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A new species of *Polyipnus* (Teleostei: Stomiiformes) from the western Indian Ocean, with comments on sternoptychid ecology

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Abstract.—*Polyipnus limatulus* is described based on material collected in the Gulf of Aden and immediately adjacent areas of the northwestern Indian Ocean. These collections were made during midwater fish surveys conducted from three vessels, R/V *Beinta* (1987), R/V *Malcolm Baldridge* (1995), and R/V *Tyro* (1992). Like other species in this genus *P. limatulus* appears to occur in association with the continental slope and/or various types of sea floor rises. *Polyipnus limatulus* shares certain apomorphic characters with the *P. spinosus* species group; among these are a multispinose posttemporal, and the occurrence of numerous spine-like denticles on the modified scales covering many of the ventral photophores. These denticles are lacking on the ACB photophore scales, a character which distinguishes the new species from a putatively closely related species, *P. asper* (eastern Indian ocean). *Polyipnus indicus* (western Indian Ocean) has somewhat similar scale denticulation but has a relatively unmodified parietal, among other differences. The new species was found to occur in relatively warm, saline, low oxygen water associated with Red Sea outflow, whereas the other *Polyipnus* species collected during the R/V *Tyro* survey, *P. omphus* Baird, 1971 was collected in the colder, less saline, higher oxygen water associated with the Somali Current.

The Stomiiformes are mainly meso- and bathypelagic fishes, found in all oceans but more diverse in the tropics and subtropics (Harold & Weitzman 1996, Harold 1998). Among the Sternoptychidae or hatchetfishes one genus in particular, *Polyipnus*, contains more species than any of the other nine genera in the family (Weitzman 1974, Harold 1994). *Polyipnus* has been the subject of several revisionary studies (Schultz 1938, 1961, 1964; Baird 1971; Borodulina 1979; Harold 1994) and a series of recent species descriptions (Harold 1989, 1990a; Aizawa 1990; Last & Harold 1994). The most diverse clade of this genus, the *Polyipnus spinosus* species group, was phylogenetically diagnosed by Harold (1994:455–458) and at that time contained 14 named species. More recently, Last & Harold (1994) described *P. latirastrus* from the Coral Sea and added it to the group, based on the presence of synapomorphies proposed by Harold (1994).

We describe here a new species belonging to *Polyipnus*, based on collections made in the Gulf of Aden and vicinity by three vessels, R/V *Beinta* (January and March 1987), R/V *Malcolm Baldridge* (August 1995), and R/V *Tyro* (August 1992 and January 1993, as part of the Somali Ecosystem Study [SES], Netherlands Indian Ocean Program [NIOP]). A total of 192 specimens were examined, ranging in standard length from 6.5 to 45.7 mm. For the first time a reasonably complete series of larval through adult specimens is available for a species of the *P. spinosus* species group and we therefore illustrate and briefly describe the larva.

Materials and Methods

Specimen body size is standard length (SL) in all cases. Morphometric, meristic, photophore and other characters were determined following the methods and terminology of Harold (1994). Values for the holotype are given in parentheses in the description. Terminology of the photophores is repeated here for convenience, and because the terms now in use replace those of Schultz (1961) that occur in much of the sternoptychid literature. The abbreviation for each photophore cluster and its verbal descriptor, as defined by Schultz (1961), are given in parentheses: ACA (SAN, supra-anal), ACB (AN, anal), ACC (SC, subcaudal), BR (BR, branchiostegal), IP (IS, isthmus), L (L, lateral), OP (PRO, preopercular + SO, subopercular + PTO, postorbital), ORB (PO, preorbital), OVA (SP, suprapectoral), OVB (SAB, supra-abdominal), PV (AB, abdominal), and VAV (PAN, preanal). Specimens were cleared and counterstained for bone and cartilage following the methods outlined by Pothoff (1984) and Taylor and Van Dyke (1985). Observations on osteology and dentition of *P. limatulus* were based on two cleared and stained adult specimens (USNM 345149, 31.8–38.0 mm SL). Institutional abbreviations are as listed in Leviton et al. (1985).

Acronyms used for various "Subareas" of the Somali Ecosystem Study are defined as follows: GAD (Gulf of Aden), between 12°20′ and 12°45′N, 38°08′ and 50°05′E; SWL (Great Swirl, an eddy created by the Somali Current), between 6°10′ and 12°05′N, 53°40′ and 55°00′E; USI (Upper Somali Current Inshore), between 7°30′ and 10°50′N, 50°21′ and 52°05′E; LSI (Lower Somali Current Inshore), between 0°06′ and 3°22′N, 44°56′ and 48°26′E; LSO (Lower Somali Current Offshore), 1°55′N, 53°34′E, represented by a single station.

Ecological comparisons were made between *P. limatulus* and other sternoptychids with which it was collected. A mathematical formula, the "weighted hydrographic index" (modified, after Wessel 1997) was used to summarize hydrographic conditions with which each species is associated. The analysis is based on 17 hauls of a rectangular midwater trawl.

Weighted hydrographic index.—To allow comparisons between species, hauls, stations, subareas, day/night occurrence and season, a weighted hydrographic index was devised to best represent the average conditions of capture for specimens of a given species under stated capture criteria (e.g., day vs. night; summer vs. winter). Construction of this index involved two steps: computation of an integrated average for each hydrographic parameter for each discrete depth segment sampled, and combination of this average with proportionate capture information for each species for each set of capture criteria. The hydrographic average was constructed as the integral average of the hydrocast data within each sampling depth segment by the method of trapezoidal approximation, evaluated for all hydrographic data points (up to N = 9 discrete values) within a sampling segment (i.e., one "haul"), such that:

$$V_x = \sum_{i=1}^{N} \left(\left(\left(\frac{|V_{i+1} - V_i|}{2} \right) + V_L \right) \times \left(\frac{D_{i+1} - D_i}{D_z - D_1} \right) \right)$$

where

V_x = computed integral average for a given hydrographic parameter (temperature, salinity, dissolved oxygen, etc.) for a given haul segment.

V_{i+1}, V_i = two sequentially successive measurements of that value within that segment.

V_L = the smaller of the two values, V_{i+1} or V_i, for each comparison.

D_{i+1}, D_i = depth at which the two measurements, V_{i+1}, V_i, respectively, was made; where $D_{i+1} > D_i$.

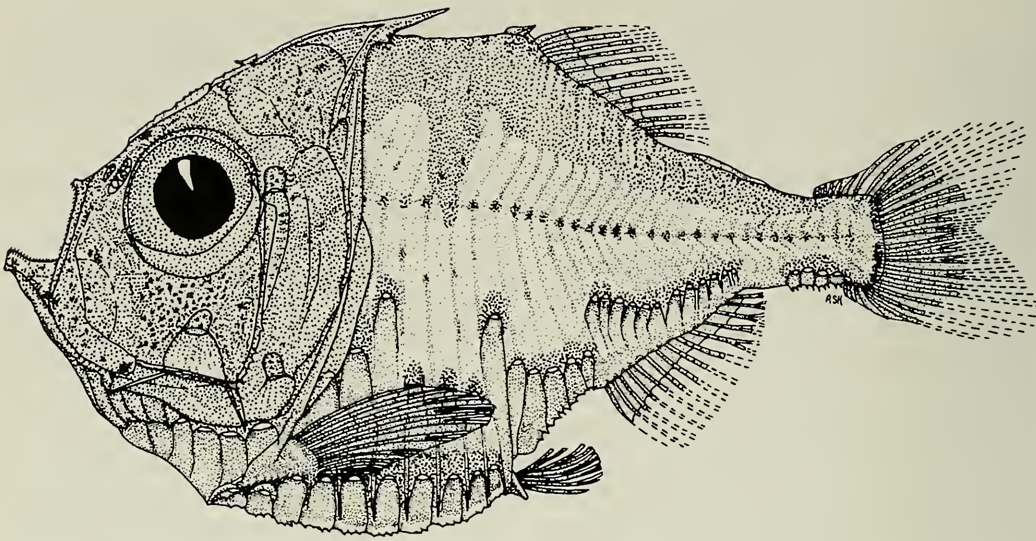

Fig. 1. *Polyipnus limatulus*, holotype, USNM 316316, 39.0 mm SL.

D_1 = shallowest depth of measurement for segment.

D_z = deepest depth of measurement for segment.

Comparisons between species (for given evaluation criteria) were then facilitated by weighting the integral average of the hydrographic values for each haul (successful in capturing the species) by proportionate capture of the species over all hauls successful in capturing the species, such that, for species A:

$$INV_A = \frac{\sum_{i=1}^{H} \left(V_{A_i} \times \frac{n_i}{N} \right)}{N}$$

where

INV_A = weighted hydrographic index for species A, as restricted by preset criteria (e.g., day vs. night, summer vs. winter).

H = number of hauls in which species A was captured.

V_{A_i} = integral average of hydrographic value for haul i.

n_i = number of specimens of species A taken in haul i.

N = total number of specimens of species A taken in all (=H) hauls.

Polyipnus limatulus Harold & Wessel, new species
Figs. 1–4, Tables 1 & 2

Polyipnus cf. *indicus* Harold, 1994:437, 450, 511 (USNM 293986, 301277, 316316; fig. 16B, pectoral girdle morphology).

Type material.—Holotype: USNM 316316, (1, 39.0 mm), 11°12′12″N, 47°57′30″E, (0-)315 m, R/V *Beinta*, Cr. 18, Sta. 4, 8 Jan 1987. Paratypes: MCZ 150026, (1, 28.5 mm), 14°05′00″N, 50°42′36″E, 0–1000 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-50 (1), 9 Aug 1995. MCZ 150036, (1, 27.4 mm), 14°05′00″N, 50°42′36″E, 300–150 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-50 (4), 9 Aug 1995. USNM 293986, (3, 42.6–45.7 mm), 12°01′00″N, 51°16′36″E, (0-)375–393 m, R/V *Beinta* Cr. 20, Sta. 18, 1600 h, 12 Mar 1987. USNM 301277, (5; 2, 26.4–31.8

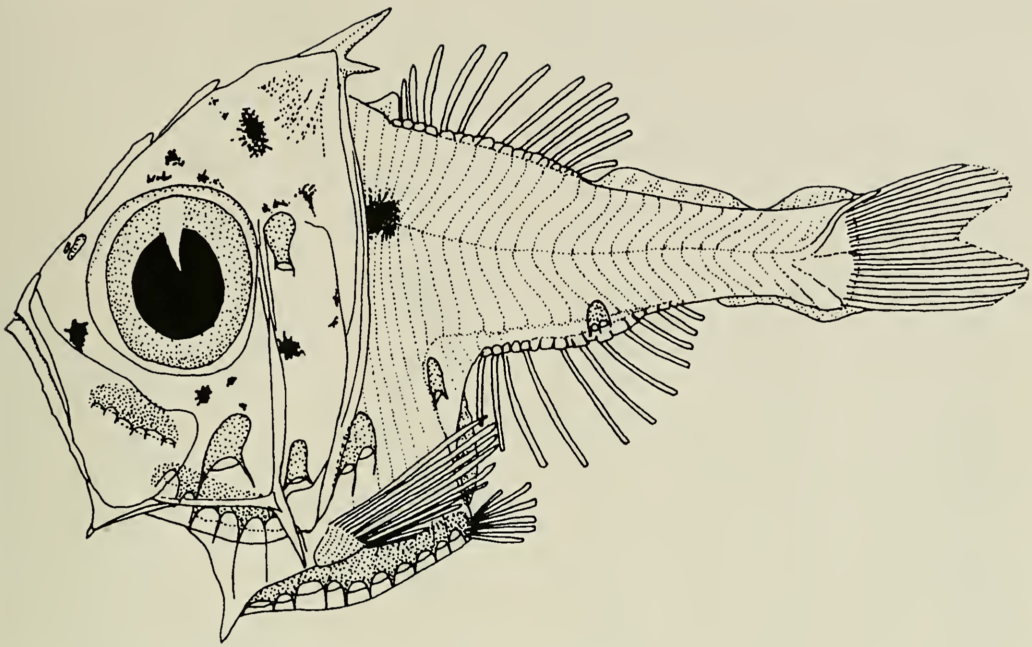

Fig. 2. *Polyipnus limatulus*, larva, MCZ 150024, 6.5 mm SL.

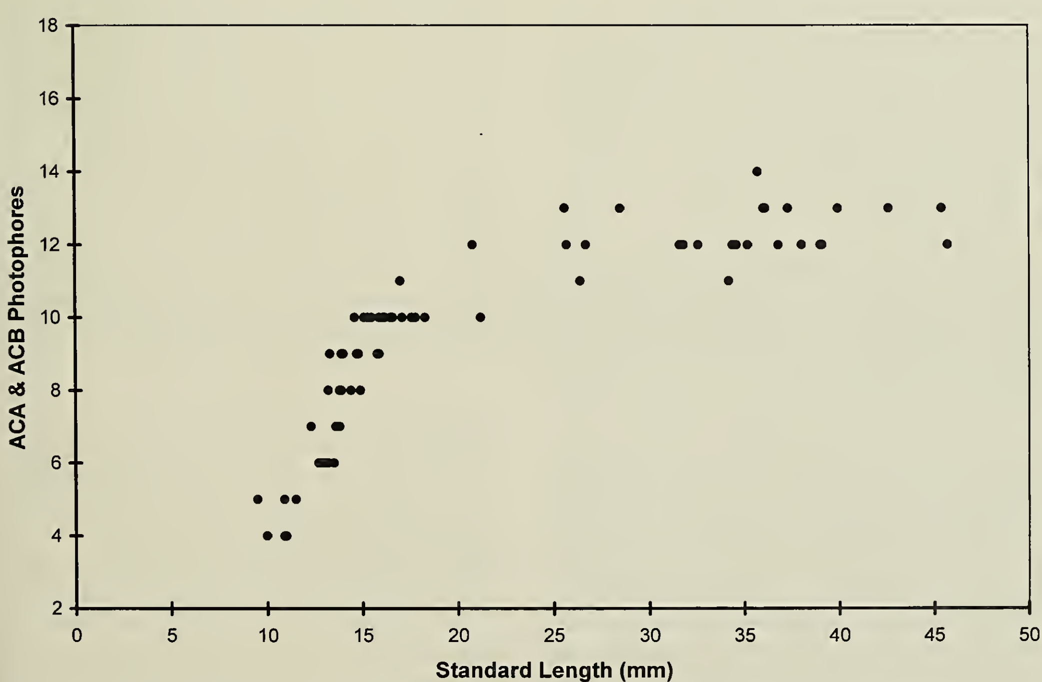

Fig. 3. Plot of ACA + ACB photophore count (combined) versus SL for *Polyipnus limatulus*.

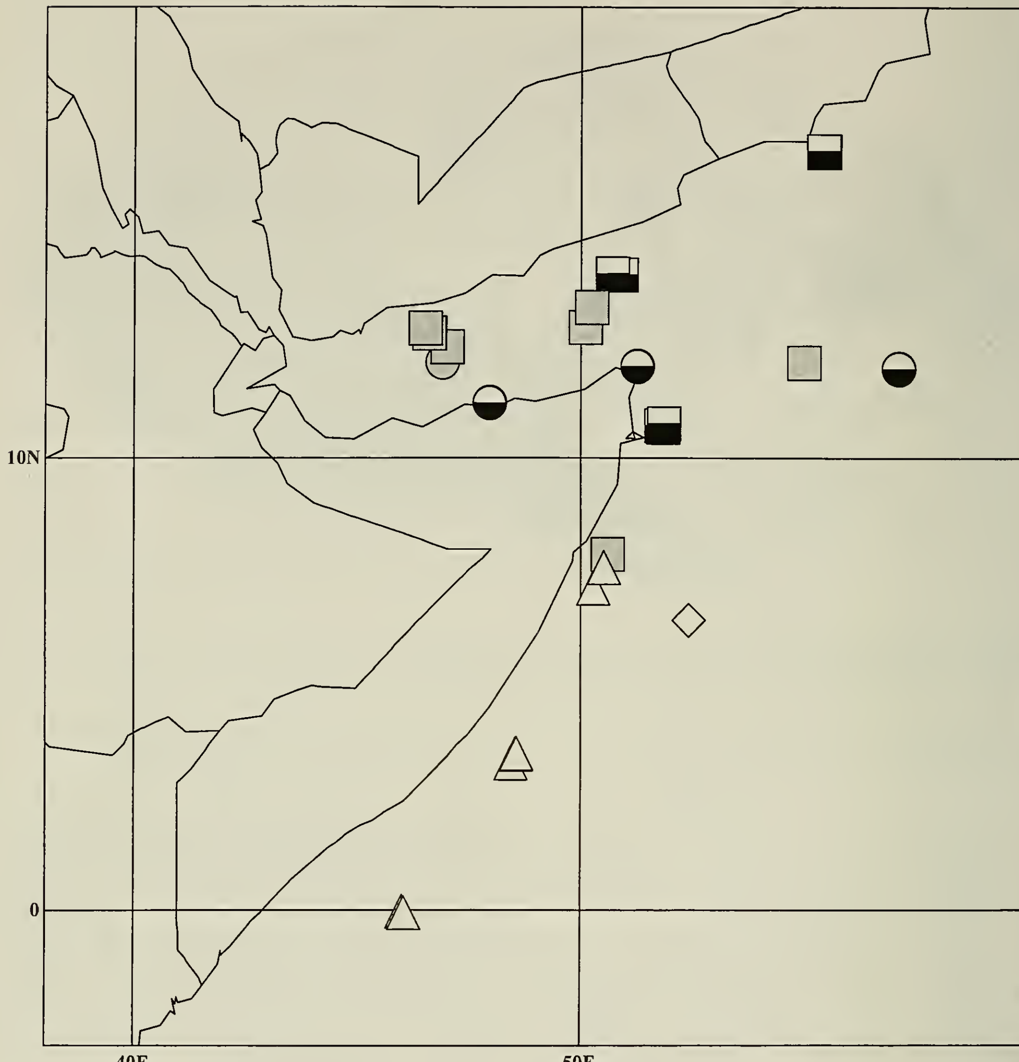

Fig. 4. Map of northwestern Indian Ocean, off east Africa, showing collection stations of *Polyipnus limatulus*. *Polyipnus limatulus:* half-filled circle = R/V *Beinta* stations, half-filled square = R/V *Malcolm Baldridge* stations, shaded circle = R/V *Tyro* cruise B1 stations (summer), shaded square = R/V *Tyro* cruise B2 stations (winter). *Polyipnus omphus:* open triangle = R/V *Tyro* cruise B1 stations (summer), open diamond = R/V *Tyro* cruise B2 stations (winter).

mm), 11°57′30″N, 51°07′30″E, (0-)366 m, R/V *Beinta*, Cr. 20, Sta. 11, 11 Mar 1987. USNM 345149, (56; 14, 32.6–39.9 mm; 2 cleared and stained, 31.8–38.0 mm), collected with holotype. ZMA 121.797, (3, 26.7–31.6 mm), 12°07′00″N, 46°54′00″E, 202–300 m, *Tyro*, Cr. B1, Seq. 582, Sta. GA2, 2304–2353 h, 5 Aug 1992. ZMA 121.798, (2, 25.6–25.7 mm), 12°46′00″N, 46°36′36″E, 200–300 m, *Tyro*, Cr. B2, Seq. 1129, Sta. GA2, 2134–2244 h, 29 Jan 1993.

Non-type larval material: MCZ 150020, (4), 16°46′24″N, 55°27′00″E, 0–1000 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-48 (1), 7 Aug 1995. MCZ 150021, (1), 16°46′24″N, 55°27′00″E, 500–300 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10–48 (3), 7 Aug 1995. MCZ 150022, (2),

Table 1.—Morphometric characters expressed as percentages of head length (2 to 6) or standard length (all others) for *Polyipnus limatulus* holotype (USNM 316316) and 26 paratypes: MCZ 150026(1), 150036(1), USNM 293986(3), 301277(2), 345149(14), ZMA 121.797 (3), and 121.798 (2).

		Paratypes		
	Holotype	Min.	Max.	Mean
1. Standard length	39	25.6	45.7	35
2. Posttemporal spine length	25.7	25.7	35.3	30.5
3. Preopercular spine length	13.9	10.1	19.2	15.0
4. Head length	36.9	33.7	38.9	35.6
5. Orbit diameter	45.8	41.1	53.2	46.1
6. Snout length	18.8	17.4	25	21.0
7. Body depth	61.3	58.5	69.5	63.3
8. Caudal peduncle length	18.7	14.5	18.8	16.5
9. Caudal peduncle depth	10.8	9.6	12.1	10.8
10. Dorsal fin length	17.9	17.6	21.9	19.5
11. Anal fin length	21.3	20.9	24.8	22.9
12. Preanal length	70.8	67.1	72.6	70.4
13. Predorsal length	59.7	58.2	64.4	60.9
14. Prepelvic length	65.6	60.6	69.1	65.1
15. Postdorsal length	47.7	44	51.9	47.4
16. Postanal length	40	36.1	42.7	39.4
17. Dorsal-pelvic length	52.8	51.6	57.3	54.9
18. ACC length (left)	6.4	5.8	9.2	6.7
19. ACC length (right)	0	5.8	7	6.4
20. ACB-ACC length (left)	5.6	2.4	5.6	3.8
21. ACB-ACC length (right)	4.6	3.5	4.6	4.1

16°46′24″N, 55°27′00″E, 300–150 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-48 (4), 7 Aug 1995. MCZ 150023, (6), 16°47′24″N, 55°27′00″E, 0–100 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-49 (1), 7 Aug 1995. MCZ 150024, (1), 16°47′00″N, 55°27′06″E, 500–300 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-49 (3), 7 Aug 1995. MCZ 150025, (1), 16°47′00″N, 55°27′06″E, 150–0 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-49 (5), 7 Aug 1995. MCZ 150027, (2), 14°03′24″N, 50°54′12″E, 300–150 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-51 (4), 9 Aug 1995. MCZ 150028, (10), 10°40′48″N, 51°51′24″E, 0–900 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-52 (1), 11 Aug 1995. MCZ 150030, (6), 10°40′48″N, 51°51′24″E, 300–150 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-52 (4), 11 Aug 1995. MCZ 150031, (2), 10°42′18″N, 51°49′06″E, 0–900 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-53 (1), 11 Aug 1995. MCZ 150032, (16), 10°42′18″N, 51°49′06″E, 300–150 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-53 (4), 11 Aug 1995. MCZ 150033, (1), 10°45′18″N, 51°52′54″E, 300–150 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-54 (4), 12 Aug 1995. MCZ 150035, (1), 10°45′00″N, 51°52′18″E, 300–150 m, R/V *Malcolm Baldridge*, Cr. 9506, Sta. 10-55 (4), 13 Aug 1995. MCZ 153593, (6), collected with MCZ 150036 (paratype). ZMA 121.799, (1), 07°53′N, 50°37′E, 200–300 m, *Tyro*, Cr. B2, Sta. US1, 2253–2343 h,

Table 2.—Frequency distribution of the number of ACB photophores in species of *Polyipnus* with two posttemporal spines.

	ACB photophores					
Species	6	7	8	9	10	11
Polyipnus asper			21	8		
Polyipnus indicus		1	14	4		
Polyipnus limatulus			2	14	9	1
Polyipnus nuttingi		1	22	6		
Polyipnus oluolus	1					

18 Jan 1993. ZMA 121.800, (1), 10°57′N, 52°01′E, 200–300 m, *Tyro*, Cr. B2, Sta. US2, 2121–2204 h, 20 Jan 1993. ZMA 121.801, (2), 12°06′N, 55°01′E, 300–500 m, *Tyro*, Cr. B2, Sta. SI, 1158–1251 h, 24 Jan 1993. ZMA 121.802, (1), 12°53′N, 50°07′E, 100–300 m, *Tyro*, Cr. B2, Sta. GA1, 0930–1018 h, 27 Jan 1993. ZMA 121.803, (7), 13°20′N, 50°15′E, 200–300 m, *Tyro*, Cr. B2, Sta. GA1, 2313–0005 h, 27 Jan 1993. ZMA 121.804, (12), 12°27′N, 47°00′E, 100–300 m, *Tyro*, Cr. B2, Sta. GA2, 0844–0947 h, 29 Jan 1993. ZMA 121.805, (29), collected with ZMA 121.798 (paratypes). ZMA 121.806, (8), 12°52′N, 46°31′E, 300–500 m, *Tyro*, Cr. B2, Sta. GA2, 2331–0030 h, 29 Jan 1993.

Diagnosis.—Characters, in combination, which serve to distinguish *Polyipnus limatulus*: Lateral pigment bar tapered and long, approaching or reaching lateral midline. Two posttemporal spines: dorsal spine long, basal spine length less than half of that of dorsal spine. Photophore scale denticles restricted to PV, VAV, and ACC clusters; no denticles on ACB photophore scales. ACB photophores 8–10. ACC photophores closely juxtaposed, with the separating interspaces much less than one half of the width of one ACC photophore. Longitudinal parietal keel or crest terminating posteriorly with a disjunct portion bearing two spines, one directed anteriorly and one directed posteriorly. Autapomorphies: none known.

Description.—Moderate-sized species, maximum observed adult body size 45.7 mm SL. D (12) 10–14. A(14)14–17. P(12)11–13. V(6)5–6. GR(11+11) 10+9–11+11 = (22) 19–22. Branchiostegal rays 10 (7 anterior ceratohyal + 3 posterior ceratohyal). Vertebrae (12+21) 12–14+19–21 = (33)32–34. Body covered with slightly imbricated, sheet-like, dorsally elongate scales. Other scales thickened and modified in association with photophores (see Harold 1994). Body profile anterior of dorsal fin and pelvic fin broadly ovate, posteriorly tapering at a 60° angle to caudal peduncle. Profile of caudal peduncle slightly elongate, and rectangular.

Orbit circular to slightly ovate with elongation in dorsoventral axis; pronounced aphakic space located ventrally to lens. Ventral margin of dentary with two keels; lateral-most keel smooth or sparsely serrate, ventromedial keel with 9–15 fine serrae. Premaxillary teeth minute and conical, uniserial over posterior half of bone and with up to three rows anteriorly; about 55 to 60 teeth in longest series. Maxillary teeth minute and conical, uniserial with 45 to 48 teeth. Dentary teeth minute; conical and uniserial over posterior half of bone, and slightly recurved in up to four rows anteriorly; 27 to 33 teeth in longest series. Palatine and mesopterygoid teeth absent. Vomerine teeth minute and conical, in five to seven longitudinal rows arranged in a transverse patch across the anterior wing-like process; no teeth present on posteromedian process. Parietal crest discontinuous; anterior portion keel-like, posterior region with two conical spines in the medial plane, directed anteriorly and posteriorly. Posttemporal dorsal limbs smooth or ornamented with two or three weak serrae. Two posttemporal spines: dorsal spine without serrae, elongate, ranging from 25.7 to 35.3% HL (n = 10), posterodorsally directed; ventral spine short, also unornamented (usually about one quarter of the length of the dorsal spine), ventrolaterally directed. Ventral margin of pectoral shield with five to 12 small conical spines, anterior spine slightly deflected laterally. Vertical and anteroventral rami of preopercle each with two parallel, deeply serrate lateral ridges, the numbers of serrae highly variable. Preopercle with two spines: ventral spine longest, ranging from 10.1 to 19.2% HL (n = 10), anteriorly curved, directed anteroventrally; dorsal spine minute, similar to adjacent serrae of adjacent lateral ridge, directed ventrolaterally. Dorsal spinous process smooth, exposed length and height about equal, terminating posterodorsally as two conical dorsolaterally-directed spines (one per side). Anal-fin pterygiophore spines absent. Morphometric characters summarized in Table 1.

Ventral margins of photophore scales smooth, except those of PV, VAV, and ACC clusters which have numerous denticles. OVB 1 + 1 + 1, variably positioned, but most commonly found in an anteriorly-inclined straight line (in holotype elevation of central OVB slightly ventral to that of first and third OVB). ACA #1 and #2 isolated, #3 joined to ACB forming continuous cluster. ACB (9)8–11, usually 9 or 10 (Table 2), with dorsal step between #3 and #4.

Color in preservative.—Dark brown pigment saddle with an elongate and narrow predorsal notch and a moderately long lateral pigment bar tapering toward and usually reaching lateral midline. Dark brown to black chromatophores delineating myosepta and lateral midline. Two prominent, vertically elongate patches of dark brown pigment at base of caudal fin rays immediately dorsal and ventral to lateral midline, especially distinct in juveniles and larvae. Central portion of caudal peduncle with internal rectangular patch of dark brown pigment in association with vertical septum.

Larval morphology.—Overall larval morphology similar to that described and illustrated by Ahlstrom et al. (1984) for *Polyipnus polli* Schultz, 1961; smallest specimen of *P. limatulus* examined (6.5 mm SL; Fig. 2) is slightly deeper bodied in the thoracic and abdominal regions than the illustration of the 5.2 mm specimen of *P. polli*, in addition to much greater development of the median fin rays and some photophore groups. Evidently, photophore development is relatively protracted in *P. polli*. For example in *P. polli* the first photophores to appear in the SAB (=OVB) cluster do so at a standard length of between 9.0 and 9.6 mm whereas in *P. limatulus* they are beginning to develop at 7.6 mm. Similarly in *P. polli* the AN (=ACB) photophores begin to appear between 7.5 and 9.0 mm SL whereas in *P. limatulus* there are two well-developed ACB photophores present on each side in 6.5 and 6.8 mm specimens. In *P. limatulus*, the combined linear cluster ACA + ACB reaches its full adult complement (11–14) at standard lengths between about 25 and 30 mm (Fig. 3). According to the occurrence of small photophore buds on the posterior margin of the ACB cluster *Polyipnus polli* adds photophores to this cluster at a standard length of 23.5 mm so the two species may be similar in the size at which the full complement is attained. These observations are in general agreement with other congeners for which photophore development has been reported, except for *P. fraseri* (*P. spinosus* species group) which has paedomorphic development of the ACB cluster (Harold 1990b).

The adults of *P. limatulus* have two vertically elongate patches of dark pigment near the base of the caudal fin rays, as described and illustrated (Fig. 1). In well-developed larvae and juveniles (9.5 + mm SL) these patches appear as two distinct black spots, one at the base of the ventral caudal-fin rays and one at the base of the dorsal caudal-fin rays, on each side of the fin base. Smaller larvae (6.5–7.6 mm SL) lack the caudal spots (Fig. 2) and any other pigmentation in the caudal region.

Etymology.—The specific name *limatulus* is based on the diminutive form of the Latin adjective *limatus*, meaning filed, polished or smoothed, in reference to the characteristic lack of denticles on the scales covering the ACB photophores.

Distribution.—*Polyipnus limatulus* is known to occur only in the Gulf of Aden and immediately adjacent areas in the northwestern Indian Ocean (Fig. 4).

Ecology.—Deep-bodied sternoptychids (Sternoptychini, sensu Baird 1986) were represented in the Somali Ecosystem Study (SES) region collections of R/V *Tyro* (1992, 1993) by 809 specimens allocated among six species: *Argyropelecus affinis* (n = 336), *A. hemigymnus* (n = 41), *A. sladeni* (n = 312), *Polyipnus limatulus* (n = 66), *P. omphus.* (n = 21), and *Sternoptyx obscura* (n = 33). *Polyipnus limatulus* was

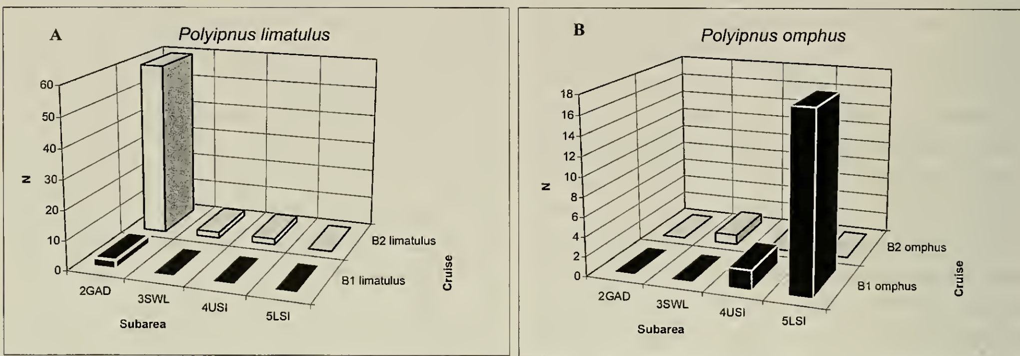

Fig. 5. Seasonal and spatial distribution of captures (n = number of specimens) of two species of *Polyipnus*, *P. limatulus* and *P. omphus*. Seasonal distribution indicated by B1 (summer) captures and B2 (winter) captures. Spatial distribution indicated by subarea (2GAD = Gulf of Aden, 3SWL = Great Swirl, 4USI = Upper Somali Inshore, 5LSI = Lower Somali Inshore; definition of subareas provided in Materials and Methods).

taken at five stations (Fig. 4: GA2, GA1 (subregion GAD); SI (subregion SWL); US2, US1 (subregion USI)) and in three SES subregions: GAD (n = 62), SWL (n = 2), USI (n = 1). Despite a nearly even distribution of effort among stations by season, geography and depth, *P. limatulus* was unequally represented in the winter (n = 62) vs. summer (n = 3) cruises. *Polyipnus omphus* was taken at four stations (Fig. 4: SB2, subregion SWL; US1, subregion USI; US0, SB1, subregion LSI) and in three SES subregions: SWL (n = 1), USI (n = 2) and LSI (n = 18). *Polyipnus omphus* was similarly unequally represented in summer (n = 20) vs. winter (n = 1) cruise stations.

A comparison of geographic (Figs. 4, 5) and seasonal (Fig. 5) captures of the two *Polyipnus* species reveals that within the SES area their occurrences are nearly opposite, with highest captures of *P. limatulus* in the north and in winter (especially GAD subregion), and highest captures of *P. omphus* in the south and in summer (especially LSI subregion).

Vertical distributional records are nearly the same in our material, with most specimens taken at night (51:15 for *P. limatulus*, 17:4 for *P. omphus*) and mostly within the 200 to 300 m depth stratum (68% of all specimens of *P. limatulus*, 71% of all specimens of *P. omphus*). All captures, day and night, are within the 100 to 500 m range. There is no evidence for diel vertical migration in our data. This conclusion is corroborated by the consistency (Fig. 6A, B) for day vs. night values for weighted-integral values of temperature, salinity and dissolved oxygen (see Wessel & Johnson 1998 and Wessel 1997 for treatment of "weight-integral" values for hydrographic data associated with SES net captures of mesopelagic fishes).

With comparison to each other and in comparison with other reported SES sternoptychids (Fig. 6A, B), *P. limatulus* and *P. omphus* are again distributional opposites. *P. limatulus* is consistently associated with warm, relatively saline, low oxygen water; *P. omphus* is associated with colder, less saline, higher oxygen water. This probably reflects the influence of Red Sea outflow water on *P. limatulus* vs. the summer intrusive occurrence of *P. omphus* in the SES area, associated with the summertime development of marked coastal and offshore upwelling in concert with development of the monsoonal Somali Current flow.

Remarks.—The parietal structure of specimens here ascribed to *P. limatulus* was noted by Harold (1994:511) as an indication that material listed in that study as *P.* cf. *indicus* from the Gulf of Aden, the

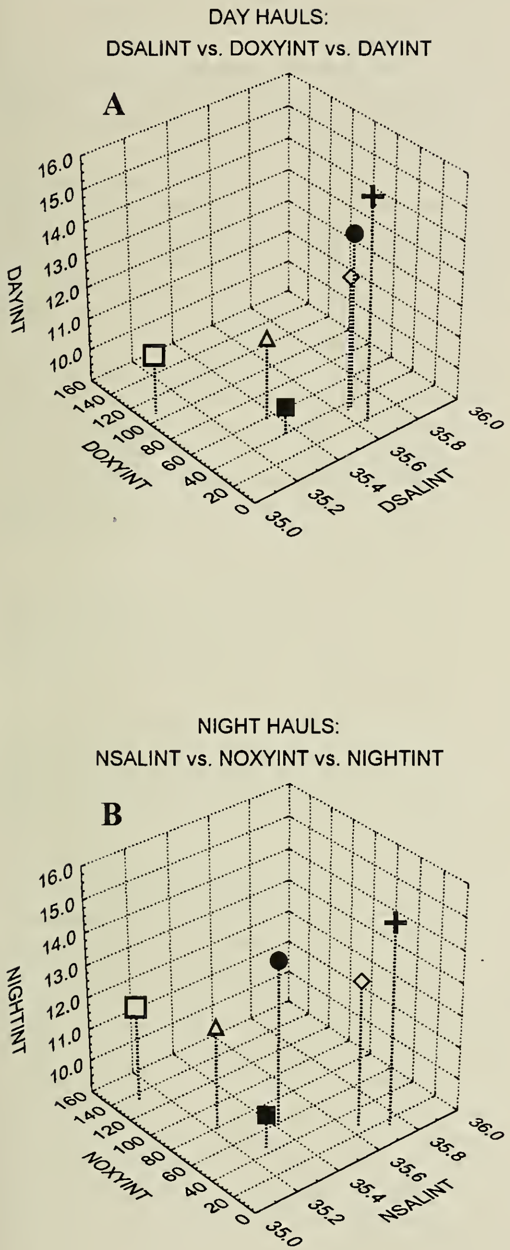

Fig. 6. Comparison of weighted integral-mean values of temperature, salinity, and dissolved oxygen for day (respectively: DAYINT, DSALINT, DOXYINT) and night (respectively: NIGHTINT, NSALINT, NOXYINT) captures of six species of sternoptychids in the Somali Current Ecosystem Area (see Materials and Methods for explanation of weighted integral-mean values). Open diamond = *Argyropelecus affinis*, open triangle = *A. hemigymnus*, filled circle = *A. sladeni*, cross = *Polyipnus limatulus*, open square = *P. omphus.*, filled square = *Sternoptyx obscura*.

northern portion of the geographic range of *P. indicus* Schultz, 1961, may represent an undescribed species. Further study of material available at that time, as well as new collections from the region (R/V *Malcolm Baldridge* and R/V *Tyro*), has indicated to us that the northern, *P.* cf. *indicus* material, should be recognized as a distinct species.

Five species of the *P. spinosus* species group have posttemporal bones with two spines: *P. limatulus*, *P. asper* Harold, 1994 (Andaman Sea, eastern Indian Ocean), *P. indicus* (western Indian Ocean), *P. nuttingi* Gilbert, 1905 (Hawaiian Islands), and *P. oluolus* Baird, 1971 (Marshall Islands). *Polyipnus limatulus* is most similar to the two other Indian Ocean species, *P. indicus* and *P. asper* (couplet 15 of Key to the Species of *Polyipnus*, in Harold 1994:470–475) in regard to body shape, and fin-ray counts. The new species is more similar to *P. asper* in regard to the presence of denticles on the ACB photophore scales. *Polyipnus limatulus* and *P. indicus*, which are both known to occur off east Africa, can be readily distinguished on the basis of the form of the parietal crest. The new species has the bispinate parietal morphology as is typical of *P. asper* and more derived species (see Harold 1994:436, fig. 6D), whereas in *P. indicus*, like *P. nuttingi*, and *P. oluolus*, the parietal crest is a simple blade lacking the posterior ornamentation (Harold 1994:436, fig. 6C). An important feature separating *P. limatulus* from *P. asper* is the lack of denticles on the ACB photophore scales in *P. limatulus*. The new species often has more ACB photophores than any of these four other species (Table 2). The other two species with two posttemporal spines, *P. nuttingi*, and *P. oluolus*, are also readily distinguished from *P. limatulus*. *Polyipnus nuttingi*, an apparent endemic of the Hawaiian Islands, has relatively high gill raker counts (21–25, usually 23 or 24) compared with *P. limatulus* (18–21, usually 19). The remaining species, *P. oluolus* (known from a single specimen from the Marshall Islands; Baird 1971), has an overall photophore configuration, which includes only six ACB, that is unusual for members of the *P. spinosus* group (Harold 1994:515–517, fig. 52).

Phylogenetic relationships of *Polyipnus* species were proposed by Harold (1994). All those species of the *P. spinosus* group with only two posttemporal spines, of which *P. limatulus* is one, appear to be basal, although not comprising a monophyletic group. Little else can be said of the relationships of the new species until a survey of the characters utilized by Harold (1994) is completed for *P. limatulus* and *P. latirastrus.*

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Literature Cited

Ahlstrom, E. H., W. J. Richards, & S. H. Weitzman. 1984. Families Gonostomatidae, Sternoptychidae, and associated stomiiform groups: development and relationships. Pp. 184–198 *in* H. G. Moser, W. J. Richards, D. M. Cohen, M. P. Fahay, A. W. Kendall, Jr., & S. L. Richardson, eds., Ontogeny and systematics of fishes.—American Society of Ichthyologists and Herpetologists, Special Publication Number 1:1–760.

Aizawa, M. 1990. A new species of the genus *Polyipnus* (Stomiiformes, Sternoptychidae) from Suruga Bay, Japan.—Japanese Journal of Ichthyology 37(2):95–97.

Baird, R. C. 1971. The systematics, distribution, and zoogeography of the marine hatchetfishes (Family Sternoptychidae).—Bulletin of the Museum of Comparative Zoology, Harvard University 142(1):1–128.

———. 1986. Tribe Sternoptychini. Pp. 255–259 *in* M. M. Smith and P. C. Heemstra, eds., Smith's sea fishes. MacMillan South Africa, Johannesburg, 1047 pp.

Borodulina, O. D. 1979. Composition of the "*Polyipnus spinosus* complex" (Sternoptychidae, Osteichthyes) with a description of 3 new species of the group.—Voprosy Ikhtiologii 19:198–208.

Gilbert, C. H. 1905. The deep-sea fishes of the Hawaiian Islands.—United States Fish Commission, Bulletin 23:575–713.

Harold, A. S. 1989. A new species of *Polyipnus* (Stomiiformes: Sternoptychidae) from the Coral Sea, with a revised key to the *Polyipnus spinosus* complex.—Copeia 1989:871–876.

———. 1990a. *Polyipnus danae* n. sp. (Stomiiformes: Sternoptychidae): a new hatchetfish species from the South China Sea.—Canadian Journal of Zoology 68:1112–1114.

———. 1990b. Redescription of *Polyipnus fraseri* Fowler, 1934 (Stomiiformes: Sternoptychidae), with remarks on paedomorphosis.—Proceedings of the Biological Society of Washington 103:509–515.

———. 1994. A taxonomic revision of the sternoptychid genus *Polyipnus* (Teleostei: Stomiiformes), with an analysis of phylogenetic relationships.—Bulletin of Marine Science 54:428–534.

———. 1998. Areas of endemism and historical inference in biogeography. Pp. 148–155 *in* A. C. Pierrot-Bults, S. van der Spoel, B. J. Zahuranec, & R. K. Johnson, eds., Pelagic biogeography. UNESCO, Intergovernmental Oceanographic Commission, Workshop Report No. 142.

———, & S. H. Weitzman. 1996. Interrelationships of stomiiform fishes. Pp. 333–353 *in* M. L. J. Stiassny, L. R. Parenti, & G. D. Johnson, eds., The interrelationships of fishes. Academic Press, London, 496 pp.

Last, P., & A. S. Harold. 1994. *Polyipnus latirastrus*, a new and unusual hatchetfish (Teleostei: Sternoptychidae) from the western Pacific.—Copeia 1994:210–215.

Leviton, A. E., R. H. Gibbs, Jr., H. Heal, & C. E. Dawson. 1985. Standards in ichthyology and herpetology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology.—Copeia 1985:802–832.

Potthoff, T. 1984. Clearing and staining techniques. Pp. 35–37 *in* H. G. Moser, W. J. Richards, D. M. Cohen, M. P. Fahay, A. W. Kendall, Jr., & S. L. Richardson, eds., Ontogeny and systematics of fishes.—American Society of Ichthyologists and Herpetologists, Special Publication Number 1:1–760.

Schultz, L. P. 1938. Review of the fishes of the genera *Polyipnus* and *Argyropelecus* (Family Sternoptychidae), with descriptions of three new species.—Proceedings of the United States National Museum 86:135–155.

———. 1961. Revision of the marine silver hatchetfishes (Family Sternoptychidae).—Proceedings of the United States National Museum 112:587–649.

———. 1964. Family Sternoptychidae. Pp. 241–273 in H. B. Bigelow, C. M. Breder, D. M. Cohen, G. W. Mead, D. Merriman, Y. H. Olsen, W. C. Schroeder, L. P. Schultz, & J. Tee-Van, eds., Fishes of the western North Atlantic, Part 4, Isospondyli.—Sears Foundation for Marine Research, Memoir Number 1, 599 pp.

Taylor, W. R., & G. C. Van Dyke. 1985. Revised procedures for staining and clearing small fishes and other vertebrates for bone and cartilage study.—Cybium 9:107–119.

Weitzman, S. H. 1974. Osteology and evolutionary relationships of the Sternoptychidae, with a new classification of stomiatoid families.—Bulletin of the American Museum of Natural History 53: 327–478.

Wessel, J. H., III. 1997. The Myctophidae of the Somali Current. Unpublished MSc. thesis, University of Charleston, South Carolina, two volumes, 374 and 250 pp.

———, & R. K. Johnson. 1998. The Sternoptychidae of the Somali Current region of the western Indian Ocean: an introduction to Somali Current mesopelagic fish studies. Pp. 372–379 *in* A. C. Pierrot-Bults, S. van der Spoel, B. J. Zahuranec, & R. K. Johnson, eds., Pelagic biogeography. UNESCO, Intergovernmental Oceanographic Commission, Workshop Report No. 142.