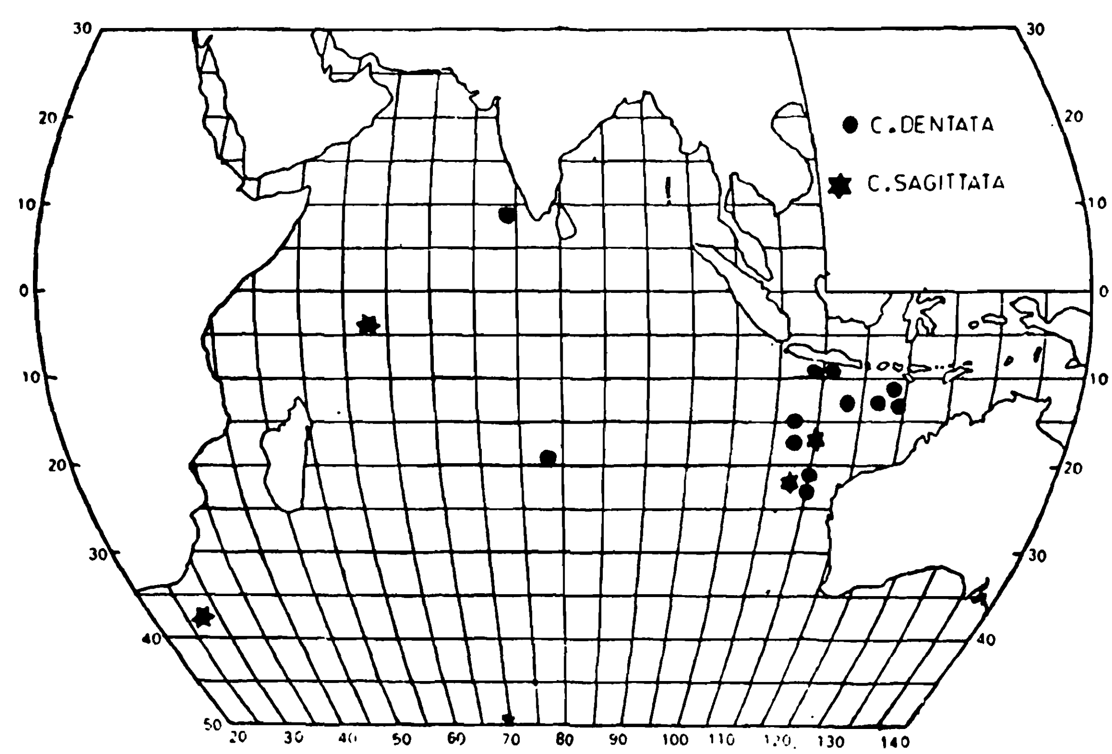


FIG. 80. *C. dentata* (Bigelow) (a–e). a. anterior nectophore lateral view; b. anterior nectophore ventral view; c. posterior nectophore; d. bract; e. gonophore.



MAP 101. Distribution of *C. dentata* and *C. sagittata* during SW/SE monsoon season. 1–3 Specimens per haul.



MAP 102. Distribution of *C. dentata* and *C. sagittata* during NE/NW monsoon season. 1–3 Specimens per haul.

Monthly variations:

Arabian Sea: *C. dentata* was collected only once during NE/NW monsoon season in the month of March off Cochin coast.

Bay of Bengal: It was collected once during SW/SE monsoon season in the month of June south of Nicobar island.

South West Indian Ocean: During SW/SE monsoon season it was captured near the Equator in June. During NE/NW monsoon season it was collected from the mid-ocean in January.

South East Indian Ocean: During SW/SE monsoon season it was collected along the 110°E longitude in the months of April and August. During NE/NW monsoon season it occurred south of Java and on the north-west areas near Australia during January (maximum number of occurrence), April and December.

C. dentata is an ubiquitous species, usually inhabiting the 200–0m and deeper depths of the ocean.

80. **Ceratocymba sagittata** (Quoy & Gaimard, 1827)
(Fig. 81 a–d)

Cymba sagittata Quoy & Gaimard, 1827, p. 16, pl. 2 C, figs, 1–9.
Diphyabyia hubrechti Bigelow, 1911, p. 231, pl. 12, fig. 7.
Ceratocymba sagittata Daniel, 1974, 181, Text-fig, 15A-D.
(cf. for detailed synonymy)

Type Specimen: Museum National d'Histoire Naturelle, Paris.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 1 p.g. (compl.); 1 eu (compl.); 1 br.; 1 go. *South West Indian Ocean:* 1 a.n.; 1 p.n.; 1 p.g. (compl.); 1 eu. (compl.). *South East Indian Ocean:* 2 p.g. (compl.); 1 a.n.; 2 p.n.; 13 br.; 12 go. NORTH EAST/NORTH WEST MONSOON SEASON: *South West Indian Ocean:* 1 a.n.; 1 br. *South East Indian Ocean:* 1 cu. (compl.); 2 br.; 3 go.

Polygastric phase: (Fig. 81 a, b). *Anterior nectophore:* Size: Length 22.2 mm; breadth at base 11.47 mm, somatocyst 8.0 mm; Hydroecium 11.3 mm; Nectosac 17.0 mm length; length from apex of nectosac to tip of nectophore 3.0 mm.

Laterally flattened, pyramidal; apical prolongation, with characteristically abylid basal half; opaque, with firm mesoglea. Four ridges at apex—two dorsal, two ventrals, and two oblique lateral ridges originating from mid-region of dorsal ridges, terminating at base of hydroecium. Somatocyst small, oblique. Hydroecium conical with a broad rectangular opening. Nectosac is a long blunt tube extending upto 3/4th length of nectophore. The dorsal and lateral ridges end in teeth and ventral facet ends in pointed tooth like projection. Basal half of ridges faintly serrated.

Posterior nectophore: (Fig. 81, b) *Size:* Length 31.8 mm; breadth 12.0 mm; length of left ventral tooth 5.8 mm; length of right ventral tooth 2.0 mm.

Four long, complete ridges, 2 dorso-laterlas, 2 ventro-laterals and a dorsal vestigeal ridge, all ending in teeth around ostium; left ventral tooth longer. Right hydroecial wing bear 6 comb-teeth. Basal edge of right hydroecial wing with about 7 denticulation.

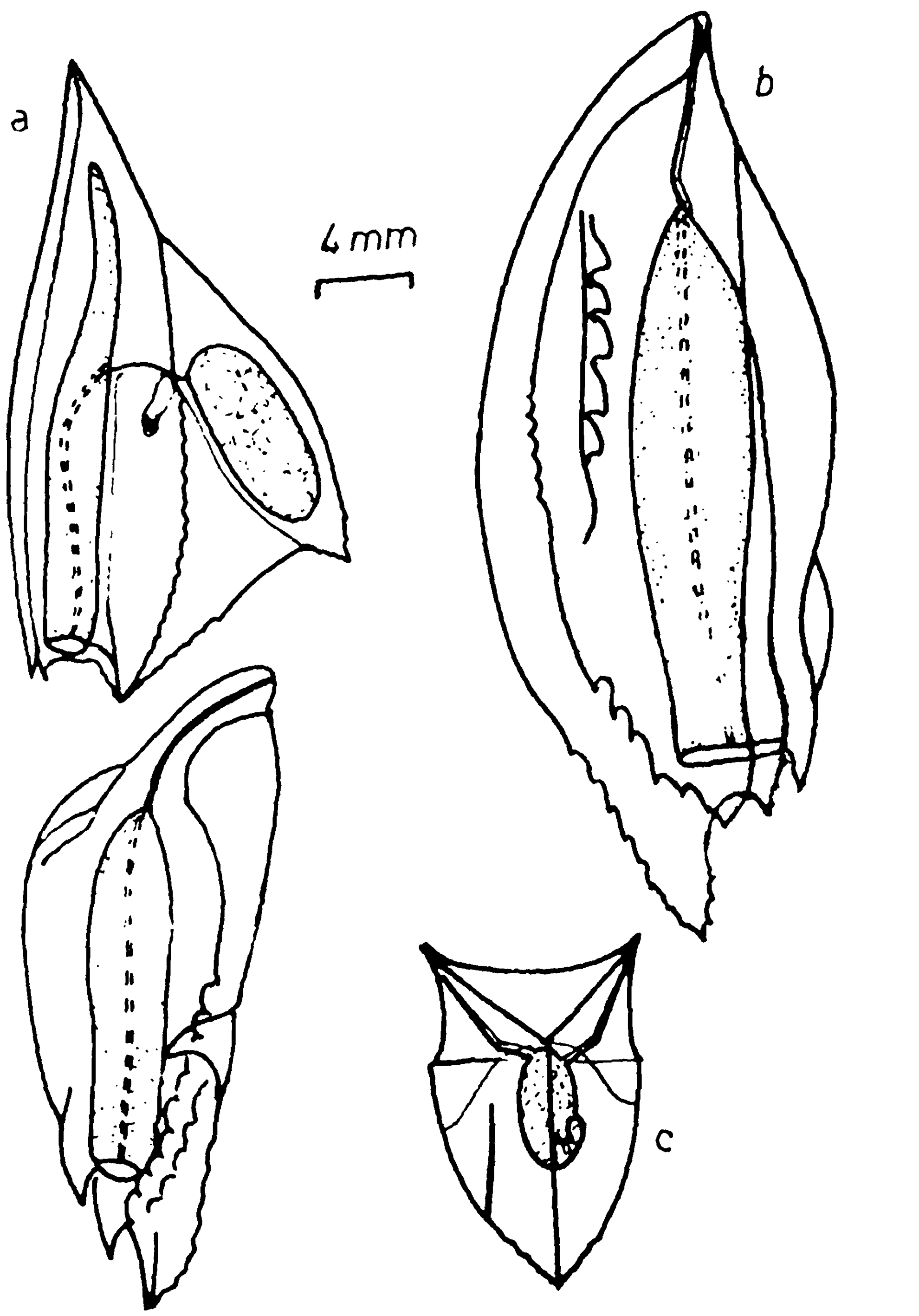


FIG. 81. *C. sagittata* (Quoy & Gaimard) (a–d). a. anterior nectophore; b. posterior nectophore; c. bract; d. gonophore.

Eudoxid phase: (Fig. 81 c, d) *Bract:* Length 15.6 mm; breadth 10.0 mm. Apical corners produced into prominent lateral horns. With triangular deeply concave apical facet. Left lateral ridge arise from basal margin, terminating midway of bract. Phyllocyst with three branches as in *C. leuckarti*, two thin anterior arms bent in middle, posterior branch thick and small, and recurved at distal end.

Gonophore: 10.0 mm in length, resemble *C. dentata* with a small inconspicuous hook-like tooth arising from right ventral ridge and curved inward. Dorsal ridge vestigeal, end in teeth at ostium.

Type locality: Off Gibraltar.

Distribution: (Maps 101 & 102). *C. sagittata* was collected from a few places only, in the Arabian Sea, south west and south east Indian Ocean. It was not collected from the Bay of Bengal. These occurred mostly during the night time.
Monthly variations:

C. sagittata was collected only during the SW/SE monsoon season three times in the equatorial belt region. These were captured during June, August and October, from the upwelling regions.

South West Indian Ocean: During SW/SE monsoon season it was captured near the Equator during April and off south Africa during August. During NE/NW monsoon season it occurred near the Equator during March and off south Africa during October.

South East Indian Ocean: During SW/SE monsoon season *C. sagittata* was recorded at four places located along the 110°E longitude during May and October and south of Java during September· It was not collected during NE/NW monsoon season.

C. sagittata usually occurs at depths of 1000—0 m or 150—100 m. It probabaly comes up in the upwelling regions near the Equator.

Genus 36. **Abyla** Quoy & Gaimard, 1827

Abyla Quoy & Gaimard, 1827, p. 14.
Amphiroa Blainville, 1834, p. 133.
Pseudabyla Sears, 1953, p. 49.

Abylinae with anterior nectophore possessing 10-11 facets; apical facet subdivided by an apical transverse ridge, into an apico-dorsal and apico-ventral facet. Posterior uectophore with dorsal ridge completely suppressed; distal end of left lateral ridge deflected towards dorsal side ending in mid-dorsal tooth; hydroecial ridges usually well expanded into wings with varying number of comb-teeth. Eudoxid is an "amphiroa"

Type Species: *Abyla trigona* Quoy & Gaimard, 1827.

Key for identifying the nine species of *Abyla* recognised by Sears (1953)—*A. trigona* Quoy & Gaimard, 1827; *A. carina* Haeckel 1888; *A. schmidti* Sears, 1953; *A. ingeborgae* Sears, 1953; *A. haeckeli* Lens & van Riemsdijk, 1908; *A. peruana* Sears, 1953; *A. bicarinata* Moser, 1925; *A. brownia* Sears, 1953; and *A. tottoni* Sears, 1953—is given below:

Key to species of **Abyla**

(After Sears, 1953)

Anterior nectophore:

1. Apico-ventral facet subdivided by a transverse ridge...	2
Apico-ventral facet not subdivided by a transverse ridge...	3
2. Ventral facet approaches a regular pentagon in shape; protrusion at juncture of horizontal and lateral ridges markedly overhangs basal half of ventro-lateral surface; ridges elevated like a rim of a pie plate..	*A. haeckeli*
Ventral facet elongate with basal sides of pentagon roughly three times as long as apical ones; protrusion at juncture of lateral and horizontal ridges not excessive; ridges well defined but not markedly elevated above facets..	*A. ingeborgae*
3. Nectophores nearly circular in dorsal or ventral view due to pronounced expansion of lateral ridges...	4
Nectophores elongate in dorsal or ventral view, but with more or less pronounced knob at juncture of the lateral and horizontal ridges.....	5
4. All ridges well defined; a definite angle at juncture of horizontal and lateral ridges; greatest width of ventral facet about 1/2 the length from insertion of horizontal ridges to basal tip..	*A. brownia*
Ridges delineating the apico-dorsal facet as well as horizontal ridge rounded and often indistinct, lateral ridge circular throughout, not angular, greatest width of ventral facet greater than distance from insertion of horizontal ridges to basal tip.. ...	*A. bicarinata*
5. Greatest width of ventral facet is about the same (0.87 to 1.0) as its length from the insertion of the horizontal ridges to its basal tip..	6

	Greatest width of ventral facet is only about 1/2 to 2/3rds (0.45 to 0.6) the length from the insertion to the horizontal ridges to its basal tip...	7
6.	Inside view, apex of hydroecium considerably higher, the apex of nectosac lower than that of somatocyst, horizontal ridge crosses somatocyst only slightly above its middle; no obvious depression ventral to transverse apical ridge....	*A. peruana*
	Apices of nectosac and somatocyst at about the same level, apex of hydroecium only slightly higher; horizontal ridge crosses somatocyst well above middle; obvious depression ventral to transverse apical ridge..	*A. tottoni*
7.	Transverse ridge in side view lies above somatocyst resulting in elongate apico-dorsal facet..	*A. schmidti*
	Transverse ridge in side view lies above hydro-ecium... ..	8
8.	Inside view, apico-dorsal facet almost vertical from insertion of lateral ridge to apical transverse ridge; lateral border of basal facet curved and tends to parallel horizontal plane; heavy and irregular serrations on lateral ridges.. ..	*A. trigona*
	Inside view, apico-dorsal facet essentially flat; lateral border of basal facet diagonal and only slightly curved; serrations fine...	*A. carina*

Posterior nectophore:

1.	About 2–5 teeth on comb of right* ventral wing.	2
	About 6–10 teeth on comb of right* ventral wing...	4
2.	Two or three teeth on comb of right ventral wing; base of left ventral wing with thickening outlined by rather small teeth, the two ventral ones on both inner and outer row being the heaviest...	*A. haeckeli*
	Four or five teeth on comb of right ventral wing; left ventral wing triangular..	3
3.	Base of left ventral wing with inner row of stout teeth continuous with its ventral margin and outer row of finer teeth projecting below on a more or less well-defined triangular pad; right ventral wing not continuous with the right ventral tooth.	*A. schmidti*
	Base of left ventral wing with three or four stout teeth on inner margin, with a few	

* right=left & VS in Sears' Key.

weak teeth almost scallop-like on outer; right ventral wing continuous with the right ventral tooth.. *A. ingeborgae*

4. Outer row of teeth on basal margin of left ventral wing continuous with its ventral margin; inner row ending on inner surface. 5

Inner and outer rows of teeth on basal margin of left ventral wing merge to become its ventral margin.. 6

5. Nectophore (exclusive of apophysis) about as wide as it is long, nearly circular in general appearance, usually about seven teeth on comb of right ventral wing... *A. bicarinata*

Nectophores (exclusive of apophysis) somewhat longer than wide; ovoid in general appearance; 8–9 teeth on comb of right ventral wing.. *A. tottoni*

6. Ventral teeth elongate, heavily serrated; about 6 teeth on comb of right ventral wing; teeth on basal margin of left ventral wing heavy and prominent... *A. trigona*

Ventral teeth stubby, 9–10 teeth on comb of right ventral wing; teeth on basal margin of left ventral wing scarcely more than strong serrations... *A. carina*

81. **Abyla trigona** Quoy & Gaimard, 1827
(Fig. 82 a–c)

Abyla trigona Quoy & Gaimard, 1827, p. 14, pl. 20, figs. 1–8 (in part).
Abyla trigona Sears, 1953, p. 35, figs. 8B, 9B, 10B, 11A.
Abyla trigona Daniel, 1974, p. 187, text-fig. 16, A & B.
(cf for detiled synomy my)

Type Specimen: Museum National d'Histoire Naturelle, Paris.

South West/South East Monsoon Season: *Arabian Sea:* 2 a.n. *Bay of Bengal:* 1 a.n.; 1 p.n. North East/North West Monsoon Season: *Arabian Sea:* 2 a.n. *South West Indian Ocean:* 7 a.n.; 4 p.n.; 2 go; 2 br.

Polygastric Phase: Anterior nectophore: (Fig. 82 a, b) Ridges heavily and irregularly serrated. Apico-dorsal facet sharply bent upward from insertion of lateral ridges to transverse apical ridge. Lateral expansion sharp, more prominent than those of *A. carina*. Facets depressed below ridges.

Posterior nectophore: (Fig 82 c) Characterised by smaller number of comb-teeth (6-8); presence of two rows of teeth on basal margin of right ventral wing; heavier serrations of ostial teeth.

Eudoxid phase: At present very difficult to identify bracts of species of *Abyla*. General features are given below: Bract is an '*amphiroa*' with rectangular apical, ventral and dorsal facets. two large lateral facets. Phyllocyst with 3 branches as in *Ceratocymba* but distal end of median thick branch not curved upward, anterior arms thin and directed toward apical corners.

Gonophores: With 4 prominent ridges and one vestigeal dorsal ridge all ending in teeth at ostium. Ventral ridges variously formed-expanded into hydroecial wings or narrow—and denticulated.

Type locality: Off Gibraltar.

Distribution: (Maps 103 & 104). This was a rare species, collected from the following regions:

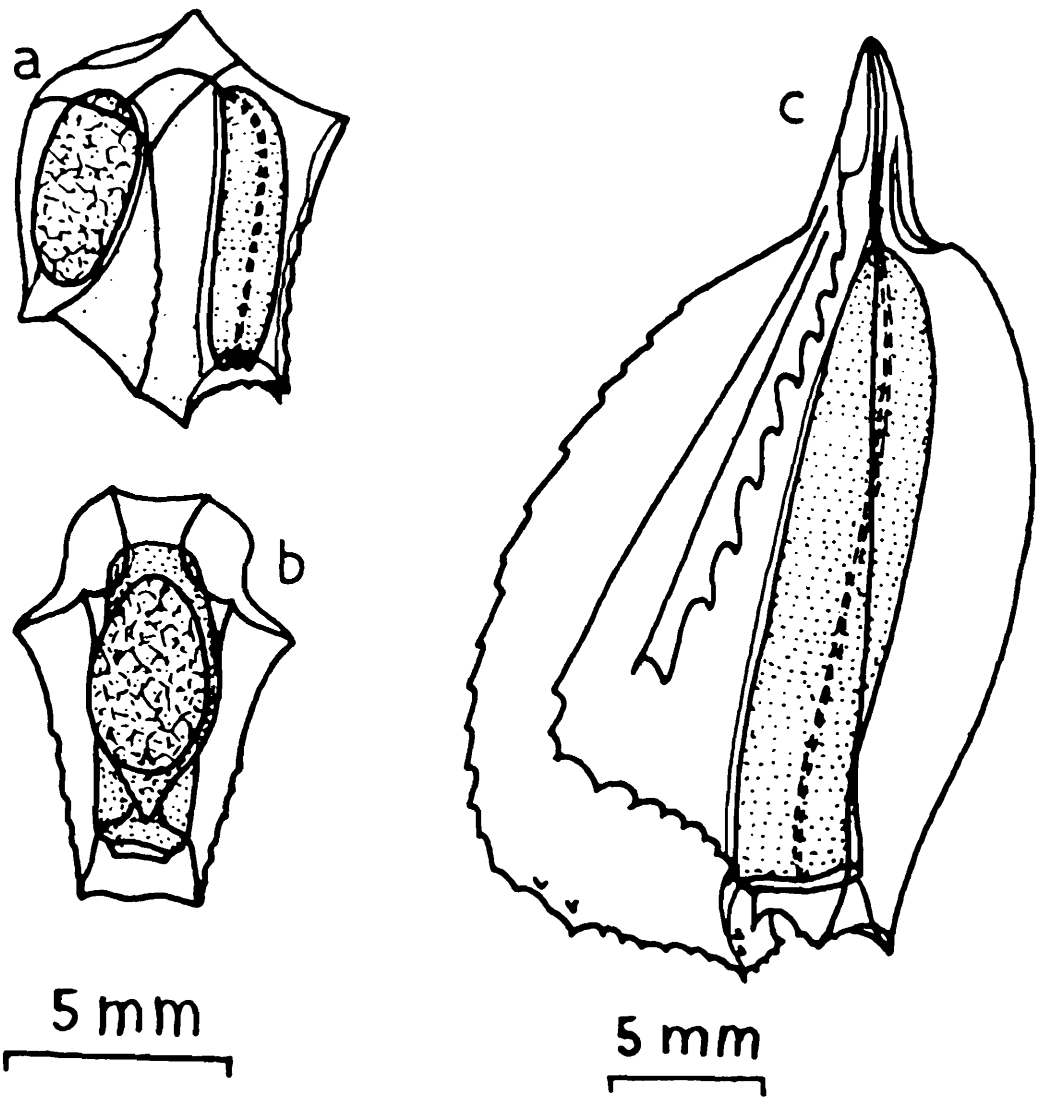
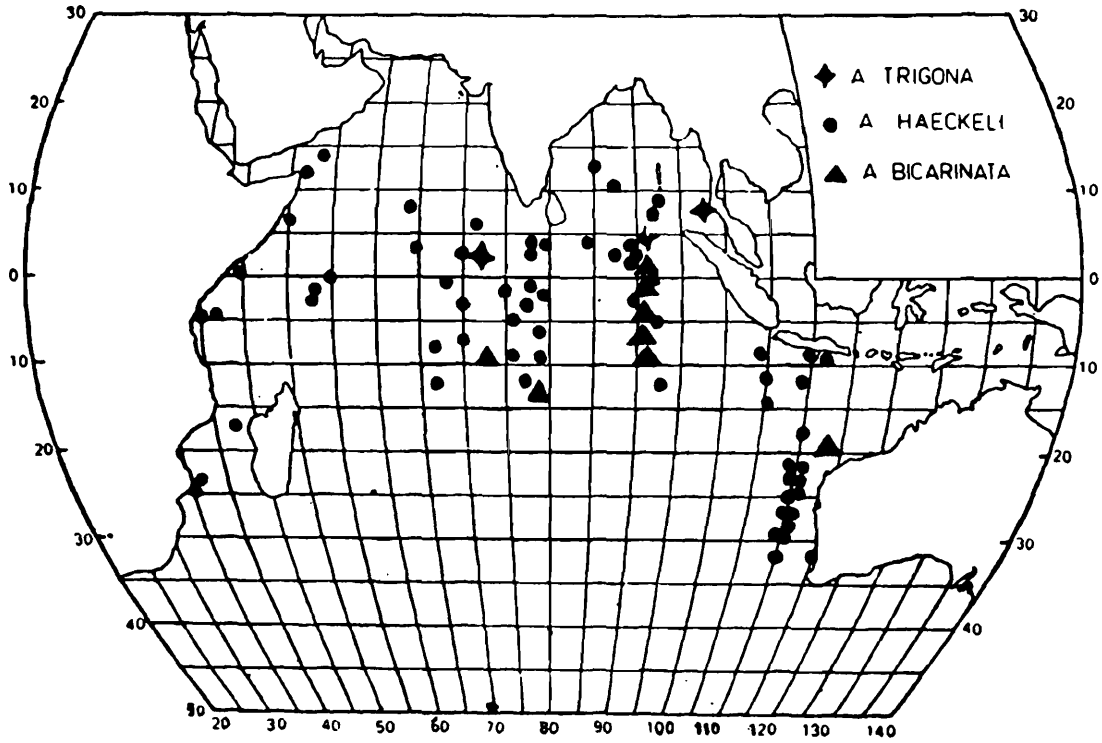
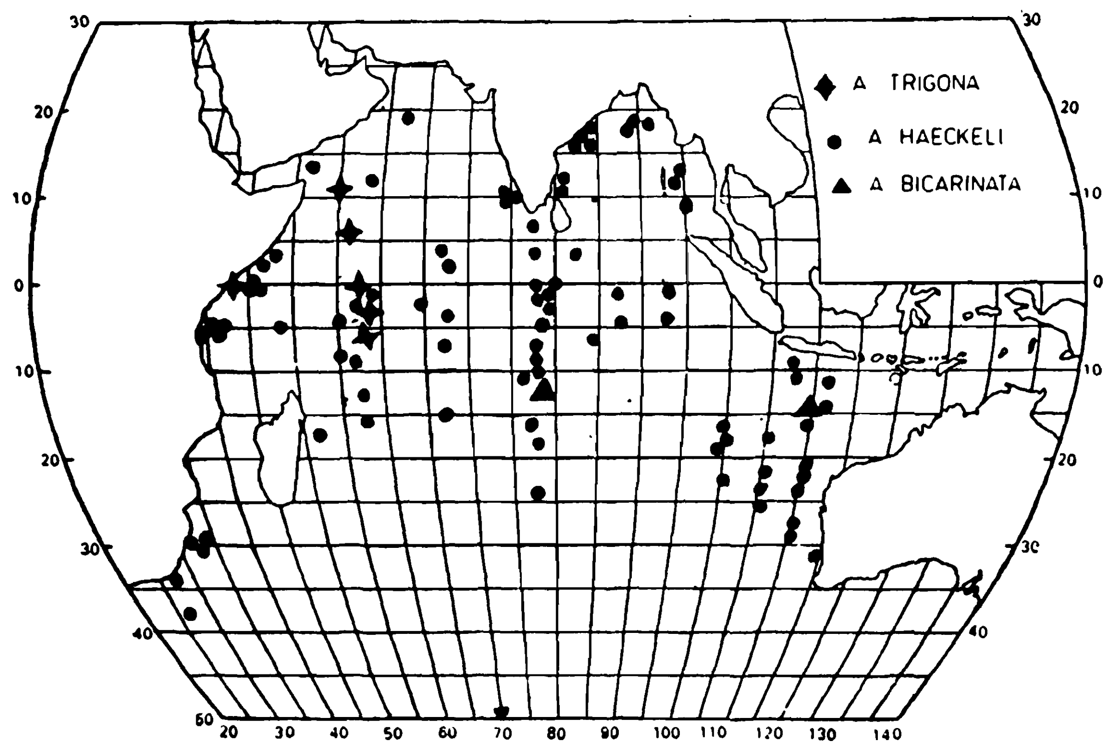


FIG. 82. *A. trigona* Quoy & Gaimard (a–c). a. anterior nectophore — lateral view; b. anterior nectophore — ventral view; c. posterior nectophore — lateral view. (Fig. c After Totton, 1965, fig. 142 A).



MAP 103. Distribution of *A. trigona*, *A. haeckeli* and *A. bicarinata* during SW/SE monsoon season. 1—3 Specimens per haul.



MAP 104. Distribution of *A. trigona*, *A. haeckeli* and *A. bicarinata* during NE/NW monsoon season. 1—3 Specimens per haul.

Arabian Sea: during August.

Bay of Bengal: during September.

South West Indian Ocean: From the oceanic region during January and March.

82. **Abyla schmidti** Sears, 1953
(Fig. 83, a–d)

Abyla schmidti Sears, 1953, p. 38, figs. 8C, 9C, 10C & 15C.
Abyla schmidti Daniel, 1974, p. 190, Text-fig. 16, C–F & N.
(cf. for detailed synonymy)

Type Specimen: Universitets Zoologiske Museum, Kobenhavn, Denmark.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 2 a.n.; 9 eu. (compl.); 8 br.; 20 go. *Bay of Bengal:* 6 a.n.; 3 p.n.; 12 eu. (compl.); 4 br.; 18 go. *South West Indian Ocean:* 15 a.n.; 5 p.n.: 15 eu. (compl.); 18 br.; 37 go. *South East Indian Ocean:* 1 p.g. (compl.) 19 a.n.; 5 p.n.; 10 eu. *Indian Ocean:* 15 a.n.; 5 p.p.: 15 eu. (compl.); 18 br.; 37 go. (compl.); 23 br.; 33 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 15 a.n.; 9 p.n.; 15 eu. (compl.); 22 br.; 20 go. *Bay of Bengal:* 12 a.n.; 5 p.n.; 25 eu. (compl.); 16 br.; 26 go. *South West Indian Ocean:* 15 a.n.; 6 p.n.; 10 eu. (compl.); 22 br.; 29 go. *South East Indian Ocean:* 17 a.n.; 5 p.n.; 9 eu. (compl.); 34 br.; 18 go.

Polygastric phase: Anterior nectophore: length—7.8 mm, breadth—5.2 mm; characterised by proportionately larger, longer apico-dorsal facet when compared to *A. trigona*. Transverse ridge lying above level of apex of somatocyst. Dorsal facet tapers toward base rather than bulging in middle as in *A. trigona* or *A. carina*.

Posterior nectophore: Length 13.0 mm; breadth 6.67 mm; nearly triangular in shape. Basal half of left ventral wing expanded with 6–7 denticulations on inner margin and denticulations on outer edge; traingular protrusion between these rows of denticulation characterises this species. Right ventral wing not highly expanded, with 3–4 comb-teeth at proximal inner edge and denticulated at basal margin. 5 ostial teeth—prominent dorsal, small laterals, strong pointed ventrals.

Eudoxid phase: Similar to *A. trigona*, lateral facets not broad, or expanded or flap-like as in *A. bicarinata*. Gonophores without expanded wings.

Type locality: Lat. 3°45'S; Long. 56°33'E (Indian Ocean).

Distribution: (Maps 105 & 106). The distribution of *A. schmidti* is presented in maps 103 and 104. *A. schmidti* occurred in the two seasons in the moderate number of stations in the different zones of the Indian Ocean. In all the stations one or two or rarely three polygastric and eudoxid phases were collected. It is seen that the night catches were more in the Arabian Sea and Bay of Bengal during both the seasons while the day catches were more in South West and South East Indian Ocean, in the two seasons.

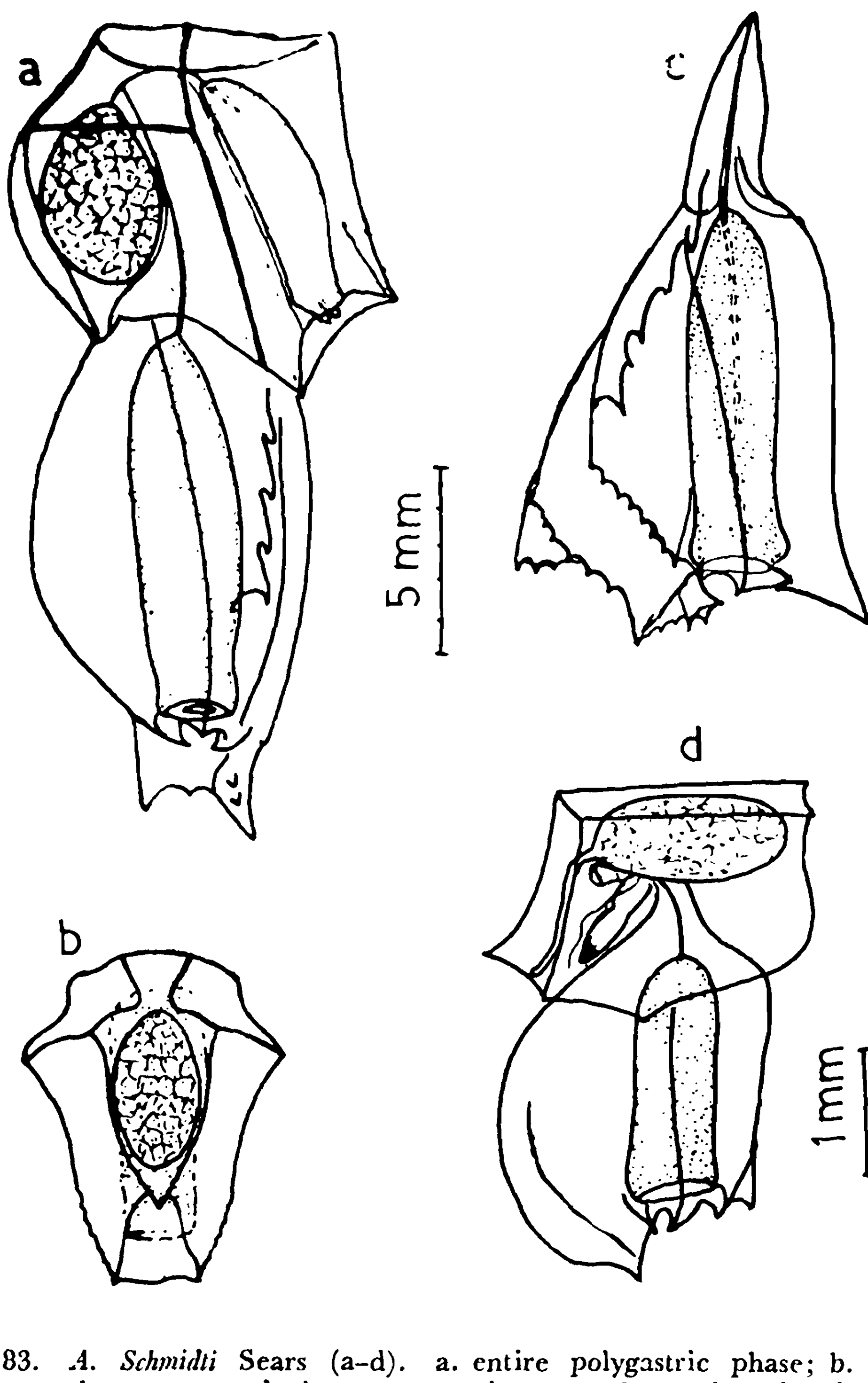
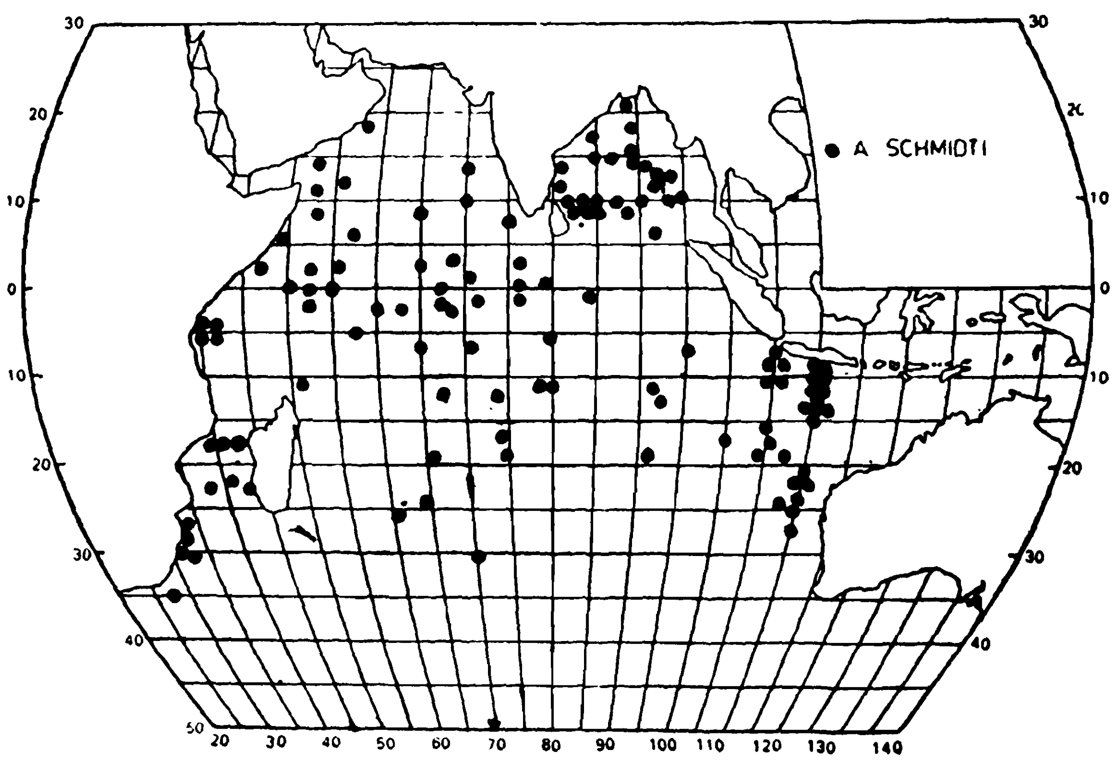
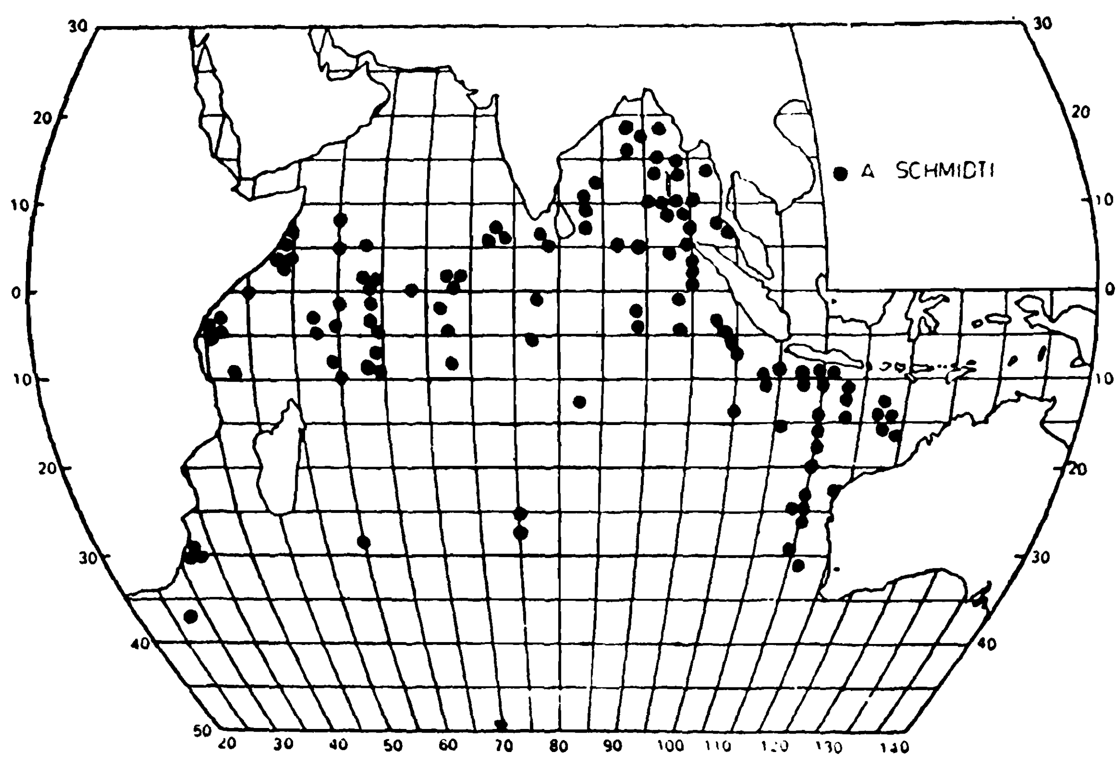


FIG. 83. *A. Schmidti* Sears (a–d). a. entire polygastric phase; b. anterior nectophore — ventral view; c. posterior nectophore; d. eudoxid phase of *Abyla* sp.



MAP 105. Distribution of *A. schmati* during SW/SE monsoon season. 1—3 Specimens per haul.



MAP 106. Distribution of *A. schmdti* during NE/NW monsoon season. 1—3 Specimens per haul.

During SW/SE monsoon season the distribution of *A. schmidti* extended from 20°N latitude to 35°S latitude, and during NE/NW monsoon season its distribution in the Arabian Sea extended only from 10°N latitude. During both the seasons there were high concentrations in the equatorial region, Bay of Bengal and along 110°E longitude.

Monthly variations:

Arabian Sea: On the western region of the Arabian Sea *A. schmidti* occurred in vast areas during January, February (maximum) and August. On the eastern region it was recorded during May.

Bay of Bengal: On the Indian region it was captured during April and June while near the Andaman Islands and Burma it occurred during March.

South West Indian Ocean: Along the African coast it was present during January, July, and October. In the oceanic region it was collected throughout the year except during May, August and September when it occurred in only one or two stations only.

South East Indian Ocean: Along the 110°E longitude it occurred throughout the year with the maximum record in August. In the oceanic region it was poorly represented and occurred during December.

83. **Abyla haeckeli** Lens & van Riemsdijk, 1908
(Fig. 84 a–e)

Abyla haeckeli Lens & van Riemsdijk, 1908 p. 32, Text-figs. 32–40. pl. 5, figs. 39-41.
Abyla haeckeli Sears, 1953, p. 39, figs. 11B, 12D, 13D, 14D, 26A.
Abyla haeckeli Daniel, 1974, p. 191, Text-fig. 16, G-I (cf. for detailed synonymy).

Type Specimen: Zoologisch Museum, Amsterdam.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 1 a.n.; 1 p.n.; 3 br.; 8 go.*Bay of Bengal:* 2 a.n.; 1 p.n.; 4 eu (compl.); 2 br.; 5 go. *South West Indian Ocean:* 1 p.g. (compl.); 14 a.n.; 4 p.n.; 5 eu. (compl.); 18 br.; 16 go. *South East Indian Ocean:* 1 p.g. (compl.); 12 a.n.; 3 p.n.; 9 eu (compl.) 28 br.; 33 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 7 a.n.; 4 eu (compl.); 4 br.; 8 go. *Bay of Bengal:* 1 a.n.; 1 p.n.; 7 eu (compl.); 2 br.; 14 go. *South West Indian Ocean:* 1 p.g. (compl.); 11 a.n.; 8 p.n.; 8 eu. (compl.) 15 br.; 21 go. *South East Indian Ocean:* 9 a.n.; 10 eu. (compl.); 25 br.; 37 go.

Polygastric phase: Anterior nectophore: (Fig. 84 a, b). As wide as high, with flat facets, ridges not elevated, characterised by presence of horizontal ridge dividing apico-ventral facet into two— rectangular apico-ventral facet and a perfect pentagonal ventral facet (*i. e.* sides being almost equal in length). Horizontal ridges lying below mid-level of somatocyst.

Posterior nectophore: (Fig. 84, c) With only 2 or 3 comb-teeth; lateral teeth lie closer to large dorsal tooth than to ventral ones. Nectophores long and slender, hydroecial wings not expanded.

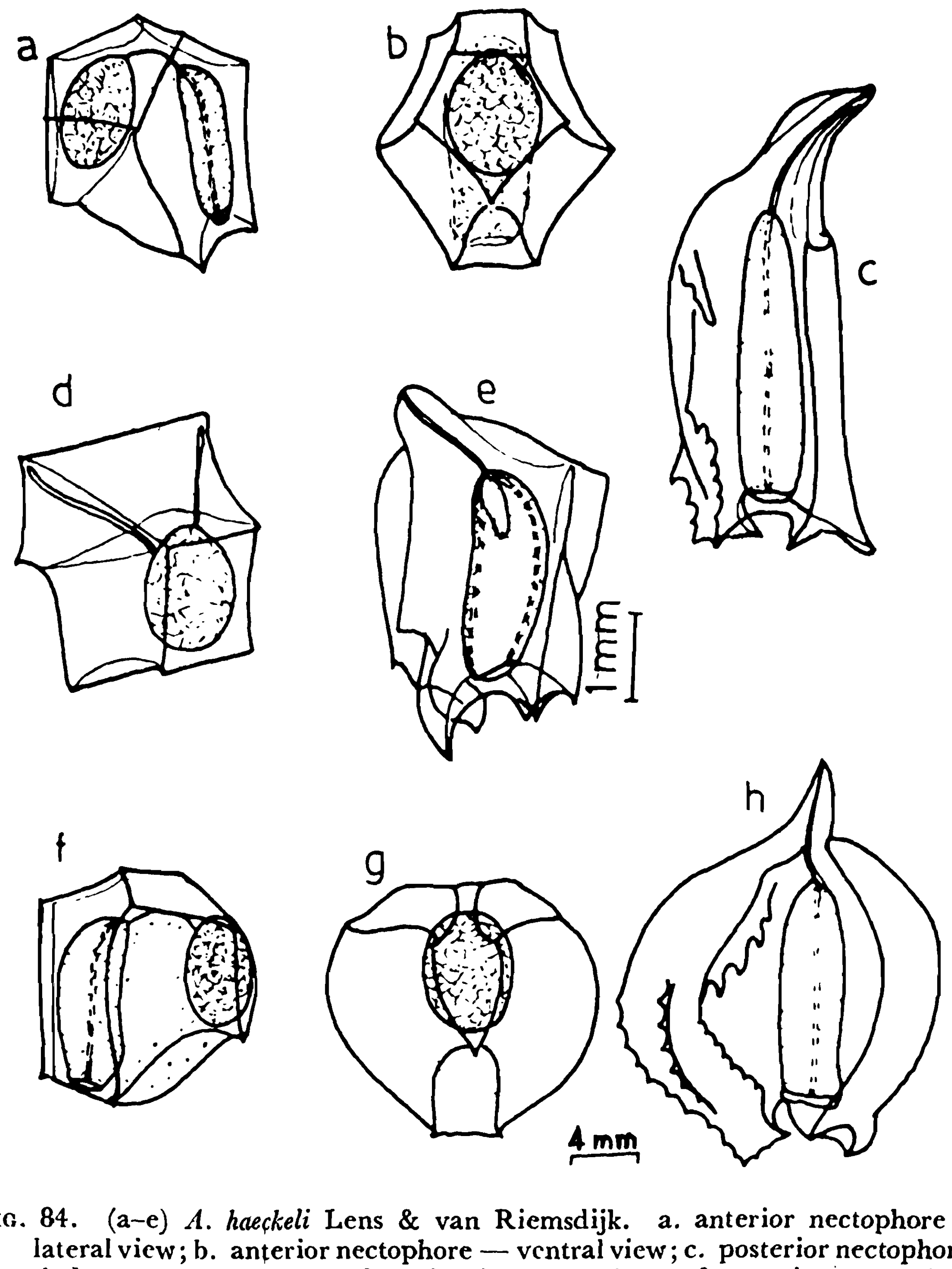


FIG. 84. (a–e) *A. haeckeli* Lens & van Riemsdijk. a. anterior nectophore — lateral view; b. anterior nectophore — ventral view; c. posterior nectophore; d. bract; e. gonophore; f. – *A. bicarinata* Moser, f. anterior nectophore lateral view; g. anterior nectophore ventral view; h. posterior nectophore. (Fig. c from Sears, 1953, fig. 11B).

Eudoxid phase: (Fig. 84 d, e) *Bract:* Baso-ventral margin of hydroecium deeply concave instead of being straight as in *A. trigona*, with a prominent basal tooth on right side and none on left side.

Gonophore: Broad, with five ostial teeth around ostium. Dorso-lateral ridges prominent lying beside flared out dorsal tooth. Ventral ridges not expanded into wings, with small teeth at edge and ending in two asymmetrical teeth at base.

Type locality: Off Kapal Island, Salu Archipelago, Philippines.

Distribution: (Maps 103 & 104). The distribution and abundance of *A. haeckeli* during the two seasons in the Indian Ocean in the eight regions of the Indian Ocean are presented in maps 103 and 104.

A. haeckeli occurred in both the seasons in the different zones of the Indian Ocean. From all these regions one or two specimens of the polygastric and eudoxid phases were collected. The night/day catches did not show much variations.

During both the seasons the distribution of *A. haeckeli* extended from 20°N latitude to 35°S latitude. In the Arabian Sea and Bay of Bengal it was recorded in fewer number of times than in South West and South East Indian Ocean. In all the four zones it occurred at many places during NE/MW monsoon season. A high concentration of this species was noted in mid-ocean region especially near the Equator and on the western coast of Australia.

Monthly variations:

Arabian Sea: It was recorded once or twice during the different months of the year both in the western and eastern sections of the Arabian Sea.

Bay of Bengal: On the Indian region it occurred during January and September and it was rarely collected near Andaman Islands and Burma.

South West Indian Ocean: *A. haeckeli* occurred in many of the places located along the African coast during January. In the oceanic region, however, it was recorded almost throughout the year.

South East Indian Ocean: Along the 110°E longitude *A. haeckeli* occurred nearly throughout the year, usually during January, May and August. In the oceanic region it was recorded rarely during April, August, September, October, November and December.

84. **Abyla bicarinata** Moser, 1925
(Fig. 84 f–h)

Abyla bicarinata Moser, 1925, p. 208, pl. 19, figs. 3–6.
Abyla bicarinata Sears, 1953, p. 45, figs. 12A, 13A, 14A & 15A.
Abyla brownia Sears, 1953, p. 46, figs. 12C, 13C, & 14C.
Abyla bicarinata Daniel, 1974, p. 192, Text-fig. 16K & L.
(cf. for detailed synonymy)

Type Specimen: Museum Für Naturkunde, Berlin.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *South West Indian Ocean:* 1 p.g. (compl.) *South East Indian Ocean:* 4 p.g. (compl.); 3 a.n.; (Daniel) 1974). NORTH EAST/NORTH WEST MONSOON SEASON: *South East Indian Ocean:* 1 p.g. (compl.); 1 a.n.

Polygastric phase: Anterior nectophore: Opaque, wider than long, lateral ridges extraordinarily expanded. Ridges not sharp as in other species of *Abyla* rounded and tumid. Basal portion of ridges near teeth very faintly serrated. Horizontal ridge lies very high almost near apex of somatocyst. Whole of somatocyst seen through ventro-lateral facet in lateral view.

Posterior nectophore: Length of 20.3 mm; breadth of 15.3 mm; with apophysis of 5.0 mm. Nectophore appears circular, due to extraordinary expansion of hydroecial wings. Opaque, ridges rounded and tumid. Dorsal ridge absent, but with a prominent dorsal tooth, lateral ridges end in the thick strong lateral teeth. Left ventral wing large with 2 rows of teeth on basal margin, outer row with 6 and inner row with 9 denticulations. Right ventral wing smaller, bearing 9 or 10 denticulations at basal margin and 3–4 very large comb-teeth on inner, thickened, proximal portion; right ventral tooth smaller than left ventral tooth.

Eudoxid phase: Bract similar to other species of *Abyla* but larger, with broad flap-like lateral facets, and with smooth edge.

Gonophore: Similar to posterior nectophore in appearance and ostial teeth, with well expanded hydroecial wings. This eudoxid may belong to this species.

Type locality: West coast of Africa(during the cruise of '*Gauss*').

Distribution: (Maps 103 & 104). This rare deep water species was recorded from the oceanic region during April, August, September and October. It comes upto the upper zones during the upwelling of deeper waters. Recorded by Sears (1953) as *A. brownia* from the Indian Ocean which is a young stage of *A. bicarinata.*

Sub family (ii) ABYLOPSINAE, Totton, 1954

Abylidae with anterior nectophore having (instead of an apical facet) a ridge formed by junction of two lateral facets. Posterior nectophore (absent in *Enneagonum*) with a flap on inner side of both right and left hydroecial wings.

Three genera, *Abylopsis* Chun, 1888; *Bassia* L. Agassiz, 1862; and *Enneagonum* Quoy & Gaimard, 1827, are recognised under this sub-family.

Key to genera of the ABYLOPSINAE
(after Sears, 1953)

Anterior nectophore:

1.	Nectophores with median apical ridge, dorsal and ventral facets as well as lateral facets sub-divided by a horizontal ridge......	2
	Nectophores with one or more of these facets replaced by ridges; opening to necto-sac next to dorsal wall of hydroecium at the base of large triangular basal facet..	**Enneagonum**
2.	Somatocyst with aical diverticulum..	**Abylopsis**
	Somatocyst without apical diverticulum; ridges opaque...	**Bassia**

Posterior nectophore:

1.	Nectophore with 5 ridges, their edges transparent, well developed ostial teeth...	**Abylopsis**
	Nectophore with 4 ridges, their edges opaque; ostial teeth as slightly developed projections.	**Bassia**
	(N.B. Posterior nectophores not developed in *Enneagonum*)	

Bract:

1.	Bracts with a dorsal facet..	2
	Bracts with median dorsal ridge; without ventro-lateral branches to somatocyst..	**Bassia**
2.	Bract cuboidal; somatocyst with apical horn and two short, stubby ventro-lateral branches..	**Enneagonum**
	Bracts with pentagonal dorsal facet; somatocyst with a slender descending branch, a small apical horn and two short, inflated ventro-lateral branches..	**Abylopsis**

Gonophores:

1.	Gonophores with four relatively inconspicuous teeth..	2

	Gonophores with five promihent teeth, dorsal, one lateral and one ventral ridge incomplete, deep pockets beneath apophysis...	**Enneagonum**
2.	Ventral ridges diagonal apically.	**Abylopsis**
	Ventral ridges vertical; all ridges opaque..	**Bassia**

The gennera: *Abylopsis*, *Bassia* and *Enneagonum* are represented in the collections.

Genus 37. **Abylopsis** Chun, 1888

Abylopsis Chun, 1888, p. 1160

Abylopsinae with flat pentagonal dorsal facet in anterior nectophore; somatocyst extending well over to ventral side of hydroecium; lower wall of hydroecium extending beyond ventral and basal facet and its ostium being sqaure in shape.

Posterior nectophore with characteristic hook-like short, oblique apophysis, right ventral ridge forked at its apical end and with a deep hydroecium effectively covered by interlocking flaps from inner surface of hydroecial wings.

Eudoxid phase with seven facets in bract, the dorsal facet being pentagonal in shape; phyllocyst with 4 branches, thin anterior and post branches and two thick bean-shaped, curved lateral branches. Gonophores with 4 ridges and 4 teeth at ostium.

Type Species: *Abylopsis tetragona* (Otto, 1823)

Two valid species: *Abylopsis tetragona* (Otto, 1823), and *A. eschscholtzi* (Huxley, 1859).

Both the species are very common, occurring all over the Indian Ocean.

Key to species of **Abylopsis**

(after Sears, 1953)

Anterior nectophore:

Ridges not obviously serrate; dorsal surface irregular pentagon, narrower, more elongate than in *A. eschscholtzi:* dorsal surface smaller than ventral; apex of nectosac extends apically above main body of somatocyst; lateral subumbral canals arched..	*A. tetragona*
Ridges heavy, serrate; dorsal surface nearly regular pentagon of same size and shape as ventral; apex of nectosac does not extend apically beyond main body of somatocyst; lateral subumbral canals not arched..	*A. eschscholtzi*

Posterior nectophore:

Nectophore at least twice as long as wide; margin of flap on inner surface of right ventral ridge denticulate; left lateral subumbral canal broken...	*A. tetragona*
Nectophore only slightly longer than wide; margin of flap on inner face of right ventral ridge entire; canals normal..	*A. eschscholtzi*

Eudoxid phase: Bract

Dorsal facet of bract subrectangular; general appearance cuboidal..	*A. tetragona*
Dorsal facet of bract almost of a regular pentagon...	*A. eschscholtzi*

Gonophore:

One ventral ridge diagonally crosses lateral surface to join dorsal and apico-lateral ridges roughly dividing lateral surface into 1/4ths towards the apex, and 3/4ths towards the base; lower half of ventral ridges only very weakly serrated...	*A. tetragona*
One ventral ridge diagonally crosses lateral surface to join dorsal and apico-lateral ridges, roughly dividing lateral surface into two equal portions; lower half of ventral ridges markedly serrated...	*A. eschscholtzi*

Both species are represented (in abundance) in the collections.

85. Abylopsis tetragona (Otto, 1823)
(Fig. 85 a-h)

Pyramis tetragona Otto, 1823, p. 306, pl. 42, figs. 2 a–e.

Abylopsis tetragona Bigelow, 1911, p. 224, pl. 14, figs. 6–8; pl. 15, fig. 2.

Abylopsis tetragona Daniel, 1974, p. 195, Text-fig. 17, A-I.
(cf. for detailed synonymy)

Type Specimen: Breslau Museum.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 29 p.g. (compl.); 325 a.n.; 139 p.n.; 476 eu.; 280 go. *Bay of Bengal:* 27 p.g. (compl.); 283 a.n.; 90 p.n.; 424 eu.; 223 go. *South West Indian Ocean:* 24 p. g. (compl.); 211 a.n; 66 p.n.; 212 eu.; 133 go. *South East Indian Ocean:* 43 p.g. (compl.); 436 a.n.; 89 p.n.; 496 eu; 301 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 15 p.g. (compl.); 573 a.n.; 143 p.n.; 757 eu.; 455 go. *Bay of Bengal:* 17 p.g. (compl.); 289 a.n.; 72 p.n.; 393 eu.; 192 go. *South West Indian Ocean:* 5 p.g. (compl.); 218 a.n.; 34 p.n.; 180 eu. 123 go. *South East Indian Ocean:* 24 p.g. (compl.); 460 a.n.; 81 p.n.; 724 eu. 328 go.

Polygastric phase: Anterior nectophore: (Fig. 85 a-c) *Size*: 7.0 mm long; 5.67 mm broad nectosac 5.0 mm, somatocyst 4.0 mm and hydroecium 3.47 mm in length. With 6 facets—1 dorsal, 1 ventral, 2 apico-lateral, 2 ventro-lateral; dorsal facet smaller than ventral, pentagonal, elongated. Ridges usually smooth, rarely serrated at mouth of hydroecium. Somatocyst with oval-shaped base and thin; elongate apical branch. Apex of nectosac extend

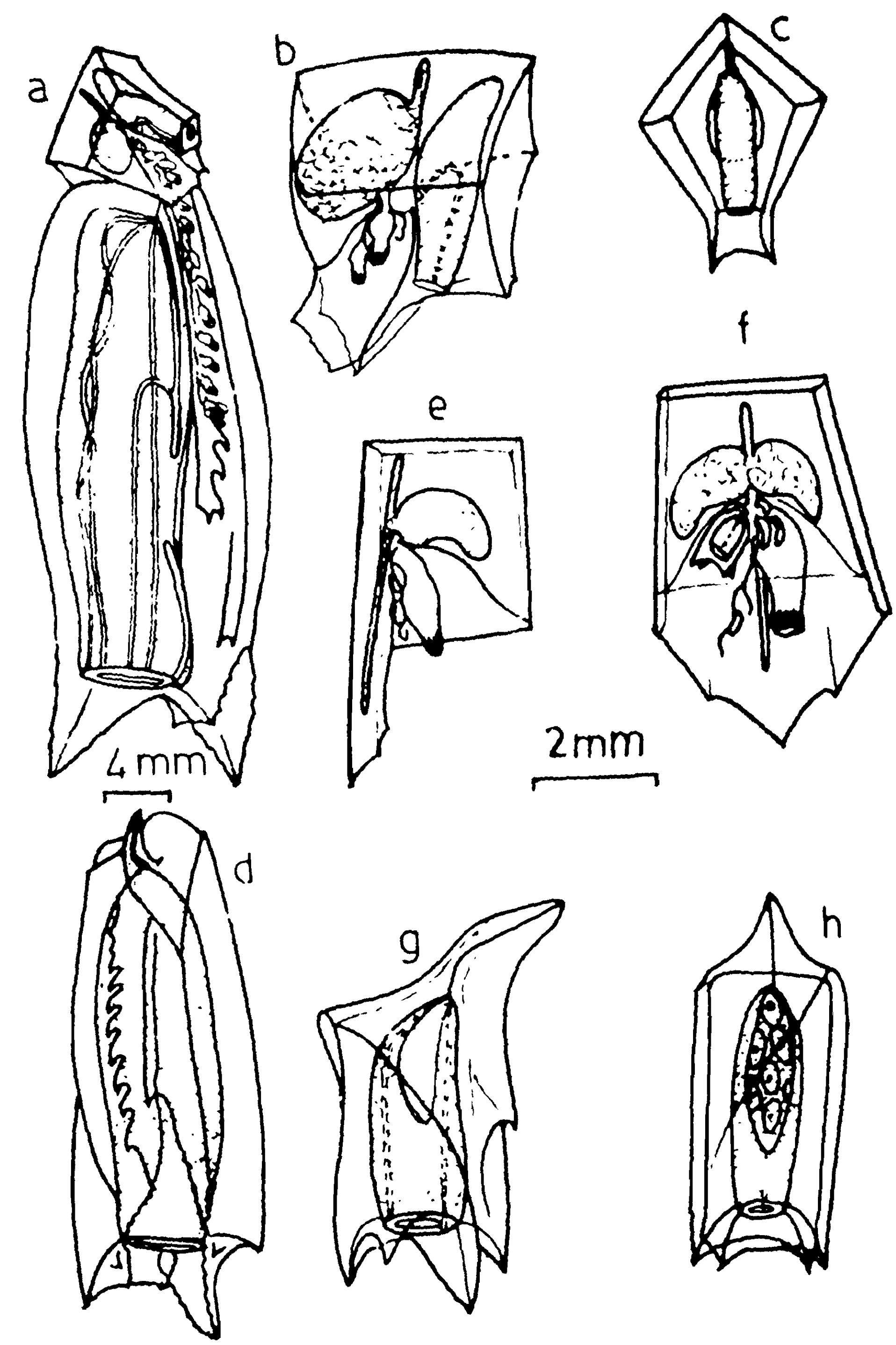


FIG. 85. *A. tetragona* (Otto) a–h). a. entire polygastric phase; b. anterior nectophore — lateral view; c. anterior nectophore — dorsal view; d. posterior nectophore; e & f. bract lateral and dorsal views; g & h. gonophores.

above main body of somatocyst in dorsal view (diagnostic character). Hydroecium small, conical, lying between and below nectosac and somatocyst. Nectosac long slightly bent towards dorsal facet in large nectophores. Lateral radial canals highly arched.

Posterior nectophore: (Fig. 85 d) *Size*: 26.0 mm long; 9.47 mm broad, three times as long as wide, 3 to 3½ times longer than anterior nectophore when fully grown. Apophysis small, oblique. With five complete ridges—one dorsal, two lateral ridges (left and right) and two ventral ridges; dorsal end in inconspicuous tooth and laterals in prominent teeth; ventrals form edges of hydroecial wings and end in asymmetrical teeth. Proximal part of hydroecial canal covered by a flap from left hydroecial wing (left ventral ridge). Proximal end of inner margin of right hydroecial wing bear nine comb-teeth. Left hydroecial wing closed in position between comb teeth and small cone-like projection from middle of hydroecial wing. Truncated apical portion of nectophore articulates with almost whole of ventral wall of anterior nectophore.

Nectosac with four radial canals arising from pedicular canal at apex of nectosac but with an extra blind ending canal arising from *rete* at junction between circular canal and ventral radial canal toward left and terminating near a blind down growth from displaced left lateral radial canal; new canal lying under left ventral ridge.

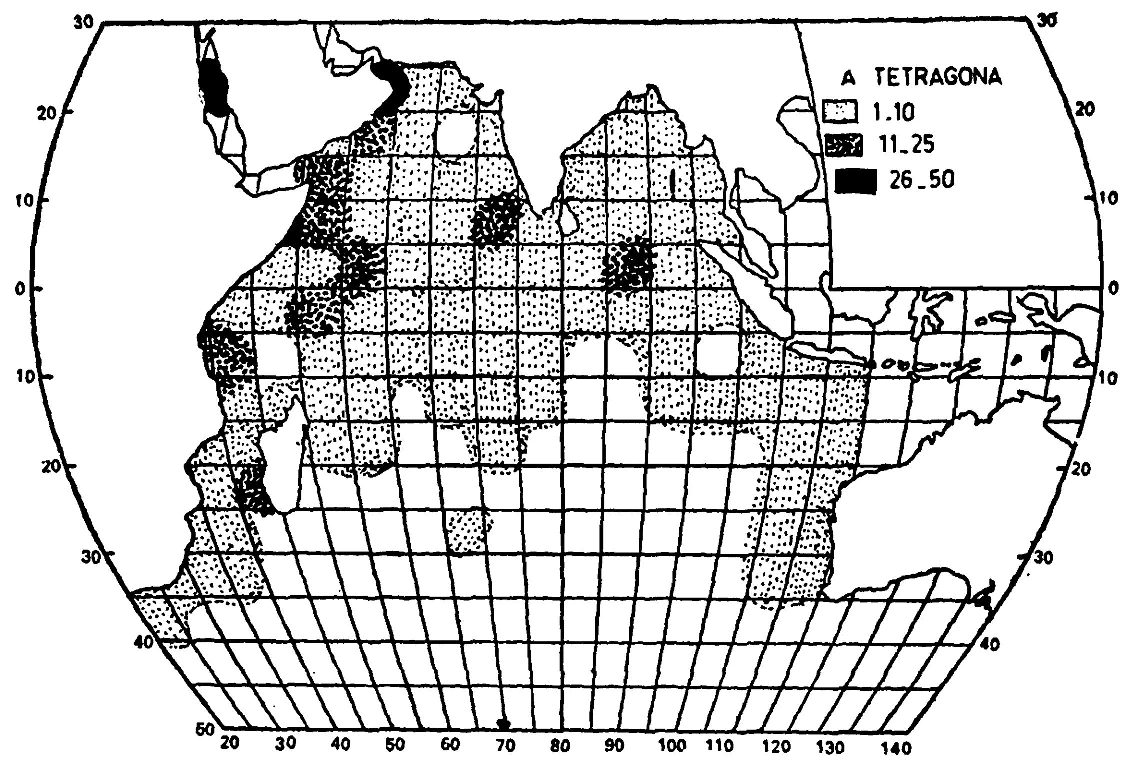
Eudoxid phase: (Fig. 85 e–h) Referred to as "*Aglaisma*": Bract 6.3 mm long; 4.7 mm broad, apical half cuboidal in shape (apical, ventral and lateral facets square in shape), with elongated, irregularly pentagonal dorsal facet. Lateral facets deep, with basal cross ridge lying far below level of lateral branches of phyllocyst. Phyllocyst with four branches—thin, thread-like anterior and posterior branches, and two thick bean-shaped lateral branches. Bracteal cavity deep, broadly conical.

Gonophore: Length ranging from 3.2 mm to 6.0 mm with four complete ridges, all ending in four teeth at ostium. Radial canals simple and straight. Manubrium shrink very much after shedding eggs or sperms and appear like special nectophore.

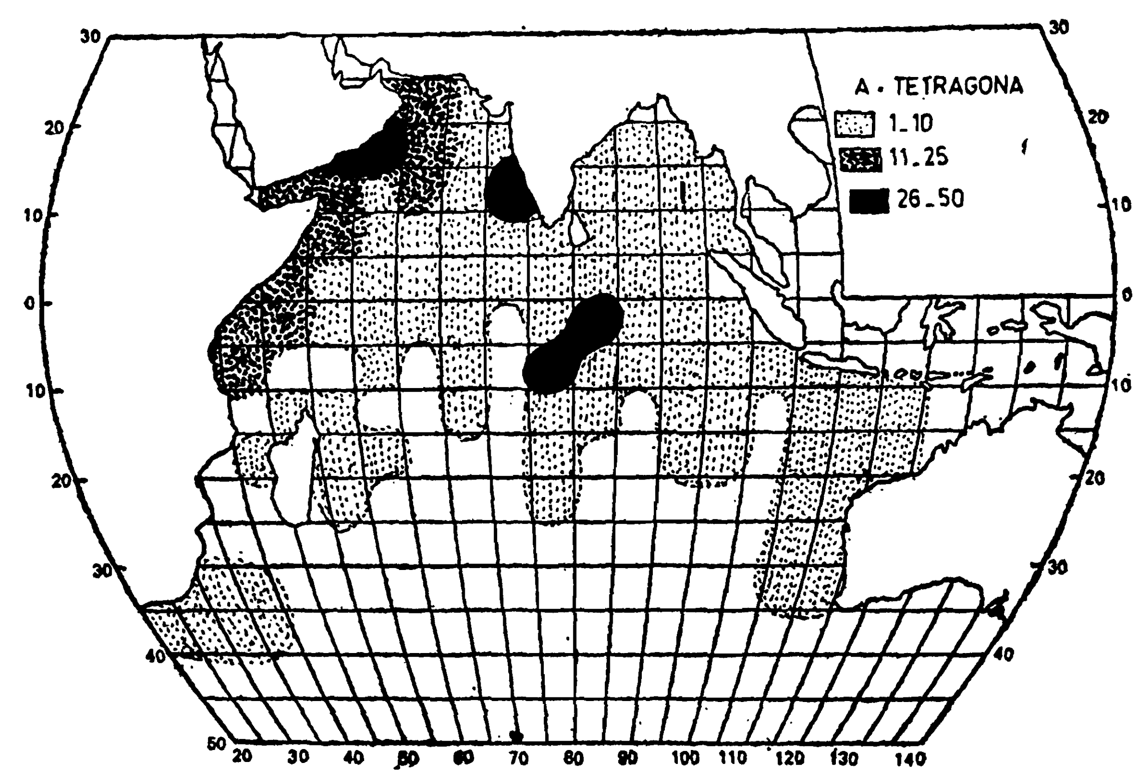
Type locality: Mediterranean Sea (?).

Distribution: (Maps 107, 108, 109 & 110). It is one of the common species that occurs in all the oceans. Average number of specimens of both polygastric and eudoxid phases in each 5° square of the Indian Ocean are presented in maps 107-110 for the two seasons.

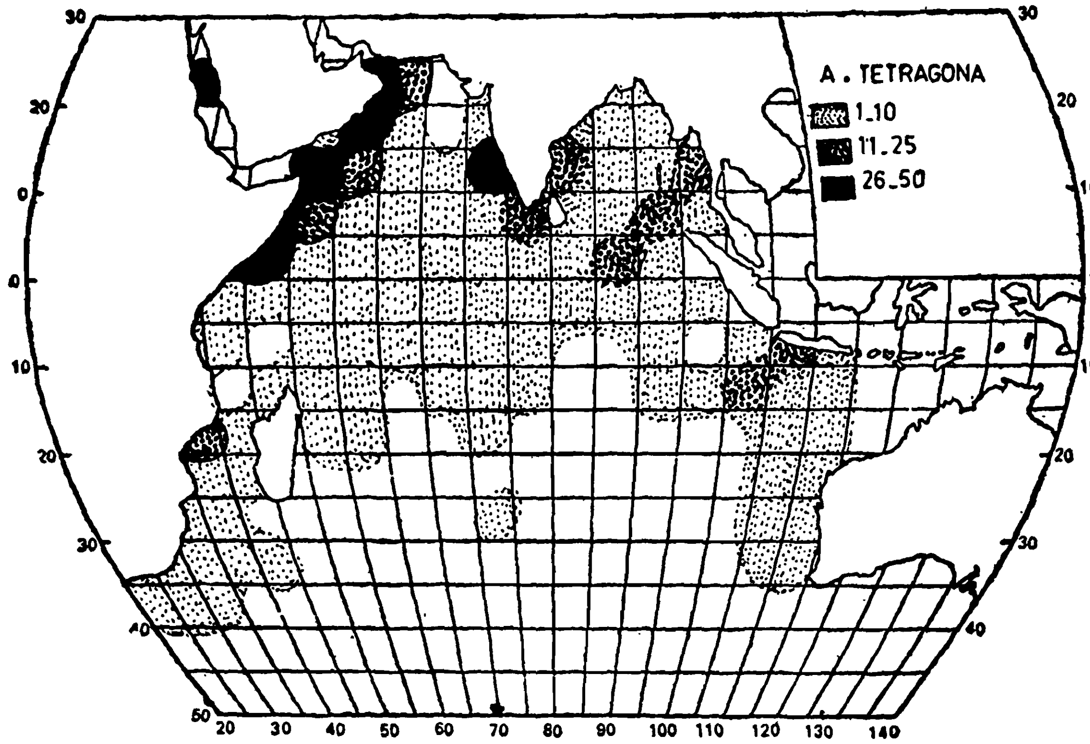
During both the seasons *A. tetragona* occurred in abundance north of the Equator and along the coastal regions of Africa (41°S lat.) and Australia (35°S lat.). In the mid-ocean its distribution extended down to 30°S latitude.



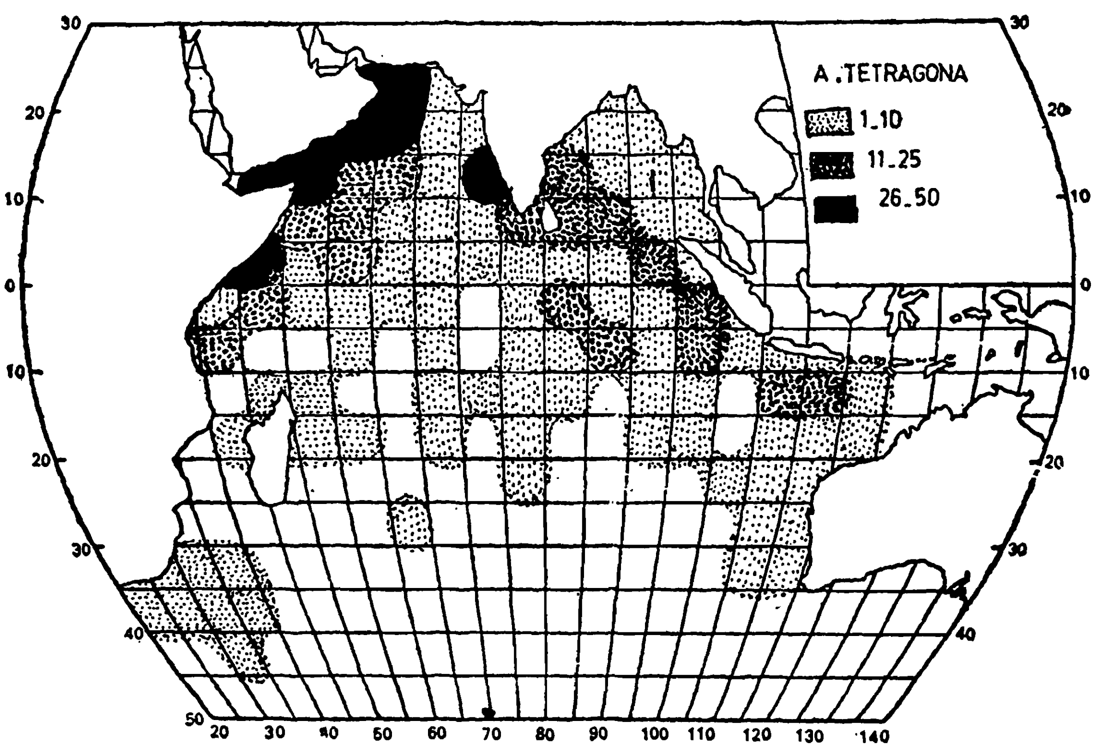
MAP 107. Distribution of *A. tetragona* — Polygastric phase during SW/SE monsoon season.



MAP 108. Distribution of *A. tetragona* — Polygastric phase during NE/WN monsoon season.



MAP 109. Distribution of *A. tetragona* — Eudoxid phase during SW/SE monsoon season.



MAP 110. Distribution of *A. tetragona* — Eudoxid phase during NE/NW monsoon season.

During SW/SE monsoon season (Map 107) the polygastric phase occurred in the highest range of 26–50 specimens per haul in a small area on Somali coast, Gulf of Oman and Red Sea. The next range of 11–25 specimens per haul occurred on the western coast of Madagascar, coast off Mombasa, along the Equator, Gulf of Aden, Arabian coast and off Cochin. The range of 1–10 specimens per haul occurred extensively. The eudoxid phase (Map 109) occurred in the highest range of 26–50 specimens per haul, only in the Arabian Sea (including the Red Sea) along the Somali coast, Gulf of Aden, Arabian coast, Gulf of Oman and on the western coast of India. Eudoxids in the range of 11–25 specimens per haul occurred next to the areas with highest density in the Arabian Sea, around Cape Comorin, Madras coast, Burma coast, south of Nicobar Islands, near the Equator, and south of Java.

During NE/NW monsoon season (Map 108) the highest density of the polygastric phase occurred along the Arabian coast, western coast of India, and in the mid-ocean between the equator and 10°S latitude. The next range of density occurred along the coasts of Africa, Somali land, Gulf of Aden and off Arabia. The highest range of 26–50 eudoxids (Map 110) per haul occurred along Somali coast, Gulf of Aden, Arabian coast, Gulf of Oman and on the western coast of India. The next range (11–25 eudoxids per haul) occurred next to the areas of highest range and around peninsular India and across the Bay of Bengal, south of Sumatra and Java.

It was observed that the eudoxid-phase occurred all over the Indian ocean usually along with the polygastric phase, and their number was inversely proportional to the number of polygastric phases.

Monthly variations:

Arabian Sea: On the western region (along Somali coast, Arabian coast) *A. tetragona* occurred mostly during August, and December. It was recorded throughout the year. On the eastern region, it occurred in a wide area during February and May (maximum) and during August and November. It was recorded throughout the year, with few records during June and September.

Bay of Bengal: On the Indian region *A. tetragona* occurred during January, April (maximum) and June. Near Andaman Islands and Burma it was captured during March, April and September (maximum). It was rarely collected during January, in this region. It was poorly represented during October in the Bay of Bengal.

South West Indian Ocean: Along the African coast it was present in January and October. In the oceanic region it was collected in moderate numbers in November.

South East Indian Ocean: It was recorded throughout the year. Along 110°E longitude it occurred during January and August in maximum number of places. In the oceanic region it was captured in a few stations throughout the year except during December when it occurred in many places.

86. **Abylopsis eschscholtzi** (Huxley, 1859)
(Fig. 86 a–f)

Aglaismoides eschscholtzi Huxley, 1859, p. 60, pl. 4 (eudoxid).
Abylopsis eschscholtzi, Bigelow, 1911, p. 226, pl. 14, figs. 1–5, pl. 15; fig. 1.
Abylopsis eschscholtzi Daniel, 1974, p. 200, Text-fig, 17, J–R.
(cf. for detailed synonymy)

Type Specimen: British Museum (Nat. Hist.), London.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 16 p.g. (compl.); 384 a.n.; 104 p.n.; 794 eu.; 217 go. *Bay of Bengal:* 25 p.g. (compl.); 594 a.n.; 128 p.n.; 1191 eu.; 234 go. *South West Indian Ocean:* 20 p.g. (compl.); 606 a.n.; 142 p.n.; 965 eu. 220 go. *South East Indian Ocean:* 74 p.g. (compl.); 1090 a.n. 253 p.n.; 2034 eu. 478 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 4 p.g. (compl.); 411 a.n.; 82 p.n.; 690 eu; 160 go. *Bay of Bengal:* 16 p.g. (compl.); 373 a.n.; 89 p.n.; 589 eu; 110 go. *South West Indian Ocean:* 8 p.g. (compl.); 372 a.n.; 88 p.n.; 727 eu. 222 go. *South East Indian Ocean:* 44 p.g. (compl.); 812 a.n.; 214 p.n.; 1119 eu. 193 go.

Polygastric phase: Anterior nectophore: (Fig. 86 a, b) *Size:* length—3.78 mm; breadth 3.78 mm; Somatocyst—1.75 mm; hydroecium 2.0 mm; nectosac 2.0 mm.

Nectophore similar to *A. tetragona* in number of facets, ridges and general shape but smaller; ridges sharp and serrated. Apex of nectosac not extending above main body of somatocyst. Dorsal facet pefectly pentagonal. Lateral radial canal not arched (upward loop) as in *A. tetragona.*

Posterior nectophore: (Fig. 86 a, c, d) Length 7.0 mm, breadth —3.5 mm, twice as long as broad. With 5 prominent, complete, highly serrated ridges; both hydroecial wings (ventral ridges) with secondary flaps overlapping and fusing to form a closed hydroecial tube in proximal half; flap on inner surface of left ventral wing with 5 denticulations along basal margin; right ventral wing 3–4 teeth. Nectosac with 4 simple, straight radial canals.

Eudoxid phase: Bract: (Fig. 86 e, f) 2.48 mm long, 2.96 mm broad, perfectly pentagonal in shape. Basal cross ridge of lateral facet higher up. Lateral ridges of dorsal facet sloping towards apical facet instead of being vertical as in *A. tetragona.* Phyllocyst as in *A. tetragona.*

Gonophore: Smaller than those of *A. tetragona* 2.3 mm to 3.5 mm in length. With four serrated ridges, ventral one curving over to lateral side and joining dorsal and apico-lateral ridges. Sexes separate.

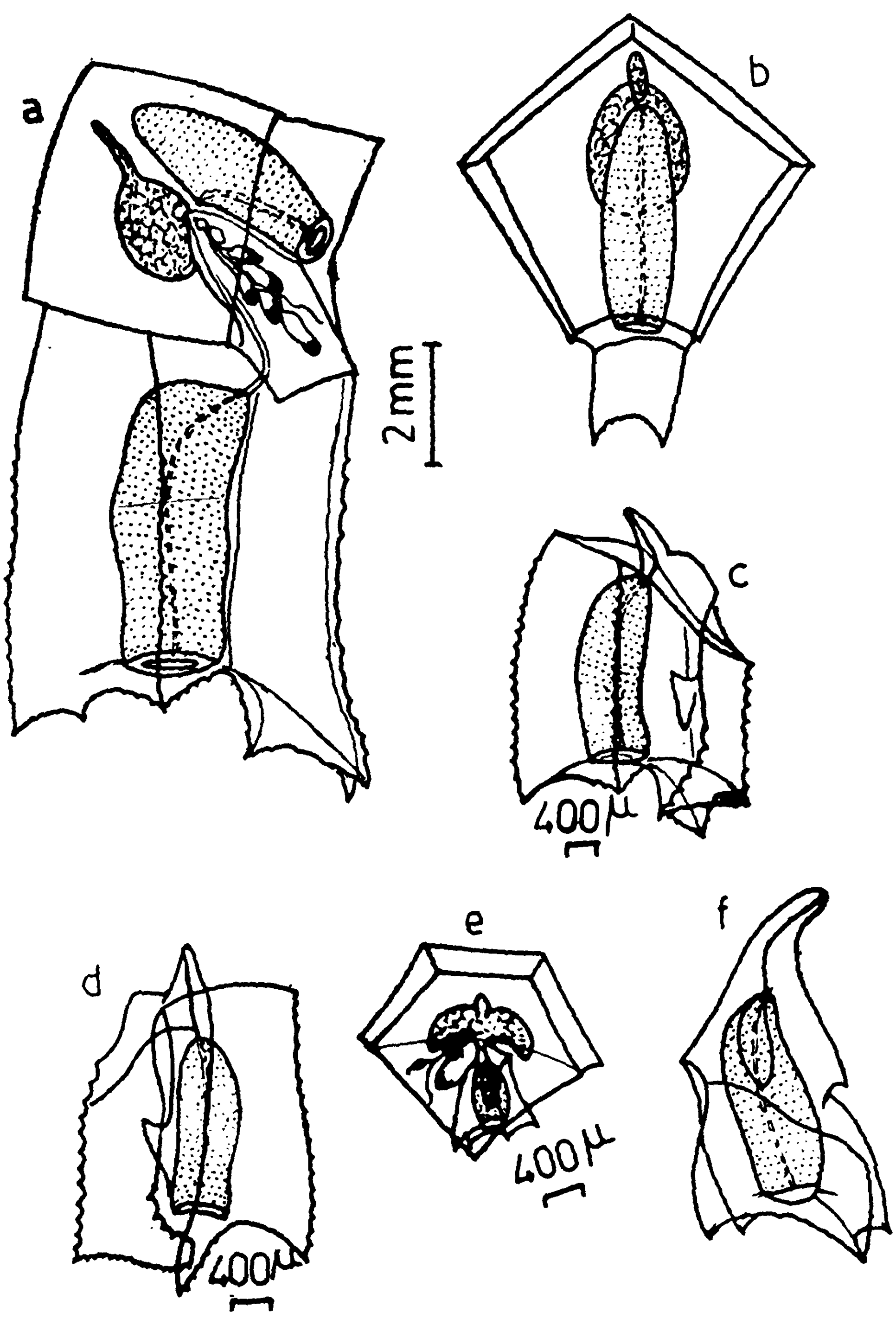


FIG. 86. *A. eschscholtzi* (Huxley) (a–f). a. entire polygastric phase, b. anterior nectophore — dorsal view; c. posterior nectophore lateral view; d. posterior nectophore ventral view; e. bract; f. gonophore.

Type locality: Between northern tip of Gt. Barrier Reef and Louisiade Archipelago.

Distribution: (Maps 111, 112, 113, 114). The average number of specimens of both polygastric and eudoxid phases in each 5° square of the Indian Ocean are presented in the four maps for the two seasons.

This species occurred in a wider area in the Indian Ocean than *A. tetragona* extending from 20°N to 40°S latitude along the African coast and 35°S latitude along the 110°E longitude, and to 35°S in the mid-ocean.

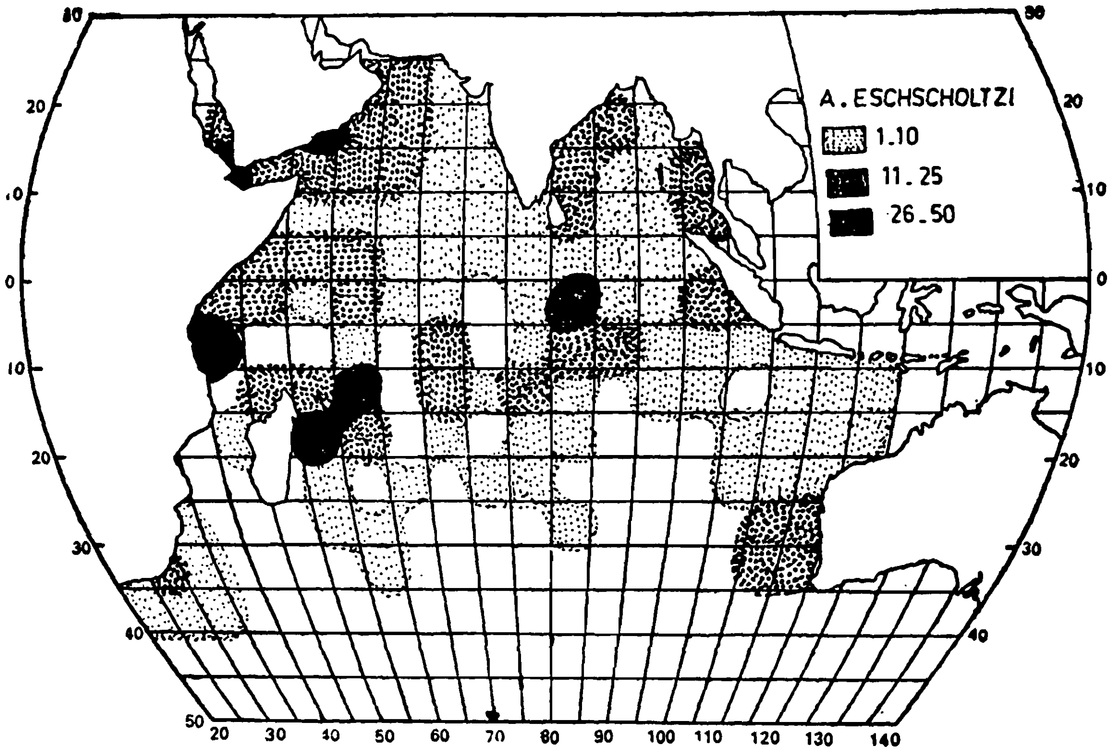
During SW/SE monsoon season (Map 111) the highest range of 26–50 polygastric phase per haul of *A. eschscholtzi* occurred only in a limited area along the Equator between 45°E to 55°E longitudes. The next range of 11–25 specimens per haul occurred along the coast of Africa and Madagascar, Somali coast, Gulf of Aden, around Cape Comorin, eastern coast of India and across Bay of Bengal (in the rich belt referred earlier), coast of Burma along the Equator and south of Java. The highest range of 26–50 eudoxids (Map 113) per haul occurred along the African coast near Mombasa, and Somali Land, Gulf of Aden, central mid-ocean near the Equator and also below 20°S latitude, Cape Comorin and across the Bay of Bengal to Burma coast. The next lower range of 11–25 eudoxids per haul occurred between Africa and Madagascar, off Somali coast, west coast of India, eastern region of the Bay of Bengal, South of Sumatra and Java and along the 110°E longitude.

During NE/NW monsoon season (Map 112) the highest range of 26–50 polygastric phases per haul occurred within the Gulf of Aden and near the Equator in the mid-ocean between 80°E–85°E longitude. The lower range of density occurred off Mombasa, Somali coast, off Gulf of Oman, east coast of Sri Lanka, South West of Sumatra, off western Australia and near Chagos Archipelago. The highest density of the eudoxid phases (Map 114) occurred in limited areas during this season *i.e.* within Red Sea and Gulf of Aden, off Mombasa, east of Madagascar and near the Equator. The lower range of density occurred on the western regions of the Indian Ocean, east coast of India, along Burma and off Australia.

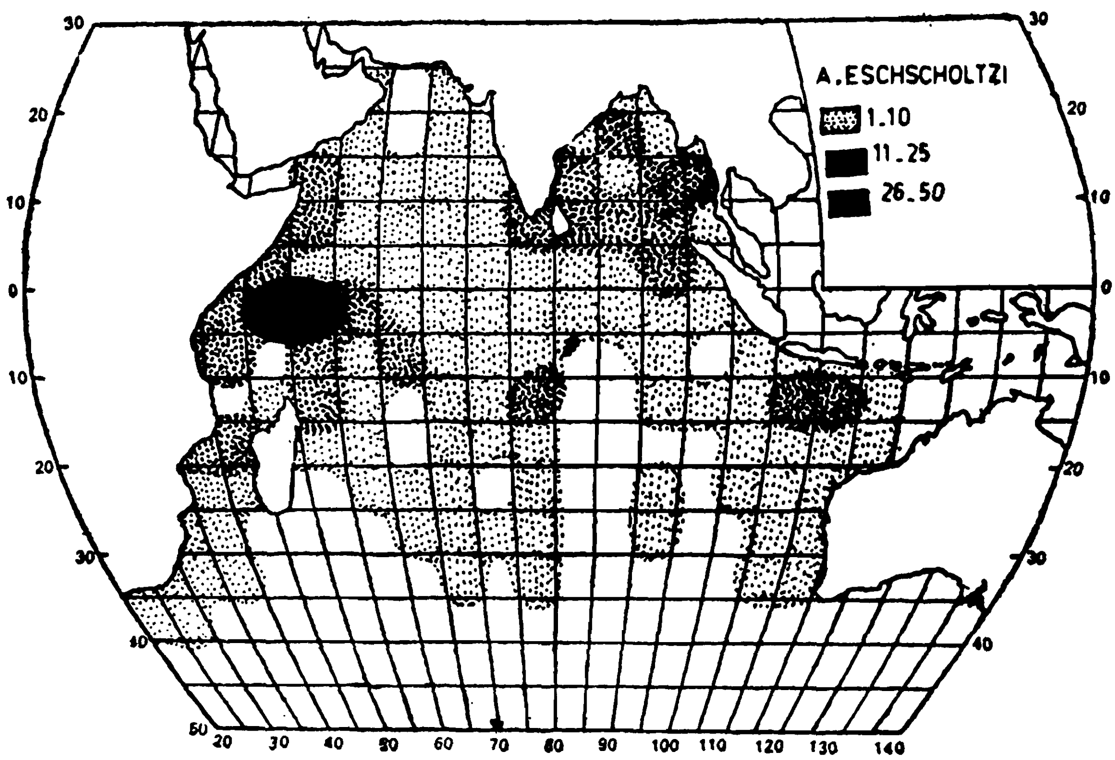
It was observed that both the phases usually occurred together all over the Indian Ocean, but the number of eudoxid phases present showed that it was inversely proportional to the number of polygastic phases.

Monthly variations:

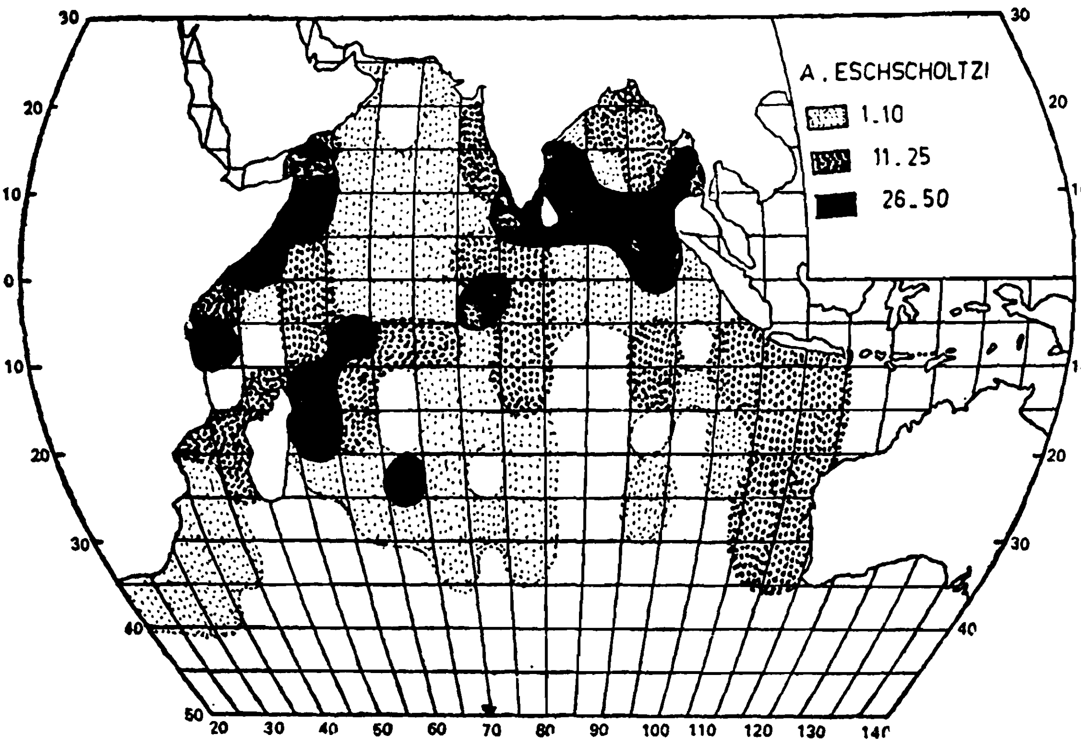
It is observed that this species occurred almost throughout the year in the different regions of the Indian Ocean.



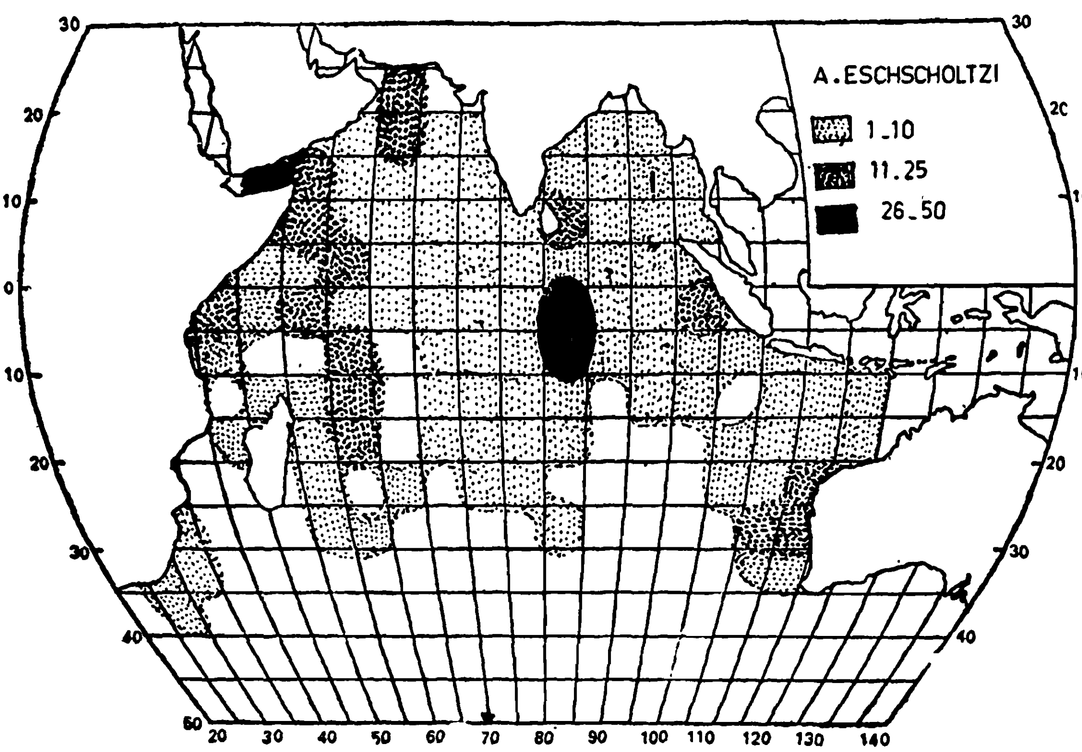
MAP 111. Distribution of *A. eschscholtzi* — Polygastric phase during SW/SE monsoon season.



MAP 112. Distribution of *A. eschscholtzi* — Polygastric phase during NE/NW monsoon season.



MAP 113. Distribution of *A. eschscholtzi*—Eudoxid phase during SW/SE monsoon season.



MAP 114. Distribution of *A. eschscholtzi*—Eudoxid phase during NE/NW monsoon season.

Arabian Sea: Along the Somali coast, Gulf of Aden, Arabian Coast and Gulf of Oman (Western part) *A. eschscholtzi* occurred during August and December in greater number of stations than in the other months. On the eastern part maximum occurrence was during May.

Bay of Bengal: Along the Indian coast and neighbouring areas it was present in maximum number of stations, during April and it occurred during September near Andaman Islands and Burma.

South West Indian Ocean: Maximum record was during January and October, along the African coast. In the oceanic region it did not show much monthly variation. It was collected during June and December.

South East Indian Ocean: Along the 110°E longitude *A. eschscholtzi* occurred in maximum number of places during January and August. In the oceanic region it occurred mainly during December.

Genus 38. **Bassia** L. Agassiz, 1862

Bassia Agassiz, 1862, p. 372.

Abylopsinae with globular somatocyst not extending over ventral side of hydroecium, and small nectosac placed beneath somatocyst; ventral facet without median ridge.

Posterior nectophore barrel-like without sharp ridges; inner flaps of ventral wings appearing to be fused to roof proximal half of hydroecium.

Eudoxid phase with bract possessing an apical ridge instead of a facet as in *Abylopsis*, long baso-sagittal ridge; phyllocyst with only two branches; lateral ones absent.

Monotypic genus for *B. bassensis* (Quoy & Gaimard, 1834)

87. **Bassia bassensis** (Quoy & Gaimard, 1834)
(Fig. 87 a–d)

Diphyes bassensis Quoy & Gaimard, 1834, p. 91, pl. 4, figs. 18–20.

Bassia bassensia Bigelow, 1911, p. 229, pl. 12, fig. 8; pl. 14, fig. 9.

Bassia bassensis Daniel, 1974, p. 204, Test-fig. 18, A–G.
(cf. for detailed synonymy)

Type Specimen: Museum National d'Histoire Naturelle, Paris.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 33 p.g. (compl.); 651 a.n.; 388 p.n.; 1022 eu; 410 go. *Bay of Bengal:* 42 p.g. (compl.); 1105 a.n.;

644 p.n.; 1690 eu; 565 go. *South West Indian Ocean:* 30 p.g. (compl.); 952 a.n.; 498 p.n.; 1363 eu. 743 go. *South East Indian Ocean:* 75 p.g. (compl.); 567 a.n.; 244 p.n.; 867 eu. 378 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 120 p.g. (compl.); 1774 a.n.; 862 p.n.; 3716 eu; 1566 go. *Bay of Bengal:* 14 p.g. (compl.); 675 a.n.; 480 p.n.; 979 eu; 290 go. *South West Indian Ocean:* 14 p.g.

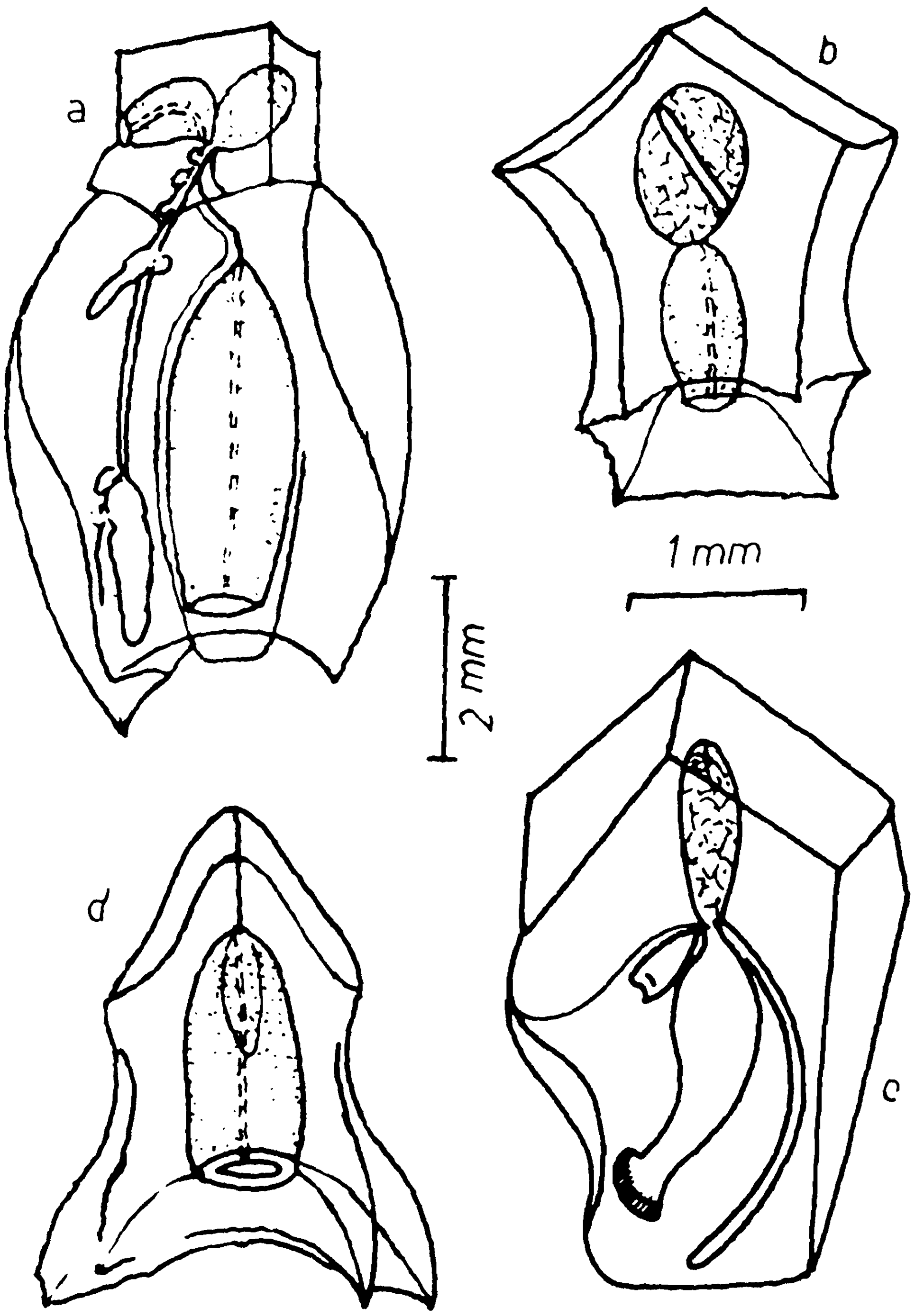


FIG. 87. *B. bassensis* (Quoy & Gaimard) (a–d). a. entire polygastric phase; b. anterior nectophore — dorsal view; c. bract; d. gonophore.

(compl.); 570 a.n.; 295 p.n.; 782 eu. 235 go. *South East Indian Ocean:* 21 p.g. (compl.); 573 a.n.; 345 p.n.; 806 eu; 282 go.

Polygastric phase: (Fig. 87 a, b) Both nectophores characteristically opaque with white ridges. *Anterior nectophore: Size:* 3.9 mm in length; 2.5 mm in breadth; Somatocyst—1.75 mm; hydroecium—1.85 mm nectosac—1.6 mm in length. With 7 facets—dorsal and ventral facets pentagonal in shape; baso-lateral facets elongate and broad; apico-lateral facets rectangular in shape. Somatocyst globular, without any other branches and with a short stalk, occurring anterior to nectosac and hydroecium. Hydroecium small, conical, with broad opening. Nectosac small, lying beside hydroecium with 4 simple radial canals; lateral canals not arched.

Posterior nectophore: Length—9.35 mm; breadth 6.75 mm; resembling *A. eschscholtzi* in general appearance, when ridges present. With 4 whitish ridges, dorsal ridge being absent. Ridges not prominent in well developed nectophores, and therefore, smooth and barrel-like in shape. Ostial teeth not pronounced, but keel-like in appearance. Ostial end twisted, displacing right lateral ridge and left ventral tooth. Ventral ridges forming hydroecial wings not fused, two flaps from these wings over lap, firmly held in place. Nectosac with simple radial canals.

Eudoxid phase: (Fig. 87, c, d) referred to as "Sphenoides" from a prior name of Huxley, 1859.

Bract: Upto 9 mm long, with 7 facets. Ridges milky-white. Four apical facets meet at tip, two elongated sloping baso-lateral facets, and a dorsal facet. Baso-sagittal ridge long. Phyllocyst with only 2 branches—thick, oval shaped anterior, and thin, thread-like posterior branches.

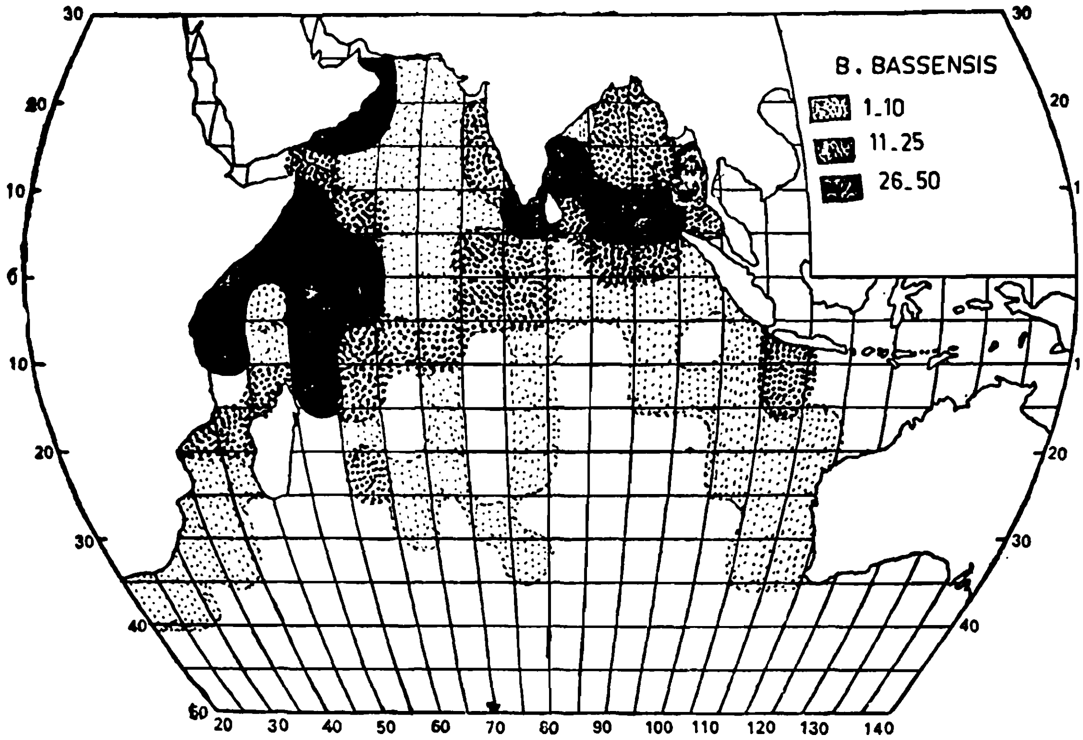
Gonophore: Upto 6.8 mm length and 3.67 mm in breadth, with 4 milky-white ridges, ending in 4 conspicuous teeth at base.

Type locality: Bass strait (South Pacific, Tasmania—Victoria).

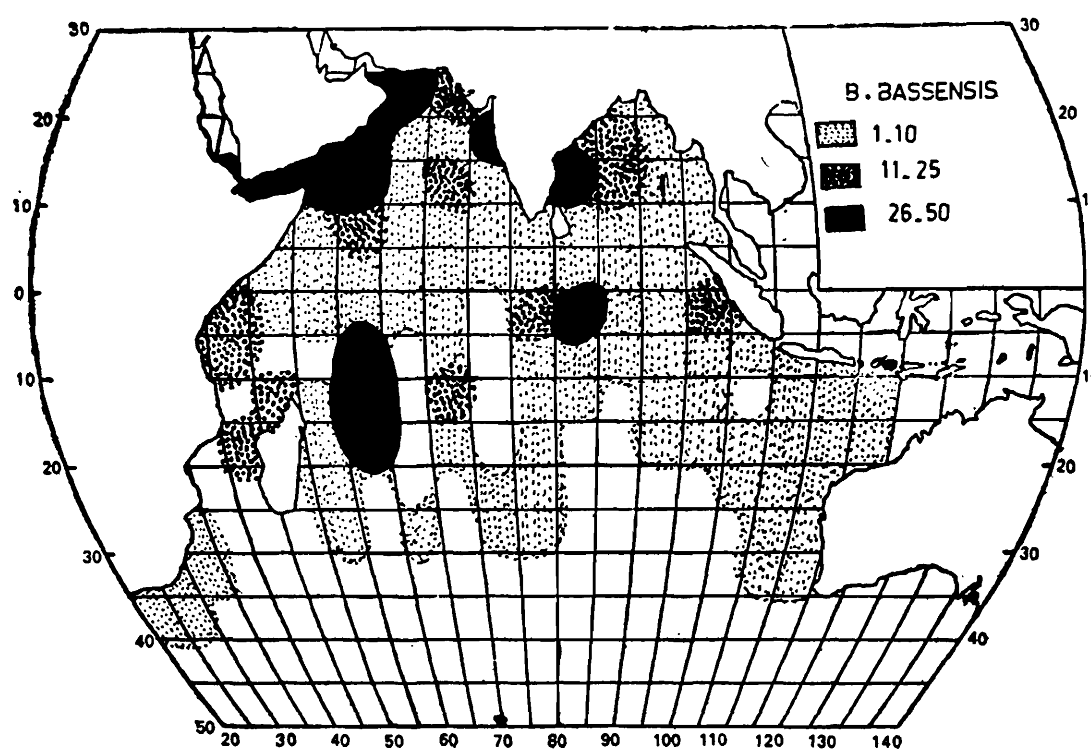
Distribution: (Maps 115, 116, 117 & 118). The average number of specimens of both polygastric and eudoxid phases in each 5° square of the Indian Ocean are presented in the four maps for the two seasons.

This species occurred in greater abundance than *A. tetragona* and *A. eschscholtzi*. It was recorded from more than 75% of the stations established in the different regions of the Indian Ocean. Its distribution extended from 20°N latitude to 40°S latitude along the African coast and 35°S latitude along 110°E longitude and 35°S in the mid-ocean during SW/SE monsoon and during NE/NW monsoon seasons.

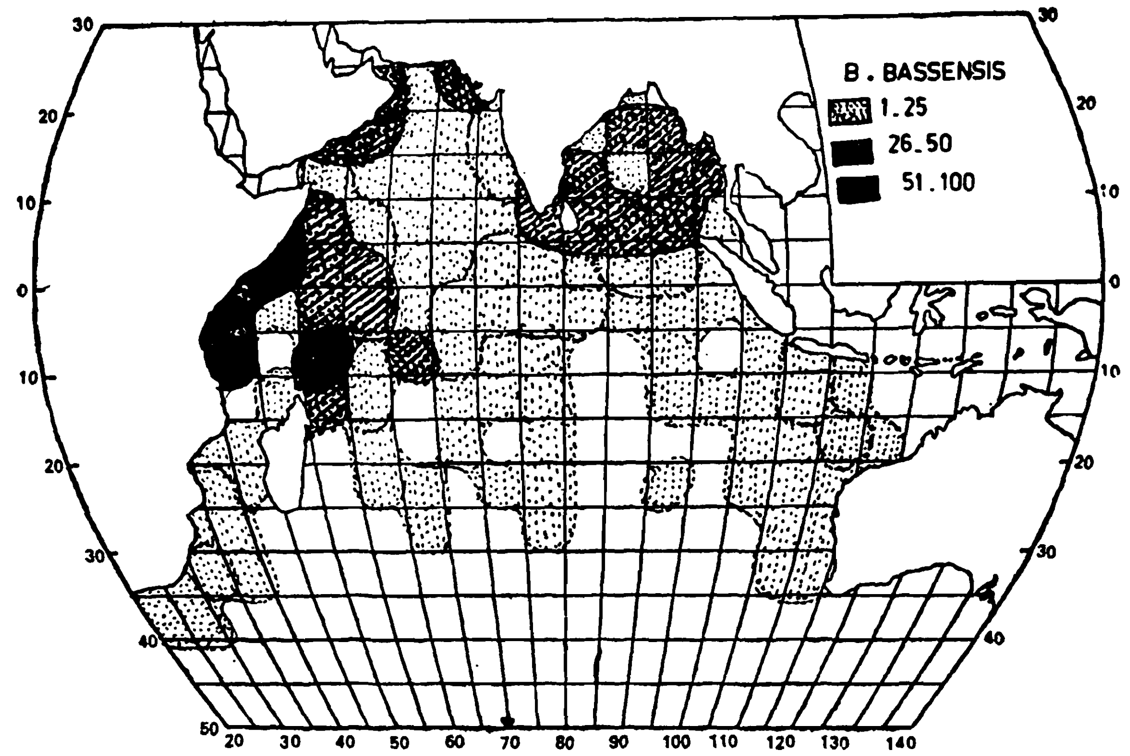
During SW/SE monsoon season (Map 115) the highest range of 26–50 polygastric phase per haul occurred in a vast area



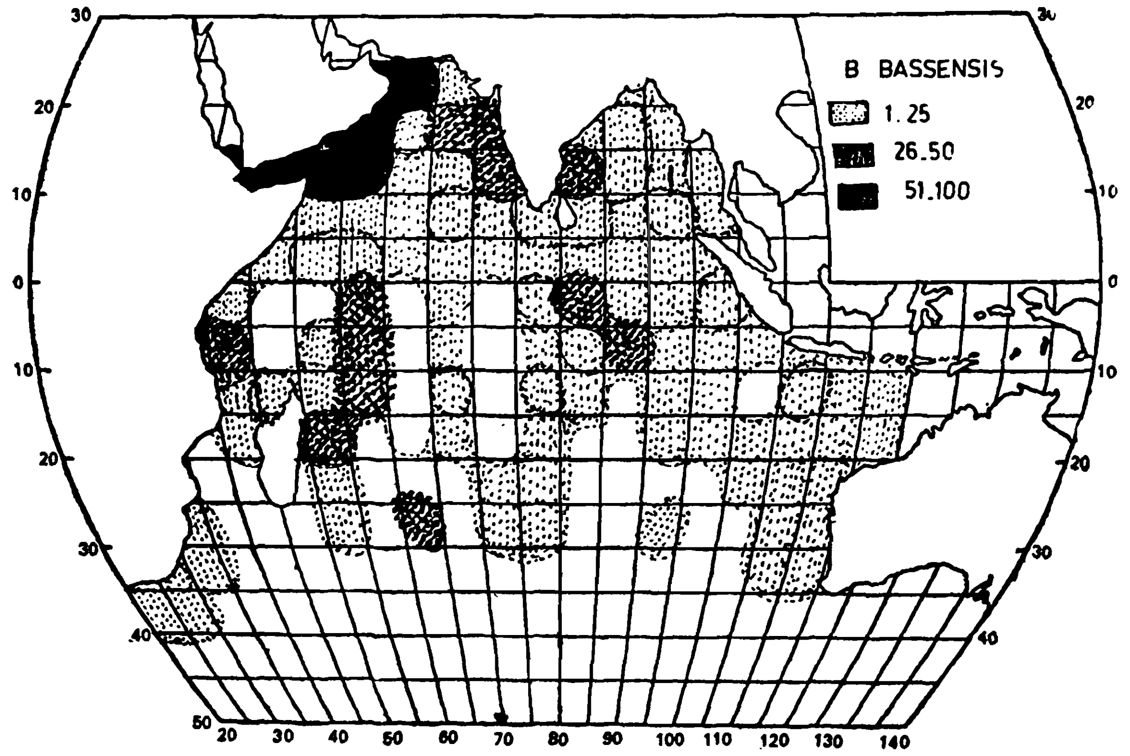
MAP 115. Distribution of *B. bassensis* — Polygastric phase during SW/SE monsoon season.



MAP 116. Distribution of *B. bassensis* — Polygastric phase during NE/NW monsoon season.



MAP 117. Distribution of *B. bassensis* — Eudoxid phase during SW/SE monsoon season.



MAP 118. Distribution of *B. bassensis* — Eudoxid phase during NE/NW monsoon season.

within 10°N–10°S latitudes as far as 60°E longitude on the African coast (Somali coast) along Arabian coast, Gulf of Oman and in large area in the Bay of Bengal. The moderate density of polygastric phases occurred between Africa and Madagascar, along Equator, Gulf of Aden, west coast of India, south of Java. The highest density range of more than 100 eudoxids (Map. 117) per haul occurred only along the coasts of Mombasa and Somali Land. The range 26–50 eudoxids per haul occurred off Somali coast, Arabian Coast, Gulf of Oman, Pakistan coast, Cape Comorin and most of the areas of Bay of Bengal. The moderate range of density of 11–25 eudoxids per haul occurred between Africa and Madagascar, Gulf of Aden, west coast of India, equatorial belt and south of Java.

During NE/NW monsoon seasoon (Map 116) the highest density of more than 50 polygastric phases per haul, occurred in the Gulf of Aden, a small area in the Arabian coast, and coast of Iran. The next range of 26–50 specimens per haul occurred off Gulf of Aden, Arabian coast, Gulf of Oman, west coast of India off Bombay, east coast of India along Madras and in equatorial belt region between 55°E to 60°E and 80E° longitudes. The highest range of more than 100 eudoxids per haul (Map 118) occurred in Gulf of Aden, Arabian coast and along the coast of Iran. The next density range of 26–50 eudoxids per haul occurred off Somali coast, west and east coasts of India and in the Chagos Archipelago and near the Equator (80°E–85°E longitude).

A comparison of the distribution of *B. bassensis* during the two seasons showed that wide areas of high concentration observed during SW/SE monsoon season was not seen during NE/NW monsoon season. *B. bassensis* like many other species become cattered during NE/NW monsoon season.

Monthly variations:

B. bassensis was recorded throughout the year in all the regions, except during February in the oceanic region in the South East Indian Ocean.

Arabian Sea: On the western part (Somali and Arabian coasts, Gulf of Aden) it was present in a wide area during August and December, while on the eastern part (coasts of Pakistan and India) it appeared in great abundance during May.

Bay of Bengal: On the Indian region it occurred during April and July in great numbers while in the Andaman Island and Burma region it was recorded during September.

South West Indian Ocean: Along the African coast it was collected during January in great abundance than during the other months. In the oceanic region it occurred without much variations.

South East Indian Ocean: Along the 110°E longitude it occurred mostly during January, May and August. In the oceanic region it was present during December in greater number of places than in the other months.

Genus 39. **Enneagonum** Quoy & Gaimard, 1827

Enneagonum Quoy & Gaimard, 1827, p. 18.
Cuboides Quoy & Gaimard, 1827, p. 19.

Abylopsinae in which only anterior nectophore is developed; pyramidal in shape, with flared out facets and a dorsal ridge bisecting dorsal facet. Nectosac long, lying along side somatocyst and hydroecium.

Eudoxid phase with perfect cuboidal shaped bract; phyllocyst either with elongated or sturdy apical branch and thick bilobed base and without posterior branch.

Type Species: Enneagonum hyalinum Quoy & Gaimard, 1827.

Upto 1968 this genus was considered as a monotypic genus for *E. hyalinum* Quoy & Gaimard, 1827. Another eudoxid phase differing from *E. hyalinum*, described as *E. searsae* by Alvarino, 1968, was included in this genus.

Key to the species of **Enneagonum**

Eudoxid phase: Bract:

Bract of medium size; phyllocyst with a short knob-like apical branch..	*E. hyalinum*
Bract large; phyllocyst with a long, thin, apical branch..	*E. searsae*

Gonophore:

Apophysis of gonophore large, conical and blunt above the horizontal apical cross-ridge, with deep pockets and a hook-like tooth below it..	*E. hyalinum*
Apophysis of gonophore very narrow above oblique apical cross-ridge ending in pointed tip; without deep pockets and without hook-like tooth.. ...	*E. searsae*

(N.B. Anterior nectophore not so far known in *E. searsae*)

88. **Enneagonum hyalinum** Quoy & Gaimard, 1827
(Fig. 88 a–c)

Enneagonum hyalinum Quoy & Gaimard, 1827, p. 18, pl. 2D, figs. 1–6.

Enneagonum hyalinum Sears, 1953, p. 58, figs. 2E, 28A, 29.

Enneagonum hyalinum Daniel, 1974, p. 208, Text-fig. 18, H–M.
(cf. for detailed synonymy)

Type Specimen: Museum National d' Histoire Naturelle, Paris.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 76 n.; 91 eu.; 61 go. *Bay of Bengal:* 72 n.; 82 eu.; 60 go. *South West Indian Ocean:* 13 n.; 9 eu; 11 go. *South East Indian Ocean:* 18 n.; 50 eu; 44 go. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 88 n.; 140 eu.; 90 go.

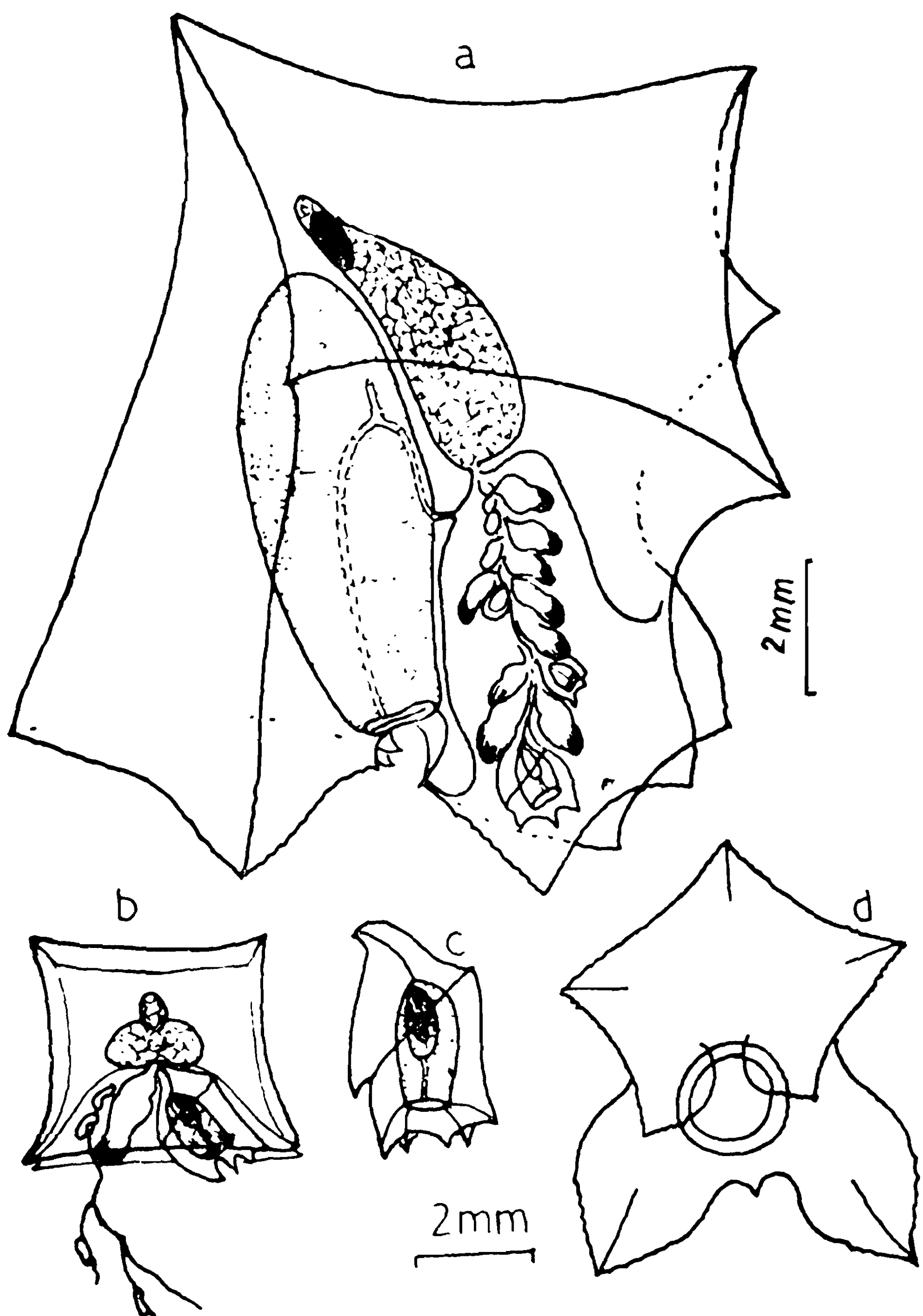


FIG. 88. *E. hyalinum* (Quoy & Gaimard) (a–d). a. polygastric phase — anterior nectophore; b. bract; c. gonophore; d. ostial view of gonophore

Bay of Bengal: 38 n.; 23 eu; 13 go. *South West Indian Ocean:* 15 n.; 15 eu.; 7 go. *South East Indian Ocean:* 11 n. 19 eu.; 10 go.

Polygastric phase: Anterior nectophore: (Fig. 88 a). *Size:* Length 8.75 mm; breadth 9.75 mm; Somatocyst 3.5 mm; Hydroecium 4.75 mm; netosac 4.5 mm.

Characteristically pyramidal in shape with flared out facets and prominent pointed angles. Instead of dorsal facet as in *Abylopsis* and *Bassia*, a median dorsal ridge present. Beneath and between these apico-dorsal facets lies a triangular basal facet, two apico-lateral facets and two baso-lateral facets. Somatocyst elongate with a constriction at apex and a short stalk. Hydroecium lying below somatocyst, deep, with 4 serrated teeth around opening. Nectosac lying alongside somatocyst and hydroecium, with arched lateral radial canals and blind apical diverticula.

Posterior nectophore: Not developed.

Eudoxid phase: (Fig. 88 b–d) *Bract:* perfectly cuboidal in shape with 5 slightly concave facets (apical, dorsal, ventral and two lateral). Basal part with broad slit-like opening of conical bracteal cavity. Phyllocyst without descending branch, with a broad slightly bilobed base and a short knob-like apical end.

Gonophore: Length of 6.67 mm with large blunt, conical apophysis. Separated from basal half by a prominent "apical cross-ridge" Dorsal ridge vestigeal, and incomplete; lateral ridges long, displaced to dorsal side, end in teeth at base, with semi-circular serrated lappet; ventral ridges complete ending in longer teeth at base. Characteristic hook-like tooth present at junction between right ventral ridge and "apical cross-ridge"

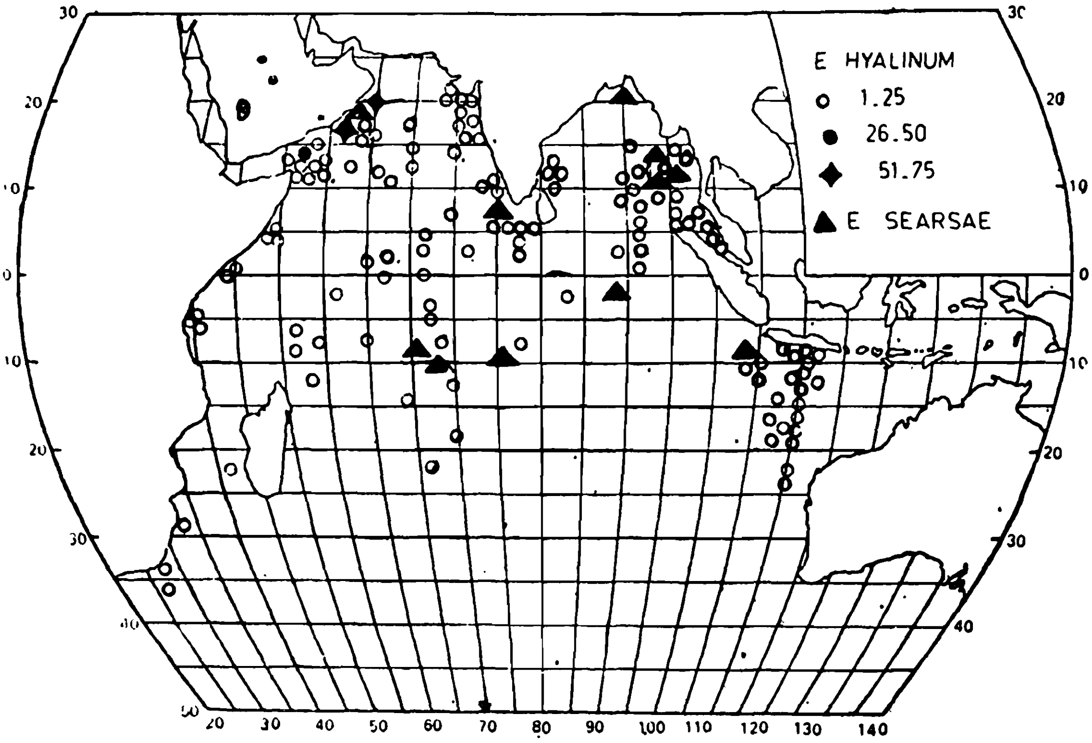
Type locality: Off Gibraltar.

Distribution: (Maps 119 & 120). The distribution and abundance of *E. hyalinum* in the different regions of the Indian Ocean are given in maps 119 and 120.

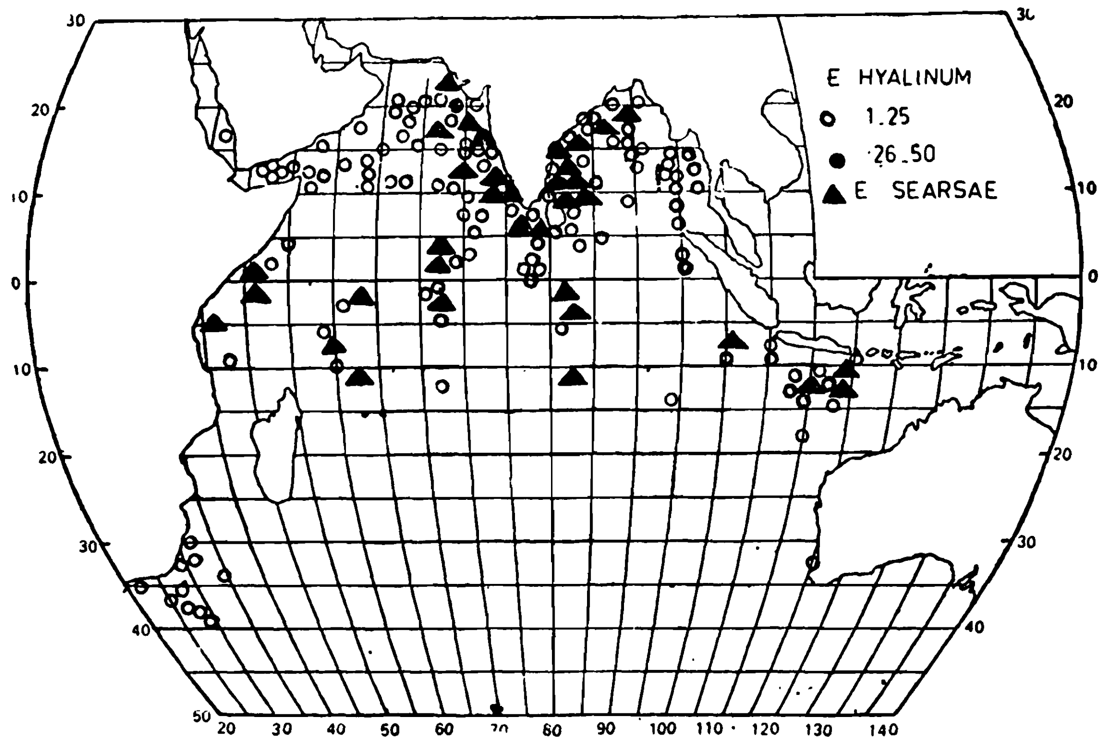
E. hyalinum occurred in high concentrations in both the seasons in the Arabian Sea and Bay of Bengal. Along the coastal regions of South Africa it occurred as far as 40°S latitude while it was very rarely collected on the west coast of Australia during NE/NW monsoon season. In the mid-oceanic regions it occurred mostly between 0°–10°S latitude and it was rarely recorded below 30°S latitude. Day time catches were more during both the seasons except in South East Indian Ocean during NE/NW monsoon season.

Monthly variations:

Arabian Sea: On the western region it occurred mostly along the Somali coast, mouth of the Gulf of Aden, Red Sea and Arabian



MAP 119. Distribution of *E. hyalinum* and *E. searsae* during SW/SE monsoon season.



MAP 120. Distribution of *E. hyalinum* and *E. searsae* during NE/NW monsoon season.

coast during February, June, July August and December. On the eastern region it was common during May and November.

Bay of Bengal: On the Indian region it was recorded almost throughout the year especially during April and June. Around the Andaman Islands, Burma and Malaya it occurred in abundance during March, August and September (Maximum).

South West Indian Ocean: Along the coastal regions of Africa *E. hyalinum* was rarely collected but off the southern tip of Africa it occurred during January. In the oceanic region it occurred at rare places almost throughout the year.

South East Indian Ocean: In this region *E. hyalinum* occurred along the 110°E longitude near south of Java during January and August. Off western Australia it occurred during April, May and August.

89. **Enneagonum Searsae** Alvarino, 1968

(Fig. 89 a, b)

Enneagonum searsae Alvarino, 1968, p. 340.

Enneagonum searsae Daniel, p. 212, Text-fig. 18, N–P.

Type Specimen: U.S. National Museum, U.S.A.

Material Examined: SOUTH WEST/SOUTH EAST MONSOON SEASON: *Arabian Sea:* 5 eu.; 2 go. *Bay of Bengal:* 5 eu; 1 go. *South West Indian Ocean:* 3 eu.; 2 go.; 1 very large nect. (?). *South East Indian Ocean:* 2 eu. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 21 eu; 12 go.; 4 large n. with elongated tips (?). *Bay of Bengal:* 11 eu; 6 go; 3 n.; with elongated tips (?). *South West Indian Ocean:* 8 eu.; 2 go. *South East Indian Ocean:* 8 eu.; 3 go.; 2 n. with elongated tips (?).

Eudoxid phase: Bract: Length 9.0 mm, breadth at base 12–14 mm. Larger than those of *E. hyalinum* with basal corners produced into elongated extensions. Phyllocyst with broad bilobed base and long thin, anterior branch. Bracteal cavity as in *E. hyalinum.*

Gonophore: Length upto 6.0 mm. Apophysis not broad, conical or blunt above apical cross-ridge as in *E. hyalinum*, but very marrow above very oblique apical cross-ridge and pointed tip. With 6–7 basal teeth around ostium, and ventral tooth long and bent over other teeth. Nectosac bent, bent region being parallel to "apical cross-ridge"

Remarks: Along with bracts of this species, a few specimens of the polygastric phase occurred which have extended ridges *i.e.* elongated tips. Probably these nectophores belong to *E. searsae.* However, it is observed that at few stations the bracts had only slightly prolonged tips, showing intermediate characters. A detailed study of these characters of this species from the different oceans will settle the validity of this species.

Type locality: Gulf of Thailand.

Distribution: (Maps 119 & 120). Its distribution is presented in maps 119 and 120. *E. searsae* occurred in very few of the stations, established during SW/SE monsoon season. During this season it

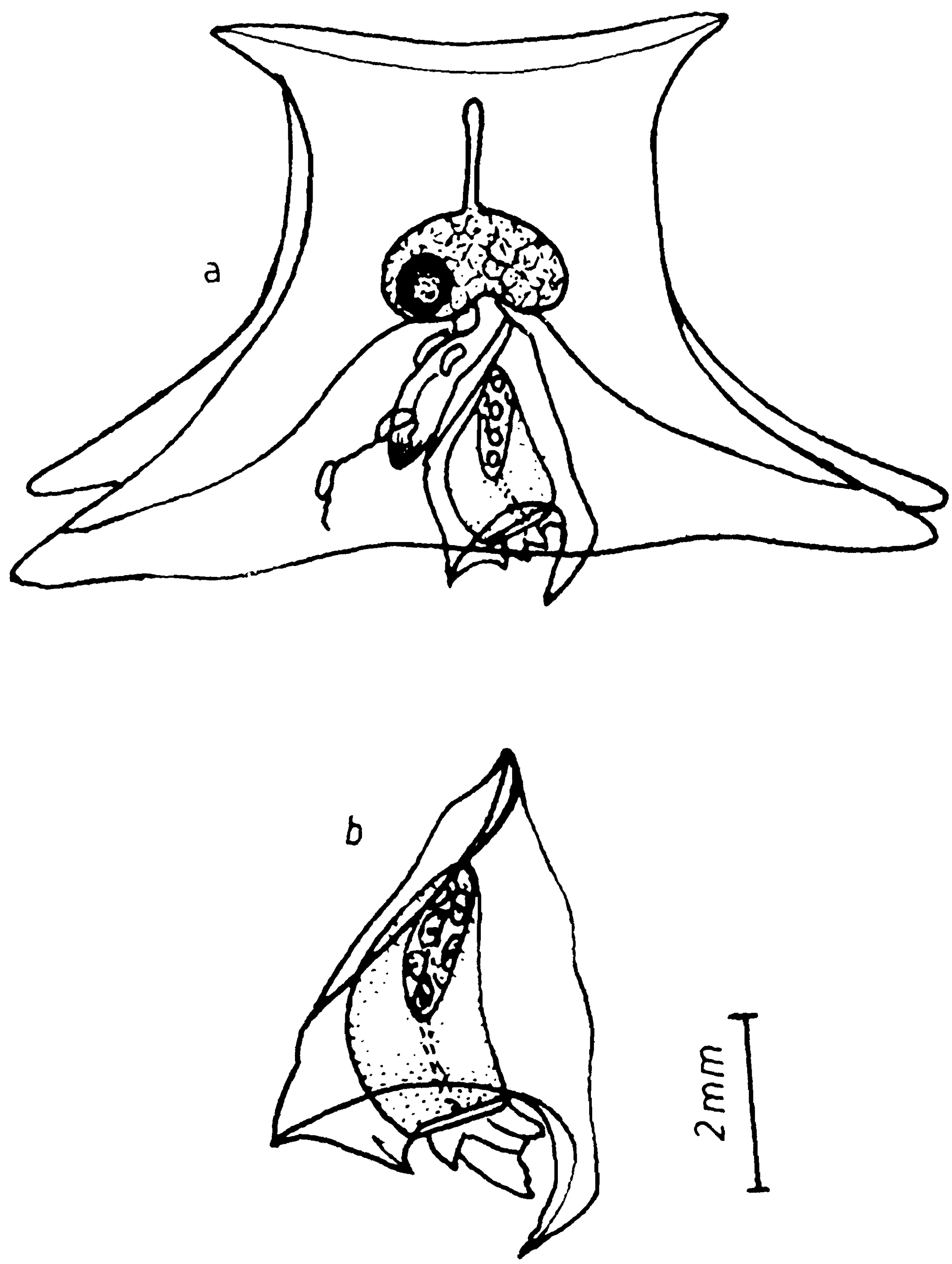


FIG. 89. *E. searsae* Alvarino. Eudoxid phase; a. bract; b. gonophore.

occurred along the Arabian coast (during July) near Laccadive Islands (August), Andaman Islands (April and September) and within 0–10°S latitude, during February, March, April and June. During NE/NW monsoon season it was collected in greater numbers which occurred along the west and east coast of India. It occurred during February and March on the western coast and during January and April on the east coast.

SYSTEMATIC SECTION OF SIPHONOPHORA OF INDIAN OCEAN

Genus 40. **Bathyphysa** Studer, 1878

Bathyphysa Studer, 1878, p. 1.

Pterophysa Fewkes, 1884, p. 1.

Linnophysa Haeckel, 1888, p. 326.

Cystonectae with extremely long, fine stem whose gastrozooids bear *wings* or *ptera* at their sides in the early growth stages.

Lens & van Riemsdijk (1908) recognized two genera: *Bathyphysa* Studer (1878) in which the siphons are borne on long pedicels, and *Pterophysa* Fewkes, 1884 in which the siphons are sessile. They reviewed the history of these two genera, and considered two species of *Bathyphysa* as valid, *viz.*, *Bathyphysa abyssorum* Studer, 1878 and *Bathyphysa sibogae* Lens & van Riemsdijk, 1908 Among *Pterophysa*, they recognized two species.:

1. *Pterophysa* (*Rhizophysa*) *conifera* Studer, 1878.

   syn. *P.* (*Bathyphysa*) *grimaldii* Bedot, 1893b
   P. grandis Fewkes, 1884.

2. *Pterophysa* (*Bathyphysa*) *studeri* Lens & van Riemsdijk, 1908.

Leloup (1936) after examination of type material of the different species, merged *Pterophysa* with the older name *Bathyphysa* as valid. Totton (1965) is in complete agreement with the conclusions of Leloup (loc. cit.). The valid species are:–

1. *Bathyphysa conifera* (Studer, 1878)

with simple and unbranched tentacle; and,

2. *Bathyphysa sibogae* Lens & van Riemsdijk, 1908.

With tentilla ending in trifid structure, as in *R. filiformis* (Forskål) Hypocystic villi are absent in *B. conifera* but present in *B. sibogae.*

Bathyphysa japonica Kawamura, (1943) from great depth is regarded as a species inquirenda; and *B. grimaldii* Bedot, recorded by Kawamura (1954) is a synonym of *B. conifera.*

Type Species: *Bathyphysa conifera* (Studer, 1878).

Two valid species: *B. conifera* (Studer, 1878) and *B. sibogae* Lens & van Riemsdijk, 1908.

Key to species of **Bathyphysa**

Tentacle without tentilla..	*B. conifera*
Tentacle with tentilla..	*B. sibogae*

90. **Bathyphysa conifera** (Studer, 1978) (Fig. 90 a, b)

Rhizophysa conifera Studer, 1878, p. 4, tab. 1, fig. 2, 4–7; tab. 2.; fig. 13–18.
Bathyphysa conifera Leloup, 1954, p. 14.
Bathyphysa conifera Totton, 1965, p. 43, pl. 5, fig. 3, pl. 6, fig. 1–4.

Type Specimen: Place of deposit not known.

Material: SOUTH WEST/SOUTH EAST MONSOON SEASON: *South East Indian Ocean:* 2 col; 3 gast. with ptera; 2 bits of stem. NORTH EAST/NORTH WEST MONSOON SEASON: *South East Indian Ocean:* 1 col.; 4 gast. with ptera.

Pneumatophore: elongate, cylindrical, 20.0 mm long, 5.0 mm in diameter.

Stem: extremely long, thin, thread like 370 cm (3.7 metre) in contracted state. With longitudinal opaque white lines of muscle bands running along entire length of the stem.

Gastrozooids: budded from close beneath pneumatophore. Young, sessile gastrozooids bearing two characteristic longitudinal *wings* or ptera at sides which disappear in older gastrozooids. Gastrozooids with simple filiform tentacles without tentilla.

Gonodendra: At base of each older gastrozooid; sessile, globular in early growth stages becoming pedunculate and elongate when mature. Typically cystonect type in structure, possessing gonopalpons, gonophores and asexual nectophores. Parts of it break away when mature.

Type locality: Mediterranean Sea.

Distribution: (Map 121). In the Indian Ocean *B. conifera* was recorded along the 110°E longitude, South of Java (at 10°S and 17°S latitudes) during August from a depth of 200–0 m.

This species was hitherto known from the Atlantic and Pacific Oceans only and is now recorded for the first time from the Indian Ocean. Probably brought to the 200–0 m zone by the upwelling of deeper waters. The known depth range for this species is from 1780–0 m in the Atlantic Ocean and from 4391–521 m in the Pacific Ocean.

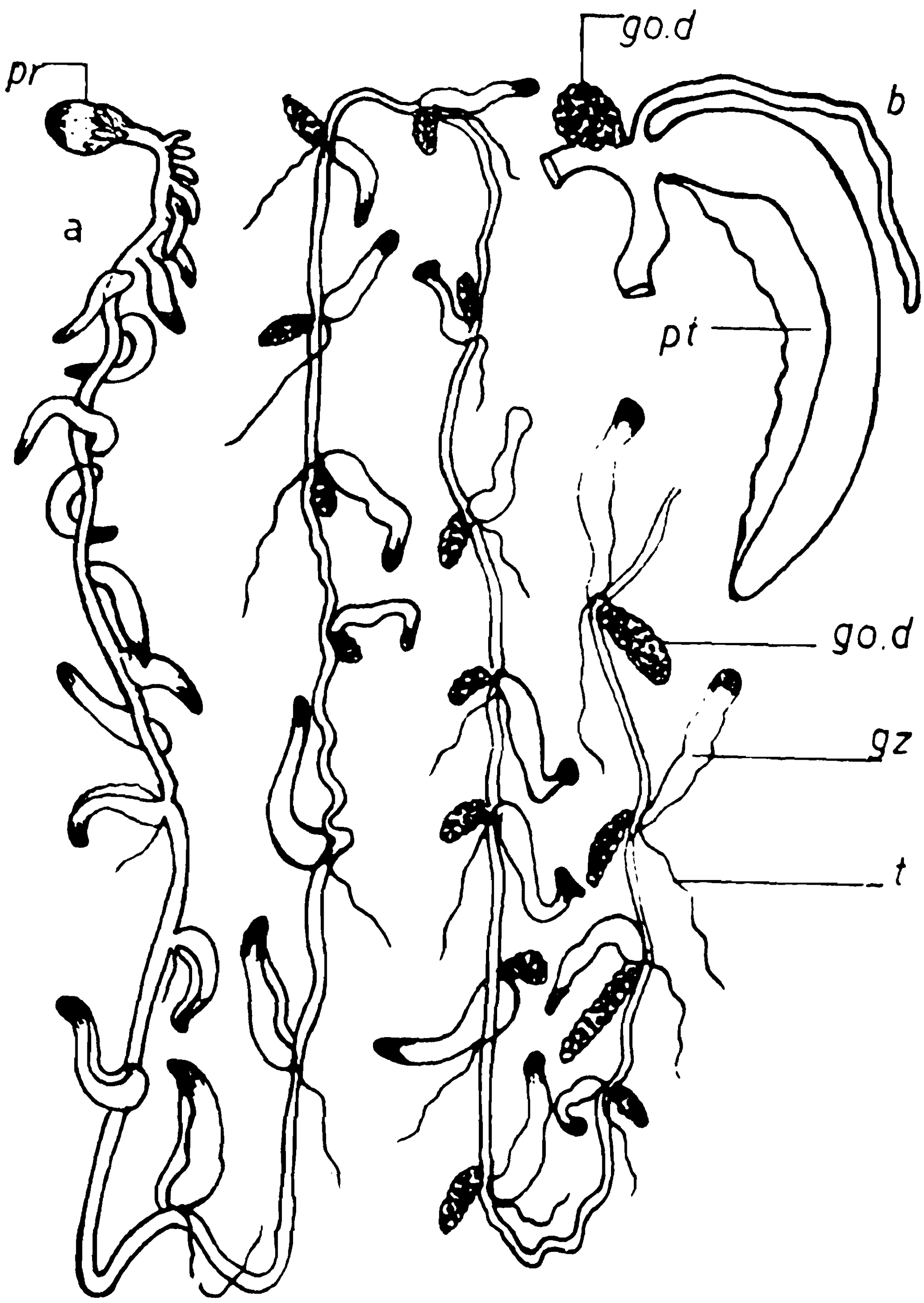


FIG. 90. *B. conifera* (Studer). a. entire specimen; b. gastrozooid with gonodendron, ptera (pt) at the side (go. d – gonodendron; gz – gastrozooid; pn– pneumatophore; pt – ptera; t – tentacle). (After Lens & van Riemsdijk 1908, pl. 19, fig. 146).

Genus 41. **Marrus** Totton, 1954

Agalmidae with large nectophores where the dorso-lateral ridges bifurcate at the distal end, without lateral vertical ridges, unlooped lateral radial canals and tentilla unicornuate and without involucrum.

Type Species: *Marrus antarcticus* Totton, 1954.

Three valid species of *Marrus* are known: *Marrus antarcticus* Totton, 1954, occurring in the cold Antarctic Ocean; *M. orthocanna* (Kramp, 1942) restricted to the Arctic Ocean and *M. orthocannoides* Totton, 1954 recorded from the west Tropical Indian Ocean.

Key to the species of **Marrus**

1.	Nectosac without musculature on its broad adaxial face...	2
	Nectosac with musculature on its broad adaxial face...	*orthocannoides*
2.	Bracts flattened, cone shaped, truncated distally; with bracteal cannal terminating on papilla....	*antarcticus*
	Bracts quadrangular, distal and lateral angles almost rectangular, without protruding points or ridges.....	*orthocanna*

91. **Marrus orthocannoides** Totton, 1954
(Fig. 91 a, b)

Marrus orthocannoides Totton, 1954, p. 59, figs. 22, 23.
Marrus orthocannoides Totton, 1965, p. 63, Text-figs. 28, 29.

Type Species: British Museum (Nat. Hist.), London.

Material: Recorded from off South and East coast of Africa by Totton (1954).

Entire colony unknown; known from fragments of nectosome and siphosome. Highly contractile. Budding zones of nectosome and siphosome occurring on same side.

Pneumatophore: Oblong, 6 mm long, 2 mm diameter.

Nectophore: Large, 19.2 mm long; 15.2 mm broad. Dorsolateral ridges dividing into two near ostium. Lateral vertical ridges absent. Place of attachment to muscular lamella deeply sunk in a narrow longitudinal furrow. Nectosac with full musculature. Proximal wall of nectosac not sunken in as in other two species. With a ventral median cleft mouth-plate. Lateral radial canals straight without forming loops or sigmoid curves, before joining ring canal.

Siphosome: 23 cm long; contracted stem 3.7–4.6 mm in diameter. Gastrozooids and tentacles unknown.

Palpons: numerous, slender, 9.2 mm long, 0.2 mm in diameter with short pedicels, close set, in 4 or 5 longitudinal rows, each with a fine palpacle.

Gonodendra: Dioecious, male and female gonodendra borne on different individuals. 4.6 mm long, fine, 2 or 3 per cormidium, 12 or more female gonophores borne on short pedicels. Globular androphores 1.1 mm in diameter.

Bracts: 15.0 mm long, 8.0 mm broad, thin, leaf-like, broad ovate, without marginal teeth, distal end thickened, obliquely truncate; attached along proximal two-thirds of length, bracteal

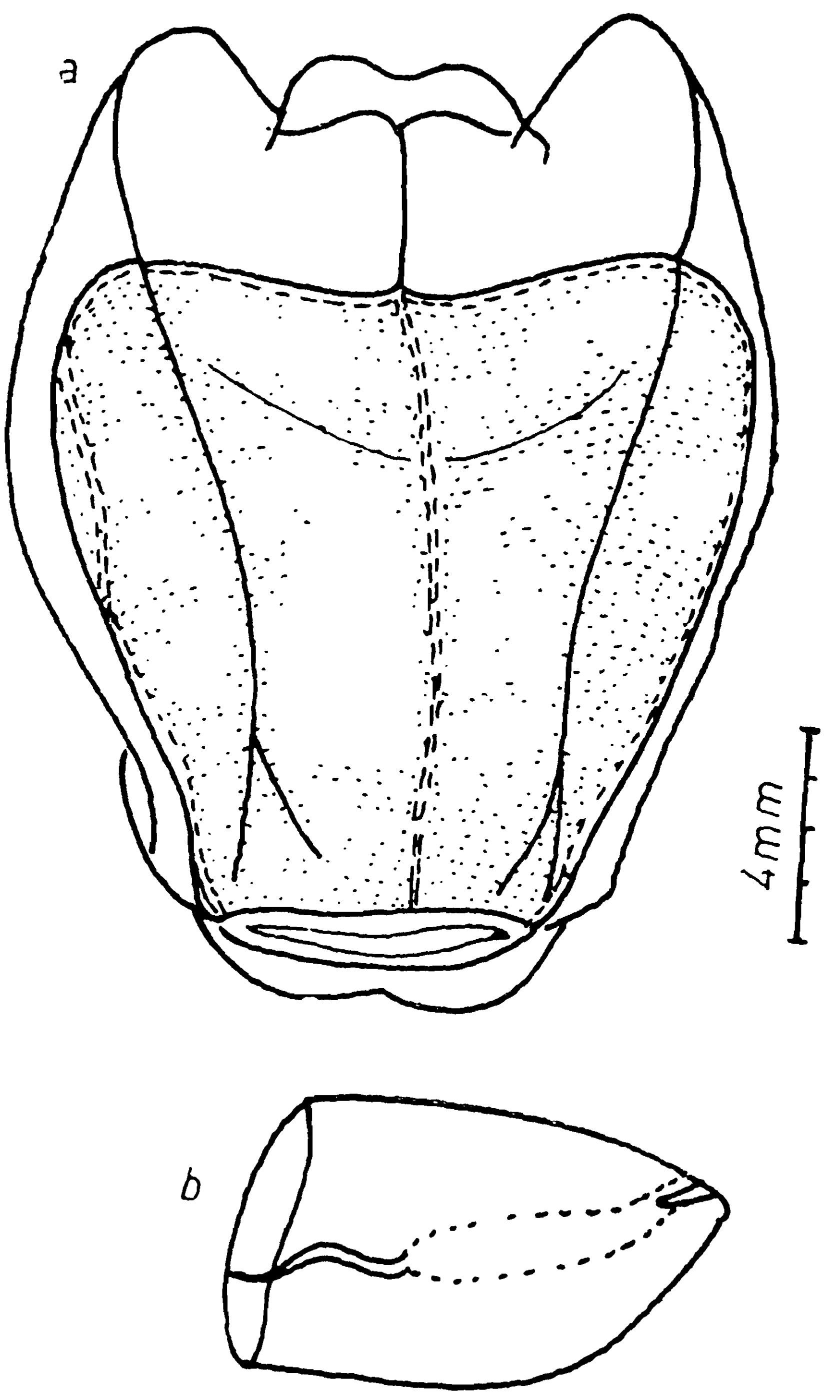
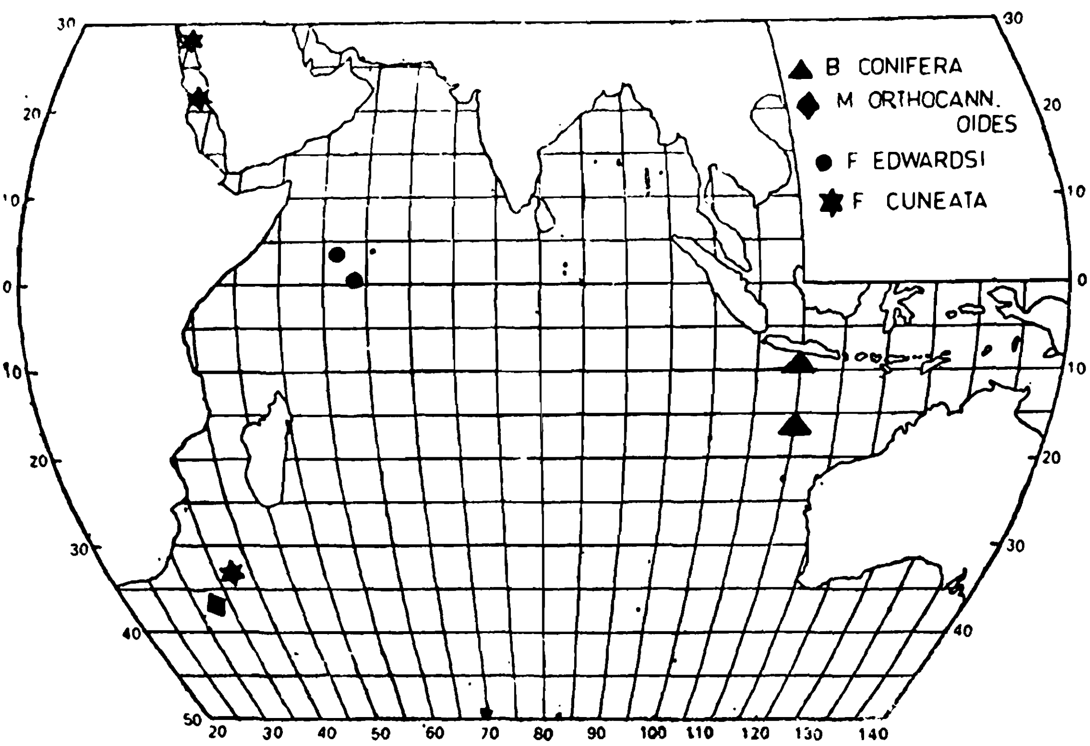
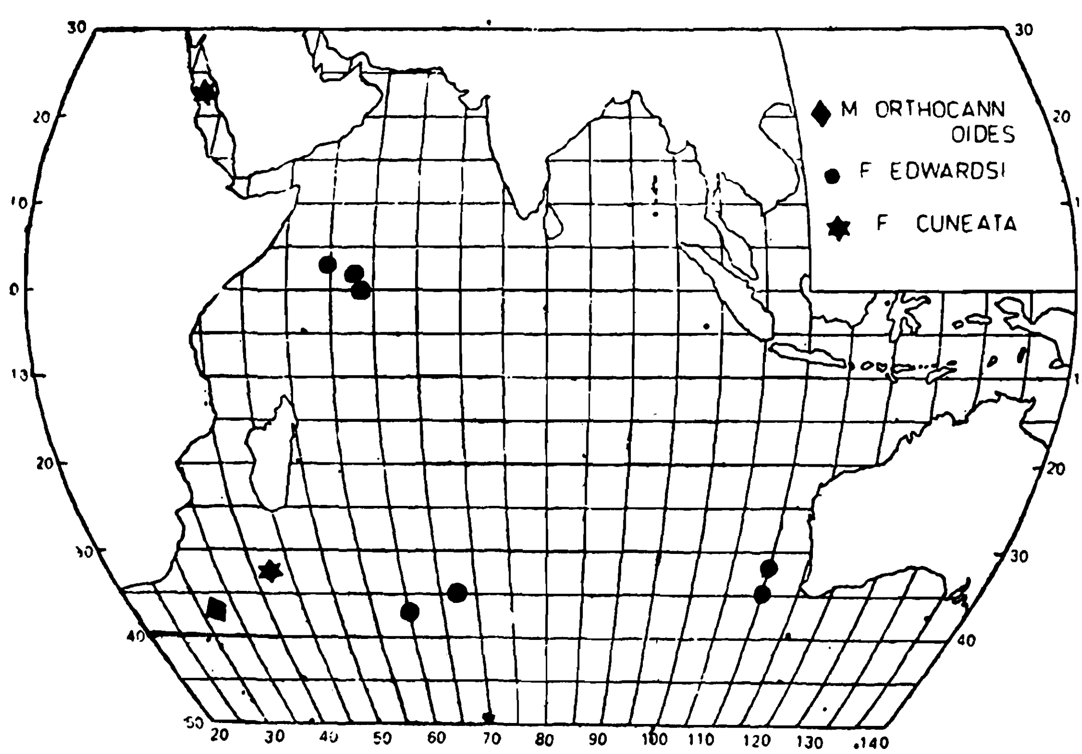


FIG. 91. *M. orthocannoides* Totton. a. nectophore — dorsal view; b. bract. (After Totton, 1965, figs. 28, 29).



MAP 121. Distribution of *B. conifera*, *M. orthocannoides*, *F. edwardsi* and *F. cuneata* during SW/SE monsoon season. 1 colony per haul.



MAP 122. Distribution of *M. orthocannoides*, *F. edwardsi* and *F. cuneata* during NE/NW monsoon season. 1 colony per haul.

canal short occurring at distal one third, ending in the middle of terminal facet. Occur in one or two rows flanking palpons.

Type locality: Antarctic Ocean:

Distribution: (Maps 121, 122). Recorded from a depth of 700 to 1400 m in the West Tropical Indian Ocean where the temperature and salinity ranged from 8.35°C to 4.85°C and 34.98 to 34.84°/$_{oo}$ respectively. It was collected from off the south east coast of Africa (Totton, 1954).

92. **Forskalia edwardsi** Kölliker, 1853
(Fig. 92 b–d)

Forskalia edwardsii Kölliker, 1853, p. 2, taf. I & II.
Forskalia edwardsii Totton, 1965, p. 100, pl. XX, figs. 1, 2, Text-figs. 52–55.

Type Specimen: Place of deposit not known.

Material: NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 2 col.; 20 nect. *South West Indian Ocean:* 4 col.; 34 nect.; 95 br. *South East Indian Ocean:* 3 col; 15 nect.

Colony: Grows upto 7–8 feet, highly transparent. Nectosome 1/3rd or 1/4th of total length of colony; cylindrical in shape bearing numerous nectophores, all arising from one meridian of the stem.

Nectophores: Elongate, proximal exumbrella portion flattened from above, tapering without marked incision at point of attachment of muscular lamella as in *F. leuckarti.* (Fig. 92 a). With a notch on lateral right side of flattened portion. Projections on either side of nectosac. Diagnostic small yellow pigment spot at junction of dorsal radial canal and circular canal. No *rete* in pedicular canal.

Gastrozooids: Borne on long peduncles, 37 mm long, covered with numerous pairs of bracts, 16 mm in length.

Bracts: Stem bracts leaf-like, pyramidal in shape, in pairs on each cormidium. Peduncular bracts—3 types—basal pair bolster shaped, triangular in cross section; others laterally flattened with a knee-like bend (sock-like shape). Distally truncated terminating in 2 or 3 pairs of tooth-like projections. Bracteal canal obtuse not bent at right angle as in *leuckarti.*

Gonodendra: Single gonodendron between two gastrozooids. With stalk 10 mm long, formed by a series of six paplons. Most distal palpon bearing three bunches of fourteen (1.3 mm × 0.6 mm) male gonophores at its base, female monovan gonophores smaller (0.6 mm × 0.37 mm) occurring at bases of proximal palpons.

Type locality: Mediterranean Sea.

Distribution: (Maps 121 & 122). In the Arabian Sea, *F. edwardsi* was collected along the Equator at five localities during January, February and June. During December it was collected in the Oceanic region between 34°S to 37°S latitudes.

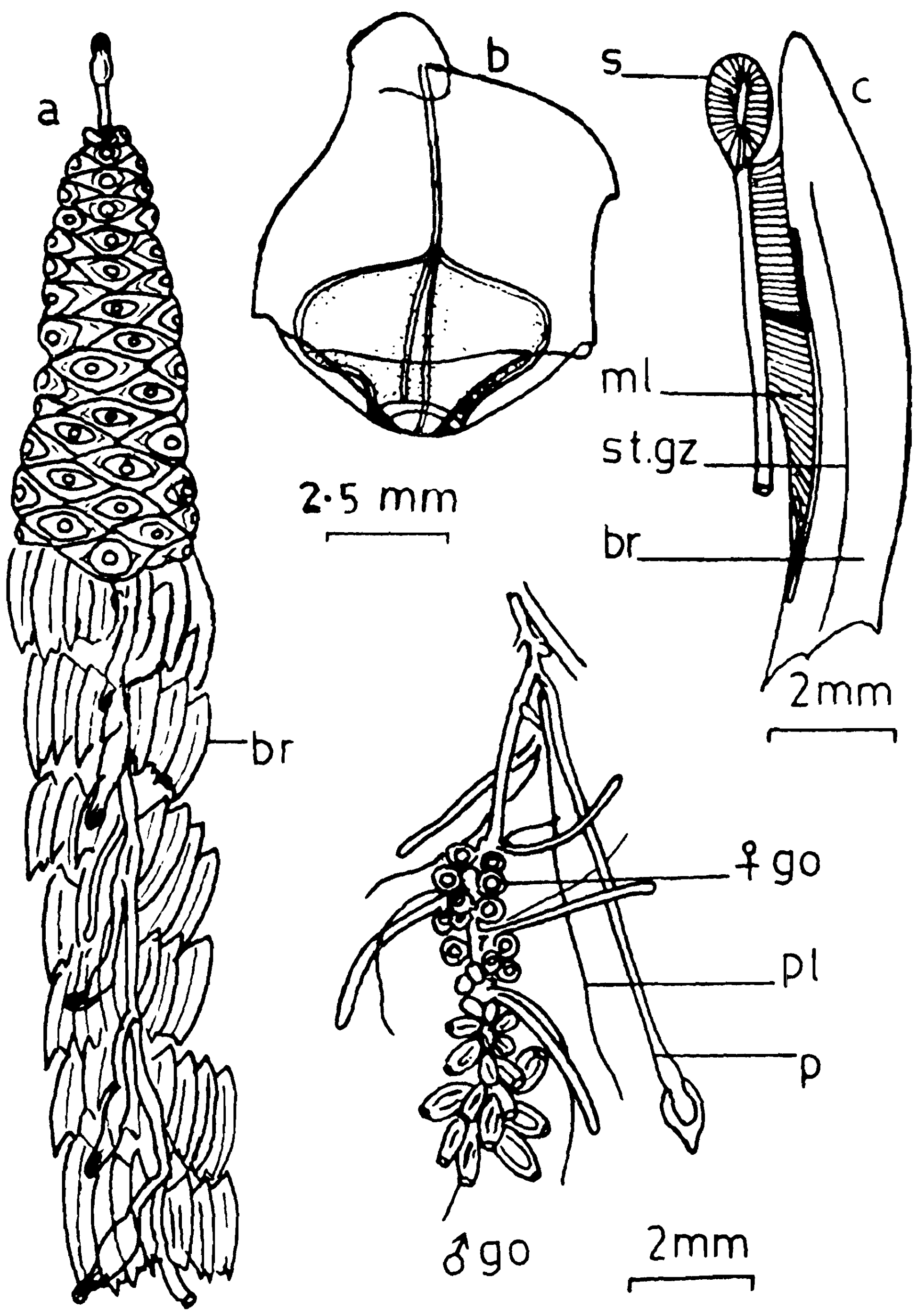


FIG. 92. *F. edwardsi* Kolliker (b–d). a. entire specimen of *F. leuckarti*; b nectophore; c. bract (br) showing attachment to stalk of gastrozooid (st. gz) and stem (s) by the large muscular lamella (ml); d. gonodendron, with female gonophore (go) at base, male gonophores (♂ go) distally and palpon (p) with its tentacle — palpacle (pl.) (Figs. b, c & d from Totton, 1965, Figs. 53 & 55 and a from pl. xx, fig. 3).

This species considered to be an inhabitant of deep cold waters is collected from 200–0 m depth due to upwelling water. It is a very common Mediterranean species.

93. **Forskalia cuneata** Chun, 1888
(Fig. 93 a, b)

Forskalia cuneata Chun, 1888, p. 1172.
Forskalia cuneata Totton, 1965, p. 109 Text-fig. 61.

Type Specimen: Place of deposit not known.

Material: Recorded by Totton (1954, 1965) from Gulf of Aqaba, Red Sea and South East Coast of Africa.

Size: about 7 cm. long.

Bracts: Characteristic with truncated outer ends and right angled bend in bracteal canal.

Gastrozooids: exceptionally large.

Tentacle: Larval tentilla acorn-shaped, deep red, with numerous short sensory hairs

Type locality: Canary Island.

Distribution: (Maps 121 & 122). Recorded only once or twice from Canary Island region, Atlantic Ocean and Mediterranean Sea. Bracts probably belonging to this species was collected by "*Discovery*" from Gulf of Aqaba, South East Coast of Africa and Red Sea (Totton, 1954). Nothing much is known about this species

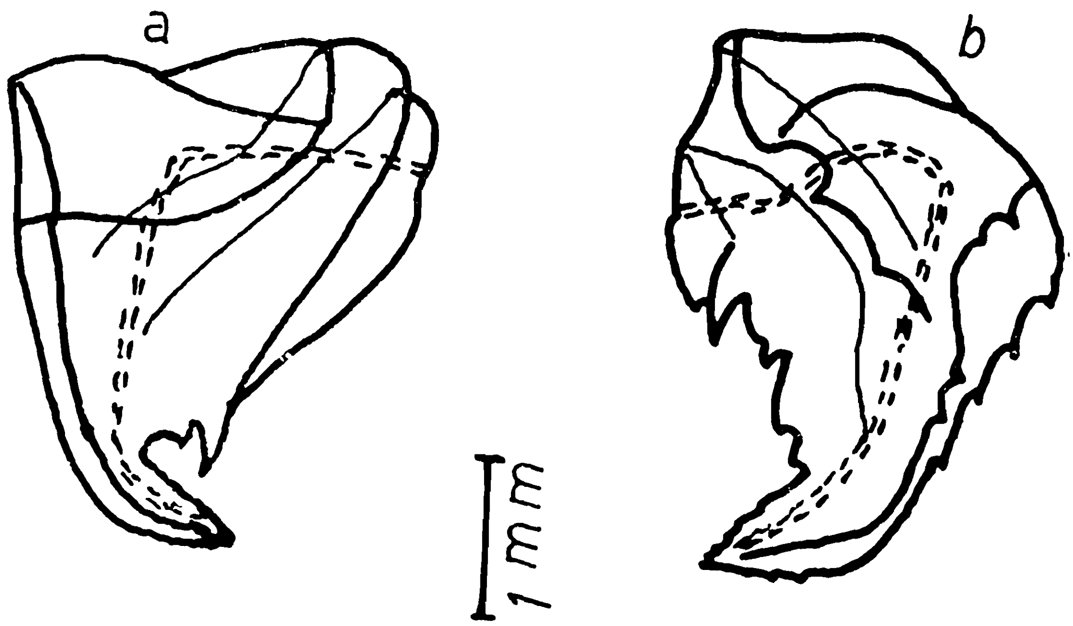


FIG. 93. *F. cuneata* Chun, a & b. bracts. (From Totton, 1954, fig. 31).

94. **Amphicaryon peltifera** (Haeckel, 1888)
(Fig. 94 a–d)

Mitrophyes peltifera Haeckel, 1888, p. 131.
Amphicaryon peltifera Totton, 1965, p. 112, Text-fig. 62.

Type Specimen: Most of Haeckel's specimens are not present in British Museum.

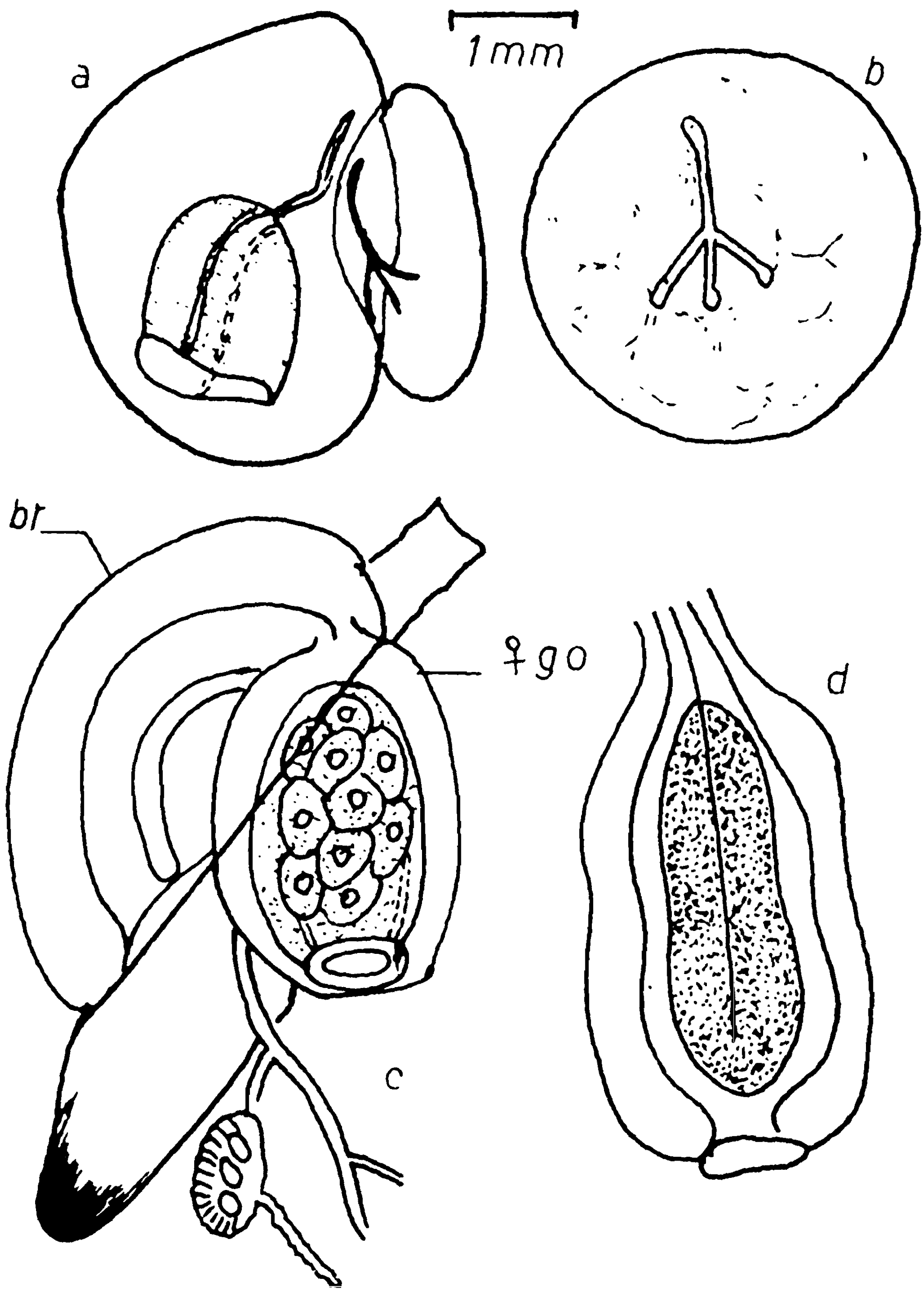


FIG. 94. *A. peltifera* Haeckel, a–d. a. entire polygastric phase; b. vestigeal nectophore with three pronged reduced radial canals; c. cormidium; d. male gonophore. (Figs. c & d from Haeckel, 1888).

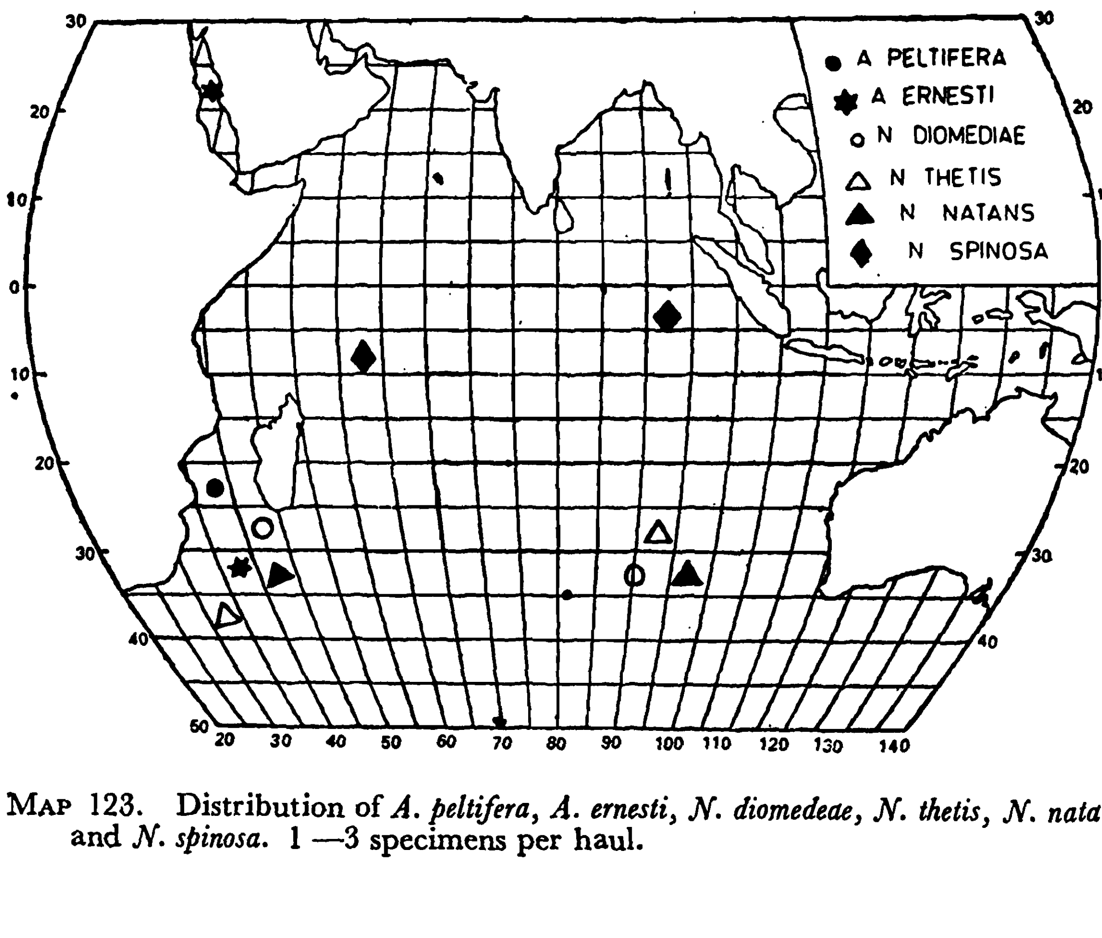
Material: SOUTH WEST MONSOON SEASON: *South West Indian Ocean:* 1 p. g. (compl.)

Polygastric phase: Larger functional nectophore: 6.0 mm in length and 4.7 mm in breadth. Resemble *A. acaule* in appearance. With shallow conical hydroecium; thin, thread-like smatocyst. Large functional nectosac with 4 simple, straight radial canals and circular canal. Ostium of nectosac broad and round

Vestigeal nectophore: Round, shield-like in shape, embraced by the larger functional nectophore, 4.5 mm in diameter. Nectosac completely absent. Only three highly reduced radial canals present; characteristically three pronged in structure. Somatocyst as in larger nectophore.

Type locality: Central Atlantic Ocean.

Distribution: (Map 123) Polygastric phase of *A. peltifera* was recorded from a depth of 200–0 m, between South East Coast of Africa and Madagascar during August.



MAP 123. Distribution of *A. peltifera*, *A. ernesti*, *N. diomedeae*, *N. thetis*, *N. natans* and *N. spinosa*. 1 —3 specimens per haul.

95. **Amphicaryon ernesti** Totton, 1954

(Fig. 95 a)

Amphicaryon ernesti Totton, 1954, p. 94, figs. 44, 45.
Amphicaryon ernesti Totton, 1965, p. 113, fig. 63.

Type Specimen: British Museum (Nat. Hist.) London.

Material: Recorded by Totton (1954) from the Red Sea and South and East coast of Africa.

Polygastric phase: Similar to *A. acaule* in shape and size. *Larger functional nectophore:* Proximal region of lateral radial canals branched. Dorsal and ventral radial canals simple and straight. Ostium of nectosac lies some distance from surface. Somatocyst thin and thread-like.

Vestigeal nectophore: Not embraced by larger larval nectophore, circular in shape but not shield-like and flat as in *A. acaule.* Dorsal surface slightly rounded, ventral concave side lies in contact with shallow, conical broad hydroecium of functional nectophore.

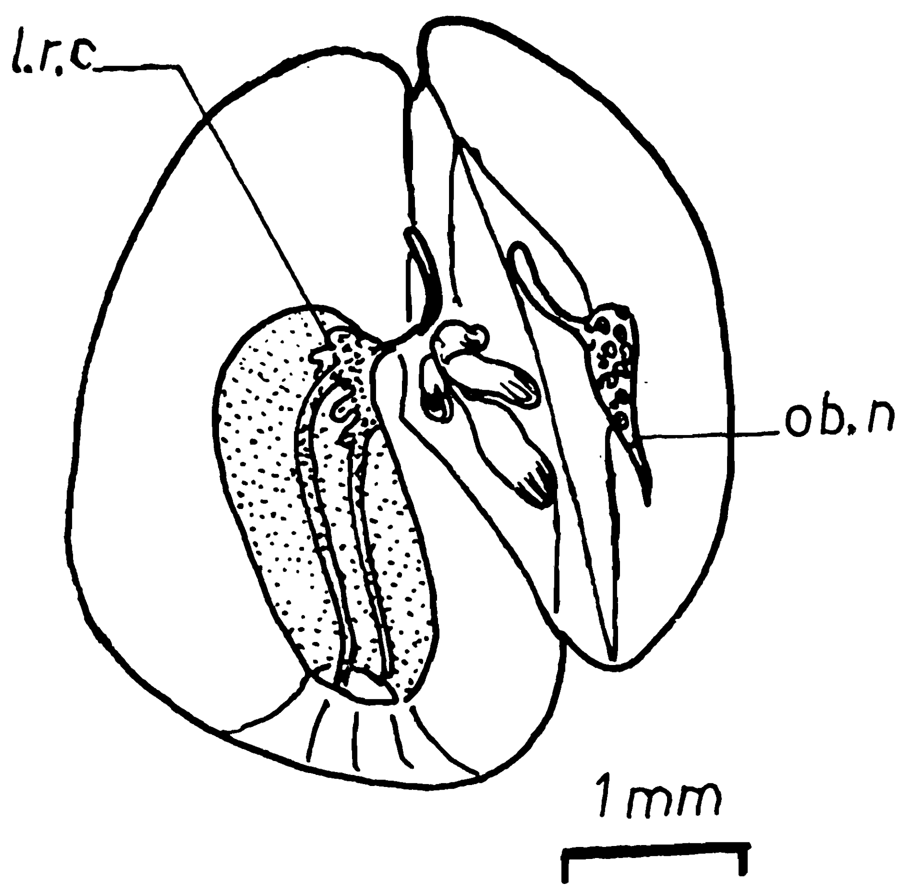


FIG. 95. *A. ernesti* Totton — polygastric phase with hypertrophied lateral radial canals (l r c) and obsolescent nectosac (ob n). (From Totton, 1954, fig. 44).

Nectosac highly reduced or obsolete. Lateral radial canals absent; ventral radial canal form network covering ventral wall of nectosac; only dorsal radial canal present.

Eudoxid phase: unknown.

Type locality: Off south and east coast of Africa.

Distribution: (Map 123). Recorded from the Red Sea and South and East coast of Africa (Totton, 1954).

Sub-family (iii) NECTOPYRAMIDINAE Bigelow, 1911

Monotypic sub-family for genus *Nectopyramis* Bigelow, 1911

Genus 41. **Nectopyramis** Bigelow, 1911a

Nectopyramis Bigelow, 1911a, p. 338.

Archisoma Bigelow, 1911b, p. 266.

Nectopyramidinae with only one nectophore having ridges, angles and serrations. Somatocyst simple or highly branched. Nectosac reduced with four radial canals arising separately from pedicular canal.

Type Species: *Nectopyramis thetis* Bigelow, 1911a.

The following four very distinct, aberrant, diverse species of *Nectopyramis* are recognised as valid; *N. diomedeae* Bigelow, 1911, *N. thetis* Bigelow, 1911a, *N. natans* (Bigelow, 1911) and *N. spinosa* Sears, 1952.

All the four species are recorded from the Indian Ocean.

Key to species of **Nectopyramis**

Polygastric phase:

1.	Somatocyst complexly branched..	2
	Somatocyst simple..	3
2.	Nectophore rhomboid, ovate.	*diomedeae*
	Nectophore triangular...	*thetis*
3.	Nectophore bow-shaped bearing ridges...	*natans*
	Nectophore globular bearing spinose ridges..	*spinosa*

Eudoxid phase:

1.	Bract triangular, or conical in shape; somatocyst with 4 main canals..	2
	Bract elongated, bow-shaped; somatocyst with only 3 main canals, dorsal canal with one lateral branch, ventral canal absent..	*natans*

2. Somatocyst with 4 main canals either simple or branching laterally once... 3

Somatocyst with 4 main canals all complexly branched... *diomedeae*

3. Somatocyst with 4 main canals simple (unbranched); bract smoothly conical like that of *Diphyes*.... *spinosa*

Somatocyst with 4 main canals which branch laterally once.. *thetis*

96. **Nectopyramis diomedeae** Bigelow, 1911
(Fig. 96 a, b)

Nectopyramis diomedeae Bigelow, 1911, p. 191, pl. 1, fig. 1-5.

Nectopyramis diomedeae Totton, 1965, p. 131, pl. XXIII, fig. 5; Text-fig. 74B, 75.

Type Specimen: Museum of Comparative Zoology, at Harvard College, USA.

Material: Recorded from South East Coast of Africa and South East Indian Ocean by Totton (1954).

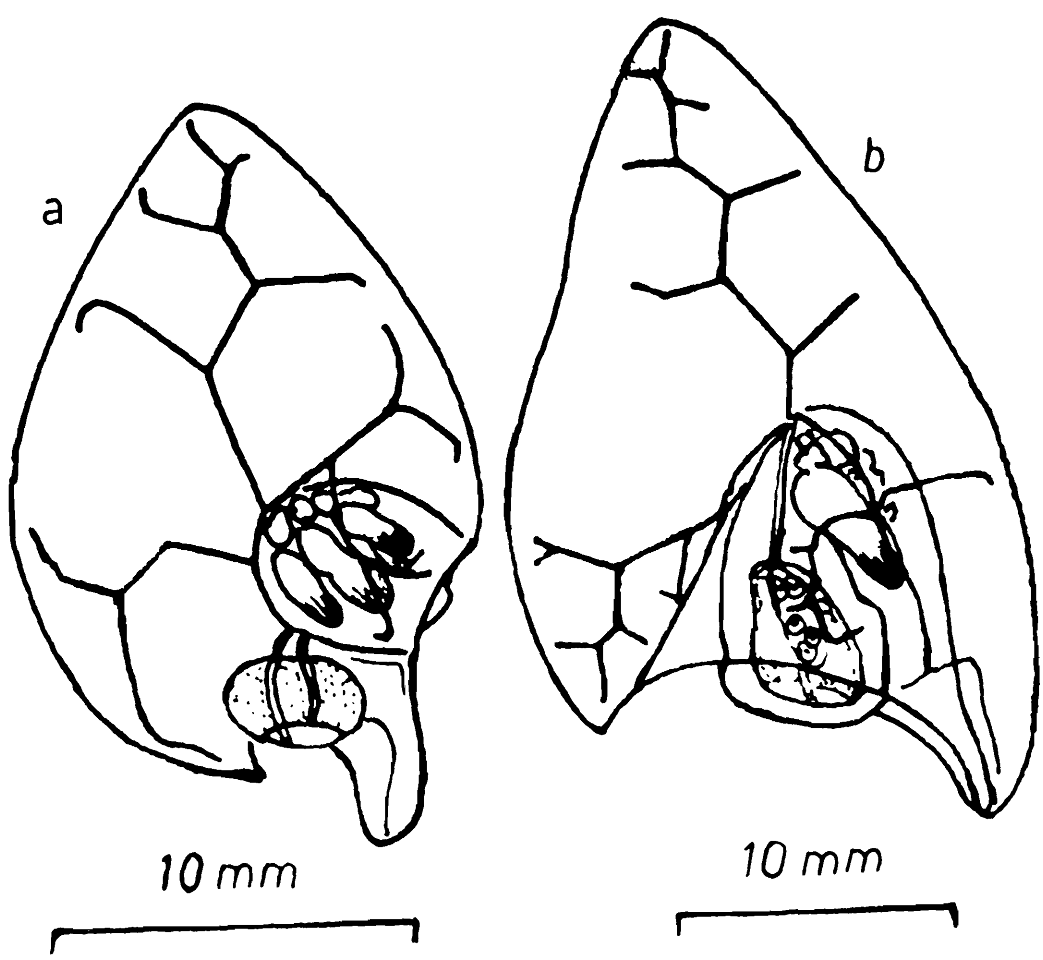


FIG. 96. *N. diomedeae* Bigelow. a. polygastric phase; b. eudoxid phase. (From Bigelow, 1911 b, pl. 1, fig. 5).

Polygastric phase: rhomboid-ovate in shape, pointed apically, 4.5 cm. in length. Nectosac relatively very small, with ostium directed to dorsal side; with four straight radial canals all originating at different points on pedicular canal. With basoventral prominence. With varying number of ridges on nectophore. Hydroecium pocket-shaped, deep, with curved slit-like ostium on ventral side. Somatocyst complexly branched.

Eudoxid phase: Bract large, 3.3. cm in length, triangular in shape, resembling nectophore of polygastric phase. Somatocyst in young bract with 4 main canals, dorsal, ventral and two hydroecial (left and right canals); in older bract these canals rebranch in complex manner. Large gonophore with manubrium bearing gonad occurs within deep conical hydroecium.

Type locality: Eastern Tropical Pacific.

Distribution: (Map. 123): Recorded from South Coast of Africa and South Eastern Indian Ocean.

97. **Nectopyramis thetis** Bigelow, 1911

(Fig. 97 a, b)

Nectopyramis thetis Bigelow, 1911a, p. 338, pl. 28, fig. 1–4.
Nectopyramis thetis Totton, 1965, p. 135, Text-figs. 76-77.

Type Specimen: Museum of Comparative Zoology at Harvard US and US National Museum.

Material: Recorded from South East coast of Africa and South East Indian Ocean by Totton, (1954).

Polygastric phase: Dorsal face (opposite hydroecium) triangular in shape, curving over below level of nectosac on ventral side. Hydroecium deep, extending along entire length of nectophore. Somatocyst with upper median branch extending to apical angle; decending branch extending beyond nectosac; left and right hydroecial canals lying below level of 'central organ' at deepest part of hydroecium; a pair of right and left dorsal canals run toward dorso-lateral angles. Nectosac on ventral side at base with 4 radial canals arising separately from pedicular canal.

Eudoxid phase: Similar to nectophore of polygastric phase in possessing two lateral, angular prominences and an apical angle. With prominent 'central organ' Bracteal canals—four—a dorsal ascending (C^3) with a short branch to surface two hydroecial canals, each with lateral branch and a ventral descending canal (C^4). Asexual nectophore with 4 radial canals arising separately from pedicular canal.

Type locality: Bay of Biscay.

Distribution: (Map 123): Recorded from SE Coast of Africa, South and Eastern Indian Ocean.

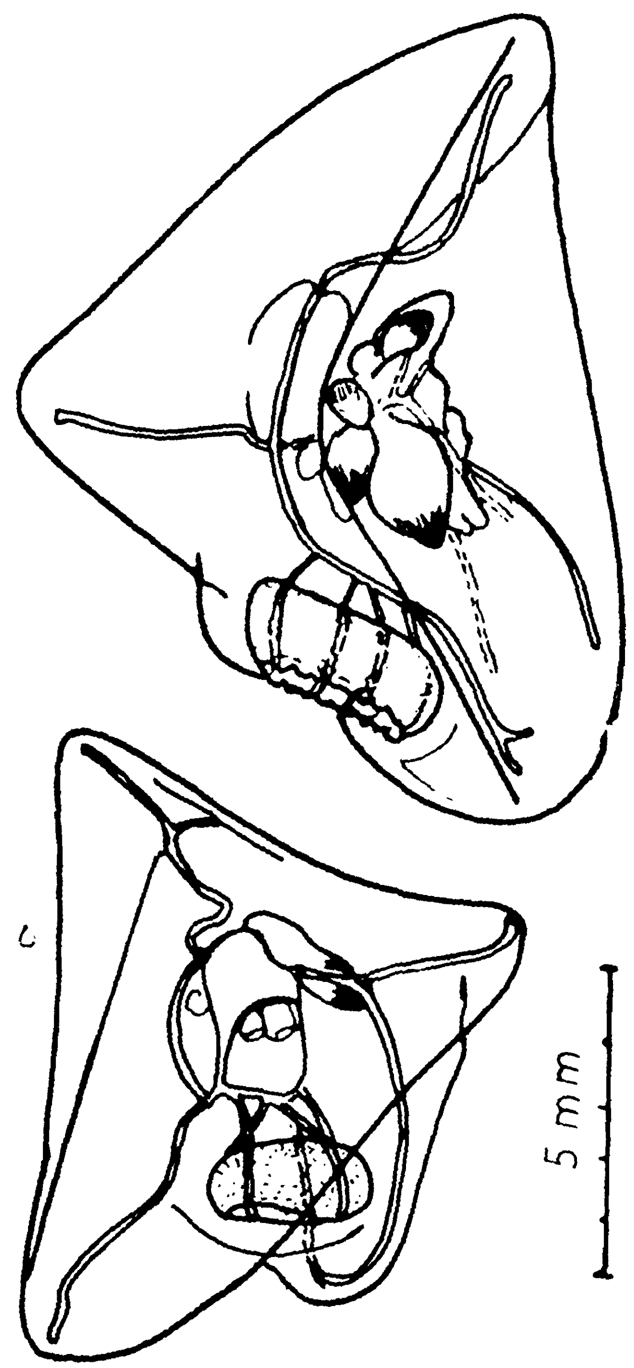


FIG. 97. *N. thetis* Bigelow. a. polygastric phase; b. eudoxid phase. (After Totton, 1965, fig. 76).

98. **Nectopyramis natans** (Bigelow, 1911b)
(Fig. 98 a, b)

Archisoma natans Bigelow, 1911, p. 266, pl. fig. 6,
Nectopyramis natans Totton, 1965, p. 135, pl. XXVII, fig. 4. Text-fig. 78.

Type Specimen: Museum of Comparative Zoology at Harvard college, USA.

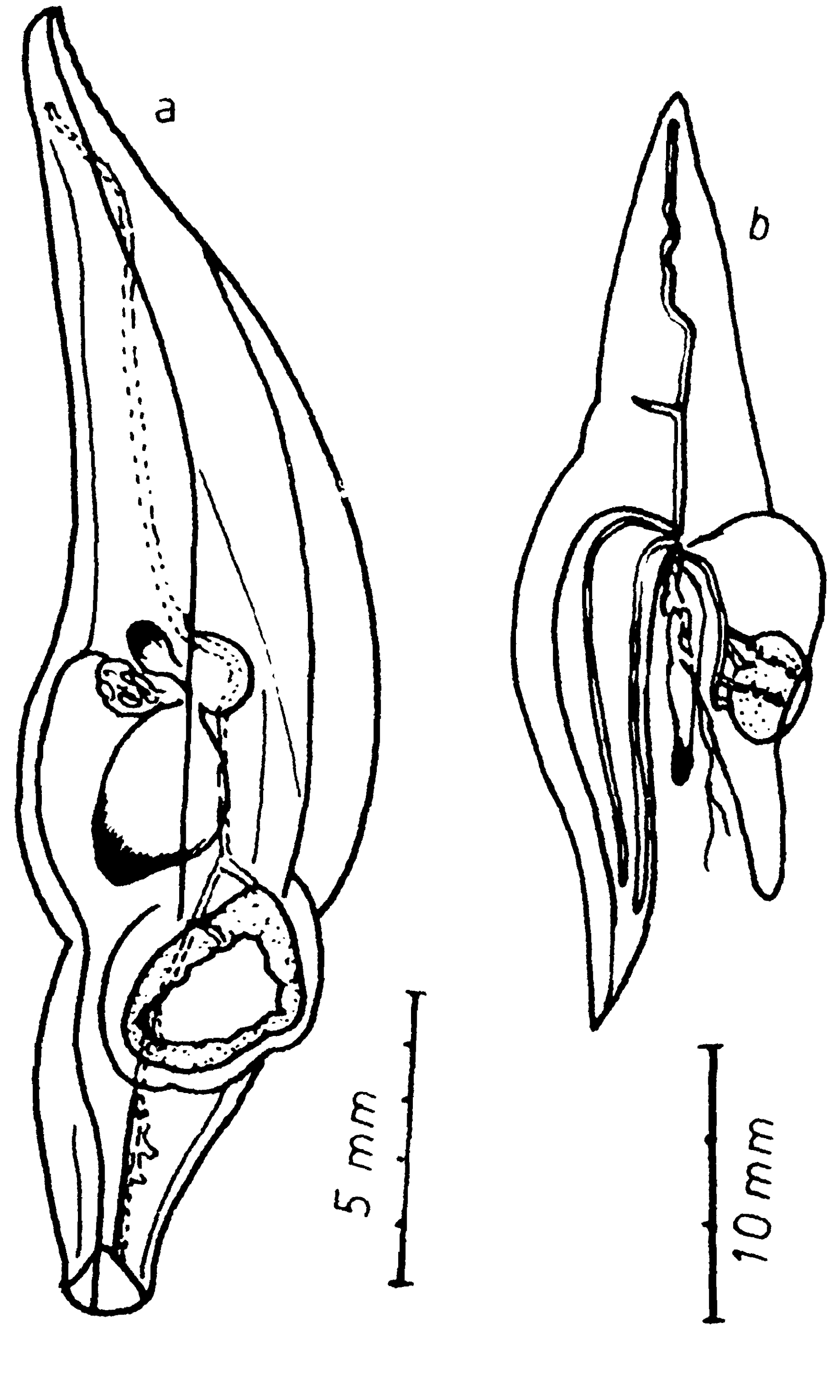


Fig. 98. *N. natans* (Bigelow). a. polygastric phase; b. eudoxid phase. (From Totton, 1954, fig. 38).

Material: Recorded from South East coast of Africa and South East Indian Ocean by Totton (1954).

Polygastric phase: Elongated, 2 cm in length, bow-shaped, pointed apex, truncated base. Three longitudinal ridges on dorsal surface extending from apex to nectosac, and a pair of lateral ridges extending entire length of nectophore. Hydroecium shallow, groove like extending entire length with deeper depression in mid-region. Somatocyst simple extending from tip to truncated end, with a bend in mid-region round 'central organ' Radial canals arising separately from pedicular canal.

Eudoxid phase: Bract 54 mm long, elongated, triangular in cross section in mid-region. Hydroecium as in polygastric phase. Somatocyst with long dorsal canal (C^3) extending upto tip of bract giving off a lateral branch toward dorsal surface; a pair of hydroecial canals uniting below hydroecium. Ventral canal and spur canals absent. Gonophores occur as small bunch at base of gastrozooid. Special nectophore 31 mm long, within bracteal cavity, with a groove like long hydroecium; radial canals as in polygastric phase.

Type locality: Eastern Tropical Pacific.

Distribution: (Map 123). Recorded from South East coast of Africa and South Eastern Indian Ocean (Totton. 1954).

99. **Nectopyramis spinosa** Sears, 1952
(Fig. 99 a, b)

Nectopyramis spinosa Sears, 1952, p. 1–4, fig. 1–3.
Nectopyramis spinosa Daniel, 1974, p. 91, Text-fig. 7, E, F.

Type Specimen: US National Museum.

Material: South West/South East Monsoon Season: *South East Indian Ocean:* 1 lar. nect. (Daniel, 1974)

Polygastric phase: Larval nectophore caducous with highly reduced or vestigeal nectosac. Second definitive nectophore as a bud within hydroecium.

Definitive nectophore: Globular with a reduced functional nectosac. Radial canals arise separately. Somatocyst simple, unbranched bent over deep conical hydroecium.

Characterised by a complex arrangement of spiny ridges—peri-hydroecial ridge; horizontal figure-of-eight ridge, a pair of horizontal buccal ridges and, a connecting dorsal ridge.

Eudoxid phase: Bract conical 6 mm long, 4 mm broad, slightly compressed on lateral sides. Hydroecium deep, conical with an oblique ostium. Bracteal canals with 4 simple unbranched canals-dorsal (C^3), ventral (C^4), left and right hydroecial canals. No spur canal. Gastrozooid with a ring of dark pigment near mouth. Asexual nectophore elongate with long pedicular canal; radial canals simple originating from pedicular canal at same point. Ostium of nectosac oblique. Gonophores small, with long pedicels occur at base of gastrozooid. Female gonophore bearing six large eggs on the manubrium.

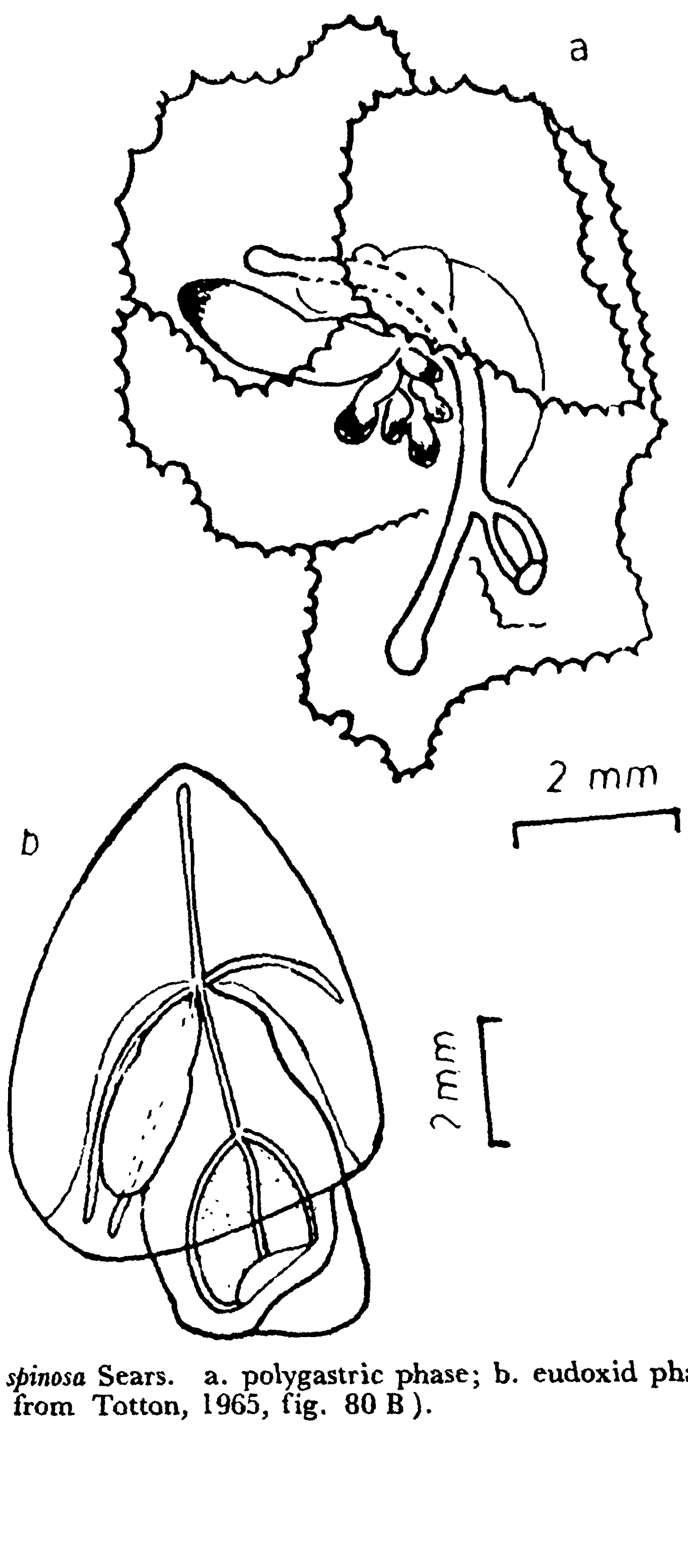


FIG. 99. *N. spinosa* Sears. a. polygastric phase; b. eudoxid phase. (Fig. b, from Totton, 1965, fig. 80 B).

Type locality: Indian Ocean.

Distribution: (Map 123). Recorded from South and Eastern Indian Ocean (Totton 1954), Seychelles and Chagos Archipelago (Browne, 1926) and South of Equator (2°S lat. 91°E long.) during September from a depth of 1000–0 m (Daniel, 1974).

100. **Vogtia serrata** Moser, 1925
(Fig. 100)

Vogtia serrata Moser, 1925, p. 420, pl. 27, fig. 6–8; pl. 28, fig. 4–9.
Vogtia serrata Totton, 1965, p. 142, Text-fig. 81, 5, pl. XXVII fig. 3.

Type Specimen: Museum Für Naturkunde, Berlin.

Material: Recorded from south and east coast of Africa (Totton, 1954).

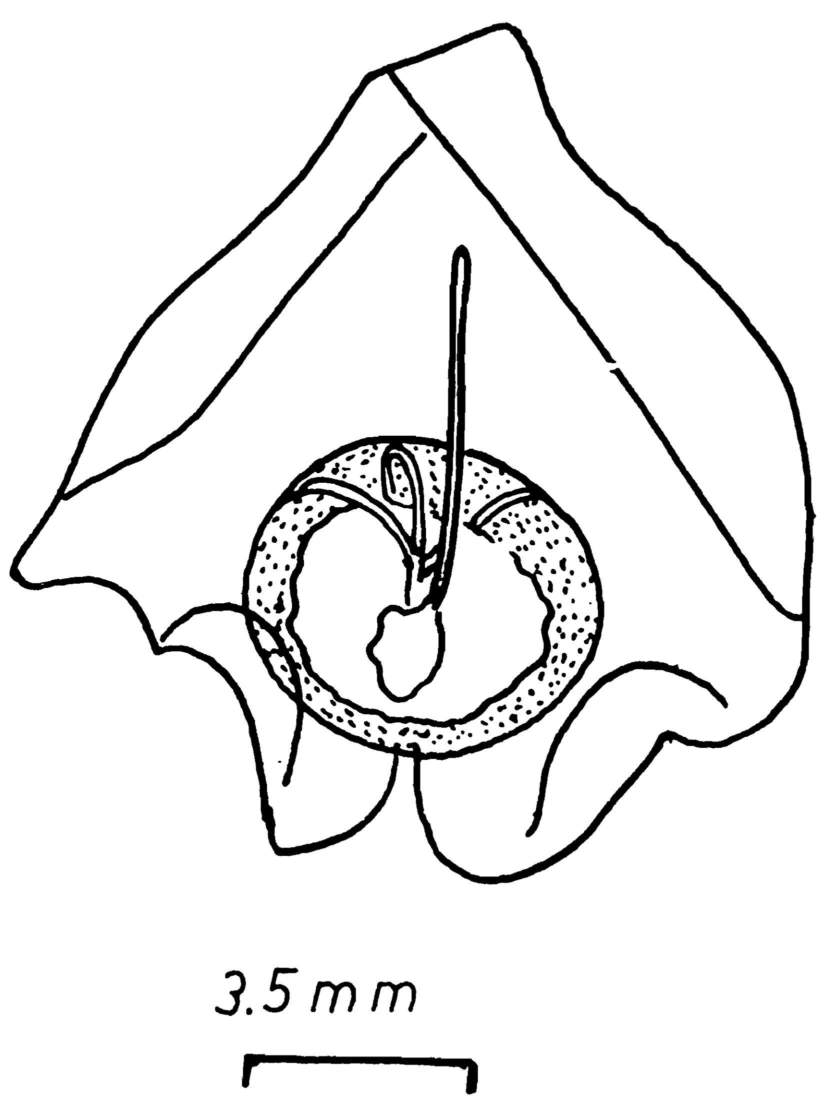


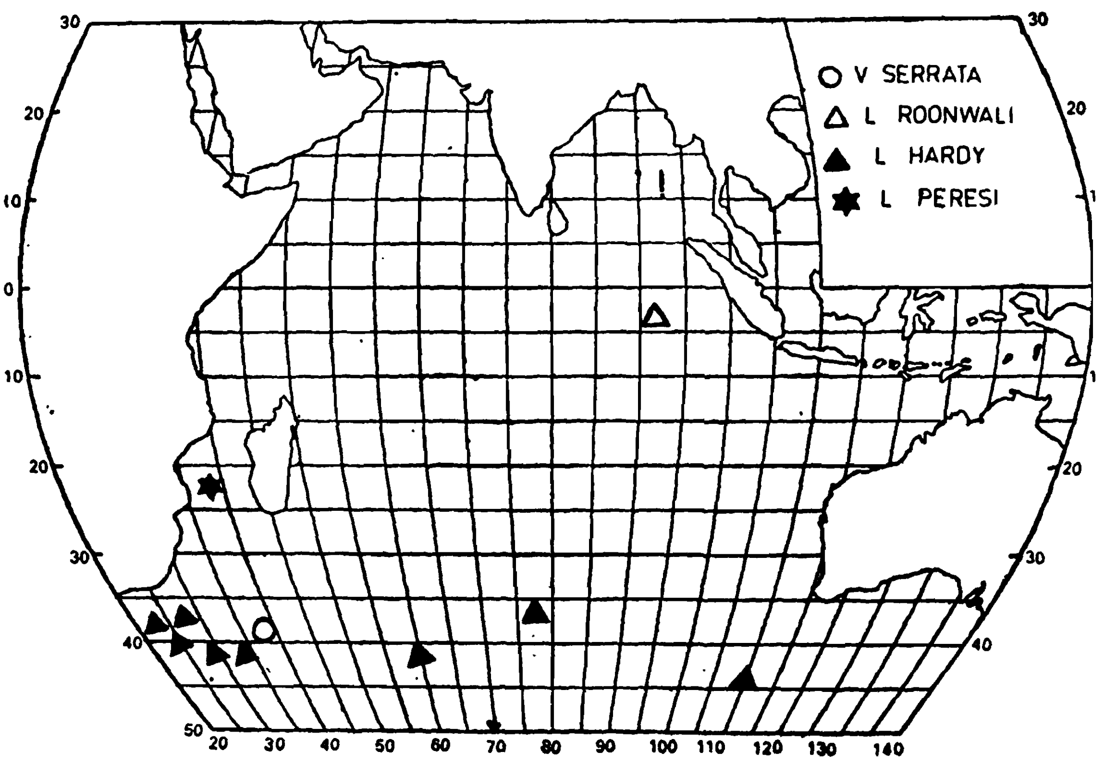
FIG. 100. *V. serrata* Moser; single nectophore. (From Totton, 1965, fig. 81, 5).

Definitive nectophore: In appearance it is intermediate between *V pentacantha* and *V. glabra;* large, longer than broad, triangular in shape; with facets and ridges smooth and devoid of spines. Differs from all other species of *Vogtia* in possessing deep hollows under baso-lateral corners, on either side of ostium.

Somatocyst, radial canals, nectosac, hydroecium, stem, cormidia as in other species of *Vogtia*.

Type locality: Antarctic Ocean.

Distribution: (Map 124). Recorded from South and East coast of Africa. It is a cold water species (Totton, 1954).



MAP 124. Distribution of *Vogtia serrata*, *L. roonwali*, *L. hardy* and *L. peresi*. 1 — 3 specimens per haul.

101. **Lensia roonwali** Daniel, 1970

(Fig. 101, a, b)

Lensia roonwali Daniel, 1970, p. 149, fig. 1 b & c.

Lensia roonwali Daniel, 1974, p. 135, Text-fig. 12, B & C.

Type Specimen: Zoological Survey of India, Calcutta, India

Material: SOUTH WEST/SOUTH EAST MONSOON SEASON: *South East Indian Ocean:* 1 n. (Daniel, 1974).

Polygastric phase: Anterior nectophore: Very small, 2.5 mm in length, 1.5 mm in breadth with 5 ridges-dorsal, laterals and left ventral complete, extending from apex to base, right ventral incomplete originating near apex and reaching base, all ridges slightly twisted; dorsal ridge displaced toward right. Nectosac large with very little mesoglea between walls of nectosac and nectophore; ostium round, large, wide open. Hydroecium nearly absent. Somatocyst small (0.33 mm.) and stalked. Ventral facet rounded sloping upwards. No baso-ventral ridge.

Remark: Probably young stage of *L. campanella.*

Posterior nectophore: Not identified.

Eudoxid phase: Not identified.

Type locality: Lat. 2° 03′ S; Long. 91°27′E (From 1000–0 m), Indian Ocean.

Distribution: (Map 124). Recorded from 20°S Lat., 91° E Long. from a depth of 1000–0 m during September.

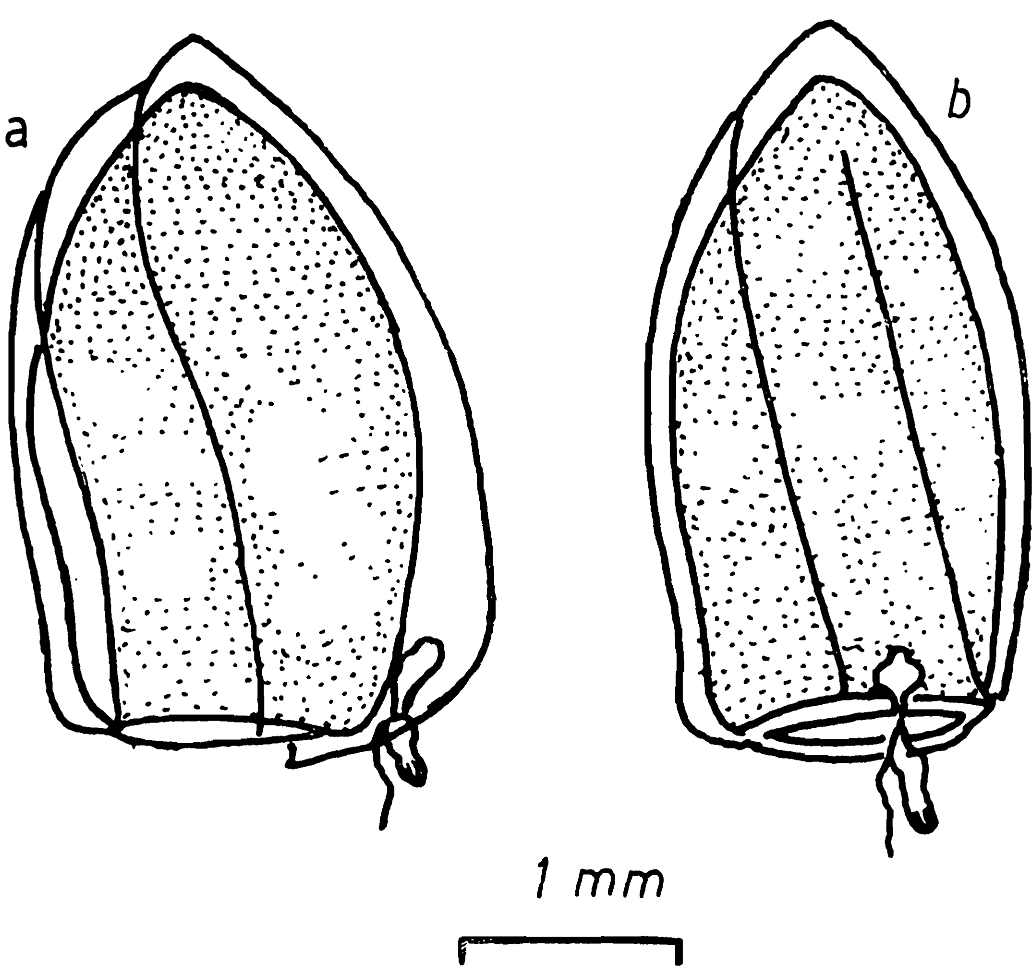


FIG. 101. *L. roonwali* Daniel. a. anterior nectophore — lateral view; b. ventral view.

102. ? **Lensia peresi** Patriti, 1970
(Fig. 102 a, b)

Lensia peresi Patriti, 1970, p. 103, fig. 1.

Type Specimen: Museum d'Histoire Naturelle, Paris & Station Marine d'Endoume, Marseilles (holotype & paratype respectively).

Material: Recorded between Madagascar and South East Coast of Africa (Patriti, 1970).

Polygastric phase: Anterior nectophore: 5.0 mm long, 3.5 mm wide, with 5 complete straight ridges. Somatocyst ovoid, inclined ventrally, with a short stalk. Hydroecium reduced, at ventral corner of ostium. Mouth-plate slightly overlapping.

Posterior nectophore: Unknown.

Eudoxid phase: Unknown.

Type locality: Off Madagascar, S. W. Indian Ocean.

Distribution: (Map 124). Recorded between South East Coast of Africa and Madagascar.

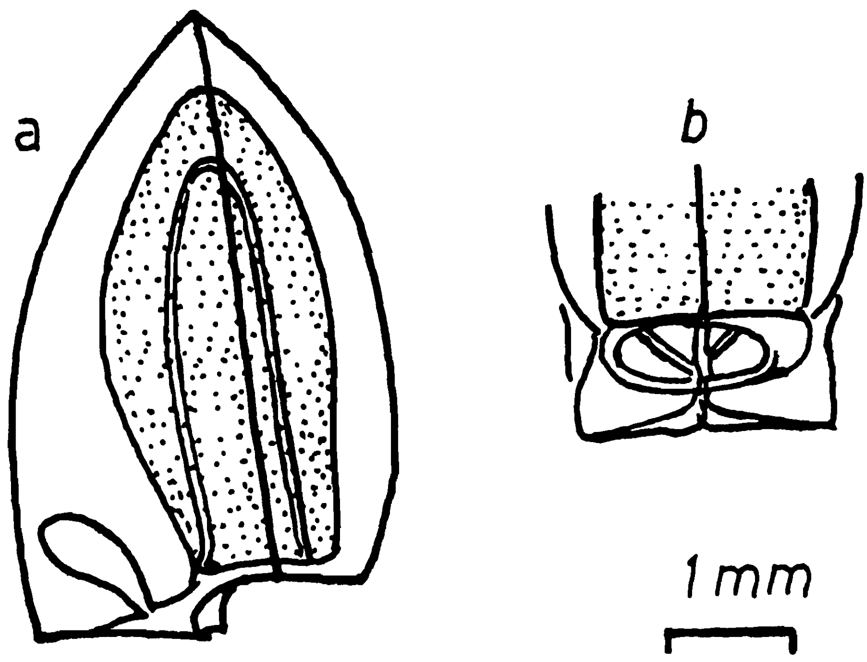


FIG. 102. *L. peresi* Patriti. a. anterior nectophore lateral view; b. dorsal view. (After Patriti, 1970, fig. 1).

103. **Lensia hardy** Totton, 1941
(Fig. 103 a–e)

Lensia hardy Totton, 1941, p. 153, fig. 10.
Lensia hardy Totton, 1965, p. 171, fig. 111.

Type Specimen: British Museum (Nat. Hist.), London.

Material: SOUTH WEST/SOUTH EAST MONSOON SEASON: *South East Indian Ocean:* 2 a.n.; 2 p.n. NORTH EAST/NORTH WEST MONSOON SEASON: *South West Indian Ocean:* 5 a.n.; 3 p.n.; 24 br.; 23 go. *South East Indian Ocean:* 1 p. n.

Polygastric phase: Anterior nectophore: Upto 14.3 mm in length, 5.3 mm in breadth, slenderly pyramidal; with 5 complete straight longitudinal ridges. Hydroecium 1.0. mm deep, sloping toward blunt notch (diagnostic feature) on ventral side. Somatocyst globular with thin short stalk, occurring on slopping hydroecium,

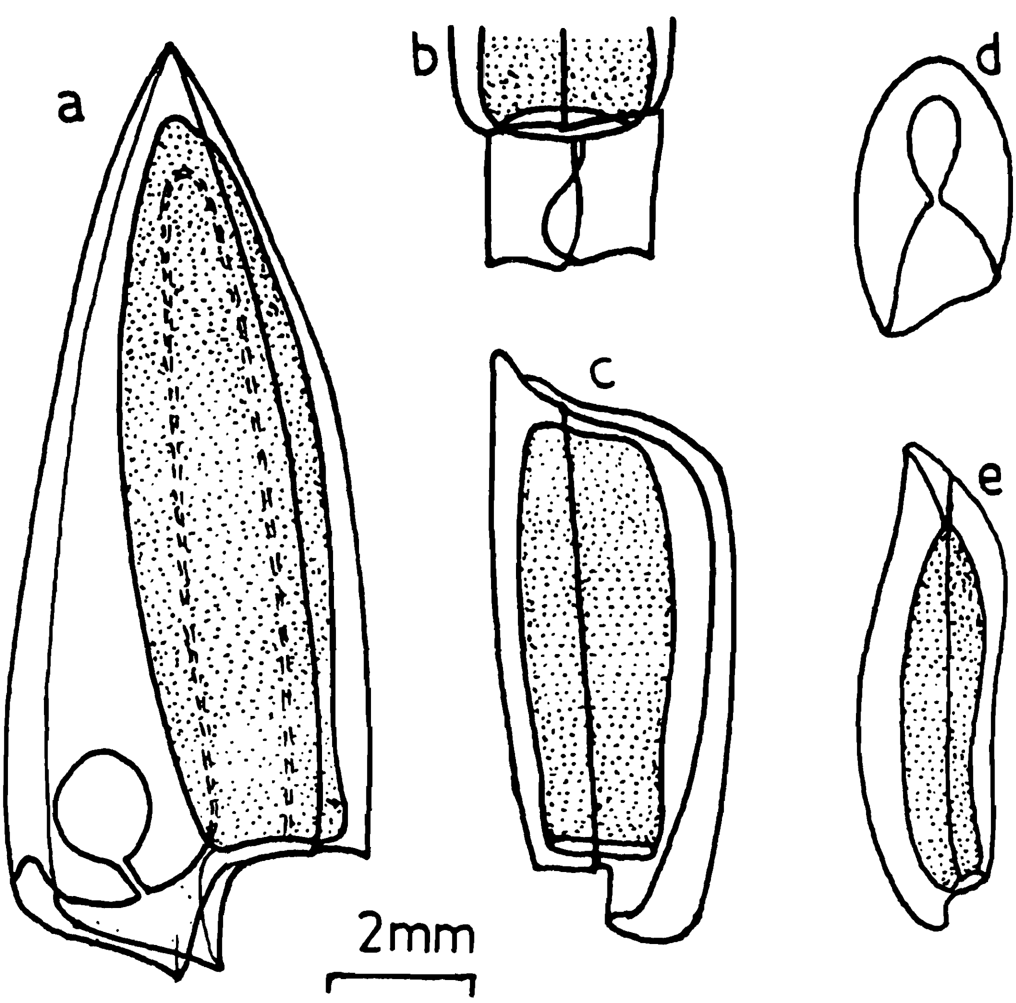


FIG. 103. *L. hardy* Totton (a–e). a. anterior nectophore, lateral view; b. dorsal view; c. posterior nectophore; d. bract; e. gonophore.

inclined toward ventral wall. Mouth-plates long; in dorsal view, margin of left flap straight overlapping larger, rounded flap.

Posterior nectophore: Upto 8.7 mm in length. Dorsal proximal end extended, fitting into ventro-basal notch of anterior nectophore. With 5 complete straight ridges, ventrals ending in mouth-plate. Hydroecium grooved.

Eudoxid phase: *Bract:* 4.5 mm in length, 2.4 mm in breadth, with blunt apex, ovoid in shape. Hydroecium (bracteal cavity) deep, conical. Somatocyst (phyllocyst) oval-shaped. Neck shield smooth, very short with a shallow notch on margin.

Gonophore: 7.7. mm in length; proximal end not truncated; produced into a conical extension which fit, into deep bracteal cavity. Ridges as in posterior nectophore. No gonad bearing manubrium present.

Type locality: Lat. 33°20′S; Long. 15°18′ E, South Atlantic Ocean.

Distribution: (Map 124). *L. hardy* is a cold-mid-water species occurring between 34°18′S -44°36′S lattitudes and 24°09′-110°03′ longitudes, (200–0 m) *i.e.* in the sub-antarctic convergence belt. It occurred during October, December and January. Previous records were from 1200–1300 m from Antarctic Ocean.

104. **Lensia minuta** Patriti, 1970

(Fig. 104 a, b)

Lensia minuta Patriti, 1970, p. 104, fig. 2.

Type Specimen: Museum d'Histoire Naturelle, Paris and Station Marine d'Endoume, Marseille (holotype & paratype respectively).

Material: Recorded between South East Coast of Africa and Madagascar (Patriti, 1970).

Polygastric phase: *Anterior Nectophore:* Small 2.0 mm long, slender, with 5 slightly curved complete ridges, deeply grooved on either side of lateral ridges. Somatocyst with very short thick stalk, ovoid at level of ostium. Hydroecium below level of ostium, narrowing towards ventral side. Baso-ventral wall rounded and sloping. Mouth-plates broad and overlapping. Nectosac with pointed apex.

Poterior nectophore: Unknown.

Eudoxid phase: Unknown.

Type locality: Off Madagascar, S. W. Indian Ocean.

Distribution: (Map 125). Recorded between South East Coast of Africa and Madagascar.

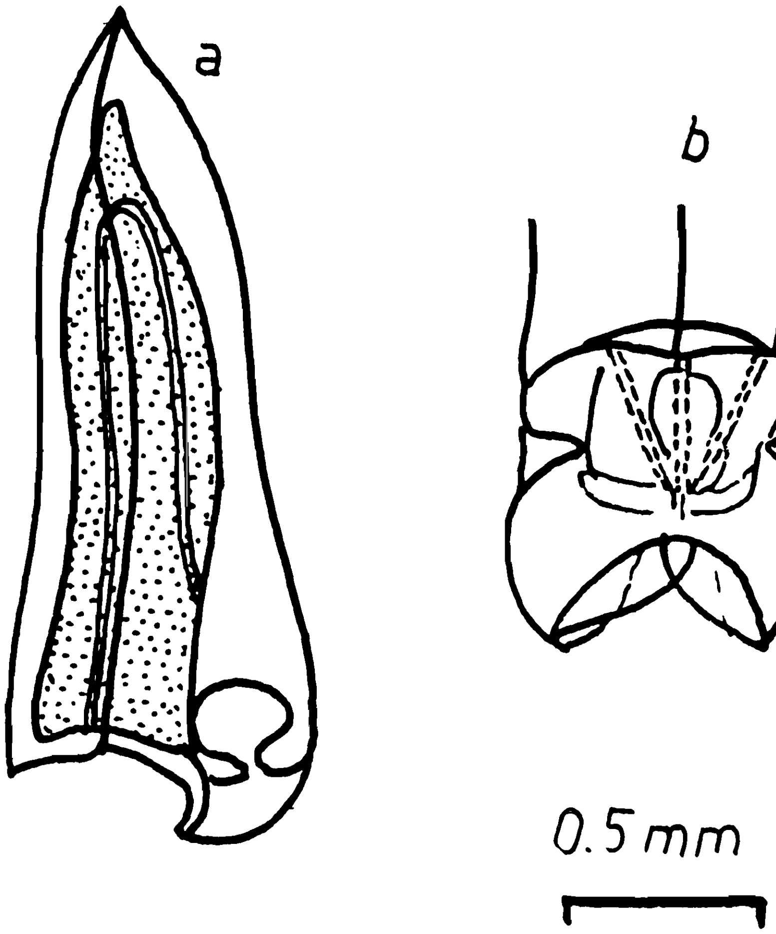
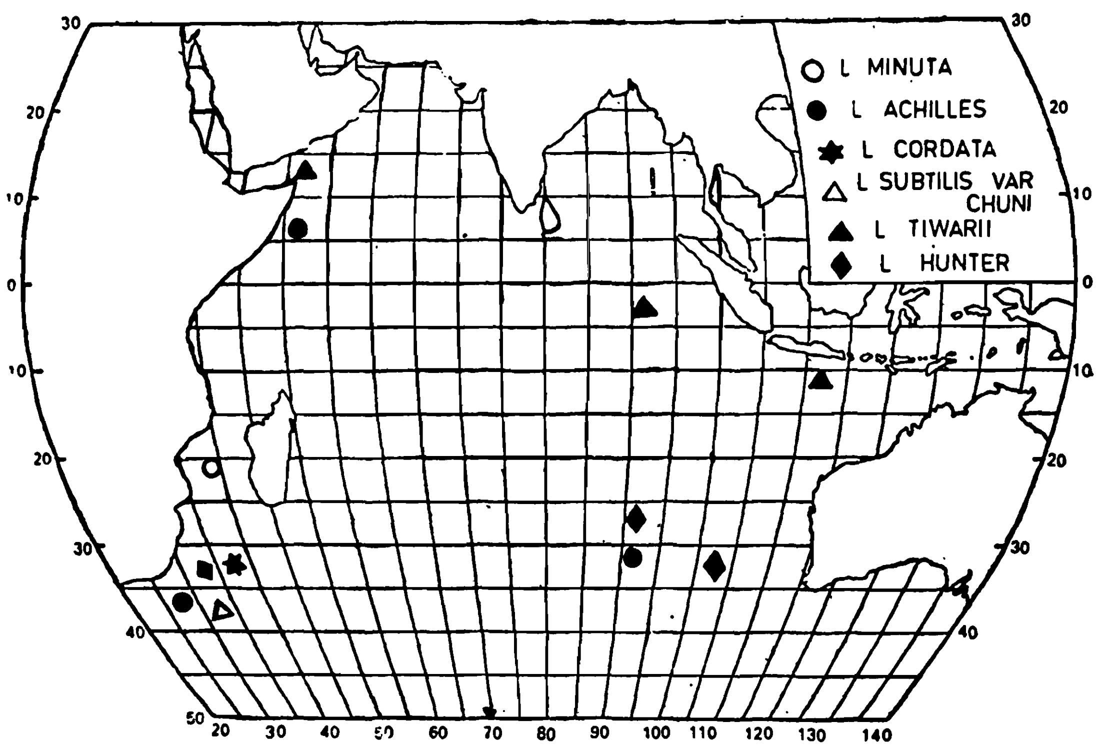


FIG. 104. *L. minuta* Patriti. a. anterior nectophore — lateral view; b. dorsal view. (From Patriti, 1970, fig. 2).



MAP 125. Distribution of *L. minuta*, *L. achilles*, *L. cordata*, *L. subtilis* var *chuni*, *L. tiwarii* and *L. hunter*. 1–3 specimens per haul.

105 **Lensia achilles** Totton, 1941
(Fig 105)

Lensia achilles Totton, 1941, p. 149, fig. 6, 7.
Lensia achilles Totton, 1965, p. 171, fig. 106.

Type Specimen: British Museum (Nat. Hist.), London.

Material: Recorded from South and East Coast of Africa (Totton, 1954).

Polygastric phase: Anterior nectophore: Coloured deep or bright orange in life. Five complete ridges, basal ends of laterals bending dorsad. Vault of hydroecium level with ostium with deep notch on baso-ventral margin. Somatocyst spindle-shaped. Mouth-plates medium sized and overlapping.

Posterior nectophore: Not identified with certainty.

Eudoxid phase: Not known.

Type locality: Lat. 33°07′ S; Long. 4°30′ E off S.W. Africa.

Distribution: (Map 125). Recorded from South and East coast of Africa, from a depth of 2500–2000 m, 1000–900 m.

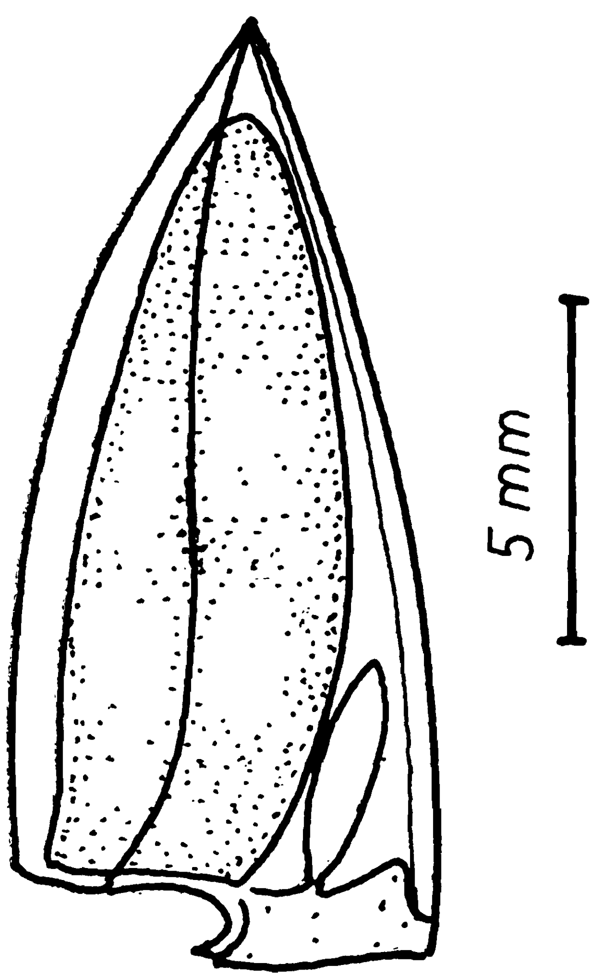


Fig. 105. *L. achilles* Totton; anterior nectophore. (From Totton, 1941, fig. 6).

106. **Lensia cordata** Totton, 1965 b
(Fig. 106)

Lensia cordata Totton, 1965 b, p. 7; fig. 2.

Type Specimen: British Museum (Nat. Hist.), London.

Material: Recorded from east coast of Africa (Totton, 1965).

Polygastric phase: Anterior nectophore: Upto 10.5 mm in length, pentagonal with five crested longitudinal complete ridges resembling *L. achilles* and *L. baryi.* Lateral ridges turn dorsal at their ostial end. Hydroecium shallow, slope toward ventral side, lying below ostial level. Somatocyst squat, heart-shaped; mouth-plates rounded and overlapping.

Posterior nectophore: Not known.

Eudoxid phase: Not known.

Type locality: East Coast of Africa, Indian Ocean.

Distribution: (Map 125). Recorded from the East coast of Africa with a closing net from a depth of 950–650 metres.

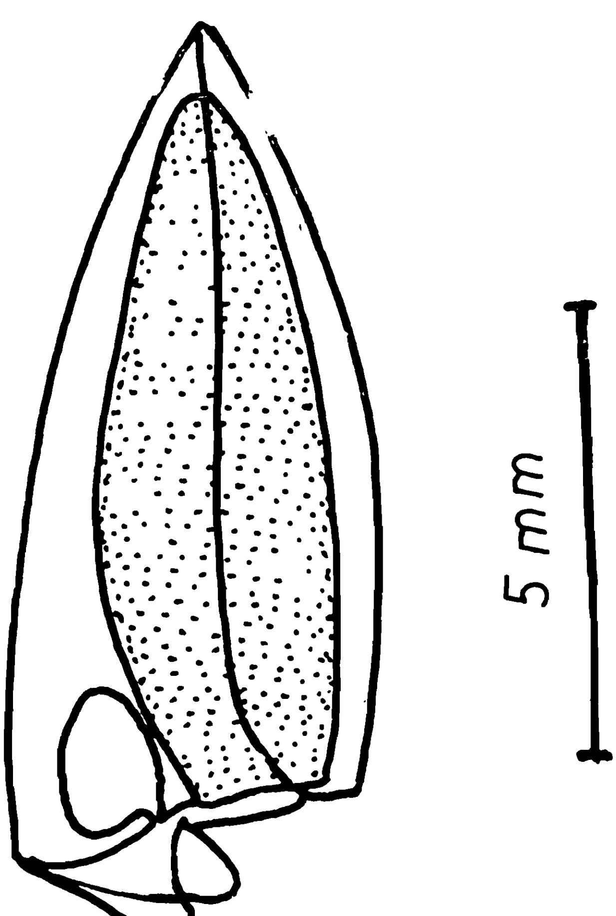


FIG. 106. *L. cordata* Totton, anterior nectophore. (From Totton, 1965 b, fig.2).

Lensia subtilis var chuni Totton, 1965
(Fig. 107)

Lensia subtilis var *chuni* Totton, 1954; Fig. 57, B, C, D.
Lensia subtilis var *chuni* Totton, 1965, p. 170,

Type Specimen: British Museum (Nat. Hist.), London.

Material: SOUTH WEST/SOUTH EAST MONSOON SEASON: *South East Indian Ocean:* 38 a.n.; 10 p.n.; 1 eu. (compl.); 26 go. NORTH EAST/NORTH WEST MONSOON SEASON: *South West Indian Ocean:* 8 a.n.

Polygastric phase: Anterior nectophore: About 3.0 mm long, with blunt apex, or proper ridges, resembling *L. subtilis*. Somatocyst with thin, short stalk and globular tip; stalk longer than that of *L. meteori*. Baso-ventral side oblique. Hydroecium absent. Mouth-plates small with rounded edges.

Type locality: South and East coast of Africa.

Distribution: (Map. 125). Recorded from South and East Coast of Africa.

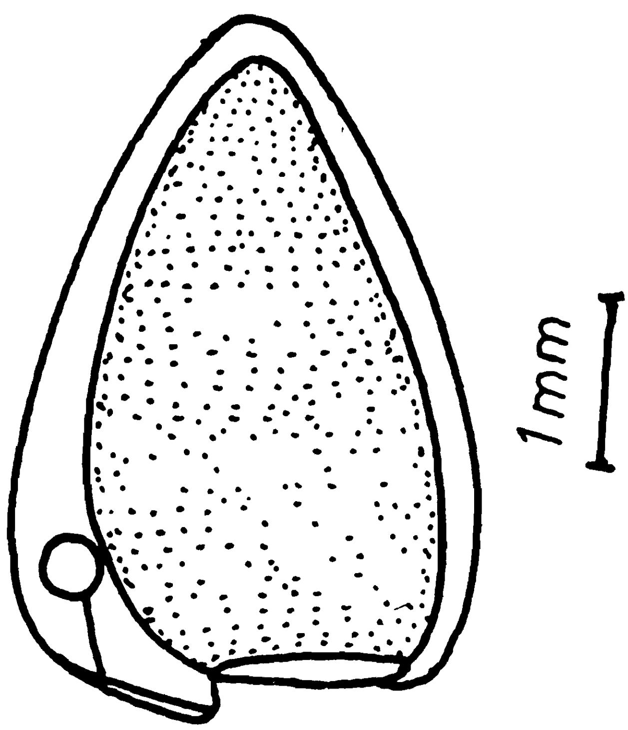


FIG. 107. *L. subtilis* var *chuni* Totton, anterior nectophore.

107. **Lensia tiwarii** Daniel, 1970
(Fig. 108)

Lensia tiwarii Daniel, 1970, p. 151, fig. 1 C.
Lensia tiwarii Daniel, 1974, p. 146, Text-fig. 12, D.

Type Specimen: Zoological Survey of India, Calcutta, India.

Material: SOUTH WEST/SOUTH EAST MONSOON SEASON: *South East Indian Ocean:* 1 a.n. NORTH EAST/NORTH WEST MONSOON SEASON: *Arabian Sea:* 1 a.n.

Polygastric phase: Anterior nectophore: Very small, 3.0 mm in length, 2.26 mm in width, smooth, rounded, with blunt apex. Without ridges. Nectosac large and rounded, with very little mesoglea between it and nectophore; ostium rounded in appearance. Ventro-basal edge oblique and above level of ostium. Hydro-

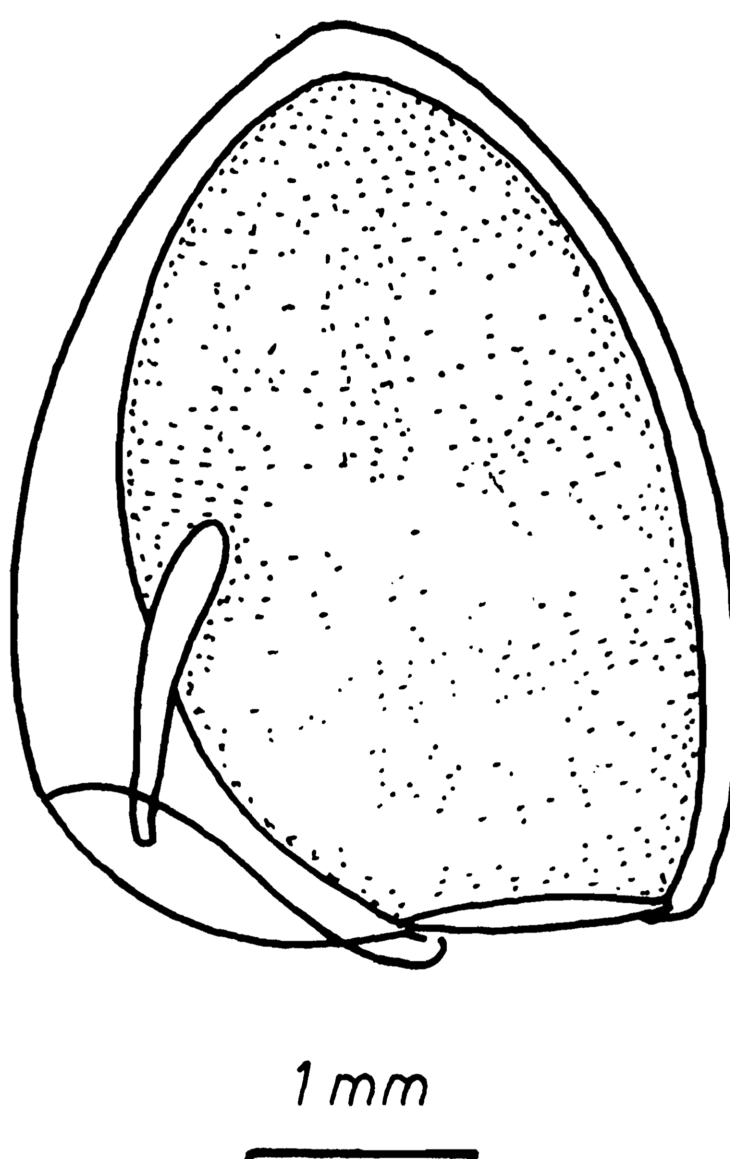


FIG. 108. *L. tiwarii* Daniel, anterior nectophore.

ecium absent. Somatocyst slender uniformly thick, with short stalk, arising from middle of basal facet and inclined over nectosac. Mouth-plates very small lying close to ventral corner of nectosac near ostium.

Posterior nectophore: Unknown.

Eudoxid phase: Unknown.

Type locality: Lat. 2°3′ S; Long. 91°27′E Indian Ocean.

Distribution: (Map 125). Recorded from South and Eastern Indian Ocean, from a depth of 1000–0 m during September (2°S lat.; 91°E long.)

108. **Lensia hunter** Totton, 1941
(Fig. 109)

Lensia hunter Totton, 1941, p. 154, figs. 11, 12.
Lensia hunter Daniel, 1974, p. 147, Text-fig. 11 A. (cf. for synonymy)

Type Specimen: British Museum (Nat. Hist.), London.

Material: SOUTH WEST/SOUTH EAST MONSOON SEASON: *South West Indian Ocean:* 1 a.n. *South East Indian Ocean:* 1 a.n.

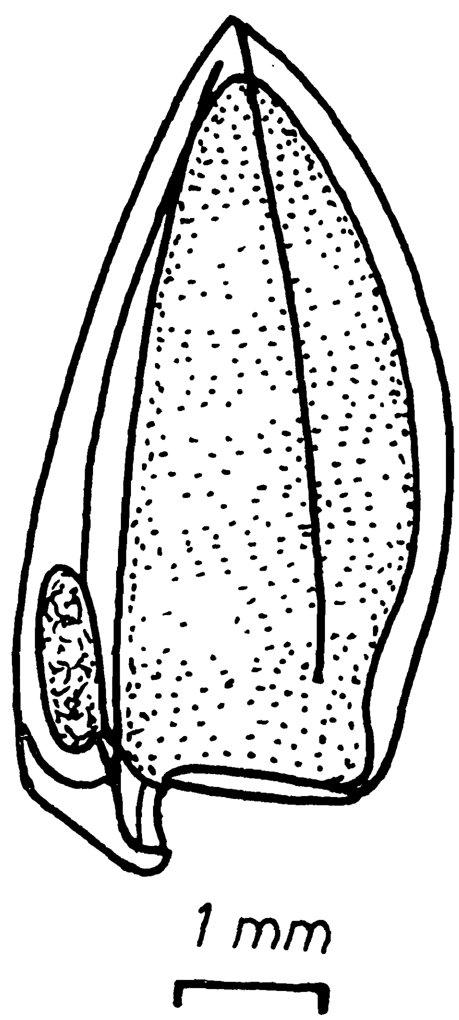


FIG. 109. *L. hunter* Totton, anterior nectophore. (From Totton, 1941, fig. 11).

Polygastric phase: Anterior nectophore: Upto 10.0 mm in length. With 7 longitudinal ridges—one dorsal, two dorso-laterals, two ventro-laterals and two ventrals as in *L. multicristata;* dorsal and ventrals complete reaching apex and base of ostium; dorso-laterals incomplete originating from apex but terminating well above ostium; ventro-laterlas also incomplete, arising near apex extending down to lateral edges of mouth-plate. Hydroecium obliquə, basal wall on ventral side of pedicel of somatocyst curving off to ventral facet. Somatocyst 2.5 mm long bilobed or slightly irregular in shape, asymmetrical with a thin short stalk. Nectosac bulged in middle, with smaller ostium.

Poterior nectophore: Not identified.

Eudoxid phase: Not identified.

Type locality: Lat. 31°54′ S; Long. 88°17′ W. Off West coast of S. America (Pacific Ocean).

Distribution: (Map 125). Recorded from South and East Coast of Africa and also from 32°S lat. and 103°E long. during August. Both the records were from 1000–0 m. depth.

109. **Lensia havock** Totton, 1941
(Fig. 110 a, b)

Lensia havock Totton, 1941, p. 159, figs. 17–19.
Lensia havock Totton, 1965, p. 175, fig. 114.

Type Specimen: British Museum (Nat. Hist.), London.

Material: SOUTH WEST/SOUTH EAST MONSOON SEASON: *South West Indian Ocean*: 1 a.n.

Polygastric phase: Anterior nectophore: 16.5 mm length, with 7 complete ridges—one dorsal, two doral-laterals, two ventro-laterals and two ventrals; dorsal ridge extend beyond velar level forming a small tooth-like projection; ventro-laterals curve over toward ventral side joining mouth-plates. Hydroecium deep, with flat vault, extending well above level of ostium, with a deep conical notch on ventral wall. Somatocyst small, club-shaped mouth-plates long, overlapping.

Posterior nectophore: Unknown.

Eudoxid phase: Unknown.

Type locality: Off Bermuda.

Distribution: (Map 126). Deep to mid-water species recorded between 100–1400 metres. In the I.I.O.E. collection it occurred along the southern tip of Africa during April. Previous record of this species by Totton (1954) was also from this region, taken from a depth of 1646 m; 3000–0 m.

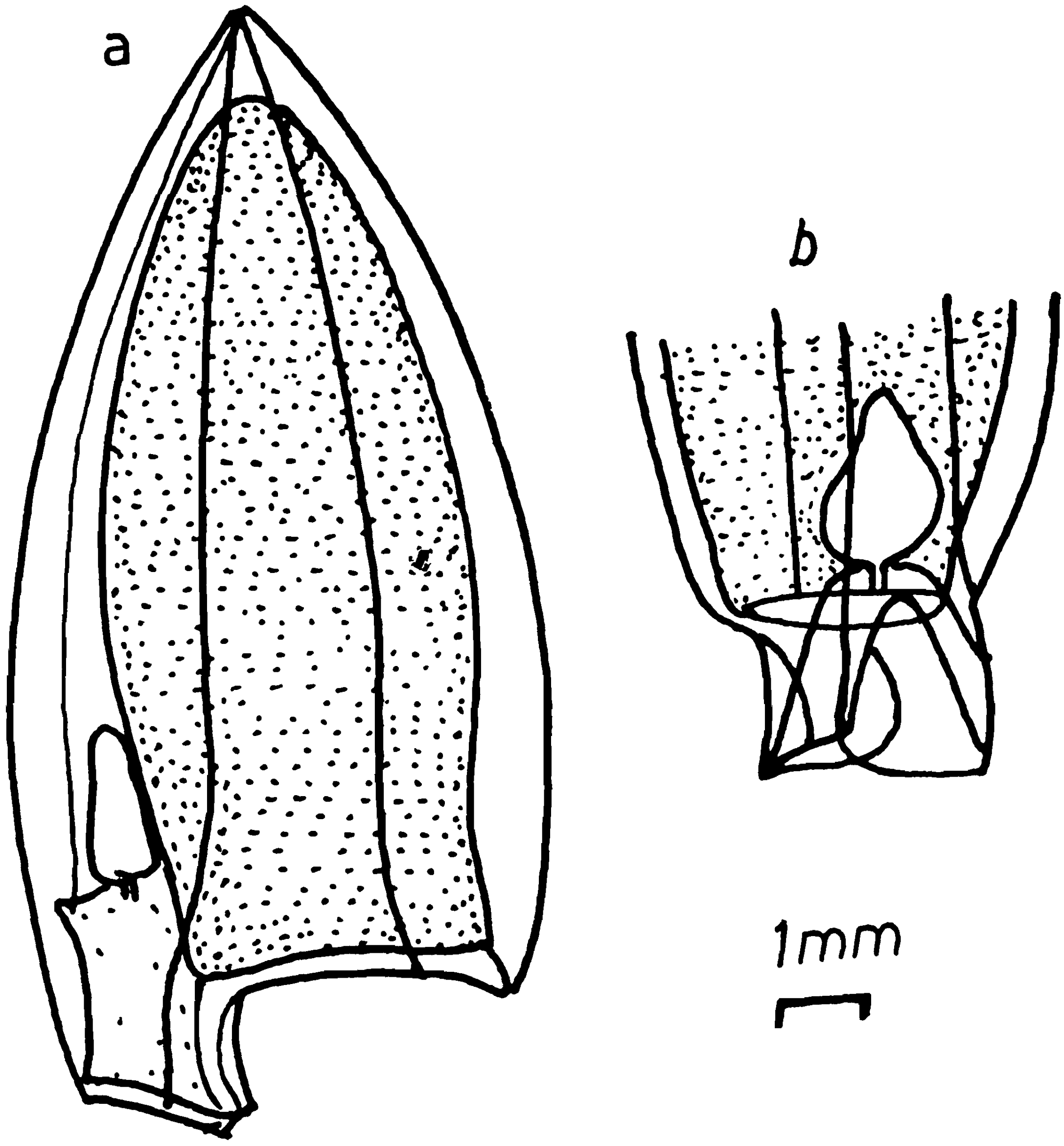
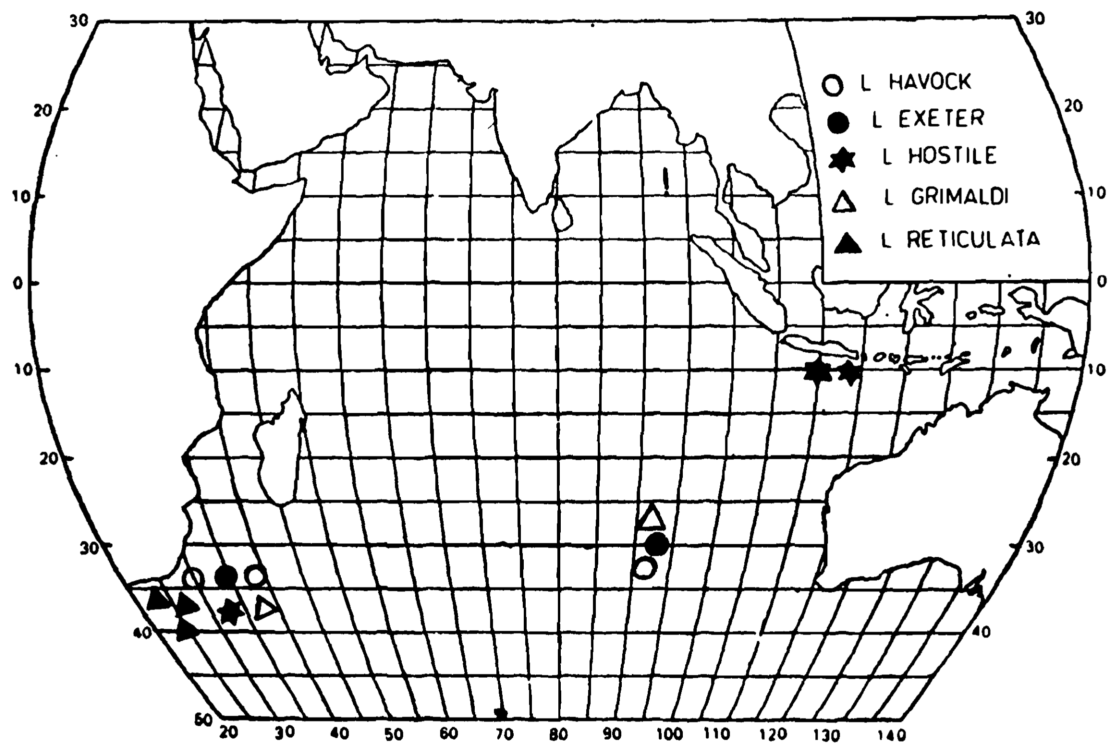


FIG. 110. *L. havock* Totton. a. anterior nectophore, b. ventral view. (From Totton, 1941, figs. 17, 18).



MAP 126. Distribution of *L. havock*, *L. exeter*, *L. hostile*, *L. grimaldi* and *L. reticulata*.

110. **Lensia exeter** Totton, 1941
(Fig. 111 a, b)

Lensia exeter Totton, 1941, p. 146, figs. 1–3.
Lensia exeter Totton, 1965, p. 176, fig. 115.

Type Specimen: British Museum (Nat. Hist.) London.

Material: Recorded from South and East coast of Africa (Totton, 1954).

Polygastric phase: Anterior nectophore: Upto 10.0 mm in length, multicristate form, with 5 groups of 3 ridges each. Velar ridge present, incomplete occurring only on dorso-lateral side, about 1.0 mm above ostium, connecting basal ends of lateral ridges, and runs down to ostial margin on dorsal side. Hydroecium deep; open on ventral side. Somatocyst one third length of nectophore, spindle-shaped. Mouth-plates long, lateral margins rounded, over-lapping.

Posterior nectophore: Unknown.

Eudoxid phase: Unknown.

Type locality: Lat. 33°20'S; Long. 15°18'E South Atlantic Ocean.

Distribution: (Map 126). Recorded from South and East coast of Africa from a depth of 750–500 m; 475–0 m; 1500–0 m.

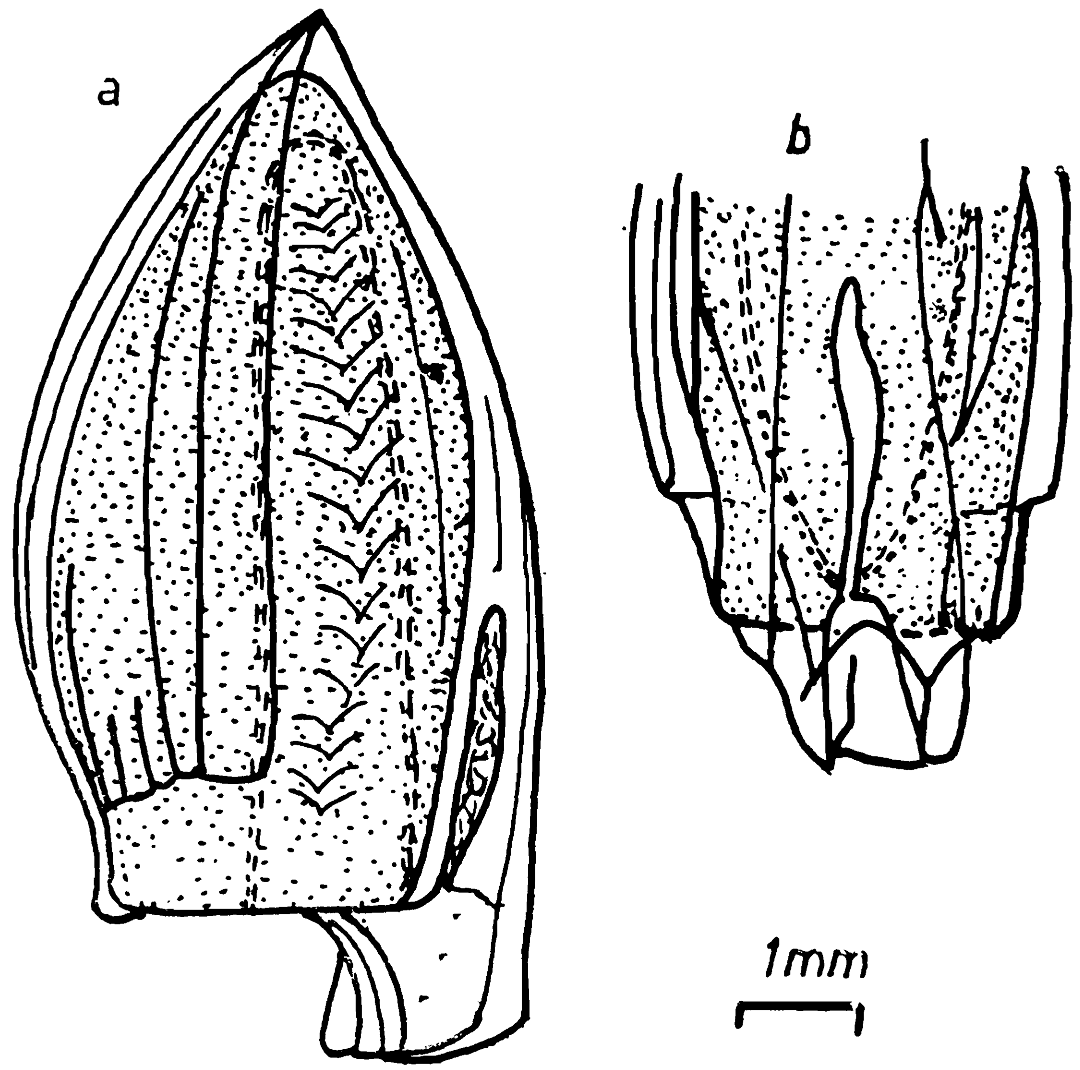


FIG. 111. *L. exeter* Totton. a. anterior nectophore lateral view; b. ventral view. (From Totton, 1941, figs. 1, 3).

111. **Lensia hostile** Totton, 1941
(Fig. 112 a, b)

Lensia hostile Totton, 1941, p. 161, fig. 20–22.
Lensia hostile Totton, 1965, p. 177, fig. 116.

Type Specimen: British Museum (Nat. Hist.) London.

Material: Recorded from South and East Coast of Africa and South East Indian Ocean (Totton, 1954).

Polygastric phase: Anterior nectophore: Upto 15.5 mm in length, multicristate form, with 5 groups of ridges—dorsal group with 3 or 4 longitudinal ridges cut off from reaching ostial margin by two converging grooves; two dorso-lateral groups with 3 or 4 complete ridges; and two ventro-lateral groups with 3 or 4 incomeplete ridges. No velar ridge present. Hydroecium deep, truncate vault, with open slit on ventral side. Somatocyst heart-shaped with apex uppermost. Mouth-plates long, and overlapping.

Posterior nectophore: Not known.

Eudoxid phase: Not known.

Type locality: Lat. 34°05′S; Long. 16°00′E. South Atlantic Ocean.

Distribution: (Map 126). Recorded from South and East coast of Africa and South East Indian Ocean from a depth of 3000–0 m and 3000–200 m.

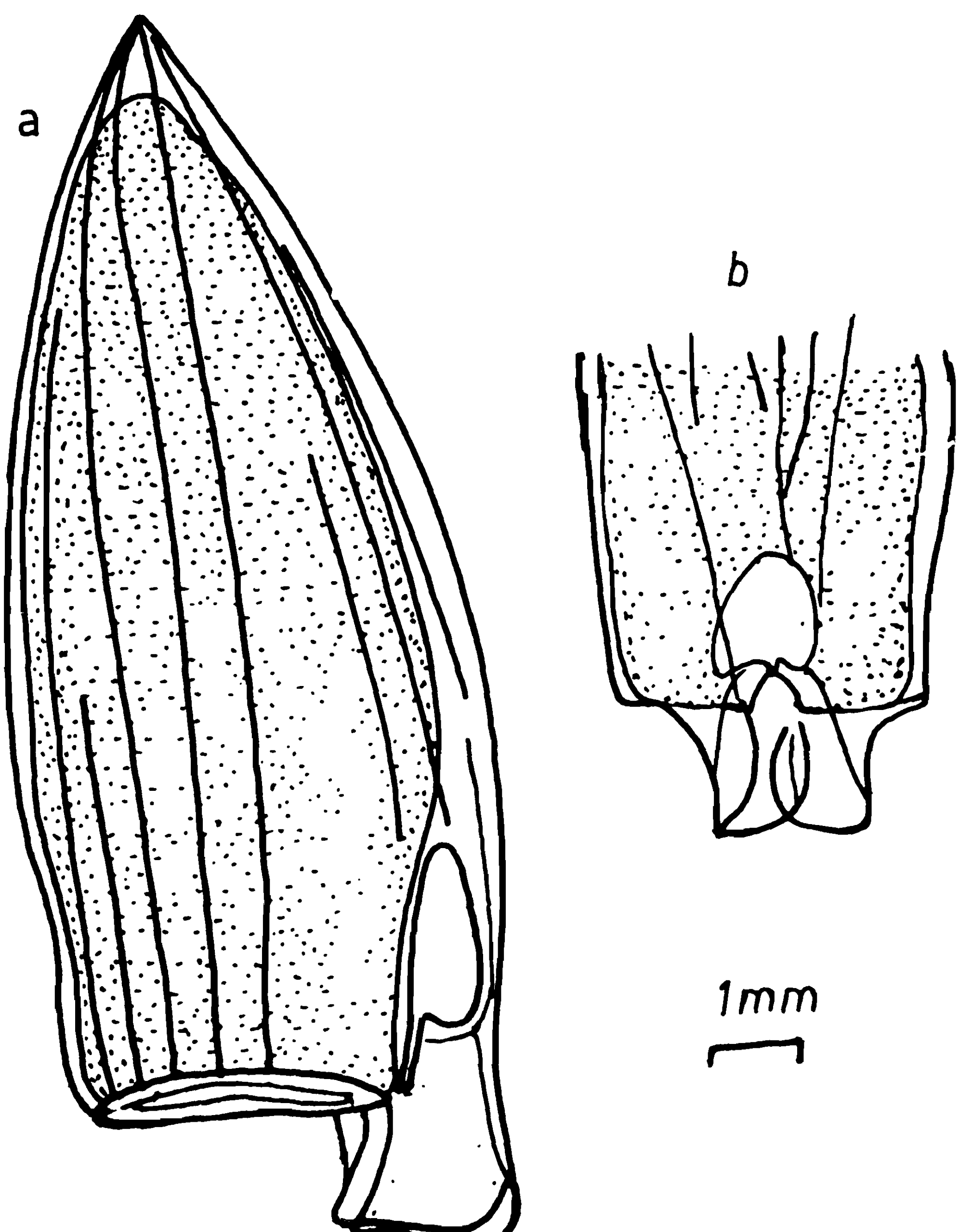


FIG. 112. *L. hostile* Totton. a. anterior nectophore lateral view; b. ventral view. (From Totton, 1941, figs. 20, 22).

112. **Lensia grimaldi** (Leloup, 1933)

(Fig. 113 a, b)

Lensia multicristata forme *grimaldi* Leloup, 1933, pp. 34, 36 figs. 8–10.
Lensia grimaldi Totton, 1941, p. 165, figs. 26–29.
Lensia grimaldi Totton, 1965, p. 178, fig. 117.

Type Specimen: Museum of Royal Histoire naturelle, Belgique.

Material: Recorded from South and East Coast of Africa (Totton, 1954).

Polygastric phase: Anterior nectophore: about 9.0 mm in length, multicristate form, with fewer number of ridges in each of 5 groups. Dorsal group (1, 2 or 3) with 2 ridges reaching apex but ending near upper limit of level of somatocyst; a pair in each dorso-lateral group, dorsal pair run down dorsal joining a partial ostial (velar)

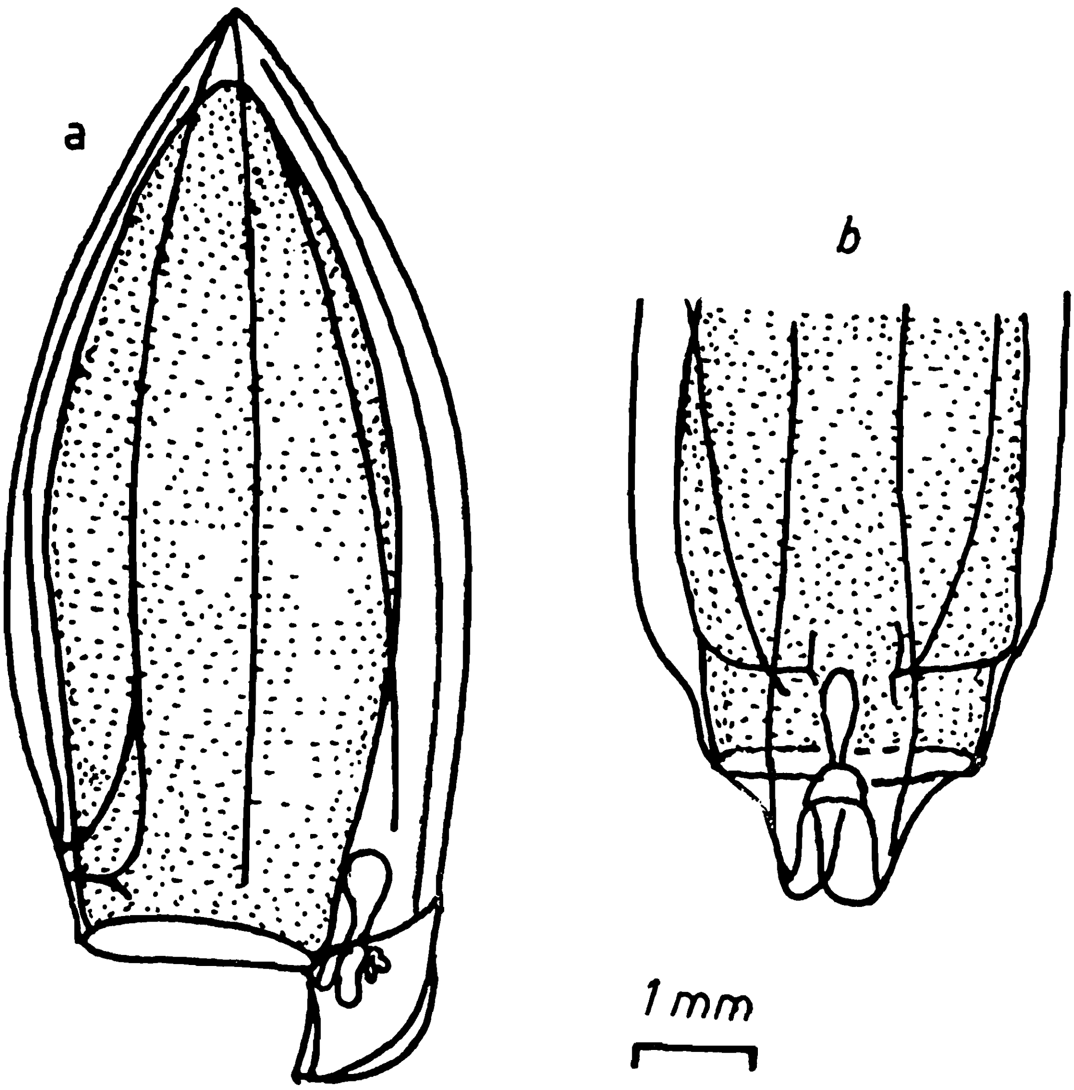


FIG. 113. *L. grimaldi* (Leloup). a. anterior nectophore — lateral view; b. ventral view. (From Totton, 1941, figs. 26, 28).

ridge on dorsal side. Ventro-lateral group consisting of 4 ridges, ventral ones complete, extending from apex to edges of mouth plates beyond ostium All other ridges end above ostial margin. Hydroecium deep, lying at level of ostium, slope toward ventral side and open ventrally. Somatocyst small, club-shaped. Mouth plates long, slightly overlapping.

Posterior nectophore: Not known.

Eudoxid phase: Not known.

Type locality: Off Monaco.

Distribution: (Map 126). *L. grimaldi* is a mid-water species occurring in South and East Coast of Africa from a depth of 3000–0 m.

113. **Lensia reticulata** Totton, 1954

(Fig. 114 a, b)

Lensia reticulata Totton, 1954, p. 118, fig. 61.

Lensia reticulata Totton, 1965, p. 172, fig. 110.

Type Specimen: British Museum (Nat. Hist.) London.

Material: NORTH EAST/NORTH WEST MONSOON SEASON: *South West Indian Ocean:* 14 a.n.

Polygastric phase: Anterior nectophore: Rare multicristate form, 3 mm in length. Longitudinal ridges, irregular, connected

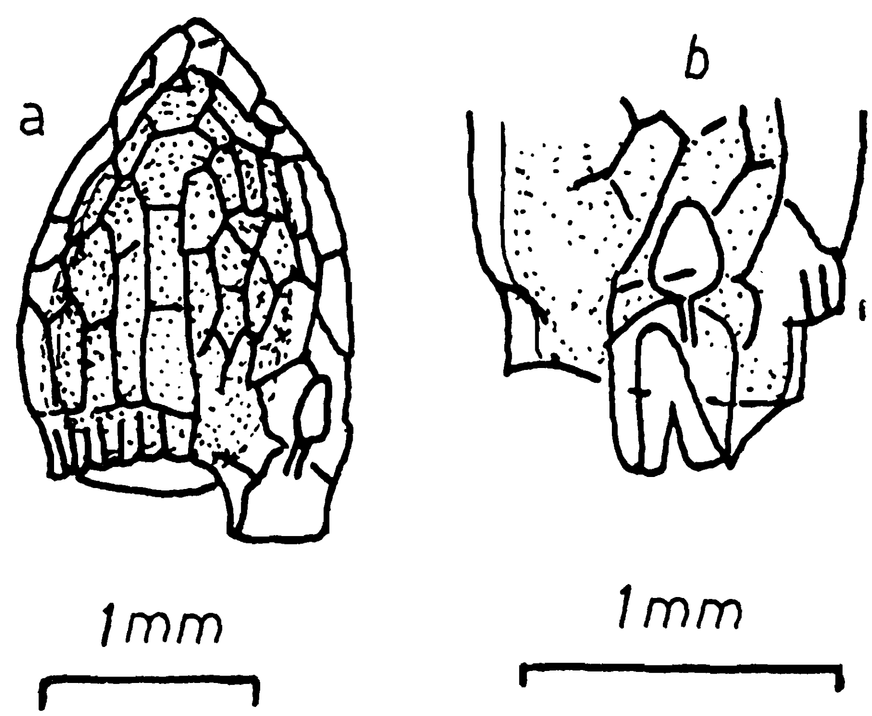


FIG. 114. *L. reticulata* Totton. a. anterior nectophore — lateral view; b. ventral view. (From Totton, 1954, fig. 61).

together by cross-reticulated ridges. Velar ridge present connecting up basal ends of 6-8 longitudinal ridges. Many short ridges of furrows extend from ostium toward velar ridge. Apex of nectophore blunt. Hydroecium deep, with deep narrow notch on ventral wall. Somatocyst small, ovoid, with thin short stalk occurring close to ventral corner of nectosac near ostium. Mouth-plates not overlapping.

Posterior nectophore: Unknown.

Eudoxid phase: Unknown.

Type locality: South and East coast of Africa (Indian Ocean).

Distribution: (Map 126). Collected from the southern tip of South Africa between 35°–40°S latitude during January. It appears to be a cold water species. Previous record was also from this region from a depth of 1400–700 m.

Genus 42. **Clausophyes** Lens & van Riemsdijk, 1908

Clausophyidae with large anterior nectophore rounded at apex, a long stemmed somatocyst with spindle-shaped apical expansion; hydroecium long, bounded by two baso-ventral wings. Posterior nectophore larger, with similar somatocyst and long open hydroecium extending entire length; nectosac with looped radial canals. Bract with rounded apex; phyllocyst with thick median branch and two lateral thin branches extending on either side of bracteal cavity down to basal margin. Asexual nectophores present in eudoxids.

Type Species: *Clausophyes ovata* (Keferstein & Ehlers, 1860).

Two species of *Clausophyes* are recognised as valid: *C. ovata* (Keferstein & Ehlers 1860) and *C. galeata* Lens & van Riemsdijk, 1908.

Key to species of **Clausophyes**

Nectophore having straight, not emarginated basal edge to mouth-plate; left hydroecial fold fits into a notch at basal edge of right hand fold, with the notch being bounded on inner side by a prominence... *ovata*

Nectophore with posterior end thick and gelatinous emarginated mouth-plate being concave on dorsal side; basal ends of hydroecial folds extending further than in *ovata;* basal end of right hydroecial wing thick and trihedral and overlaps left one. *galeata*

Only *C. ovata* is represented in the Indian Ocean.

114. **Clausophyes ovata** (Keferstein & Ehlers, 1860) (Fig. 115 a–f)

Diphyes ovata Keferstein & Ehlers, 1860, p. 17. pl. 5, fig. 1–5·
Clausophyes ovata Totton, 1965, p. 193, pl. 35, fig. 1, 4–10. Text-fig. 131.

Type Specimen: Place of deposit not known from literature.

Material: Recorded from western Arabian Sea; South East coast of Africa and South East Indian Ocean (Totton, 1954).

Polygastric phase: Anterior nectophore: Upto 20.0 mm in length, pear-shaped laterally compressed, smooth, soft in consistency, with rounded apex; smaller than posterior nectophore, with oblique ostium. Hydroecium is an open groove, bounded by two broad baso-ventral wings, basally projecting beyond level of ostium. Somatocyst long, stalked, with spindle-shaped expansion near apex of nectosac, extending beyond it to apex of nectophore as a narrow canal; junction of pedicular canal, base of somatocyst and stem meet at a point mid-way along the nectophore on the ventral side. Radial canals orginate from mid-region.

Posterior nectophoie: Upto 30 mm in length. Hydroecium is an open groove extending whole length from apex to base. Attachment to anterior nectophore lying in mid-region. Nectosac with looped lateral radial canals. Somatocyst similar to anterior nectophore. Mouth-plate truncated, without lateral teeth.

Eudoxid phase: Bract with rounded apex 5.0 mm long; phyllocyst with thick median branch reaching upto apex and two lateral thin, thread like branches extending on left and right side of bracteal cavity (hydroecium), to basal margin. Asexual swimming bells present. Gonophores not known.

Type locality: Mediterranean Sea.

Distribution: (Map 127). Recorded from deeper water, taken by closing net from a depth ranging from 3000–2000m to 310–260m. Occurs along South Eastern coast of Africa, Arabian Sea and South Eastern Indian Ocean.

Genus *Crystallophyes* Moser, 1925

Crystallophyes Moser, 1925, p. 368.

Clausophyidae with anterior nectophore having five longitudinal ridges not dividing dichotomously; hydroecium extending entire length of nectophore; without prominent ostial teeth. Posterior nectophore with 5 ridges not meeting at apex; dorso-ventrally flattened at proximal end.

Monotypic genus for *C. amygdalina* Moser, 1925

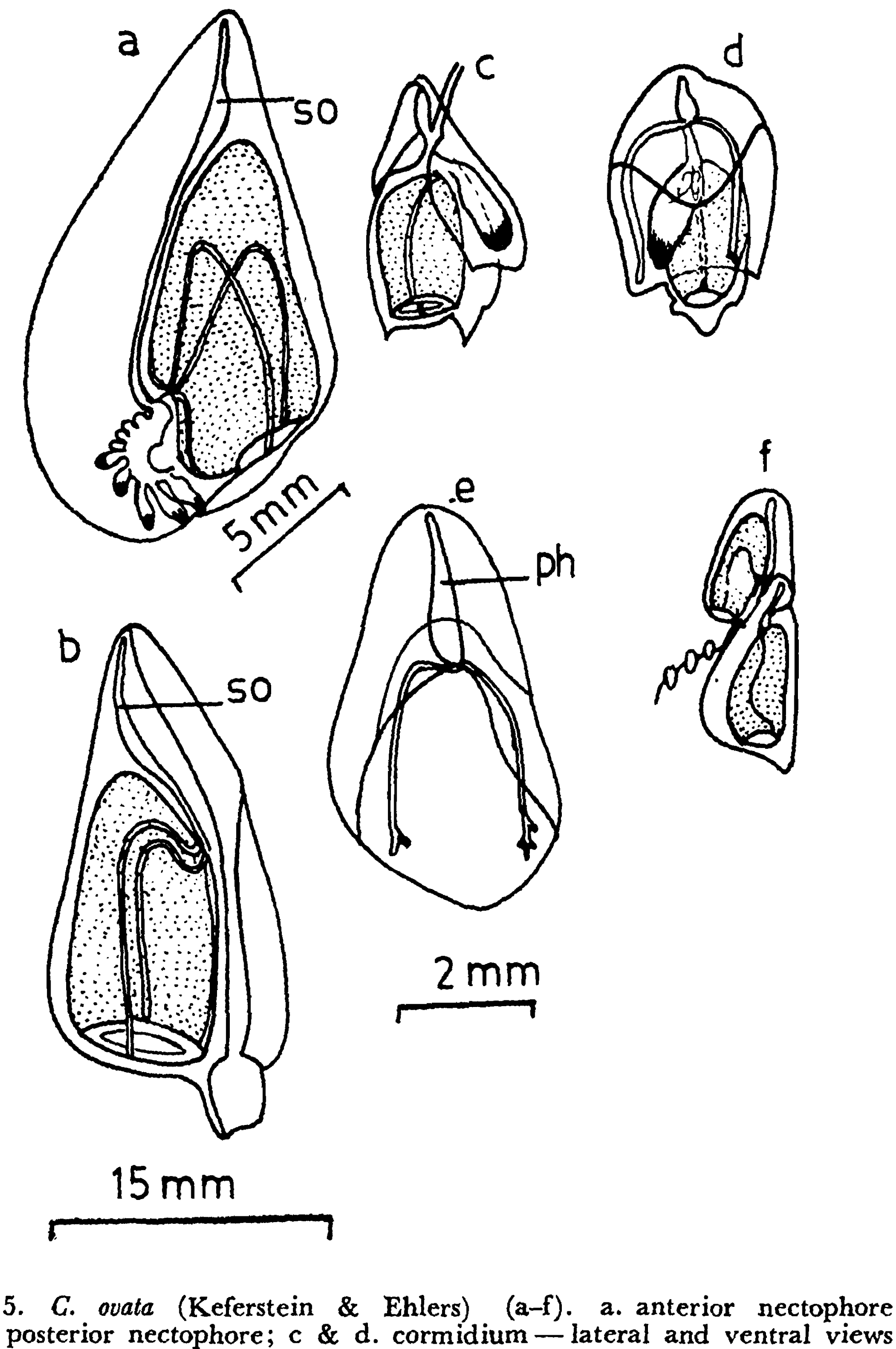
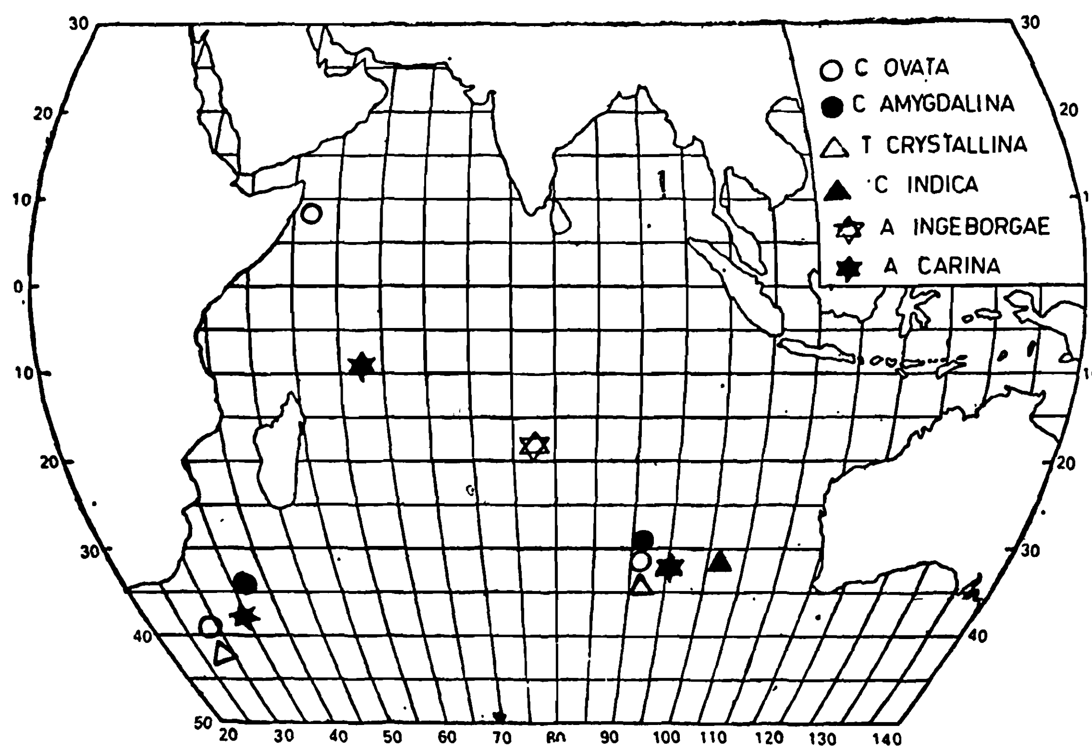


FIG. 115. *C. ovata* (Keferstein & Ehlers) (a–f). a. anterior nectophore; b. posterior nectophore; c & d. cormidium — lateral and ventral views; e. bract; f. entire specimen. (Figs. a, b from Moser, 1925, pl.24, fig. 4; c, d & f from Keferstein&Ehlers, 1861, pl. 5; e from Totton, 1965, fig. 131).



Map 127. Distribution of *C. ovata*, *C. amygdalina*, *T crystallina*, *C. indica*, *A. ingeborgae* and *A. carina*.

115. **Crystallophyes amygdalina** Moser, 1925 (Fig. 116 a, b)

Crystallophyes amygdalina Moser, 1925, p. 368, pl. XXIV, fig. 5.
Crystallophyes amygdalina Totton, 1965, p. 197, Fig. 133, 134.

Type Specimen: Museum Für Naturkunde, Berlin.

Material: Recorded from south east coast of Africa (Totton, 1954).

Polygastric phase: Anterior nectophore: (Fig. 116 a) 8–10 mm in length, with five complete, longitudinal ridges, not dividing dichotomously as in *Chuniphyes;* ostial ends of lateral ridges characteristically curved; without prominent ostial teeth. Hydroecium large, extending entire length of nectophore, not very deep at base of somatocyst. With very small mouth-plate. Somatocyst spindle-shaped at base, extending into a short, thin branch with minute side branches, upto apex of nectophore.

Posterior nectophore: (Fig. 116b) equal to anterior nectophore in size, with 5 longitudinal ridges, not meeting in a point. Dorso-ventrally flattened in apical region. Ventral ridges join laterals at short distance below apex. Lateral ridges end in prominent teeth at ostium. Somatocyst thin, thread-like extending nearly upto apex; pedicular canal enter nectosac at one-fourth distance from apex of nectosac; lateral radial canals not looped. Hydroecium extend from apex to ostium; hydroecial folds (ventral ridges) with two small pointed flaps on inner edges at mid-length.

Eudoxid phase: Not recorded:

Type locality: West coast of Africa (during cruise of "*Gauss*" to South Pole).

Distribution: (Map 127). *C. amygdalina* is a mid-water species, recorded from South East coast of Africa, from a depth of 750-500 m.

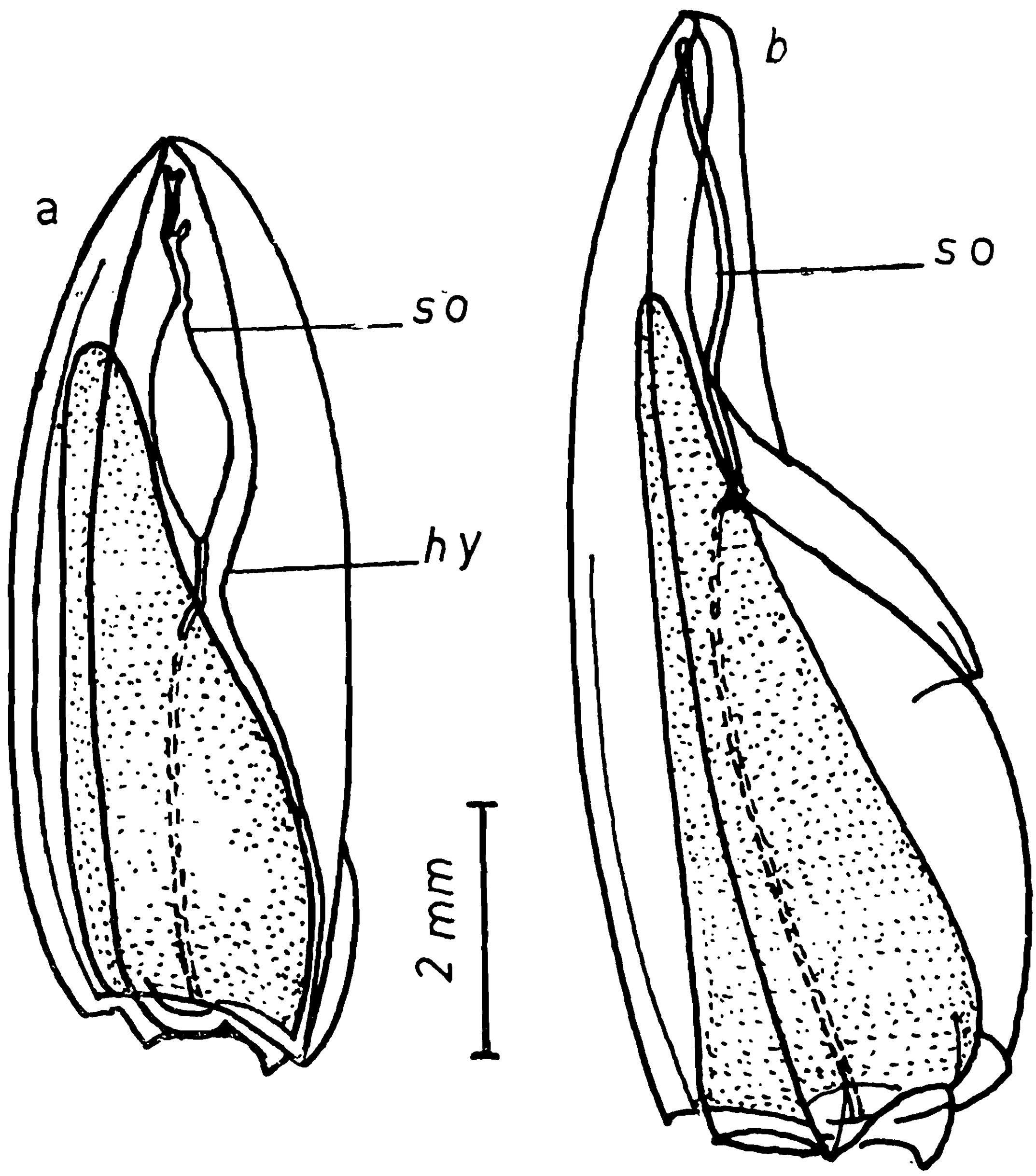


FIG. 116. *C. amygdalina* Moser. a. anterior nectophore; b. posterior nectophore. (From Totton, 1965, figs. 133, 134).

Genus 43. **Thalassophyes** Moser, 1925

Thalassophyes Moser, 1925, p. 367.

Clausophyidae with nectophores lacking opaque spots.

Monotypic genus for *T crystallina* Moser, 1925. It is highly probable that *T crystallina* and *H. maculata* are conspecific. Except for the presence of opaque spots in *H. maculata* and its absence in *T crystallina*, these two species are indistinguishable from one another. Further, the number, position and opacity of these spots vary in different specimens.

116. **Thalassophyes crystallina** Moser, 1925
(Fig. 117 a, b)

Thalassophyes crystallina Moser, 1925, p. 367, Taf. XXIII, fig. 5, 6.
Thalassophyes crystallina Totton, 1965, p. 201, fig. 136.

Type Specimen: Museum Für Naturkunde, Berlin.

Material: Recorded from South East coast of Africa (Totton 1954).

Polygastric phase: Anterior nectophore: Pyramidal, with 5 longitudinal ridges without any opaque spots. Hydroecium deep with a pair of incomplete ventro-lateral ridges. In other features resemble *H. maculata.*

Posterior nectophore and *Eudoxid phases* probably not distinguishable from *H. maculata.*

Type locality: West coast of Africa (during cruise of *Gauss* to South Pole).

Distribution: (Map. 127). Mid-water species like *H. maculata* recorded from South East coast of Africa.

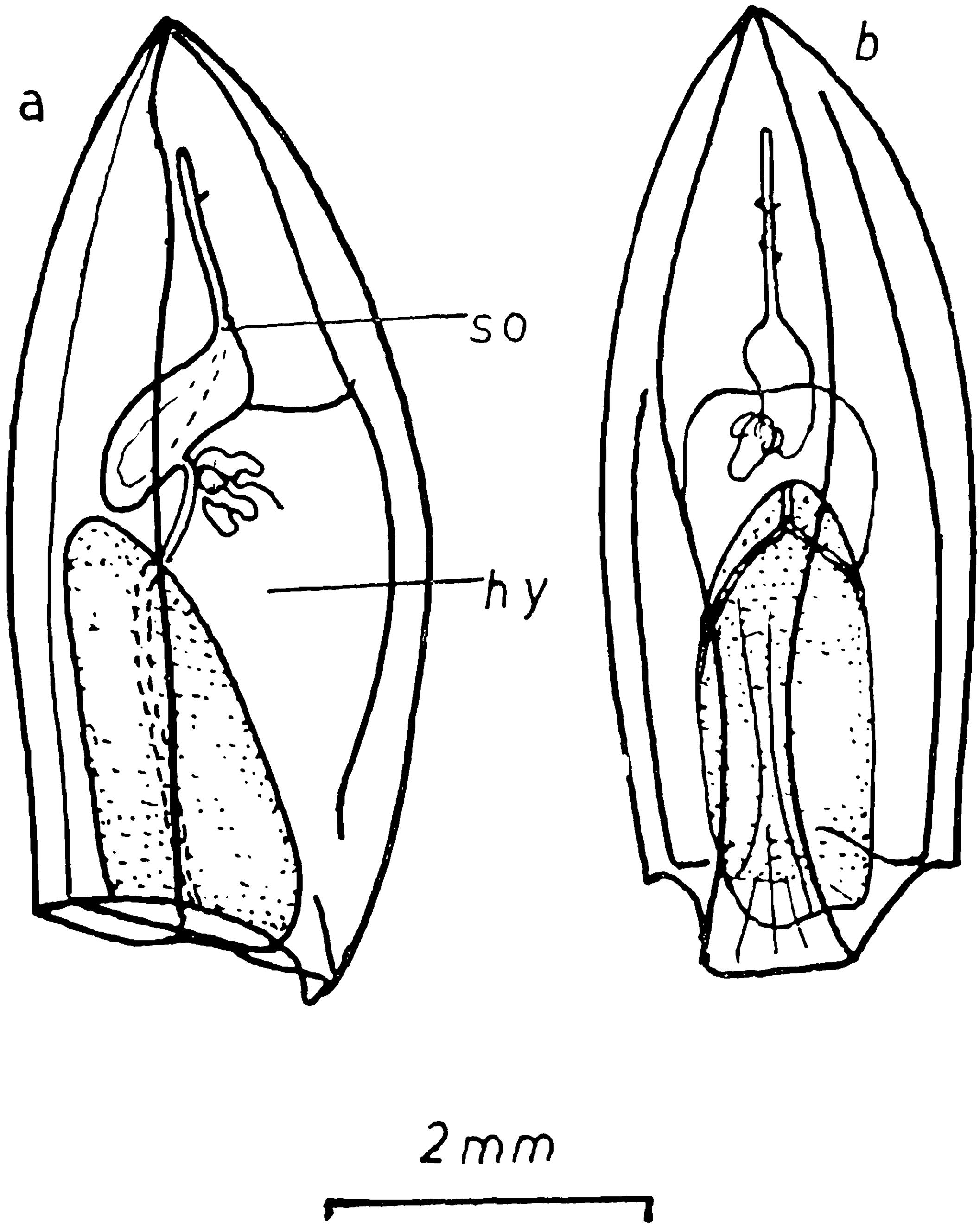


FIG. 117. *T. crystallina* Moser. a. anterior nectophore — lateral view; b. ʌentral view. (From Totton; 1965, fig: 136).

117. **Ceratocymba indica** Daniel, 1970
(Fig. 118 a, b)

Ceratocymba indica Daniel, 1970, p. 152.

Type Specimen: Zoological Survey of India, Calcutta, India.

Material: Recorded from South East Indian Ocean during August (SOUTH WEST/SOUTH EAST MONSOON SEASON) by Daniel (1970).

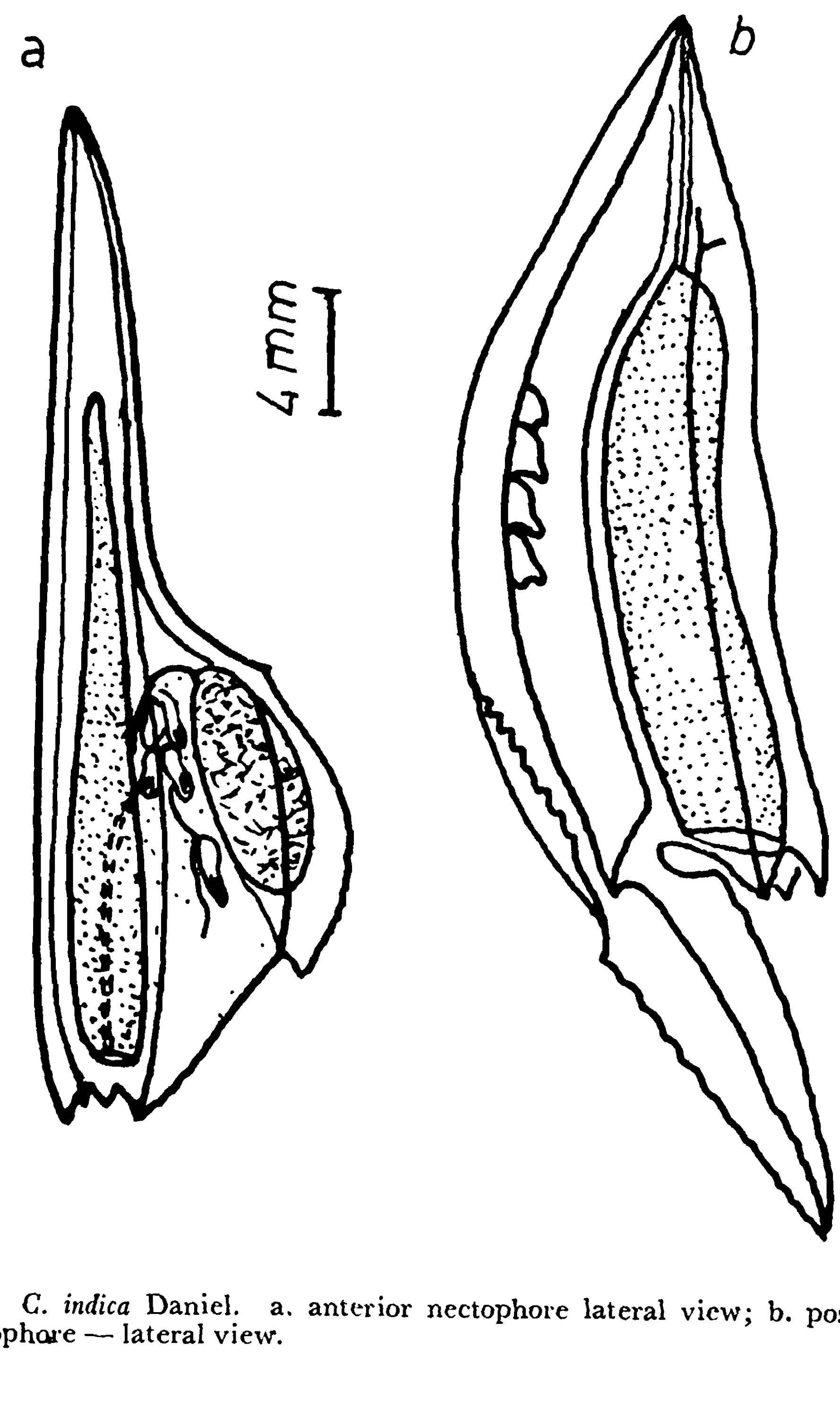


FIG. 118. *C. indica* Daniel. a. anterior nectophore lateral view; b. posterior nectophore — lateral view.

Polygastric phase: Anterior nectophore: Size: Length, 26.0 mm breadth at base 7.67 mm; breadth at apical prolongation, 1.87 mm; Somatocyst, 5.87 mm; hydroecium 11.3 mm; nectosac 17.2 mm; length from apex of nectosac to tip of nectophore, 7.3 mm.

With extremely long apical prolongation, 4 ridges as in *C. sagittata*, laterals arising at level of apex of nectosac (below in *C. sagittata*); all ridges faintly serrated and end in teeth. Space between apex of nectosac and tip of nectophore greater in *C. indica* than in *C. sagittata*. Baso-lateral margin of hydroecium very oblique.

Posterior nectophore: Size: Length, 31.3 mm, breadth, 8.0 mm; length of left ventral tooth, 10.87 mm; length of right ventral tooth, 1.0 mm. Long, thinner than *C. sagittata*. Dorsal ridge not vestigeal (as in *C. sagittata*), long; laterals arising from base of a apophysis, and all three ridges ending in teeth at ostium. Right hydroecial wing bearing four comb-teeth, with rounded base and recurved hook-like tip on inner margin and ending in small tooth; left ventral hydroecial wing ending in extremely long, three facetted tooth at base, 2–3 time as long as in *C. sagittata*.

Eudoxid phase: Not known.

Type locality: South Indian Ocean.

Distribution: (Map 127). Recorded from Latitude 32°39′ S; Longitude 101° 12′E, from a depth of 1000–0 m. during August.

118. **Abyla ingeborgae** Sears, 1953
(Fig. 119 a–c)

Abla ingeborgae Sears, 1953, p. 42, fig. 12E, 13E, 14E.
Abylya ingeborgae Totton, 1965, p. 211, fig. 144.

Type Specimen: Universitets Zoologiske Museum, Kobenhavn, Denmark.

Material: North East/North West Monsoon Season: *South West Indian Ocean:* 1 a.n.

Polygastric phase: Anterior nectophore: Similar to *A. haeckeli* except for elongated ventral facet (*i.e.* ventral facet only about one half as wide at insertion of horizontal ridge, high from this point to basal tip.). Width of nectophore only 2/3rd its height. Horizontal ridge well above middle of somatocyst, not below as *A. haeckeli*. Apical ventro-lateral facet, therefore smaller than basal ventrolateral facet. Dorsal facet rectangular. Basal end of dorsal wall of hydroecium only serrated.

Posterior nectophore: With 5 comb-teeth, basal border of right ventral wing "more nearly triangular" than concave. Dorsal tooth smaller, less prominent than in *A. haeckeli*. Lateral teeth equal in size (right tooth in *A. haeckeli* smaller). Ventral extent of basal margin of right ventral wing not delimited by strong teeth and ventral margin not as thick as in *A. haeckeli*.

Eudoxid phase: Bract similar to those of *A. haeckeli* with conspicuous dorsal tooth and ridge in gonophore

Type locality: South Atlantic Ocean.

Distribution: (Map 127). A single anterior nectophore was recorded from Lat. 17°30′ S; Long. 78°04′E from a depth of 200–0 m during January.

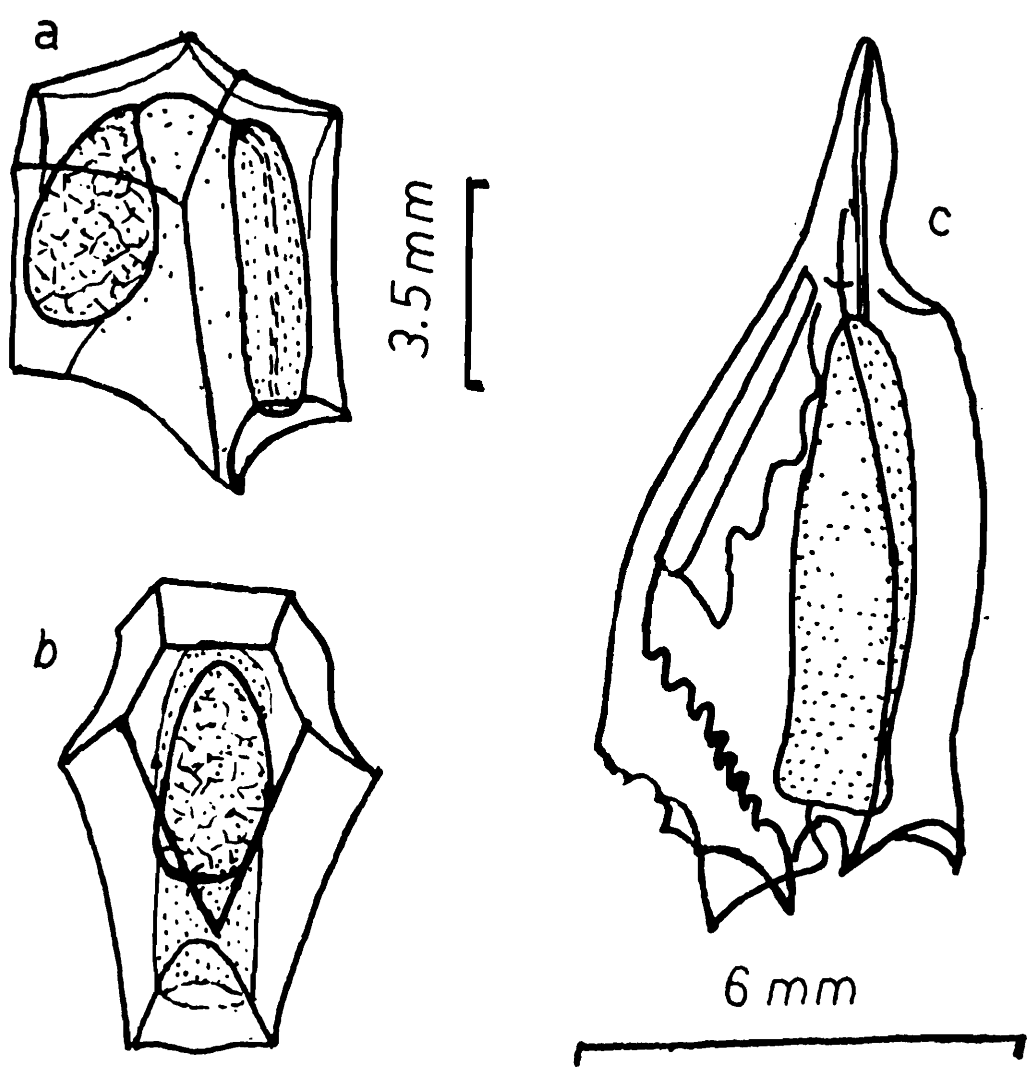


FIG. 119. *A. ingeboragae* Sears. a. anterior nectophore — lateral view; b. anterior nectophore— ventral view; c. posterior nectophore. (fig. c from Sears, 1953, fig. 11 c).

119. ? **Abyla carina** Haeckel, 1888

(Fig. 120 a–c)

Synonymised under *A. trigona* by Bigelow (1911, p. 221) and suspected to be a synonym by Totton (1965, p. 210). However, distinguishing features as statêd by Sears (1953) are given below.

Type Specimen: Most of Haeckel specimens collected by "challenger" were lost.

Material: Recorded from South and East Coast of Africa (Totton, 1954); from Seychelles & Chagos Archipelago (Browne, 1926).

Polygastric phase: Anterior nectophore: Basal facet diagonal in lateral view. Dorso-lateral ridges of apico-dorsal facet diagonal to dorsal facet. Transverse apical ridge slightly elevated above

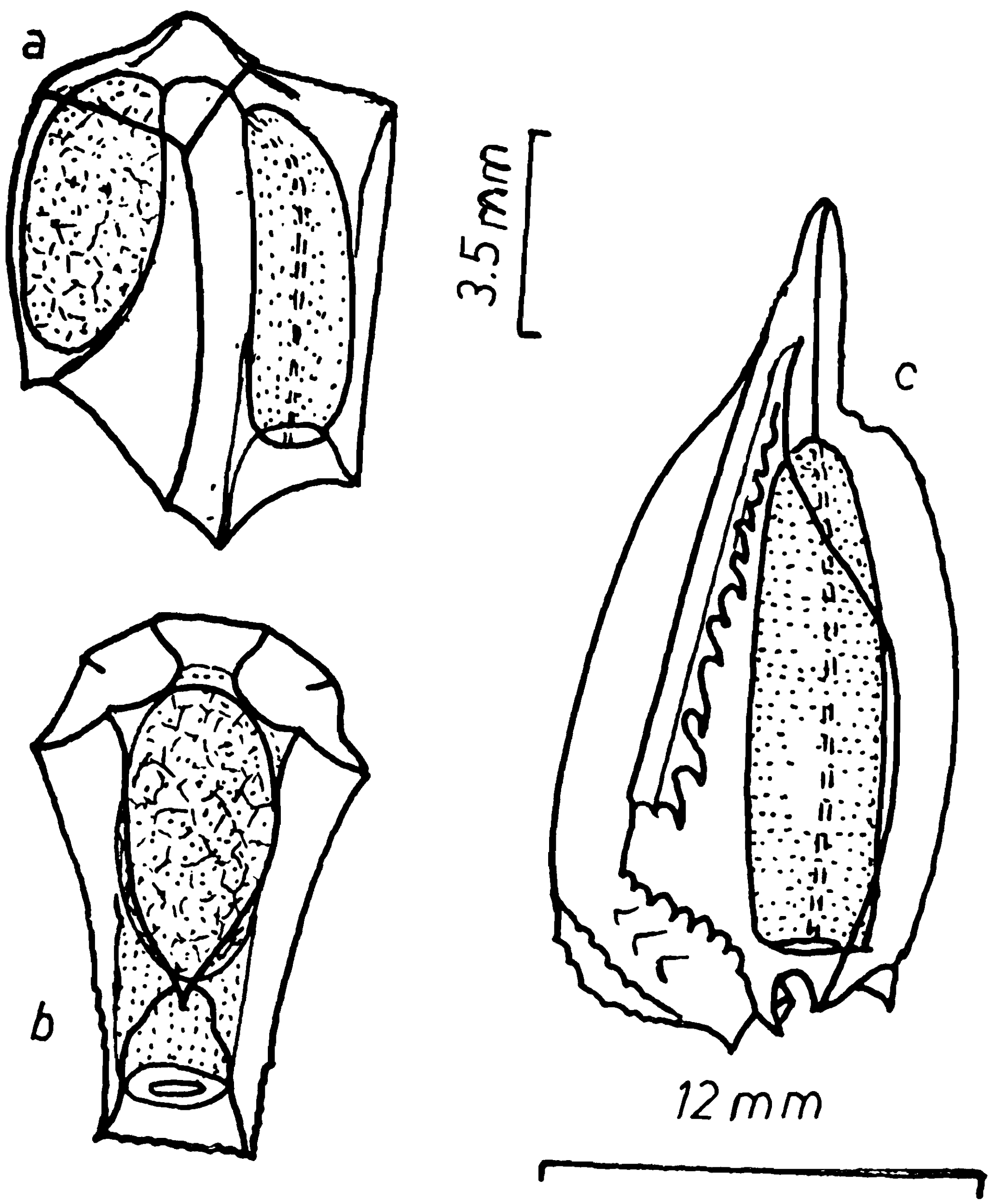


FIG. 120. *A. carina* Haeckel. a. anterior nectophore lateral view; b. ventral view; c. posterior nectophore. (From Sears, 1953, figs. 8A, 9A & 7).

surface of apical facet. Lateral expansions (protrusions) as seen in dorsal or ventral view not prominent. Ridges as a whole not elevated above facets. Basal part of ridges serrated. Nectophore more massive than that of *A. trigona.*

Posterior nectophore: Differs in minor features only from *A. trigona.*

Eudoxid phase: Possibly not distinguishable from that of *A. trigona.*

Type locality: Canary Island.

Distribution: (Map 127). It was recorded from South and East coast of Africa, Seychelles and Chagos Archipelago and South and East of Indian Ocean.

REMARKS

The distribution and abundance of Siphonophora in the Indian Ocean shows that there is not a single place in the Ocean that is devoid of this group. However, their abundance in the zooplankton varies in the different zones and seasons. The richest concentration occurs along the land mass—Arabian Coast, Gulf of Oman, Gulf of Aden and Southern tip of Africa (more than 1000 specimens per standard haul). Regions of fair abundance (501–1000 specimens per haul) are found on the coast of Africa extending to 10°S latitude and along the West and East Coast of India and across Bay of Bengal between 5°N and 15°N. Mid-ocean densities are low compared to the coastal regions and the minimum population range is found in the southern part of the Indian Ocean from 20°S latitude.

During SW/SE monsoon season the maximum density of more than 1000 specimens per haul occurs in the Gulf of Oman and along the Somali Coast. The next range in density (501–1000 per haul) lie along the coastal regions of West Pakistan, Iran, Arabia and Africa extending to 20°S latitude and north-eastern coast of Madagascar. Similar concentrations occur around peninsular India from Cochin on the West Coast to North of Madras on the East Coast, extending across the Bay of Bengal between 5°N–15°N latitudes to Burma and Malaya. Moderate numbers ranging from 201–500 per haul occur in the Arabian Sea, Bay of Bengal, North of Madagascar upto equator, South of Java and off Western Australia. Areas of low density (1–200 per haul) are observed in the Central region of the Arabian Sea and in the Oceanic regions of the Southern Indian Ocean.

During this season a comparative study reveals that the Siphonophores occur in greater numbers during night in the

Arabian Sea while the day values are higher in the Bay of Bengal. In the open ocean, especially south of the equator, the day and night values are more or less equal.

During NE/NW monsoon season the highest density of more than 1000 Siphonophores per haul occurs outside the Gulf of Oman on the coasts of Iran and West Pakistan, southern part of the Red Sea, Gulf of Aden, south eastern coast of Arabia and also at the southern tip of Africa. The second high densities in the range of 501–1000 Siphonophores per haul occur along the Somali and Arabian Coasts. Comparable densities are noticed along the west coast of India between Bombay and Goa and off Cochin in the Arabian Sea.

Extensive aras of moderate density (201–500 per haul) occur in the Arabian Sea, Bay of Bengal, off Somali Coast, north of Madagascar and South of Java. Low density areas (1–200 per haul) occur in the Central Bay of Bengal and in the Oceanic regions south of 10°S latitude.

The day/night variations in abundance of Siphonophores in the NE/NW monsoon season shows that a slightly higher night values occur in the Arabian Sea and in all the other regions the day and night values are more or less similar.

There is a concentration of Siphonophores in the equatorial belt (5°N to 5°S latitude) during SW/SE monsoon season and their scattering towards land masses and higher latitudes during the NE/NW monsoon season.

The monthly variations in the abundance of Siphonophora in the eight different regions of the Indian Ocean are given below.

I. *Arabian Sea:*

(*i*) *Western part:*

The population maxima ranging from 1300–1600 siphonophores per standard haul occurs during the months of August, October and November while a very low density of 100 per haul occurs during September.

(*ii*) *Eastern part:*

In this region, high densities ranging from 1025–1050 per haul occur during September and October. Low densities of 240–260 per haul are recorded in the months of May, June and August.

II. *Bay of Bengal:*

(*i*) *Indian region:*

On the Indian coast, the maximum density of 950 per haul is seen in the month of July. Densities ranging from 525–650 per haul are recorded during the months of April, June and October. Low densities of less than 150 per haul occur in the months of March, September and November.

(*ii*) *Burma and Andaman region:*

In this zone maximum density of 770 per haul occur in the month of September. Very low densities ranging from 50–60 per haul occur in the months of February, November and December. In the month of March a low density of 150 per haul is recorded.

III. *South West Indian Ocean:*

(*i*) *African region:*

Data are available for this region for January, April and July to November. The highest number of Siphonophore examples ranging from 740–810 per haul occur in July and November and the lowest density of about 30 per haul occur in April. In September less than150 per haul occur.

(*ii*) *Oceanic region:*

In this region the population maxima are relatively low, ranging from 400–470 Siphonophores per haul which are recorded in January, June, October and December. Low densities ranging from 200–225 per haul occur in Feburary, April, May and August.

IV *South East Indian Ocean:*

(*i*) *Australian region:*

The maximum density which is less than 600 per haul is seen during February and lesser density of about 200 per haul during May, June, August and September.

(*ii*) *Oceanic region:*

A maximum density of 700 specimens per haul occurs during November; 300–350 per haul during February and May and in low densities ranging from 50–250 per haul during the other months.

Of the 120 species reported from the Indian Ocean, the seasonal variations of 18 rare species given in the annotated list of species—page 2 (*M. orthocannoides*, *A. ernesti*, *N. diomedeae*, *N. thetis*, *N. natans*, *V. serrata*, *L. achilles*, *L. cordata*, *L. peresi*, *L. minuta*, *L. subtilis* var *chuni*, *L. exeter*, *L. hostile*. *L. grimaldi*, *C. ovata*, *C. amygdalina*, *T crystallina*, *A. carina*) are not known, since these species were recorded prior to the International Indian Ocean Expedition by ships that traversed the Indian Ocean establishing stations at a point only once or twice.

Thirteen species (dealt with under annotated list p. 2) *i.e.*, (*B. conifera*, *F. edwardsi*, *F. cuneata*, *A. peltifera*, *N. spinosa*, *L. roonwali*, *L. hardy*, *L. tiwarii*, *L. hunter*, *L. havock*, *L. reticulata* *C. indica*, *A. ingeborgae*) and twenty five species occurring in Indian seas—marked with asteriks *i.e.*, (*A. uvaria*, *A. haeckeli*, *H. amphytridis* *C. cordiformis*, *E. richardi*, *B. elongata*, *F. formosa*, *F. tholoides* *A. intermedia*, *M. praeclara*, *P. reticulata*, *D. annectens*, *E. indica* *L. gnanamuthui*, *L. tottoni*, *L. nagabhushanami*, *L. lelouveteau*, *L. ajax*, *L. multilobata*, *H. maculata*, *S. gracilis*, *S. irregularis*, *S. princeps*, *A. trigona*, *A. bicarinata*) although rare, were also collected during the International Indian Ocean Expedition and thus their seasonal variations are therefore known.

The rest of the sixty four species occurring in the Indian seas are common. However, the number of species and their abundance vary during each month in the eight zones of the Indian Ocean. In some of the zones there is a predominance of some of the sixty four species in the Siphonophore constituent of the zooplankton, in particular months, depending upon the wind regimes, ocean currents, upwelling and other hydrographical factors, temperature, salinity, oxygen and sonic and deep scattering layers (Daniel, Nagabhushanam and Daniel 1968; Daniel, 1977 and unpublished Ph.D. thesis—1975).

An overall picture that has emerged from an analysis of the 127 maps shows that 51 species occur near the Indian Coast and 53 species occur in the Burma and Andaman regions throughout the year. These species exhibit concentrations in particular months of the year. In the Indian region a maximum concentration of 35 species (*i.e.* about 55%) occurred during the months of April and June, while on the Burma and Andaman region 45 species (*i.e.*, about 70%) of them occurred during September.

In the Arabian Sea, in the Arabian region 56 species occurred in abundance throughout the year except in September, while in the Indian region there is a concentration of 33 species (*i.e.*, 51% during May.

Along the African region in the South West Indian Ocean there is a concentration of about 60% of the species during January. In the Australian region in the South East Indian Ocean there is a concentration of 51% of the species during August.

In the Oceanic region (South West/South East Indian Ocean) the Siphonophores occur throughout the year, as in the other zones, but there is no concentration of species in any one of the particular months. However, as pointed out earlier there is a concentration of species (about 94%) in the equatorial belt region 5°N to 5°S latitudes during the SW/SE monsoon season; but during the NE/NW monsoon season the species scatter from this region and move closer to land-masses and higher latitudes (see also Daniel, & Daniel, 1968; Daniel, 1975—unpublished thesis). This aggregation of species in this narrow equatorial belt region has been attributed to the converging of various ocean currents in this zone, circulation of water in the form of a clock-wise gyral complex probably centred near 3°N mainly during South West monsoon period, upwelling of deeper waters (Panikkar, 1969; Gopalakrishnan & Brinton, 1969; Alvarino, 1974; and Daniel, 1975 unpublished thesis), physical and chemical profiles along the equator showing the presence of relatively cool (26°C) water in the 0–100 m layer west of 55°E longitude and the high salinity, oxygen and inorganic phosphate content (Fisher, 1964, Taft, 1965; Daniel, 1975–unpublished thesis) and the formation of a barrier due to the mixing between the water masses with reduced salinity emerging from the river systems of the east coast of India into the Bay of Bengal and the water of higher salinity occurring in the Oceanic region. Further, the extension of the clock-wise gyral circulation occurring in the Arabian Sea during South West monsoon period in the equatorial region of the Bay of Bengal may also contribute to the concentration of the siphonophores in this region. During the NE/NW monsoon period the gyral circulation probably weakens and the siphonophores get scattered towards land masses and higher latitudes.

The influence of thermocline on Siphonophora shows that in the Indian Ocean out of the 46 species studied only 6 species—*A. rosacea*, *V. pentacantha*, *V. glabra*, *D. arctica*, *L. multicristata* and *L. fowleri* were never recorded above the thermocline which probably acted as a barrier in their upward migration (Daniel, 1977). A number of previous workers have underlined the controversial nature of the problems relating to the zoological constituents of the sonic scattering layer (Daniel, Nagabhushanam, & Daniel, 1968; Daniel, 1977), and it is obvious that much work remains to be done.

Further, as already indicated in the Introduction, detailed studies arer equired on deep sea Siphonophores, embryological and early (larval) development of many species, histology (nematoeysts, arrangement of longitudinal muscles in the mesoglea, position and size of the axial canal in many species), physiology, biology and genetics and their bearing on taxonomy. The chemical nature of the secretions of nematocysts of various species for their utilization in the preparation of drugs in the pharmaceutical industry require detailed studies.

PHYLOGENY

Theories:

From a review of literature (Haeckel, 1888; Moser, 1925; Hyman, 1940; Garstang, 1946; Leloup, 1954; Totton, 1954, 1965) it appears that the nineteenth century was an era of active systematic studies on the various groups of animals and speculations (theories) as to their organization, relationships and phylogeny. The morphological and physiological peculiarities which distinguish the Siphonophora from other Cnidaria (Coelenterata) have led to two diverse theories as to the real nature and import of their organisation. These two essentially, different interpretations—the 'poly organ' and 'poly person' theories are antitheses to one another.

Of these the 'Poly organ' theory is the older and was supported by Eschscholtz (1829), Huxley (1859), Müller (1871) and Metschnikoff (1874). According to this view the adult organization of all Siphonophora is a simple "medusa-like animal" which is distinguished from the typical medusae only in the multiplication and differentiation of its polymorphic 'organs,' *i.e.*, the individual remains basically a colonial Hydromedusa.

In contrast to this older interpretation is the 'poly person' theory supported by Vogt (1854), Leuckart (1851, 1854), Kolliker (1853), Gegenbaur (1854), Claus (1863, 1878) and Chun (1882, 1897a) and Schneider (1898). According to this view, the adult Siphonophore organisation is a colony of animals, composed of many polyp-like individuals ("persons") which according to the laws of the division of labour have undergone various modifications both in the way of specialisation and reduction. The colony is a swimming "Hydropolyp" stock composed of many polymorphic persons, partly polypoid and partly medusoid. Leuckart (1854) claimed that the initial invagination which gives rise to the float (pneumatophore) may be identified with the entocodon or Glockenkern of a medusa bud. Claus (1878) supported this view by homologizing the pericystic spaces between the radial septa of physonects with the radial canals of a medusa. Chun (1897a) further supported this argument by identifying the medusa with the primary nectophore of the Calycophorae. This view was slightly modified by Woltereck (1905) and Moser (1925) by stating that the float should be homologized with the second nectophore of Calycophora since the first or the larval nectophore is caducous.

According to the 'poly organ' theory it is presumed that the ontogenic primitive form of the Siphonophora is a simple "Hydromedusa" and the order Siphonophora arose from a primitive medusa. The poly person theory, on the other hand, states that the ontogenic primitive form is a swimming "Hydropolyp" stock and that this order arose from a primitive polyp. According to Haeckel (1888) both these contrasting theories are a mixture of "truth" and "error." The poly-person theory is partly right in regarding the origin of Siphonophora from a primitive Hydromedusa (with a well-developed umbrella and several medusa organs). It is, however, partly wrong in attributing to the fully developed siphonophoran stock the value of a single animal or individual composed of many organs in the morphological and physiological sense whereas, the poly person theory on the other hand is correct in stating that the fully grown Siphonophora is a colony composed of many polymorphic persons. However, according to him this explanation goes too far when it seeks to attribute the several (morphological) "organs" to the value of individual animals or persons *i.e.* different individuals (though modified) living together as a colony and well adapted for a pelagic mode of life.

Therefore, Haeckel (1888) postulated a new theory of the organisation of Siphonophora based on the comparative anatomy and ontogeny and called it the "Medusome" theory. This theory incorporated the truths (according to him) in the two views described above and eliminated their errors. His 'medusome' theory is summarized below: The primitive larva which arises directly from the gastrula of the siphonophora is always a simple medusa. This primary medusiform larva occurs as two distinct forms—the '*Disconula*' larva giving rise to the Order Chondrophora and the '*Siphonula*' larva giving rise to the Order Siphonophora. '*Siphonula*' larva is a bilateral medusa with a ventral umbrellar cleft, a single tentacle, and forms other persons (zooids) by one sided linear budding from the stomach wall of manubrium. It's origin probably takes root among the Anthomedusae. All the parts which arise by budding from the primary larva are (according to Haeckel, 1869) either medusiform persons or special organs of the same. In this view, he was supported by Metschnikoff (1874) and Balfour (1885). They considered the Siphonophores as transformed medusa, the great larval bract of *Physophora* being interpreted as a split and reduced umbrella and the polyp as its manubrium. The float itself was regarded as a second umbrella (medusa), but retroverted (turned inside out) as a gas-holder. Impressed very much by the budding powers of the manubrium in the various species of *Sarsia* Haeckel (1888) formed his elaborate "Medusome" theory. According to this all the zooids of the Siphonophore colony were interpreted as dislocated parts of so many dismembered medusoid buds of a proliferating Anthomedusan.

A similar view that the Siphonophora arose very early from the primitive medusa was held by Moser (1925). She contends that the fact that the planula soon develops a swimming bell pointed to a medusan ancestry. She considered the siphonophores with single nectophore to be the most primitive and from this type those with many nectophores and those with floats have been derived. She regarded the Siphonophora as ancestral to the Hydrozoa.

This view was accepted by Hyman (1940) and she stated that this could readily have developed from the metagastraea by putting forth tentacles and when thus armed for food capture would not have been limited to a bottom habitat. This primitive medusa seems still to be represented in the actinula larva of the Trachylina and as long ago suggested by Brooks (1887), the ontogeny of this group appears to repeat more nearly than that of other coelenterates the phylogenetic history. According to her the typical hydroid colony with alternation of generations represents a persistent larval stage.

Based on literature on the Siphonophora up to that time, a masterly review on the "morphology and relationship" of Siphonophora was published by Garstang (1946). He stated that the theories put forward by the above mentioned authors placing the Calycophore (with one nectophore) as the primitive type of Siphonophore, followed by those with float and nectophores and then those with only float was not correct. However, Garstang after his review on the development of various physonects and calycophores noted that the float in physonects developed from a simple apical invagination without an entocodon and showed no traces of origin from a medusa or nectophore, whereas, in Calycophorae the aboral extremity of the larva atrophies so that the pneumatophore has no homologue in this group, medusoid or otherwise. The primary nectophore is a ventral bud which secondarily assumes a sub-apical position. There is no 'aboral manubrium' He further noted that the Siphonophores developed from a bilaterally symmetrical, solid planula larva by unilateral (ventral) budding. He concluded that the Siphonophores are especially related to the Corynoids. He reversed Chun's system of the arrangement of the sub-orders and placed the passively floating Siphonophores—the Cystonects without nectophores as the most primitive and then the physonects with float and nectophores and lastly the actively swimming Calycophores which have undergone the most radical changes. It is considered that the atrophy of the aboral extremity of the Calycophore larval body may imply the previous possession of an aboral float, which has been discarded in favour of a precocious nectophore.

Therefore, Garstang in support of Korschelt & Heider's (1890; 1910) view of the general direction of Siphonophore evolution, *i.e.*, from passive floatation to active swimming, rather than the reverse, as was implied in all the medusoid hypotheses, rejected those theories. This view is in harmony with the evidence of pneumatophore development, which reveals an evolutionary line from cystonects with large float and no nectophores to physonects with nectophores and small float and culminating in the Calycophore type with nectophores and no float at all.

Leloup (1954) summarized the already published works on the Siphonophora *i.e.*, on the nature of these animals—whether they are individuals or colonies— and on their origin and phylogeny. He was of the opinion that the Siphonophores are derived from littoral gymnoblastic hydroids connected with the family Tubulariidae, and that they arose from tachygenic actinula. The change from the fixed benthic way of life to a planktonic one must have taken place during a larval phase and the Siphonophores progressively abandoned a passive life to an active one with a transition towards an alternation of generation. Basing his findings by a comparative study of the larvae, embryology and morphology arranged the different families in their probable evolutionary sequence, which differred greatly from that of Totton (1965).

Leloup chose a hypothetical pelagic hydropolyp Tubulariidae —actinula—as an ancestral type that developed a float by aboral invagination into two lines of evolution (*i*) with vertical float and without an aboral tentacle (therefore oral) and bilateral symmetry giving rise to the Siphonophora and (*ii*) with horizontal polythalamous float and aboral tentacle giving rise to the Chondrophora.

According to Leloup the Cystonectae diverged from the hypothetical larva which possessed only one zone of proliferation and treated the Rhizophysidae as more primitive than the Physaliidae. Among the Physonectae with two zones of proliferation (one in the nectosome & the other in the siphosome), he placed the Forskaliidae as the most primitive and then Agalmidae, Apolemiidae, Physophoridae and finally the families Rhodaliidae and Athorybiidae (=Anthophysidae). His arrangement of the various families of Calycophorae (without aboral float) showed the family Hippopodiidae to be the most primitive among them with the genera *Desmophyes* and *Stephanophyes* as a diverging side group. According to him, the Prayidae gave rise to two evolutionary lines—one leading to the neotenous monophyids—Sphaeronectidae and to the degenerate diphyids (*Amphicaryon*) and degenerate monophyids —*Nectopyramis* spp. and the other line, leading to Clausophyidae, Diphyidae and Abylidae.

The arrangement of the different families and the probable primitive nature of the various characters such as the primary nectophore, presence or absence of somatocyst in the posterior nectophore differ greatly in the most recent account of the Siphonophora given by Totton, 1965.

The views of Totton (1960, 1965), who has spent more than three decades of intensive study of the fresh, preserved and developmental stages of Siphonophora, differ greatly from those of Leloup's views (1954) and are in agreement with Garstang's main conclusions. He has put forward the "Paedophore" theory regarding the organisation of Siphonophora. According to him, a fully grown siphonophore is essentially an over-grown oozoid polyp that remains juvenile and asexual (larval) nurse-carrier-paedophore-of large number of other unseparated asexual juvenile polyps-the gastrozooids, palpons and bracts-as well as sexual adults-the medusoid gonophores and asexual adults-the medusoid nectophores-all budded from the original and often much elongated oozooid or from other juveniles. The sexual adult medusoid gonophores usually separate from this permanent larval stage, and lead a short independent life until their germ cells-ova and sperms are shed.

His study of the larvae of representative of all the major groups of Siphonophora led him to endorse Garstang's findings that the actinula of the gymnoblastic hydroids is "merely a planula with precocious adult character and that it is provided with additional yolk so that it develops some at least of the future polyp tentacles as well as a mouth before its liberation" (Garstang, 1946 p. 144). According to Totton (1965) the Siphonophora arose during a comparatively recent radiation, after this new type of neotenic organism, the actinula. This view was put forward by him in 1960 as the Paedophore Hypothesis and it was elaborated in his 1965 account. The fully grown asexual polyp never becomes an adult-the sexual medusa-but gives rise to it by budding. The reverse phenomenon is usually not seen in the Hydroids, *i.e.*, a medusa rarely or never truly gives rise by budding to a polyp (except in the case of the limnomedusan *Proboscidactyla ornata* Mc Crady), which always develops from an egg or from another polyp showing the polyp's larval character.

Totton's (1965 p. 32) views on phylogeny is summarized as follows:

Stage 1: Continuous metamorphosis: from planula to medusa stage (Therefore no alternation of generation).

Stage 2: Very simple fixed larval polyp giving rise by budding to a well developed medusa.

Stage 3: Advanced (complex) fixed polyp-phase with well developed medusa-phase.

Stage 4: Larva of polyp as in 3 retained by the medusoid stage instead of being shed as either an ovum or a planula, and becoming an actinula with reduction of the medusa-phase.

Stage 5: Larva of this new type of polyp-phase adapted for permanent planktonic life (Siphonophora), medusa-phase reduced to gonophores.

Stage 6: Larva of 3 becoming, contemporaneously with 4 still more advanced with further reduction of the medusa-phase.

This is represented in the form of a diagram:

4 → Corymorphines, Chondrophora etc.

1 → 2 → 3 → 6 → General Hydroid stock with differential rates of evolution of polyp and medusa phases

5 → Siphonophora.

Among the Order Siphonophora, according to Totton 1965, the Cystonectae and Physonectae are more closely related to each other than to the highly organised Calycophorae. There is a gas-filled float in both Cystonectae and Physonectae and the gonophores are budded from the bases of reduced gastrozooids-the palpons; cormidia as a rule do not separate from the main stem (except probably in *Apolemia*); and individual gonophores numerous, somewhat reduced. On the other hand in Calycophorae, a float is absent; palpons are absent (except in *Stephanophyes*); only a single bract covers the gastrozooid and gonophores; cormidia usually separate as eudoxid phase from the main stem (except in Hippopodiidae); and gonophores fewer in number, fully formed functional medusoids which break away from the eudoxid and lead a short free existence as sexual by mature adults while the ova or sperm ripen on the manubrium and are shed.

After two and a half decades of research on Siphonophora, the author agrees with Garstang's (1946) conclusions on morphology and relationship of Siphonophora and realises that views on phylogeny are mainly speculations on evolution. It is also probable that as stated by Totton (1954), the Siphonophores may form large groups of interbreeding populations. The classification and the arrangement of the various families, genera and species followed by Totton (1965) is accepted in this work except for the systematic position of *Eudoxia macra* and *E. indica* n. sp. of unknown parentage. Totton (1954) considered *E. macra* to be closely allied to the family Clausophyidae but tentatively included it under family Diphyidae. These two species have been shifted to the sub-family Sulculeolariinae (Family Diphyidae) based on various morphological structures.

List of species of Siphonophora not collected from the Indian Ocean.

Order SIPHONOPHORA Eschscholtz, 1829

Suborder CYSTONECTAE Haeckel, 1888

Genus ? **Salacella** Delage & Herouard, 1901

1. ? *Salacella polygastrica* (Haeckel, 1888)

Genus **Bathyphysa** Studer, 1878

2. *Bathyphysa sibogae* Lens & van Riemsdijk, 1908
3. ? *Bathyphysa japonica* Kawamura, 1943

Family ? EPIBULIIDAE Haeckel, 1888b

Genus ? **Epibulia** Eschscholtz, 1829

4. ? *Epibulia chamissonis* (Eysenhardt, 1829)
5. ? *Epibulia ritteriana* Haeckel, 1888 (=*E. chamissonis*)

Suborder PHYSONECTAE Haeckel, 1888

Family APOLEMIIDAE Huxley, 1859

Genus **Tottonia** Margulis, 1980

6. *Tottonia contorta* Margulis, 1980

Genus **Romosia** Stepanyants, 1967

7. *Romosia* sp. Stepanyants, 1967

Family AGALMIDAE Brandt, 1835

Genus **Agalma** Eschscholtz, 1825

8. *Agalma clausi* Bedot, 1888

Genus **Halistemma** Huxely, 1859

9. *Halistemma cupulifera* Lens & van Riemsdijk, 1908
10. *Halistemma striata* Totton, 1965

Genus **Nanomia** A. Agassiz, 1865

11. *Nanomia cara* A. Agassiz, 1865

Genus **Marrus** Totton, 1954

12. *Marrus antarcticus* Totton, 1954
13. *Marrus orthocanna* (Kramp, 1942)

Genus **Moseria** Totton, 1965

14. *Moseria convoluta* (Moser, 1925)
15. *Moseria similis* Margulis, 1977

Genus **Rudjakovia** Margulis 1982

16. *Rudjakovia plikata* Margulis 1982

Genus **Stepanyantsia** Margulis, 1982

17. *Stepanyantsia polymorpha* Margulis, 1982

Genus **Mica** Margulis, 1981

18. *Mica micula* Margulis, 1982

Family PYROSTEPHIDAE Moser, 1925

Genus **Pyrostephos** Moser, 1925

19. *Pyrostephos vanhoeffeni* Moser, 1925

Family ATHORYBIIDAE

Genus **Athorybia** Eschscholtz, 1829

20. *Athorybia lucida* Biggs, 1978

Family RHODALIIDAE Haeckel, 1888

Genus **Angelopsis** Fewkes, 1886

21. *Angelopsis globosa* Fewkes, 1886
22. *Angelopsis dilata* Bigelow, 1911

Genus **Stephalia** Haeckel, 1888

23. *Stephalia corona* Haeckel, 1888
24. *Stephalia bathyphysa* Haeckel, 1888.

Genus: **Sagamalia** Kawamura 1954

25. *Sagamalia hinomaru* Kawamura 1954

Genus: **Thermopalia** Pugh, 1983

26. *Thermopalia taraxaca* Pugh, 1983

Genus **Rhodalia** Haeckel, 1888

27. *Rhodalia miranda* Haeckel, 1888

Genus **Archangelopsis** Lens & van Riemsdijk,1908

28. *Archangelopsis typica* Lens & van Riemsdijk, 1908

Genus **Dromalia** Bigelow, 1911

26. *Dromalia alexandri* Bigelow, 1911

Family FORSKALIIDAE Haeckel, 1888

Genus **Forskalia** Kolliker, 1853

27. ? *Forskalia misakiensis* Kawamura, 1954

Suborder CALYCOPHORAE Leuckart, 1854

Family PRAYIDAE Kolliker, 1853

Subfamily (*ii*) PRAYNIAE Chun, 1897

Genus **Rosacea**

28. *Rosacea flaccida* Biggs, Pugh & Carré 1978

Genus **Prayola** Carré, 1969

29. *Prayola tottoni* Carré, 1969

Genus **Lilyopsis** Chun, 1885

30. *Lilyopsis rosea* Chun, 1885 (=*L. gracilis*)
31. ? *Lilyopsis gracilis* Fewkes, 1883

Genus **Maresearsia** Totton

32. ? *Maresearsia sphaera* Stepanyant, 1967

Genus **Desmophyes** Haeckel, 1888

33. *Desmophyes villafranchae* Carré, 1969

Genus **Stephanophyes** Chun, 1888

34. *Stephanophyes superba* Chun, 1888

Family DIPHYIDAE Quoy & Gaimad, 1827

Subfamily (*ii*) DIPHYINAE Moser, 1925

Genus **Diphyes** Cuvier, 1817

35. *Diphyes antarctica* Moser, 1925

Genus **Lensia** Totton, 1932

36. *Lensia baryi* Totton, 1965
37. *Lensia asymmetrica* Stepanyants, 1970
38. *Lensia zenkevitchi* Margulis 1970
39. *Lensia canupusi* Stepanyants, 1977

Genus **Muggiaea** Busch, 1851

40. *Muggiaea kochi* (Will, 1844)
41. *Muggiaea bargmannae* Totton, 1954

Genus **Clausophyes** Lens & van Riemsdijk, 1908

42. *Clausophyes galeata* Lens & van Riemsdijk, 1908

Family SPHAERONECTIDAE Huxley, 1859

Genus **Spaeronectes** Huxley, 1859

43. *Sphaeronectes gamulini* Carré, 1966
44. ? *Sphaeronectes japonica* (Stepanyants, 1967)
45. *Sphaeronectes bougisi* Carré 1968a
46. *Sphaeronectes fragilis* Carré 1968b

Family ABYLIDAE L. Agassiz, 1862

Subfamily (1) ABYLINAE L. Agassiz, 1862

Genus **Ceratocymba** Chun, 1888

47. ? *Ceratocymba intermedia* Sears, 1953

Genus **Abyla** Quoy & Gaimard, 1827

48. *Abyla tottoni* Sears, 1953
49. ? *Abyla peruana* Sears, 1953
50. ? *Abyla brownia* Sears, 1953 (=young ones of *A. bicarinata* Moser).

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ALPHABETICAL INDEX

For Sub Orders, Families, Genera and Species (names in italics are synonyms; sub orders, families and sub-families in capital letters).

Numbers in bold indicate pages containing detailed description and distribution.

Dr. (Mrs) Ruby Daniel started her research work on Siphonophores of Madras coast at the Zoological Research Laboratories, Madras University, Madras in 1953. She had a brilliant academic career. She secured first rank in B.Sc. from the Presidency College of Madras and obtained M.Sc. by examination in 1955 and Ph.D. by thesis in 1972. She is an acknowledged authority on Siphonophora and was specially requested to work out the Siphonophores of the Indian Ocean Expedition. She has published about 50 research papers and one Monograph. She was also in the Zoological Survey of India as Assistant Zoologist for some years. She is happily married to Dr. Augustine Daniel, Joint Director, Zoological Survey of India who is also an acknowledged Internationally reputed Marine Biologist.