ROBERT P. HIGGINS

Indian Ocean Kinorhyncha: 1, Condyloderes and Sphenoderes, New Cyclorhagid Genera

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY • 1969 NUMBER 14

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY

NUMBER 14

Robert P. Higgins

Indian Ocean Kinorhyncha: 1, Condyloderes and Sphenoderes, New Cyclorhagid Genera

SMITHSONIAN INSTITUTION PRESS
CITY OF WASHINGTON
1969

SERIAL PUBLICATIONS OF THE SMITHSONIAN INSTITUTION

The emphasis upon publications as a means of diffusing knowledge was expressed by the first Secretary of the Smithsonian Institution. In his formal plan for the Institution, Joseph Henry articulated a program that included the following statement: "It is proposed to publish a series of reports, giving an account of the new discoveries in science, and of the changes made from year to year in all branches of knowledge not strictly professional." This keynote of basic research has been adhered to over the years in the issuance of thousands of titles in serial publications under the Smithsonian imprint, commencing with *Smithsonian Contributions to Knowledge* in 1848 and continuing with the following active series:

Smithsonian Annals of Flight
Smithsonian Contributions to Anthropology
Smithsonian Contributions to Astrophysics
Smithsonian Contributions to Botany
Smithsonian Contributions to the Earth Sciences
Smithsonian Contributions to Paleobiology
Smithsonian Contributions to Zoology
Smithsonian Studies in History and Technology

In these series, the Institution publishes original articles and monographs dealing with the research and collections of its several museums and offices and of professional colleagues at other institutions of learning. These papers report newly acquired facts, synoptic interpretations of data, or original theory in specialized fields. Each publication is distributed by mailing lists to libraries, laboratories, institutes, and interested specialists throughout the world. Indvidual copies may be obtained from the Smithsonian Institution Press as long as stocks are available.

S. DILLON RIPLEY
Secretary
Smithsonian Institution

Official publication date is handstamped in a limited number of initial copies and is recorded in the Institution's annual report, Smithsonian Year.

UNITED STATES GOVERNMENT PRINTING OFFICE
WASHINGTON : 1969

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price 25 cents. (paper cover)

ABSTRACT

Higgins, Robert P. Indian Ocean Kinorhyncha: 1, Condyloderes and Sphenoderes, New Cyclorhagid Genera. *Smithsonian Contributions to Zoology,* 14: 1–13. 1969.—*Condyloderes multispinosus* (McIntyre, 1962), new genus, new combination; *Condyloderes paradoxus,* new species; and *Sphenoderes indicus,* new genus, new species (phylum Kinorhyncha) are described from the coatsts of Scotland and India.

The first kinorhynchs reported from the Indian Ocean were *Campyloderes vanhoeffeni* Zelinka, 1913 and *Echinoderes ehlersi* Zelinka, 1913. The former of these cyclorhagid species was collected during the Deutschen Südpolar Expedition, 1901–1903 at both Gauss Station, Antarctica (Davis Sea) and Kerguelen Island. A second species, *C. macquariae* Johnston, 1938, was described from Macquarie Island, and until *C. adherens* Nyholm, 1947a was found off the Swedish Coast, the genus was considered Antarctic in distribution. Recently *C. macquariae* has been recorded from the tropical waters of New Caledonia (Higgins, 1967) but none of the other species have been found since their original description.

The second Indian Ocean kinorhynch, *Echinoderes ehlersi,* is known only from a single collection from Zanzibar made by Vanhöeffen in 1885 and was the first kinorhynch to be described from tropical seas (Zelinka, 1913).

Two additional species of the order of Cyclorhagida, *E. bengalensis* Timm, 1958 and *E. sonadiae* Timm, 1958, were described from the vicinity of Cox Bazar, East Pakistan. A few years later, an additional cyclorhagid species, *Cateria gerlachi* Higgins, 1968, was discovered in a beach at Waltair, India (Ganapati and Rao, 1962; Rao and Ganapati, 1966) and has been discussed in the first of the current series of papers based upon the Kinorhyncha I have collected from the Indian Ocean.

Between 1964 and 1965, German scientists on board the *Meteor* found kinorhynchs at record depths of 4690 m off the coast of the Somali Republic (Thiel, 1966) but no information has been published on the taxonomic identity of the specimens.

During the spring of 1964 I made extensive collections of kinorhynchs along the coasts of India, Kenya, and the island of Nosy Bé, Malagasy Republic. The report which follows concerns specimens representing new genera of the families Centroderidae Zelinka, 1896, and Semnoderidae Remane, 1936.

Robert P. Higgins, Office of Oceanography and Limnology, Smithsonian Institution, Washington, D.C. 20560.

METHODS.—Samples of the upper few centimeters of fine sediment were taken by a meiobenthic dredge. The sediment was placed in buckets and diluted about three times its volume with seawater. Minute bubbles of air were forced through the mud by a hand pump fitted with a plastic tube and stone air-breaker.

Because of their hydrophobic cuticle, kinorhynchs brought to the surface by bubbles are retained on the surface film. By placing a piece of moderately absorbent paper on the surface film, the trapped meiofauna can be removed and washed into an accumulating filter and then preserved by 7 percent formalin.

In the laboratory, specimens were stained with Semichon's and transferred to a glycerin-alcohol solution, which was allowed to evaporate to glycerin. Specimens were removed from the glycerin and individually placed in Hoyer's mounting medium between two coverslips and positioned in Cobb aluminum slide frames. This mounting procedure makes it possible to observe both surfaces of the specimen with oil immersion phase optics.

Each specimen was meristically analyzed and the resulting data are expressed in a standard format of abbreviations and terminology (Higgins, 1968).

Measurements are given in microns (μ). Total length (TL) is measured on the midline, from the anterior margin of segment 3 (the first trunk segment) to the posterior margin of segment 13, exclusive of spines. Maximum sternal width (MSW) is measured at the anteroventral margin of the widest pair of ventral (sternal) plates as first encountered in measuring each segment from anterior to posterior. Sternal width at segment 12 (SW) or standard width is measured at the anteroventral margin of the twelfth ventral plates.

Middorsal spines (D), lateral spines (L), and lateral accessory appendages (LA) are numbered by segment

and their cumulative mean length expressed by DM, LM, and LAM. Measurements are given for the laterotermi nal spines (LTS), laterotermi nal accessory spines (LTAS), and midterminal spine (MTS).

Various indices using the above measurements are indicated by the relative abbreviations separated by a slash (/) and are calculated by dividing the first measurement by the second.

ACKNOWLEDGMENTS.—I would like to thank Dr. T. S. Satyanarayna Rao, International Indian Ocean Expedition Liaison Officer, Bombay, for his extensive help in arranging my research in India; Dr. P. N. Ganapati and the staff of the Department of Biology, Andhra University, Waltair, India, and C. R. Eswaran and T. S. Menon, Fisheries Research Station, Mr. A. D. McIntyre, Department of Agriculture and Fisheries for Scotland for his assistance in providing certain specimens mentioned in this study; Mr. J. W. Cowles, British Museum (Natural History) for making holotype material available to me; and Drs. H. L. Sanders and R. R. Hessler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, my companions in this portion of the United States Program in Biology of the International Indian Ocean Expedition.

This study was made possible by the National Science Foundation's support of the United States Program in Biology, IIOE, and grant GB 3069 which is gratefully acknowledged. The manuscript was written while the author was in residence with the Systematics-Ecology Program, Marine Biological Labratory, Woods Hole, Massachusetts.

Key to the Adults of the Kinorhynch Genera

1. First trunk segment entire, bivalvate, or with single midventral plate; round or oval in cross-section; lateral, dorsal, and terminal spines usually well developed (Order Cyclorhagida) . . . 3
   First trunk segment with single, strongly arched dorsal plate, single midventral plate and two lateroventral plates; trunk spines, if present, restricted to laterotermi nal spines (Order Homalorhagida, Family Pycnophyidae) . . . 2
2(1). With laterotermi nal spines . . . *Pycnophyes*
   Without laterotermi nal spines . . . *Trachydemus*
3(1). First trunk segment entire, without midventral plate (Suborder Cyclorhagae) . . . 4
   First trunk segment bivalvate, and/or with midventral plate; if not bivalvate, midventral plates on segments 3–8 . . . 7
4(3). First and second trunk segments entire; midterminal spine absent (Family Echinoderidae) . . . *Echinoderes*
   Second trunk segment with two lateroventral plates; midterminal spine present (Family Centroderidae) . . . 5
5(4). Elongate spines extending from posterolateral margins of first trunk segment; laterotermi nal accessory spines present in addition to laterotermi nal spines . . . 6
   Elongate spines not present on posterolateral margins of first trunk segment; laterotermi nal accessory spines absent . . . *Condyloderes*, new genus
6(5). Lateral spines on most trunk segments; few lateral accessory spines present . . . *Campyloderes*
   Lateral spines on few trunk segments, without lateral accessory spines . . . *Centroderes*
7(3). Midventral plate on segments 3–8, tapering in posterior progression; lateroventral articulation zone weakly developed; middorsal spine absent on segments 3, 7, 9, and 12 (Suborder Cryptorhagae, Family Cateriidae) . . . *Cateria*
   Midventral plate, if present, restricted to first trunk segment; first trunk segment with bilateral plates; lateroventral articulation zone obvious; middorsal spines on all trunk segments (Suborder Conchorhagae, Family Semnoderidae) . . . 8
8(7). Midventral and middorsal plate present on first trunk segment; with well-developed placids (series of plates at anterior margin of first trunk segment) . . . *Sphenoderes*, new genus
   Midventral and middorsal plate absent; without distinct placids . . . *Semnoderes*

Order CYCLORHAGIDA (Zelinka, 1896) Higgins, 1964

CYCLORHAGAE Zelinka, 1896, p. 197.
CONCHORHAGAE Zelinka, 1907, p. 135 [part].
HETERORHAGAE Lang, 1949, p. 8.
HETERORHAGA Gerlach, 1956, p. 124.

DEFINITION.—Kinorhyncha with variable number of trichoscalids; second segment (neck) usually with 14–16 well-formed placids or neck plates which form the closing apparatus; trunk segments round to oval in cross-section; protonephridia each with single liga-

ment; gonopores lateral between segments 12–13; pharynx musculature forming closed ring; oblique muscles present in most; armor joints, if present, consisting of dorsal acetabulum and ventral condyle; variously provided with lateral, middorsal, and midterminal spines; surface of trunk segments commonly covered with minute hairs or denticles, arranged in distinctive patterns.

Suborder CYCLORHAGAE (Zelinka, 1896) Zelinka, 1928

NOMOSTOMATA Zelinka, 1907, p. 136 [part].
XENOSTOMATA Zelinka, 1907, p. 136 [part].
CYCLORHAGATA Lang, 1949, p. 8.
CYCLORHAGAEA Chitwood, 1958, p. 943.

DEFINITION.—Cyclorhagida with segment 3 entire, consisting of a closed ring; segments 4– or 5–13 each with a dorsal (tergal) plate lateroventrally articulating with a pair of ventral (sternal) plates.

Family CENTRODERIDAE Zelinka, 1896

MESITODERIDAE Zelinka, 1907, p. 136.
CAMPYLODERIDAE Remane, 1936, p. 347.

DEFINITION.—Cyclorhagae with segments 4–13 divided ventrally to form series of paired ventral plates; segment 13 tapering terminally to form midterminal spine; dorsal spines on all trunk segments; lateral spines and lateral accessory appendages (thought to be adhesive tubes) present on many segments, not restricted to posterior half of trunk.

Condyloderes, new genus

TYPE-SPECIES.—*Centroderes multispinosus* McIntyre, 1962.

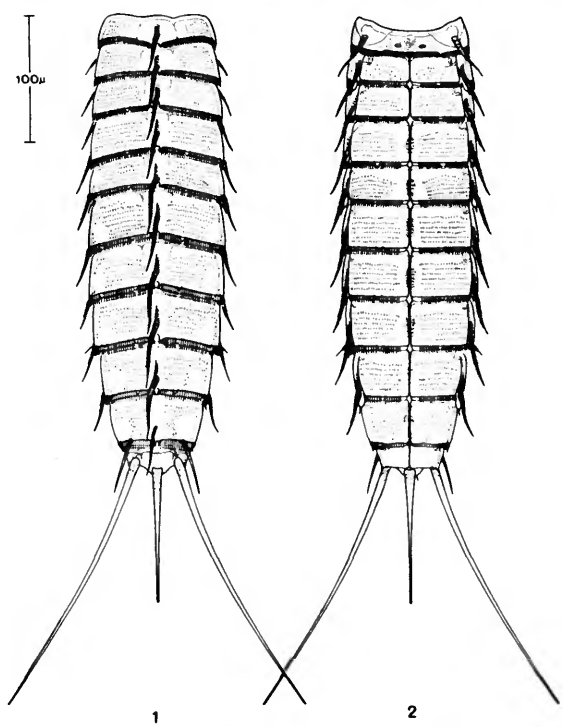
DEFINITION.—Centroderidae with six rows of scalids on segment 1 (head), succeeding rows with 10, 10, 20, 10, 28, and 14–15 scalids; pair of needle-like spinoscalids (row 5) centered anterior to each trichoscalid (row 6); spinoscalids of row 1 with 6–9 setae extending from base; 16 weakly formed placids with knobby projections; lateral and dorsal spines, variously pilose, strongly flexible, on segments 3–12; lateral spines of segment 12 slightly more dorsal than others; lateral accessory appendages, flattened and wide basally, narrowly tubicolous distally, on segments 4, 7, 10, and 11 (and on segment 6 in one species); prominent laterodorsal spines on either side of shorter midterminal spine; without laterodorsal accessory spines; ventrolateral pores, similar to the base of adhesive tubes of other genera, on segment 3; prominent conical to tubicolous intersegmental structures positioned laterodorsally between tergal plates and ventrally on sternal plates of most trunk segments.

Condyloderes multispinosus (McIntyre, 1962), new combination

FIGURES 1–9

Centroderes multispinosus McIntyre, 1962.

DIAGNOSIS.—*Condyloderes* with three nearly equal knobby projections along anterior margin of midventral placid, three larger projections near posterior margin, one projection near anterior margin and slightly larger projection near posterior margin of remaining placids; middorsal and lateral spines pilose; lateral accessory appendages short, ovoid, on segments

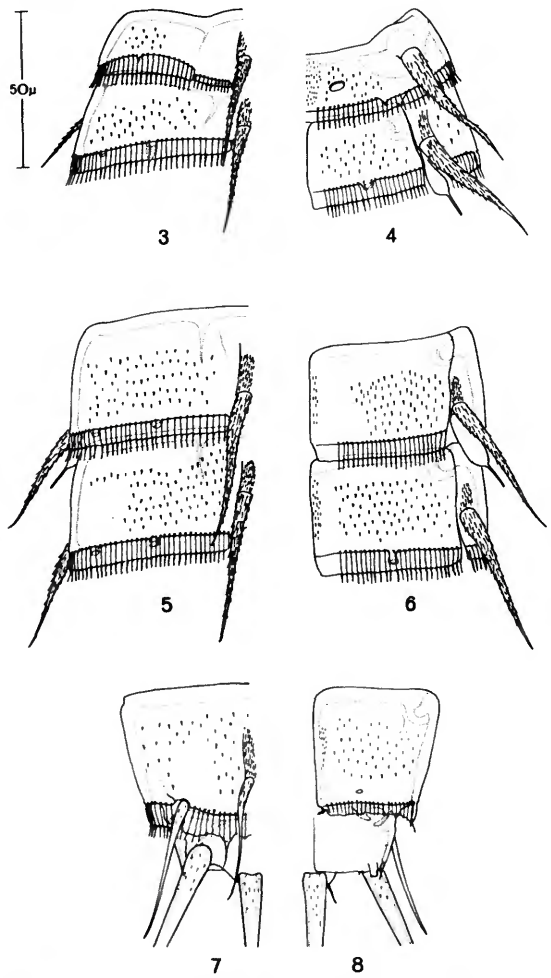


FIGURES 1–2.—*Condyloderes multispinosus* (McIntyre), adult female, topotype, TL 370μ, trunk segments: 1, dorsal view; 2, ventral view.

4, 7, 10 and 11; intersegmental protuberances of seventh ventral plates missing.

HOLOTYPE.—Adult of undetermined sex, TL ca. 350μ; Loch Nevis (West Coast), Scotland; 101 m; 1962?; British Museum (Natural History) 1962/82.

TOPOTYPES.—1 juvenile, TL 272μ, Higgins K80.1; 1 adult of undertermined sex, TL 336μ, Higgins K80.2; 1 female, TL 352μ, Higgins K81.1; 1 female, TL 370μ, (K81.2); USNM 37459; material provided by McIntyre without data.



FIGURES 3–8.—*Condyloderes multispinosus* (McIntyre), adult female, topotype, TL 370μ: 3, dorsal view, lateral half, segments 3–4; 4, ventral view, lateral half, segments 3–4; 5, dorsal view, lateral half, segments 7–8; 6, ventral view, lateral half, segments 7–8; 7, dorsal view, lateral half, segments 12–13; 8, ventral view, lateral half, segments 12–13.

REDESCRIPTION.—Topotypic adults, TL 336μ–370μ; MSW–9 88μ–90μ; SW 65μ–80μ; SW/TL 0.18–0.22.

First segment (Figure 9) with 9 thin, unsegmented oral styles, ca. 30μ surrounding mouth cone; 6 rows of scalids, first row with 10 uniformly thick, blunt scalids, ca. 70μ, generally with 9 setae, 10μ–20μ, near origin, 2 smaller setae at joint; second row with 10 tapering, pointed scalids, ca. 50μ; third row with 20 tapering, pointed scalids, ca. 40μ; fourth row with 10 slightly more robust, tapering, pointed scalids, ca. 35μ; fifth row with 28 filiform scalids, ca. 30μ, one pair centered over each of the 14 trichoscalids of row 6; trichoscalids, heavily setate, ca. 25μ, centered above placids (segment 2) except for placids adjacent to midventral placid.

Second segment (neck) with 16 nearly truncate placids, poorly cuticularized; midventral placid distinctly larger than others, three knobby projections along anterior margin (Figure 9), three similar but slightly larger projections near middle; remaining placids with single projection in both positions, placids adjacent to midventral placid slightly narrower than others.

Third segment (first trunk segment) slightly vaulted dorsally, especially noticeable along median one-fourth of segment; posterior border of segment with distinctive pectinate fringe (Figures 3–4), basal half lanceolate in longitudinal section, appearing as a series of lammelate units, becoming aristate at apex to form border of setae; short, weakly developed hairs on dorsal and ventral surface, small, dense patch of very short hairs midventrally, pattern as illustrated (Figures 1–4); distinctive pores on either side of ventral midline, similar to base of adhesive tubes of male homalorhagids but no tubular extensions apparent; patch of closely set hairs at base of each lateral and middorsal spine, spines pilose, lateral spine 28μ–34μ, middorsal spine 24μ–30μ.

Fourth segment with two ventral plates; without lateroventral pores; spinoid intersegmental protuberances on subdorsal posterior border, a second blunt-tubicolous protuberance more laterally and a third protuberance centered at posterior border of each ventral plate; lateral spine 30μ–34μ; lateral accessory appendage 15μ–16μ, slightly dorsal to lateral spine, originating from intersegmental zone of tergal plate near the lateroventral articulation zone, increasingly ovoid from point of origin, flat in cross-section, abruptly tapering, becoming filiform distal one-third

TABLE 1.—*Measurements (μ) and indices for specimens of* Condyloderes multispinosus

	Adult (McIntyre, 1962 Fig. 1, p. 506)	Juvenile K80.1	Adult K80.2	Adult ♀ K81.1	Adult ♀ USMN 37459	Adult Range
TL	345	272	336	352	370	336–370
SW	80	–	–	65	80	65–80
SW/TL	0. 23	–	–	0. 18	0. 22	0. 18–0. 23
MSW–9	90	–	–	88	90	88–90
DM	49. 0	28. 7	39. 9	44. 8	44. 6	39. 9–49. 0
DM/TL	0. 14	0. 10	0. 12	0. 13	0. 12	0. 12–0. 14
LM	45. 5	28. 2	36. 7	40. 2	41. 8	36. 7–45. 5
LM/TL	0. 13	0. 10	0. 11	0. 11	0. 11	0. 11–0. 13
LAM	14	19	21	21	20	14–21
LAM/TL	0. 04	0. 07	0. 06	0. 06	0. 05	0. 04–0. 06
LTS	220	170	210	200	222	200–222
LTS/TL	0. 64	0. 63	0. 63	0. 57	0. 60	0. 57–0. 64
MTS	80	74	96	104	104	80–104
MTS/TL	0. 23	0. 27	0. 29	0. 30	0. 35	0. 23–0. 35

to one-half the length; middorsal spine 28μ–34μ; segment with minute hairs, pattern as illustrated; pectinate fringe as in segment 3.

Segments 5, 6, 8, and 9 similar to fourth but without lateral accessory appendage; subdorsal intersegmental protuberance more bluntly tubicolous; L–5 34μ40μ, L–6 35μ–40μ, L–8 38μ–42μ, L–9 40μ–46μ; D–5 28μ–42μ, D–6 30μ34μ, D–8 40μ–52μ, D–9 50μ–54μ.

Segments 7, 10, and 11 similar to preceding segments but with lateral accessory appendages; LA–7

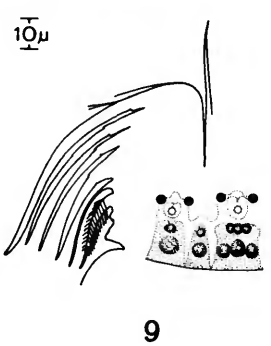


FIGURE 9.—*Condyloderes multispinosus* (McIntyre), adult female, topotype TL 370μ; diagrammatic perspective, lateral half, segments 1 (head) and 2 (neck or placids) showing midventral placid and 2 lateral placids only.

20μ–22μ, LA–10 26μ–28μ, LA–11 16μ–20μ; L–7 36μ–42μ, L–10 42μ–50μ, L–11 50μ–58μ; D–7 38μ–50μ, D–10 52μ–53μ, D–11 52μ–60μ; ventral intersegmental protuberance missing in segment 7.

Segment 12 (Figures 7, 8) without intersegmental protuberances; lateral spine thin, 40μ–42μ, slightly pilose, dorsally displaced from lateral margin; middorsal spine 40μ; without lateral accessory appendage.

Segment 13 (terminal segment) without hairs, middorsal, or laterotermínal accessory spines; laterotermínal spine prominent, 210μ–222μ, one-fourth to one-third the trunk length, slightly pilose at base.

See Table 1 for measurements and indices for specimens of *Condyloderes multispinosus.*

DISCUSSION.—Several unique features appear in *Condyloderes multispinsosus:* (1) the series of flexible setae at the base of the first row of spinoscalids; (2) a single pair of needle-like spinoscalids (28 total) centered over each trichoscalid (14 total); (3) knobby thickenings on the otherwise weakly cuticularized placids; (4) middorsal and lateral spines with minute hairs; (5) no laterotermínal accessory spines; and (6) the presence of the tubicolous intersegmental protuberances immediately below the pectinate fringe on the posterior margin of all but the last two trunk segments.

Condyloderes multispinosus was originally placed in the genus *Centroderes* after rejecting the genus *Campyloderes* because of the lack of especially long lateral spines on segment 3, and because of the size of the segment relative to those behind it (McIntyre, personal communication). Indeed, the choice of assignment of McIntyre's species to either *Centroderes* or *Campyloderes* would be difficult. Very little is known about either of these two genera but it is not unlikely that they may be considered congeneric once careful studies are made.

Although there as superficial similarities between *Condyloderes multispinosus* and *Centroderes spinosus*

(Reinhard, 1881) Zelinka, 1928, these similarities are minor compared with the unique features used as the basis for erecting the new genus. Certainly there is merit in noting that although *Centroderes* lacks lateral accessory appendages, *C. spinosus* does have lateral spines present only in the positions occupied by the lateral accessory appendages of *Condyloderes multispinosus*. Both species have dorsally displaced lateral spines on segment 12, but the middorsal and laterotermal accessory spines of the terminal segment of *Centroderes spinosus* are absent in *Condyloderes multispinosus*.

To complicate matters further, *Campyloderes adherens* may possess both dorsally displaced lateral spines on segment 12 and the middorsal spine on the terminal segment as well as lack laterotermal accessory spines. Although this opinion is derived from Nyholm's illustration (Nyholm, 1947a, fig. 3, p. 5) it is contradicted on page 5 of the text which states: "... bears a medium terminal spine (*ts*), two short lateral terminal spines (*lts*) and two lateral spines (*ls*)." Furthermore, Nyholm states (1947a, p. 4): "Nor are sensory hairs or adhesive tubes produced." Yet, both Text-figure 1 (p. 3) and Text-figure 3 (p. 5) show "*se* adhesive tube" and the illustrated appendage is suggestive of the lateral accessory appendage in *Condyloderes multispinosus*. The illustrated placids of Nyholm's species, however, are not like those of *Condyloderes multispinosus* but are typical of those found in both *Centroderes spinosus* and *Campyloderes macquariae* which I have studied.

In addition to the unique characteristics already listed for the genus *Condyloderes*, several contrasting characteristics of the genera *Campyloderes* and *Centroderes* should be mentioned. First of all, the head and neck in the latter two genera are significantly different from these areas in the new genus. The mouth styles for example, are without joints in *Condyloderes multispinosus* yet are distinctly 2-joined in the two previously described genera. The lateroventral elongate spines which originate on the posterior margin of the first trunk segment and extend the length of several segments of the latter genera are not evidenced in *Condyloderes* although the two pores on this same segment suggest some affinity. Finally, the flexible, pilose middorsal and lateral spines of *Condyloderes* present a considerable contrast to the straight and rigid, nonpilose spines of *Centroderes* and *Campyloderes*.

DISTRIBUTION.—Scotland: Fladen (North Sea), Lock Nevis (West Coast), and Lock Torridon (West Coast).

Condyloderes paradoxus, new species

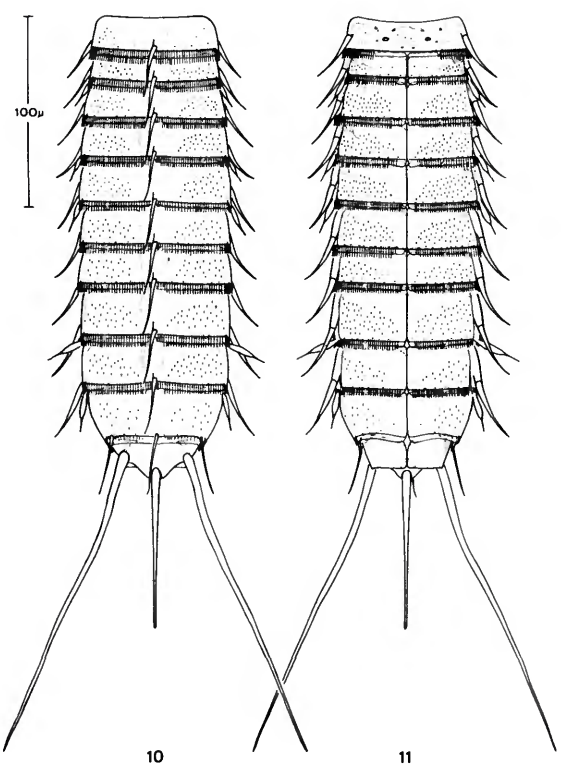
FIGURES 10–20

DIAGNOSIS.—*Condyloderes* with unequal submarginal knobby projections on midventral placid, central projection larger than lateral ones, slightly depressed to accommodate trichoscalid centered above it, three equal knobby projections near posterior margin; middorsal spines not pilose, lateral spines sparcely pilose at base only; lateral accessory appendages lanceolate on segments 4, 6, 7, 10, and 11; tubicolous intersegmental protuberances present on seventh ventral plate.

HOLOTYPE.—Adult male, TL 246μ; about 10 km off shore E of Visakhapatnam (Bay of Bengal), India; 40 m; brown sandy mud; 26 March 1964; col. R. P. Higgins (RH37.81); USNM 37460.

ALLOTYPE.—Adult female, TL 263μ; as holotype; (RH37.78); USNM 37461.

PARATYPES.—Four adult males, TL 216μ–264μ; one adult of undetermined sex, TL 235μ; one juvenile in



FIGURES 10–11.—*Condyloderes paradoxus*, new species, adult male, holotype, TL 246μ, trunk segments: 10, dorsal view; 11, ventral view.

molt, TL 213μ; as holotype; (RH37 series, retained in author's collection); four adult males, TL 250μ–282μ; ca. 5 km SE Kakinada Bay (Bay of Bengal), India; 40 m; soft brown mud; 23 March 1964; col. R. P. Higgins (RH36 series, retained in author's collection).

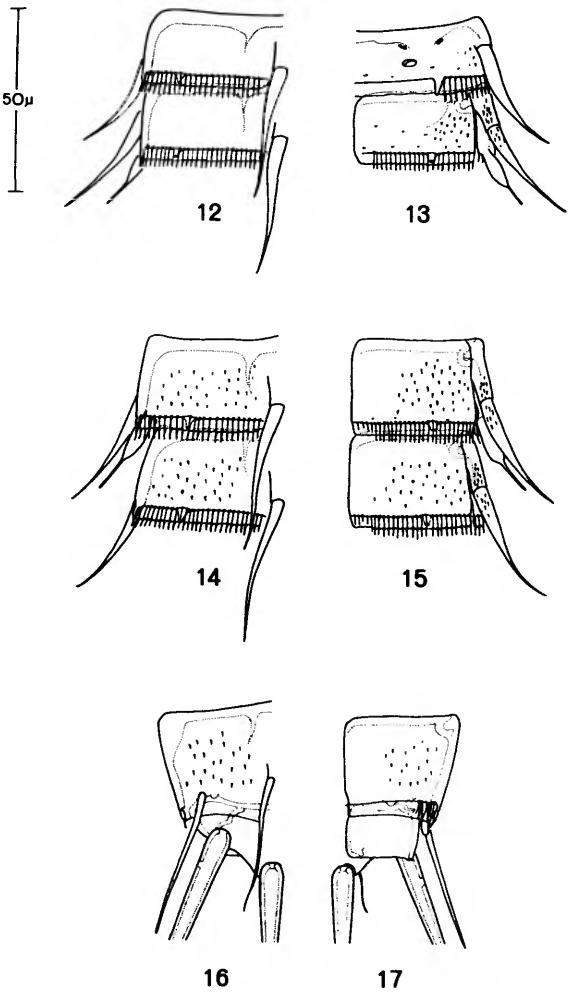
DESCRIPTION.—Holotypic adult, TL 246μ; MSW–9 68μ; SW 64μ; SW/TL 0.26.

First segment (Figure 18) with nine, thin unsegmented oral styles, ca. 15μ, surrounding mouth cone; six rows of scalids, first row with ten uniformly thick, blunt scalids, ca. 50μ, generally with nine setae, 10μ–20μ, near origin, two smaller setae at base (Figure 19); second row with ten tapering, pointed scalids, ca. 40μ; third row with 20 tapering, pointed scalids, ca. 30μ; fourth row with ten tapering, pointed scalids, ca. 25μ, basal portion elongated along longitudinal axis; fifth row with 28 filiform scalids, ca. 17μ, one pair centered over each of the 14 trichoscalids of row six; trichoscalids, ca. 20μ, not heavily setate, centered above placids (segment 2) except for placids adjacent to midventral placid, midventral trichoscalid at margin of midventral placid (Figure 18), other trichoscalids above placids, extra spinoscalid, ca. 22μ, in normal trichoscalid position above placid (Figures 18, 20).

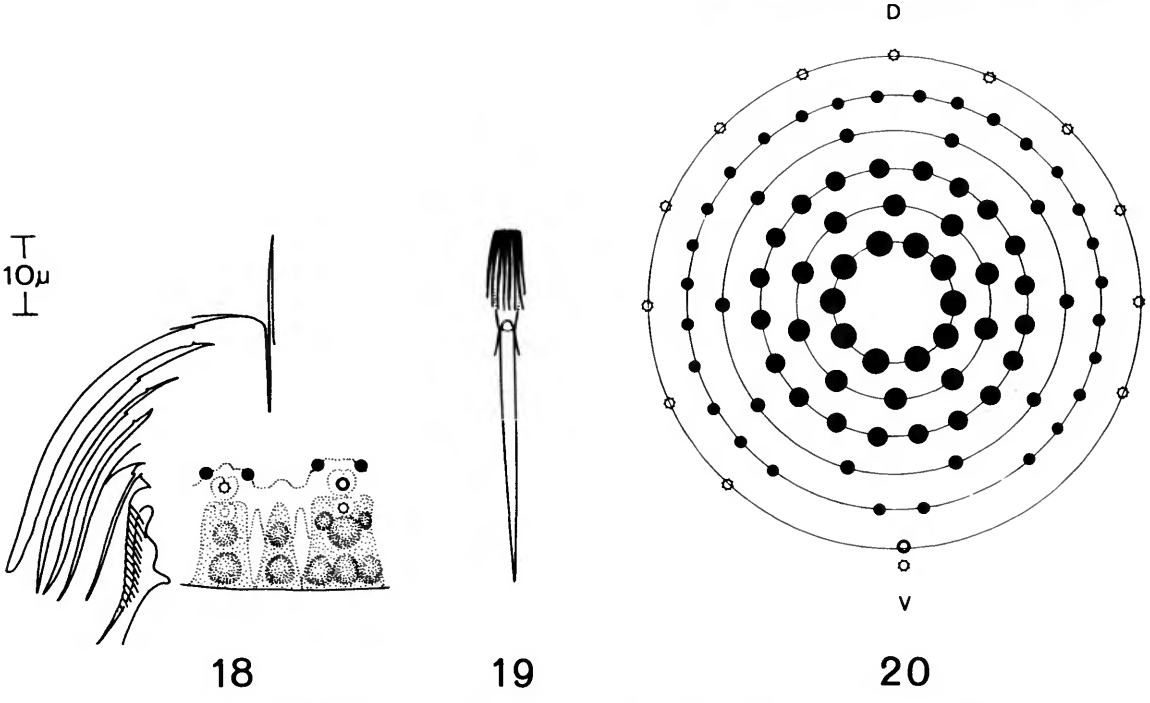
Second segment (neck) with 16 nearly truncate placids, poorly cuticularized; midventral placid distinctly larger than others, with trichoscalid at midmargin, three knobby projections submarginal, central projection larger, depressed to accommodate trichoscalid, second row of three nearly equal projections near base; remaining placids with single submarginal and basal projection, placids adjacent to midventral placid slightly narrower than others.

Third segment (first trunk segment) slightly vaulted dorsally, especially noticeable along median one-fourth of segment; posterior border of segment with distinctive pectinate fringe (Figures 12–13), basal half lanceolate in longitudinal section, appearing as a series of lammelate units, becoming aristate at apex to form border of setae; very short, weakly developed hairs on dorsal and ventral surface, pattern as illustrated (Figures 10–13); distinctive pores on either side of ventral midline, similar to base of adhesive tubes of male homalorhagids but no tubular extensions apparent; spinoid intersegmental protuberance on subdorsal posterior border and at posterior border of each ventral plate; slight indication of closely set hairs at base of lateral spines, lateral spine 29μ; middorsal spine 28μ.

Fourth segment with two ventral plates; without lateroventral pores; spinoid intersegmental protuberances on subdorsal posterior border and centered at posterior border of each ventral plate; lateral spine 28μ; lateral accessory appendage 18μ, slightly dorsal to lateral spine, originating from intersegmental zone of tergal plate near the lateroventral articulation zone, basal two-thirds lanceolate-ovoid, flattened in cross-section, abruptly tapering, becoming filiform distal one-third; middorsal spine 29μ; segment with minute



FIGURES 12–17.—*Condyloderes paradoxus*, new species, adult male, holotype, TL 246μ: 12, dorsal view, lateral half, segments 3–4; 13, ventral view, lateral half, segments 3–4; 14, dorsal view, lateral half, segments 7–8; 15, ventral view, lateral half, segments 7–8; 16, dorsal view, lateral half, segments 12–13; 17, ventral view, lateral half, segments 12–13.



FIGURES 18–20.—*Condyloderes paradoxus,* new species, adult male, holotype, TL 246μ: 18, diagrammatic perspective, lateral half, segments 1 (head) and 2 (neck or placids) showing midventral placid and 2 lateral placids only; 19, outer surface view, spinoscalid, row 1, showing basal setae; 20, diagrammatic perspective, anterior view, scalid arrangement, centermost row 1 through row 5 are spinoscalids, outermost row (6) with trichoscalids (note ventral trichoscalid displacement and extra spinoscalid).

hairs, pattern as illustrated; pectinate fringe as in segment 3.

Segments 5, 8, and 9 similar to fourth but without lateral accessory appendages; L–5 31μ, L–8 33μ, L–9 33μ; D–5 30μ, D–8 31μ, D–9 32μ.

Segments 6, 7, 10, and 11 similar to preceding segments but with lateral accessory appendages; LA–6 18μ, LA–7 22μ, LA–10 27μ, LA–11 22μ; L–6 33μ, L–7 34μ, L–10 32μ, L–11 36μ; D–6 29μ, D–7 32μ, D–10 34μ, D–11 36μ.

Segment 12 (Figures 7–8) without subdorsal intersegmental protuberances; lateral spine thin, dorsally displaced, not pilose, 32μ; middorsal spine 38μ; without lateral accessory appendage.

Segment 13 (terminal segment) without hairs, middorsal spine, or laterotermínal accessory spines; laterotermínal spine prominent, 170μ, slightly over two-thirds the trunk length; midterminal spine 85μ, nearly one-third the trunk length.

See Table 2 for measurements and indices for selected specimens of *Condyloderes paradoxus,* new species.

DISCUSSION.—The most easily observed feature of *Condyloderes paradoxus,* new species, which distinguishes it from *C. multispinosus* is the former species' lateral accessory appendage on segment 6. Although the displaced midventral trichoscalid on the anterior margin of the midventral placid and the extra spinoscalid in its normal position above the placid are distinctive, the head must be everted in order to observe these characters.

A close examination of the other placids reveals a slight modification in this same relative position, thereby suggesting that such a phenomenon may have been more extensive in the placid row during its development or evolutionary history.

The presence of the midventral trichoscalid on the border of the enlarged midventral placid corresponds with the submarginal positioning of the knobby projections typical of the genus. In *C. paradoxus,* new

TABLE 2.—*Measurements (μ) and indices for selected specimens of* Condyloderes paradoxus, *new species*

	Juvenile RH37.82	Adult ♂ RH37.85	Adult ♂ RH37.83	Adult ♂ USNM 37460 Holotype	Adult ♂ RH36.29	Adult ♀ USNM 37461 Allotype	Adult Range
TL	213	216	245	246	282	263	216–282
SW	–	–	62	64	64	–	62–64
SW/TL	–	–	0. 25	0. 26	0. 23	–	0. 23–0. 26
MSW–9	–	–	68	68	70	–	68–70
DM	28. 0	28. 4	32. 3	31. 9	33. 1	32. 6	28. 4–33. 1
DM/TL	0. 13	0. 13	0. 13	0. 13	0. 12	0. 12	0. 12–0. 13
LM	23. 4	32. 1	31. 7	32. 1	33. 5	33. 6	31. 7–32. 1
LM/TL	0. 11	0. 15	0. 13	0. 13	0. 12	0. 13	0. 12–0. 15
LAM	16. 6	17. 6	20. 0	21. 4	18. 6	18. 6	17. 6–21. 4
LAM/TL	0. 08	0. 08	0. 08	0. 09	0. 07	0. 07	0. 07–0. 09
LTS	120	162	155	170	160	148	148–170
LTS/TL	0. 57	0. 75	0. 63	0. 69	0. 57	0. 56	0. 56–0. 69
MTS	64	96	86	85	broken	88	85–96
MTS/TL	0. 30	0. 22	0. 28	0. 29		0. 30	0. 22–0. 30

species, the central projection is slightly enlarged and posteriorly displaced. The remaining placid characteristics are similar to those described for *C. multispinosus.*

In *C. paradoxus,* new species, there is less hair on the trunk segments and a corresponding lack of hair on the spines; the middorsal spines lack hair and the lateral spines possess only a few minute hairs basally. There is a vague pattern of hairs displayed on the dorsal and ventral trunk plates which differs from that of *C. multispinosus.*

The adults of *C. paradoxus,* new species, are larger (TL 216μ–282μ) than those of *C. multispinosus* (TL 336μ–370μ). The standard width index (SW) of the former species (0.23–0.26) is greater than in *C. multispinosus* (0.18–0.23) making the trunk of *C. paradoxus,* new species, relatively wider than that of *C. multispinosus.* Similarly, the average relative length of the lateral accessory appendages of the new species (0.07–0.09) is greater than in *C. multispinosus* (0.04–0.06), and in addition to being relatively longer, those of *C. paradoxus,* new species, are more lanceolate than in *C. multispinosus.*

The muscular pharynx was visible in two specimens of *C. paradoxus,* new species. This structure is narrowly elongate, 20μ × 80μ. In the cyclorhagid family Echinoderidae, *Echinoderes* has a nearly eliptical or somewhat rounded pharynx. Within the family Centroderidae, *Centroderes* has a distinctly pear-shaped pharynx, slightly narrowed anteriorly; in *Campyloderes,* the anterior portion is narrowly elongate but the posterior one-third is distinctly broad.

In another suborder, Conchorhagae, *Semnoderes* exhibits a nearly oval to pear-shaped pharynx, but in the suborder Cryptoghagae, the elongate pharynx of *Cateria* is remarkably similar to that of *Condyloderes paradoxus,* new species, in its relative dimensions (length width ratio of 4:1).

Suborder CONCHORHAGAE Zelinka, 1896

CONCHORHAGATA Lang, 1949, p. 8.

DEFINITION.—Cyclorhagida with third segment bilaterally divided into clamshell-like closing apparatus, with or without wedgeshaped midventral and middorsal plates; placids weakly developed or with 16 distinct, well-cuticularized placids; mouth styles 2-jointed; scalids in six to seven rows, trichoscalids present or absent; middorsal spines on all trunk segments, lateral spines on segments 4– or 5–12, lateral accessory appendages on several segments, lateroterminal accessory spines well developed; midterminal spine usually equal to trunk length.

Family SEMNODERIDAE Remane, 1936

PENTACONTIDAE Zelinka, 1907, p. 135

DEFINITION.—Same as for suborder.

Sphenoderes, new genus

TYPE-SPECIES.—*Sphenoderes indicus*, new species.

DEFINITION.—Semnoderidae with 16 well-developed placids; scalids in six rows, trichoscalid row present; wedge-like midventral and middorsal plates between bilateral plates of third segment; middorsal spines on all trunk segments, lateral spines on segments 5–11, lateral accessory appendages on segments 7, 10, and 11.

Sphenoderes indicus, new species

FIGURES 21–23

DIAGNOSIS.—*Sphenoderes* as genus.

HOLOTYPE.—Adult female, TL 256μ; about 10 km off shore E of Visakhapatnam (Bay of Bengal), India; 40 m; brown sandy mud; 26 March 1964; col. R. P. Higgins (RH37.89); USNM 37462.

ALLOTYPE.—Adult male, 256μ; as holotype; (RH 37.91); USNM 37463.

PARATYPES.—Two adult females, TL 232μ–240μ; one adult male, 232μ; as holotype; (RH37 series, retained in author's collection). Two adult females, TL 226μ–280μ; ca. 5 km SE Kakinada Bay (Bay of Bengal), India; 40 m; soft brown mud; 23 March 1964; col. R. P. Higgins (RH36 series, retained in author's collection). Two adult females, TL 228μ–248μ; ca. 12 km off shore from largest tributary of Coloroon River, near Porto Novo (Bay of Bengal), India; 22 m; brown sandy mud; 14 March 1964; col. R. P. Higgins (RH27 series, retained in author's collection). One adult male, TL 305μ and one adult female, TL 400μ; near "Rozi" W Jamnagar (Gulf of Kutch), India; 6 m; gray-brown mangrove mud; 14 February 1964; col. R. P. Higgins (RH4 series, retained in author's collection).

DESCRIPTION.—Holotypic female, TL 256μ; MSW–7 90μ; SW 64μ; SW/TL 0.25.

First segment (head) (Figure 23) with six rows of scalids; first row with ten uniformly thick, blunt scalids, ca. 42μ with two setae at joint, 6μ–8μ, second row with ten tapering scalids, ca. 38μ; third row with 20(?) tapering scalids, ca. 30μ; fourth row with ten (?) tapering scalids, ca. 23μ; fifth row with ten(?) tapering scalids; ca. 20μ; sixth row with 14 trichoscalids, weakly ringed, not setose, ca. 13μ; protrusible proboscis with 7–9 2-jointed oval styles, ca. 20μ.

Second segment (Figures 21–22) with 16 well-developed placids, middorsal and midventral placids with broad base, adjacent placids narrowly rounded at anterior margin, remaining placids distinctly truncate.

Third segment (first trunk segment) with wedge-shaped middorsal and midventral plates between bilateral plates of third segment; robust middorsal spine 22μ; minute hairs on surface of plates forming slight pattern, poorly developed anteriorly, becoming more distinct on posterior margin of segment.

Fourth segment with lateroventral plates articulating with dorsal plate, lateroventral articulation zone continuous with midventral plate of first trunk segment; middorsal spine 24μ; pachycycli (thickened anterior margins) distinct but articulation mechanisms of anterolateral margins of ventral plates not clear; adhesive tubes not evident; hair pattern similar to third segment; posterior margins with striate extensions of hair-like processes.

Fifth segment similar to fourth, middorsal spine 24μ; with robust lateral spine near lateroventral margin of dorsal plate, 20μ; dorsoventral muscle scars prominent, horizontally oriented subdorsally and in middle of each ventral plate.

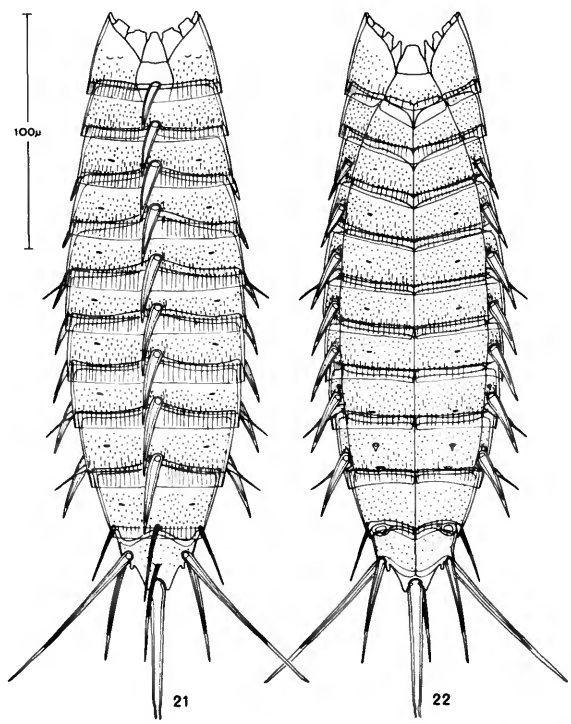


FIGURE 21–22.—*Sphenoderes indicus*, new genus, new species, adult female, holotype, TL 256μ, neck (placids) and trunk segments, midterminal spine partially shown (MTS 296μ): 21, dorsal view; 22, ventral view.

TABLE 3.—*Measurements (μ) and indices for selected specimens of* Sphenoderes indicus, *new species*

	Adult ♀ RH36.86	Adult ♀ USNM 37462 Holotype	Adult ♀ RH4.120	Adult ♂ RH37.93	Adult ♂ USNM 37463 Allotype	Adult ♂ RH4.121	Adult Range
TL	226	256	400	232	256	305	226–400
SW	–	64	–	–	–	–	–
SW/TL	–	0.25	–	–	–	–	–
MSW-7	–	90	–	–	–	–	–
DM	31.5	32.7	31.7	30.3	32.5	29.0	29.0–32.7
DM/TL	0.14	0.13	0.08	0.13	0.13	0.10	0.08–0.13
LM	23.5	24.0	27.5	25.0	25.6	25.6	23.5–27.5
LM/TL	0.01	0.09	0.07	0.09	0.10	0.08	0.07–0.10
LAM	15	18	18	17	18	18	15–18
LAM/TL	0.07	0.07	0.05	0.07	0.07	0.06	0.05–0.07
LTS	76	76	80	67	73	broken	67–80
LTS/TL	0.34	0.30	0.20	0.29	0.29		0.20–0.30
LTAS	38	43	42	37	44	44	38–44
LTAS/TL	0.17	0.17	0.11	0.16	0.17	0.14	0.11–0.17
MTS	330	296	376	280	broken	360	280–376
MTS/TL	1.46	1.16	0.94	1.21		1.18	0.94–1.21

Segments 6, 8, and 9 similar to fifth; L–6 21μ, L–8 24μ, L–9 24μ; D–6 28μ, D–8 30μ, D–9 33μ.

Segments 7, 10, and 11 similar to preceding segments but with lateral accessory appendages; lateral accessory appendages broadly flattened at proximal one-half, tapering to capillate distally, 18μ; keyhole-shaped muscle scar(?) immediately anterior to lateral spine on segment 10 and centered on ventral plates of segment 11; intersegmental protuberance at posterior margin of segment 11; L–7 24μ, L–10 27μ, L–11 26μ; D–7 28μ, D–10 35μ, D–11 35μ.

Segment 12 with thin middorsal spine, 34μ; lateral spine, 26μ, ventral muscle scars not evident.

Segment 13 (terminal segment) with thin middorsal spine, 66μ; lateral terminal spine dorsal to lateroterminal accessory spine, 76μ, one-third the trunk length; lateroterminal accessory spine 43μ, less than one-fifth the trunk length; gonopores lateroventral near anterior margin; small posteriorly directed marginal protuberance medial to base of each lateroterminal spine.

See Table 3 for measurements and indices for selected specimens of *Sphenoderes indicus,* new species.

DISCUSSION.—Because of the strongly curved dorsoventral axis of fixed conchorhagids, dorsoventral orientation of the specimen on a slide mount is difficult. The problem is further complicated by the relatively few specimens in the average sample. Consequently, the chances are great that the specimen will be viewed laterally. The diagnostic character that must be determined in order to distinguish *Sphenoderes indicus,* new species, from *Semnoderes* is the presence of the middorsal and midventral wedge-shaped plates between the bilateral plates of the third segment in the former taxon. This character can be seen by carefully studying the margins of the anteriormost trunk segment even when the specimen is mounted laterally.

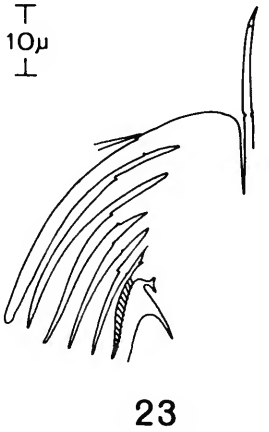


FIGURE 23.—*Sphenoderes indicus,* new genus new species, adult, composite diagrammatic perspective, lateral half, segment 1 (head).

The characteristic placids of *Spenoderes* may be obscured if the head is retracted, otherwise, no placids have been seen in the genus *Semnoderes*. If specimens are properly cleared, the placids, even when retracted, are usually visible.

Three species of *Semnoderes* have been described and can be distinguished from one another by the number and position of the lateral accessory appendages. *Semnoderes armiger* Zelinka, 1928, possesses lateral accessory appendages on segments 4, 7, 8, 10, and 11; *S. ponticus* Băcescu and Băcescu, 1956, has lateral accessory appendages on segments 6, 7, 8, 10, and 11; and *S. pacificus* Higgins, 1967, has lateral appendages on segments 4, 7, 10, and 11.

Semnoderes armiger is well described although the details of the head are not as elaborately illustrated as the remainder of the animal; unfortunately, only five specimens were seen by Zelinka. This species has been reported from Gullmar Fjord, Sweden by Nyholm (1947b) and from Fladen and Loch Nevis, Scotland by McIntyre (1962, 1964).

Semnoderes pacificus is known from New Caledonia and Redondo Beach, California. This is a particularly noteworthy species in that the first row of spinoscalids are distally segmented and the other rows of spinoscalids have medially serrated borders; trichoscalids are present in this species but not in the others.

The type-material of *Sphenoderes indicus,* new species, included eleven adult individuals and three juveniles. Of the adults, the two from the Northwest Coast of India, Bay of Kutch (Jamnagar) are considerably larger (305μ–400μ) than the average (ca. 250μ) from the East Coast (Porto Novo to Visakhapatnam). The only morphological difference noted was a more flexible and seemingly segmented middorsal spine on the twelfth segment of the Jamnagar (RH4 series) specimens. The lateral mounting of the latter specimens prevents proper doroventral analysis, but the remaining diagnostic characters seem to be identical with those from the East Coast. I should like to call the readers attention to Table 3, however, in order to note the potentially important discrepancies in the indices for DM/TL, LM/TL, LAM/TL, and LTAS/TL.

More intensive study of the Jamnagar population may reveal that two different species exist.

DISTRIBUTION.—Jamnagar (Gulf of Kutch), Porto Novo, Kakanada, and Visakhapatnam (Bay of Bengal), India.

Literature Cited

Băcescu, M., and E. Băcescu

1956. Kinorhinchii—Reprezentanti ai Unei Clase de Animale, Nouă Pentru Fauna Romineasca. *Communications de l'Academie de la Republique Populaire Romaine*, 6(4):543–549, figures 1–6.

Chitwood, B. G.

1958. The Classification of the Phylum Kinorhyncha. *Proceedings of the 15th International Congress of Zoology*, 1958:941–943.

Ganapati, P. N., and G. C. Rao

1962. Ecology of the Interstitial Fauna Inhabiting the Sandy Beaches of Waltair Coast. *Journal of the Marine Biological Association of India*, 4(1):44–57, figures 1–3, tables 1–11.

Gerlach, S. A.

1956. Über einen Aberranten Vertreter der Kinorhynchen aus dem Küstengrundwasser. *Kieler Meeresforschungen*, 12:120–124, figures 1–15, plates 40–42.

Higgins, R. P.

1964. Redescription of the Kinorhynch *Echinoderes remanei* (Blake, 1930) Karling, 1954. *Transactions of the American Microscopical Society*, 83(2):243–247, figures 1–3.

1967. The Kinorchyncha of New Caledonia. In *Expedition Française sur les Recifs Coralliens de la Nouvelle Caledonia*, 2:75–90, figures 1–12.

1968. Taxonomy and Postembryonic Development of the Cryptorhagae: A New Suborder for the Mesopsammic Kinorhynch Genus *Cateria*. *Transactions of the American Microscopical Society*, 87(1):21–39, figures 1–25.

Johnston, T. H.

1938. Report on the Echinoderida. *Scientific Reports of the Australasian Antarctic Expedition, 1911–1914*, series C, 10 (7):1–13, figures 1–7.

Lang, K.

1949. Echinoderida. In Odhner, J. H., editor, *Further Zoological Results of the Swedish Antarctic Expedition 1901–1903*, 4 (2):1–22, figures 1–8.

McIntyre, A. D.

1962. The Class Kinorhyncha (Echinoderida) in British Waters. *Journal of the Marine Biological Association of the United Kingdom*, 44:503–509, figures 1–2.

1964. Meiobenthos of Sublittoral Muds. *Journal of the Marine Biological Association of the United Kingdom*, 44: 665–674.

Nyholm, K. G.

1947a. *Campylodereș*—An "Antarctic" Genus of Echinoderida off the West Coast of Sweden. *Arkiv für Zoologi*, 39A (13):1–6, text-figures 1–3, figures 1–4, plate 1.

1947b. Studies in the Echinoderida. *Arkiv für Zoologi*, 39A (14):1–36, text-figures 1–22, figures 1–7, 1–9, plates 1–2.

Rao, G. C., and P. N. Ganapati

1966. Occurrence of an Aberrant Kinorhynch *Cateria styx* Gerlach, in Waltair Beach Sands. *Current Science*, 35 (8):212–213, figures 1–3.

Reinhard, W.
1881. Uber *Echinoderes* und *Desmoscolex* der Umgegen von Odessa. *Zoologischer Anzeiger*, 4:588–591.

Remane, A.
1936. Gastrotricha and Kinorhyncha. In Bronn, editor, *Klassen und Ordnungen des Tierreichs*, 4 (sec. 2, pt. 1, no. 2): vi+385, figures 1–297.

Thiel, H.
1966. Quantitative Untersuchungen über die Meiofauna des Tiefseebodens. *Veroffentlichungen des Institutes für Meeresforschungen in Bremerhaven*, 2:131–147, figures 1–3, tables 1–4.

Timm, R. W.
1958. Two New Species of *Echinoderella* (Phylum Kinorhyncha) from the Bay of Bengal. *Journal of the Bombay Natural History Society*, 55(1):107–109, figures 1–2.

Zelinka, C.
1896. Demonstration von Taflen der Echinoderes—Monographie. *Verhandlungen der Deutschen Zoologischen Gesellschaft* 6. *Jahresversammlung, Bonn*, 197–199.
1907. Zur Kenntnis der Echinoderen. *Zoologischer Anzeiger* 32(5):130–136.
1913. Die Echinoderen der Deutschen Südpolar Expedition 1901–1903. *Deutsche Südpolar Expedition* 1901–1903 14 (Zoology, 6):419–436, figures 1–11, plate 39.
1928. *Monographie der Echinodera*, iv+396 pages, 27 plates. Leipzig: Wilhelm Englemann.

U.S. GOVERNMENT PRINTING OFFICE: 1969 O—332-760

Publication in *Smithsonian Contributions to Zoology*

Manuscripts for serial publications are accepted by the Smithsonian Institution Press, subject to substantive review, only through departments of the various Smithsonian museums. Non-Smithsonian authors should address inquiries to the appropriate department. If submission is invited, the following format requirements of the Press will govern the preparation of copy. (An instruction sheet for the preparation of illustrations is available from the Press on request.)

Copy must be typewritten, double-spaced, on one side of standard white bond paper, with 1½″ top and left margins, submitted in ribbon copy with a carbon or duplicate, and accompanied by the original artwork. Duplicate copies of all material, including illustrations, should be retained by the author. There may be several paragraphs to a page, but each page should begin with a new paragraph. Number consecutively all pages, including title page, abstract, text, literature cited, legends, and tables. The minimum length is 30 pages of typescript and illustrations.

The *title* should be complete and clear for easy indexing by abstracting services. Taxonomic titles will carry a final line indicating the higher categories to which the taxon is referable: "(Hymenoptera: Sphecidae)." Include an *abstract* as an introductory part of the text. Identify the *author* on the first page of text with an unnumbered footnote that includes his professional mailing address. A *table of contents* is optional. An *index,* if required, may be supplied by the author when he returns page proof.

Two *headings* are used: (1) text heads (boldface in print) for major sections and chapters and (2) paragraph sideheads (caps and small caps in print) for subdivisions. Further headings may be worked out with the editor.

In *taxonomic keys,* number only the first item of each couplet; if there is only one couplet, omit the number. For easy reference, number also the taxa and their corresponding headings throughout the text; do not incorporate page references in the key.

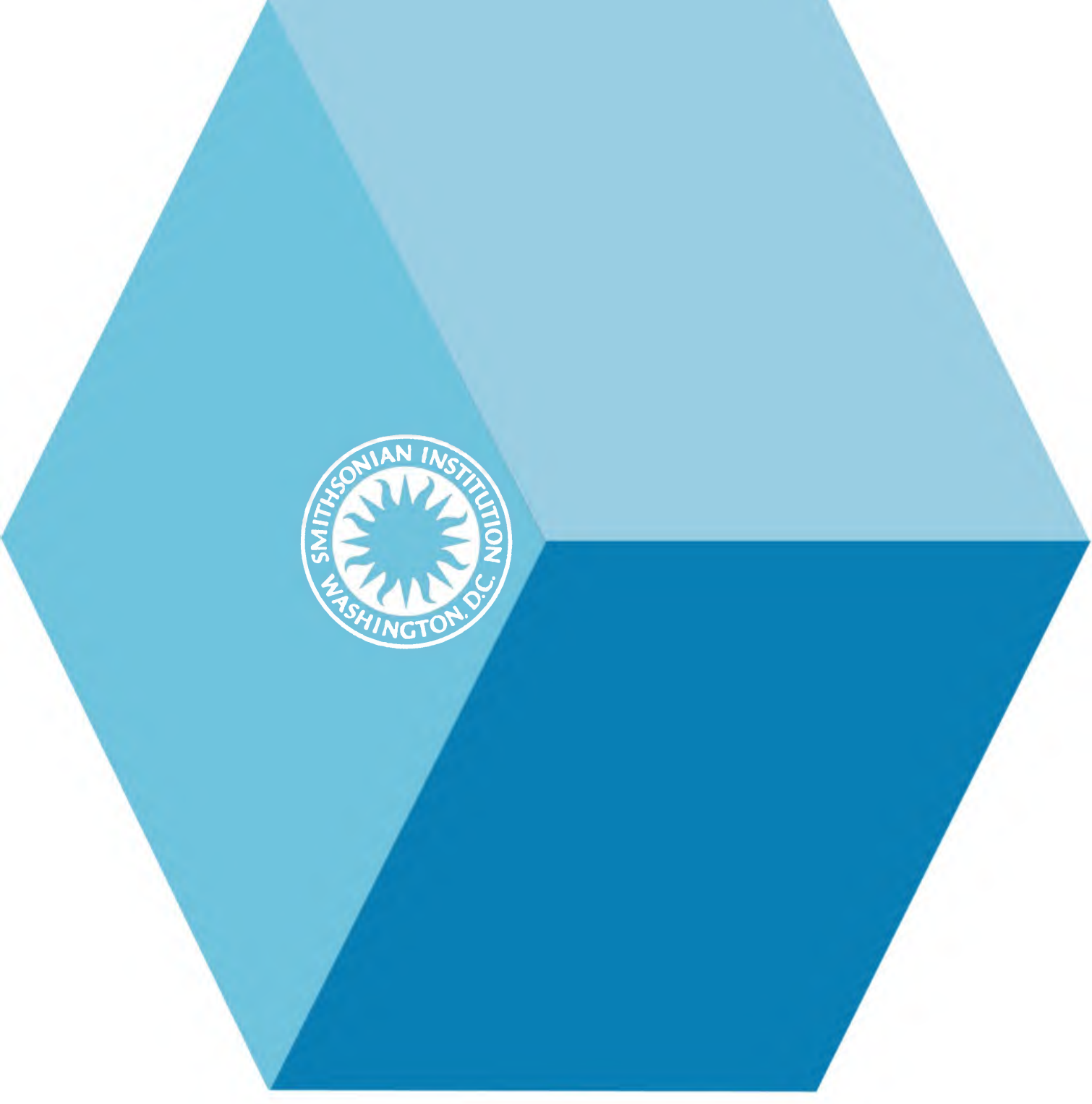
In *synonymy,* use the short form (taxon, author, date, page) with a full reference at the end of the paper under "Literature Cited." Begin each taxon at the left margin with subsequent lines indented about three spaces. Within a taxon, use a period-dash (.—) to separate each reference. Enclose with square brackets any annotation in or at the end of the taxon. For *references within the text,* use the author-date system: "(Jones, 1910)" or "Jones (1910)." If the reference is expanded, abbreviate the data: "Jones (1910, p. 122, pl. 20: fig. 1)."

Simple *tabulations* in the text (e.g., columns of data) may carry headings or not, but they should not contain rules. Formal *tables* must be submitted as pages separate from the text, and each table, no matter how large, should be pasted up as a single sheet of copy.

Illustrations (line drawings, maps, photographs, shaded drawings) can be intermixed throughout the printed text. They will be termed *Figures* and should be numbered consecutively; however, if a group of figures is treated as a single figure, the individual components should be indicated by lowercase italic letters on the illustration, in the legend, and in text references: "Figure 9*b*." If illustrations (usually tone photographs) are printed separately from the text as full pages on a different stock of paper, they will be termed *Plates,* and individual components should be lettered (Plate 9*b*) but may be numbered (Plate 9: figure 2). Never combine the numbering system of text illustrations with that of plate illustrations. Submit all legends on pages separate from the text and not attached to the artwork.

In the *bibliography* (usually called "Literature Cited"), spell out book, journal, and article titles, using initial caps with all words except minor terms such as "and, of, the." (For capitalization of titles in foreign languages, follow the national practice of each language.) Underscore (for italics) book and journal titles. Use the colon-parentheses system for volume, number, and page citations: "10(2):5–9." Spell out such words as "figures" and "plates" (or "pages" when used alone).

For *free copies* of his own paper, a Smithsonian author should indicate his requirements on "Form 36" (submitted to the Press with the manuscript). A non-Smithsonian author will receive 50 free copies; order forms for quantities above this amount with instructions for payment will be supplied when page proof is forwarded.


SMITHSONIAN INSTITUTION
WASHINGTON, D.C.